Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

FREEDOM OF INFORMATION ACT PROGRAM

July 12, 2023

In reply refer to: FOIA #BPA-2021-00513-F

SENT VIA EMAIL ONLY TO: amissel@advocateswest.org

Andrew Missel
Advocates for the West
3701 SE Milwaukie Avenue, Suite B
Portland OR 97202

Dear Mr. Missel,

This communication is in regards to your request to the Bonneville Power Administration (BPA) for agency records made under the Freedom of Information Act, 5 U.S.C. § 552 (FOIA) with the assigned tracking number BPA-2021-00513-F.

Release of Previously Withheld Information
As communicated to you on July 10th, 2023, BPA has agreed to withdraw the Exemption 5 redactions previously made to records released in response to BPA-2021-00513-F. Those records are attached.

Questions about this communication may be directed to James King, FOIA Public Liaison, at jjking@bpa.gov or 503-230-7621 or E. Thanh Knudson, Case Coordinator (ACS Staffing Group), at 503-230-5221 or etknudson@bpa.gov.

Sincerely,

Candice D. Palen
Freedom of Information/Privacy Act Officer

Enclosures: Agency records responsive to FOIA request BPA-2021-00513-F accompany this communication.

From: Erin Rechisky

Sent: Wed Apr 01 13:09:47 2015

To: Creason,Anne M (BPA) - KEWL-4

Subject: RE: Spatial and temporal covariability in early ocean survival of Chinook salmon (Oncorhynchus tshawytscha) along the west coast of North America

Importance: Normal

Hi Anne,

Thanks for this. I saw a talk at the SOE meeting a few years ago that incorporated some of this work and I contacted Patrick for Figure 4 so I could show the decline in survival was happening coast-wide, not just the Columbia.

Yes, it's likely that ocean conditions up to and including AK are just as important for survival as the very early marine period for yearling Chinook. Because this study used CWT returns, the assumption is that any variability seen in the survival estimates happened within the first year. So exactly when and where mortality is highest and most variable is still unknown.

Erin

From: Creason,Anne M (BPA) - KEWL-4 [mailto:amcreason@bpa.gov]
Sent: Tuesday, March 31, 2015 3:54 PM
To: Erin Rechisky

Subject: FW: Spatial and temporal covariability in early ocean survival of Chinook salmon (Oncorhynchus tshawytscha) along the west coast of North America

Very interesting. Curious to hear what your take is on this one.

They are looking at hatchery returns from California to Alaska. It appears the subyearlings and coastal hatcheries seem to be more influenced by ocean conditions in the first month after they hit salt water. However, the yearling Chinook from the Columbia seem to be correlated with the patterns of Alaskan groups. This suggests that the ocean conditions right when they hit the ocean aren't as important as what happens later– maybe the yearlings are able to swim to Alaska without spending a lot of time feeding off the local coast?

From: David Welch

Sent: Wed Aug 26 11:57:23 2015

To: Jason Sweet; Shields, Barbara A (bashields123@gmail.com); Josh Murauskas; John R. Skalski; Jim Anderson (jim@cbr.washington.edu)

Cc: Erin Rechisky; Aswea Porter; Sonia Batten

Subject: North Pacific blob & fisheries management...

Importance: Normal

Attachments: North Pacific 'blob' stirs up fisheries management _ Nature News & Comment.pdf

This just came out in this week's issue of Nature, commenting on the potential impact of the N Pacific "blob" on fisheries management—I thought you would find it interesting reading.

The point I would raise to everyone I am sending this to, is that at the AFS meeting there were also reports of massive negative freshwater impacts on survival of returning adult salmon (96.5% in-river losses of upper Columbia River sockeye were reported from Bonneville Dam to the Canadian border for example, and major losses are also expected for Snake River adult sockeye). So this year seems to be a pretty good example of what the world will be like ***every year*** once temperate zone climate warms up in the next few decades.

In this sort of scenario where both freshwater and marine survival is changing, identifying the "right" policy choice will in my view then require balancing how much time animals such as salmon spend in freshwater VS the marine phase (since the length of the life cycle is fixed) and potentially reserving freshwater for use later in summer vs using it to expedite smolt migration to the ocean via enhanced spill. Correctly answering the question of how best to maximize salmon conservation then requires using a whole life-cycle model, because reducing time in freshwater increases time in the ocean.

In short, 2015 looks like a rehearsal for what the 20130s will look like, and the apparent results look absolutely dismal—I don't think there is any way for us to "manage" this scenario.

Regards, David

David

kintamav_RGB

Office: (250) 729-2600 (x) 223

Mobile: (b) (6) [redacted]

From: Zelinsky,Benjamin D (BPA) - EWP-4

Sent: Tue Mar 01 15:38:27 2016

To: David Welch

Cc: Mendoza Flores,Luisa F (BPA) - EWB-4; Welch,Dorothy W (BPA) - EWM-4; Petersen,Christine H (BPA) - EWP-4; Barco III,John W (BPA) - EWP-4; Sweet,Jason C (BPA) - PGB-5

Subject: RE: (Very) High Level Proposal Outline…

Importance: Normal

David,

We would like to find some time to meet with you to discuss these options in more depth. Even though it is a long trip, we think it would be useful to have you come down and meet with us in person. It would be a good chance for you to meet my boss, John Barco and have another round of discussion with Lorri Bodi and other key BPA managers.

Our initial internal conversation highlighted option 2 (below) as being of particular interest with the Fraser comparison being a higher priority than the Sacramento work. We also have an interest in option 1 – there appears to be some overlap between options 1 and 2. In preparation for the meeting, let's make sure BPA understands the differences between those two options.

Option 3 also appears to have some overlap as well. For example, is there a way to incorporate 3c into option 2?

Finally, if you could start thinking about schedule and costs related to these options, we will need that information before we can make a decision on how to proceed.

Give me a holler if you have any questions. I'll have Luisa (cc'd) above reach out to you and to schedule the meeting.

Thanks,

Ben

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, January 22, 2016 1:16 PM
To: Zelinsky,Benjamin D (BPA) - EWP-4
Subject: (Very) High Level Proposal Outline…

Ben- As discussed, some points outlining what we could contribute.

1) Collect & analyze the available data on SARS for west coast salmon stocks and compare to Columbia. (So

far, we have done this for the 2000s only, and for only two regions—Strait of Georgia & Puget Sound). The older data will show that in all regions south of Alaska, coast-wide SARS dropped by almost an order of magnitude since the 1960s-1970s while survival in Alaska has remained high. The data for the 2000s also shows that at least in the recent period the average SARs of BC Chinook are lower than Columbia River Chinook, and that Puget Sound steelhead have lower SARs than Columbia River steelhead—by about a factor of 3 (i.e., SARS are only 1/3rd of the Columbia's). If the Columbia's rebuilding targets of 4-6% SARS aren't being met anywhere else without dams, it raises question of whether they are realistic for the Columbia. It will also contribute perspective on what is really keeping salmon stocks from recovering.

2) Revisit & update our 2008 "Smolt Survival in Large Rivers" publication, which showed that survival rates were slightly lower in the Fraser than in the Columbia. As discussed, we can present a somewhat more nuanced approach now, and show that the newer data we have shows that in the Fraser the high losses appear to be due to predation and confined to the tributaries--the new data indicates that smolts then have very high survival in the Fraser mainstem. This will be an interesting new perspective we didn't have when we did the earlier report. We could potentially include data on Sacramento River smolt survival from California, and JSATS data in the Columbia as well as PIT tag data in the comparison, depending upon how much work is supported. We should consider asking John Skalski to come in as a co-author, because this would build more regional acceptance for the findings if he is involved.

3) Complete a publication addressing some conceptual problems in how people think about salmon management. (This could probably be published in Science and have a huge impact coast-wide because the issues are not confined to the Columbia; in my opinion this would be a big and important paper for the Columbia). Once survival is scaled for the time smolts take to reach Bonneville survival rates seem to be quite stable across years, so flow manipulation may not really work as claimed. The key point here is that much of the claimed survival benefit from getting smolts to Bonneville faster by increasing flows is in fact simply because the smolts are observed for a shorter time. As I have said before, the basic conceptual flaw here is that just measuring survival to Bonneville Dam without taking into account how long the smolts take to get there is like using a Geiger counter to count radioactive decay and concluding that because more fission is recorded in longer time intervals, radioactivity is worse. There are three potentially important points here:

(a) Annual survival values in the hydrosystem should be scaled by the time smolts take to reach Bonneville Dam (they generally aren't). Our preliminary analysis says that once we scale the FPC's survival data by travel time most of the claimed benefit of flow vanishes—It seems to be an artifact of not considering the travel time (but we need to look at this more rigorously to be completely certain of how true this conclusion applies).

(b) Smolts which arrive early at BON then end up spending more time in the coastal ocean because they get there faster. Our data says that survival rates in the ocean aren't much different than in the hydrosystem, so higher flow may not actually benefit the smolts, just put them someplace else.

(c) Josh Murauskas (Anchor QEA) did some work with me a while back that showed that SARS for the full range of PIT-tagged smolts are inconsistent with the specific populations that the FPC focus on. (Josh downloaded the entire PIT tag dataset). I can't recall exact numbers right now, but as I recall the full data set is much larger than the FPC dataset and also shows that survival rates per day are quite stable between years once corrected for travel time. In addition to Murauskas, we might also consider bringing in Skalski to garner more regional credibility.

4) An acoustic tagging study to establish what levels of Total Dissolved Gas goals negatively affect survival of free-ranging smolts in the Columbia River. We would experimentally determine what different levels of TDG exposure does to survival in the lower river and coastal ocean relative to unexposed controls. This could save a lot of money and improve salmon conservation by identifying TDG levels that actually reduce salmon survival. We have observational data from our 2011 Bonneville Dam tagging that smolts released at times of high TDG experienced substantially lower survival 4-5 days later when they reached the plume. These chronic (sub-lethal) effects due to potential crippling of the smolts making them vulnerable to predators would not be captured by past lab studies but are now feasible in the field. This study could be tied in with Jim Anderson's work looking at fish condition, because the fish enumerated for fish condition could be tagged in conjunction with the TDG study and used to establish their early marine survival. Skalski could again be brought in as a collaborator. (We have had some preliminary discussions with both Jim & John last autumn).

5) Early marine survival of bypassed vs spill fish. John Skalski advises that the bypassed fish seem to have lower survival based on SARs. We could measure this directly using acoustic tags and validate whether it is true by measuring survival to the coastal ocean rather than waiting for the adults to return.

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

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Browse animations of the results from our

fisheries telemetry work on-line: **http://kintama.com/media/videos/**

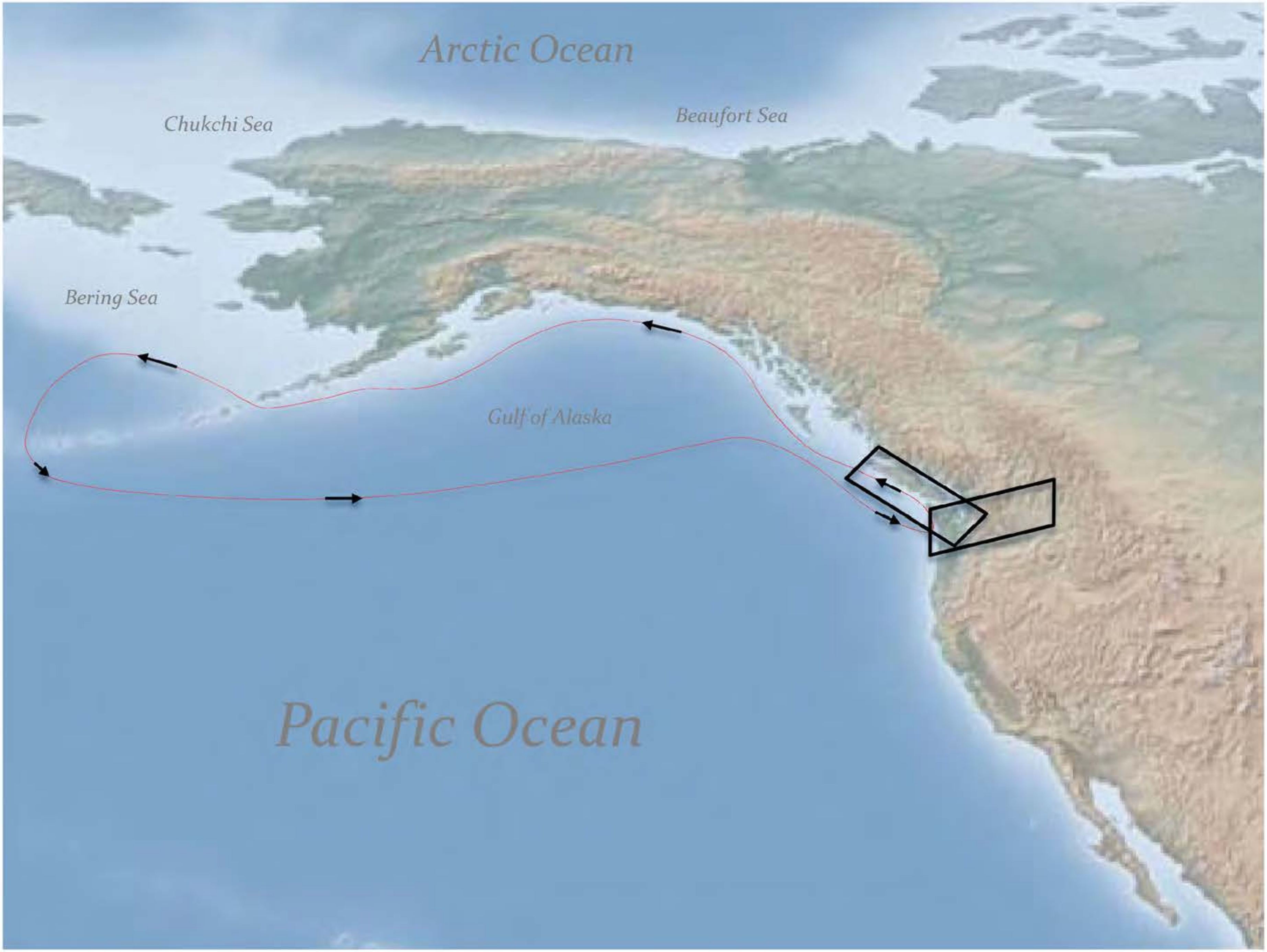
P Please consider the environment before printing this e-mail

Outline

1. Setting the Scene—The Environmental Forecast
2. SAR Comparison: Columbia vs Everywhere Else
3. Large River Comparison: Fraser vs Columbia Rivers
4. Managing Hydrosystem Survival
5. Budgets/Timeline

David Welch
david.welch@kintama.com
(250) 739-9044

KINTAMA

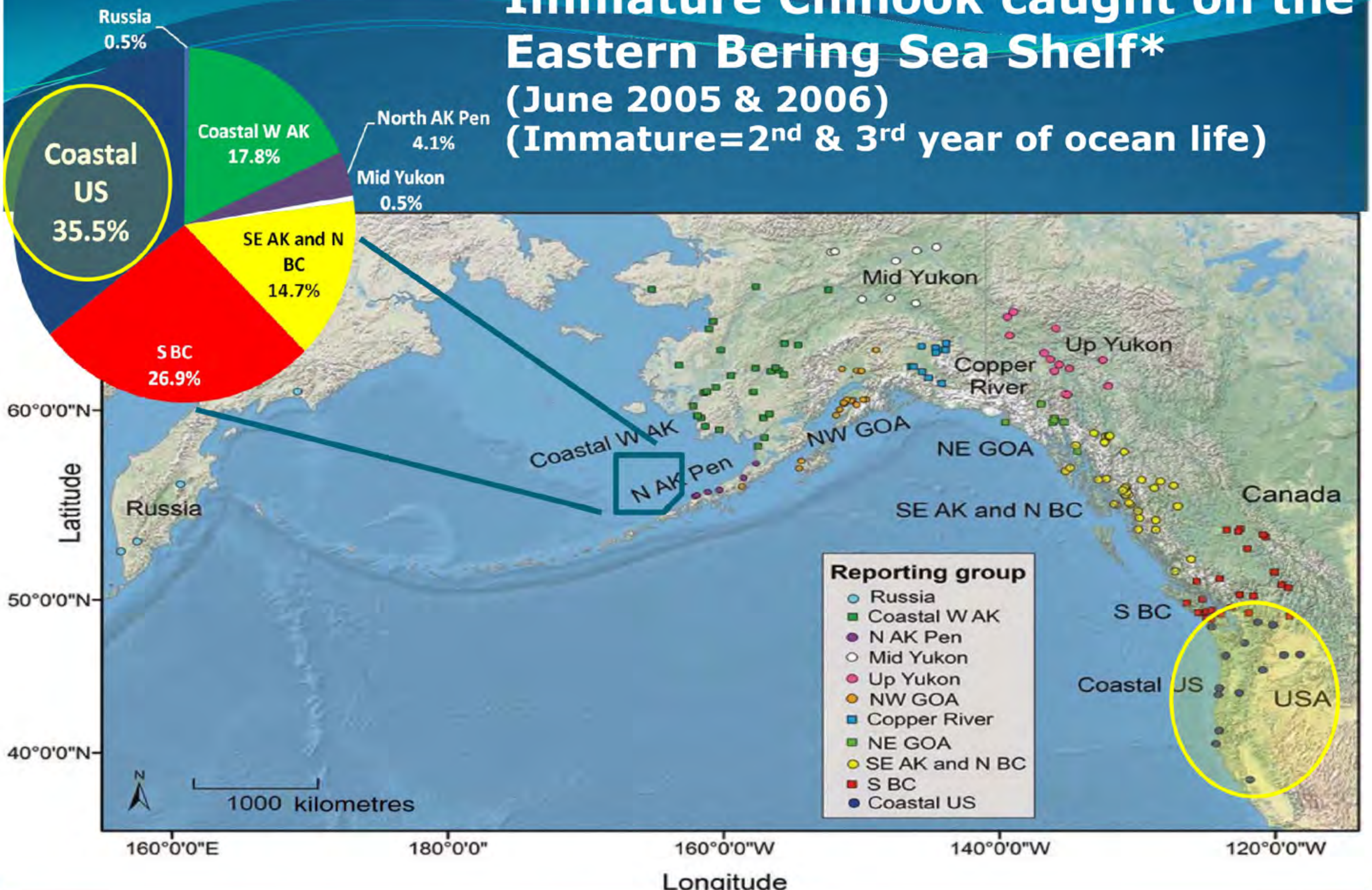


Arctic Ocean
Chukchi Sea
Beaufort Sea
Bering Sea
Gulf of Alaska
Pacific Ocean

Immature Chinook caught on the Eastern Bering Sea Shelf*

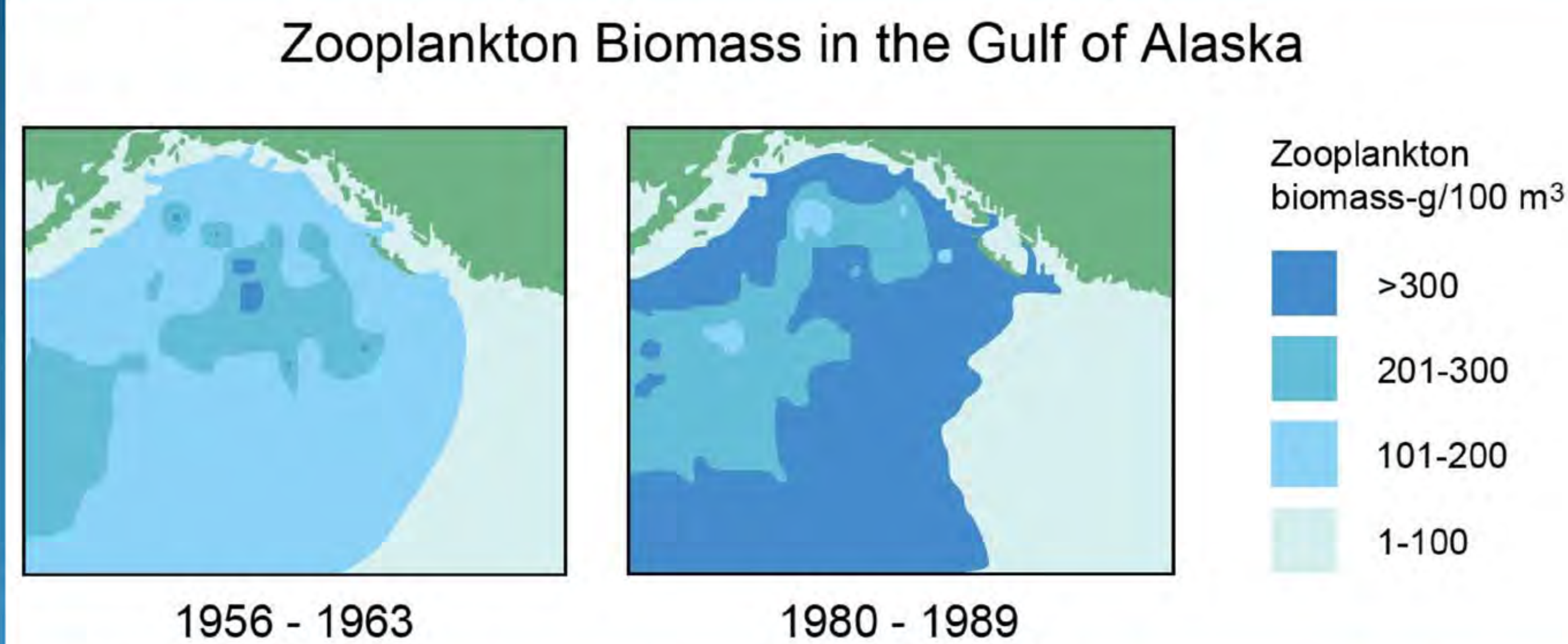
(June 2005 & 2006)

(Immature=2nd & 3rd year of ocean life)



* Larson et al. (2013). Can. J. Fish. Aquat. Sci. 70:1-14.

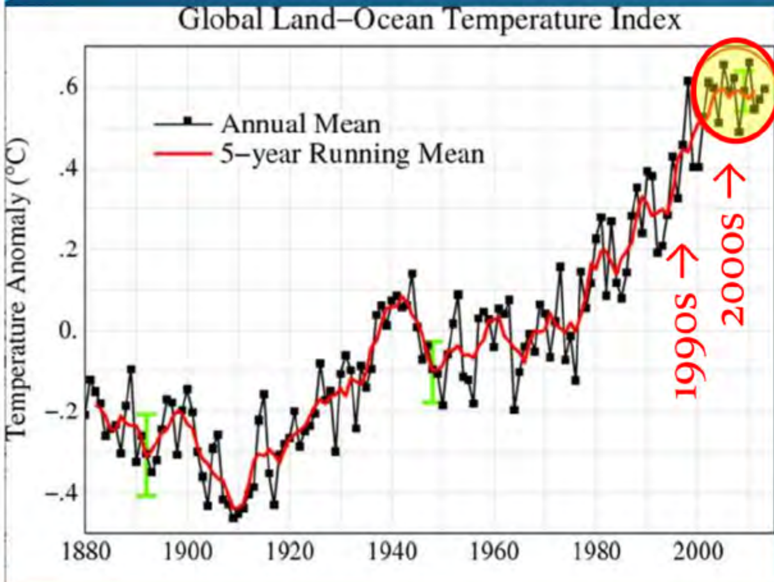
Big, Long-Term Changes Are Occurring in the Ocean

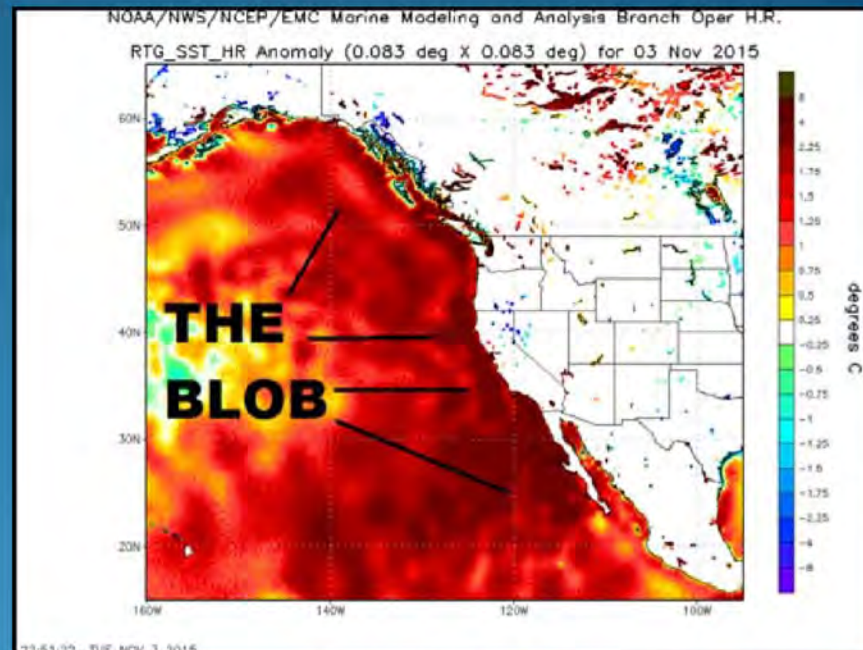


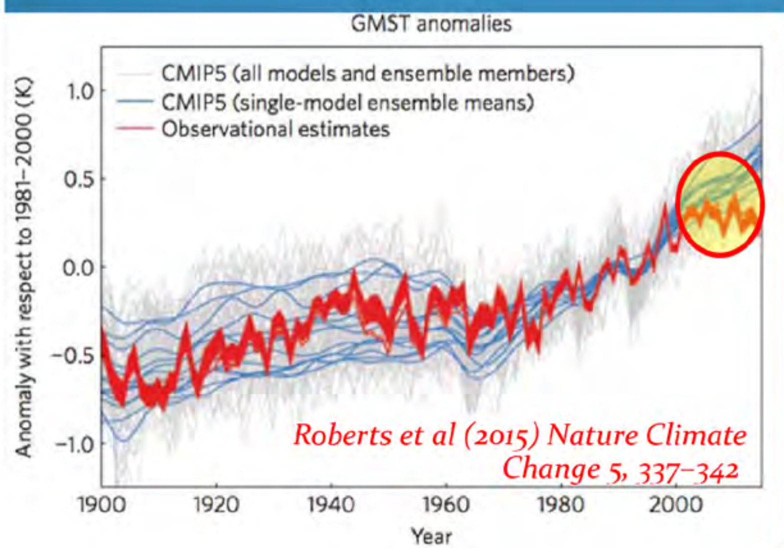
- Plankton far more abundant in the 80s than the 1950s & 60s
- 1980s corresponds to a period when salmon stocks from many (not all) regions increased

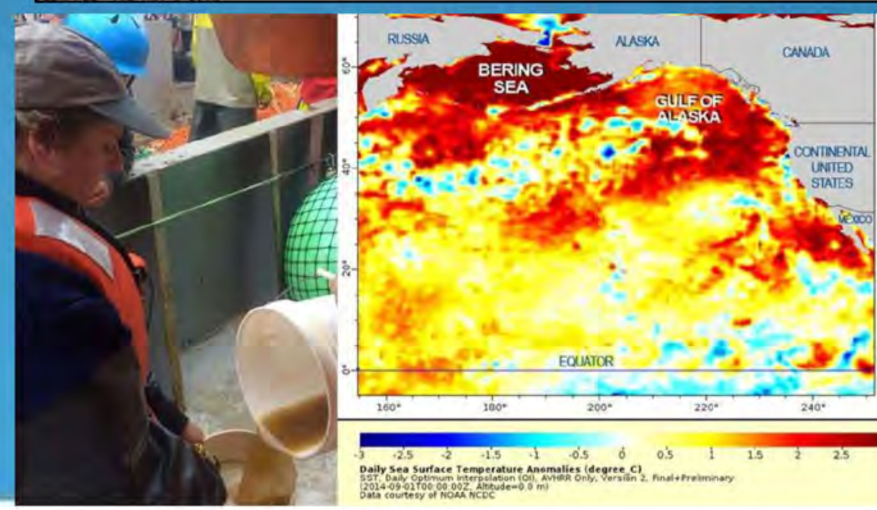
Brodeur, R. D., & Ware, D. M. (1992). *Fisheries Oceanography, 1(1), 32-38.*

The Future of Salmon is Hot & Sunny









Chinook Resource Problems are Not Limited to the Pacific North-West

ALASKA
Journal of Commerce

HOME OIL & GAS FISHERIES CONSTRUCTION TRANSPORTATION TECH & TELECOM POLITICS A

Book of Lists Top Forty Under 40 Money Mining Health Opinion Movers & Shakers Special Se

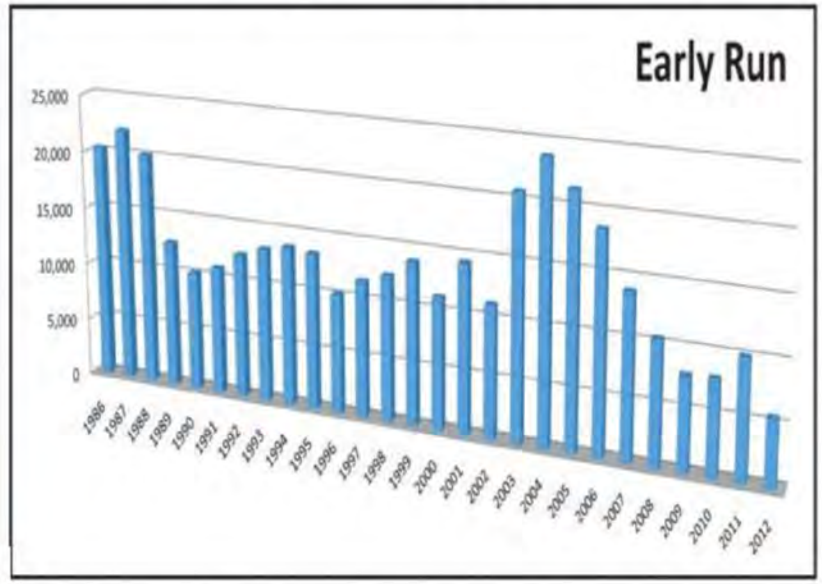
Alaska Journal / November-Issue-1 2013 / Kings in cycle: Salmon follow boom and bust patt...

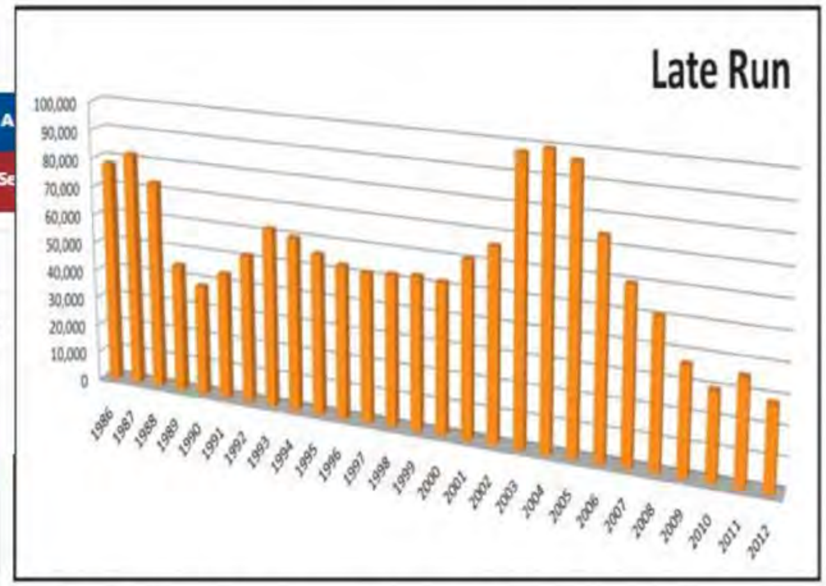
Kings in cycle: Salmon follow boom and bust pattern

By: Rashah McChesney and Molly Dischner, Morris News Service-Alaska
Posted: Thu, 10/31/2013 - 7:04am

Source: http://www.alaskajournal.com/Alaska-Journal-of-Commerce/November-Issue-1-2013/Kings-in-cycle-Salmon-follow-boom-and-bust-pattern/

Kenai River King Salmon returns 1986-2012

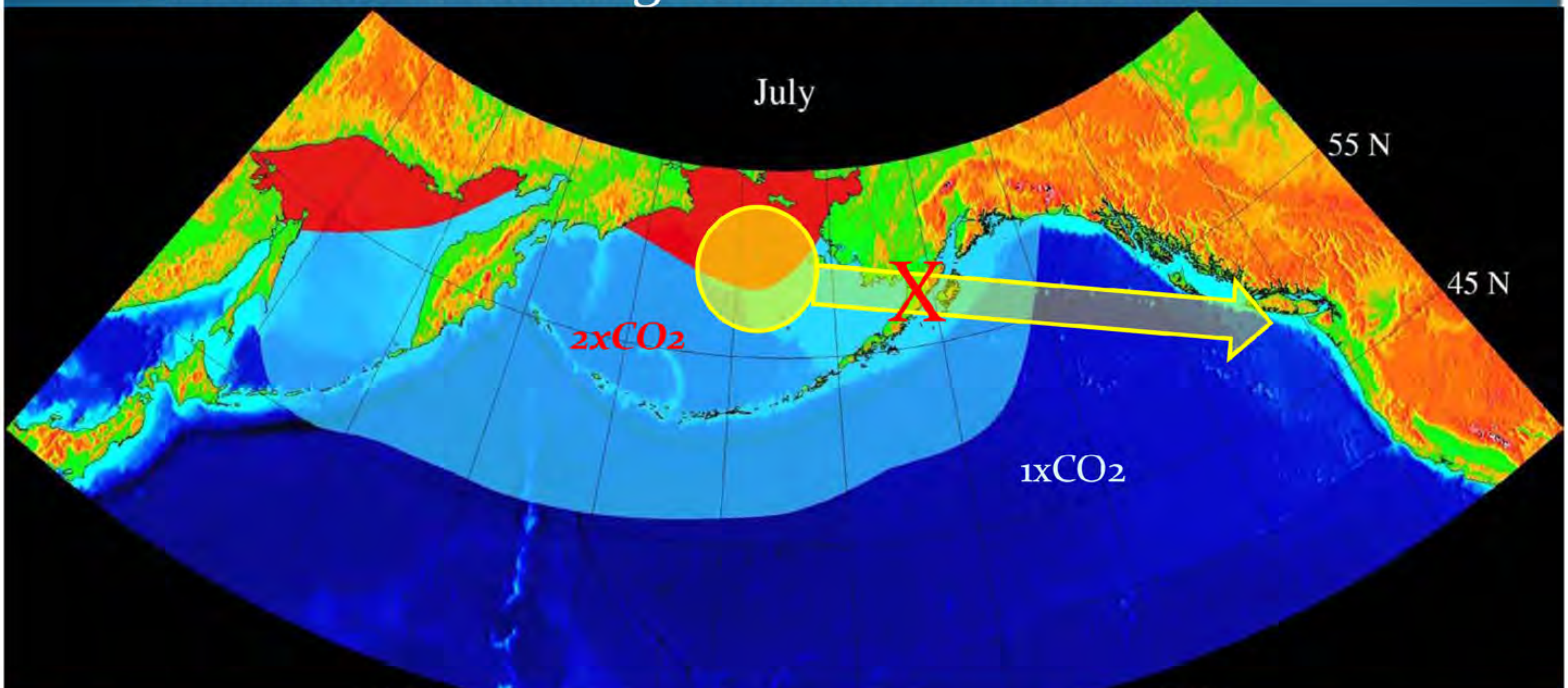




Source: Alaska Department of Fish and Game 2013 interim escapement goal report, run estimates using a state-space model

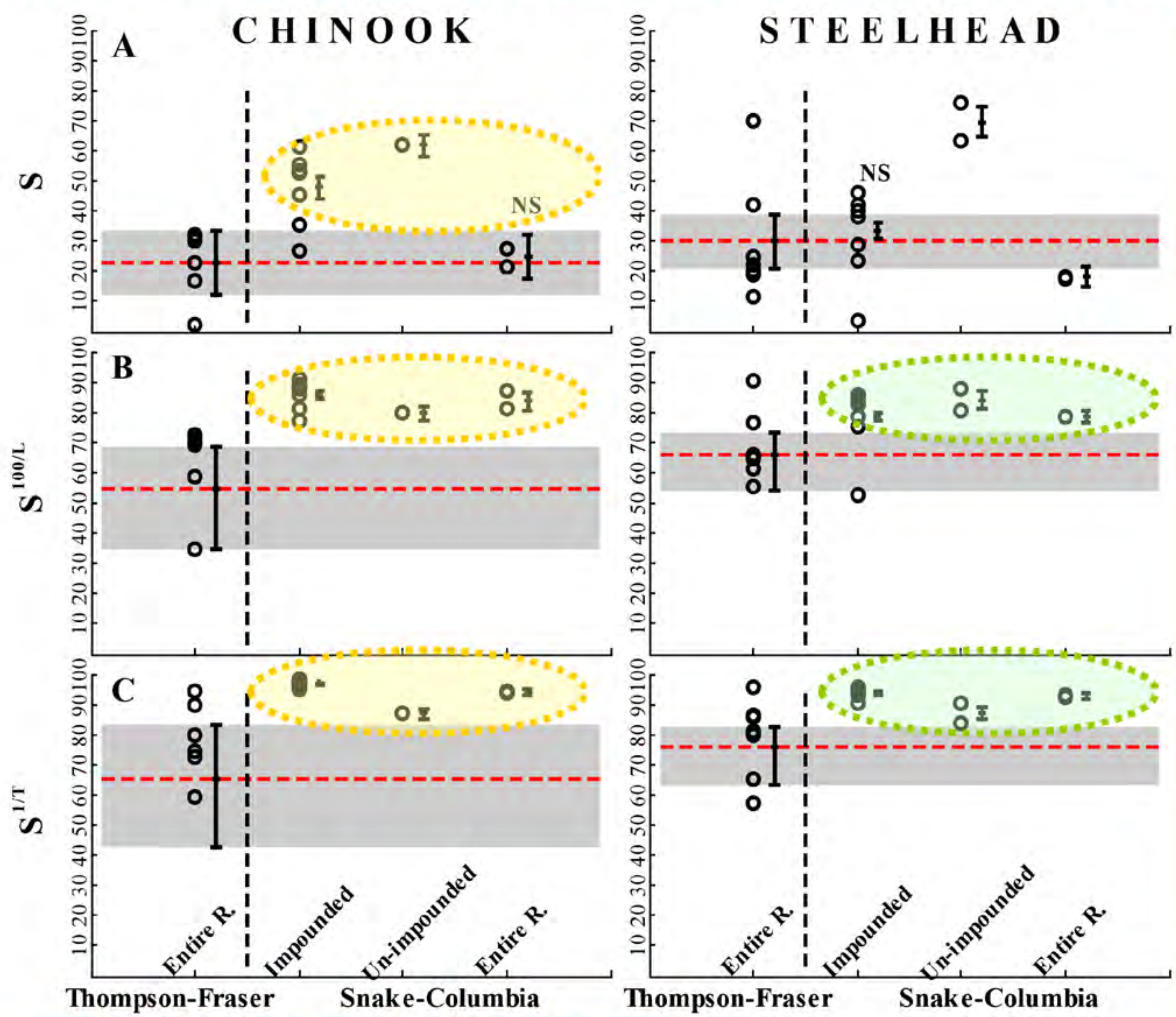
Global Warming-The Long Term View

- The details of how juvenile salmon migrate to the Bering Sea and then back to freshwater as adults may be critical to whether or not migration can be successful.



Welch, *et al* (1998). Thermal limits and ocean migrations of sockeye salmon : *Long-term consequences of global warming. Can. J. Fish. Aquatic Sci. 55:937-948.*

2008 “Large-Rivers” Paper: Thompson-Fraser v. Snake-Columbia Smolt Survivals



Welch et al (2008) PLoS Biology 6(10):e265

Survival To River Mouth

Survival per 100 Km

Survival per Day

In most comparisons, survival in the impounded section of the Snake-Columbia R was higher than in the lower river or the un-dammed Fraser

2008 "Large-Rivers" Paper: Thompson-Fraser v. Snake-Columbia Smolt Survivals

An Update Needed.

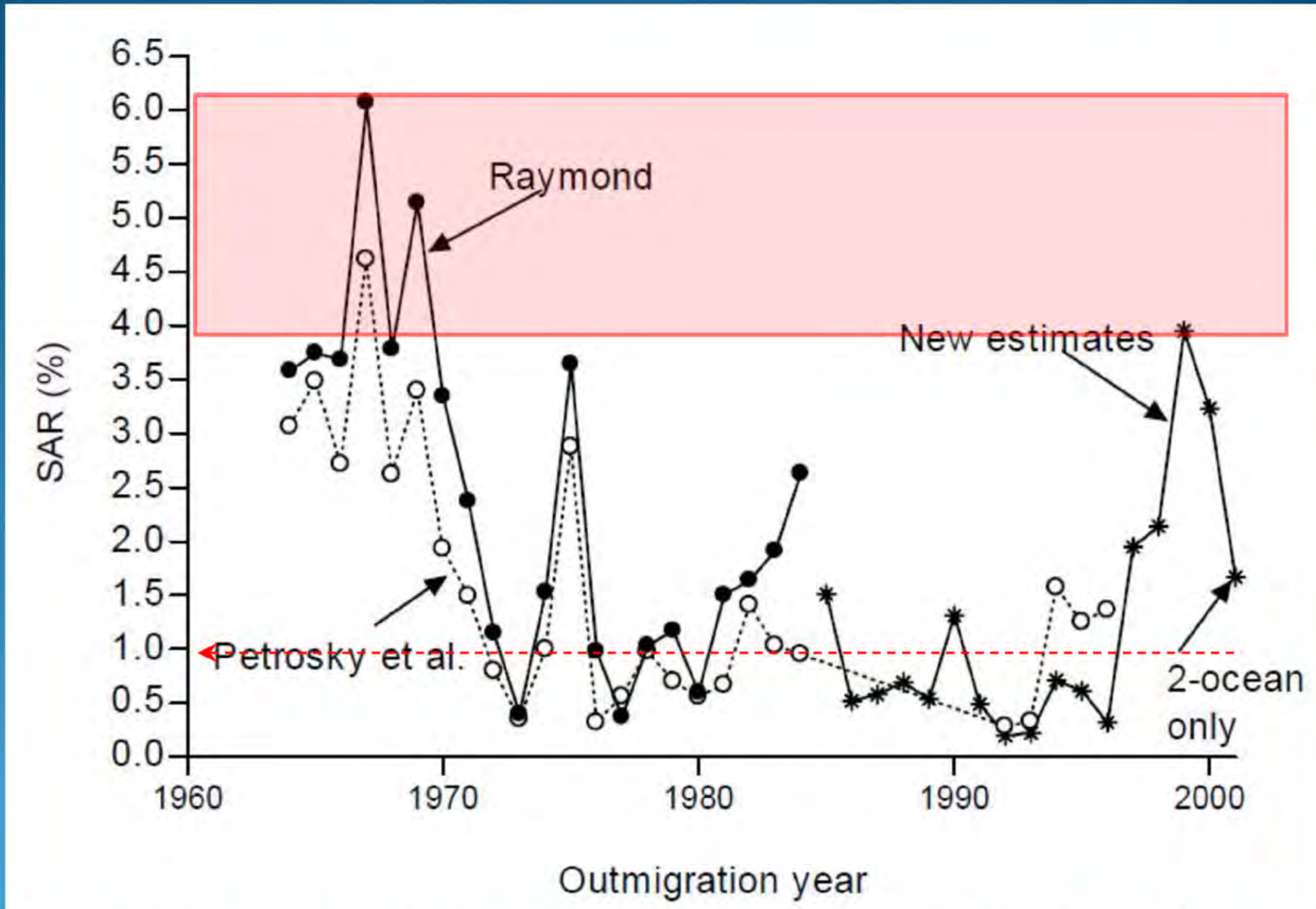
We now have tributary survival data for 3 Fraser River Populations showing that much of the survival loss is confined to the tributary, not the Mainstem

- Cultus Lake sockeye (2004-07)
- Chilko Lake sockeye (2009-16)[a,b]
- Chilko Lake Chinook (2016 only)

[a] Joint work with Scott Hinch/UBC
[b] Trib/mainstem data for 2011+12 only

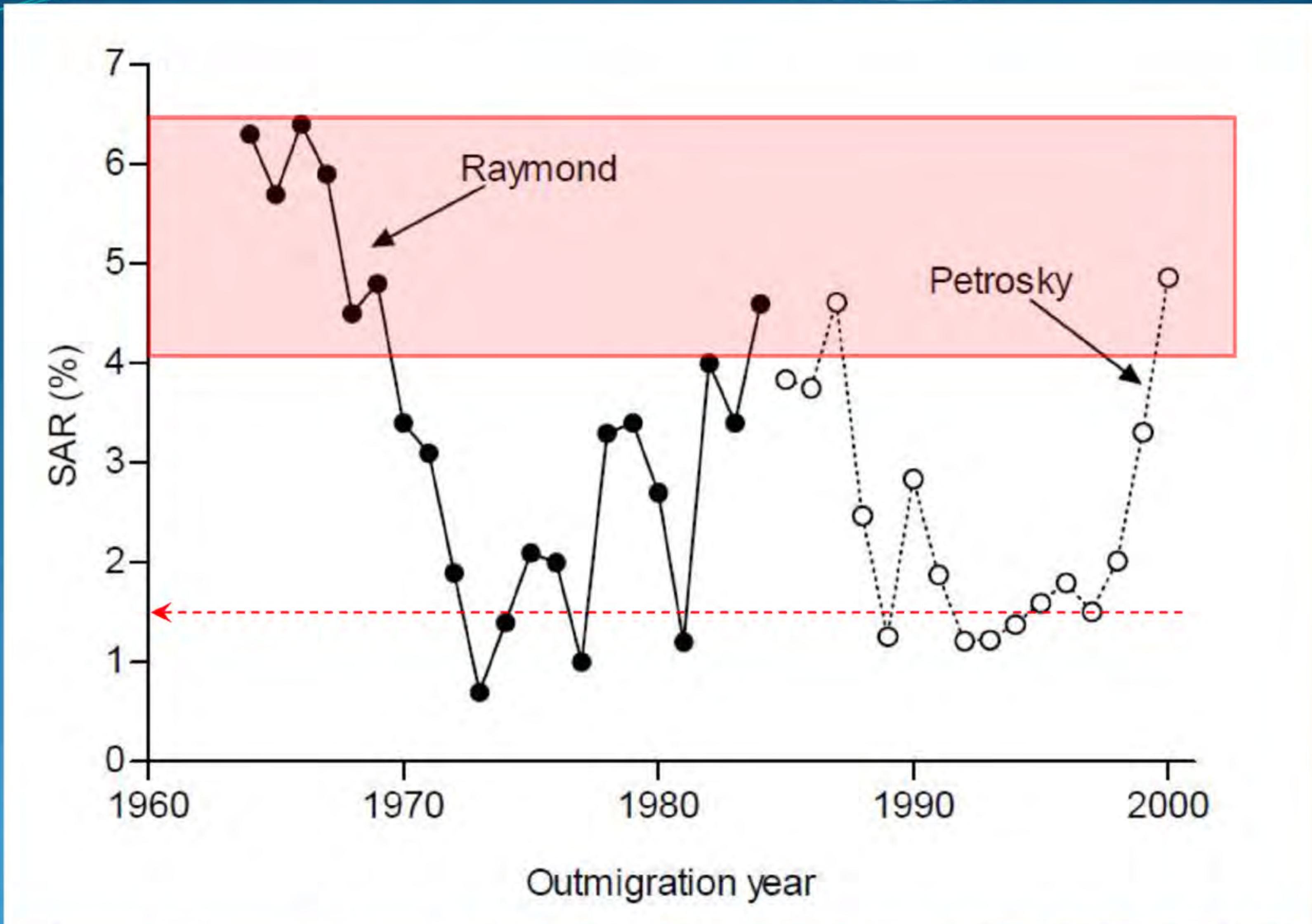
Columbia R SARS

Wild Snake River Spring Chinook SARS



Source: Williams et al (2005) NOAA Technical Memorandum NMFS-NWFSC-63 **Effects of the Federal Columbia River Power System on Salmonid Populations** (Fig. 2, p. 10)

Wild Snake River Steelhead SARS



Source: Williams et al (2005) NOAA Technical Memorandum NMFS-NWFSC-63 **Effects of the Federal Columbia River Power System on Salmonid Populations** (Fig. 4, p. 12)

Survival to Adult Return(SAR)

The product of survival through multiple habitats:

$$SAR = S_1 \cdot S_2 \cdot S_3 \cdot \ldots \cdot S_{\text{Late Marine}}$$

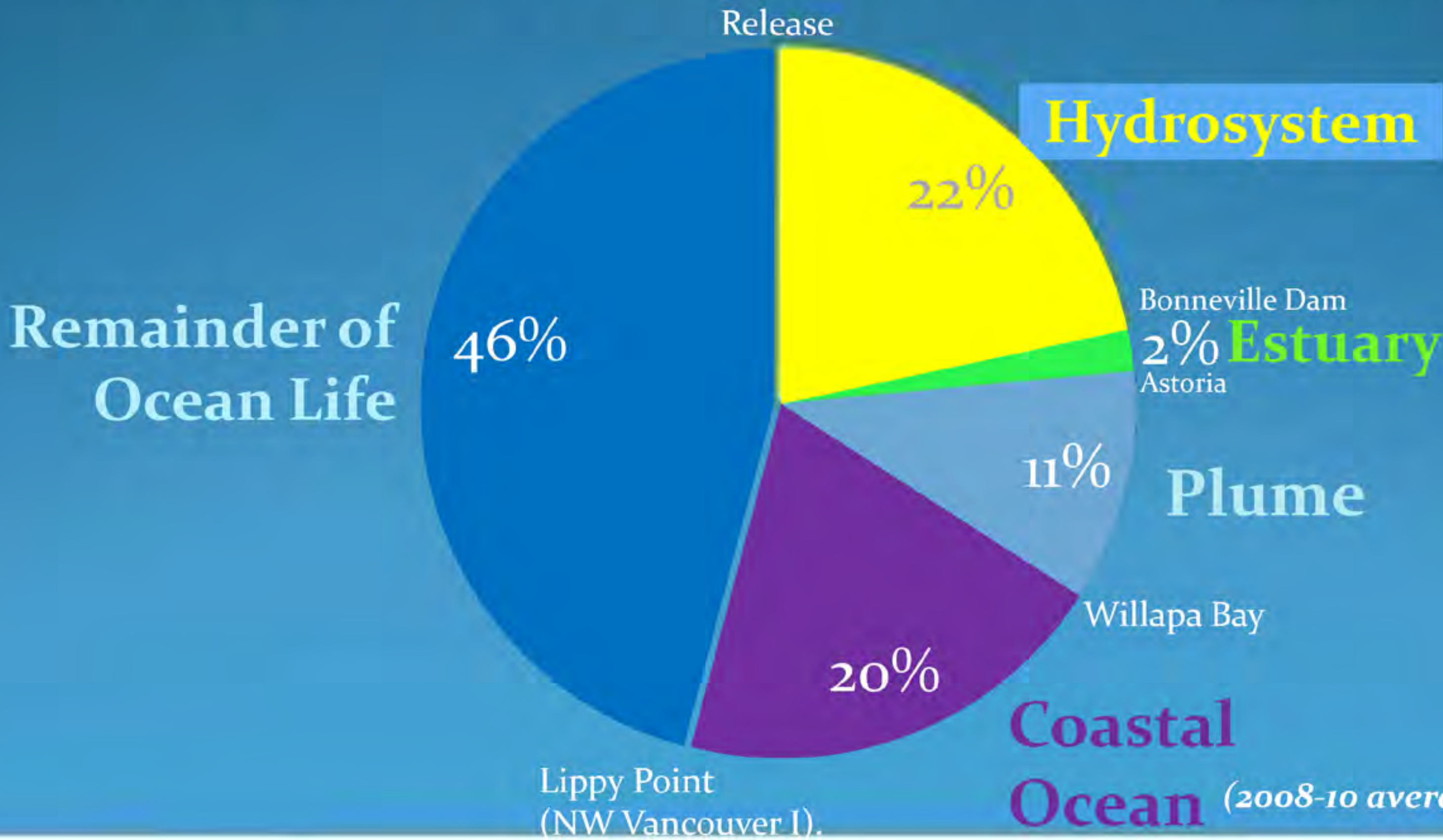
- It seems reasonable that many life history segments are key drivers of adult numbers, since:

$$\text{ADULT RETURN} = \#\ \text{Smolts Out} \cdot \text{SAR}$$

$$= \#\text{Smolts} \cdot S_1 \cdot S_2 \cdot S_3 \cdot \ldots \cdot S_{\text{Late Marine}}$$

Where is Columbia River Survival Determined?

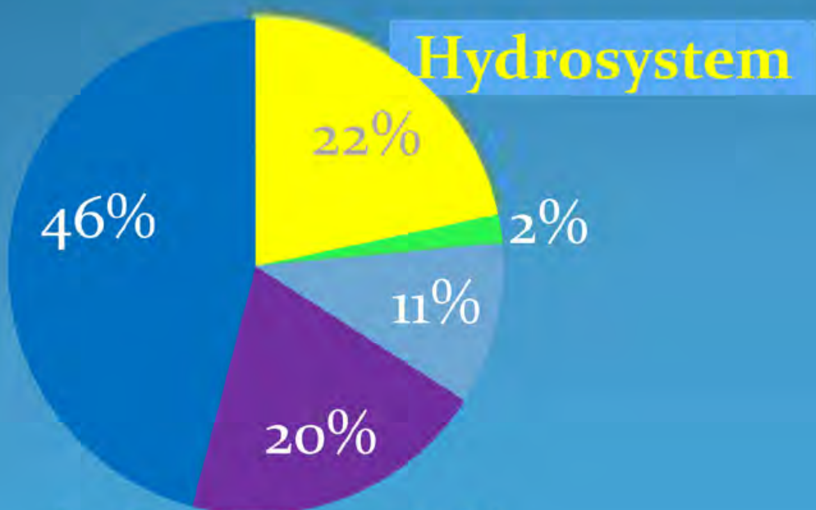
- Acoustic tag-based survival estimates indicate that majority of Chinook survival is determined at sea; hydrosystem & estuary have smaller roles compared to the ocean (Plume, Coastal Ocean, & "Remainder of Ocean").



(2008-10 average survivals)

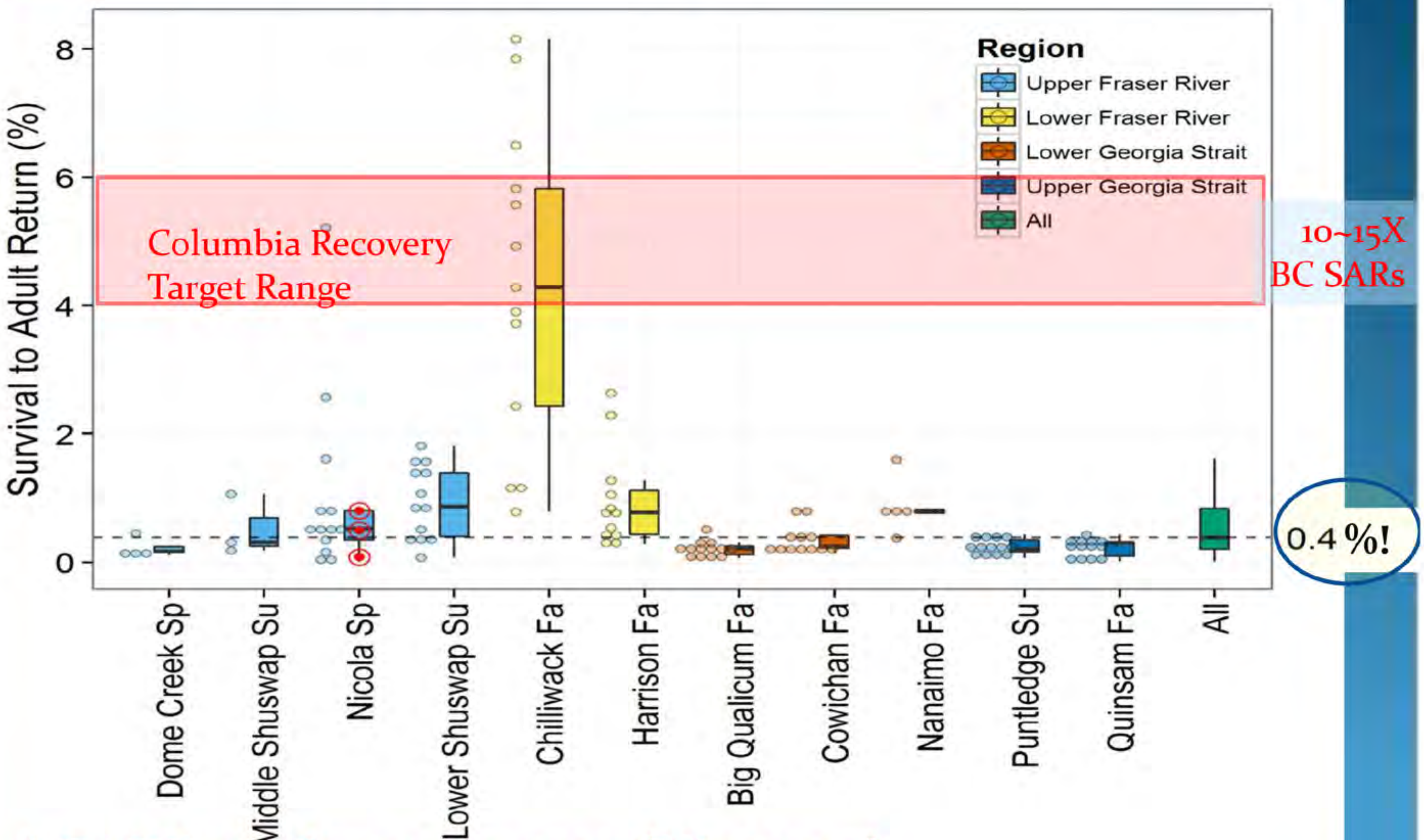
Where Are Columbia River Survivals Determined?

- We Can Now Quantify Relative Importance of Events Happening in the Ocean to SARs
- A Major Implication is that Studies Based on Statistical Correlation of SARS with Various Environmental Conditions have almost No Statistical Power… Thus Negligible Credibility



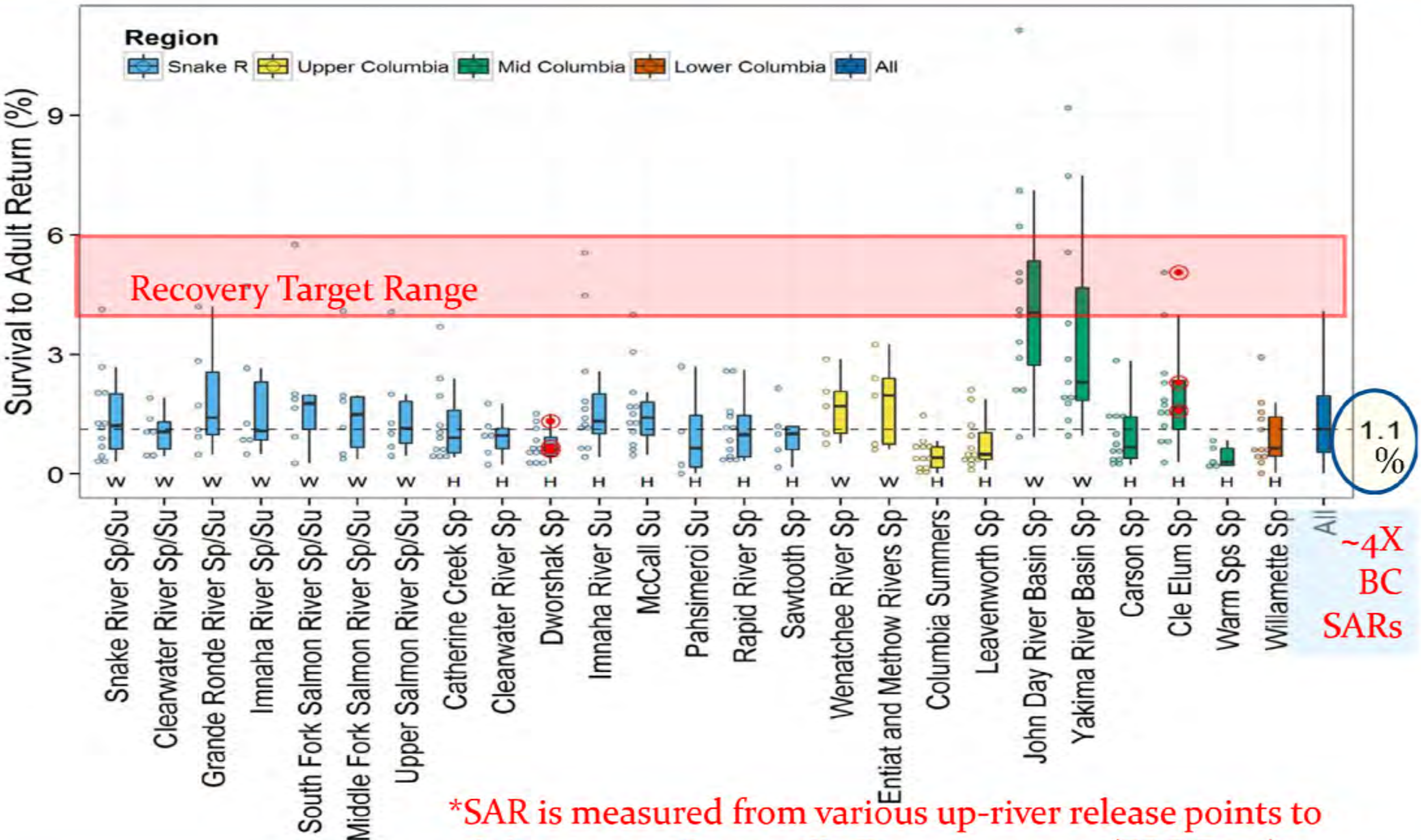
(2008-10 average survivals)

BC Chinook SARs



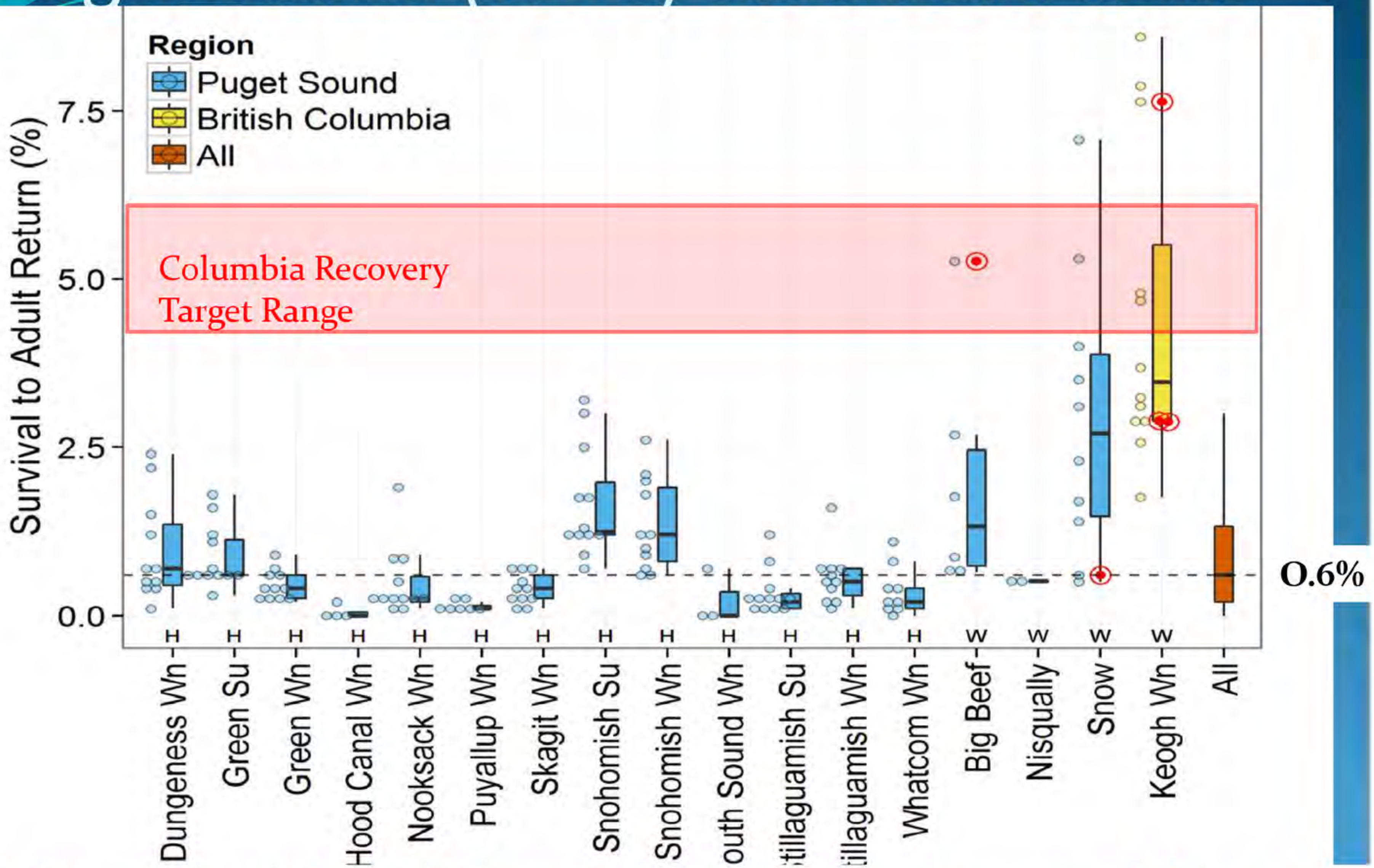
* SARS are for 2000-2012 (Kintama).

Columbia River Chinook SARs



*SAR is measured from various up-river release points to adult return at Bonneville Dam, 2000-2011 (FPC Data)

Puget Sound (& BC) Steelhead SARS



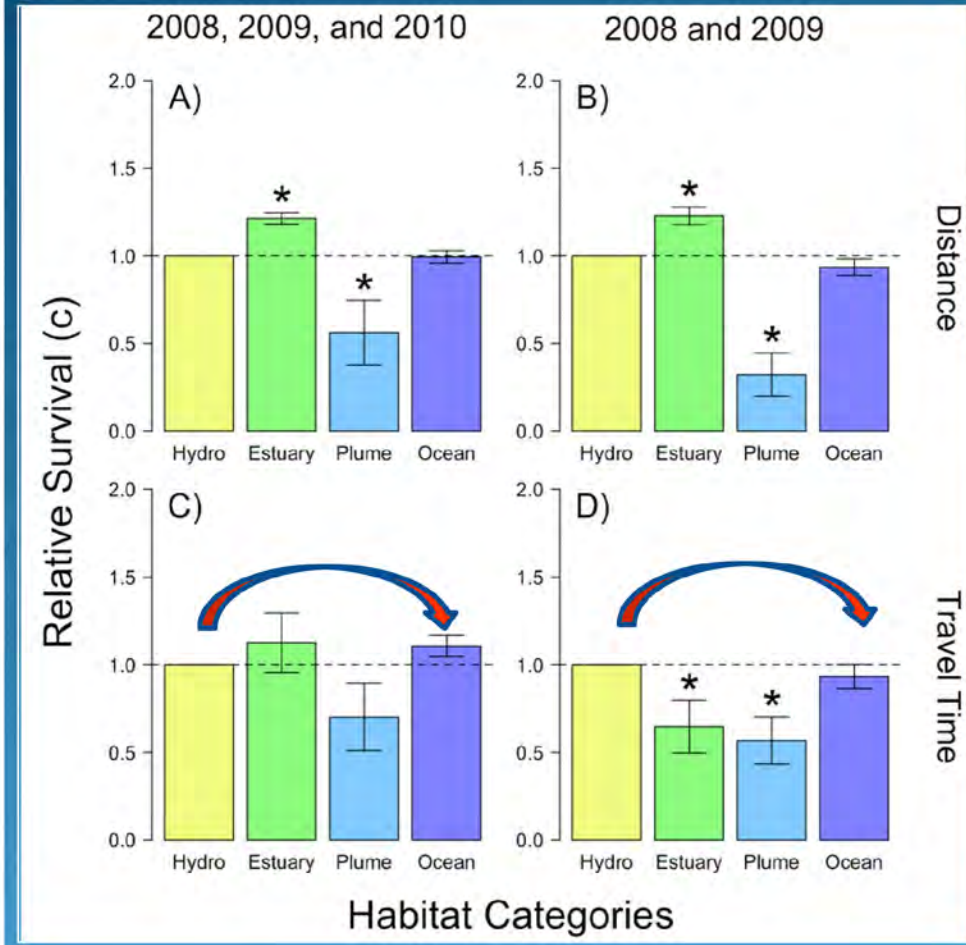
* Puget Sounds SARS are for various years, 2000 & later

Implications

- For BC Chinook stocks to "rebuild" to the Columbia level, SARS will have to increase 300-400%.
- To achieve the Columbia's Rebuilding Goals, BC Chinook SARs would have to increase 1,000~1,500%.
- Strongly suggests that the Columbia has the wrong perspective: It will not be possible to rebuild to current SAR targets (the 1960s) if other regions can't.
- Suggests (again) that the major issue is a common problem in the ocean.

Ocean vs Freshwater Survival

Ocean vs Freshwater Survival



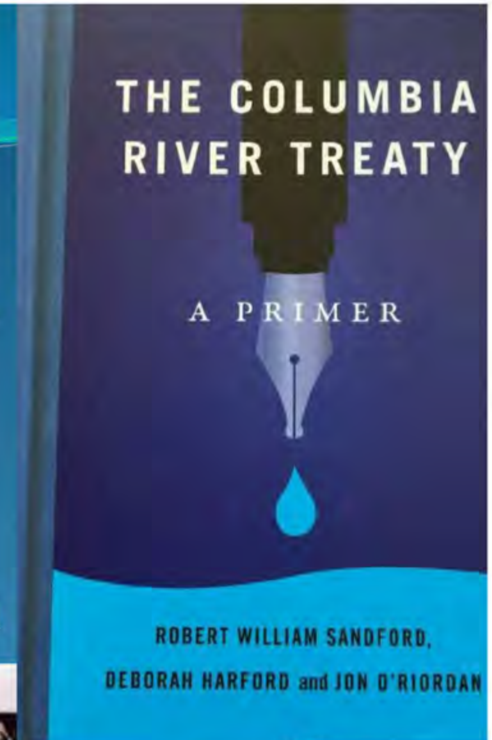
- Measured hydrosystem and coastal ocean survival rates are similar; $S_{FW} \approx S_{Ocean}$

- This means that moving smolts out of the river faster will not necessarily benefit salmon conservation, but may just change where the smolts die: ➔ *"no net benefit".*

- There are important management implications; hydropower operations could potentially be shaped differently, easing some current constraints on power generation without hurting salmon conservation

Perspective

- Manipulating the hydrosystem for salmon (spill, drawdown, breach) is in essence a trade-off:
  - Smolts spend less time in the river…
  - … & more time in the ocean
  - Whether this improves conservation depends entirely on the implicit assumption that the ocean is the better environment

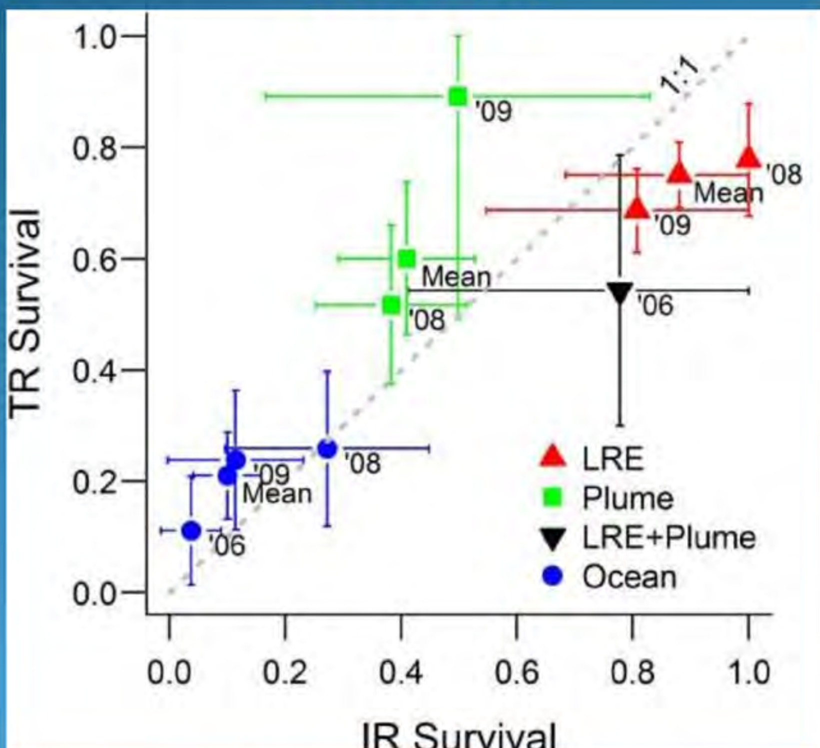


Out of the frying pan and into the fire

“Delayed Mortality” & “Differential-Delayed (Transport) Mortality” Show Role of Ocean

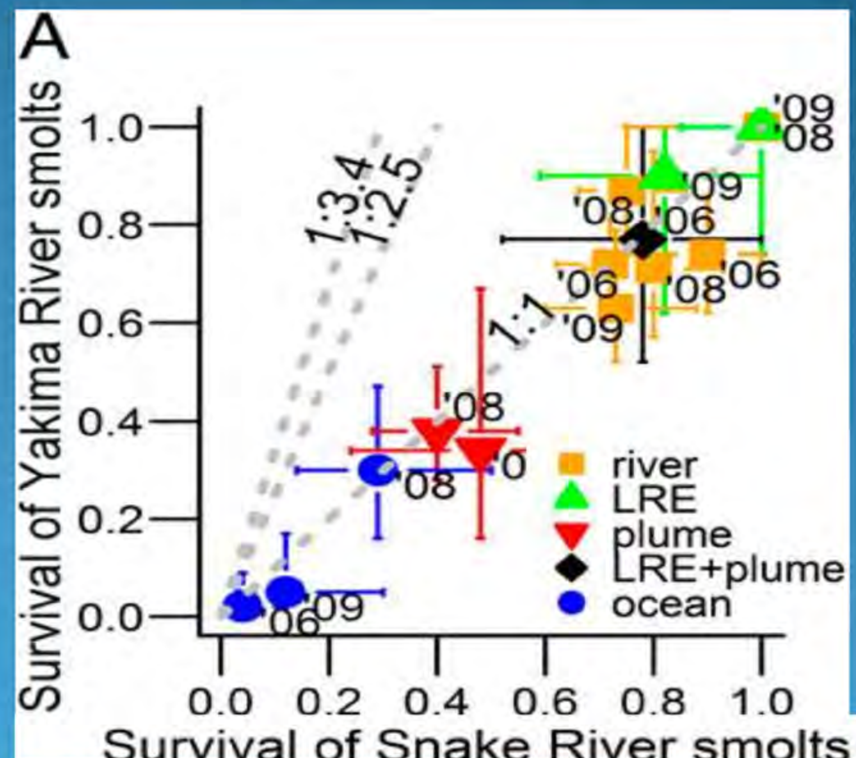
- *Transport findings can only occur if* $S_{ocean} \approx S_{Hydrosystem}$

Transport vs In-River Survival



Rechisky *et al* (2012). *Nature Sci. Reports*
doi:10.1038/srep00448

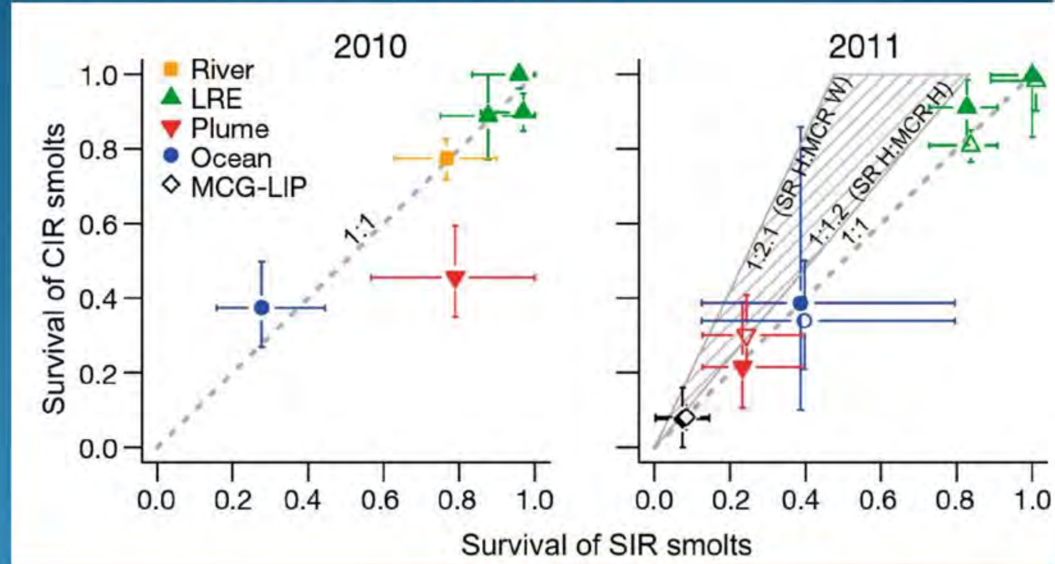
4 vs 8 Dam Survival

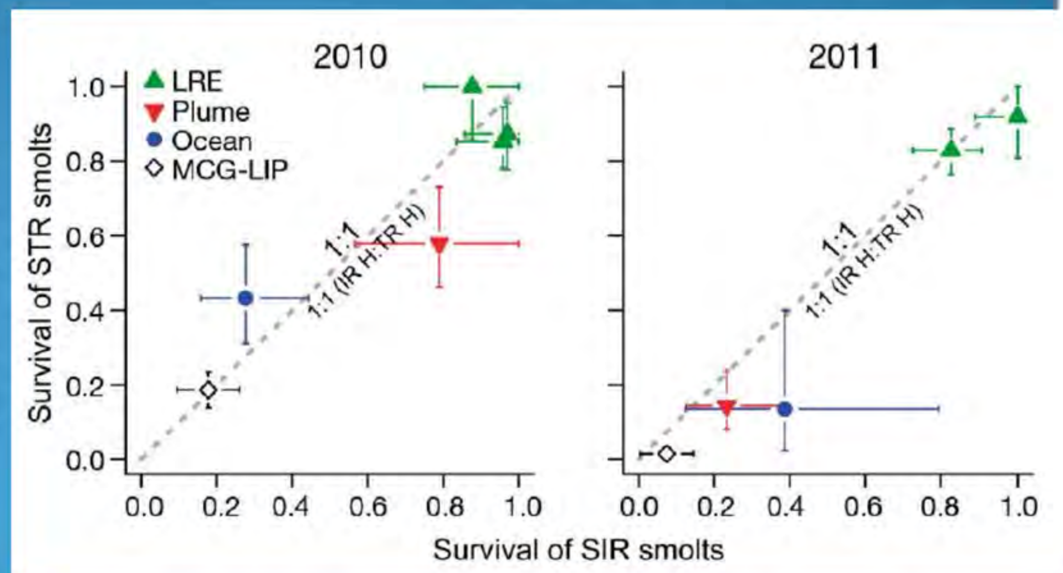


Rechisky *et al* (2013). *Proc. Nat. Acad. Sci. USA*
doi:10.1073/pnas.1219910110

Follow-Up DM & DDM Studies

- In 2010 & 2011 extended studies to smolts randomly selected at John Day & Bonneville Dams
- Stock ID done afterwards from DNA
- No survival differences found
- Study extends delayed mortality results to include upper Columbia stocks
- New studies covered "most" of the size range of migrating smolts





Rechisky et al (2014). *Mar. Ecol. Prog. Series, 496, 159–180 doi:10.3354/meps10692*

Complete a non-competitive justification for procurements with an anticipated value of over $10,000 following this format as it applies. A non competitive transaction justification is not required for procurements under $10,000, procured from Federal Prison Industries, other federal agencies, AbilityOne Nonprofit Agencies for the Blind or other Severely Handicapped, Government Printing and Binding or for utility services. (BPI 11.7.1.1)

1. **Description of Materials or Services:**
Provide a complete description of the requirement, what program or project it supports and how it supports the mission of BPA. Quantities and detailed descriptions are not required unless as a part of the justification contained in section 3 of this justification. If requesting materials, include the Manufacturer, Manufacturer's part number, and indicate whether or not a time critical outage schedule for use of these items applies.

This contract will provide novel information on the relative survival of two major population groups listed under the US ESA: Snake River spring Chinook salmon and Snake River basin steelhead. Using telemetry data from Kintama's prior BPA project 2003-114-00, as well as survival data collated from other agencies in the broader region (British Columbia, Washington, Oregon, and Idaho), Kintama will produce three reports comparing survival of Columbia River salmon smolts and adults from the Basin from a broader perspective than has been used in the past. Specifically, Kintama will (1) collate and compare SAR data on survival of salmon originating from other regions in the Pacific Northwest with similar data for the Columbia, to provide an understanding of what level of survival should be expected in regions lacking the Columbia's hydropower dams, (2) will update a previous comparison of downstream smolt survival in the Fraser & Columbia Rivers to better define relative survival rates, and (3) compare Columbia River smolt survival rates in the hydrosystem with their subsequent estuary & coastal ocean survival rates.

Collectively, these three reports will help the Action Agencies to develop a revised BiOp by placing the Columbia River's recovery goals in context with the performance achieved in other salmon-producing rivers within the broader region.

2. **Non Competitive Authority:** *From the list below check the applicable BPI authority permitting the proposed non-competitive transaction. Contact your Contracting Officer or Team Lead if you need assistance.*
   - ☐ Repair parts, accessories, supplemental equipment or services required for supplies or services previously furnished or contracted for which are available from only one contractor. (BPI 11.7.1.2(a));
   - ☐ Required by law or Executive Order (BPI 11.7.1.2(b));
   - ☐ The entity has the responsibility to manage the property or resource to be affected by the services performed. (BPI 11.7.1.2 (c));
   - ☐ BPA standard items, when a Business Line Vice President or equivalent level manager has determined in writing that BPA must standardize the use of the item, and that determination is available for review by the HCA. (BPI 11.7.1.2 (e));

☐ Agreements with nonprofit research organizations such as the Electric Power Research Institute (EPRI) for the purposes identified in this section (BPI 11.7.1.2 (f) (1-6));

☐ Establish or maintain an essential engineering, research, or development capability to be provided by an educational or other nonprofit institution or a federally funded research and development center. (BPI 11.7.1.3 (a));

☐ When other parties have offered BPA an opportunity to participate in specific projects on a cost-sharing basis, and the sponsor has arranged for a substantial portion of the required funding for the entire project. (BPI 11.7.1.3(b));

☒ This is the only feasible source which can meet BPA's requirement and no other supplies or services will satisfy agency requirements (BPI 11.7.2);

3. <u>Justification</u>:

Provide sufficient information to support the proposed non competitive transaction based on the authority cited above and instructions of this section. Keep in mind that this document is reviewed and that your explanations may be formally questioned and protested if your justification is insufficient or not valid. For the BPI authorities 11.7.1.2 (f), 11.7.1.3(a) and 11.7.1.3(b), be sure to address the specific information required by those sections. For the BPI authority 11.7.2, unique source, all of the following elements must be provided: (1) The minimum mandatory requirements for the procurement (may be addressed in Section 1, Description of Materials or Services); (2) Identify what other sources were considered during market research (may be addressed in Section 6, Market Survey, below) and why those sources do not meet the minimum mandatory requirements and are not feasible due to form, fit, function, capabilities, capacity, experience, price, or delivery timeframe; (3) Demonstrate that the proposed contractor is the only feasible source based on unique capabilities, unique experiences, or unique attributes.

Kintama Research Services

Kintama Research Services is a world leader in the design and use of large-scale underwater acoustic telemetry arrays, with particular experience in applying these technologies to provide novel scientific information relevant to salmon management. Bonneville Power Administration contracted with Kintama Research Services, Ltd. under project #2003-114-00 from 2003-2012 for in-river, estuary and early marine survival estimates as they relate to delayed mortality due to migration through the FCRPS or transportation around the FCRPS.

As part of previously funded work Kintama found that Columbia River salmon smolt survival rates were similar to (and in some cases slightly better) than equivalent survival rates on the Fraser River, which has no dams (Welch et al. 2008). Kintama has continued to conduct research on smolt survival in the Fraser River system and has collected additional new data which will allow an important refinement and improved perspective on where the mortality is geographically occurring in the Fraser, which will provide an important refinement on that earlier publication. As part of a different research project Kintama also collated preliminary coast-wide data on smolt to adult survival rates (SARS) during the period 2000-2010, and found that at least in the 2000-2010 period SARS for Columbia River salmon stocks seem to be substantially higher than in British Columbia or Puget Sound. This finding is contrary to the usual assumption that survival must be lower in the Columbia River hydrosystem because of the presence of dams. Extending this data collection backwards to earlier decades is necessary to provide a fuller perspective, but if Columbia River SARS are already higher than in other west coast regions lacking dams, then the rationale for meeting current BiOP mandated rebuilding targets may need to be reviewed. Finally, one major component of Kintama's previous BPA-funded work has not yet been published in the scientific peer-reviewed literature. This work indicates that smolt survival rates migrating through the FCRPS and in the coastal ocean are similar. There are major management implications from this finding, which have not been incorporated into the current management thinking. Kintama will prepare this analysis which will outline the implications and their relevance to BiOP-related obligations.

To our knowledge, no other organization has yet assembled this broader perspective on the performance of the FCRPS. Kintama's staff experience in developing telemetry-based measurements of salmon survival in both freshwater and early marine environments is unique, and the data they have prepared provides a broader perspective on the challenges of successfully managing Columbia River salmon populations than is currently available. As the generator of these data, Kintama is uniquely positioned to efficiently analyze them and provide the outlined research products. The scientific credibility of the company and its' staff is high; Kintama's previous peer-reviewed scientific publications on acoustic telemetry now number more than 40 (www.kintama.com/publications/primary-publications)and have all been in the top-ranked scientific journals, including two in the Proceedings of the U.S. National Academy of Science (Welch et al. 2011; Rechisky et al. 2013).

Welch, the president and founder of Kintama has received multiple awards for his scientific research, including the American Fisheries Society's award for Best Published Paper (2014), the American Fisheries Society's Award of Excellence-Fisheries Management (2012), the Canadian Society for Meteorology & Oceanography's J. P. Tully Medal in Oceanography (2012), and the Prix d'Excellence (2008) and Prix de Distinction (2007) from Fisheries & Oceans Canada for *"Exceptional Scientific Contributions to the Government of Canada"* and *"Outstanding Scientific Contributions Related To National And International Climate Change Research*, respectively. Dr Rechisky has over 20 years of work on acoustic telemetry of marine fish, and completed her PhD at the University of British Columbia analyzing the Columbia River data to look at the credence of the delayed mortality and differential-delayed mortality theories. She is also the current Secretary of the American Fisheries Society's B.C.-Washington Chapter. Aswea Porter, M.Sc., has worked for Kintama since 2006, and is senior data analyst and has primary responsibility for managing Kintama's acoustic telemetry database and much of the underlying preparatory analysis needed for production of scientific reports and published papers, as well as extensive involvement in the writing phase.

Why BPA is doing Estuary and Ocean Research:

The history of Columbia River salmon research has emphasized the role of the dams in reducing survival. Initial, early work focused on measuring survival through the Snake River dams because the poor adult returns to this tributary suggested a greater problem with these dams, which were also the most recently constructed (1970s), which coincided with a period of large-scale change in ocean climate and reduced salmon survival coast-wide. As a result, the PIT tag system was progressively implemented downstream, first at the Snake River dams and then subsequently at the lowest four Columbia River mainstem dams, but no major source of mortality was found that could explain the magnitude of the poor adult salmon returns observed. Perhaps for this reason this then led to the development of the delayed mortality theory, which suggested that survival was poor in the estuary or coastal ocean as a result of cumulative damage occurring from multiple dam passages. From this perspective, poor estuary or ocean survival was the result of upstream dam operations, and partly for this reason estuary/ocean research became of interest to BPA.

It is not difficult to understand how this process evolved, because it seemed obvious to most biologists that the major dams built in the Columbia River must be having massive impacts. However, the reality was somewhat different, with the advent of the PIT tag system (and then JSATS) certainly documenting some losses during in-river migration, bit nowhere near enough to explain the disastrously poor survival levels observed in the 1990s. However, there was apparently both an unwillingness to clearly note that most of the "survival problem" seemed to be determined at sea and a reluctance to note that salmon stocks in other river systems without major dams also had severe conservation problems. Overall, these threads, rarely commented upon, suggested a common ocean mechanism was suppressing adult salmon returns and was likely the most important factor in determining salmon abundance. Given the oft-stated claim that "*nothing could be done about the ocean*", it was not surprising that the delayed mortality theory was developed, which in essence stated that marine survival of the Snake River stocks was particularly poor because they migrated through more dams than certain other stocks which had better SARS.

With earlier financial support from BPA, Kintama specifically tested this important theory and found no evidence for elevated mortality for smolts migrating through a greater number of dams (or for smolts transported around the dams in barges). Importantly, Kintama's data also pointed to a previously unsuspected reason why management efforts had been largely unsuccessful at recovering salmon populations to the recovery targets: smolt survival rates in the coastal ocean were about the same as the survival rates experienced migrating through the 8 dam FCRPS. If correct, this observation places a wholly new complexion on the reason for poor adult SARS, and suggests that moving smolts more rapidly downriver may do more harm than good in years when ocean survival rates are lower than freshwater survival rates. This possibility appears to have never been recognized by fisheries managers, whose assumption was that mimicking the more rapid flow rates of the unimpeded "pre-dam" river would give the best survival results (because it came closest to the original "natural" river condition). The hidden underlying assumption was that the ocean was largely a benign environment for salmon, and that most of the survival problem was man-made and the result of dam construction.

Understanding the role of the estuary and ocean in determining overall survival is thus of direct relevance to BPA, because at present ocean effects on survival are confounded with the effects of the hydrosystem, and both blame and credit for certain management actions may be improperly attributed without a clearer understanding of how survival is determined. Because of Kintama's experience, the company is uniquely capable of providing this broader perspective.

History of Sole Source to Kintama:

Kintama has no history of sole source contracting.

Why we still need Kintama's services:

Judge Michael Simon stated in his 2016 Opinion and Order (regarding the FCRSP BiOp):

"*The Federal Columbia River Power System remains a system that "cries out" for a new approach and for new thinking if wild Pacific salmon and steelhead, which have been in these waters since well before the arrival of* Homo sapiens, *are to have any reasonable chance of surviving their encounter with modern man.*" New thinking should clearly include a regional perspective, which includes the comparative performance of salmonid populations originating from a broader region. Chinook and steelhead population coming from undammed British Columbia rivers appear to have astoundingly low SARs when compared with the Columbia, and this point has apparently never been picked up on despite during decades of studies. In Alaska, fishery disasters have been repeatedly declared for Chinook salmon originating from multiple pristine watersheds, indicating again that it is not just dams that can drive down salmon populations. Kintama's experience and technical capacity offers a perspective that appears to be remarkably lacking in past BiOp efforts in the Columbia, which have focused on incremental technical fixes to various parts of the hydrosystem. However, this lack of wider perspective may have blinded the region to the possibility that the FCRPS has already been successful in addressing most of the anthropogenic problems, and that the remaining issues may be related largely to climate change in the ocean, and not due to hydrosystem operations,

Kintama has also been successful in prior work, demonstrating an ability to successfully publish important new research that did not necessarily agree with conventional thinking. Kintama approached BPA in 2001 with an experimental design that could potentially test whether Snake River spring Chinook, which migrate through the four additional Snake River dams relative to mid-Columbia River spring Chinook, were suffering increased mortality downstream of Bonneville Dam in the estuary and during the early marine migration, or hydrosystem-induced delayed mortality. Recognizing the potential, BPA funded Kintama to develop a large-scale acoustic telemetry array which extended from the Snake River basin to southeast Alaska. After several seasons of field testing equipment and surgical fish tagging trials, Kintama launched an extensive study which would track 14 cm long acoustic tagged fish from the Snake River to Alaska. BPA funded this study and an additional study to evaluate transportation-induced delayed mortality from 2006-2011 (and a wrap up year in 2012). This study may still be the most geographically extensive acoustic telemetry study ever conducted. Results indicated that Snake River spring Chinook had very similar early marine survival relative to their downstream counterparts, and that transportation had little or no effect on early marine survival. Kintama published multiple peer-reviewed journal articles which used these data including two papers in the U.S. Proceedings of the National Academy of Sciences (http://kintama.com/publications/).

Although multiple publications were produced, Kintama approached BPA in 2015 for funding to support analysis and complete three additional reports which will use data obtained during project #2003-114-00 as well as other telemetry data available from Kintama and Kintama's collaborators, as well as collated smolt-to-adult return data developed by a range of government and NGO organizations. All three reports will compare survival of Columbia River basin salmon to salmon from other regions to provide a broader perspective on the performance of Columbia River salmon stocks than is currently available. Specifically Kintama will:

1) Collect & analyze the available data on SARS for west coast salmon stocks and compare to Columbia. Preliminary analysis indicates that in all regions south of Alaska, coast-wide SARS dropped by almost an order of magnitude since the 1960s-1970s, demonstrating that the Columbia River salmon conservation problem is not unique to the region. Initial analysis of the data for the 2000s also shows that at least in the recent period the average SARs of BC Chinook are lower than Columbia River Chinook, and that Puget Sound steelhead have lower SARs than Columbia River steelhead—by about a factor of 3 (i.e., SARS are only 1/3rd of the Columbia's). If the Columbia's rebuilding targets of 4-6% SARS aren't being met in river systems lacking dams, it raises question of whether they are realistic for the Columbia. The analysis will also contribute perspective on what is really keeping salmon stocks from recovering.

2) Revisit & update Kintama's earlier 2008 "Survival of Migrating Salmon Smolts in Large Rivers with and without Dams" publication, which found that survival rates were slightly lower in the

Fraser than in the Columbia. Kintama can now present a more nuanced approach, and show that the newer data we have shows that in the Fraser the losses appear to be due to predation and are largely confined to the tributaries, not the Fraser mainstem. This is again an important perspective, and Kintama developed much of the Fraser River data that is needed for this analysis.

3) Complete a publication addressing conceptual problems in how biologists think about salmon management. Once survival is scaled for the time smolts take to reach Bonneville survival rates seem to be quite stable across years, so flow manipulation may not really work as claimed. The key point is that much of the claimed survival benefit from getting smolts to Bonneville faster by increasing flows is in fact partially an artifact resulting from measuring survival over a shorter period of time and survival after passing Bonneville Dam is not accounted for. The basic conceptual flaw is that just measuring survival to Bonneville Dam without taking into account how long the smolts take to arrive there and be counted is like using a Geiger counter to count radioactive decay and concluding that because more fission is recorded over longer time intervals, radioactivity is worse. There are two potentially important points here:
   a) Annual survival values in the hydrosystem should be scaled by the time smolts take to reach Bonneville Dam (they generally aren't). Kintama's preliminary analysis indicates that once Columbia River survival data is scaled by travel time most of the claimed benefit of flow vanishes—it seems to be an artifact of not considering the travel time.
   b) Smolts which arrive early at Bonneville Dam then end up spending more time in the coastal ocean because they get there faster. Kintama's data indicates that survival rates in the ocean aren't much different than in the hydrosystem, so higher flow may not actually benefit the smolts, just put them someplace else. If the hydrosystem is manipulated to accelerate smolt arrival in a region with worse survival, then logically managers should take this into account while developing management plans.

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4. **Actions to Promote Competition:** At the onset of each procurement, all unique source justifications are scrutinized and screened for the possibility of further competition by Supply Chain. Further, competition barriers are discussed with the customer and options explored when available. *This section is prefilled and needs no editing.*

5. **Project Estimated Amount:** The anticipated price to the Government is $
Requester must fill in the estimated or actual amount here (attach any and all quotes received). At time of award the Contracting Officer will determine if price is fair and reasonable.

6. **Market Survey:** *Describe the market research that was performed that led you to your conclusion that there was need to waive competition. If no market research was performed, such as in instances of Urgent and Compelling, explain in detail here.*

7. **Requirements Certification:** I certify that the requirement outlined in this justification is a bonafide need of the Bonneville Power Administration and that the supporting data under my cognizance, which are included in the justification, are accurate and complete to the best of my knowledge and belief.
(Signature of the responsible manager)

Name & Title Date

8. **Approval** *This part is filled out by Contracting Staff as part of the Justification*

   a. **Contracting Officer's Certification: (required)** I certify that the foregoing justification is accurate and complete to the best of my knowledge and belief.

Contracting Officer Signature Date

Complete a non-competitive justification for procurements with an anticipated value of over $10,000 following this format as it applies. A non competitive transaction justification is not required for procurements under $10,000, procured from Federal Prison Industries, other federal agencies, AbilityOne Nonprofit Agencies for the Blind or other Severely Handicapped, Government Printing and Binding or for utility services. (BPI 11.7.1.1)

1. **Description of Materials or Services:**
Provide a complete description of the requirement, what program or project it supports and how it supports the mission of BPA. Quantities and detailed descriptions are not required unless as a part of the justification contained in section 3 of this justification. If requesting materials, include the Manufacturer, Manufacturer's part number, and indicate whether or not a time critical outage schedule for use of these items applies.

This contract will provide novel information on the relative survival of two major population groups listed under the US ESA: Snake River spring Chinook salmon and Snake River basin steelhead. Using telemetry data from Kintama's prior BPA project 2003-114-00, as well as survival data collated from other agencies in the broader region (British Columbia, Washington, Oregon, and Idaho), Kintama will produce three reports comparing survival of Columbia River salmon smolts and adults from the Basin from a broader perspective than has been used in the past. Specifically, Kintama will (1) collate and compare SAR data on survival of salmon originating from other regions in the Pacific Northwest with similar data for the Columbia, to provide an understanding of what level of survival should be expected in regions lacking the Columbia's hydropower dams, (2) will update a previous comparison of downstream smolt survival in the Fraser & Columbia Rivers to better define relative survival rates, and (3) compare Columbia River smolt survival rates in the hydrosystem with their subsequent estuary & coastal ocean survival rates.

Collectively, these three reports will help the Action Agencies to develop a revised BiOp by placing the Columbia River's recovery goals in context with the performance achieved in other salmon-producing rivers within the broader region.

2. **Non Competitive Authority:** *From the list below check the applicable BPI authority permitting the proposed non-competitive transaction. Contact your Contracting Officer or Team Lead if you need assistance.*

- ☐ Repair parts, accessories, supplemental equipment or services required for supplies or services previously furnished or contracted for which are available from only one contractor. (BPI 11.7.1.2(a));
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As part of previously funded work Kintama found that Columbia River salmon smolt survival rates were similar to (and in some cases slightly better) than equivalent survival rates on the Fraser River, which has no dams (Welch et al. 2008). Kintama has continued to conduct research on smolt survival in the Fraser River system and has collected additional new data which will allow an important refinement and improved perspective on where the mortality is geographically occurring in the Fraser, which will provide an important refinement on that earlier publication. As part of a different research project Kintama also collated preliminary coast-wide data on smolt to adult survival rates (SARS) during the period 2000-2010, and found that at least in the 2000-2010 period SARS for Columbia River salmon stocks seem to be substantially higher than in British Columbia or Puget Sound. This finding is contrary to the usual assumption that survival must be lower in the Columbia River hydrosystem because of the presence of dams. Extending this data collection backwards to earlier decades is necessary to provide a fuller perspective, but if Columbia River SARS are already higher than in other west coast regions lacking dams, then the rationale for meeting current BiOP mandated rebuilding targets may need to be reviewed. Finally, one major component of Kintama's previous BPA-funded work has not yet been published in the scientific peer-reviewed literature. This work indicates that smolt survival rates migrating through the FCRPS and in the coastal ocean are similar. There are major management implications from this finding, which have not been incorporated into the current management thinking. Kintama will prepare this analysis which will outline the implications and their relevance to BiOP-related obligations.

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Welch, the president and founder of Kintama has received multiple awards for his scientific research, including the American Fisheries Society's award for Best Published Paper (2014), the American Fisheries Society's Award of Excellence-Fisheries Management (2012), the Canadian Society for Meteorology & Oceanography's J. P. Tully Medal in Oceanography (2012), and the Prix d'Excellence (2008) and Prix de Distinction (2007) from Fisheries & Oceans Canada for *"Exceptional Scientific Contributions to the Government of Canada"* and *"Outstanding Scientific Contributions Related To National And International Climate Change Research*, respectively. Dr Rechisky has over 20 years of work on acoustic telemetry of marine fish, and completed her PhD at the University of British Columbia analyzing the Columbia River data to look at the credence of the delayed mortality and differential-delayed mortality theories. She is also the current Secretary of the American Fisheries Society's B.C.-Washington Chapter. Aswea Porter, M.Sc., has worked for Kintama since 2006, and is senior data analyst and has primary responsibility for managing Kintama's acoustic telemetry database and much of the underlying preparatory analysis needed for production of scientific reports and published papers, as well as extensive involvement in the writing phase.

Why BPA is doing Estuary and Ocean Research:

Columbia River salmon research has primarily focused on the role of the dams in reducing survival. Initially, early work focused on measuring survival through the Snake River dams because the particularly poor adult returns to this tributary suggested a greater problem with these dams, which were also the most recently constructed. Completion of these dams in the 1970s also coincided with a period of large-scale change in ocean climate and reduced salmon survival coast-wide. As a result, the effect of the dams on reducing salmon returns from the ocean was confounded with the deterioration in ocean climate for salmon that occurred at about the same time and whose effect on salmon returns was also widely observed outside of the Columbia River. Presumably as a result of the particularly poor returns of salmon to the Snake River, the PIT tag system was progressively implemented downstream, first at the Snake River dams and then subsequently at the lowest four Columbia River mainstem dams, but no major source of mortality was found that could explain the magnitude of the poor adult salmon returns observed. Perhaps for this reason this then led to the development of the delayed mortality theory, which suggested that survival in the estuary and/or coastal ocean was poor as a result of cumulative damage occurring from multiple dam passage. Viewed from this perspective, poor estuary or ocean survival was the result of upstream dam operations, and partly for this reason estuary/ocean research became of interest to BPA.

It is not difficult to understand how this process evolved, because it seemed obvious to most biologists at the time that the major dams built in the Columbia River must be having massive impacts. However, the reality was somewhat different, with the advent of the PIT tag system (and then JSATS) documenting some losses during in-river migration, but nowhere near enough to explain the disastrously poor survival levels observed in the 1990s. However, there was apparently both an unwillingness to accept that most of the "survival problem" seemed to be determined at sea and a reluctance to note that salmon stocks in other river systems without major dams also had severe conservation problems. Overall, these additional observations, rarely commented upon, suggested a common ocean mechanism was suppressing adult salmon returns and was likely the most important factor in determining salmon abundance. However, given the oft-stated claim that "*nothing could be done about the ocean*", it was not surprising that the delayed mortality theory was developed, which in essence stated that marine survival of the Snake River stocks was particularly poor because they migrated through more dams than certain other stocks which had better SARS, possibly as a result of greater induced stress. If true, ocean survival could then potentially be improved by manipulating the hydrosystem to reduce stress and the "delayed mortality" component of ocean survival.

With earlier financial support from BPA, Kintama specifically tested this important theory and found no evidence for elevated mortality for smolts migrating through a greater number of dams (or for smolts transported around the dams in barges). Importantly, Kintama's data also pointed to a previously unsuspected reason why management efforts had been largely unsuccessful at recovering salmon populations to the recovery targets: smolt survival rates in the coastal ocean were about the same as the survival rates experienced migrating through the 8 dam FCRPS. If correct, this observation places a wholly new complexion on the reason for poor adult SARS, and suggests that moving smolts more rapidly downriver may do more harm than good in those years when ocean survival rates are lower than freshwater survival rates. This possibility appears to have never been recognized by fisheries managers, whose assumption was that mimicking the more rapid flow rates of the unimpeded "pre-dam" river would give the best survival results because it came closest to the original "natural" river condition. The underlying hidden assumption was that the ocean was largely a benign environment for salmon, and that most of the survival problem was man-made and the result of dam construction.

Understanding the role of the estuary and ocean in determining overall survival is thus of direct relevance to BPA, because at present ocean effects on survival are confounded with the effects of the hydrosystem, and both blame and credit for certain management actions may be improperly attributed without a clearer understanding of how survival is determined. Because of Kintama's experience, the company is uniquely capable of providing this broader perspective.

History of Sole Source to Kintama:

Kintama has no history of sole source contracting.

Why we still need Kintama's services:

Judge Michael Simon stated in his 2016 Opinion and Order (regarding the FCRSP BiOp):

"The Federal Columbia River Power System remains a system that "cries out" for a new approach and for new thinking if wild Pacific salmon and steelhead, which have been in these waters since well before the arrival of Homo sapiens, *are to have any reasonable chance of surviving their encounter with modern man."* New thinking could clearly include a regional perspective including the comparative performance of salmonid populations originating from a broader region. This perspective is currently largely lacking in the Columbia River basin, with almost all work intensively focused on studying salmon within the hydrosystem. However, taking a broader perspective may provide a more nuanced perspective on the region's efforts to restore Columbia River salmon runs. Preliminary analysis suggests that Chinook and steelhead population coming from a wide range of undammed British Columbia & Puget Sound rivers appear to have astoundingly low SARs when compared with the Columbia, and this point has apparently never been picked up on despite during decades of studies. In Alaska, fishery disasters have been repeatedly declared for Chinook salmon originating from multiple pristine watersheds, indicating again that it is not just dams that can drive down salmon populations. Kintama's experience and technical capacity offers a perspective that appears to be remarkably lacking in past BiOp efforts in the Columbia, which have focused on incremental technical fixes to various parts of the hydrosystem. However, this focus may have blinded the region to the possibility that the FCRPS has already been successful in addressing most of the anthropogenic problems, and that the remaining issues may be related largely to climate change in the ocean, and not hydrosystem operations,

Kintama has also been successful in prior work, demonstrating an ability to successfully publish important new research that did not necessarily agree with conventional thinking. Kintama approached BPA in 2001 with an experimental design that could potentially test whether Snake River spring Chinook, which migrate through the four additional Snake River dams relative to mid-Columbia River spring Chinook, were suffering increased mortality downstream of Bonneville Dam in the estuary and during the early marine migration, or hydrosystem-induced delayed mortality. Recognizing the potential, BPA funded Kintama to develop a large-scale acoustic telemetry array which extended from the Snake River basin to southeast Alaska. After several seasons of field testing equipment and surgical fish tagging trials, Kintama launched an extensive study which would track 13-14 cm long acoustic tagged Chinook smolts from the Snake River to Alaska. BPA funded this study and an additional study to evaluate transportation-induced delayed mortality from 2006-2011 (and a wrap up year in 2012). This study may still be the most geographically extensive acoustic telemetry study ever conducted. Results indicated that Snake River spring Chinook had very similar early marine survival relative to their downstream counterparts, and that transportation had little or no effect on early marine survival. Kintama published multiple peer-reviewed journal articles using these data (http://kintama.com/publications/) including two papers in the U.S. Proceedings of the National Academy of Sciences, one of the "*top five*" scientific journals in the world (http://www.pnas.org/content/106/17/6883.full).

Although extensive publications were produced during the prior period of funding, Kintama approached BPA in 2015 to support analysis and complete three additional reports which will use data obtained during project #2003-114-00 in combination with other telemetry data available from Kintama and Kintama's collaborators, as well as collated smolt-to-adult return data developed by a range of government and NGO organizations. These three reports will compare survival of Columbia River basin salmon to salmon from other regions to provide a broader perspective on the performance of Columbia River salmon stocks than is currently available. Specifically Kintama will:

1) Collect & analyze the available data on SARS for west coast salmon stocks and compare to the Columbia. Preliminary analysis indicates that in all regions examined south of Alaska, coast-wide

SARS dropped by almost an order of magnitude since the 1960s-1970s, demonstrating that the Columbia River salmon conservation problem is not unique to the Columbia. Initial analysis of the data for the 2000s also shows that in at least in the recent period the average SARs of BC Chinook are lower than Columbia River Chinook, and that Puget Sound steelhead have lower SARs than Columbia River steelhead—by about a factor of 3 (i.e., SARS are only 1/3rd of the Columbia's). If the Columbia's rebuilding targets of 4-6% SARS are not being met in river systems lacking dams, it raises question of whether they are realistic for the Columbia. The analysis will also contribute perspective on what is really keeping salmon stocks from recovering.

2) Revisit & update Kintama's earlier 2008 "Survival of Migrating Salmon Smolts in Large Rivers with and without Dams" publication, which found that survival rates were slightly lower in the Fraser than in the Columbia. Kintama can now present a more nuanced approach, and show that the newer data we have shows that in the Fraser the losses appear to be due to predation and are largely confined to the tributaries, not the Fraser mainstem. This is again an important perspective, and Kintama developed much of the Fraser River data that is needed for this analysis.

3) Complete a publication addressing important conceptual problems in how biologists think about salmon management. The basic conceptual flaw we will demonstrate is that just measuring survival to Bonneville Dam without taking into account how long the smolts take to arrive there and be counted is like using a Geiger counter to count radioactive decay and concluding that because more fission is recorded over longer time intervals, radioactivity is worse. The potentially important point for management here is that smolts which arrive early at Bonneville Dam then end up spending more time in the coastal ocean because they get there faster. Kintama's data indicates that survival rates in the ocean aren't much different than in the hydrosystem, so higher flow may not actually benefit the smolts, just put them someplace else. If the hydrosystem is manipulated to accelerate smolt arrival in a region with worse survival, then logically managers should take this into account while developing management plans.

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4. **Actions to Promote Competition:** At the onset of each procurement, all unique source justifications are scrutinized and screened for the possibility of further competition by Supply Chain. Further, competition barriers are discussed with the customer and options explored when available. *This section is prefilled and needs no editing.*

5. **Project Estimated Amount:** The anticipated price to the Government is $411,600 ($343,000 to take the three reports to White Paper stage, and additional $68,600 to complete reports if appropriate for publication in the peer-reviewed scientific literature).

6. **Market Survey:** *Describe the market research that was performed that led you to your conclusion that there was need to waive competition. If no market research was performed, such as in instances of Urgent and Compelling, explain in detail here.*

7. **Requirements Certification:** I certify that the requirement outlined in this justification is a bonafide need of the Bonneville Power Administration and that the supporting data under my

cognizance, which are included in the justification, are accurate and complete to the best of my knowledge and belief.
(Signature of the responsible manager)

Name & Title Date

8. **Approval** *This part is filled out by Contracting Staff as part of the Justification*

   a. **Contracting Officer's Certification: (required)** I certify that the foregoing justification is accurate and complete to the best of my knowledge and belief.

Contracting Officer Signature Date

Statement of Work Template

A statement of work should address each of the following topics in the sequence presented below. In the event that a topic is not relevant to a specific acquisition action, it need not be covered.

Part A General

A.1 Objective

The objective of this contract is to provide novel information to BPA & Action Agencies on the survival of two Columbia River populations listed under the US ESA (Snake River spring Chinook salmon and Snake River basin steelhead) relative to salmon survival in other regions of the west coast. Using telemetry data from Kintama's prior BPA project 2003-114-00, as well survival data collated from the broader region, Kintama will produce three reports comparing survival of salmon smolts and adults from the Columbia River Basin to survival of salmon originating from other regions in the Pacific Northwest. These reports will provide a broader perspective on the relative performance of Columbia River salmon survival relative to salmon in other regions lacking dams.

A.2 Background

Beginning in 2001, BPA funded Kintama to design an experiment that could potentially test whether Snake River spring Chinook were suffering increased mortality downstream of Bonneville Dam in the estuary and during the early marine migration due to "hydrosystem-induced delayed mortality" (the major project was #2003-114-00, which superseded an earlier "Innovative Proposals" award in 2001-02). Kintama designed and developed a large-scale acoustic telemetry array and tracked 13-14 cm long acoustic tagged Chinook smolts from the Snake River to Alaska from 2006-2011. The results demonstrated that Snake River spring Chinook had very similar early marine survival relative to their downstream counterparts, and that transportation and the number of dams passed had negligible impact on early marine survival. The results were published in a number of top-ranked peer-reviewed scientific journals and constitute some of the largest-scale experimental tests conducted in ecology.

Although a number of publications were produced, Kintama is proposing to complete three additional reports using data obtained during project #2003-114-00 as well as other telemetry data for B.C. that is available from Kintama and Kintama's collaborators, as well as comparative smolt-to-adult return data for a wide geographic range of west coast salmon stocks. All three reports will compare survival of Columbia River basin salmon (Chinook and steelhead) to salmon from other regions, but taking different perspectives. These broader analyses on Columbia River salmon survival will provide a more holistic view of what salmon survival performance is like along the west coast and offers a perspective that is lacking from recent BiOPs—what levels of salmon survival can be expected in regions without dams.

A.3 Location of Project

This project will be performed at the Kintama Research Services office in Nanaimo, BC Canada.

A.4 BPA-Furnished Property or Services

Description	Point of Delivery	Date to be Delivered
NONE		

A.5 Contractor-Furnished Property or Service

The Contractor shall provide all property and services to perform the work of this contract.

A.6 Definitions

SARs-Smolt to Adult Survival

A.7 Documentation

Specifications and standards (either Federal or industry-wide) which are to be used in the performance of work are listed here, for incorporation by reference into the contract.

Part B Technical Approach/Tasks

B.1 General Requirements

Kintama will collate available data and produce three reports, initially for internal BPA use; if these reports are deemed useful, additional work will then be completed to bring them to a sufficient standard that they are appropriate for submission to peer-reviewed scientific journals for publication. These three reports will:

1) Collect & analyze the available data on Chinook and steelhead SARS for west coast salmon stocks from British Columbia and Puget Sound, and compare to the Columbia River Basin. If the Columbia's rebuilding targets of 4-6% SARS are not being met in regions without dams, which appears to be the case, then the question of whether current rebuilding targets are realistic should be re-assessed. The analysis will also contribute perspective on what is really keeping salmon stocks from recovering.

2) Revisit & update Kintama's 2008 "*Survival of Migrating Salmon Smolts in Large Rivers with and without Dams*" publication, which showed that survival rates were slightly lower in the Fraser than in the Columbia. The re-analysis will be done to refine insights into geographic differences in where comparative survival is high or low in the two river systems, using more recently collected data from the Fraser River that was not available at the time the original report was completed.

3) Collate and analyze data to complete a report addressing some fundamental conceptual problems about how people currently think about salmon management in the Columbia River. Once survival estimates are scaled for the time smolts take to reach Bonneville Dam in different years, survival rates seem to be quite stable across years, so flow manipulation may not really work as claimed. Kintama's acoustic telemetry-based survival data also indicates that survival rates in the ocean aren't much different than in the hydrosystem, so higher flow may not actually benefit the smolts, just place them in a region (the coastal ocean) where survival may be no better than (and, in some years, possibly worse) than in the hydrosystem.

B.2 Methods to be Used

This is a completion contract. Three reports will be completed and submitted to BPA for internal use and review. If the results warrant publication, further funding may be negotiated to support refinement to a level where it can be submitted for peer review and publication in a scientific journal.

B.3 Specific Requirements

Christine—Let's keep this as simple and clean as possible. Any boilerplate you can provide?

The specific steps or activities to be accomplished by the contractor will be described in sufficient detail for the prospective contractor to prepare thorough proposals. If BPA approval or review is required at specific points, they should be defined in this Subpart. In general, this section should include the following elements in chronological order.

Phases (may contain go, no go, decision points). For each phase, include the following:

> Tasks *(may contain go, no go decision points) and detailed activities. Include sub tasks as needed. For each Task, include a due date expressed in elapsed days after award, not in specific calendar dates, as well as the following:*
>
> > *Deliverables. Deliverables could be specific products such as computer disks or printouts, copies of a publication or a report, presentation of workshops or briefings, test plans, specifications, drawings, test data, or other types of measurable results.*

Quality Assurance. ***This section should clearly state the manner in which BPA will determine whether the contractor has met the requirements of each Task or Deliverable. If BPA reserves the right to reject a report as incomplete or inaccurate, the criteria by which that decision will be made should be outlined. Indicate the minimum quality level, and the range of deviation acceptable. Also describe how rejection or variances outside the acceptable range of deviation may reduce or nullify payments and will require the contractor to rework or submit a plan for remedy.***

Payment. ***A description of how pricing, as shown in the Schedule of Prices of the contract Terms, correlates with each Task or Deliverable. Also include any instructions about the payment process that are unique to this task. For example, "Upon completion of this Task, BPA will pay the contractor the fixed price indicated in the Schedule of Prices. Contractor shall not invoice BPA for this Task prior to BPA acceptance of the work."***

Phase 1

Tasks: Collect & analyze the available data on Chinook and steelhead SARS for west coast salmon stocks and compare to Columbia Basin.

Deliverables: report and presentation?

QA:

Payment:

Phase 2

Tasks

Deliverables

QA

Payment

Phase 3

Tasks

Deliverables

QA

Payment

B.4 Summary of Deliverables.

Description	Format	Due Date	Days for BPA Review
Comparative Chinook and steelhead SARS for west coast salmon stocks	White paper report for internal BPA use	31 July 2017	1 month
Updated comparative analysis of Kintama's 2008 "*Survival of Migrating Salmon Smolts in Large Rivers with and without Dams*" publication	White paper report for internal BPA use	1 March 2017	1 month
Comparison of ocean & hydrosystem survival rates and implications for Columbia River salmon conservation	White paper report for internal BPA use	1 March 2017	1 month

Part C Inspection and Acceptance (Quality Assurance)

This section should provide a summary of the methods that the COTR and Field Inspectors will use to perform quality assurance. At a minimum, BPA should describe its intent to conduct periodic surveillance. Other methods may include Trend Analysis, Third-Party Audits, and Contractor Reported Data.

Part D Technical Exhibits

In some instances, voluminous and detailed data is required to provide the contractor with sufficient information to develop a proposal. Such detail should be appended as exhibits to the work statement.

From: Creason,Anne M (BPA) - EWL-4

Sent: Fri Aug 19 12:04:25 2016

To: David Welch

Cc: Zelinsky,Benjamin D (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4

Subject: RE: Draft SOW & Sole Source. Justification..

Importance: Normal

Thanks David. Yes, Christine and I spoke regarding the "appearance of bias" issue and I complete agree that you should do what is necessary to make sure your study is viewed as unbiased as possible.

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, August 19, 2016 11:48 AM
To: Creason,Anne M (BPA) - EWL-4
Cc: Zelinsky,Benjamin D (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4
Subject: RE: Draft SOW & Sole Source. Justification..

Thanks so much—I apologize for the confusion.

Erin did much of the leg work on putting these two files together during my two week's absence on holidays, and then left for two weeks vacation just before I got back. I guess I must have somehow incorrectly assumed that Christine assumed the lead.

As a result, I had an extensive phone discussion this morning with Christine about one issue—the need to be able to certify to journals (if we go for the full publication route) that BPA has not "influenced or directed" the study and that Kintama is solely responsible for the analysis and conclusions. This is obviously a delicate balancing act since BPA will be the funder, but one that in my view we should try to maintain. I suggest that you ask Christine for her "Readers Digest" version of the issue I laid out for her, and we can then touch base by telephone to discuss further if you have questions or concerns.

David

kintamav_RGB

Office: (250) 729-2600 (x) 223

Mobile: (b) (6) [redacted]

From: Creason,Anne M (BPA) - EWL-4 [mailto:amcreason@bpa.gov]
Sent: Friday, August 19, 2016 11:41 AM
To: David Welch
Cc: Zelinsky,Benjamin D (BPA) - EWP-4
Subject: FW: Draft SOW & Sole Source. Justification..

Importance: High

Hi David—

Just wanted to make sure you have my correct email address. You had sent this email and information to Christine Peterson, who is more of a technical contact, and won't be the COTR on this.

I'll have a look and get back to you. I'm still waiting for Ben to get back to me on the funding part of this before I dive too much further into getting this submitted.

Thanks—

Anne

From: Petersen,Christine H (BPA) - EWP-4
Sent: Friday, August 19, 2016 11:37 AM
To: Creason,Anne M (BPA) - EWL-4
Subject: FW: Draft SOW & Sole Source. Justification..

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, August 19, 2016 11:14 AM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Aswea Porter; Erin Rechisky
Subject: Draft SOW & Sole Source. Justification..

Hi Anne-

Please see attached. As mentioned, if we can keep the specific reporting/check-in requirements as simple as possible, this will be helpful from the perspective of getting the papers published in high quality reputable journals where the authors need to certify that *"...the funders played no role in the design or execution of the study"*. Ideally, the requirements here will simply state that Kintama will provide a white paper to BPA, and BPA will make a decision to support additional funding for the peer-reviewed publication at that time. Your contracting folks may want more details than this of course, to satisfy their own requirements.

I have also used **red font** for the summary of deliverables section, as you may want to look at this closely from BPA's scheduling perspective. There is a ***lot*** of work to do to meet these timelines, but I think it is just feasible if we start soon.

Finally, we will be glad to investigate the possibility of including Willamette R SARS in the SAR report, so please provide a contact if you have one for this data. However, to ensure that we scrupulously maintain a balanced perspective here, can you also advise on any other substantial sources of below Bonneville SAR data for the Columbia River that we should also try to incorporate?

I look forwards to your response. FYI, I have not CCed Ben Zelinski on this, as I leave it up to you to forward for comments as appropriate.

Thanks, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

10-1850 Northfield Road, Nanaimo, BC, Canada V9S 3B3

Office Tel: (250) 729-2600 (x) 223   Fax: (250) 729-2622 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: **http://kintama.com/media/videos/**

P Please consider the environment before printing this e-mail

From: David Welch

Sent: Tue Aug 23 15:38:15 2016

To: Petersen,Christine H (BPA) - EWP-4

Cc: BROSNAN, IAN G. (ARC-SG)

Subject: RE: Elder et al 2016

Importance: Normal

Attachments: JAAH TDG Paper Revision 2 Submission Proof (1 June 2016).pdf

Thanks, Christine-- I appreciate the perspective-- the Columbia River "juggernaut" has gotten so massive that sometimes it is hard to sort out why people say and do some of the things that they do. I think that the answer is "Groupthink" and it is not something unique to the region or the Columbia River biologists... there is a great book called "Criminal Investigative Failures" (Rossmo, D. K. (2008). Criminal investigative failures: CRC Press.) that takes apart a number of very high profile wrongful criminal convictions to see what went wrong. (I went to this literature because here the pressure on public officials to come up with an answer is even greater and the sometimes "unprofessional" behavior of the individuals that results has an even greater impact than what occurs in operating the dams).

One of the key points from that book is that groupthink tends to come to dominate a group of detectives when they feel beleaguered, all sit around the same table, and develop tunnel vision... they become convinced they have the correct culprit far too early/quickly and narrow the investigation process down and exclude potential offenders... and then they become motivated to defend those initial decisions because they all sat around the table and collectively made them and they now feel the need to defend the integrity of their colleagues and "the process", rather than push the "restart button". I see strong analogies to the lack of willingness of salmon biologists coast-wide to admit that a lot of the salmon problems are out at sea, and that they need to address them head on rather than continue to fight for continued efforts to do things in freshwater.

I copy Ian Brosnan for his knowledge that I have given you the accepted copy of the manuscript. Please keep this within tight bounds at BPA until it is published... No sense in giving the FPC any extra time to prepare one of their memos trashing a result that they don't like...

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, August 23, 2016 3:21 PM
To: David Welch

Subject: RE: Elder et al 2016

Hi David,
No problem at all - at many places with various organizational structures, it is perfectly fine to talk with anyone on the 'team' about a contract matter. Our own organizational structure can be a bit hard to discern - the set of folks at your presentation were from both 'power generation' and our F&W program.

It would be nice to see your current TDG paper, and I would not disperse it widely. I saw a version from two years ago. Tomorrow, a couple of us are going to the Corps temperature modeling presentation. Water quality will play a big role in this EIS, and there are a number of small debates that we have not chosen to engage in recently.

Yes, when we were talking about how the Columbia River area came to have the arrangement of agency roles, with FPC serving as an unofficial biometry experts/policy voices. In a sense, I think the 'action agencies' (Corps, BPA, Bureau) don't effectively do their PR job. We have staff who put together presentations showing our side of the story, and I think they get presented internally and don't reach outside news agencies. Our rarely visited youtube channel has some great pieces on projects we've funded, done by John Tyler. There is a weekly meeting called FPAC which is attended by the state agencies, tribes, and one NOAA rep, where FPC play the role of presenting environmental conditions and fish numbers every week, and they also tend to push the agenda that is reflected in the memos that they write up. I rarely paid attention, but I noticed that Jason Sweet sometimes listens to their online recordings in order to see what the hot issues are. There have been examples where there is suddenly a set of news articles which claim the same thing (that dams are heating the river, or lack of spill is killing fish yet a little bit more could double returns) and this can be traced back to FPAC and press releases that are sent out. We are not able to really write a rebuttal to a memo because it isn't exactly our place as a government agency. One could argue that NOAA is the agency which is supposed to regulate the Action agencies, and should be the official statisticians and policy makers. BPA needs to ultimately convince NOAA, the NPCC council and the court, but losing in the public perception can be a big problem for us.

http://blogs.idahostatesman.com/a-primer-on-the-salmon-science-debate-underlying-spill-test-proposal/
http://www.oregonlive.com/opinion/index.ssf/2015/05/planned_cormorant_slaughter_is.html

-----Original Message-----
From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, August 19, 2016 2:12 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: RE: Elder et al 2016

Right-- it was-- I just falsely assumed that since I had been talking with you about issues this week that you had taken over as COTR sometime after I had left on holidays.

It would be good to talk about the TDG paper and get your take on it, but can I send you the accepted draft copy without having it too broadly distributed at this point (discreet discussion at BPA is fine)? I just don't want to be seen as lobbying over the results-- the study has limitations, but it also is the first paper I know of that documents the possibility that sub-lethal TDG exposure can potentially be causing elevated mortality later in the plume, and multiple days after exposure. This is presumably because of stroke-like symptoms from TDG making the affected smolts more susceptible to predation but of course we can't get at the mechanism from this sort of observationa; study.

You can see the reviewer's & editor's final comments on it accepting the version I will send you, noting the likely key points of contention, and if you want I can provide the earlier criticisms and our detailed rebuttals. As for actually publication, when it can be freely cited, I'm not sure-- it may well be months before the journal actually puts it on their website.

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, August 19, 2016 1:36 PM
To: David Welch
Subject: Re: Elder et al 2016

Hi,
Sorry, here is where I think the misunderstanding started this morning. I thought you might be wanting to generally talk about what you are doing, or sources of data, or the TDG topic.

Christine

----- Original Message -----
From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, August 18, 2016 04:21 PM Pacific Standard Time
To: Petersen,Christine H (BPA) - EWP-4
Subject: RE: Elder et al 2016

Hi Christine--

Are you available to take a brief phone call now? Or should I call you in the morning on Friday?

David

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, August 18, 2016 3:35 PM
To: David Welch
Subject: FW: Elder et al 2016

Hi David,

Agnes just mentioned the status of your paper with Ian Brosnan. I thought I would forward this paper that just went into print. Several thought that Tim Elder's statistical methods were hard to understand, and also didn't understand the inference of a elevated effect from going through multiple dams when his tables seem to show lower mortality with multiple dams (more of a culling effect?).
Scott and I saw a draft of this when it looked a bit different, and I gave it extra points for selecting this technique which would not require them to presume the shape of the curve of the relationship (like a linear regression) and for considering TDG and barometric pressure as variables. I realized I have to look more into the importance of barometric pressure differential because I havent' considered it before.

Along other lines, was your group able to identify sources of Willamette SARs data? This might be a challenging location due to the history of hatcheries and their various release locations but there are a few people with OSU and the Corps who could probably find wild or reliable hatchery data.

Christine Petersen

-----Original Message-----
From: Bettin,Scott W (BPA) - EWP-4
Sent: Thursday, August 18, 2016 2:51 PM
To: Grimm,Lydia T (BPA) - A-7; Bodi,Lorri (BPA) - E-4; Francis,Rose (BPA) - LN-7; Barco III,John W (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4; Doumbia,Julie A (BPA) - PGB-5; Sweet,Jason C (BPA) - PGB-5
Subject: FW: Elder et al 2016

http://www.fpc.org/documents/memos/47-16.pdf

It appears Michele is catching up on her reading. A 12 page review of the document was kicked off with this sentence. "The subject analysis is so extensively flawed that the conclusions reached are not credible or applicable to any fish passage management questions." - s

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4
Sent: Friday, August 12, 2016 12:54 PM
To: Bettin,Scott W (BPA) - EWP-4; Sweet,Jason C (BPA) - PGB-5
Subject: FW: Elder et al 2016

Charlie spotted that this paper you got from Mark Weiland a couple years ago got into print. I think they get a bonus point for considering TDG and even having this as a major risk around dams. I'm not sure how the rest of the world will perceive it. They aren't dwelling on the routes the fish went through.

-----Original Message-----
From: Charlie Paulsen [mailto:cpaulsen@paulsenenvironmentalresearch.com]
Sent: Friday, August 12, 2016 10:23 AM

To: Petersen,Christine H (BPA) - EWP-4; Doumbia,Julie A (BPA) - PGB-5
Subject: Elder et al 2016

Christine & Julie:

I saw this discussed in CBB this morning, and I'm not quite sure what to make of it. If you get a chance to look at it I'd appreciate hearing your views.

Charlie

From: Petersen,Christine H (BPA) - EWP-4

Sent: Tue Aug 23 15:45:50 2016

To: 'David.Welch@kintama.com'

Cc: 'ian.g.brosnan@nasa.gov'

Subject: Re: Elder et al 2016

Importance: Normal

Thank you.

I might share with our new water quality person Kim Johnson.

Best
Christine

----- Original Message -----
From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, August 23, 2016 03:38 PM Pacific Standard Time
To: Petersen,Christine H (BPA) - EWP-4
Cc: BROSNAN, IAN G. (ARC-SG) <ian.g.brosnan@nasa.gov>
Subject: RE: Elder et al 2016

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http://www.oregonlive.com/opinion/index.ssf/2015/05/planned_cormorant_slaughter_is.html

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From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, August 19, 2016 1:36 PM
To: David Welch
Subject: Re: Elder et al 2016

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Christine

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Sent: Thursday, August 18, 2016 04:21 PM Pacific Standard Time
To: Petersen,Christine H (BPA) - EWP-4
Subject: RE: Elder et al 2016

Hi Christine--

Are you available to take a brief phone call now? Or should I call you in the morning on Friday?

David

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Christine Petersen

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Subject: FW: Elder et al 2016

http://www.fpc.org/documents/memos/47-16.pdf

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Sent: Friday, August 12, 2016 12:54 PM
To: Bettin,Scott W (BPA) - EWP-4; Sweet,Jason C (BPA) - PGB-5
Subject: FW: Elder et al 2016

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Sent: Friday, August 12, 2016 10:23 AM
To: Petersen,Christine H (BPA) - EWP-4; Doumbia,Julie A (BPA) - PGB-5
Subject: Elder et al 2016

Christine & Julie:

I saw this discussed in CBB this morning, and I'm not quite
sure what to make of it. If you get a chance to look at it
I'd appreciate hearing your views.

Charlie

From: David Welch

Sent: Tue Aug 23 15:56:38 2016

To: Petersen,Christine H (BPA) - EWP-4

Subject: RE: Elder et al 2016

Importance: Normal

No opinion on the Kokanee vs sockeye debate in the Okanogan... sorry, but I just don't know enough to be able to comment intelligently!

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, August 23, 2016 3:55 PM
To: David Welch
Subject: Re: Elder et al 2016

Oh,
Here is a question from left field. Do you have an opinion on whether they should open the fish ladder at Okanagan Lake and let sockeye enter there? I believe the controversy is over whether they would crowd out the kokanee. Jeff Fryer was showing me some of the locations there.

I think another good example of a small set of experts spreading their idea is in the film Dam Nation from last year. Patagonia clothing awards some profits for projects like this. The concept for their first 30 min was spot on- there are thousands of unmaintained dam and agricultural diversions structures around the world that are unmaintained, outdated, and just need funding for removal or modification. But the director seemed like he had only a few months to do research so he set upon material from around 2001 to cocclude that the lower Snake dams are currently the worst, and worthy of a special campaign- even though a billion was just spent on upgardes. The filmmakers were unable to identify any of the hundreds of better candidates to profile. Their economics argument for power vs maintenance cost was flawed. Their recreation argument was flawed too. Nobody would kayak the Snake. Reservoirs are popular for boating.

----- Original Message -----
From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, August 23, 2016 03:38 PM Pacific Standard Time
To: Petersen,Christine H (BPA) - EWP-4
Cc: BROSNAN, IAN G. (ARC-SG) <ian.g.brosnan@nasa.gov>
Subject: RE: Elder et al 2016

Thanks, Christine-- I appreciate the perspective-- the Columbia River "juggernaut" has gotten so massive that sometimes it is hard to sort out why people say and do some of the things that they do. I think that the answer is "Groupthink" and it is not something unique to the region or the Columbia River biologists... there is a great book called "Criminal Investigative Failures" (Rossmo, D. K. (2008). Criminal investigative failures: CRC Press.) that takes apart a number of very high profile wrongful criminal convictions to see what went wrong. (I went to this literature because here the pressure on public officials to come up with an answer is even greater and the sometimes "unprofessional" behavior of the individuals that results has an even greater impact than what occurs in operating the dams).

One of the key points from that book is that groupthink tends to come to dominate a group of detectives when they feel beleaguered, all sit around the same table, and develop tunnel vision... they become convinced they have the correct culprit far too early/quickly and narrow the investigation process down and exclude potential offenders... and then they become motivated to defend those initial decisions because they all sat around the table and collectively made them and they now feel the need to defend the integrity of their colleagues and "the process", rather than push the "restart button". I see strong analogies to the lack of willingness of salmon biologists coast-wide to admit that a lot of the salmon problems are out at sea, and that they need to address them head on rather than continue to fight for continued efforts to do things in freshwater.

I copy Ian Brosnan for his knowledge that I have given you the accepted copy of the manuscript. Please keep this within tight bounds at BPA until it is published... No sense in giving the FPC any extra time to prepare one of their memos trashing a result that they don't like..

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From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, August 23, 2016 3:21 PM
To: David Welch
Subject: RE: Elder et al 2016

Hi David,
No problem at all - at many places with various organizational structures, it is perfectly fine to talk with anyone on the 'team' about a contract matter. Our own organizational structure can be a bit hard to discern - the set of folks at your presentation were from both 'power generation' and our F&W program.

It would be nice to see your current TDG paper, and I would not disperse it widely. I saw a version from two years ago. Tomorrow, a couple of us are going to the Corps temperature modeling presentation. Water quality will play a big role in this EIS, and there are a number of small debates that we have not chosen to engage in recently.

Yes, when we were talking about how the Columbia River area came to have the arrangement of agency roles, with FPC serving as an unofficial biometry experts/policy voices. In a sense, I think the 'action agencies' (Corps, BPA, Bureau) don't effectively do their PR job. We have staff who put together presentations showing our side of the story, and I think they get presented internally and don't reach outside news agencies. Our rarely visited youtube channel has some great pieces on projects we've funded, done by John Tyler. There is a weekly meeting called FPAC which is attended by the state agencies, tribes, and one NOAA rep, where FPC play the role of presenting environmental conditions and fish numbers every week, and they also tend to push the agenda that is reflected in the memos that they write up. I rarely paid attention, but I noticed that Jason Sweet sometimes listens to their online recordings in order to see what the hot issues are. There have been examples where there is suddenly a set of news articles which claim the same thing (that dams are heating the river, or lack of spill is killing fish yet a little bit more could double returns) and this can be traced back to FPAC and press releases that are sent out. We are not able to really write a rebuttal to a memo because it isn't exactly our place as a government agency. One could argue that NOAA is the agency which is supposed to regulate the Action agencies, and should be the official statisticians and policy makers. BPA needs to ultimately convince NOAA, the NPCC council and the court, but losing in the public perception can be a big problem for us.

http://blogs.idahostatesman.com/a-primer-on-the-salmon-science-debate-underlying-spill-test-proposal/
http://www.oregonlive.com/opinion/index.ssf/2015/05/planned_cormorant_slaughter_is.html

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I'd appreciate hearing your views.

Charlie

From: Zelinsky,Benjamin D (BPA) - EWP-4

Sent: Mon Aug 29 14:26:22 2016

To: David Welch (david.welch@kintama.com)

Cc: Creason,Anne M (BPA) - EWL-4; Erin Rechisky (Erin.Rechisky@kintama.com)

Subject: funding issue

Importance: Normal

So it turns out the manager who thought they might have some money available didn't realize that that money was designated for transmission work. Needless to say, this would have been nice to know a month ago. So, I am now looking for a different source of funding from our FY17 budget. We should adjust our expectations downward and our schedule outward but I'm not done trying to find a way to make this work. Let me see what I can do this week and then lets have a call to discuss status and next steps later this week.

Sorry for the mixed news. I'll share another update as soon as I learn more about what our options are.

Ben

From: David Welch

Sent: Wed Aug 31 11:21:27 2016

To: Zelinsky,Benjamin D (BPA) - EWP-4

Subject: RE: Touching base...

Importance: Normal

Great—ttyt.

From: Zelinsky,Benjamin D (BPA) - EWP-4 [mailto:bdzelinsky@bpa.gov]
Sent: Wednesday, August 31, 2016 10:54 AM
To: David Welch
Subject: RE: Touching base...

Would tomorrow at 10 work for a call?

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, August 30, 2016 3:55 PM
To: Zelinsky,Benjamin D (BPA) - EWP-4
Subject: Touching base...

Hi Ben—

I was wondering if we could have a quiet chat at some point as to exactly where you think things will go. Two months ago out of the blue I received a very good offer to purchase the building we work out of, which as I think you know, I had spent a lot of time (& $) having constructed to support our tagging operations.

Since the field work that requires the tagging infrastructure is not currently being supported on either side of the border, my decision was to sell the building, put all of the high end equipment into temperature controlled storage, and move three of us into a smaller rental office somewhere until scientific interest and revenues increased to support the larger facility. (This building is 8,500 square feet, and has work space for up to 14 staff).

From BPA's perspective, this change should be of no consequence, because you folks are only contracting us for 3 (perhaps now 2) reports. However, it is of concern to me because I need to make some decisions about what sort of office space to lease, and how many staff to keep on to support analysis and writing of these reports.

We will not be moving out of the current offices until the end of November, so there is no immediate urgency concerning the move, but the slow and unpredictable nature of government contracting does make me concerned about making any further decisions until I can be sure something will go through.

As for my view of the three reports, the one I would recommend dropping right now for budgetary reasons would be the "Large Rivers comparison" between the Fraser and the Columbia Rivers. This would keep what I would think are the two most important reports meeting BPA's key information needs: one showing that SARS are lower for salmon stocks outside the Columbia River basin and one demonstrating a major flaw in how the region thinks about salmon survival (because they have ignored what survival rates are like in the coastal ocean). Although traction on the latter issue has been slow in the region, it is a critical paper for challenging the current mindset, because it can demonstrate that there is a fundamental flaw in how people are thinking about the survival issues, and will also offer a potential way to address the problems.

However, there is not a lot of point making strategic recommendations to you if there is not a budget available. Your guidance would be appreciated.

Best, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

10-1850 Northfield Road, Nanaimo, BC, Canada V9S 3B3

Office Tel: (250) 729-2600 (x) 223 Fax: (250) 729-2622 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: David Welch

Sent: Fri Oct 21 14:02:07 2016

To: Ben Zelinsky

Subject: Moving forwards--

Importance: Normal

Hi Ben—

After due consideration, I am prepared to move forwards with the abbreviated contract (and thank you for your support and efforts in this).

My suggestion here is that we move forwards with the third item (Comparison of Ocean and Hydrosystem Survival Rates, targeting the journal Science for this paper).

The rationale is two-fold: (a) it is the only one of the three products that comes (just) under the $119K availability, and (b) once done it will strongly set the stage for the broad survey paper showing that SARS in other regions are even worse than in the Columbia River hydrosystem. This will certainly give Lori a serious negotiating position when she can point out that survival rates are worse in other places and the reason that transport in the Columbia River hasn't been very effective Is because folks have been "dumping" fish into a region with equally poor (or worse) survival.

[redacted] Give me a call at the house after 2:30 (or email) if you need further discussion in order to move forward—I believe that the narrative for the SOP that we sent BPA earlier is probably sufficient to move forwards, but of course I'm not in a position to be certain.

Thank you, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

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Office Tel: (250) 729-2600 (x) 223   Fax: (250) 729-2622 Mobile: [redacted]

House: (250) 756-7747

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Browse animations of our

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P Please consider the environment before printing this e-mail

Complete a non-competitive justification for procurements with an anticipated value of over $10,000 following this format as it applies. A non competitive transaction justification is not required for procurements under $10,000, procured from Federal Prison Industries, other federal agencies, AbilityOne Nonprofit Agencies for the Blind or other Severely Handicapped, Government Printing and Binding or for utility services. (BPI 11.7.1.1)

1. **Description of Materials or Services:**
Provide a complete description of the requirement, what program or project it supports and how it supports the mission of BPA. Quantities and detailed descriptions are not required unless as a part of the justification contained in section 3 of this justification. If requesting materials, include the Manufacturer, Manufacturer's part number, and indicate whether or not a time critical outage schedule for use of these items applies.

This contract will provide technical support for estuary-related BiOp issues. The contractor will help the Action Agencies evaluate restoration and acquisition projects for survival benefits accruing from the implementation of a set of projects provided by BPA. The contractor will provide technical/policy staff support to the Action Agencies relative to the Expert Regional Technical Group, including the development of templates and other needed products. The contractor will work with the University of Washington and a panel of scientists to extend the Landscape Planning Framework to additional reaches in the estuary.

2. **Non Competitive Authority:** *From the list below check the applicable BPI authority permitting the proposed non-competitive transaction. Contact your Contracting Officer or Team Lead if you need assistance.*

☐ Repair parts, accessories, supplemental equipment or services required for supplies or services previously furnished or contracted for which are available from only one contractor. (BPI 11.7.1.2(a));

☐ Required by law or Executive Order (BPI 11.7.1.2(b));

☐ The entity has the responsibility to manage the property or resource to be affected by the services performed. (BPI 11.7.1.2 (c));

☐ BPA standard items, when a Business Line Vice President or equivalent level manager has determined in writing that BPA must standardize the use of the item, and that determination is available for review by the HCA. (BPI 11.7.1.2 (e));

☐ Agreements with nonprofit research organizations such as the Electric Power Research Institute (EPRI) for the purposes identified in this section (BPI 11.7.1.2 (f) (1-6));

☐ Establish or maintain an essential engineering, research, or development capability to be provided by an educational or other nonprofit institution or a federally funded research and development center. (BPI 11.7.1.3 (a));

☐ When other parties have offered BPA an opportunity to participate in specific projects on a cost-sharing basis, and the sponsor has arranged for a substantial portion of the required funding for the entire project. (BPI 11.7.1.3(b));

X☐ This is the only feasible source which can meet BPA's requirement and no other supplies or services will satisfy agency requirements (BPI 11.7.2);

3. **Justification:**

Provide sufficient information to support the proposed non competitive transaction based on the authority cited above and instructions of this section. Keep in mind that this document is reviewed and that your explanations may be formally questioned and protested if your justification is insufficient or not valid. For the BPI authorities 11.7.1.2 (f), 11.7.1.3(a) and 11.7.1.3(b), be sure to address the specific information required by those sections. For the BPI authority 11.7.2, unique source, all of the following elements must be provided: (1) The minimum mandatory requirements for the procurement (may be addressed in Section 1, Description of Materials or Services); (2) Identify what other sources were considered during market research (may be addressed in Section 6, Market Survey, below) and why those sources do not meet the minimum mandatory requirements and are not feasible due to form, fit, function, capabilities, capacity, experience, price, or delivery timeframe; (3) Demonstrate that the proposed contractor is the only feasible source based on unique capabilities, unique experiences, or unique attributes.

PCTrask

Bonneville Power Administration has contracted with PC Trask and Associates, Inc. under project #2007-389-00 since October, 2006 for Estuary related FCRPS Biological Opinion (BiOp) issues.

Why BPA is doing Estuary Habitat Restoration:

To my knowledge, the Estuary Habitat program started back as early as 2003. The objective as noted in the 2004 BiOp is: *the Action Agencies will continue to implement actions based on these plans directed at providing biological benefit to ESA-listed fish.* The habitat work has continued in the 2010 BiOp and the 2014 BiOp where the objective is: *RPA Actions 36 and 37 require the Action Agencies to fund and implement habitat improvement projects in the lower Columbia River estuary (LCRE) to partially offset adverse effects to salmon from FCRPS operations. The purpose of this program is to improve the survival of juvenile migrants during passage through and residence in the estuary and thus increase the proportion and fitness of juvenile migrants that leave the estuary to begin their ocean life stage. As described below, the best available scientific information indicates that this can be accomplished by improving habitat quality and quantity in the LCRE wherehabitat important for salmon has been altered from its original state by floodplain development and flow regulation. Recent application of this science now focuses the Action Agencies' habitat improvement program on reconnecting large floodplain areas adjacent to the mainstem Columbia River as the most likely means of achieving the expected survival improvements*

History of Sole Source to PCTrask:

Back in 2006, Cathy Tortorici (NOAA Fisheries Estuary Scientist) was part of the Habitat Technical Subgroup of the FCRPS Hydropower BiOp Remand Collaboration. The subgroup struggled with how to credit estuary projects (in support of the BiOp). Cathy had PCTrask already on contract to work on the Estuary Module, so she added funds to see if there was a way to move the estuary portion forward building off the Estuary Module. PCTrask came up with a conceptual model for how the Subgroup might use the Estuary Module to credit federal projects in support of the BiOp. Everyone liked the approach and so Tracey Yerxa (the BPA-F&W Project Manager at the time) started the contract. BPA (in coordination with Corps of Engineers & NOAA Fisheries) are still implementing restoration actions to fulfill our obligations under the FCRPS BiOp.

Why we still need PCTrask services:

The estuary program has evolved over the years where PCTrask has played an important part. In the early years (2006-2011), PCTrask worked with the subgroup developing a credit mechanism and evaluated and scored projects for salmonid benefits using the "Estuary Module". They also played a role in tracking habitat progress and assisted BPA in reporting this progress to the region. Around 2011-ish, the Expert Regional Technical Group (ERTG) was formed consisting of 5 regional estuary experts; they are now the responsible party to score the projects. The ERTG meets monthly and will review projects at 60% design. However there is a lot of work and expense prior to a project getting to 60% design. PCTrask plays an important role in that they "channel their inter-ERTG" and provide BPA with a preliminary score as well as a social/technical complexity outlook. This way BPA knows whether or not a project will be a good investment and if it is worth moving forward in feasibility/design and ultimately restoration where the Action Agencies (AA's consist of BPA, BOR & Corps of Engineers) receive credit.

In the 2010 BiOp court hearings, Judge Redden instructed the Action Agencies (BPA & Corps of Engineers) to do a better job with providing a pipeline of future actions. PCTrask along with BPA, COE and our restoration partners spent a lot of time searching the estuary for potential projects. This team scored each project, PCTrask created cost estimates and we now have that list. There were 150 actions scored, some have already been implemented and many more will be. Having this list of projects played a key role for the Defendants (NOAA, COE, BOR with support from BPA) in the recent Federal Court hearings where the Estuary is a hot topic for the Plaintiffs (Oregon, Environmental groups, etc.).

PCTrask knows all of those projects, they know all areas of the estuary and what would constitute a cost effective project for BPA. They are very successful in presenting projects to the ERTG; whereas many of our restoration partners do not shine in that area**. If a project gets a higher score, this is a cost savings to BPA in that there are less benefits to achieve.** The Action Agencies are required to achieve 45 Ocean and 30 Stream Benefit Units (SBUs) by 2018. For example, if a project costs $1M to implement, the better it is presented to ERTG, the better score. The cost will still be $1M. PCTrask also maintains a GIS database of all estuary actions; this information is then uploaded into www.cbfish.org (the F&W programs database).

PCTrask knows about all of our previously restored actions. BPA has had turnover within the Estuary Team, so PCTrask offers the history that we need to continue our success and fulfill our legal obligations outlined in the BiOp.

To summarize, PCTrask is instrumental in BPA's continued success in fulfilling our BiOp requirements. This expertise is invaluable and is not available through other contractors.

University of Washington

The University of Washington was identified early-on in the project primarily because Si Simenstad conceived of and developed (with assistance from the US Geological Survey) the Ecosystem Classification, the digital platform upon which the Landscape Planning Framework is premised. In addition, Si's efforts through the University of Washington in cooperation with NOAA Fisheries' Northwest Fisheries Science Center have pioneered the estuary community's understanding of the relationship between juvenile salmonids and their habitat requirements. This expertise is invaluable and is not available through other contractors.

Ron Thom

Ron is an ERTG member since inception in 2011. He was employed with PNNL until he retired in 2013. During that entire time, Ron was funded under F&W project 2002-077-00 along with other ERTG members and the ERTG facilitator. When he retired, he had an agreement with PNNL that for 3-years he could directly bill PNNL for his time/travel. That 3-year agreement expired June 30, 2016. There are 2 options which allow Ron to continue as an ERTG member:

1) Emeritus status – keeps his office at the lab and interactions w/ staff, but cannot charge to projects, e.g., ERTG, unless he is subcontracted directly by BPA or some other non-PNNL entity;

2) Contractor status – gives up his office at the lab, but is subcontracted by PNNL as a consultant (like Dan and Kim) for work on the ERTG .

Emeritus status allows Ron to be at the PNNL lab. He is a resource to other PNNL staff who is actively involved in evaluating the effectiveness of BPA funded estuary habitat projects.

The AAs want Ron to continue as an ERTG member based on his 40+ years of experience & research in coastal & estuarine ecosystems. He also has cohesiveness with the other 4 ERTG members. Where the other members have expertise in geomorphology or fish presence, Ron is an expert of habitat metrics which basically is the center stone of a restoration project.

After discussion with Stephanie Green & Kellie Bowen (Contract Specialists) and the desire to go with option 1 for the many benefits that brings, we could have either contracted with him directly or add him as a subcontractor under another BPA funded project. The PNNL contract runs from September – August. Since the agreement expired at the end of June, we had made the change late spring. Given the fact that the PCTrask also supports the ERTG process, all parties agreed that Ron would be a subcontractor under the PCTrask contract. Therefore Ron will charge his time/travel to PCTrask and PCTrask will then bill BPA. There is a 10% markup on subcontracts, but there would be an administrative expense (in staff time) if BPA was to hire Ron via the SLMO process.

Below is a quick Bio on Ron as well as a link to his full Bio on the PNNL web page.

Ron has conducted research in coastal and estuarine ecosystems since 1971. His research includes coastal ecosystem restoration; adaptive management of restored systems; effects of pollution; benthic primary production; climate change; and ecology of fisheries resources. He has a Ph.D in Fisheries and has published numerous papers on estuarine related topics.
http://marine.pnnl.gov/staff/staff_info.asp?staff_num=749

4. **Actions to Promote Competition:** At the onset of each procurement, all unique source justifications are scrutinized and screened for the possibility of further competition by Supply Chain. Further, competition barriers are discussed with the customer and options explored when available. *This section is prefilled and needs no editing.*

5. **Project Estimated Amount:** The anticipated price to the Government is $316,736
Requester must fill in the estimated or actual amount here (attach any and all quotes received). At time of award the Contracting Officer will determine if price is fair and reasonable.
This value has been available to this project since 2011. It is slightly higher with the addition of Ron's work. The on-call services are still a high priority for the F&W program to fulfill our BiOp obligations.

6. **Market Survey:** *Describe the market research that was performed that led you to your conclusion that there was need to waive competition. If no market research was performed, such as in instances of Urgent and Compelling, explain in detail here.*
See justification

7. **Requirements Certification:** I certify that the requirement outlined in this justification is a bonafide need of the Bonneville Power Administration and that the supporting data under my cognizance, which are included in the justification, are accurate and complete to the best of my knowledge and belief.
(Signature of the responsible manager)

John Skidmore F&W Implementation Manager 7/17/2015
Name & Title Date

8. **Approval** *This part is filled out by Contracting Staff as part of the Justification*

   a. **Contracting Officer's Certification: (required)** I certify that the foregoing justification is accurate and complete to the best of my knowledge and belief.

Contracting Officer Signature Date

Statement of Work Template

A statement of work should address each of the following topics in the sequence presented below. In the event that a topic is not relevant to a specific acquisition action, it need not be covered.

Part A General

A.1 Objective

Provide novel information to BPA & Action Agencies on comparative fresh water and early marine survival rates of Columbia River spring Chinook populations and publish the analysis and their implications for management in the peer-reviewed scientific literature. Using telemetry data from Kintama's prior BPA project 2003-114-00, Kintama will complete an analysis comparing survival of acoustic-tagged salmon smolts migrating sequentially through the hydrosystem, the undammed lower river and estuary, the Columbia River plume, and the coastal ocean. The report will provide important perspective that that is currently lacking on the relative survival of juvenile Columbia River salmon migrating through the hydrosystem, and should also provide a simple and consistent explanation for why transported smolts do not have substantially improved survival relative to smolts that migrate through the hydrosystem.

Christine: The text in the next paragraph should be moved to the Sole Source Justification for why the work should be awarded sole-source...

Beginning in 2001, BPA funded Kintama to design an experiment that could test whether Snake River spring Chinook were suffering increased mortality downstream of Bonneville Dam in the estuary and during the early marine migration due to "hydrosystem-induced delayed mortality" (the major project was #2003-114-00, which superseded an earlier "Innovative Proposals" award in 2001-02). Kintama designed and developed a large-scale acoustic telemetry array and tracked 13-14 cm long acoustic tagged Chinook smolts from the Snake River to Alaska from 2006-2011. The results demonstrated that Snake River spring Chinook had very similar early marine survival relative to their downstream counterparts, and that transportation and the number of dams passed had negligible impact on subsequently experienced early marine survival. Kintama's earlier results were published in a number of top-ranked peer-reviewed scientific journals and constitute some of the largest experimental tests conducted in ecology. The current contract is intended to fund additional work using the same dataset collected by the proponents to support preparation and publication of one additional peer-reviewed analysis which should be of importance to the development of the next BiOP.

A.3 Location of Project

This project will be performed at the Kintama Research Services office in Nanaimo, BC Canada.

A.4 BPA-Furnished Property or Services

Description	Point of Delivery	Date to be Delivered
NONE		

A.5 Contractor-Furnished Property or Service

The Contractor shall provide all property and services to perform the work of this contract.

A.6 Definitions

SARs-Smolt to Adult Survival

A.7 Documentation

Specifications and standards (either Federal or industry-wide) which are to be used in the performance of work are listed here, for incorporation by reference into the contract.

Part B Technical Approach/Tasks

B.1 General Requirements

Kintama will collate available data and produce a report for submission to a peer-reviewed scientific journal for publication. This report will compare and contrast various measurements of smolt survival in four regions: (1) the hydropower system, (2) the undammed lower Columbia River and estuary, (3) the Columbia River plume, and (4) the coastal ocean. A particular focus of the publication will be to evaluate whether smolts moved out of the FCRPS by management actions such as increasing spill or transport are likely to fare better in the ocean as a result, which is a critical unidentified assumption in current conservation thinking. The report will also attempt to quantify how variability in survival during the remainder of the marine life history may affect the statistical power of correlations between environmental conditions during smolt outmigration and adult return rates several years later.

Contract Description:

B.2 Methods to be Used

This is a completion contract. One report will be completed and submitted to BPA for internal use and review, and submitted for peer review and publication in a scientific journal. Further funding may be negotiated to support publication of two additional reports.

B.3 Specific Requirements

Christine—Let's keep this as simple and clean as possible. Any boilerplate you can provide?

The specific steps or activities to be accomplished by the contractor will be described in sufficient detail for the prospective contractor to prepare thorough proposals. If BPA approval or review is required at specific points, they should be defined in this Subpart. In general, this section should include the following elements in chronological order.

Phases *(may contain go, no go, decision points). For each phase, include the following:*

> Tasks *(may contain go, no go decision points) and detailed activities. Include sub tasks as needed. For each Task, include a due date expressed in elapsed days after award, not in specific calendar dates, as well as the following:*
>
> > *Deliverables. Deliverables could be specific products such as computer disks or printouts, copies of a publication or a report, presentation of workshops or briefings, test plans, specifications, drawings, test data, or other types of measurable results.*
> >
> > *Quality Assurance. This section should clearly state the manner in which BPA will determine whether the contractor has met the requirements of each Task or Deliverable. If BPA reserves the right to reject a report as incomplete or inaccurate, the criteria by which that decision will be made should be outlined. Indicate the minimum quality level, and the range of deviation acceptable. Also describe how rejection or variances outside the acceptable range of deviation may reduce or nullify payments and will require the contractor to rework or submit a plan for remedy.*
> >
> > *Payment. A description of how pricing, as shown in the Schedule of Prices of the contract Terms, correlates with each Task or Deliverable. Also include any instructions about the payment process that are unique to this task. For example, "Upon completion of this Task, BPA will pay the contractor the fixed price indicated in the Schedule of Prices. Contractor shall not invoice BPA for this Task prior to BPA acceptance of the work."*

Phase 1

Deliverables: Preparation of a report comparing relative survival of acoustic-tagged Chinook smolts in 4 sequential habitats (hydrosystem, lower river & estuary, Columbia River Plume, Coastal Ocean), and comparison with contemporaneous survival estimates derived from PIT tag studies.

QA: A copy of the manuscript will be provided to BPA staff for comment. Care must be taken here not to compromise the scientific integrity of the analysis, because publication in major peer-reviewed scientific journals requires the authors certify that funders "played no role in the design or analysis reported in the paper". In order to maintain scientific independence, our request is that BPA staff confine their comments to the application of the scientific findings to management, so that Kintama can identify and expand upon those areas deemed of greatest importance for translating the scientific findings into useful management advice.

Payment: 35% upon signing of contract. The remainder to be billed monthly in arrears.

Phase 2

Tasks—Prepare final formatting and submit manuscript to major scientific journal

Deliverables—Journal agreement to send submitted manuscript to anonymous peer review

QA—Nil. Done by 3rd party scientific journal to their required standards.

Payment

B.4 Summary of Deliverables.

Description	Format	Due Date	Days for BPA Review
Comparison of ocean & hydrosystem survival rates and implications for Columbia River salmon conservation	White paper report for internal BPA use & comment on management implications	1 March 2017	1 month
	Correspondence with journal seeking agreement to review manuscript, final formatting to meet specific journal	1 April 2017	N/A

	requirements, web submission to start review		

Part C Inspection and Acceptance (Quality Assurance)

This section should provide a summary of the methods that the COTR and Field Inspectors will use to perform quality assurance. At a minimum, BPA should describe its intent to conduct periodic surveillance. Other methods may include Trend Analysis, Third-Party Audits, and Contractor Reported Data.

Part D Technical Exhibits

In some instances, voluminous and detailed data is required to provide the contractor with sufficient information to develop a proposal. Such detail should be appended as exhibits to the work statement.

From: David Welch

Sent: Mon Nov 07 10:20:00 2016

To: Petersen,Christine H (BPA) - EWP-4

Subject: Sole Source Justification...

Importance: Normal

Christine: The text in the next paragraph should be moved to the Sole Source Justification for why the work should be awarded sole-source…

Beginning in 2001, BPA funded Kintama to design an experiment that could test whether Snake River spring Chinook were suffering increased mortality downstream of Bonneville Dam in the estuary and during the early marine migration due to “hydrosystem-induced delayed mortality” (the major project was #2003-114-00, which superseded an earlier “Innovative Proposals” award in 2001-02). Kintama designed and developed a large-scale acoustic telemetry array and tracked 13-14 cm long acoustic tagged Chinook smolts from the Snake River to Alaska from 2006-2011. The results demonstrated that Snake River spring Chinook had very similar early marine survival relative to their downstream counterparts, and that transportation and the number of dams passed had negligible impact on subsequently experienced early marine survival. Kintama’s earlier results were published in a number of top-ranked peer-reviewed scientific journals and constitute some of the largest experimental tests conducted in ecology. The current contract is intended to fund additional work using the same dataset collected by the proponents to support preparation and publication of one additional peer-reviewed analysis which should be of importance to the development of the next BiOP.

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, November 07, 2016 9:32 AM
To: David Welch; Erin Rechisky
Subject: phone call?

Hi,

Would you like to check in, within the next couple of days – on the status of the contract? We could go over any remaining questions about Pisces, and select dates for various milestones.

I have some time free this afternoon, tomorrow after 3 or around noon, Wednesday is pretty free.

Talk to you soon,

Christine Petersen

(503)230-4695

From: Erin Rechisky

Sent: Tue Nov 08 11:15:06 2016

To: Petersen,Christine H (BPA) - EWP-4

Subject: RE: phone call?

Importance: Normal

Ok. 250-729-2600 x224

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: November 8, 2016 11:11 AM
To: Erin Rechisky; David Welch
Subject: RE: phone call?

Sounds good – I will call you at 3 today.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Tuesday, November 08, 2016 10:38 AM
To: Petersen,Christine H (BPA) - EWP-4; David Welch

Subject: RE: phone call?

Hi Christine,

I can talk at 3 today.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: November 7, 2016 12:16 PM
To: Erin Rechisky; David Welch
Subject: RE: phone call?

Thank you.

Please feel free to modify anything that I copied in already, as a placeholder, or to break the analysis work element into separate tasks in a reasonable way.

Maybe I could try to give you a call tomorrow at either noon or 3pm?

Thank you for the sole source language – this is very helpful. Basically, we will need to have a more thorough statement and rationale than we typically need for typical BPA Fish and Wildlife program. Typically, a short argument such as "this agency/ company was previously involved in the project and has special understanding of the work involved" would be adequate for continuing to work with a contractor for future years.   However, under our standard federal procedures, there are often legal cases which arise when construction companies challenge the bidding process after a rival company got the bid. This results in a more rigorous procedure for newly started projects, where they look a bit more closely and document everything. Still – this is not an enormous project so I am hoping we can submit this fairly soon in nearly final form. Then we can see what feedback we get, and assess if anything needs to be added or rewritten.

Christine

(503)230-4695

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Monday, November 07, 2016 10:24 AM
To: David Welch; Petersen,Christine H (BPA) - EWP-4
Subject: RE: phone call?

Hi Christine,

I am only in the office until 1:00 today, but I'll be in all day tomorrow, and until 2:00 on Wed and Thurs.

Once David edits the info in Pisces, let's have a look and talk tomorrow about what other tasks need to be completed in order to move the contracting process along.

Erin

From: David Welch
Sent: November 7, 2016 10:19 AM
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: RE: phone call?

Thanks, Christine—I am just about to enter the info that I can into PICSCES. You will see that Erin and I have substantially streamlined the attached material, and have highlighted one part that would make an excellent justification for the Sole Source designation—I probably won't be able to add that to PISCES, but we'll see.

I am leaving for a conference tomorrow morning (Tuesday), so if we don't touch base today it is probably easiest to deal directly with Erin until I am back in the office next Tuesday, 15 November. I can always be contacted on my cell if need be.

Regards, David

kintamav_RGB

Office: (250) 729-2600 (x) 223

Mobile: [redacted]

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, November 07, 2016 9:32 AM
To: David Welch; Erin Rechisky
Subject: phone call?

Hi,

Would you like to check in, within the next couple of days – on the status of the contract? We could go over any remaining questions about Pisces, and select dates for various milestones.

I have some time free this afternoon, tomorrow after 3 or around noon, Wednesday is pretty free.

Talk to you soon,

Christine Petersen

(503)230-4695

Complete a non-competitive justification for procurements with an anticipated value of over $10,000 following this format as it applies. A non-competitive transaction justification is not required for procurements under $10,000, procured from Federal Prison Industries, other federal agencies, AbilityOne Nonprofit Agencies for the Blind or other Severely Handicapped, Government Printing and Binding or for utility services. (BPI 11.7.1.1)

1. <u>Description of Materials or Services:</u>

Provide a complete description of the requirement, what program or project it supports and how it supports the mission of BPA. Quantities and detailed descriptions are not required unless as a part of the justification contained in section 3 of this justification. If requesting materials, include the Manufacturer, Manufacturer's part number, and indicate whether or not a time critical outage schedule for use of these items applies.

This contract will provide novel information on the relative survival of two major population groups listed under the US ESA: Snake River spring Chinook salmon and Snake River basin steelhead. Using telemetry data from Kintama's prior BPA project 2003-114-00, as well as survival data collated from other agencies in the broader region (British Columbia, Washington, Oregon, and Idaho), Kintama will produce three reports comparing survival of Columbia River salmon smolts and adults from the Basin from a broader perspective than has been used in the past. Specifically, Kintama will (1) collate and compare SAR data on survival of salmon originating from other regions in the Pacific Northwest with similar data for the Columbia, to provide an understanding of what level of survival should be expected in regions lacking the Columbia's hydropower dams, (2) will update a previous comparison of downstream smolt survival in the Fraser & Columbia Rivers to better define relative survival rates, and (3) compare Columbia River smolt survival rates in the hydrosystem with their subsequent estuary & coastal ocean survival rates.

Collectively, these three reports will help the Action Agencies to develop a revised BiOp by placing the Columbia River's recovery goals in context with the performance achieved in other salmon-producing rivers within the broader region.

2. <u>Non Competitive Authority:</u> *From the list below check the applicable BPI authority permitting the proposed non-competitive transaction. Contact your Contracting Officer or Team Lead if you need assistance.*

- ☐ Repair parts, accessories, supplemental equipment or services required for supplies or services previously furnished or contracted for which are available from only one contractor. (BPI 11.7.1.2(a));
- ☐ Required by law or Executive Order (BPI 11.7.1.2(b));
- ☐ The entity has the responsibility to manage the property or resource to be affected by the services performed. (BPI 11.7.1.2 (c));
- ☐ BPA standard items, when a Business Line Vice President or equivalent level manager has determined in writing that BPA must standardize the use of the item, and that determination is available for review by the HCA. (BPI 11.7.1.2 (e));

☐ Agreements with nonprofit research organizations such as the Electric Power Research Institute (EPRI) for the purposes identified in this section (BPI 11.7.1.2 (f) (1-6));

☐ Establish or maintain an essential engineering, research, or development capability to be provided by an educational or other nonprofit institution or a federally funded research and development center. (BPI 11.7.1.3 (a));

☐ When other parties have offered BPA an opportunity to participate in specific projects on a cost-sharing basis, and the sponsor has arranged for a substantial portion of the required funding for the entire project. (BPI 11.7.1.3(b));

☒ This is the only feasible source which can meet BPA's requirement and no other supplies or services will satisfy agency requirements (BPI 11.7.2);

3. Justification:

Provide sufficient information to support the proposed non-competitive transaction based on the authority cited above and instructions of this section. Keep in mind that this document is reviewed and that your explanations may be formally questioned and protested if your justification is insufficient or not valid. For the BPI authorities 11.7.1.2 (f), 11.7.1.3(a) and 11.7.1.3(b), be sure to address the specific information required by those sections. For the BPI authority 11.7.2, unique source, all of the following elements must be provided: (1) The minimum mandatory requirements for the procurement (may be addressed in Section 1, Description of Materials or Services); (2) Identify what other sources were considered during market research (may be addressed in Section 6, Market Survey, below) and why those sources do not meet the minimum mandatory requirements and are not feasible due to form, fit, function, capabilities, capacity, experience, price, or delivery timeframe; (3) Demonstrate that the proposed contractor is the only feasible source based on unique capabilities, unique experiences, or unique attributes.

Kintama Research Services

Kintama Research Services is a world leader in the design and use of large-scale underwater acoustic telemetry arrays, with particular experience in applying these technologies to provide novel scientific information relevant to salmon management. Bonneville Power Administration contracted with Kintama Research Services, Ltd. under project #2003-114-00 in the Fish and Wildlife program for in-river, estuary and early marine survival estimates as they relate to delayed mortality due to migration through the hydrosystem or transportation around the FCRPS. Active data gathering and research under this project occurred from 2003 to 2012.

One major component of Kintama's previous BPA-funded work has not yet been published in the scientific peer-reviewed literature. This work indicates that smolt survival rates migrating through the FCRPS and in the coastal ocean are similar on a daily time step. There are major management implications from this finding, which have not been incorporated into the current management thinking. Kintama will prepare this analysis which will outline the implications and their relevance to BiOP-related obligations for meeting both hydrosystem survival, SAR, and adult abundance targets. As part of previously funded work, Kintama found that Columbia River Chinook salmon smolt survival rates were similar to (and in some cases slightly better) than equivalent survival rates on the Fraser River, which has no dams (Welch et al. 2008). Kintama has continued to conduct research on smolt survival in the Fraser River system and has collected additional new data which will allow an improved perspective on where the mortality is geographically occurring in the Fraser, which will provide an important refinement on that earlier publication. As part of a different research project, Kintama also collated preliminary coast-wide data on smolt to adult survival rates (SARS) during the period 2000-2010, and found that at least in the 2000-2010 period SARS for Columbia River salmon stocks seem to be substantially higher than in British Columbia or Puget Sound. This finding is contrary to the usual assumption that survival must be lower in the Columbia River hydrosystem because of the presence of dams. Extending this data collection backwards to earlier decades is necessary to provide a fuller perspective, but if Columbia River SARS are already higher than in other west coast regions lacking dams, then the rationale for meeting current Northwest Power and Conservation Council rebuilding targets may need to be reviewed.

Kintama's staff experience in developing telemetry-based measurements of salmon survival in both freshwater and early marine environments is unique, and the data they have prepared provides a broader perspective on the challenges of successfully managing Columbia River salmon populations than is currently available. As the generator of these data, Kintama is uniquely positioned to efficiently analyze them and provide the outlined research products. The scientific credibility of the company and it's staff is high; Kintama's previous peer-reviewed scientific publications on acoustic telemetry now number more than 40 (www.kintama.com/publications/primary-publications)and have all been in the top-ranked scientific journals, including two in the Proceedings of the U.S. National Academy of Science (Welch et al. 2011; Rechisky et al. 2013).

David Welch, the president and founder of Kintama has received multiple awards for his scientific research, including the American Fisheries Society's award for Best Published Paper (2014), the American Fisheries Society's Award of Excellence-Fisheries Management (2012), the Canadian Society for Meteorology & Oceanography's J. P. Tully Medal in Oceanography (2012), and the Prix d'Excellence (2008) and Prix de Distinction (2007) from Fisheries & Oceans Canada for *"Exceptional Scientific Contributions to the Government of Canada"* and *"Outstanding Scientific Contributions Related To National And International Climate Change Research*, respectively. Dr Rechisky has over 20 years of work on acoustic telemetry of marine fish, and completed her PhD at the University of British Columbia analyzing the Columbia River data to look at the credence of the delayed mortality and differential-delayed mortality theories. She is also the current Secretary of the American Fisheries Society's B.C.-Washington Chapter. Aswea Porter, M.Sc., has worked for Kintama since 2006, and is senior data analyst and has primary responsibility for managing Kintama's acoustic telemetry database and much of the underlying preparatory analysis needed for production of scientific reports and published papers, as well as extensive involvement in the writing phase.

Why BPA is doing Estuary and Ocean Research:

Columbia River salmon research has primarily focused on the role of the dams in reducing survival. Initially, early work focused on measuring survival through the Snake River dams because the particularly poor adult returns to this tributary suggested a greater problem with these dams, which were also the most recently constructed. Completion of these dams in the 1970s also coincided with a period of large-scale change in ocean climate and reduced salmon survival coast-wide. As a result, the effect of the dams on reducing salmon returns from the ocean was confounded with the deterioration in ocean climate for salmon that occurred at about the same time and whose effect on salmon returns was also widely observed outside of the Columbia River. Presumably as a result of the particularly poor returns of salmon to the Snake River, the PIT tag system was progressively implemented downstream, first at the Snake River dams and then subsequently at the lowest four Columbia River mainstem dams, but no major source of mortality was found that could explain the magnitude of the poor adult salmon returns observed. Perhaps for this reason, this then led to the development of the hypothesis of delayed mortality, which suggested that survival in the estuary and/or coastal ocean was poor as a result of cumulative damage occurring from multiple dam passage. Viewed from this perspective, poor estuary or ocean survival was the result of upstream dam operations, and partly for this reason estuary/ocean research became of interest to BPA.

The 1980-90s were a period of decline of many interior ESUs of salmon, and it appeared obvious to most biologists at the time that the major dams built in the Columbia River must be having massive impacts. However, with the advent of the PIT tag system (and then JSATS), moderate losses were documented during in-river migration, but nowhere near enough to explain the poor survival levels observed in the 1990s. There was a reluctance to note that salmon stocks in other river systems without major dams also had severe conservation problems. These additional observations, suggested a common ocean mechanism was suppressing adult salmon returns and was likely the most important factor in determining salmon abundance. Given the oft-stated claim that "*nothing could be done about the ocean*", it was not surprising that the delayed mortality theory was developed, which in essence stated that marine survival of the Snake River stocks was particularly poor because they migrated through more dams than certain other stocks which had better SARS, possibly as a result of greater induced stress. If true, ocean survival could then potentially be improved by manipulating the hydrosystem to reduce stress and the "delayed mortality" component of ocean survival.

With earlier financial support from BPA, Kintama specifically tested this important theory and found no evidence for elevated mortality for smolts migrating through a greater number of dams (or for smolts transported around the dams in barges). Importantly, Kintama's data also pointed to a previously unsuspected reason why management efforts had been largely unsuccessful at recovering salmon populations to the recovery targets: smolt survival rates in the coastal ocean were about the same as the survival rates experienced migrating through the 8 dam FCRPS. If correct, this observation places a wholly new interpretation on the reason for poor adult SARS, and suggests that moving smolts more rapidly downriver may do more harm than good in those years when ocean survival rates are lower than freshwater survival rates. This possibility appears to have never been recognized by fisheries managers, whose assumption was that mimicking the more rapid flow rates of the unimpeded "pre-dam" river would give the best survival results because it came closest to the original "natural" river condition. The underlying hidden assumption was that the ocean was largely a benign environment for salmon, and that most of the survival problem was man-made and the result of dam construction.

Understanding the role of the estuary and ocean in determining overall survival is thus of direct relevance to BPA, because at present ocean effects on survival are confounded with the effects of the hydrosystem, and both blame and credit for certain management actions may be improperly attributed without a clearer understanding of how survival is determined. Because of Kintama's experience, the company is uniquely capable of providing this broader perspective.

History of Sole Source to Kintama:

There is no history of sole source contracting with Kintama. The earlier BiOp program project 2003-114-00 was awarded via a bidding process.

Why we still need Kintama's services:

Judge Michael Simon stated in his 2016 Opinion and Order (regarding the FCRSP BiOp):

"The Federal Columbia River Power System remains a system that "cries out" for a new approach and for new thinking if wild Pacific salmon and steelhead, which have been in these waters since well before the arrival of Homo sapiens*, are to have any reasonable chance of surviving their encounter with modern man."*

New thinking could clearly include a regional perspective including the comparative performance of salmonid populations originating from a broader region. This perspective is currently largely lacking in the Columbia River basin, with almost all work intensively focused on studying salmon within the hydrosystem. However, taking a broader perspective that includes analysis of pre- and post-hydrosystem survival rates, and comparison with other west coast rivers, may provide a more nuanced perspective on the region's efforts to restore Columbia River salmon runs. Preliminary analysis suggests that Chinook and steelhead population coming from a wide range of undammed British Columbia & Puget Sound rivers appear to have astoundingly low SARs when compared with the Columbia, and this point has apparently never been picked up on, despite decades of studies. In Alaska, fishery disasters have been repeatedly declared for Chinook salmon originating from multiple pristine watersheds, indicating again that it is not just dams that can drive down salmon populations. Kintama's experience and technical capacity offers a perspective that appears to be remarkably lacking in past BiOp efforts in the Columbia, which have focused on incremental technical fixes to various parts of the hydrosystem. However, this focus may have blinded the region to the possibility that the FCRPS has already been successful in addressing most of the anthropogenic problems, and that the remaining issues may be related largely to climate change in the ocean, and not hydrosystem operations,

Kintama has also been successful in prior work, demonstrating an ability to successfully publish important new research that did not necessarily agree with conventional thinking. Kintama approached BPA in 2001 with an experimental design that could potentially test whether Snake River spring Chinook, which migrate through the four additional Snake River dams relative to mid-Columbia River spring Chinook, were suffering increased mortality downstream of Bonneville Dam in the estuary and during the early marine migration, or hydrosystem-induced delayed mortality. Recognizing the potential, BPA funded Kintama to develop a large-scale acoustic telemetry array which extended from the Snake River basin to southeast Alaska. After several seasons of field testing equipment and surgical fish tagging trials, Kintama launched an extensive study which would track 13-14 cm long acoustic tagged Chinook smolts from the Snake River to Alaska. BPA funded this study and an additional study to evaluate transportation-induced delayed mortality from 2006-2011 (and a wrap up year in 2012). This study may still be the most geographically extensive acoustic telemetry study ever conducted. Results indicated that Snake River spring Chinook had very similar early marine survival relative to their downstream counterparts, and that transportation had little or no effect on early marine survival.

Kintama published multiple peer-reviewed journal articles using these data (http://kintama.com/publications/) including two papers in the U.S. Proceedings of the National Academy of Sciences, one of the "*top five*" scientific journals in the world (http://www.pnas.org/content/106/17/6883.full). Although extensive publications were produced during the prior period of funding, Kintama approached BPA in 2015 to support analysis and complete an additional report which will use data obtained during project #2003-114-00 in combination with other telemetry data available from Kintama and Kintama's collaborators, as well as collated smolt-to-adult return data developed by a range of government and NGO organizations. This report will compare survival of Columbia River basin salmon to salmon from other regions to provide a broader perspective on the performance of Columbia River salmon stocks than is currently available.

Specifically Kintama will complete a publication addressing important conceptual problems in how biologists think about salmon management. The basic conceptual flaw we will demonstrate is that just measuring survival to Bonneville Dam without taking into account how long the smolts take to arrive there and be counted is like using a Geiger counter to count radioactive decay and concluding that because more fission is recorded over longer time intervals, radioactivity is worse. The potentially important point for management here is that smolts which arrive early at Bonneville Dam then end up spending more time in the coastal ocean because they get there faster. Kintama's data indicates that survival rates in the ocean aren't much different than in the hydrosystem, so higher flow may not actually benefit the smolts, just put them someplace else. If the hydrosystem is manipulated to accelerate smolt arrival in a region with worse survival, then logically managers should take this into account while developing management plans.

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4. **Actions to Promote Competition:** At the onset of each procurement, all unique source justifications are scrutinized and screened for the possibility of further competition by Supply Chain. Further, competition barriers are discussed with the customer and options explored when available. *This section is prefilled and needs no editing.*

5. **Project Estimated Amount:** The anticipated price to the Government is **$110,000** take the report to White Paper stage, and to complete report revisions during the peer-review process after submission to a scientific journal.

6. **Market Survey:** *Describe the market research that was performed that led you to your conclusion that there was need to waive competition. If no market research was performed, such as in instances of Urgent and Compelling, explain in detail here.*

   See justification

7. **Requirements Certification:** I certify that the requirement outlined in this justification is a bonafide need of the Bonneville Power Administration and that the supporting data under my cognizance, which are included in the justification, are accurate and complete to the best of my knowledge and belief.
   (Signature of the responsible manager)

   Name & Title Date

8. **Approval** *This part is filled out by Contracting Staff as part of the Justification*

   a. **Contracting Officer's Certification: (required)** I certify that the foregoing justification is accurate and complete to the best of my knowledge and belief.

Contracting Officer Signature | Date

From: David Welch

Sent: Thu Dec 15 12:09:50 2016

To: Zelinsky,Benjamin D (BPA) - EWP-4

Subject: RE: Catching up?

Importance: Normal

Glad to. My calendar is pretty well clear between now and end of January, so you can co-ordinate and see what times work for your side.

I suggest that bullet item #2 be split into two parts. The existing Bullet can remain, and the new bullet #3 comes in like this:

- An update on the Chilko results and their implications
- Status update on the current contract and a refresher of the goals and scope of the work
- Refresher on the broader picture (SARS higher in the Columbia basin than in BC/Puget Sound rivers) and how to make this potential work most useful
- Discussion of how to share the results with the region and any $ requests associated with that

Please make sure that I'm not stepping on any toes here, in discussing this directly with you—I have approached you rather than Christine with this because I get a sense that Christine views her work as more "*managing the process*" than asking how things should be used, but I don't want to create any antipathy either.

Regards, David

From: Zelinsky,Benjamin D (BPA) - EWP-4 [mailto:bdzelinsky@bpa.gov]
Sent: Thursday, December 15, 2016 9:53 AM
To: David Welch
Subject: RE: Catching up?

David,

Well – I'm glad things are moving albeit glacially. What do you think about giving a group of us an update - either via web conference or in person with three goals:

- An update on the Chilko results and their implications
- Discussion of how to share the results with the region and any $ requests associated with that
- Status update on the current contract and a refresher of the goals and scope of the work

I'd be happy to help set that up. I'd want Lorri to be part of it both due to her interest in the work and given that any funding requests would go through her. My sense is money is pretty tight right now for BPA so I wouldn't have high expectations but I think it would be good for us to know what the options are.

Ben

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, December 14, 2016 3:00 PM
To: Zelinsky,Benjamin D (BPA) - EWP-4
Subject: Catching up?

Hi Ben—

The contract process is moving forwards at its usual glacial pace—Erin and I have been working with Christine and I expect that we will have the contract in place either December 15th (don't hold your breath on that one!) or sometime after the start of the New Year.

I did want to catch up with you separately from Christine to get your thoughts and counsel. We have now completed our report on this year's study on Chilko (Fraser River) Chinook movements and survival. The results are quite striking—the Chinook from this population took a month(!) to reach the Fraser River mouth and had 49% survival after release.

We will be documenting this result up as part of a different paper, but this result brings me back to the reasons I reached out to BPA 18(!) months ago—As I reported back in 2008, survival isn't better in the Fraser River, and this new result demonstrates that smolts don't necessarily just immediately migrate down undammed rivers at high speed either. So it will be a useful additional reference to cite in likely the most important paper: one comparing the SARS in the two rivers and pointing out that the Columbia River has SARS 3-4X ***higher*** than the Fraser River, despite the presence of dams.

This isn't funded, and my question is, is Christine the right person to work with to try to find financial support for this additional piece of work? Or, do I try lobbying someone higher (perhaps Lori directly), to get across the importance of documenting this finding? As you appreciate, BPA is a large organization, and the number of folks prepared to push things forward rather than just go through the motions isn't a large fraction of the staff.

Your candid thoughts and advice would be valued.

Thanks,

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile: [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: David Welch

Sent: Wed Dec 21 16:50:42 2016

To: Petersen,Christine H (BPA) - EWP-4

Subject: RE: Redfish Lake reference...

Importance: Normal

Thanks!

I hadn't remembered the Willamette angle to that paper. Your comment about them being very large smolts as yearlings ties in with something I have been interested in for a long time—theyt I don't think size is a good predictor of marine survival, despite many opinions to the contrary.

If my memory is correct, don't Willamette Chinook have very low SARS, despite the limited dam passage and the very large size of the yearlings?

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, December 21, 2016 4:29 PM
To: David Welch
Subject: RE: Redfish Lake reference...

Thank you.

That is interesting that they were able to catch so many.

This was the paper (that I noticed you are an author of!) that showed a pattern with Willamette Chinook being unusually abundant at one transect SEAK – which is surprising because they're not that abundant. Barbara Shield's students apparently were among the first to popularize that quite a few move out of the tributaries as fry, and they can't expect that there is no wetland habitat downstream. We are debating whether it is essential to try to flush them out of the various high head reservoirs at these small sizes vs. leaving them to exit as yearlings (they get very big). Right now, they are finishing plans to design a big $100m collector at Cougar reservoir which might be a test for all the other reservoirs. A subtlety could make a collector like that effective for steelhead but not Chinook etc.

https://www.researchgate.net/profile/Marc_Trudel2/publication/239937944_Annual_coastal_migration_of_juvenile_Chinook_salmon_Static_stock-specific_patterns_in_a_highly_dynamic_ocean/links/0c96051c33f92384b0000000.pdf

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, December 21, 2016 4:03 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: Redfish Lake reference...

Here is the reference I was referring to… they used CWTs, not PIT tags, to identify the Snake R smolts.

http://www.tandfonline.com/doi/abs/10.1080/00028487.2014.968292

Merry Christmas!

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: David Welch

Sent: Wed Jan 11 13:50:17 2017

To: Erin Rechisky; Petersen,Christine H (BPA) - EWP-4

Subject: RE: date change.

Importance: Normal

Attachments: Brosnan et al (Survival Rates of Out Migrating Yearling Chinook Salmon in the Lower Columbia River and Plume after Exposure to Gas Supersaturated Water-JAAH 2016).pdf

Hi Christine—Just to clarify Erin's last comment, we are not "fishing" for a contract at this late date this year, but in our recent TDG paper (attached) we made this comment ((p. 249):

"Although our results are consistent with the known

effects of TDG, the uncertainty in the underlying assumptions

calls for a controlled experiment to clarify how survival

in the lower freshwater reaches of the Columbia River

and the coastal ocean is affected by TDG exposure. A

formal experiment that uses simultaneous paired releases

of smolts that are exposed to different levels of TDG

along with control groups of unexposed smolts could easily be performed by using the same techniques described here

and by Rechisky et al. (2012, 2013).”.

Just boosting flow to very high spill levels that increase TDG past the legal limits, as the courts might impose, will yield very low statistical power if the goal is to see if this increases adult returns several years later. We hope to cover this in the report/paper that is currently wending its way through your contract process, but its worth making the point here:

· Survival through the hydrosystem is about S_{HS}=60%

· SAR (Survival to adult return is about SAR=1%

· Survival in ***<u>the rest of the life history</u>*** can be calculated as SAR=S_{HS}xS_{Later}. So S_{Later}=SAR/S_{HS}= 0.01/0.6 ≈ 0.017 (i.e., “later” survival is only 1.7%!).

· We can also write later survival as a sequence of life history periods where survival in each of N periods is equal to hydrosystem survival.

· This leads to $S_{Later}=(S_{HS})^N$. This means that there are N=log(S_{Later})/log(S_{HS})=8 subsequent periods in the life history “below Bonneville” where a salmon cohort experiences survival reductions just as large as experienced going through all 8 FCRPS dams, assuming that value is about 60%.

So, why is this important? The key point is this. TDG fluctuations will chiefly impact survival during ***<u>only</u>*** the first of those 9 survival periods (0.6^9= the SAR of 0.01). It is entirely reasonable to assume that the random environmental variability in survival during each of those 9 periods is equal, so looking at the subsequent adult returns 2-3 years later to determine what the effect of increased spill will be is entirely impractical… the signal (effect of TDG on survival) will be buried in a huge amount of variability from random events happening in the ocean.

What this means is that using adult returns to test for the effect of manipulations of the hydropower system on survival will have extremely low statistical power… basically, you shouldn't even bother trying to do these studies correlating adult returns to TDG changes. Instead, the region should measure survival to someplace below Bonneville (say, Astoria or Willapa Bay) shortly after the smolts have passed by Bonneville using a controlled study (matching release groups of acoustically tagged smolts with treatment (high TDG exposure) and control (Low TDG exposure)). It doesn't matter whose tag system is used for this—it could be JSATS or Vemco—there are plusses and minuses to both systems.

I intend to work this point into the paper we are proposing to do for you that is described in the current contract proposal. However, we can't just substitute the other part of the work we proposed because Erin and I know it will take substantially more work to get that study (on comparative survival in the Columbia vs BC/Puget Sound) ready for prime time because the amount of funds you had available ($110K) wasn't large enough to support the staff time on the other (currently unfunded) part of work. However, I was discussing with Erin a logical way we could combine both the SAR comparison with the update to the large rivers survival comparison. The amount of work to do would remain about the same, but it might make a tighter package for people to use, if it was funded.

This is a big part of what I would like to outline in the conference call.

Best, David

From: Erin Rechisky
Sent: Wednesday, January 11, 2017 12:09 PM
To: Petersen,Christine H (BPA) - EWP-4; David Welch
Subject: RE: date change.

Hi Christine,

We'd like to change the following end dates all within Work Element C:

- Milestone A: end on July 31
- Milestone B: end on June 30
- Milestone C: end on August 31
- Milestone E: end on August 31

Regarding the top paper priorities, David and I would like to discuss this with you and Ben, and perhaps Jeff as well. Could you set up a conference call? David and I are available for most of this Friday. We could meet anytime between 9 and 4. We are in the office tomorrow as well, but David has an appointment at 10:30 and I leave at about 2:00 on Thursdays.

Also, can you send a link to the news articles about the preliminary injunction you mentioned? Kintama could potentially submit a proposal to monitor smolts but we'd have to start this work ASAP in order to have the proposal reviewed, approved and then order transmitters prior to the outmigration- which might not be feasible at this late date.

Thanks,
Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: January 11, 2017 11:04 AM
To: Erin Rechisky; David Welch
Subject: RE: date change.

Hi Erin,

Can you tell me which dates you would like to change?

I was just talking to the CO in our procurement group and they are still working through their backlog and there could be a possibility of doing last minute changes.

On another note, Ben Zelinsky told me that he had been talking to Jeff Stier, who does a lot of work helping to support our court case. Ben explained that he and Lorri Bodi had picked the Columbia River daily survival rates synthesis as the top priority topic of those three alternatives that you had presented last spring, while continuing to try find funding. Jeff was saying that he had thought that the Fraser vs Columbia SAR comparison would be of greatest value to him when he tries to advance a legal argument around 'net impact' (an ESA concept). I was starting to forget the difference between this alternative and therange wide SAR literature review as these topics tend to have some overkap in interpretation. Kintama has a lot of Fraser data from various studies.

In any case, we weren't sure if we would want to sudeny change our order of b priorit and ask you to do the second paper first in this contract. We could also just pass this mestage along to you (without intrudine on the intellectual freedom clause where we are implying what we specifically want to see included in each paper). In any case, Jeff sent the request to attempt to find technical support funds for a second paper.

Also of some interest for you or Ian Brosnan, there was a preliminary injunction asking the judge to require a spill to gas cap experiment this spring...there were some news articles about it yeaterday. It would be hard to design monitoring. Will this high snowpack result in high forced spill levels and high gas like in 2011 anyway?

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: Erin Rechisky <Erin.Rechisky@kintama.com>
Date: 1/11/17 9:49 AM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Subject: RE: date change.

Hi Christine,

I wanted to modify some of the milestones end dates in Pisces but I don't seem to have write permission. Can you give me access or should I tell you what we wanted to change.

Thanks,
Erin

From: David Welch
Sent: December 21, 2016 3:08 PM
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: RE: date change.

Thanks, Christine—Sorry for the delay in responding—just back from my annual meeting with our IT service provider.

This sounds sensible—I will ask Erin to put it on her list to review the dates of the intermediate milestones held in PICES next, after she gets a manuscript off her desk and to our co-authors (by Friday, we are hoping).

I will wait for you to get some feedback on the broader issues of whether a pre-award is possible, and then we can more intelligently discuss the possibilities at that point.

If I don't hear from you before Friday noon, Merry Christmas to you and yours!

Regards, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, December 21, 2016 12:41 PM
To: Erin Rechisky; David Welch
Subject: date change.

Hello,

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I will try to raise the question of whether it is in any way possible to do a pre-award agreement which would allow invoicing to the period before the final contract is issued, which is a practice we have for most of our regular Fish and Wildlife program contracts.

Talk to you soon,

Christine P.

From: Petersen,Christine H (BPA) - EWP-4

Sent: Wed Jan 11 15:00:24 2017

To: David Welch; Erin Rechisky

Subject: RE: date change.

Importance: Normal

Okay, I will see if I can set something up. Some of this could focus on a potentail second paper, but if Jeff is available, he could express his priorities.

The spill proposal is a wildcard for this year. It has come up in the past (in regular managements forums, not before a judge) and John Skalski had a precision analysis showing the sample sizes that would be required. I don't understand if a monitoring design has been or included or raised in the proposal by State of Oregon, but the decision to go forward or not is supposed to be March 19 so it doesn't give a lot of time

Http://www.opb.org/news/article/snake-river-dam-removal-environmental-groups-washington/

Sent from my Verizon 4G LTE smartphone

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From: David Welch <David.Welch@kintama.com>
Date: 1/11/17 1:50 PM (GMT-08:00)

To: Erin Rechisky <Erin.Rechisky@kintama.com>, "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
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Christine P.

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Jan 20 14:43:43 2017

To: david.welch@kintama.com

Subject: FW: FCRPS - Oregon's corrected Bowles Declaration

Importance: Normal

Attachments: 2123.pdf; JUSTICE-#7995304-v1-NWF_0640_Corr_Ltr_to_Court_011817.pdf

Hi,

FYI – this was the publicly filed declaration from state of Oregon supporting the requested injunction to do a spill test.

One thing that Jason and I noticed was that Bob Lessard's CSS chapter 2 produced the result of lower SAR in their high flow year – however, I think it was very sensitive to their choice to use 2011 as a representative high flow year, 2009 for an average year, 2010 for a low flow year – and setting all other variables aside. It is a different pattern of result than their Table 1 in this declaration.
http://www.fpc.org/documents/CSS/CSS_2016_Final.pdf

Christine Petersen

From: Eitel, Michael (ENRD) [mailto:Michael.Eitel@usdoj.gov]
Sent: Wednesday, January 18, 2017 4:23 PM
To: Lear, Gayle HQ @ NWD; Godwin, Mary E HQ @ NWD; Peters, Rock (Rock.D.Peters@usace.army.mil); Feil, Dan; Langeslay; Michael Tehan; Ritchie Graves (Ritchie.Graves@noaa.gov); Ryan Couch - NOAA Federal; Francis,Rose (BPA) - LN-7; Leary,Jill C (BPA) - LN-7; Grimm,Lydia T (BPA) - A-7; Jeremiah Williamson
Cc: Philpott, Romney (ENRD); Gelatt, Andrea (ENRD)
Subject: FCRPS - Oregon's corrected Bowles Declaration

Attached is a corrected Bowles declaration filed today. It looks like the only changes are to Tables 1 and 2 on page 20 (NOTE: highlights are my additions to flag the changes discussed in Oregon's letter). We should use this declaration moving forward, which shouldn't disrupt any work you have done (because only footnote numbers, not paragraph numbers, changed).

Thanks,
Mike

From: David Welch

Sent: Wed Jan 25 10:06:56 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: RE: date change.

Importance: Normal

Thanks, Christine

Currently my schedule is pretty open except for February 2nd (Thursday, next week), when Erin and I will be in Vancouver at a meeting.

David

P.S. No sign of the contract as yet—I assume that this was mailed/couriered, as opposed to emailed?

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, January 25, 2017 9:46 AM
To: David Welch

Subject: RE: date change.

Hi David,

I think this shows that we are generally aligned in our understanding. I forwarded this to Jeff and Ben. Unfortunately we haven't been able to identify a good time for this phone call yet – this Wednesday morning would have been the best possibility as of last Friday, but unfortunately now Jeff Stier is out all day and hasn't been able to offer a substitute time yet. Expect to be contacted soon though.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, January 24, 2017 10:33 AM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: date change.

Thanks, Christine—

A bit of perspective on how we got to where we are today. When I had originally proposed the work to BPA, I broke the work down into three logical units (with peer-reviewed published research papers as the products) and made my best calculation as to how long it would take to do each of the three. I have pasted in below my original summary (devoid of the detailed calculations) as to who amongst Kintama staff would do what parts of which papers. This was generally agreed to, but last October it was belatedly realized that the source of funds available could not be used to fund all the work (Ben Z will know the details).

A total of $110K was then identified from another source. This amount fits with the 1st paper in the list, which I will call (A-Survival Rates). This paper is important to BPA because when published in a high profile journal, it will be the first time that someone has clearly laid out in the peer-reviewed scientific literature that if smolts are transferred out of the hydrosystem adult returns may not be better simply because we need to account for poor survival in the ocean (and the data supports this as probably true). Current management ignores this, and just assumes that if survival to Bonneville Dam is higher, this is a good thing. It ignores the point that if fish spend a week less in the hydrosystem, they spend a week more in the ocean—and right now our data suggests that survival isn't better in the ocean—so it is not a benign place to put the fish. The paper will basically put people on notice that they (at least logically) have to account for what survival rates are in the ocean and that managers and "fish advocates" haven't been doing so. It will also demonstrate very simply why transportation (barging) hasn't been working—it is not because of "differential-delayed mortality" but because where the smolts are transported to isn't really any better from a survival perspective.

(B–Comparison of SARS) is the analysis that Geoff Stier thinks is more important, if I understand you. This paper will show that the current Columbia River recovery targets are not being met in either British Columbia or Puget Sound salmon stocks, and in fact survival (SARs) are lower than for Columbia River populations.

(C) is an update to the Fraser vs Columbia survival comparison paper published in PLoS Biology in 2008.

As I mentioned briefly on the phone last Friday, it occurred to me that we could probably incorporate important elements of paper (C) into paper (B) and save (at a best guess) half the funds needed for (C) if we did so, because it would become an "add-on" to (B) rather than a full stand-alone paper, and the elements of (B) would be the major focus. We can certainly do either (B) or (B)+(C), but the projected costs will be $162K or $232K to do the work, so more than the available budget. (Projected budgets are higher because none of the work has been done or written up for the study, unlike (A).

We can run through the above material briefly as part of the conference call, but I would suggest sharing at least elements of this email with people first. Ben earlier suggested we can also give a quick update on some work we did in the Fraser River looking at survival and movement speeds of tagged Chinook & sockeye, to give some context to the discussion, and which relates to study component (C).

David

BPA Study Component

Data Synthesis (Collection & Graph/Table Production, initial summary of major findings and explanation of methods)(a)

Report

Full Paper (b)

Total (USD)

(A) Comparison of Ocean & Hydrosystem Survival rates (Target Journal: Science)

Welch, 3 months; Porter, 1 month

$90,650

$ 18,130

$ 108,780

(B) Comparison of SARs & Extension back to beginning of data series (Target Journal: Transactions American Fisheries Society)

4 months of staff work for Aswea, 1 month for Erin, 2 months for Welch

$134,750

$ 26,950

$ 161,700

(C) Comparative Salmon Survival in Fraser & Columbia Rivers using acoustic tags (Target Journal: PLoS Biology)

2 months of work for Welch, Porter, & Rechisky

$117,600

$ 23,520

$ 141,120

Sub-Totals

$225,400

$45,080

TOTAL

$ 411,600

(a) Professional staff charged at $700/day, Welch @ $1,000/day. Includes an overhead of 22.5%

(b) Time to convert initial to peer-reviewed scientific journal paper estimated at 20% of base cost plus $2K per paper for publication charges

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, January 19, 2017 2:08 PM
To: Erin Rechisky; David Welch
Subject: RE: date change.

Hi,

I didn't respond last week. A lot of our internal communications were really disrupted by the snowstorm and people not being in the office, plus our manager returned from leave.

Here is a status report. Our contracting officer finished your contract yesterday and it is being sent to you. There was also a budget meeting today where Jeff Stier and Ben Zelinsky were able to talk about your contract finally. Jeff felt there was a bit of a misunderstanding when Lorri Bodi and John Barco made the decision with Ben to prioritize the current Columbia River daily survivals+big picture synthesis paper that is in the current contract. Jeff was the one who initially proposed having you do a synthesis paper, and he is still in favor of a Fraser vs. Columbia comparison (I'm not sure exactly how we should title these, as option A, B, C, given that there are some overlapping themes).

What we're going to do is try to find a time to talk now that all of us are in the office, and I think we are likely to want to call you on the phone. I passed on that you had mentioned that the labor involved in a SARs literature review or Fraser comparison would be larger, so I think they have to evaluate how much potential there would be for moving other things around in our program budget to be able to transfer a moderate amount of funding for either a more labor intensive first paper, or to add the second paper. Ben and our budget manager have a better understanding of this.

In any case, when we try to schedule a call, I think that a reminder for everyone of the initial three paper options would be helpful, and it could be helpful to have ballpark figures for labor? I liked how you laid out the current paper that we put in the contract. Also, for none of these will you just be rehashing your already published Fraser and Columbia survivals, but you are both proposing a new framework for interpretation, plus adding new years of data.

More soon about scheduling.

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Wednesday, January 11, 2017 1:46 PM
To: Petersen,Christine H (BPA) - EWP-4; David Welch
Subject: RE: date change.

Thanks Christine. Good luck with all of that snow.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: January 11, 2017 1:16 PM
To: Erin Rechisky; David Welch
Subject: RE: date change.

Hi

I sent a message to Jan asking her to change the dates, and also asking if we'd need to change the contract if you were to choose to include Fraser results. I think we were deliberately keeping the text a bit generalized.

We might be a bit slow to respond this week. It typically only snows once or twice in winter here, but we just got a foot of snow. I will ask Jeff if he would like to discuss this or have Ben or Anne and I call you. ...or not try to change things at this time.

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: Erin Rechisky <Erin.Rechisky@kintama.com>
Date: 1/11/17 12:09 PM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>, David Welch <David.Welch@kintama.com>
Subject: RE: date change.

Hi Christine,

We'd like to change the following end dates all within Work Element C:

- Milestone A: end on July 31
- Milestone B: end on June 30
- Milestone C: end on August 31
- Milestone E: end on August 31

Regarding the top paper priorities, David and I would like to discuss this with you and Ben, and perhaps Jeff as well. Could you set up a conference call? David and I are available for most of this Friday. We could meet anytime between 9 and 4. We are in the office tomorrow as well, but David has an appointment at 10:30 and I leave at about 2:00 on Thursdays.

Also, can you send a link to the news articles about the preliminary injunction you mentioned? Kintama could potentially submit a proposal to monitor smolts but we'd have to start this work ASAP in order to have the proposal reviewed, approved and then order transmitters prior to the outmigration- which might not be feasible at this late date.

Thanks,
Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]

Sent: January 11, 2017 11:04 AM
To: Erin Rechisky; David Welch
Subject: RE: date change.

Hi Erin,

Can you tell me which dates you would like to change?

I was just talking to the CO in our procurement group and they are still working through their backlog and there could be a possibility of doing last minute changes.

On another note, Ben Zelinsky told me that he had been talking to Jeff Stier, who does a lot of work helping to support our court case. Ben explained that he and Lorri Bodi had picked the Columbia River daily survival rates synthesis as the top priority topic of those three alternatives that you had presented last spring, while continuing to try find funding. Jeff was saying that he had thought that the Fraser vs Columbia SAR comparison would be of greatest value to him when he tries to advance a legal argument around 'net impact' (an ESA concept). I was starting to forget the difference between this alternative and therange wide SAR literature review as these topics tend to have some overkap in interpretation. Kintama has a lot of Fraser data from various studies.

In any case, we weren't sure if we would want to sudeny change our order of b priorit and ask you to do the second paper first in this contract. We could also just pass this mestage along to you (without intrudine on the intellectual freedom clause where we are implying what we specifically want to see included in each paper). In any case, Jeff sent the request to attempt to find technical support funds for a second paper.

Also of some interest for you or Ian Brosnan, there was a preliminary injunction asking the judge to require a spill to gas cap experiment this spring...there were some news articles about it yeaterday. It would be hard to design monitoring. Will this high snowpack result in high forced spill levels and high gas like in 2011 anyway?

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: Erin Rechisky <Erin.Rechisky@kintama.com>
Date: 1/11/17 9:49 AM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Subject: RE: date change.

Hi Christine,

I wanted to modify some of the milestones end dates in Pisces but I don't seem to have write permission. Can you give me access or should I tell you what we wanted to change.

Thanks,
Erin

From: David Welch
Sent: December 21, 2016 3:08 PM
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: RE: date change.

Thanks, Christine—Sorry for the delay in responding—just back from my annual meeting with our IT service provider.

This sounds sensible—I will ask Erin to put it on her list to review the dates of the intermediate milestones held in PICES next, after she gets a manuscript off her desk and to our co-authors (by Friday, we are hoping).

I will wait for you to get some feedback on the broader issues of whether a pre-award is possible, and then we can more intelligently discuss the possibilities at that point.

If I don't hear from you before Friday noon, Merry Christmas to you and yours!

Regards, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, December 21, 2016 12:41 PM
To: Erin Rechisky; David Welch

Subject: date change.

Hello,

I changed the dates in the contract in a relatively simple way, moving the start and end dates one month forward. You might want to glance at the intermediate milestone dates describing goals like submitting the paper to a journal.

I will try to raise the question of whether it is in any way possible to do a pre-award agreement which would allow invoicing to the period before the final contract is issued, which is a practice we have for most of our regular Fish and Wildlife program contracts.

Talk to you soon,

Christine P.

From: chpetersen@bpa.gov

Sent: Mon Jan 30 12:54:48 2017

To: Erin Rechisky

Subject: RE: Outline of change in Kintama contract direction

Importance: Normal

No, it is very good to ask about expected time line and process because we all might ask or review why we came to doing the mod in the first place, and we initially had to work with our finance team to arrange to redirect funds from the closeout of the 15 Mile Steelhead project.

I looked back, and one of the major announcement emails for starting your project managed to leave Jeff Stier's email address off out of the dozen recipients even though he was the one who advocated for soliciting a new proposal. So he had heard Lorri and John were going but didn't see the details. Myself, I can see why it made sense to go forward with the existing contract because it is a compelling topic and we earlier had a certain budget. At the program level, I know that some maneuvering often has to happen, particularly with habitat projects where prices for land and options can be very negotiable.

I will write back later

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: Erin Rechisky <Erin.Rechisky@kintama.com>

Date: 1/30/17 12:39 PM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Subject: RE: Outline of change in Kintama contract direction

Right. We needed hear back from Jeff Stier after his meeting with Lorri Bodi. Sorry to put undue pressure on you.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: January 30, 2017 12:35 PM
To: Erin Rechisky
Subject: RE: Outline of change in Kintama contract direction

Let me go find Ben again this afternoon. I just spoke to him earlier about another situation where he is supposed to gather information regarding spring spill.

In order to proceed with an amendment wE need to identify this additional source of funding. Jeff has some ability to get funds from outside our regular program budget but I need to positively hear that he was able to talk to Lorri Bodi and make that happen.

Ben was going to follow up with Jeff today, but he has an unusual job where he often is outside the building working with other agencies.

More later

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: Erin Rechisky <Erin.Rechisky@kintama.com>
Date: 1/30/17 12:19 PM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Cc: David Welch <David.Welch@kintama.com>
Subject: RE: Outline of change in Kintama contract direction

Hi Christine.

Are we going to hold off on amending the contract for now?

Thanks,
Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: January 27, 2017 4:33 PM
To: David Welch; Erin Rechisky
Subject: RE: Outline of change in Kintama contract direction

Thanks,

Jeff Stier is going to try to pull strings for the budget on Monday, and I will try to check in with both Ben and Jeff early next week.

Have a nice weekend!

Christine Petersen

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, January 27, 2017 1:52 PM
To: Stier,Jeffrey K (BPA) - E-4; Petersen,Christine H (BPA) - EWP-4; Zelinsky,Benjamin D (BPA) - EWP-4
Cc: Erin Rechisky
Subject: Outline of change in Kintama contract direction

Jeff, Christine, Ben—

Here is an outline of what we would do under the “Course Correction” that we have just discussed. We will entirely change the focus of the work as follows:

1) We will compare published SARS for Chinook & steelhead in the Columbia River with published SARS for Chinook in British Columbia (many rivers, including the Fraser) and steelhead for Puget Sound (also multiple rivers). Columbia River survival data will mainly come from the published CSS reports, to eliminate possible criticism that the data are not correct; official regional fisheries agency data to be used for BC & Puget Sound. This comparison will provide perspective by establishing what survival over the whole life cycle from smolt outmigration to adult return is.

2) We will update Kintama’s acoustic tag survival data for Fraser River Chinook to provide an updated perspective on what in-river smolt survival is in the Fraser River and compare that with published Columbia River smolt survival data. The focus of this work will be to establish relative smolt survivals in the two river systems (the first phase of the migratory life cycle) and establish whether or not survival is at comparable levels.

3) Erin and I discussed this new approach briefly after we ended the call; we aren’t yet certain whether in the paper we would lead with #1 & bring in #2 as supporting perspective, or reverse the sequence. We will need to sort this out as we see the paper come together and certainly welcome advice and guidance from you folks as to what is most helpful in supporting your focus, so long as we retain professional independence—the analysis and conclusions are our responsibility so that we can certify our professional independence from the funders when we publish this work.

4) Budget implications: The current agreed budget for the work originally planned is $110K. **We will commit to doing the new & expanded focus of the work for a budget of $232K.** (Changing course and doing both #1 & #2 above was originally costed out at $162K and $141K ($303K). If we roll them together into one published paper instead of two we can cut the cost of the #2 component in half).

Regards,

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: David Welch
Sent: Tue Jan 31 13:51:35 2017
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: RE: Outline of change in Kintama contract direction
Importance: Normal

Thanks for the update!

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, January 31, 2017 1:51 PM
To: David Welch; Erin Rechisky
Subject: RE: Outline of change in Kintama contract direction

Hi David and Erin,

Jeff Stier asked Lorri Bodi and another administrator for the extra funding – he included your revised paper description for clarify. As of this afternoon, I haven't heard if they found a way to sort out the finance, but they are usually the type to be able to make a quick yes or no decision. They might have had to reach out to our accounting team to find a way to make it happen.

With the contract starting Feb 1., we definitely need to make clear what our expectations are going forward. Tomorrow morning or later this afternoon I will ask Jeff or Ben if they have made any headway, or at least get the status from them.

Thank you for your patience,
Christine Petersen

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, January 31, 2017 1:08 PM
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: RE: Outline of change in Kintama contract direction

Hi Christine-

Just checking in as to whether there was any formal decision about the change in focus within the contracted work? Erin and I are in the office tomorrow (Wednesday) but then over in Vancouver at the university for Thursday & Friday if there is a need to discuss next steps.

(I'm here for the next 30 minutes or so, but then will be out and (eventually) working from home—I
(b) (6) [redacted]

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, January 27, 2017 4:33 PM

To: David Welch; Erin Rechisky
Subject: RE: Outline of change in Kintama contract direction

Thanks,

Jeff Stier is going to try to pull strings for the budget on Monday, and I will try to check in with both Ben and Jeff early next week.

Have a nice weekend!

Christine Petersen

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, January 27, 2017 1:52 PM
To: Stier,Jeffrey K (BPA) - E-4; Petersen,Christine H (BPA) - EWP-4; Zelinsky,Benjamin D (BPA) - EWP-4
Cc: Erin Rechisky
Subject: Outline of change in Kintama contract direction

Jeff, Christine, Ben—

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3) Erin and I discussed this new approach briefly after we ended the call; we aren't yet certain whether in the paper we would lead with #1 & bring in #2 as supporting perspective, or reverse the sequence. We will need to sort this out as we see the paper come together and certainly welcome advice and guidance from you folks as to what is most helpful in supporting your focus, so long as we retain professional independence—the analysis and conclusions are our responsibility so that we can certify our professional independence from the funders when we publish this work.

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course and doing both #1 & #2 above was originally costed out at $162K and $141K ($303K). If we roll them together into one published paper instead of two we can cut the cost of the #2 component in half).

Regards,
David

David Welch, Ph.D.
kintamav_RGB

President, Kintama Research Services Ltd.
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From: Erin Rechisky

Sent: Tue Feb 14 08:55:44 2017

To: David Welch; Petersen,Christine H (BPA) - EWP-4

Subject: RE: call, on schedule

Importance: Normal

Hi Christine,

We can call you today before 10, or after 3:30 as you suggest.

I am in the office and David should be here soon.

Just let us know your preference.

Erin

From: David Welch
Sent: February 13, 2017 12:38 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: Re: call, on schedule

Hi Christine

Today is a stat holiday here, so I'm not sure if Erin will check her email at all. I am in the office all day tomorrow, as is Erin so far as I know. I am then away until March 4th.

How about a discussion tomorrow at a time that works for you? (Anytime after 9 should work,[redacted]

In short, we can make this work...somehow/someway. Some of our BC work is still up in the air awaiting a funding decision, but I think we can work around that given what you have outlined.

[redacted] so just wanted to let you know my initial response.

Set a time tomorrow after 9, and we can discuss in greater detail.

David

David Welch, Kintama Research

Tel: +1 (250) 729-2600 x223

Cell: [redacted]

Sent from my iPad

On Feb 13, 2017, at 12:30, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

Let's see – are either of you available for a phone call in the next couple of days. Unfortunately I have to attend a long meeting tracking the Corps research plans. I should be available after 3:30 today, or 8-10, after 3 tomorrow, or all of Wednesday.

In short, Lorri Bodi, Jeff Stier gave top priority to adding additional funds to your project, but I am trying to work out an optimal scheduling balance so that we wouldn't necessarily have to bump some medium priority work. Some of this could be achieved by allowing some tasks to go over into the next fiscal year starting October 1. Yet, we would want to make sure that your initial results or first draft are available in time for our Biological Assessment process – so we would not want to delay your primary data analysis that long. Jeff Stier just told me that this summer could be a time where a presentation and early draft of your results could be very helpful for the BA. I relayed to him that you suggested having a few check-ins with early results along the way.

In order to help make this judgment call for how much funding we would need to allocate to get you to a certain stage by Sept 30 when we could draw from the next fiscal year, I would like to know your best estimate for a schedule of work (given all of your obligations and activities at Kintama this year).

-If we were to ask you to work quickly (given all other commitments), how early could you complete at least a Columbia vs. Fraser SARs analysis, and give either a presentation of key preliminary results or an early draft?

-If were asked you to work more slowly, and to get to a stage by Sept 30th where you have a fairly developed draft, but held off on the peer review publication submission and revisions – what fraction of the total budget (including submission to journal) do you think this would be? You do have ‘report’ vs ‘full paper’ totals in an earlier email, on the three separate papers.

Hopefully I can make this more clear over the phone.

Christine Petersen

From: Erin Rechisky

Sent: Tue Feb 14 09:01:50 2017

To: Petersen,Christine H (BPA) - EWP-4; David Welch

Subject: RE: call, on schedule

Importance: Normal

We should both be here. Call when it is convenient for you.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: February 14, 2017 8:41 AM
To: David Welch
Cc: Erin Rechisky
Subject: RE: call, on schedule

Hi,

I'm working around a long Corps meeting where they provide opportunity to provide feedback on their research projects. They have been cruising very quickly through their agenda, so I might be able to try to call you a little after

11am? If not, 3pm might be the best time to try to reach you.

Talk to you soon

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Monday, February 13, 2017 12:38 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: Re: call, on schedule

Hi Christine

Today is a stat holiday here, so I'm not sure if Erin will check her email at all. I am in the office all day tomorrow, as is Erin so far as I know. I am then away until March 4th.

How about a discussion tomorrow at a time that works for you? (Anytime after 9 should work, [redacted]

In short, we can make this work...somehow/someway. Some of our BC work is still up in the air awaiting a funding decision, but I think we can work around that given what you have outlined.

[redacted] so just wanted to let you know my initial response.

Set a time tomorrow after 9, and we can discuss in greater detail.

David

David Welch, Kintama Research

Tel: +1 (250) 729-2600 x223

Cell: [redacted]

Sent from my iPad

On Feb 13, 2017, at 12:30, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

Let's see – are either of you available for a phone call in the next couple of days. Unfortunately I have to attend a long meeting tracking the Corps research plans. I should be available after 3:30 today, or 8-10, after 3 tomorrow, or all of Wednesday.

In short, Lorri Bodi, Jeff Stier gave top priority to adding additional funds to your project, but I am trying to work out an optimal scheduling balance so that we wouldn't necessarily have to bump some medium priority work. Some of this could be achieved by allowing some tasks to go over into the next fiscal year starting October 1. Yet, we would want to make sure that your initial results or first draft are available in time for our Biological Assessment process – so we would not want to delay your primary data analysis that long. Jeff Stier just told me that this summer could be a time where a presentation and early draft of your results could be very helpful for the BA. I relayed to him that you suggested having a few check-ins with early results along the way.

In order to help make this judgment call for how much funding we would need to allocate to get you to a certain stage by Sept 30 when we could draw from the next fiscal year, I would like to know your best estimate for a schedule of work (given all of your obligations and activities at Kintama this year).

-If we were to ask you to work quickly (given all other commitments), how early could you complete at least a Columbia vs. Fraser SARs analysis, and give either a presentation of key preliminary results or an early draft?

-If were asked you to work more slowly, and to get to a stage by Sept 30th where you have a fairly developed draft, but held off on the peer review publication submission and revisions – what fraction of the total budget (including submission to journal) do you think this would be? You do have 'report' vs 'full paper' totals in an earlier email, on the three separate papers.

Hopefully I can make this more clear over the phone.

Christine Petersen

From: David Welch

Sent: Fri Mar 10 15:22:20 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Ben Zelinsky; Erin Rechisky

Subject: 2018 Spill test???

Importance: Normal

Attachments: Brosnan, Welch et al (Columbia R Plume Survival-MEPS 2014).pdf

Christine & Ben—

I just saw this comment in the Columba Basin Bulleting as, no doubt, did you:

"However, although in the opening remarks Simon said he was leaning towards ordering the federal agencies to begin maximum allowable spill to the gas cap at the dams beginning April 3 and continuing for two years to see what can be learned about salmon survivability with increased spill, by hearing's end his leaning was toward beginning the spill next year.

That would give both fisheries and dam managers time to devise a study design in order to learn if the spill will help or hinder salmon and steelhead."

Just a reminder as BPA has its internal discussions on Judge Simon's comments that our previous acoustic tag work uncovered evidence for substantial sub-lethal mortality from high dissolved gas levels, and that these effects were only expressed several days later, after the smolts reached the plume (see the attached paper). I strongly suspect that this mortality occurred because smolts weakened by gas bubbles were picked off by predators, something that we can't test for in a laboratory setting. (Much like strokes in humans, the animals may be normal looking, but their movements may be crippled due to damage to the circulatory system).

I'm well aware that Vemco's acoustic tags are not popular in the Columbia River basin, but a solid designed study could equally well be done using JSATS or Vemco tagging. The key point is that survival has to be measured to past the plume, so that predators have a chance to select and remove damaged individuals. A rigorously designed TDG study with treatment and control groups would have vastly more statistical power than what is currently being contemplated—which is to wait 2-3 years and see how many adults come back. For reasons that I can outline, studies looking at adult returns have hopelessly low statistical power and cannot give credible scientific results. It might be worth a conference call to discuss the reasons for this and bring in John Skalski to add his perspective.

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

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fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: David Welch

Sent: Fri Mar 10 19:15:31 2017

To: Zelinsky,Benjamin D (BPA) - EWP-4

Subject: RE: 2018 Spill test???

Importance: Normal

Thanks for the update, Ben-

Have a good weekend, and I trust that things are working out for you as you hope.

Best, David

From: Zelinsky,Benjamin D (BPA) - EWP-4 [mailto:bdzelinsky@bpa.gov]
Sent: Friday, March 10, 2017 5:26 PM
To: David Welch; Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: RE: 2018 Spill test???

Thanks David

We are still figuring out our next steps but I'll make sure folks are aware of the work you've done and the work you could do for us going forward. For starters I shared your email with Lydia and Jason.

We will keep you in mind as we develop an action plan.

Ben

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: David Welch <David.Welch@kintama.com>
Date: 3/10/17 3:22 PM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Cc: "Zelinsky,Benjamin D (BPA) - EWP-4" <bdzelinsky@bpa.gov>, Erin Rechisky <Erin.Rechisky@kintama.com>
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P Please consider the environment before printing this e-mail

From: chpetersen@bpa.gov

Sent: Fri Mar 10 19:47:32 2017

To: David Welch

Subject: RE: 2018 Spill test???

Importance: Normal

Hi

[redacted] don't have copies of all the declarations but some sound worthwhile to read later.

He thought it was most likely to occur tomorrow bUT clearly if they consider this year, they aren't interested in monitoring because they would need to revise where they tag fish- NOAAwon't intercept enough at Lower Granite. By the way, you should look into this week's TMT discussion at the Corps. They need to draw down Dworshak due to the high water forecast, but the hatcherit's are worried about TDG. Indeed, they are seeing damage at levels above 104%, but they aren't going to release early- some wanted early spill if they did release early which would be an interesting paradox because this could increase TDG exposure.

BTW- when reviewing NOAA's report on transport with aubyearlings, I was going into the CSS report tables. They now have just enough data points to start to see a pattern , and I noticed they must have updated their methods for bias correction for holdover yearlings. But... most of their hatchery groups actually have higher mean SAR for bypass detected subyearlings. The dam survival tests show equal or higher survival for bypass vs spill route. The size distributions for the routes are almost identical , unlike the pattern Charlie Paulsen's bypass selectivity study with yearlings that show that spillway fish can be 6-10 mm larger.

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: "Zelinsky,Benjamin D (BPA) - EWP-4" <bdzelinsky@bpa.gov>
Date: 3/10/17 5:25 PM (GMT-08:00)
To: David Welch <David.Welch@kintama.com>, "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
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P Please consider the environment before printing this e-mail

From: David Welch

Sent: Thu Mar 16 12:05:44 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Ben Zelinsky

Subject: RE: TMT Dworshak Update

Importance: Normal

Attachments: Cum_Survs_Chilko_CH_byDist_2016_labels.png

Interesting update… thanks! (I copy Erin and Ben Z for their info too).

I'm pretty sure that we have shared this survival graph from acoustic tagging work we did up in the Chilko (=upper Fraser River) last year. Chinook survival to the Fraser River mouth was similar to the work from the Thompson R (another upper Fraser River tributary) that was in our earlier 2008 Large Rivers comparison paper; as you can see, survival to the Fraser River mouth was "only" 50%, so the lack of dams doesn't mean that folks are going to get 80% survival, and suggests that survival in the Columbia River basin may already be exceeding what it is in other big river systems.

Obviously, having data makes it possible to have a debate that is less dependent on folks' expert opinions alone!

Just a quick note. I am here this week, but then gone until the end of the month (b) (6) [redacted]

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Christine, we should perhaps touch base on the first invoice I will send in. It will not be for a substantial amount, but we can use it as a test case to see if there will be any hiccups in setting up international payments.

Is there a time that works to set up a brief phone call, preferably tomorrow morning?

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, March 16, 2017 8:58 AM
To: David Welch
Subject: FW: TMT Dworshak Update

Hi David,

This had a detail related to gas bubble trauma in the Dworshak hatchery. The TDG level probably did exceed 104.5%.

By the way, there was an interesting exchange at the NOAA lifecycle model meeting on Tuesday. Bob Lessard has been developing a multistage model using flow/temperature for an early juvenile stage for subpopulations in the Grande Ronde, while the smolt to adult survival is driven by only the variables of spill ('powerhouse contact rate'), water transit time/flow, and PDO. He was showing results indicating that survival is ***higher*** under low flows because spill and spill efficiency is higher. NOAA researchers asked about figures extending forecasted survival past the range of historical observation. This made them explicitly state what they assume a maximum outmigration survival rate would be. Bob said that survivals are currently often in the 60% range now so surely they could be nudged up to 80-85%.

Christine

From: Norris,Tony (BPA) - PGPO-5
Sent: Wednesday, March 15, 2017 3:09 PM
To: ADL_DIR_ALL; ADL_PGB_ALL; ADL_PGL_ALL; ADL_PGPO_ALL; ADL_PGPW_ALL; ADL_PGSD_ALL; ADL_PGSP_ALL; ADL_PGST_ALL; Bettin,Scott W (BPA) - EWP-4; Bodi,Lorri (BPA) - E-4; Connolly,Kieran P (BPA) - PG-5; Cooper,Suzanne B (BPA) - PT-5; Dernovsek,David K (BPA) - PTF-5; Evans,Elizabeth A (BPA) - PB-6; Francis,Rose (BPA) - LN-7; Gendron,Mark O (BPA) - P-6; Grimm,Lydia T (BPA) - A-7; Johnson,Kimberly O (BPA) - PGA-6; Johnson,Robert C (BPA) - PTFR-5; Kerns,Steven R (BPA) - PGS-5; Kingsbury,Pamela A (BPA) - PGPL-5; Le,Nga (Dan) (BPA) - PTF-5; Leary,Jill C (BPA) - LN-7; Mercier,Bryan K (BPA) - EW-4; Pendergrass,Richard M (BPA) - PGP-5; Petersen,Christine H (BPA) - EWP-4; Petross,Dennis W (BPA) - PGAF-6; Rector,William Eric (BPA) - PBA-6; Smith,Gregory M (BPA) - EWP-4; Spain,Alex J (BPA) - PTF-5; Stier,Jeffrey K (BPA) - E-4; Sweet,Jason C (BPA) - PGB-5
Cc: Todd,Wayne A (BPA) - PGA-6
Subject: TMT Dworshak Update

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Vancouver. It is expected when the system flood control conditions are ended that the discharge will increase to 25 kcfs at that time.

There will be a TMT meeting on Friday at 1:30 to discuss the potential for releasing the chinook from the hatchery next week (~1 week early).   There is currently no plan to release the steelhead early. The Corps still plans on dropping discharge to 8 kcfs for 1-2 days to accommodate the fish release from the hatcheries. Currently, the chinook are experiencing significant gas bubble trauma with 9/10 fish observed with gas bubble in the gills. TDG in the hatchery is currently at 104.5% with TDG downstream of Dworshak at 125-126%. Variations are due to changes in temperature and barometric pressure.

Steve Hall, NWW Corps reported to the TMT about the adverse condition of the new unit 3 stator bars. Steve indicated that the impact to the schedule is unknown at this time.

Tony Norris, P.E.

Operations Research Analyst

Operations Planning, PGPO-5

Bonneville Power Administration

503-230-3946 office

[redacted] mobile

From: David Welch

Sent: Fri Mar 17 09:36:44 2017

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky

Subject: RE: TMT Dworshak Update

Importance: Normal

Works for me, and I know Erin is in.

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, March 17, 2017 9:36 AM
To: David Welch; Erin Rechisky
Subject: RE: TMT Dworshak Update

Thanks,

This is somewhat short notice, but would 10-11am work for a call this morning?

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, March 16, 2017 12:06 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky; Zelinsky,Benjamin D (BPA) - EWP-4
Subject: RE: TMT Dworshak Update

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Operations Research Analyst

Operations Planning, PGPO-5

Bonneville Power Administration

503-230-3946 office

(b) (6) [redacted] mobile

From: Erin Rechisky

Sent: Mon May 01 12:45:06 2017

To: Petersen,Christine H (BPA) - EWP-4

Subject: RE: dates

Importance: Normal

Attachments: BPA Draft Budget WE and Staff totals (Apr 2017).xlsx

Hi Christine.

Thanks for the information.

David and I changed the deliverable dates in Pisces using your recommended end date of Jan 31 2019. I have also uploaded the new budget and filled in the budgets for each WE. I made new spreadsheet that totalled across rows (WE) and columns (personnel). I have attached it for you to see.

Yes, we should discuss the begin/end dates, but I am only here for another 10 minutes today. I will be in the office all day tomorrow if that works for you.

250-667-6951.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: May 1, 2017 12:13 PM
To: Erin Rechisky
Subject: RE: dates

Good question

There is no template that I know of. The simplest approach that many people do is to take the entire budget total (including benefits, overhead etc) and then come up with a ballpark figures of what percentage of time they spend on each work element, such as 15% on writing the annual report, 3% administration, 40% field work etc. For a million dollar contract, this approach can produce weir results because they might report that they spent $10,000 on filling out the status reports on pisces even though it probably takes less than half an hour.

Another paradox is that even though we would tend to advise you not to overthink this, I have seen our finance managers get immersed in reviews of our program where they are closely scrutinizing these work element totals where they discuss ending a specific work element for a project so that they could hypothetically take the amount listed and divert it to something else. Hence they are assuming that it accurately does break down that way.

In your situation, this contract is being funded under the technical services budget and it is less likely to be reviewed in such as fashion compared to big projects that the state wildlife agencies are involved in. I suggest simplifying it by picking best guesses for percentage of time for data analysis, journal article writing, and administration and multiply by the total contract value.

I looked at the revised work elements F and G.

I'm pretty happy with the text. It is straightforward. For collate and compare PNW SARs, you describe the assessment of yearling vs. subyearling SARs. This should be interesting how you set the Snake River standard or baseline.

Do you want to talk on the phone about dates? I reminded myself that in the original one, we set the monitoringResources.org protocol date as 1/31/2018 or the end of the contract. What time do you think is reasonable? Some people find this website involves some bureaucracy in actually completing and publishing the protocol. I find it is much easier if you have your final report with methods already written, so I suggest picking a later date. For field work, we want the protocol published before you do anything in the field because it proves that you are fully prepared and any reviewer with the Council can transparently see what you're doing. For data analysis or academic research, it is a little bit gray that it should even be required – but it became a default requirement a few years ago.

Can you set a period when you hope to submit your article? Do you want to actually state where you hope to submit it (milestone C?). This is probably different than in the initial contract when you were going to do the other set of topics.

On my side, I need to write a memo to our contracting officer clearly describing the differences in this contract modification (that we created F and G and are cancelling B and C.

Talk to you soon

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Monday, May 01, 2017 10:25 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: RE: dates

Hi Christine,

Does BPA have a template for calculating the budget so that it is summarized by person as well as by WE? I am about to make one, but it will be time consuming so I thought I check with you first.

Why is the WE Budget tab broken down completely different from the budget we have to upload?

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: April 28, 2017 3:57 PM
To: Erin Rechisky
Subject: dates

Hi Erin,

I was just glancing in the contract late this afternoon. Next week do you want to talk about what would be a reasonable set of dates for the journal article work element? The final end date is 1/31/2019 which gives more latitude for responding to journal review etc.

Have a nice weekend

Christine

		Technical				
		SAR Analysis		Fraser/Columbia FW Survival		
WE	WE Title	CEO days	Data Analyst days	Research Manager days	CEO days	Data Analyst days
Produce Piscies Status Report	Periodic Status Reports for BPA					
Manage and Administer Projects	Administer Contract					
Analyze/Interpret Data	Compare Columbia R salmon survival to other regions using two phases of the migratory life	45	60	15	15	15
Produce Journal Article	Comparing Survival of Chinook and Steelhead Stocks along the West Coast of North America	15	20	5	5	5
		18.375				
		1888				

From: Erin Rechisky

Sent: Tue May 02 09:22:01 2017

To: Petersen,Christine H (BPA) - EWP-4

Subject: RE: dates

Importance: Normal

I'll just review the text one last time.

I am available right now if you want to give me a call. Do you by any chance have access to a toll free conference line? If so, I'll use skype instead of my cell.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: May 1, 2017 1:12 PM
To: Erin Rechisky
Subject: RE: dates

Yes

If you are happy with the text Kbecause I am you could press submit and then I could route to Peter Lofy for his review of the text. We can still continue to make minor changes and upload attachments until our contracting officer gets it.

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: Erin Rechisky <Erin.Rechisky@kintama.com>
Date: 5/1/17 12:45 PM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Subject: RE: dates

Hi Christine.

Thanks for the information.

David and I changed the deliverable dates in Pisces using your recommended end date of Jan 31 2019. I have also uploaded the new budget and filled in the budgets for each WE. I made new spreadsheet that totalled across rows (WE) and columns (personnel). I have attached it for you to see.

Yes, we should discuss the begin/end dates, but I am only here for another 10 minutes today. I will be in the office all day tomorrow if that works for you.

250-667-6951.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: May 1, 2017 12:13 PM
To: Erin Rechisky
Subject: RE: dates

Good question

There is no template that I know of. The simplest approach that many people do is to take the entire budget total (including benefits, overhead etc) and then come up with a ballpark figures of what percentage of time they spend on each work element, such as 15% on writing the annual report, 3% administration, 40% field work etc. For a million dollar contract, this approach can produce weir results because they might report that they spent $10,000 on filling out the status reports on pisces even though it probably takes less than half an hour.

Another paradox is that even though we would tend to advise you not to overthink this, I have seen our finance managers get immersed in reviews of our program where they are closely scrutinizing these work element totals where they discuss ending a specific work element for a project so that they could hypothetically take the amount listed and divert it to something else. Hence they are assuming that it accurately does break down that way.

In your situation, this contract is being funded under the technical services budget and it is less likely to be reviewed in such as fashion compared to big projects that the state wildlife agencies are involved in. I suggest simplifying it by picking best guesses for percentage of time for data analysis, journal article writing, and administration and multiply by the total contract value.

I looked at the revised work elements F and G.

I'm pretty happy with the text. It is straightforward. For collate and compare PNW SARs, you describe the assessment of yearling vs. subyearling SARs. This should be interesting how you set the Snake River standard or baseline.

Do you want to talk on the phone about dates? I reminded myself that in the original one, we set the monitoringResources.org protocol date as 1/31/2018 or the end of the contract. What time do you think is reasonable? Some people find this website involves some bureaucracy in actually completing and publishing the protocol. I find it is much easier if you have your final report with methods already written, so I suggest picking a later date. For field work, we want the protocol published before you do anything in the field because it proves that you are fully prepared and any reviewer with the Council can transparently see what you're doing. For data analysis or academic research, it is a little bit gray that it should even be required – but it became a default requirement a few years ago.

Can you set a period when you hope to submit your article? Do you want to actually state where you hope to submit it (milestone C?). This is probably different than in the initial contract when you were going to do the other set of topics.

On my side, I need to write a memo to our contracting officer clearly describing the differences in this contract modification (that we created F and G and are cancelling B and C.

Talk to you soon

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Monday, May 01, 2017 10:25 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: RE: dates

Hi Christine,

Does BPA have a template for calculating the budget so that it is summarized by person as well as by WE? I am about to make one, but it will be time consuming so I thought I check with you first.

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Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: April 28, 2017 3:57 PM

To: Erin Rechisky
Subject: dates

Hi Erin,

I was just glancing in the contract late this afternoon. Next week do you want to talk about what would be a reasonable set of dates for the journal article work element? The final end date is 1/31/2019 which gives more latitude for responding to journal review etc.

Have a nice weekend

Christine

From: Erin Rechisky

Sent: Tue May 02 15:39:07 2017

To: Petersen,Christine H (BPA) - EWP-4

Subject: RE: dates

Importance: Normal

In Contract Contacts I changed David's role to Supervisor. We need to assign a role for Lisa Dexter.

That's 2 of the 4 "problems".

Erin

From: Erin Rechisky
Sent: May 2, 2017 3:36 PM
To: 'Petersen,Christine H (BPA) - EWP-4'
Subject: RE: dates

Hi Christine,

I submitted the SOW but there were errors. Can you see this on your end?

Also, I just realized we need to change the title of the contract. We need to change it from this: EXP SURVIVAL IN

LARGE WESTERN RIVERS ANALYSIS

To this:

Comparing Survival of Chinook and Steelhead Stocks along the West Coast of North America (If it needs to be shorter then perhaps this: Comparing Survival of PNW Salmon Stocks).

Let me know if I need to address the "4 problems".

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From: Erin Rechisky

Sent: Tue May 02 16:05:59 2017

To: Petersen,Christine H (BPA) - EWP-4

Subject: RE: dates

Importance: Normal

Ok re: the title. It's pretty broad so it will do.

Thanks for asking about the methods.

Is there anything I need to do?

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: May 2, 2017 4:01 PM
To: Erin Rechisky
Subject: RE: dates

I'm not sure who Lisa Dexter is – she is probably involved with Bioanalyst.

It would be very hard to change the title of the contract when we are doing a modification. The title is only used in paperwork and doesn't necessarily need to be accurate with regards to the new emphasis on a broad range of rivers and hatcheries.

I wrote to the monitoringmethods people, and I also spoke to Jan Douglas. She said she doesn't care about publishing the protocol, so hopefully we could just avoid linking to anything for that page on pisces.

The memo is something I need to take care of.

Christine

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Have a nice weekend

Christine

From: David Welch

Sent: Wed May 17 10:16:03 2017

To: Douglas,Jan M (BPA) - NSSP-4

Cc: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky

Subject: RE: Modification contract 75025 BPA

Importance: Normal

Attachments: BPA-Kintama Contract Modification-Signed Cover Page (17 May 2017).pdf

Hi Jan-

I have attached the signed & dated contract modification for your records.

Christine—I noticed one minor discrepancy in reviewing the details of the contract modification: On the SOW "Page 5 of 8" (P. 8 of the modification), the 3rd milestone on that page states "Submit manuscript to Science or other high level journal", while on SOW "page 8 of 8" (P. 11 of the modification) the Milestone states "Submit manuscript to AFS Fisheries?".

I don't think we need to make any changes to the contract as the contract leaves it open as to where we will publish, but I thought you, Erin, and I should have a discussion about where the manuscript should be most usefully published. The suggestion of the journal "Science was a holdover from the original focus of the contract, which was to compare survival between different habitats (hydrosystem vs Ocean, essentially). My own opinion is that with the contract modified to focus on the comparative SARS, the American Fisheries Society journal "Fisheries" might be an excellent fit because it goes out to virtually all AFS members. It would therefore get very extensive coverage in the Columbia River biologists, so might have the greatest impact there (i.e., actually get read and thoughtfully discussed!). There are some limitations to that journal however (particularly the lack of any ability to provide supplementary info in a series of on-line only appendices).

As I say, I don't think the name of the journal needs to be revised, but it might be worth a bit of your time to canvas your colleagues in BPA and see if they have any thoughts on what journals might be particularly influential (if they are!).

David

From: Douglas,Jan M (BPA) - NSSP-4 [mailto:jmdouglas@bpa.gov]
Sent: Wednesday, May 17, 2017 9:34 AM
To: David Welch
Cc: Petersen,Christine H (BPA) - EWP-4
Subject: Modification contract 75025 BPA

Attached is a modification 001 to the contract for project 1996 017 00, please review and sign and return as soon as possible.

As always you can call me or your COTR Christine Petersen at 503 230 4695 for any question you may have.

THANK YOU FOR WORKING WITH BPA

jAN

Call Anytime I Will Do My Very Best To Assist!

Jan Douglas (J.D.)

Bonneville Power Administration

Contracting NSSP – 4

jmdouglas@bpa.gov

503 230 4164

Trout Pic

BPA-Logo-2015-Color-Text

From: Petersen,Christine H (BPA) - EWP-4

Sent: Wed May 17 10:55:24 2017

To: David Welch; Douglas,Jan M (BPA) - NSSP-4

Cc: Erin Rechisky

Subject: RE: Modification contract 75025 BPA

Importance: Normal

Hi,

Let's see – Erin and I had a long conversation about the wording of the contract, including whether to state the targeted journal and what that might be. Then earlier this week I discussed with Jan how we had gone about the contract modification. She asked what the target journal might be, and my understanding is that while we often might put it specifically in the contract text, we sometimes do not. We all do understand that the decision to pick the journal often reasonably should be delayed.

In any case, in this modification, we chose to cancel Work Elements B and C ('Analyze/interpret data' and 'Product Journal article) and replace them with F and G. The cancelled work element C is where we referred to "Submit manuscript to Science". When the substance of a work element is dramatically changed (so that we cannot just highlight a simple addition of a few sentences in italic text), it can be tricky to make clear what language or tasks were kept, deleted, or added so we take the approach of cancelling the original work element but still showing the copy of the text. Then it is clear what is being cancelled without having to find and open the original contract.

I agree with you entirely that you should consider the pros and cons of various journals as you go about this. It is possible that you might discover some interesting result as you go about your analysis that might provide some insight or conclusion that you had not yet anticipated. This could change your opinion about the best journal. I will bring this up with several colleagues in our policy and 'hydro' teams here at BPA, which will also be a good reminder that you are in progress with this effort .

Thanks

Christine Petersen

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Sent: Wednesday, May 17, 2017 10:16 AM
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Cc: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
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I don't think we need to make any changes to the contract as the contract leaves it open as to where we will publish, but I thought you, Erin, and I should have a discussion about where the manuscript should be most usefully published. The suggestion of the journal "Science was a holdover from the original focus of the contract, which was to compare survival between different habitats (hydrosystem vs Ocean, essentially). My own opinion is that with the contract modified to focus on the comparative SARS, the American Fisheries Society journal "Fisheries" might be an excellent fit because it goes out to virtually all AFS members. It would therefore get very extensive coverage in the Columbia River biologists, so might have the greatest impact there (i.e., actually get read and thoughtfully discussed!). There are some limitations to that journal however (particularly the lack of any ability to provide supplementary info in a series of on-line only appendices).

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All—

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Please find attached a corrected version. Jan & Christine, if one of you could update your records with the new address, we would appreciate it—we have sold the old building, so it will never be used in future.

Thanks, David

David Welch

kintamav_RGB

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Mobile: [redacted]

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Sent: Wed May 17 14:00:23 2017

To: Douglas,Jan M (BPA) - NSSP-4

Subject: RE: REVISED: Modification contract 75025 BPA

Importance: Normal

Correct. Sorry I missed it first time—I was too busy looking at the details!

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As I say, I don't think the name of the journal needs to be revised, but it might be worth a bit of your time to canvas your colleagues in BPA and see if they have any thoughts on what journals might be particularly influential (if they are!).

David

From: Douglas,Jan M (BPA) - NSSP-4 [mailto:jmdouglas@bpa.gov]
Sent: Wednesday, May 17, 2017 9:34 AM
To: David Welch
Cc: Petersen,Christine H (BPA) - EWP-4
Subject: Modification contract 75025 BPA

Attached is a modification 001 to the contract for project 1996 017 00, please review and sign and return as soon as possible.

As always you can call me or your COTR Christine Petersen at 503 230 4695 for any question you may have.

THANK YOU FOR WORKING WITH BPA

jAN

Call Anytime I Will Do My Very Best To Assist!

Jan Douglas (J.D.)

Bonneville Power Administration

Contracting NSSP – 4

jmdouglas@bpa.gov

503 230 4164

Trout Pic

BPA-Logo-2015-Color-Text

From: Douglas,Jan M (BPA) - NSSP-4

Sent: Wed May 17 14:27:43 2017

To: 'David Welch'

Subject: RE: REVISED: Modification contract 75025 BPA

Importance: Normal

Thank you, I knew I would mess this one up if I tried .... Thanks

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, May 17, 2017 2:03 PM
To: Douglas,Jan M (BPA) - NSSP-4
Subject: RE: REVISED: Modification contract 75025 BPA

Nope… x3 J

473***7*** Vista View ***Crescent***

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From: Douglas,Jan M (BPA) - NSSP-4 [mailto:jmdouglas@bpa.gov]
Sent: Wednesday, May 17, 2017 2:02 PM
To: David Welch
Subject: RE: REVISED: Modification contract 75025 BPA

Want to make sure

4732 vista view court

V9VIN8 I like inside not a "one"

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, May 17, 2017 11:24 AM
To: David Welch; Douglas,Jan M (BPA) - NSSP-4
Cc: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: REVISED: Modification contract 75025 BPA

All—

Erin pointed out that I had missed the change of our address that is right in the upper left hand corner of the first page!

Please find attached a corrected version. Jan & Christine, if one of you could update your records with the new address, we would appreciate it—we have sold the old building, so it will never be used in future.

Thanks, David

David Welch

kintamav_RGB

Office: (250) 729-2600

Mobile: (b) (6) [redacted]

From: David Welch
Sent: Wednesday, May 17, 2017 10:16 AM
To: 'Douglas,Jan M (BPA) - NSSP-4'
Cc: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: RE: Modification contract 75025 BPA

Hi Jan-

I have attached the signed & dated contract modification for your records.

Christine—I noticed one minor discrepancy in reviewing the details of the contract modification: On the SOW "Page 5 of 8" (P. 8 of the modification), the 3rd milestone on that page states "Submit manuscript to Science or other high level journal", while on SOW "page 8 of 8" (P. 11 of the modification) the Milestone states "Submit manuscript to AFS Fisheries?".

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From: Douglas,Jan M (BPA) - NSSP-4 [mailto:jmdouglas@bpa.gov]
Sent: Wednesday, May 17, 2017 9:34 AM
To: David Welch
Cc: Petersen,Christine H (BPA) - EWP-4
Subject: Modification contract 75025 BPA

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THANK YOU FOR WORKING WITH BPA

jAN

Call Anytime I Will Do My Very Best To Assist!

Jan Douglas (J.D.)

Bonneville Power Administration

Contracting NSSP – 4

jmdouglas@bpa.gov

503 230 4164

Trout Pic

BPA-Logo-2015-Color-Text

From: David Welch

Sent: Tue May 23 13:54:08 2017

To: Petersen,Christine H (BPA) - EWP-4

Subject: RE: Final CSS Oversight Comm. Synthesis Report - Experimental Spill

Importance: Normal

Got it—now to find the time to read & digest it!

A question: Why do biologists in the Columbia basin rely so heavily on modeling instead of direct measurement of mortality in the field? (The biggest problem with modeling studies is that they incorporate our biases and preconceptions). Why not just set up an experiment in the river where paired releases of smolts exposed to different levels of TDG are released simultaneously and their survival measured over the migration route? What really struck Ian Brosnan & I from the 2011 study we reported on was that there was a really big loss of smolts in the plume area, which could well be explained by a high density of predators (seabirds, marine seals, fish), who were identifying and preying upon "crippled" fish that might have survived to that point (4-5 days below Bonneville) but were physically limited because of occlusion of blood flow to some important area of the brain (or, more generally, nervous system) which prevented them from swimming normally. None of this will be captured by modeling approaches because knowledge that it might occur won't be included in the model.

This focus on the CSS' models then precludes incorporating information they have discounted and thus have not included.

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, May 23, 2017 1:34 PM
To: David Welch
Subject: RE: Final CSS Oversight Comm. Synthesis Report - Experimental Spill

Here – I see that a pdf version is now online at the CSS website. Do you want to see if this one opens?

http://www.fpc.org/documents/CSS.html

http://www.fpc.org/documents/CSS/30-17.pdf

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, May 23, 2017 1:29 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: RE: Final CSS Oversight Comm. Synthesis Report - Experimental Spill

Thanks—No go; I get the same error message from Word as before. Is it possible for you to turn this into a PDF and then email me the PDF?

I will withhold any comment until I can actually read the document!

Thanks, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, May 23, 2017 11:04 AM
To: David Welch
Subject: RE: Final CSS Oversight Comm. Synthesis Report - Experimental Spill

Hi, Sorry for the delay.

I saved this version on my hard drive, and hopefully it will open. If it doesn't, let me know and I'll try to save it in a different format.

Yes – we're trying to review this right now. Jason Sweet is out this week, but he is our agency lead on more proactively producing a proposal from BPA, which we would then merge with a Corps proposal. I have heard reports of the Corps using several of the Vicksburg physical models to look at high flow or spill scenarios, but they already have run a lot of dye studies when the models were first built. A trip going on right now is investigating the specific problem of jetty wall erosion under high spill at Little Goose.

Anyway – there are various critiques that can be made both of the statistical details and conceptual framework they are proposing here (for example, continuing to cite the 2-6% SAR goals, with dam route passage as the only means of influencing SAR as a type of carryover effect).

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, May 23, 2017 10:57 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: RE: Final CSS Oversight Comm. Synthesis Report - Experimental Spill

Hi Christine—

Just a reminder—for some reason the Final Synthesis report was corrupted and I could not open it.

Could you re-send?

Thanks, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, May 16, 2017 10:59 AM
To: David Welch
Subject: FW: Final CSS Oversight Comm. Synthesis Report - Experimental Spill
Importance: High

Hi,

This is just an FYI- it is somewhat relevant to the paper you did with Ian on the 2011 outmigration. The attached report has background and a proposal for a 4 year solid block high TDG experiment.

Christine

From: Sweet,Jason C (BPA) - PGB-5
Sent: Thursday, May 11, 2017 8:06 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: FW: Final CSS Oversight Comm. Synthesis Report - Experimental Spill
Importance: High

From: Grimm,Lydia T (BPA) - A-7
Sent: Wednesday, May 10, 2017 9:15 AM
To: Sweet,Jason C (BPA) - PGB-5; Bettin,Scott W (BPA) - EWP-4; Francis,Rose (BPA) - LN-7
Cc: Zelinsky,Benjamin D (BPA) - A-7
Subject: FW: Final CSS Oversight Comm. Synthesis Report - Experimental Spill

Importance: High

Have not opened yet, but passing along for immediate info and attention, thanks!

From: Nancy Schifferdecker - NOAA Affiliate [mailto:nancy.schifferdecker@noaa.gov]
Sent: Wednesday, May 10, 2017 8:32 AM
To: Gregory J Fuhrer; Lesa Stark; Linda Ulmer; Grimm,Lydia T (BPA) - A-7; Mark Bagdovitz; Mary Lou Soscia; Robert Dach; Rock Peters; Rosemary Furfey; Roy Elicker; Dan Feil; David Redhorse; Eric Johnston; Lief R Horwitz; Mike J. Langeslay; ML Smith; Palmer, John; Patty Dornbusch; Steve Waste; Vince Kozakiewicz; Zelinsky,Benjamin D (BPA) - A-7; Cloutier, G Paul NWP; Wilson,David B (BPA) - DKP-7; Jeremiah Williamson
Cc: Nancy Schifferdecker
Subject: Fwd: Final CSS Oversight Comm. Synthesis Report - Experimental Spill

Caucus: Mark has forwarded this for your awareness. Please see his note to me below for further context.

Nancy

---------- Forwarded message ----------

From: **Bagdovitz, Mark** <mark_bagdovitz@fws.gov>
Date: Wed, May 10, 2017 at 8:23 AM
Subject: Fwd: Final CSS Oversight Comm. Synthesis Report - Experimental Spill
To: Nancy Schifferdecker - NOAA Affiliate <nancy.schifferdecker@noaa.gov>, Howard Schaller <howard_schaller@fws.gov>

Nancy - Could you please forward this note to the Federal Caucus as soon as you can.

This is the CSS response to the ISAB's review of Experimental Spill Management. The CSS Oversight Committee expects to send it to the ISAB by the end of the week.

As you may recall, I informed the FC members late last year that this report was coming out in mid January. But that didn't happen due to the complexities of the analysis. The final review wasn't completed until recently.

Plus, the concerns expressed by the FC members regarding the timing of the report's release and the FCRPS litigation were not lost on anyone.

If anyone has any questions, they can call me. However, this is the first I've seen of this report, so I'll be reviewing it along with everyone else.

Thanks.

~MSB

Forwarded message ---------

From: **Schaller, Howard** <howard_schaller@fws.gov>
Date: Wed, May 10, 2017 at 8:04 AM
Subject: Final CSS Oversight Comm. Synthesis Report - Experimental Spill
To: Mark Bagdovitz <mark_bagdovitz@fws.gov>

Mark

Attached is the Final version of the Synthesis Report documenting Experimental Spill Management and response to ISAB comments, questions and recommendations. Please distribute to the Federal Caucus,

The CSS Oversight Comm. plans to forward this report to ISAB at the close of business on Friday.

Thanks.

Howard

Howard Schaller, Ph.D.

Supervisory Fish Biologist
Pacific Region - Fisheries and Aquatic Conservation Program
U.S. Fish & Wildlife Service
911 N.E. 11th Avenue
Portland, Oregon 97232

Phone: 503 231-6153

Cell: [redacted]
Fax: 503 231-2062

—

Mark Bagdovitz

U.S. Fish and Wildlife Service, Fisheries Program

Portland, Oregon

(503) 736-4711 - desk

[redacted] - cell

Mark_Bagdovitz@fws.gov

From: Petersen,Christine H (BPA) - EWP-4

Sent: Wed Jun 07 13:03:02 2017

To: david.welch@kintama.com; Erin Rechisky (Erin.Rechisky@kintama.com)

Subject: FW: Action: Update on advocate letter assessment

Importance: Normal

Attachments: Response to Advocates_060617.docx; Advocates Letter to Congressional_051717.docx; Advoacates Letter to OR.docx

Hi David, Erin

I've been meaning to check in with you, especially before your trip later in June. My coworker was going around with a checklist trying to consolidate documents that we have ready for our Biological Assessment effort, however, they have not even distributed writing assignments or an organizational chart for who will be contributing to various sections. I think we can actually make a lot of headway with those figures you sent us a couple weeks ago as far as addressing SAR trends, and developing Jeff Stier's argument about 'expected' return rates to the Columbia River.

If you have anything such as a drafty abstract or any newly developed figures, this could be helpful. I expect this writing effort to really get underway in July.

I personally have my hands full with the EIS. They are currently trying to refine over 100 initial 'alternative actions' as far as hydrosystem operations or design changes into a more tractable set to be used for evaluating potential effects on fish and wildlife species.

Finally – I did have a specific question for you, if you have a minute. This might relate to the TDG paper you did with Ian Brosnan. I'm trying to help a coworker in communications develop a response to a set of letters sent to members of congress from a list of sports fishing and environmental groups. They are largely citing FPC memos and arguments relating to spill.

There is an argument that TDG regulations are far too conservative, because even with high TDG conditions this spring, the smolt monitoring project samples for Gas bubble trauma are still typically low (setting aside Rock Island, where the sampling tank has water input from a shallow area). Do you have any conceptual argument that you would use to explain observed GBT patterns? I would like to cite your paper, but we have to translate study findings into easily accessible language. We could talk about a real delayed effect that isn't shown in fin observations.

I might consider using your recent SAR findings (80%+ of hatchery SAR observations are typically low, with a few high outliers occurring, but with no clear geographical pattern to explain it)- this could address the argument that hydrosystem effects are particularly high. Paradoxically, I might agree that the hydrosystem could actually be the highest human caused source of mortality (except when harvest is particularly high) because most sources of mortality are predation in different environments.

Thanks

Christine

Questions/Comments in Letters (Congressional and Oregon)

1. Much of 2017 spill is involuntary and above that ordered by Judge Simon and smolt have shown minimal adverse impacts. Even with these very high involuntary spill levels of 2017, there have been no instances of GBT that would require mitigating action under a voluntary spill program such as what the court ordered. In previous years, when we've experienced similar high spill conditions, we saw substantial increases in adult returns two years later. (both letters)
2. Spill as a measure to help salmon survive the federal hydro-system has been studied intensively by the 20+ year-old Comparative Survival Study (CSS). The CSS is a well-established, highly credible, and collaborative scientific undertaking. (both letters)
    a. Its findings are reviewed annually by the Northwest Power and Conservation Council's (NPCC) Independent Science Advisory Board (ISAB) as well as other regional groups. Independent researchers, the federal government, the states of Idaho, Washington and Oregon as well as the lower River treaty tribes (Nez Perce, Warm Springs, Umatilla and Yakama) are all actively engaged in these regional analyses. The CSS science addresses and incorporates hypothetical and empirically-based questions posed by ISAB and other regional science entities, and is associated with potential alternatives for achieving regional fish and wildlife goals and objectives. These analyses reflect the best available science and indicate that increasing voluntary spill in the spring to the levels ordered by the Court (and adjusted based on modeling to identify any additional biological constraints) will improve juvenile salmon survival significantly. The benefits of increased voluntary spill at these levels have been widely accepted by fishery experts at all levels: federal, state and tribal.
3. Any potential unintended consequences of increased spill will be avoided because of review by the court and other entities. (Congressional)
4. The federal hydro-system is the largest source of human-caused mortality for salmon and steelhead in the Columbia Basin - killing up to 70% of the fish annually. (Oregon)
5. Adult returns must be the metric of success, not performance standards focused narrowly on juvenile passage through each dam. (Oregon)
    a. The performance standards mentioned (97%) refer to juvenile survival from the just above to just below a single dam. Juvenile salmon must get past eight dams, and survival decreases with each successive dam. The 97% number also fails to account for the fish that die in the reservoirs behind each dam from predation, disease and warm water. And it ignores fish that die after they pass all the dams because of injuries and wear-and-tear from dam passage. For most salmon and steelhead populations, juvenile survival through the entire hydrosystem is about 50% or less.

DRAFT Response: Providing safe fish passage through the eight federal dams on the lower Columbia and Snake rivers in the centerpiece of Action Agency efforts. Surface passage systems such as spillway weirs are now operating at all federal dams on the lower Columbia and Snake rivers. Surface passage has reduced the percent of fish that go through powerhouses (i.e. turbines), decreased fish travel time through the system and increased overall fish survival. The performance standard targets are 96 percent for yearling chinook and steelhead, and 93 percent for subyearling chinook. Performance testing demonstrates that all eight federal dams are on track to meet performance standards.

6. Repeated assessments conducted by NOAA-Fisheries over the past twenty years have consistently found that most of the listed stocks remain at high risk of extinction and that protection of all listed species under federal law is still warranted. This year's Snake River Spring Chinook was recently downsized to be one of the lowest returns in decades. These fish are in dire need of more help today, not less, and spill is one of the most effective measures in our control to protect and enhance salmon populations in the Columbia. (both letters)
    a. In 2015, a critically low snowpack and unusually high temperatures combined to kill hundreds of thousands of juvenile and adult salmon. Just 1% of the Snake River's critically endangered returning adult sockeye salmon
    b. Increased spill can aid juvenile survival and increase adult returns in all years and is an especially critical, albeit partial, buffer for future climate change effects.

    DRAFT Response: Natural-origin fish for all ESA-listed salmon and steelhead species in the Upper Columbia and Snake rivers have increased in abundance since the first ESA listings in the 1990s. On average, natural-origin chinook numbers have more than tripled and wild steelhead numbers have doubled in that time. Listed hatchery fish display similar trends and help conserve the genetic resources of the species by providing a safety ned in times of poor climate and ocean conditions. Several factors contribute to increases in abundance including fish passage improvements, reduction in travel time, habitat enhancement, harvest levels, predation management and ocean conditions. Annual variation in abundance and productivity of natural-origin populations can be substantial. Biologists consider trends to be more important than the results of a single year.

7. Any increase in power costs, if they rise at all, is likely to be modest, even accepting BPA's initial estimates. (both letters)
    a. Any potential increase in power costs are expected to be modest, and a bargain in comparison to what our state and region has spent on the failures of the past. Based on BPA's estimates, the impact of the spill order on the average household would likely be far less than $1/month. Furthermore, in Bonneville's testimony in its current rate case, they acknowledge that the actual costs of increased spill could be significantly less, depending on the market and other factors. Further, it is common for Northwest power costs to be very low in the spring due to our region's rainfall and snowpack, and more recently from the increase in solar power generated in California.

    DRAFT Response: BPA estimates that total fish and wildlife program costs are roughly $10/month for average residential customers of utilities that buy all of their power from BPA. The increased spill could be a significant cost overall, but the estimated $40 million increase converted to average residential customers is about a $1/month increase. BPA staff was very clear in testimony on the proposed spill surcharge that actual costs are equally as likely to be lower or higher than the forecast cost. The spill assumptions that were modeled in the Connolly declaration generated a distribution of potential costs based on the 80-year water record, and some of those data points in the 80-year record would be more than $40 million and some would be less than $40 million, but the unbiased forecast in that range is $40 million. The advocacy groups' statement is misleading because it fails to acknowledge the flip side – that actual costs *of increased spill could alternatively be more than was estimated earlier this year. BPA staff certainly did not testify that the difference could be "significantly" less (or "significantly" more). The advocacy groups may be basing their statement of "significance" on their own assessment of the data, which showed the distribution range for the modeling outputs. But it is misleading for them to indicate that BPA staff, the actual experts on this topic, opined that this distribution range is significant.*

From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Jun 08 17:01:13 2017

To: David Welch

Subject: RE: Action: Update on advocate letter assessment

Importance: Normal

Thank you very much David,

I haven't called – I was involved in the EIS meeting the last two days, and this morning I went out to the new chum spawning channel that WDFW is building.

This is great – an update is pretty much what we need, but they have not started writing the BA yet (or I learned that they wish to call it the 'Proposed Action' rather than a Biological assessment today), and hence there will be plenty of time to cite a more developed draft later.

Your approach for addressing TDG effects is also quite helpful. I will keep you updated if we are actually able to cite Brosnan et al.

thanks

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, June 07, 2017 2:38 PM
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Cc: Aswea Porter
Subject: [EXTERNAL] RE: Action: Update on advocate letter assessment

Hi Christine—

(b) (6) [redacted]

(b) (6) [redacted]

Coincidentally, I just sent back to Aswea comments/requests on some revised graphs we can give you folks. Several of the graphs need some more work to make them more interpretable by people and really drive home the key point about Snake River stocks ***not*** having worse survival. Also, there is LOTS of work still needed to work out some of the fine points.

I should be able to share some of these graphs with you later this week (or by Monday, at the latest), with the caveat that the relative rankings of survival are not absolute—we have work to do to sort out a number of important survival differences between the different data sources, and very substantial work to do in writing ("framing") the issues so that biologists and non-biologists alike can understand how we have come to the rather paradoxical situation where people assume that survival is worse for Columbia River stocks than elsewhere when in fact this is not true.

The way I am inclined to re-state your comment below about TDG is that survival of many (most?) stocks of Chinook & steelhead in the Columbia River is already apparently quite high compared to other stocks returning to rivers outside the Columbia River basin that lack dams. Looking at gas bubbles evident in smolts collected at the dams and relating it to lab-based mortality studies may seriously underestimate the real magnitude of TDG-induced mortality because it excludes smolts that may be compromised by gas bubbles but that do not directly die from TDG (they die from predators picking off compromised smolts that are counted as remaining alive in lab studies). Paradoxically, it could be that SARS would then be even higher for Columbia River stocks relative to non-Columbia River stocks in years of high flow if TDG was not allowed to exceed their current gas caps.

Does this make sense? Give me a call to discuss if you wish. (I'm here for another 20-30 minutes today, and in all day tomorrow).

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, June 07, 2017 1:03 PM
To: David Welch; Erin Rechisky
Subject: FW: Action: Update on advocate letter assessment

Hi David, Erin

I've been meaning to check in with you, especially before your trip later in June. My coworker was going around with a checklist trying to consolidate documents that we have ready for our Biological Assessment effort, however, they have not even distributed writing assignments or an organizational chart for who will be contributing to various sections. I think we can actually make a lot of headway with those figures you sent us a couple weeks ago as far as addressing SAR trends, and developing Jeff Stier's argument about 'expected' return rates to the Columbia River.

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Thanks

Christine

From: David Welch

Sent: Fri Jun 30 15:17:55 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] SAR Figures for BPA-Kintama Discussion (30 June 2017).docx

Importance: Normal

Attachments: SAR Figures for BPA-Kintama Discussion (30 June 2017).docx

Hi Christine—

Here is an short version of what we have been working on… key results only. Please distribute as appropriate.

We have primarily focused on the Chinook results, listing what we view as key take home messages in the numbered bullet points, but we have also included similar graphs for steelhead just so that folks can see (if they have time) that our findings for Chinook also seem to apply to steelhead. (No comments on the steelhead… too much to cover).

I tried turning this into an Adobe pdf but unfortunately the figures are too complex, and the figures were badly corrupted in the conversion process, so I am sending the Word document "as is".

Next week I will try to turn the figures into Powerpoint slides to make it easier for everyone to stay on track and view them.

From our perspective, we have three goals:

1) Demonstrate that we are making useful progress.

2) Lay out in broad brush strokes where we think the data are pointing

3) (& most important for us) Get a better sense of what the major policy issues are for the region, and how this helps.

As ever, the balance here is that we are looking for “neutral” enlightenment about what makes the science most helpful but without prescriptive advice about what would make your professional lives easier—a fine balance!

Please note the each page is marked “Draft”… still early days, with much to do. We will lay out some of the remaining caveats when we introduce the work next Wednesday.

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile: [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

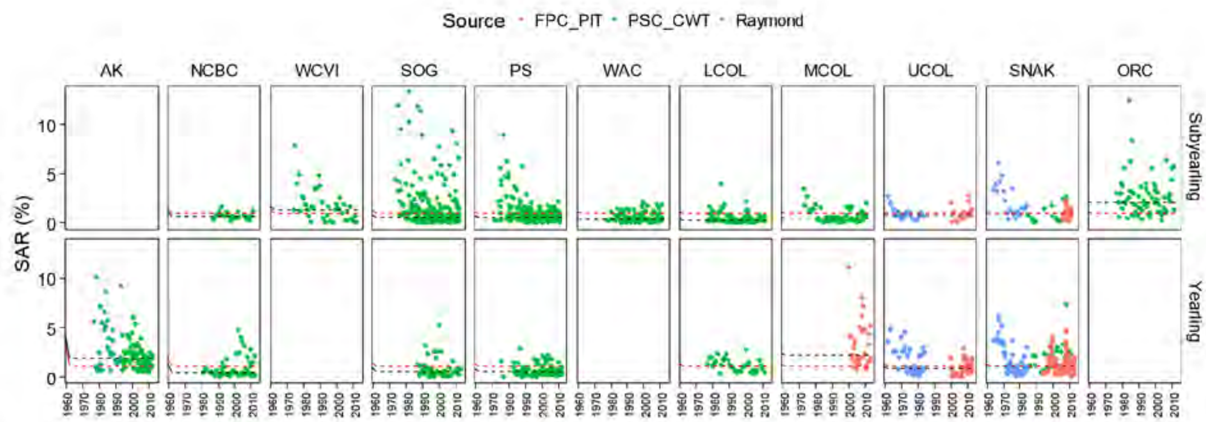
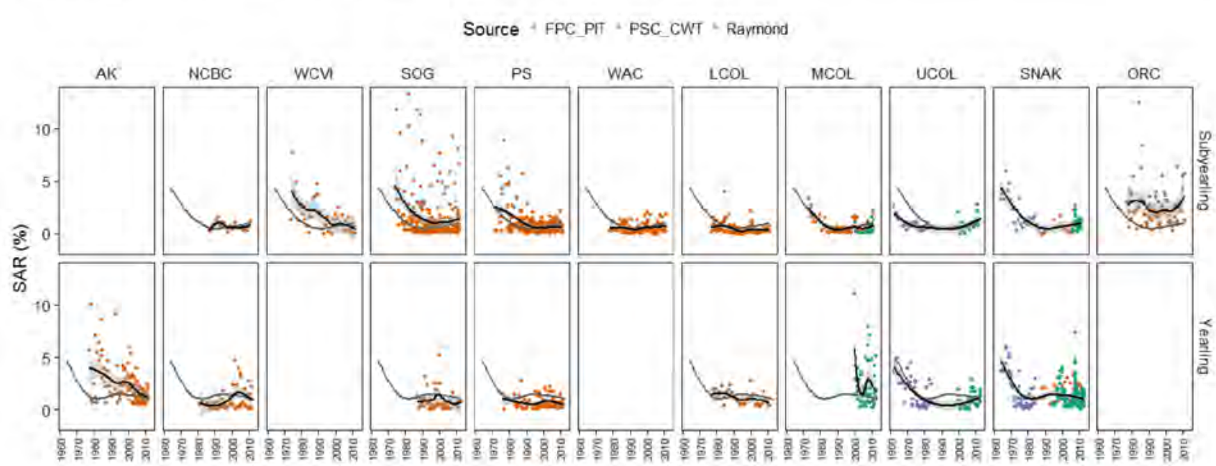


Fig. 2a. Comparative time series of smolt to adult survival (SAR) data for west coast Chinook stocks (excluding California). Top row: subyearlings; bottom row: yearlings. Regions are oriented from north (left) to south (right). Green dots are SAR measurements based on CWT tags, blue dots are SARs reported by Raymond (19??a,b), and red dots are SARs based on PIT tags (CSS, 20??). Median survival across all available data for each panel is shown as a black dashed line; median Snake River survival is shown as a red dashed line and is overplotted on all panels. Blank panels indicate regions where the life history type does not occur (for example, Fall (subyearling) Chinook do not occur in Alaska, while Spring (yearling) Chinook do not occur in the low elevations streams on the west coast of Vancouver Island. In the second, alternate, version of the graphs shown ***below this text***, a loess curve fit to the data in each panel is shown along with the 95% confidence interval (shaded region). The Snake River loess curve is overplotted on each panel (in grey) to facilitate comparison. (Data remain the same in the two versions).



Discussion Points:

1) Snake River stocks (both yearlings & subyearlings) show a substantial decline in SARs over time starting in the late-70s, the time (a) the FCRPS was completed and (b) a major regime shift occurred around 1977.

2) Although Snake River subyearlings had higher survival than Upper Columbia River subyearlings in the 1960s (consistent with the idea that the completion of the Snake River dams drove the decline in Snake River stocks) yearling Snake River SARS fell throughout the 1960s and early 1970s
3) This decline in SARs with time is seen in many other regions not affected by the construction of the FCRPS. This suggests that the decline in Columbia River SARS is primarily due to ocean changes and not the dams. *{We will build on this theme in the paper/report to make the case that Columbia River basin stocks are largely declining in response to continent-wide changes in ocean survival, and possibly see if we can quantify the relative contributions}.*
4) Despite this decline, Snake River SARs have been higher than in many other regions; the pattern of decline is consistent with the idea that the region of poor ocean survival is expanding to the north, in very recent years reaching Alaska (ca. 2010).
5) By 1990 or earlier, SARs of subyearling Chinook stocks from the Strait of Georgia (SOG), Puget Sound (PS), and Washington coast had declined to being no better than the Columbia River basin stocks. For yearlings, SARs in the Strait of Georgia & Puget Sound were lower. *{Note: losses to fisheries have been removed from CWT data but not (we think) PIT tag data. As these losses primarily affect subyearling Chinook (which remain coastal resident for the marine phase of their life history), it is possible that relative survival of Columbia River basin subyearling stocks may change once this is sorted out…TBD}.*
6) The higher SARs seen for the mid-Columbia River stocks (which underlies the delayed mortality theory) is only evident for yearling Chinook; for subyearling Chinook the SARs are apparently virtually identical, with the single exception of ORC (Oregon Coast subyearling Chinook).
7) Overall, the coastwide data suggest that marine survival began declining earliest to the south and then the region of poor marine survival progressively moved farther north along the coast so that in the most recent years even SE Alaska has survival no better than experienced by Snake River Chinook. (And Alaska has declared an emergency over poor adult Chinook returns to many regions of the state). Obviously, almost none of the rivers outside the Columbia have dams, so the argument that Snake River stocks' poor performance is due to the completion of the FCRPS is not consistent with the broader data.

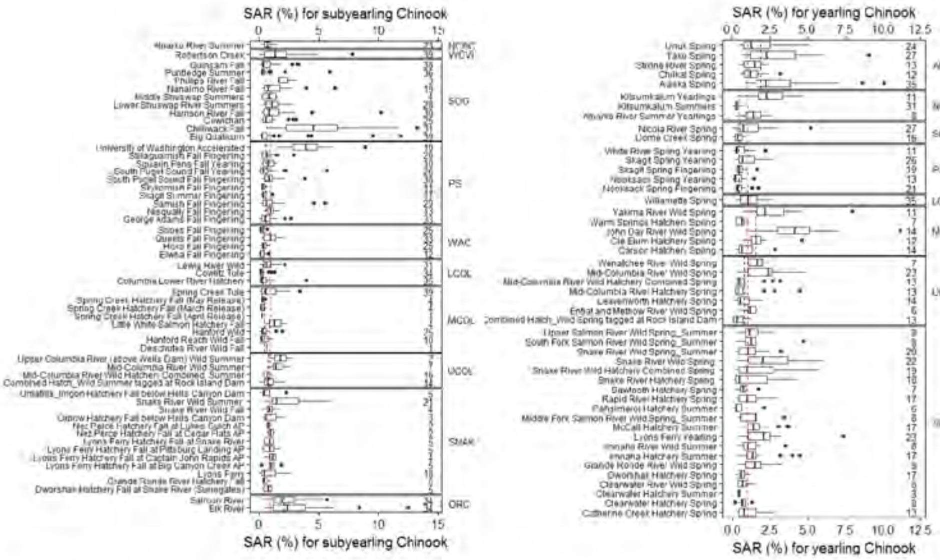


Fig. 3. Box and whisker plot of SARs by population (all available years). The black horizontal line within each bar is the median of the SAR data available for that population. Median survival across all available data for each panel (geographic region) is shown as a black dashed line; median Snake River survival is shown as a red dashed line and overplotted on all panels for comparison. The number of years of data is shown to the right.

Discussion Points:

1) For yearling Chinook (right hand panel) only Alaska and Mid-Columbia stocks have better SARs; for all other regions, Snake River yearling Chinook SARS are higher (better).
2) For subyearlings, Snake River SARs are similar to or better than survival in all regions of the coast apart from coastal Oregon (ORC; two populations) and two hatchery populations from farther north: University of Washington Accelerated Fall Chinook in Puget Sound and Chilliwack Fall Chinook from the Strait of Georgia (lower Fraser River). The very large survival difference (up to ~4X) of these four stocks relative to the majority of populations in each region is striking, and it would be very useful to establish why these stocks have so much higher survival than the remainder: is it an identifiable rearing strategy that can be adopted elsewhere, or is it some difference in the marine ecology of the places animals from these populations rear in?
3) When data for all available years is combined for each region, Snake River yearling Chinook SARS are higher than Puget Sound, Strait of Georgia, or North & Central BC, and similar to those in the Willamette R (Lower Columbia River, below all the FCRPS dams). *{But see below for caveats about possible differences between PIT & CWT-based life history survivals, and the degree to which commercial and sport harvest are accounted for in these estimates… we are still working on this, and they are complex issues}.*
4) In no region outside the Columbia River are the Columbia River basin's official SAR recovery targets of 2%-6% currently achieved. The Alaskan stocks come closest, but the previous time series graph shows that in recent years Alaskan SARS have fallen well below the Columbia River basin rebuilding targets as well, and have reached (?) the current survival rates of Columbia basin stocks despite the absence of dams.

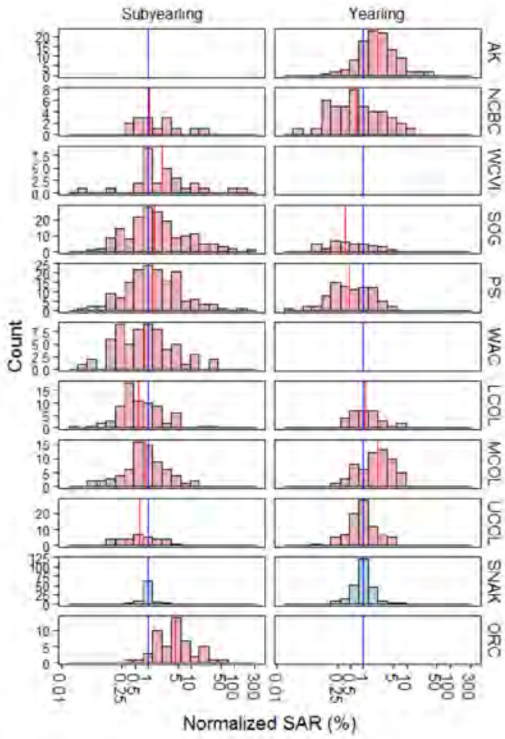


Fig. 4. Normalized SARs, obtained by dividing each individual SAR estimate (i.e., for each stock and each year) by the median SAR calculated across all available Snake River SARs for that year. Columbia & Snake River SAR estimates do not include pre-dam survival. Snake River SAR is overplotted in blue. Note the logarithmic scale on the x-axis. *(Probably need to show tick marks as 2X, 4X, 8X, 16X, etc. to facilitate visual comparison).*For yearling Chinook, the graph shows the roughly normal (Gaussian) distribution of SARs once log-transformed . SARs for the Upper Columbia stocks (9 dams) and lower Columbia River (Willamette; 1(?) dam) are virtually identical to Snake River stocks.

Discussion Points:

1) SARs for yearling Chinook from Puget Sound, Strait of Georgia, and north-central BC are all lower than for the Snake River, and thus for the Columbia River basin as a whole.
2) This raises questions about the validity of the delayed mortality theory (more dam passage results in lower marine survival) and also on whether Columbia River recovery targets are realistic (if rivers without dams cannot achieve the survival achieved by Columbia River basin populations with dams, how will Columbia River basin biologists achieve these targets?).
3) For subyearling Chinook, SARS for lower, mid, and upper Columbia River are all lower than the SARs attained by Snake River stocks. SARS are nearly the same as for subyearling Chinook from the Washington Coast, Puget Sound, and Strait of Georgia, and lower than those obtained by subyearling Chinook from the Oregon Coast and west coast of Vancouver Island.
4) The subyearling pattern is somewhat more complicated than that of yearling Chinook, but we think that the lack of a consistent relationship with dam passage is notable (shouldn't there be one if there is delayed mortality?), as are the similar survival levels to the Strait of Georgia stocks. The Strait of Georgia includes quite a number of stocks from the Fraser River, a river of similar size to the Columbia, but which lacks dams lying along the smolt migration pathway.

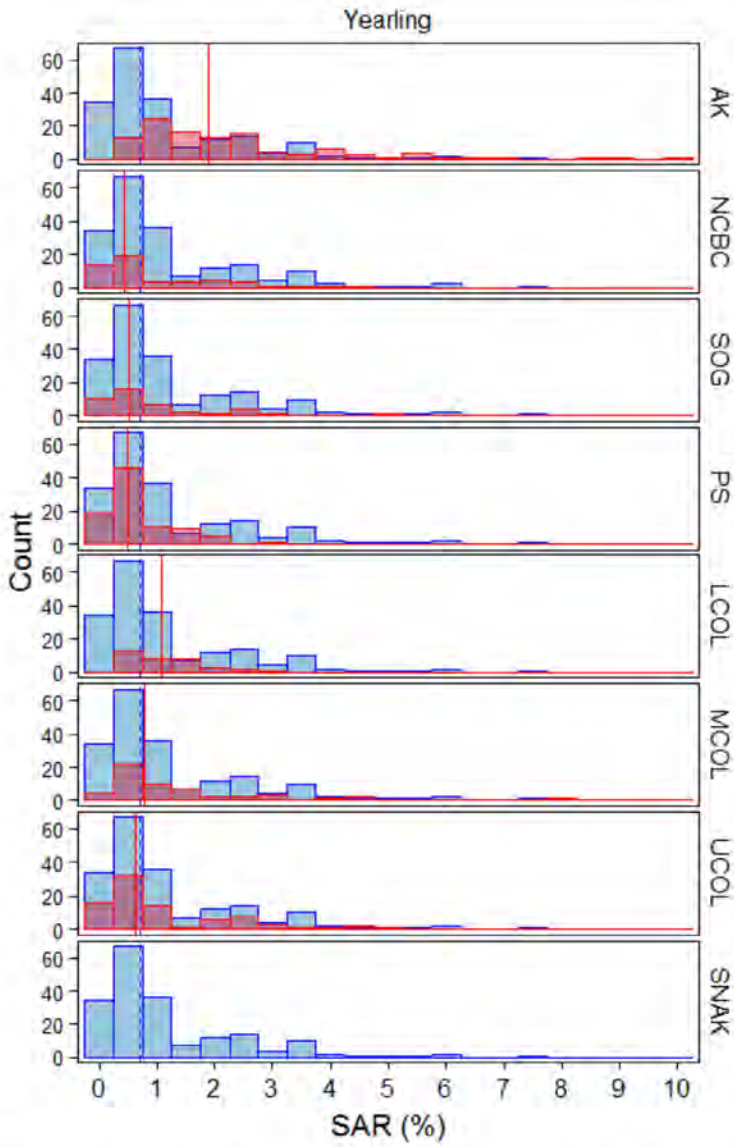


Fig. 6. Comparison of estimated SARs, all years. In this figure, conventional PIT-tag based SAR estimates for Columbia River stocks have been multiplied by estimated smolt survival from release to the first dam encountered for Snake River, Upper and mid-Columbia River populations. Survival values for other regions remain the same as in previous graphs, i.e., CWT-based SARs from hatchery release to adult return.

1) Note that unless adult survival from the upper-most dam back to the spawning grounds, which is excluded from the figure owing to lack of data, is quite low for Snake River stocks, Snake River stocks have higher SARs than are achieved in Puget Sound, Strait of Georgia, and North-Central BC populations, and indistinguishable SARs from populations in the MCOL and UCOL regions. In short, populations of Columbia River basin yearling Chinook that migrate through multiple dams have higher survival than all other populations except for Alaska. The Lower Columbia River (Willamette) stock has higher survival than any other region save Alaska.

2) We could not include the subyearlings because at this time we don't know how many were removed from the counts released due to transportation. Reminder that the SNAK dataset includes only hatchery-origin stocks except for a small number of wild estimates recorded before 2006. The MCOL data set is missing Cle Elum 2002-2006. The UCOL dataset is missing Leavenworth (2002-2006).

Steelhead

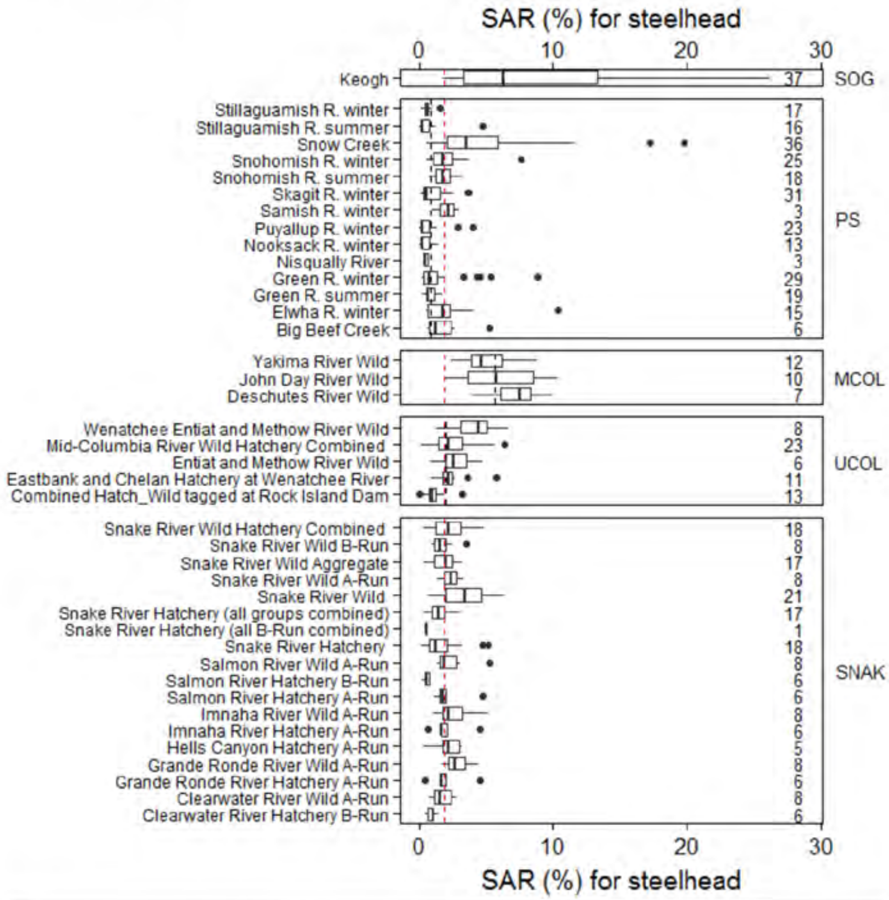


Fig. 7. Interpretation of this box & whisker plot of steelhead SARS similar to that of the prior Chinook plot. (Included just to show that the conclusions for steelhead will broadly parallel what we have found for Chinook).

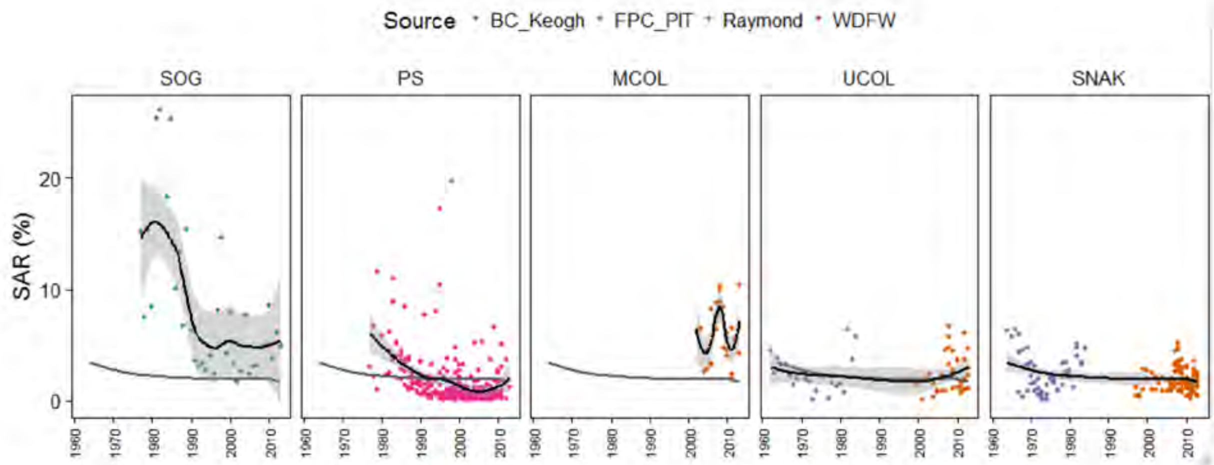
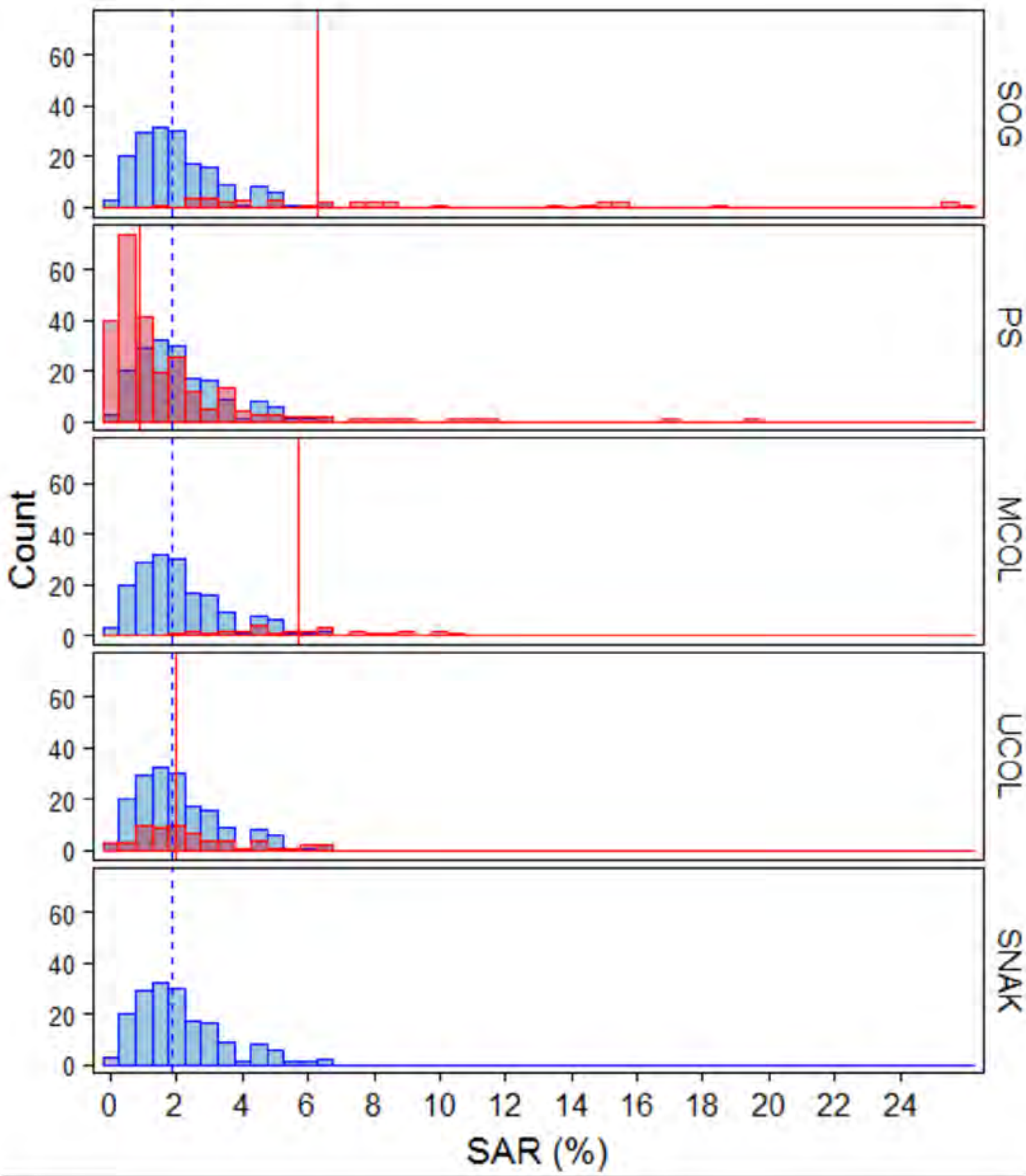


Fig. . Time series of steelhead SARS. Interpretation similar to that of the prior Chinook plot. (Included now just to show that the conclusions for steelhead will broadly parallel what we have found for Chinook). Note the sharp decline in Puget Sound & Strait of Georgia steelhead SARS after 1990.



SOG
PS
MCOL
UCOL
SNAK
Count
0
20
40
60
0
2
4
6
8
10
12
14
16
18
20
22
24
SAR (%)

Fig. .

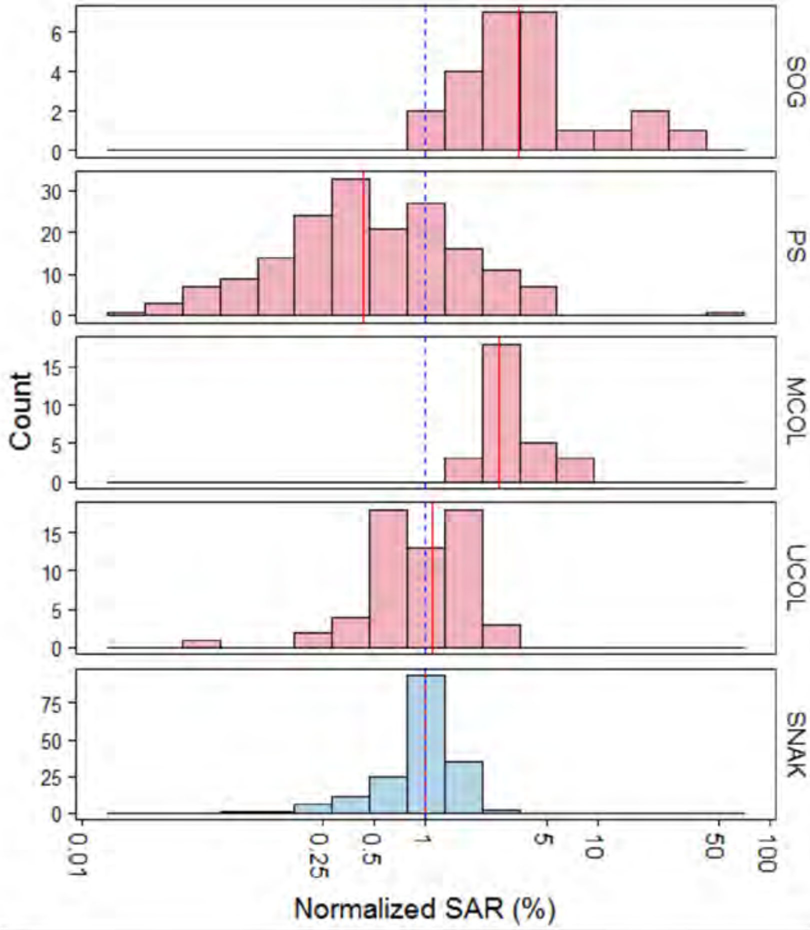


Fig. ? Normalized steelhead SARs.

From: David Welch

Sent: Tue Jul 04 16:46:24 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] BPA-Kintama Progress Update (5 July 2017).pptx

Importance: High

Attachments: BPA-Kintama Progress Update (5 July 2017).pptx

Hi Christine—

I hope you had a good 4th of July. I am sending this email to you now in the hope that you can distribute it to others (if you think appropriate) prior to the phone meeting Wednesday at 10 AM so they can glance over it if they have time.

In addition to presenting the initial results, we are very interested in the thoughts & reactions of BPA staff as to what additional analyses we could do that would help shed clarity on the issues you are currently deliberating. It is hardly a secret that I think many of the conclusions about salmon conservation reached in the Columbia River basin do not hold water when viewed from a broader perspective, and I think the analysis we have put together so far strongly supports this view. However, your folks' perspective on what is really important to clarify may differ from our assumptions, so we would appreciate your thoughts.

As discussed previously, please confine comments to ***what issues are important to clarify***, ***not what conclusions are desirable***—we continue to walk that fine line of making the results as robust and scientifically relevant as possible but avoiding as much as possible "screening the data" for bits & pieces supporting a particular viewpoint. So we need direction on what are important issues we may currently be missing, but not requests as to what conclusions would make life easier for you!

Each slide has a number in the lower right. We will try to call out each slide number so that you can page forwards, and we can try to make sure we are discussing the same material…. Since this is a phone call in, we won't be able to see what you are looking at.

Regards, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

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fisheries work on-line: http://kintama.com/media/videos/

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Initial Kintama Progress Update to BPA

5 July 2017

KINTAMA

- Results primarily confined to Chinook in this update
  - Subyearling & yearling populations separated
- We show a few steelhead results to indicate the same general conclusions will likely hold more broadly
- ***Important Caveat:*** We are still trying to refine the CWT vs PIT tag database analyses to make the comparisons as robust as possible.

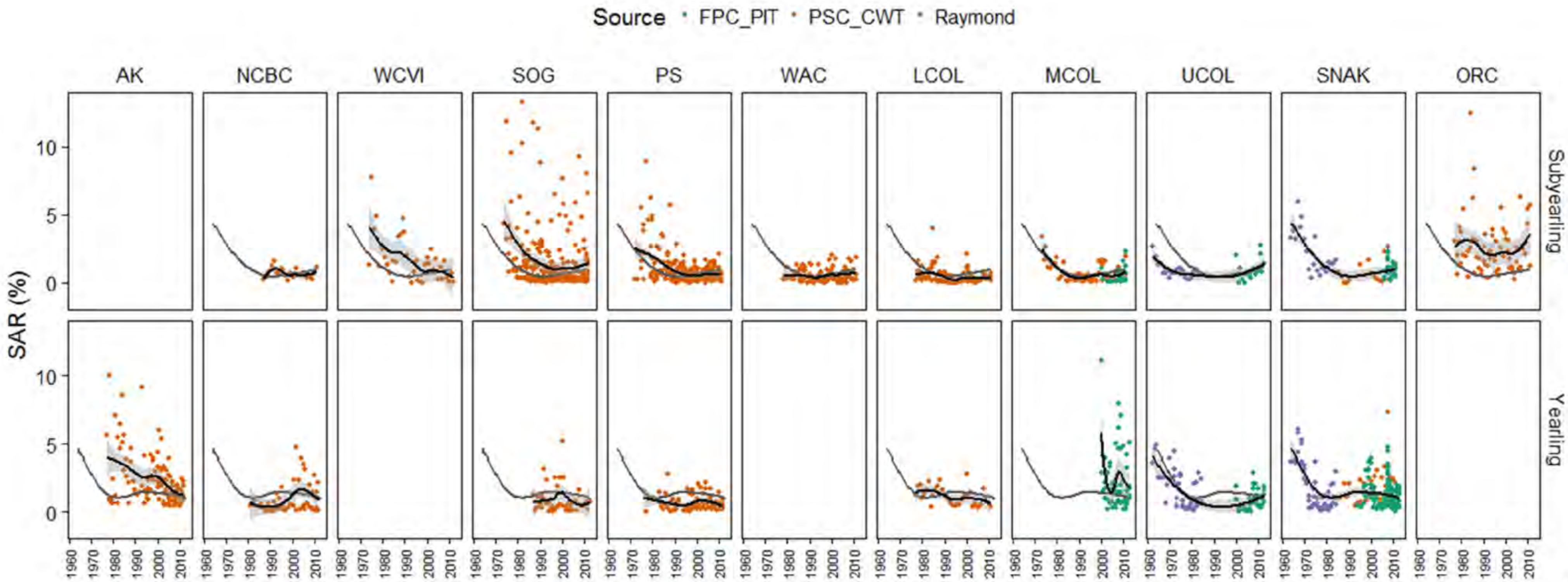
KINTAMA

Primary Results (Tentative)

- The broad coast-wide analysis of SARs leads to very different perspective from the current (narrow) view in the Columbia River basin:
  1) SARs in all regions fell starting in the early-mid 1970s
  2) For CR basin stocks, only MCOL yearlings SARs are higher than Snake River SARs- and only two MCOL populations (not all).
  3) For Yearling Chinook, Snake River SARs same as Upper & Lower Columbia & are higher than Puget Sound, Strait of Georgia, North-Central BC
     - ➢ Little or no evidence for "delayed mortality" in Snake River Chinook
  4) Data are consistent with a coast-wide northern expansion with time of a region of poor ocean survival, progressively encompassing more stocks (even Alaska now affected & has similar survival to Snake River!)
  5) Snake River populations do not have lower survival than other stocks not migrating through the Snake River dams

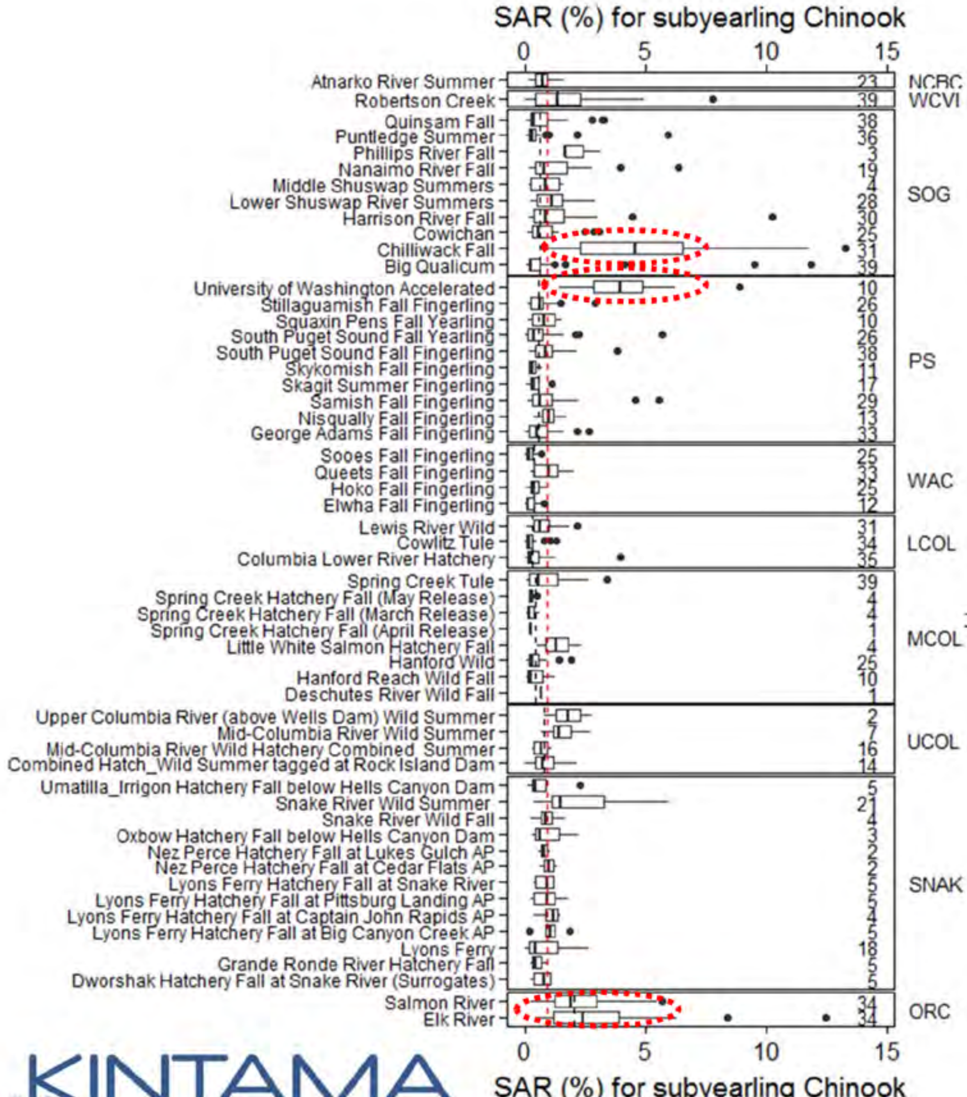
KINTAMA

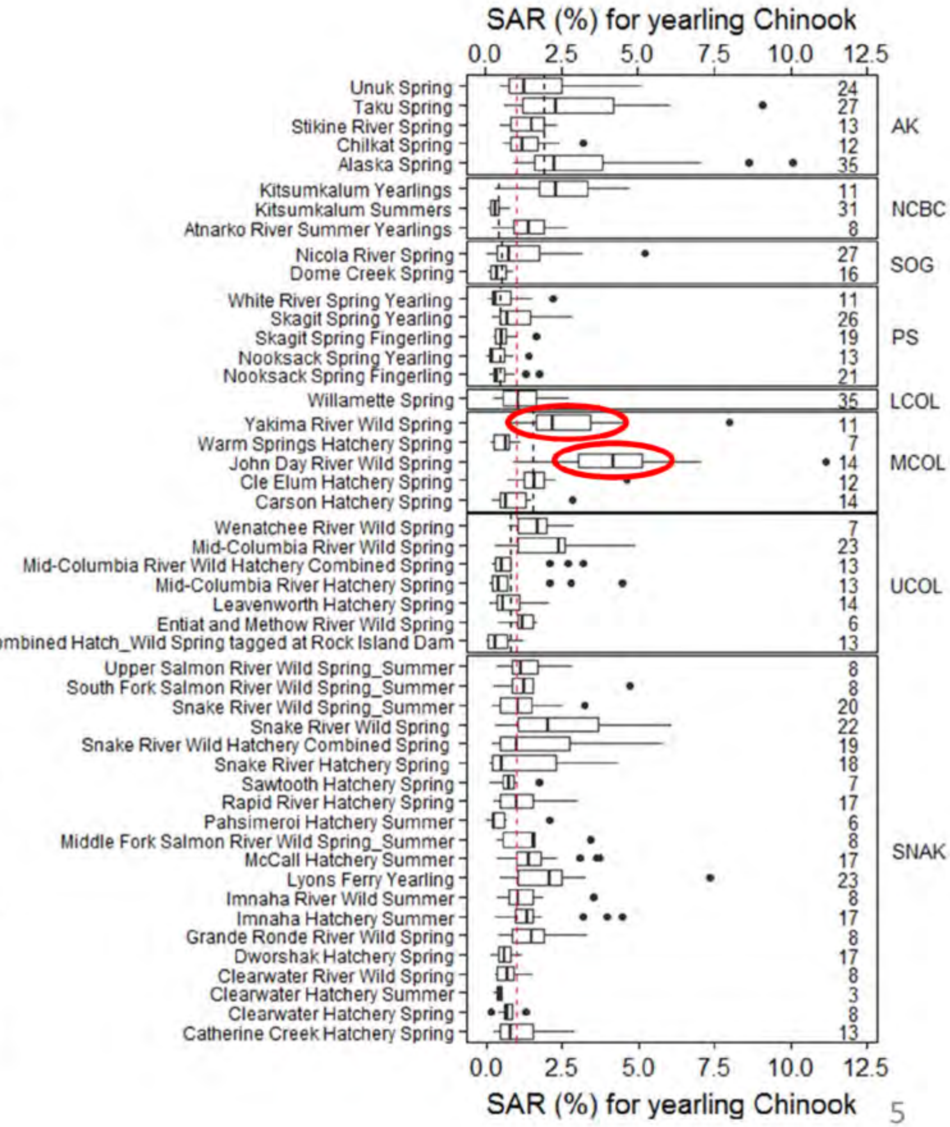
Chinook-All SAR Data by Region



- Plotted SARS against time, split out by regions (columns) & Chinook life history types (rows)
- LOWESS trend line (black) fitted to the SAR data. Snake River trend line (gray) overplotted on all panels to facilitate comparison.

Stock-Specific Chinook SARS-All Years

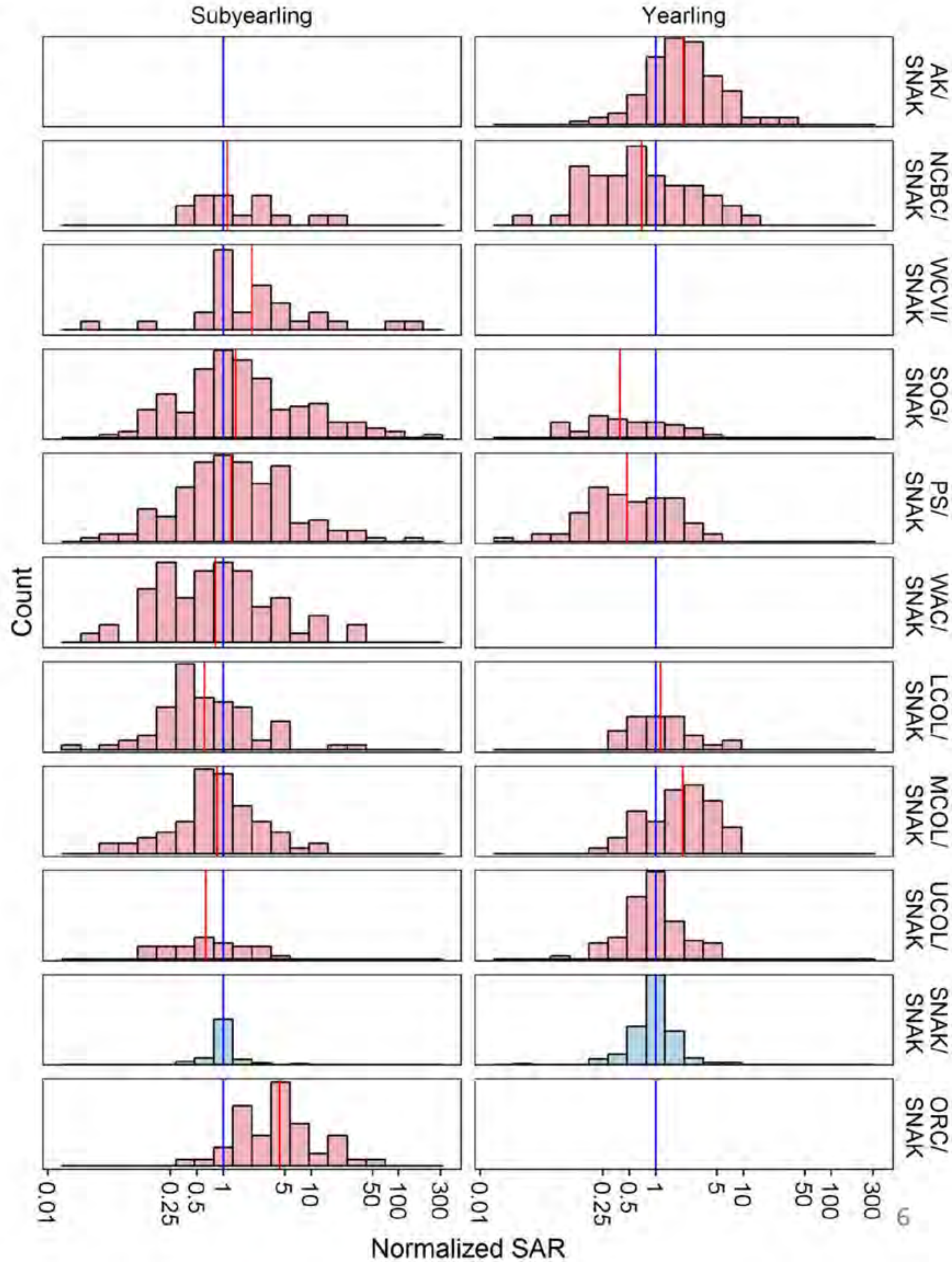




KINTAMA

Comparison of Regional SARs
(Region X/Snake)

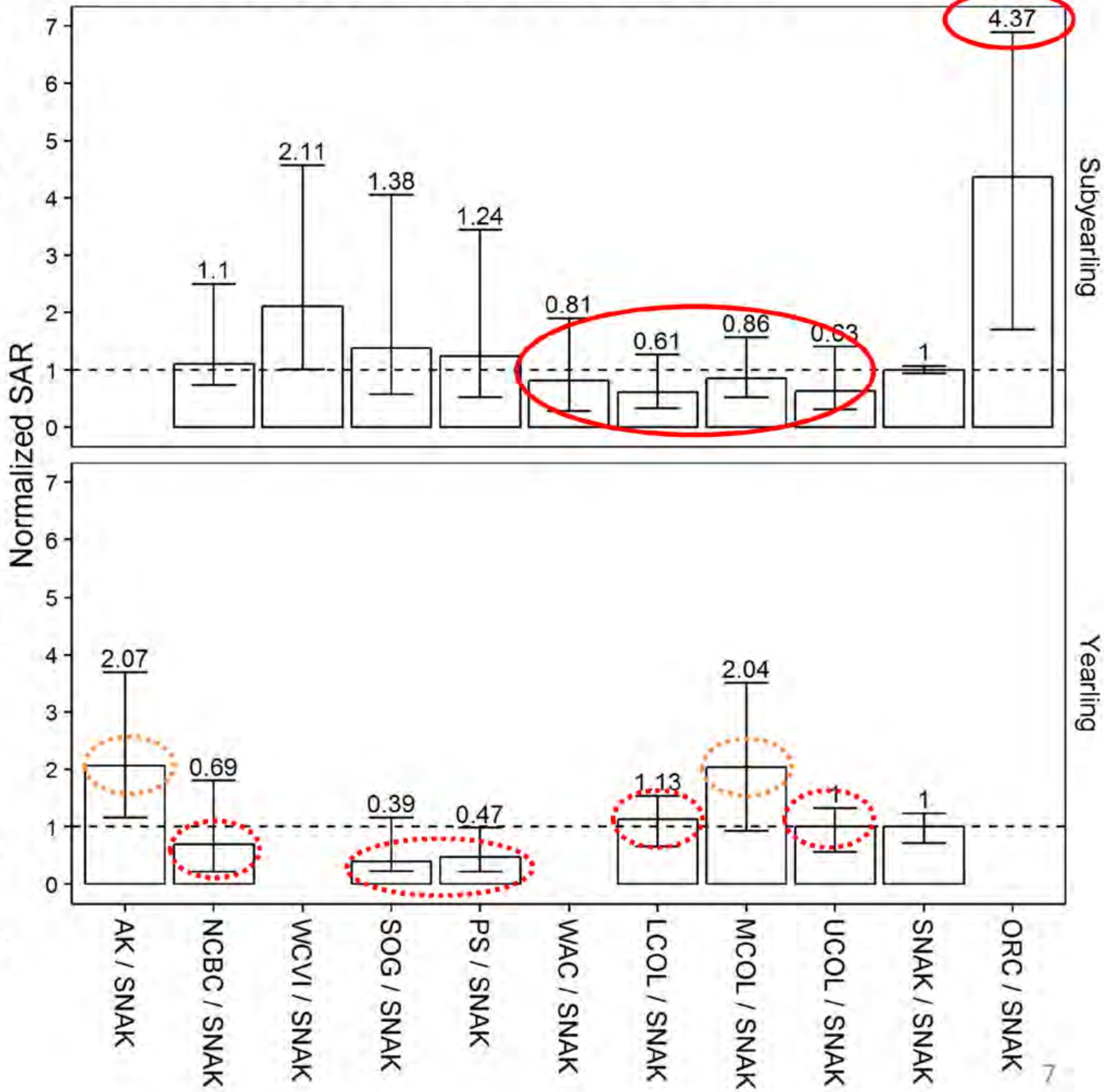
- Divided annual SARs for Region X by the Snake River median SAR for the same year
- Plotted the results as a frequency histogram
- Snake River is in blue



KINTAMA

Relative Chinook SARS

1. Same data as prior slide, just different presentation (error bars are 25 & 75 percentiles)
2. For subyearlings:
   1. Oregon Coast Chinook have SARS 4.37X Snake River.
   2. But Upper/Mid/Lower Columbia River SARS are **lower** than Snake River subyearling SARS, as are WAC (Washington Coast).
3. For Yearling Chinook:
   1. Snake River SARs same as Upper & Lower Columbia & higher than Puget Sound, Strait of Georgia, North-Central BC
4. Only Mid-Columbia & Alaska have higher SARs than Snake River (& recall Alaskan SARs have fallen to Snake River levels in recent years)



Major Remaining Uncertainties

1) SARs are derived by different methodologies:
   a) In Columbia, early data from Raymond (branding)
   b) CWT survival data is from smolt release to adult return to spawning grounds
   c) FPC survival data is based on PIT tags:
      i. Survival calculated from smolts reaching a dam to adults returning to a dam
      ii. Excludes smolt survival “pre-dams” and adult survival “post-dams”.
      iii. Not corrected for harvest in sport & commercial fisheries
   d) CWT survival data:
      i. Corrected for losses to sport & commercial fisheries
      ii. Survival calculated from release to adult return to spawning grounds
2) Unclear at this point how much correction of SARs for harvest and pre/post dam survival will move the comparisons around… but doing this is important!

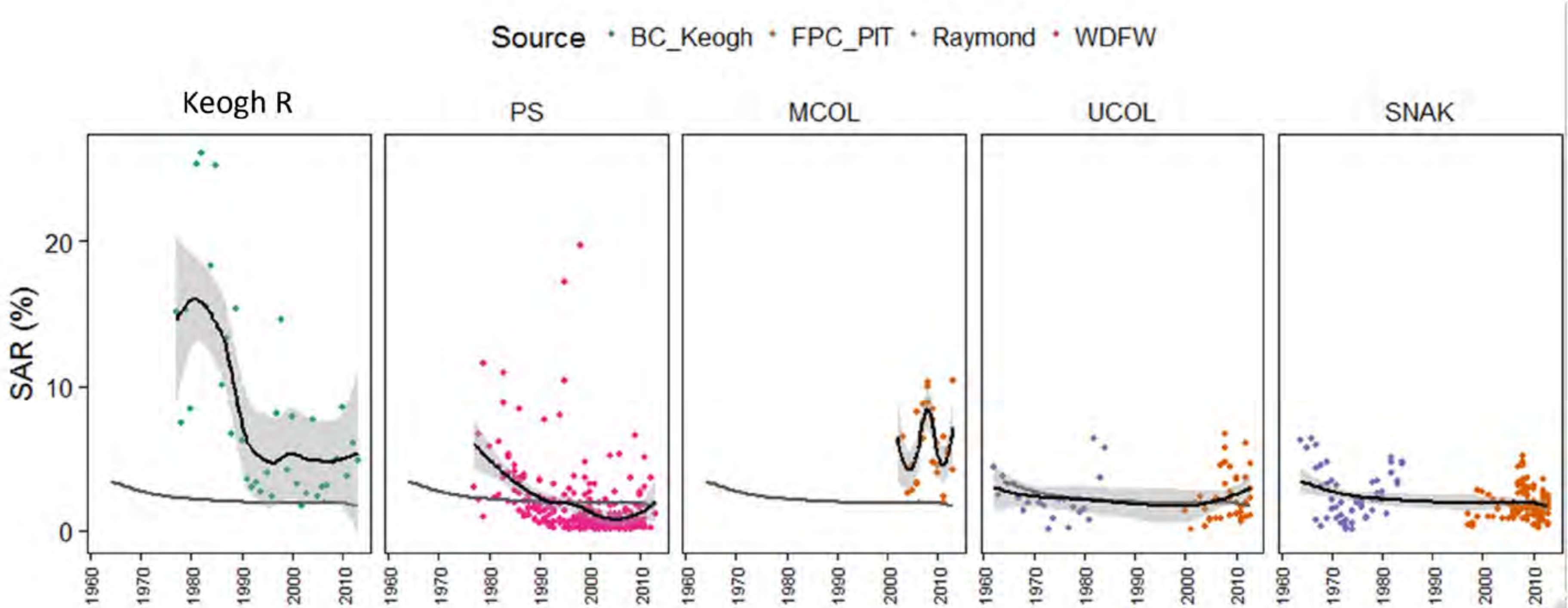
Questions from Kintama

1) Is this analysis useful?
2) What analyses can we do/add that will better address the legal (& social/economic) issues that you face?

Steelhead Results
(Different Species, Similar Story)

KINTAMA

Steelhead-Available SAR Time Series



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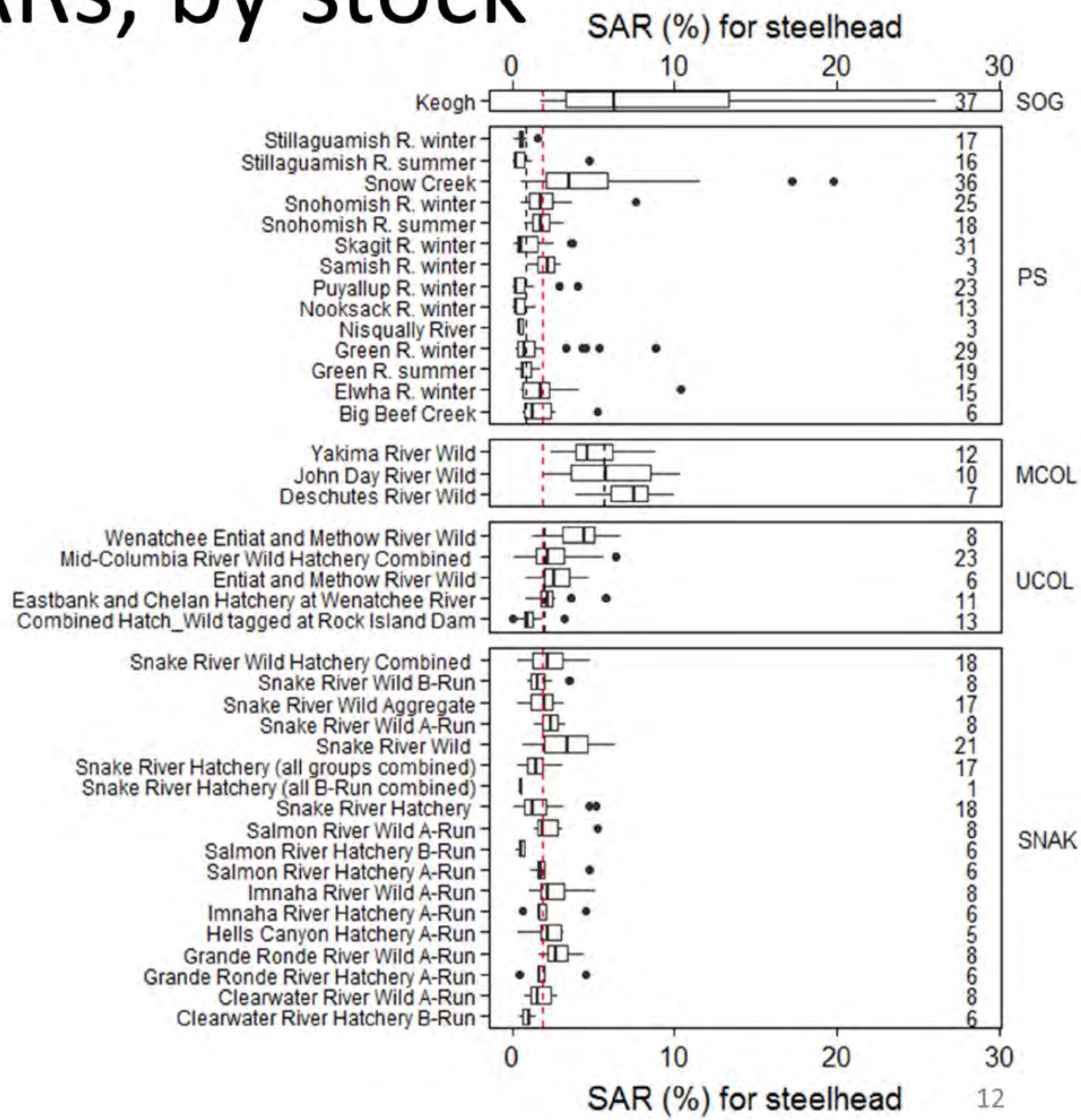
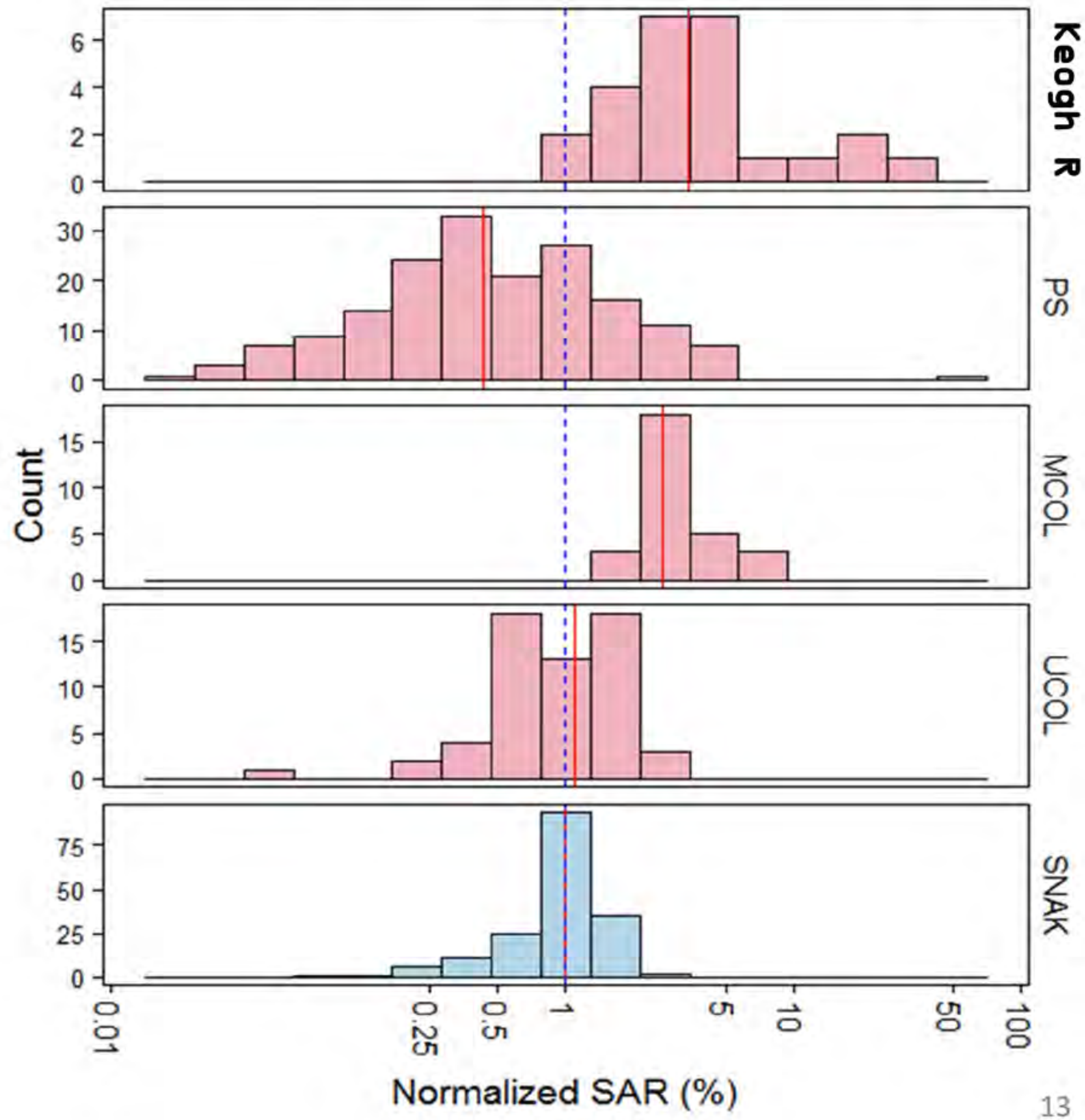
Steelhead SARs, by stock



KINTAMA

Steelhead-Normalized SARs (All Years)



KINTAMA

From: Petersen,Christine H (BPA) - EWP-4

Sent: Wed Jul 05 09:13:53 2017

To: David Welch

Cc: Erin Rechisky; Aswea Porter

Subject: RE: BPA-Kintama Progress Update (5 July 2017).pptx

Importance: Normal

Hi,

Thanks – I distributed it to the group, and we look forward to talking with you in an hour. A couple people will be calling in from home. I invited a few staff who haven't been involved in this so far, but should know you have this underway. We will probably have plenty of questions.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, July 04, 2017 4:46 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky; Aswea Porter
Subject: [EXTERNAL] BPA-Kintama Progress Update (5 July 2017).pptx
Importance: High

Hi Christine—

I hope you had a good 4th of July. I am sending this email to you now in the hope that you can distribute it to others (if you think appropriate) prior to the phone meeting Wednesday at 10 AM so they can glance over it if they have time.

In addition to presenting the initial results, we are very interested in the thoughts & reactions of BPA staff as to what additional analyses we could do that would help shed clarity on the issues you are currently deliberating. It is hardly a secret that I think many of the conclusions about salmon conservation reached in the Columbia River basin do not hold water when viewed from a broader perspective, and I think the analysis we have put together so far strongly supports this view. However, your folks' perspective on what is really important to clarify may differ from our assumptions, so we would appreciate your thoughts.

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Each slide has a number in the lower right. We will try to call out each slide number so that you can page forwards, and we can try to make sure we are discussing the same material.... Since this is a phone call in, we won't be able to see what you are looking at.

Regards, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

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Skype: david.welch.kintama

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fisheries work on-line: http://kintama.com/media/videos/

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From: Douglas,Jan M (BPA) - NSSP-4

Sent: Tue Jul 11 13:15:54 2017

To: 'David Welch'

Subject: RE: Modification contract 75025 BPA

Importance: Normal

(b) (6) [redacted]

I know its wonderful when you own a business, you can work 24 hours a day for yourself….

Been fun David…. Jan

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, July 11, 2017 9:25 AM
To: Douglas,Jan M (BPA) - NSSP-4
Subject: [EXTERNAL] RE: Modification contract 75025 BPA

Lol… So when you retire, are you going to break the news to him that ***he*** has to get back out on the streets in order to support you at your current level of financial expenditures!?

Just a thought…

J

From: Douglas,Jan M (BPA) - NSSP-4 [mailto:jmdouglas@bpa.gov]
Sent: Tuesday, July 11, 2017 8:50 AM
To: David Welch
Subject: RE: Modification contract 75025 BPA

(b) (6) [redacted]

Thank You David…. Jan

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, July 11, 2017 8:40 AM
To: Douglas,Jan M (BPA) - NSSP-4
Subject: [EXTERNAL] RE: Modification contract 75025 BPA

No worries, but I wasn't working from home—I was just on my way home at the end of a long day of meetings, and it was more attractive to check & re-send from home!

(b) (6)

[redacted]

David

From: Douglas,Jan M (BPA) - NSSP-4 [mailto:jmdouglas@bpa.gov]
Sent: Tuesday, July 11, 2017 8:33 AM
To: David Welch
Subject: RE: Modification contract 75025 BPA

David thank you so much, working from home is a wonderful thing.....

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Monday, July 10, 2017 4:14 PM
To: Douglas,Jan M (BPA) - NSSP-4
Subject: [EXTERNAL] FW: Modification contract 75025 BPA

Hello Jan—

I have had a look at the PDF you sent along. Here is the signed original from May 17th.

I am working at home now—If I have made a mistake and there is something different from what you have asked for, please give me a call at the house: (b) (6) [redacted] my cell has poor reception at the house.

Regards

David Welch

From: David Welch
Sent: Wednesday, May 17, 2017 10:16 AM
To: Douglas,Jan M (BPA) - NSSP-4
Cc: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: RE: Modification contract 75025 BPA

Hi Jan-

I have attached the signed & dated contract modification for your records.

Christine—I noticed one minor discrepancy in reviewing the details of the contract modification: On the SOW "Page 5 of 8" (P. 8 of the modification), the 3rd milestone on that page states "Submit manuscript to Science or other high level journal", while on SOW "page 8 of 8" (P. 11 of the modification) the Milestone states "Submit manuscript to AFS Fisheries?".

I don't think we need to make any changes to the contract as the contract leaves it open as to where we will publish, but I thought you, Erin, and I should have a discussion about where the manuscript should be most usefully published. The suggestion of the journal "Science was a holdover from the original focus of the contract, which was to compare survival between different habitats (hydrosystem vs Ocean, essentially). My own opinion is that with the contract modified to focus on the comparative SARS, the American Fisheries Society journal "Fisheries" might be an excellent fit because it goes out to virtually all AFS members. It would therefore get very extensive coverage in the Columbia River biologists, so might have the greatest impact there (i.e., actually get read and thoughtfully discussed!). There are some limitations to that journal however (particularly the lack of any ability to provide supplementary info in a series of on-line only appendices).

As I say, I don't think the name of the journal needs to be revised, but it might be worth a bit of your time to canvas your colleagues in BPA and see if they have any thoughts on what journals might be particularly influential (if they are!).

David

From: Douglas,Jan M (BPA) - NSSP-4 [mailto:jmdouglas@bpa.gov]

Sent: Wednesday, May 17, 2017 9:34 AM
To: David Welch
Cc: Petersen,Christine H (BPA) - EWP-4
Subject: Modification contract 75025 BPA

Attached is a modification 001 to the contract for project 1996 017 00, please review and sign and return as soon as possible.

As always you can call me or your COTR Christine Petersen at 503 230 4695 for any question you may have.

THANK YOU FOR WORKING WITH BPA

jAN

Call Anytime I Will Do My Very Best To Assist!

Jan Douglas (J.D.)

Bonneville Power Administration

Contracting NSSP – 4

jmdouglas@bpa.gov

503 230 4164

Trout Pic

BPA-Logo-2015-Color-Text

From: Erin Rechisky

Sent: Mon Jul 17 14:45:41 2017

To: chpetersen@bpa.gov

Cc: David Welch

Subject: [EXTERNAL] Re: Milestone "Feb-Jun 2017 (2/1/2017 - 6/30/2017)" is due in 5 days

Importance: Normal

Thanks Christine.
I've cc'd David.
Erin

------ Original message------
From: Petersen, Christine H (BPA) - EWP-4
Date: Mon, Jul 17, 2017 1:29 PM
To: Erin Rechisky;
Subject:RE: Milestone "Feb-Jun 2017 (2/1/2017 - 6/30/2017)" is due in 5 days

Hi Erin,

You don't need to put the date that it was signed - just check it off. The date for this was a 'milestone' set with the original contract schedule in mind, so it isn't relevant after we did the modification.

By the way, I just ran into Jeff Stier. I think that if you just take the time to explain the slides that you had, like you were able to when Greg Smith, Maura and Makary were with me two weeks ago - this would be the best approach. Jeff is closely involved with the court case and our Biological Assessment (which is like a recommendation to NOAA for how we think the next Biological Opinion should be written). Jeff wants to advocate for additional spending on habitat restoration projects in tributaries, and less emphasis on continuing to modify dams, in order to achieve species recovery. He would like to be able to accurately convey your findings at any meetings or forums he participates in so he probably will have a few questions.

Christine

-----Original Message-----
From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Monday, July 17, 2017 12:33 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: Milestone "Feb-Jun 2017 (2/1/2017 - 6/30/2017)" is due in 5 days

Hi Christine,
It looks like the only thing to check off on the status report is "Return signed contract...". Is that correct? Do we need to put the date that the amended contract was signed? The date completed in the status report has Feb 16, 2017, which is referring to the initial contract prior to any changes we made.

Thanks,
Erin

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: July 11, 2017 2:41 PM
To: Erin Rechisky
Subject: RE: Milestone "Feb-Jun 2017 (2/1/2017 - 6/30/2017)" is due in 5 days

Yes - I will take a look tomorrow and make sure that it is now open.

By the way, Greg Smith and I essentially relayed your presentation to our policy group here, and they are all quite interested in what you're finding.

Christine

-----Original Message-----
From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Tuesday, July 11, 2017 11:32 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: Milestone "Feb-Jun 2017 (2/1/2017 - 6/30/2017)" is due in 5 days

Hi Christine,
Yes, I thought that maybe since the contract was locked I could not access the status reports. I'll stand by.
Erin

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: July 11, 2017 10:22 AM
To: Erin Rechisky
Subject: RE: Milestone "Feb-Jun 2017 (2/1/2017 - 6/30/2017)" is due in 5 days

Oh... let's see. I saw that just today the signed contract modification that we did was received and entered at BPA. This probably explains the pending status. When it is unlocked, the status report should be fairly straightforward, so this is probably the problem. Let me ask if it somehow needs to update overnight in order for the pending status to change to 'issued'. Sorry about the confusion.
By the way, the other problem people occasionally have is highlighting the correct quarterly status report but this shouldn't be a problem because it is the first one.

Christine

-----Original Message-----
From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Tuesday, July 11, 2017 10:13 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] FW: Milestone "Feb-Jun 2017 (2/1/2017 - 6/30/2017)" is due in 5 days

Hi Christine,
I'd like to check off the milestone below in Pisces but I don't see how to do it. Also, when I open the SOW tab the status of the Contract Actions is Pending and the SOW Status is Locked. I am not sure if this is preventing me from checking off the periodic status report due in 4 days... I am also a bit rusty on reporting in Pisces, so I may be I am in the wrong place.
Thanks,
Erin

-----Original Message-----
From: donotreply@cbfish.org [mailto:donotreply@cbfish.org]
Sent: July 10, 2017 2:00 AM
To: Erin Rechisky
Subject: Milestone "Feb-Jun 2017 (2/1/2017 - 6/30/2017)" is due in 5 days

Dear Erin,

Milestone "Feb-Jun 2017 (2/1/2017 - 6/30/2017)" of work element "185 - Periodic Status Reports for BPA" on contract #75025 under project #1996-017-00 ("Technical and Analytical Support for ESA Activities/Issues") is due on Jul 15, 2017.

If you feel this email has reached you in error, please contact your COTR, Christine Petersen (chpetersen@bpa.gov).

Thank you,

Environment Fish and Wildlife
Bonneville Power Administration

From: Petersen,Christine H (BPA) - EWP-4

Sent: Mon Jul 31 11:12:27 2017

To: David Welch

Cc: Erin Rechisky

Subject: RE: Discuss coastwide SARs comparison

Importance: Normal

Hello,

Sorry not to get back to you. I am still trying to identify whether the August 28-31 period or Sept 7-15 would be preferable and I need to talk further with Jeff Stier. In my opinion, we ought to give you an opportunity to make a bit more progress, but I am not completely aware of any timeline issues with the Biological Assessment that would make us prefer either date, and I also have to consider who at BPA will be available.

By the way, Maura Moody (who was on the earlier conference call) asked when a draft document might be available that she could cite for the BA. Her job is consolidating all the materials that we have available, but I believe that Jeff Stier will be the one who would actually write a section that might cite your findings (i.e. he is the one who needs to be best informed on the contents). So to put this in context, we do not want to unnecessarily push you to produce a preliminary draft publication that might run the risk of having major revisions to results and key figures. Yet, Maura would like to know when you guess you might have a draft document with a title.

Finally – I received a comment on your earlier presentation that was worth passing on. Basically – it was a suggestion from Brady Allen that many hatcheries in the Columbia region do have both CWT and PIT based SARs. The Columbia stands out for having more PIT based SARs available than other regions. Carefully comparing these two tag types at a subset of Columbia area hatcheries could possibly demonstrate the comparability of these categories of SAR estimates between the rest of the regions.

Thanks

Christine Petersen

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, July 26, 2017 1:29 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] RE: Discuss coastwide SARs comparison

Hi Christine—

Apologies for the slow response on this email–(b) (6) [redacted]
(b) (6) [redacted]

Completion of the next phase of the work will be long-drawn out because it is complex (identifying, collating, and analyzing all of the factors that might make survival estimates from CWTs and PIT tags different.. we need to quantify the magnitude and direction of the differences before we can be sure how similar survival is inside & outside the Columbia River basin).

Erin and I could potentially come down before completing this next phase, but the presentation will be similar to what we have given you. Given holidays &[redacted]n August, this is only feasible August 8-10th, inclusive.

Alternatively, August 28-31 (Sept 1st if that is not a stat holiday for you) are possible, as is September 7-15th. (I'm then[redacted]and next available 2-12 October, before I am away for a week).

These times are not completely cut and dried, as potentially just one of us could go down, but I would prefer both of us to do so because it is useful for both Erin and I to be involved in the dialogue around goals for the coming BiOP if possible—but if these times won't work for you, we will look at times that will work for you where only one of us attends.

Regards, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, July 18, 2017 2:22 PM
To: David Welch
Subject: RE: Discuss coastwide SARs comparison

Sorry about that. We used to have this as a 'party line' available if we reserved it, but recent someone added a restriction so that someone has to push two buttons on a BPA internal phone in order for it to work.

By the way, regarding the visit to present your work at BPA, please suggest a time when you feel you might have completed a next step in the project. Jeff suggested sooner rather than later, and he is much more plugged into the schedule for the Biological Assessment document. However, many managers and staff in our research and policy group have seen the PowerPoint presentation. WE should pin down whethe we are anticipating aan update with more refined material or perhaps some of the interpretation you might put in a paper, or whether you would be working with the B.A. authors who would want to very accurately describe your current results.

Thanks,

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: David Welch <David.Welch@kintama.com>
Date: 7/18/17 12:59 PM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>, "Stier,Jeffrey K (BPA) - E-4" <jkstier@bpa.gov>, Erin Rechisky <Erin.Rechisky@kintama.com>, Aswea Porter <Aswea.Porter@kintama.com>

Subject: [EXTERNAL] RE: Discuss coastwide SARs comparison

Christine—We can't reach the prescribed number from our area! Can you please call me back on [redacted]

-----Original Appointment-----
From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, July 17, 2017 9:06 AM
To: Petersen,Christine H (BPA) - EWP-4; Stier,Jeffrey K (BPA) - E-4; David Welch; Erin Rechisky; Aswea Porter
Subject: Discuss coastwide SARs comparison
When: Tuesday, July 18, 2017 1:00 PM-2:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: EW Phone Bridge: [redacted] no passcode

Sorry – I'm resending this a third time – I was attempting to change to 1-2pm, but then I lost our phone bridge, and when I revised that to the [redacted] number it somehow jumped to a 10:30am meeting.

We'd like to move this earlier by one hour – will this work for everyone? (might be a little easier for Aswea as well). Note: I need to change the phone bridge information as well

---

We'd like to set up another status report call so that Jeff Stier could go over initial results and ask some questions.

I'm going to reserve the external phone bridge line that we have. If this gives you any problems on Tuesday, please let us know via email right away, and we could potentially switch to a 3-way call.

Bridge Information: To access this conference bridge dial (b) (2) [redacted]

From: Erin Rechisky

Sent: Tue Aug 01 16:18:32 2017

To: Petersen,Christine H (BPA) - EWP-4; David Welch; Aswea Porter

Subject: [EXTERNAL] RE: interview DART regarding CWT SARs

Importance: Normal

Hi Christine,

Thank you. We've had a few minutes to query the data and it looks promising. We are agree that we should contact Chris and Susannah should we use these data.

David, Aswea and I are going to discuss this more on Thursday when we are all in the office. Please stand by.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: August 1, 2017 2:59 PM
To: David Welch; Aswea Porter; Erin Rechisky
Subject: interview DART regarding CWT SARs

Hello,

Here is an idea for helping identify a QA/QC'd source of CWT SARs for the Columbia basin. Unfortunately, our hatchery research lead here is out this week, and I have not made contact with Jack Christiansen yet (he was with USFWS working as a consultant on hatchery procedures, but will be starting with Anchor QEA after a year's hiatus).

DART has a long list of SARs from PIT and CWT in their Status and Trends section.

http://www.cbr.washington.edu/trends/index.php

If you click through these, it is clear that they must have used some sort of filtering process to either exclude years, or select which hatchery groups are being reported. Many have only a few years of data. Some have relatively recent SARs but others haven't had recent years updated for 10 years. One might think that they are individually corresponding with diverse hatchery managers to get the latest SAR data point, but the metadata suggests that the DART database folks are doing large downloads from the RMPC (which I believe runs the RMIS), and is overseen by PSMFC. PSMFC has to defend their statistical methods to the harvest managers so we could assume that there is a lot of quality control involved here.

Do you think it would be a good idea to contact Chris Van Holmes and Susannah Iltis of DART and interview them about what they know about this source of data? They could probably tell us a lot about it, and you would not have to explain your purpose to someone at PSMFC. Several of the major hatcheries where CSS distributes tags are included, such as Lookingglass, Kooskia etc. Chris and Susannah could probably explain how the latest data becomes available and why there are so many odd gaps (are the programs frequently starting and stopping, and so forth).

By the way, with PIT, we think that there could be a 'last segment' concern. Hatcheries might be tagging with both CWT and PIT, my coworker says they primarily only collect CWT at the hatchery and might ignore the PIT. They would be using a first dam to last dam SAR with PIT, and they could also get hatchery to first dam with PIT estimate if they were interested, but some hatcheries might not screen every fish for PIT tags. (You should doublecheck everything I'm saying here).

Do you want me to ask a few preliminary questions?

Thanks

Christine

From: David Welch

Sent: Thu Aug 03 14:28:53 2017

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky

Subject: [EXTERNAL] RE: last week of August?

Importance: Normal

The 31st works for both of us. If that date won't work, the 1st of September will as well, but is less preferable.

Once you confirm a solid date I will book plane tickets and see if we can do the trip without an overnight hotel stay!

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, August 03, 2017 2:21 PM
To: David Welch; Erin Rechisky
Subject: last week of August?

Okay – I was just able to catch Jeff Stier at his desk and also talk to Maura Moody, who is coordinating our BA.

We would like to go ahead and select a date on the week of Aug 28-1st. Do you have any top preferences? The 31st or 1st? We could start with that and then see how it works on calendars over here.

Jeff said that for the BA, what he would like to do is write paragraphs based on your presentation materials and fact check the statements he is making with you to make sure that none of the assertions could be undermined or be risky to make, due to any subsequent additions of data or QA/QC. I could see how one could safely make qualitative descriptions of your temporal and coastwide patterns, while understanding that certain individual data points in the figure might change due to the issues with hatchery-to-first dam survival and CWT vs. PIT and so forth.

Thank you

Christine Petersen

From: David Welch

Sent: Fri Aug 04 10:55:47 2017

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky

Subject: [EXTERNAL] RE: last week of August?

Importance: Normal

Thanks, Christine—

Its probably best If we move the NOAA presentation forward from our end. Should I contact Rich Zabel or Tom Cooney? My inclination would be Rich, as I know him reasonably well. However, if you think Tom I the better approach, please give me his contact info—I don't know him.

I will keep you in the loop, but will try to get down perhaps in early September—not sure what will work with our mutual schedules as yet.

Let me know about the BPA meeting times. My current availability for later meeting dates:

Sept 1-18 (open, but some challenges on my side (a few days here and there))

Oct 2-13 (Open)

Oct 23-27 (Open)

I will have to check on Erin's specific availability for a BPA meeting once we get a sense of what time blocks would work from your side.

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, August 04, 2017 10:40 AM
To: David Welch; Erin Rechisky
Subject: RE: last week of August?

Hi,

Okay – my latest understanding is that two top managers who we would like to participate will not be available in that week before labor day, and we will need to start looking closer to October, especially if they wanted Elliot Mainzer. I hope to hear more from Jeff Stier and Lorri Bodi soon.

In any case, I think this proposal or understanding that Jeff Stier could pass any material he writes for the Biological Assessment citing your work to review for accuracy should be very helpful. The Biological Assessment is essentially a proposal to NOAA for their Biological Opinion. It might make sense to turn attention to facilitate having you do a discussion oriented presentation with NOAA, potentially at the Science Center (the Portland office where Tom Cooney and others are located does 'hold the pen' for the BiOp, however they draw heavily from analysis done at the Science Center). Jeff Stier said it would be great for you to do that, and that you should do most of the organizing for it rather than BPA overseeing or strongly facilitating it… but I think we could initiate it. All their technical staff are familiar with your work and also the Fraser vs. Columbia paper dialog that resulted in the Hilborn paper in PNAS etc.

If I were to contact Rich Zabel or Tom Cooney to suggest they invite you to give a presentation and engage in a discussion, what time do you think would be most appropriate or convenient for you? August, September? Do you think it would be appropriate to forward your powerpoint presentation from two weeks ago? I would just need to put a little thought into who to contact and how to frame the invitation

Thanks

Christine Petersen

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, August 03, 2017 2:40 PM
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: [EXTERNAL] RE: last week of August?

Just a quick additional comment. I just checked and we can do the round trip by air in one day, but in that case we don't arrive at PDX until 10 AM, and have to depart PDX at 18:25

Erin is a (b) (6) [redacted] so security procedures at BPA will be less onerous. In my case however, that is just not the case. Assuming the plane isn't delayed in arriving in the morning, we could plan on starting the presentation at 1300 or 1330 hrs, but 1400 hrs might be safer.

Of course we can simply fly down the night before, and precise timing isn't an issue—we can simply meet whatever works for your people.

Just some guidance on timing!

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, August 03, 2017 2:21 PM
To: David Welch; Erin Rechisky
Subject: last week of August?

Okay – I was just able to catch Jeff Stier at his desk and also talk to Maura Moody, who is coordinating our BA.

We would like to go ahead and select a date on the week of Aug 28-1st. Do you have any top preferences? The 31st or 1st? We could start with that and then see how it works on calendars over here.

Jeff said that for the BA, what he would like to do is write paragraphs based on your presentation materials and fact check the statements he is making with you to make sure that none of the assertions could be undermined or be risky to make, due to any subsequent additions of data or QA/QC. I could see how one could safely make qualitative descriptions of your temporal and coastwide patterns, while understanding that certain individual data points in the figure might change due to the issues with hatchery-to-first dam survival and CWT vs. PIT and so forth.

Thank you

Christine Petersen

From: David Welch

Sent: Mon Aug 07 12:52:24 2017

To: Rich Zabel (rich.zabel@noaa.gov)

Cc: Petersen,Christine H (CONTR) - KEWR-4; Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] NOAA BiOP Review & Assessment...

Importance: High

Hi Rich-

I am working with my staff on a coast-wide assessment of Chinook & steelhead survival rates (SARs) with support from BPA.

Although we are not yet done with the analysis, we are at a point where an initial presentation to NOAA staff for information and feedback would be useful.

Perhaps the key finding from our work is that Snake River survival rates are about the same as Chinook stocks in other regions that have no dams, and may in fact be substantially higher. This raises the question of what role the dams really play in determining survival, since survival in other regions of the coast lacking dams is no better, and in a number of regions is in fact a good deal worse. It will be hard to argue that the Columbia River basin salmon problem will be “fixed” by taking out the dams if other regions aren’t doing better.

A second finding of nearly equal importance to my mind is that once this large-scale view of SARS is developed, the argument for delayed mortality occurring due to Snake River dam passage essentially vanishes. The FPC's argument that John Day and Yakima stocks of Spring Chinook have higher SARs than Snake River stocks because these two stocks have unusually high survival look like they are special cases, and not supported by a broader view of the survival data. Again the implication is that the dams aren't playing much of a negative role and that it is ocean effects that are driving salmon returns.

Although we are not yet finished with our analysis, there is a lot of material now assembled. It would be beneficial to have an initial meeting with your key staff to outline what we have found and to have a discussion about what your folks see as useful and where you see the need to better tighten up our analysis. Until we can get our analyses as tight as possible, I would prefer it if you could keep the contents of this email confidential (i.e., within NOAA)—I expect that the FPC will not take kindly to any analysis that doesn't support what they have been saying for many years, and I want to avoid a pre-emptive attack on our credibility until we have had time to assemble the best possible analysis.

I am away on holidays 12-25 August, but Erin and I could drive down in the 28 August-15 September period. (We have some obligations with field work & schools re-opening in September, but I don't have a good handle on specific dates as yet). A presentation with discussion would take at least a couple of hours and it might be best to block off 3 hrs to allow as much dialogue as possible.

Regards, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

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www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: David Welch

Sent: Wed Aug 09 13:28:28 2017

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] RE: FPC SMP survivals

Importance: Normal

Thanks, Christine—

As Erin mentions we had a look at Table 4.12—it may indeed be useful. One approach that I will ask Aswea to explore is to take the various Snake River trap estimates to LMO and divide those survivals by the 0.96 survival standard per project that the dams are supposed to meet; this would allow us to cobble together a trap-to-LGR survival estimate, but of course this is limiting survival to just the trap data, not the hatcheries. (The correction factor would be $S_{LMO}/(0.96)^2$, or ca. 1.085 x S_{LMO}).

While not ideal, because S_{LMO} is around 80% this would yield an estimate of trapped smolt survival upstream of LGR of about 87%, and a "pre-dam loss" of 13% of the smolts. Given that survival in the Strait of Georgia/Puget Sound area for Chinook is only about 40% of Snake River values, this 13% loss in the headwaters of the Snake River is only a small proportion of the 60% reduction needed just to get Snake River survivals ***down to*** equal the level of the Strait of Georgia/Puget Sound! Obviously, the big public policy question is that if Snake River survival is not a good deal ***lower*** than survival in other river systems, then the role of the Snake River dams in causing poor salmon returns needs to be re-thought.

I also had a good call about some of these issues with Stuart Ellis of CRITFC. It helped clarify a few of the issues for me, but didn't come up with a magic new data source that would resolve these issues.

As Erin mentions, please do ask Brandon why the survival estimates are to LMO instead of LGR; perhaps its as simple as no one has thought of standardizing to LGR?

David

P.S. While I am away, I am also going to ask Aswea to compare the CWT & PIT tag based survival estimates for the Snake River that we have in the existing data base, we may get lucky and find a direct hatchery-specific comparison. If not, we can at least do a comparison of values for common years. We can also extend this to the data sets John Skalski emailed about recently—I have it on my list to give him a call.

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, August 09, 2017 12:04 PM
To: Erin Rechisky; Aswea Porter; David Welch
Subject: FPC SMP survivals

Hello,

As of today I haven't heard anything back from CSS staff after emailing a request to their listed contacts on their website, regarding hatchery-to-Lower Granite survival rates for the groups in the SAR tables in Appendix B of the CSS annual report. People could be on vacation etc.

I just did go back to the FPC website, and after hunting around a bit, it looks like some of the information that you might be looking for are in the FPC annual report (a different document than the CSS report) under the Smolt Monitoring Project chapters. Brandon Chockley with SMP has been very responsive to informational requests, so please let me know if you have a directed request for him.

It might take a bit of work to align these wild and hatchery tag groups with those in Appendix B. Maybe it is in a prior report, but I haven't identified why their method reports survival from trap-to-Lower monumental rather than Lower Granite (perhaps a question for Brandon Chockley). Yet, there are other metrics in the same chapter that report hatchery-to-LGR. By the way, as a side note, NOAA, and BPA in our various reports, can opt to report in-river survival from the Snake trap at the top of Lower Granite reservoir, to Bonneville dam, or from Lower Granite to Bonneville – there is a difference of about 2-5%. You probably aren't concerned for your project with the in-river survival estimates, however, practices like this could be relevant for your task of stitching together SARs based on multiple reaches and segments of the migration. NOAA biometricians like Jim Faulkner and Steve Smith spend a lot of time on their detection rate estimates, which sometimes produce unrealistic or unexpected survival estimates when the assumptions are violated – they might see nearly 100% survival for Rock Island to McNary, and then lower than expected in the next reach. Detections at the dams decline in high spill and high flow conditions. It would be nice if you could have an SAR for the same tag from from Hatchery to return to Bonneville and Lower Granite-to Bonneville so that the difference would equal hatchery-to Lower Granite – without having to rely on the detection efficiency uncertainties.

Anyway – in the 2016 FPC annual report – look at chapter 4 , table 4.12.
http://www.fpc.org/documents/FPC_Annual_Reports.html

They also have a query here: http://fpc.org/survival/smp_smoltsurvival_traptag_reltoLMN_query.html#8/46.130/-

116.741

It looks like all the hatchery groups are hatchery origin fish intercepted at these various traps (hence it is under the domain of the SMP rather than the CSS study which tags fish at the hatcheries).

Appendix H isn't in the draft document, so going back to prior year reports, appendix H has a lot of tables. It looks like they have the aggregate hatchery, wild Chinook and steelhead groups that NOAA also reports.

Are any of these trap-to-dam estimates useful. Should we ask SMP for above-Lower Granite data?

Christine

From: David Welch

Sent: Wed Aug 23 13:35:38 2017

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] Re: visit in November

Importance: Normal

(b) (6) [redacted] so the 17th doesn't work for me.

When you say the Nicola populations' stream flows were critically low, were you referring to flows or temperature? All of the Fraser watershed (apart from deeper lakes) is now likely over 20C for a significant part of the summer which will affect summer returning adults (sockeye and chinook). Scott Hinch has a number of nice papers on this issue for sockeye.

What people tend to forget is that upper Fraser coho are at critically low levels yet the smolts go out in the spring and adults return in the late fall. For this reason I tend to think the problem for all of the species is primarily in the ocean. (I can give you an extended life history explanation, which I've pulled together but haven't yet published...but I can't type it into my phone!).

I've made good progress on the writing of the SAR comparison while I have been away. I can share that in a week or two, but have to run it past Erin and Aswea first. Also, I have heard nothing from Rich Zabel--do you know if he is around?

I also wanted to raise the possibility of funding support from BPA for the ~1/3rd of the project that we started but then switched to doing the SAR comparison when Jeff said that was more important. I agree with his judgement relative to the BIOP but in terms of long term strategy I believe the remaining part could be a real game-changer. Could we set up a time for a brief discussion on this next week--I would like to lobby for BPA to find the funding to support this in next FY's budget?

David

David Welch
M: [redacted]
Kintama Research Services
Sent from my iPhone

On Aug 23, 2017, at 11:07 AM, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

I didn't mention November 17th in my initial email, but this might be preferable. Would this work for you? It is Friday the week before American thanksgiving.

Thank you for the Chinook news. It looks like that cohort year will require some rebuilding, with that level of impact.

Before I worked here, I was part of a project with Mary Ruckelshaus, Tim Beechie at the NOAA science center, where we were attempting to use the University of Washington downscaled water temperature data using their atmospheric projections reflecting climate scenarios (it turns out that downscaling from atmospheric data does not perform well in predicting local water temperatures. With a model calibrated in Washington, their Alaska peak temperatures in a flat area like the Yukon was about 14C, when in reality it peaks at about 18-20C each summer, while in California they were about 4-5C too warm. It would be a better approach to place temperature gauges where none have been placed in order to thoroughly document current conditions, and then project forward with simple warming scenarios, plus some provision for changed snowpack.

Anyway, my part of the project was digging around for datasets showing life history timing of Chinook for migration and spawning, and comparing to temperature gauge data, identifying if there was a temperature trigger for spawning or other behaviors in different reaches. In the Fraser we were using the Nicola area populations. It looks like their streamflows are critically low some of the time.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Wednesday, August 23, 2017 10:53 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: visit in November

Works for me.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: August 23, 2017 10:30 AM
To: Erin Rechisky
Subject: RE: visit in November

Quick question – how does the 17th of November look? (I forgot to put this date in the initial email due to a typo).

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Tuesday, August 22, 2017 9:47 AM
To: David Welch; Petersen,Christine H (BPA) - EWP-4
Cc: Aswea Porter
Subject: [EXTERNAL] RE: visit in November

Hi Christine,

Right now Nov 27th works best for me(b) (6) [redacted]

Erin

From: David Welch
Sent: August 18, 2017 5:24 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky; Aswea Porter
Subject: Re: visit in November

All those proposed dates work well for me; I will let Erin respond if any of those dates cause conflicts for her.

Thanks for the news articles... I will send you by separate email a summary of the catastrophically bad chinook returns currently occurring up and down the coast. Take a look at the cumulative Fraser R returns this year relative to the 10 yr average about half way down-if things continue as they currently are, adult returns will likely be <5% of the 10 yr average!

David Welch

M: [redacted]

Kintama Research Services

Sent from my iPhone

On Aug 18, 2017, at 3:03 PM, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

We would like to check availability of November 27th, 21st or 22nd for a visit to BPA? We're looking at November due to schedules here etc.

Michelle DeHart said they are working on the data request, and that it might fit well into the annual report writing that they are doing this month.

thanks

Christine Petersen

(503)230-4695

FYI – here are a couple news pieces from this week for Columbia salmon politics.

http://www.seattletimes.com/seattle-news/steelhead-struggling-home-in-record-low-numbers/

http://www.wildsalmon.org/images//stories/PDFs/congress/2017.Scientists.spill.letter.gen.final.8.16.pdf

From: David Welch

Sent: Wed Aug 23 14:33:38 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] Re: visit in November

Importance: Normal

I can do either the 21st or 22nd, so let's see if we can nail down one of those two dates before we let things slip even farther. [redacted]

We can certainly get you those Bullet point "nuggets". One way to safely do this is to state that we are comparing CWT SARS with PIT tag SARS and that the fine-scale assessment of how directly comparable the mean survival levels are is still under evaluation. That should cover the issue for the analysts.

Can you ask if there is a preferred format? A formal letter from us to you or...?

David Welch
M: -[redacted]
Kintama Research Services
Sent from my iPhone

On Aug 23, 2017, at 2:02 PM, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

Let’s see – I went back and spoke with our administrative assistant, and she explained that the 17th, 21, or 22nd were narrowly determined based on availability of Elliot Mainzer, our lead administrator at BPA who they would like to be there, - in addition to various fish and wildlife managers. She said that outside of those dates (the 27th not being available), they would have to start looking at December.

It looks like there will be difficulties with having both of you on these dates. Would you prefer just sending one person to do the presentation, or starting to look at later dates?

Switching gears, I also spoke with Maura Moody. She reminded me or wanted to pass on that by early September they would appreciate a page of summary description highlighting key results that could safely be repeated and cited for our Biological assessment. ‘Nuggets’ was the term she used. It might involve some careful writing so that you don’t use any description that could potentially be revised in the last stages of your project (where you have not received the Fish Passage Center data yet), but focus on the safest and robust assertions of the larger geographical pattern. I believe that earlier we had said that Jeff Stier would write some paragraphs and ask you to review it for accuracy. Would you be able to get started with some bullet points? You might start from the prior presentation that you gave us, which already has a lot of material in it.

Talk to you soon,

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, August 23, 2017 1:36 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] Re: visit in November

(b) (6) [redacted] so the 17th doesn't work for me,

From: Petersen,Christine H (BPA) - EWP-4

Sent: Wed Aug 30 11:11:44 2017

To: David Welch

Cc: Erin Rechisky; Aswea Porter

Subject: RE: visit in November

Importance: Normal

Hello,

Yes – I spoke with Jeff Stier and Maura again. Jeff would appreciate a results summary from you, based on your study as it currently stands, before he starts to draft language for our Biological Assessment document. I don't think we want to request a specific format such as a formal letter or even using 'bullet points' if you prefer to write in narrative paragraphs. I think that an update in the form of the results outline that you sent two months ago would work great.

They would find this very useful at the start of September (after labor day is fine) and Jeff does intend to review with you what he writes, citing your project.

Christine

From: David Welch [mailto:David.Welch@kintama.com]

Sent: Wednesday, August 23, 2017 2:34 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky; Aswea Porter
Subject: [EXTERNAL] Re: visit in November

I can do either the 21st or 22nd, so let's see if we can nail down one of those two dates before we let things slip even farther. [redacted] but Elliot's attendance is obviously critical.

We can certainly get you those Bullet point "nuggets". One way to safely do this is to state that we are comparing CWT SARS with PIT tag SARS and that the fine-scale assessment of how directly comparable the mean survival levels are is still under evaluation. That should cover the issue for the analysts.

Can you ask if there is a preferred format? A formal letter from us to you or...?

David Welch

M: [redacted]

Kintama Research Services

Sent from my iPhone

On Aug 23, 2017, at 2:02 PM, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

Let's see – I went back and spoke with our administrative assistant, and she explained that the 17th, 21, or 22nd were narrowly determined based on availability of Elliot Mainzer, our lead administrator at BPA who they would like to be there, - in addition to various fish and wildlife managers. She said that outside of those dates (the 27th not being available), they would have to start looking at December.

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Talk to you soon,

Christine

From: David Welch

Sent: Tue Sep 05 16:52:46 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] Kintama Bullet Points for BPA (5 September 2017).docx

Importance: High

Attachments: Kintama Bullet Points for BPA (5 September 2017).docx

Hi Christine—

As promised, here is our summary (watermarked "DRAFT"). I have deliberately excluded most of the detailed figures that we provided in an earlier Powerpoint presentation, although those remain valid. Here we have concentrated on the big picture issues. I have included three key updated figures in this document for simplicity of reference (there have been some changes to the figures as we have been fine-tuning the analysis).

I am sending this as a Word document as it is likely that BPA staff will want to cut and paste into their own documents and then re-work the material.

The major caveat is, as outlined in the "Bullet Points" summary, that the exact equivalence of PIT tag SARs and CWT SARs is not yet certain. Basically, the two methods of tagging will likely yield somewhat different SARs because they measure survival over slightly different parts of the life history.

However, as we note in the document, unless the ratio of mean SARs exceeds 2, Snake River PIT-tag based SARs ***<u>are not lower</u>*** than the CWT-based SARs measured in the Salish Sea.

We are currently working to estimate the exact equivalence of CWT & PIT tag based SARs by comparing SARs for the same population and calculating the ratio of the survivals... we will provide the preliminary results as soon as possible.

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

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P Please consider the environment before printing this e-mail

From: David Welch

Sent: Wed Sep 06 13:39:05 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] RE: Kintama Bullet Points for BPA (5 September 2017).docx

Importance: Normal

No worries. I will be working with Aswea this week on the evaluation of the CWT vs PIT tag SAR comparison, and on drafting parts of the paper for publication. I'm available all week if you need to discuss.

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, September 06, 2017 1:37 PM
To: David Welch
Cc: Erin Rechisky; Aswea Porter
Subject: RE: Kintama Bullet Points for BPA (5 September 2017).docx

Hi,

Thank you very much!

I forwarded these to coworkers and we'll contact you with any questions.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, September 05, 2017 4:53 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky; Aswea Porter
Subject: [EXTERNAL] Kintama Bullet Points for BPA (5 September 2017).docx
Importance: High

Hi Christine—

As promised, here is our summary (watermarked "DRAFT"). I have deliberately excluded most of the detailed figures that we provided in an earlier Powerpoint presentation, although those remain valid. Here we have concentrated on the big picture issues. I have included three key updated figures in this document for simplicity of reference (there have been some changes to the figures as we have been fine-tuning the analysis).

I am sending this as a Word document as it is likely that BPA staff will want to cut and paste into their own documents and then re-work the material.

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David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

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Office: (250) 729-2600 Mobile: (b) (6) [redacted]

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P Please consider the environment before printing this e-mail

From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Sep 21 15:46:52 2017

To: Renner,Marcella P (BPA) - E-4; Jule,Kristen R (BPA) - EWP-4; david.welch@kintama.com

Subject: RE: Update call with BPA

Importance: Normal

Also David, Marcella just said that the November in person visit to BPA may change or be cancelled as far as Elliot Mainzer no longer being available.
We have officially cancelled, Marcella?

Do you think you will try to reschedule that second meeting or put the emphasis on October 4?

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: "Renner,Marcella P (BPA) - E-4" <mprenner@bpa.gov>
Date: 9/21/17 3:25 PM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>, "Jule,Kristen R (BPA) - EWP-4" <krjule@bpa.gov>, david.welch@kintama.com
Subject: RE: Update call with BPA

The 4th is good. Say 2-3:30?

Thank you,

Marcella

Xt. 5136

From: Petersen,Christine H (BPA) - EWP-4
Sent: Thursday, September 21, 2017 1:51 PM
To: Renner,Marcella P (BPA) - E-4 <mprenner@bpa.gov>; Jule,Kristen R (BPA) - EWP-4 <krjule@bpa.gov>; david.welch@kintama.com
Subject: FW: Update call with BPA

Hi,

I just called David, and received this email. He suggested pinning down the date for a BPA update – he suggests a minimum of an hour – so perhaps you could schedule 90 minutes but allow some people to leave early if necessary.

I don't remember if we concluded that October 4th would indeed be the best, but David lays out alternative times in the days beforehand.

Also – David said that he could just ask Rich Zabel to pick a later time, without giving a detailed reason, given that they have not set up scheduling and webinar details yet. But, if David were to send this request, you might want to suggest an alternative time.

If BPA were to send a message along, we would want to communicate that because we are engaged in the BA dialog, we are making the request to move this presentation down the road because Kintama very much value NOAA's comments and input into their data and methods but some BPA staff have not seen the paper results at all yet and aren't prepared to discuss it yet.

I'll copy in David's phone number here:

Office: (250) 729-2600 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, September 21, 2017 1:08 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky; Aswea Porter
Subject: [EXTERNAL] RE: Update call with BPA

[redacted]

Next week, Monday & Tuesday mornings are open. Wednesday-Friday is out because [redacted] so that block of time is out while I take him over and cheer him on.

Monday, October 2nd I can present between 9 AM & 1 PM, Tuesday, October 3rd, between 9-12 AM, 1-2 PM, and 3-4 PM.

Wednesday the 4th I can do anytime from 7 AM to 12:30 [redacted] and the NOAA presentation is now scheduled for that day at 1-3 PM. (We could also do after 3 PM with you folks, or anytime on the 5th & 6th, but that is of course after the NOAA presentation).

It will take an hour, at least, but the amount of time depends on whether your BA team just wants to discuss the implications of the results or also wants to discuss and get some assurance about the quality of our analysis—the latter will take longer, and perhaps require a few calls.

We have made some good progress on cross-validating the PIT tag and CWT SAR estimates. Although we are not done, my sense is that we will still be able to show that Snake River SARs are "about" the same as those in regions without dams, which is the key policy issue. How well we are able to make that comparison (i.e., how closely we can show that they are essentially "the same" isn't quite clear, but we are working on that right now).

Let me know if any of these dates work for your folks; if not, we can try to find something else that will work.

From: David Welch

Sent: Thu Sep 21 16:48:45 2017

To: Renner,Marcella P (BPA) - E-4; Petersen,Christine H (BPA) - EWP-4; Jule,Kristen R (BPA) - EWP-4

Subject: [EXTERNAL] RE: Update call with BPA

Importance: Normal

That works on our end.

Christine, if you folks can advise as to:

1) Whether BPA or Kintama will take the lead to contact Rich Zabel and ask for the Kintama presentation to be put back?

2) Is the subsequent presentation to Lori Bodi & Elliot Mainzer scrubbed or the date changed?

Also, obviously we will need the details on a phone bridge for the presentation.

Regards, David

kintamav_RGB

Office: (250) 729-2600

Mobile: [redacted]

From: Renner,Marcella P (BPA) - E-4 [mailto:mprenner@bpa.gov]
Sent: Thursday, September 21, 2017 3:25 PM
To: Petersen,Christine H (BPA) - EWP-4; Jule,Kristen R (BPA) - EWP-4; David Welch
Subject: RE: Update call with BPA

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Marcella

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Sent: Thursday, September 21, 2017 1:51 PM
To: Renner,Marcella P (BPA) - E-4 <mprenner@bpa.gov>; Jule,Kristen R (BPA) - EWP-4 <krjule@bpa.gov>;

david.welch@kintama.com
Subject: FW: Update call with BPA

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Also – David said that he could just ask Rich Zabel to pick a later time, without giving a detailed reason, given that they have not set up scheduling and webinar details yet. But, if David were to send this request, you might want to suggest an alternative time.

If BPA were to send a message along, we would want to communicate that because we are engaged in the BA dialog, we are making the request to move this presentation down the road because Kintama very much value NOAA's comments and input into their data and methods but some BPA staff have not seen the paper results at all yet and aren't prepared to discuss it yet.

I'll copy in David's phone number here:

Office: (250) 729-2600 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, September 21, 2017 1:08 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky; Aswea Porter
Subject: [EXTERNAL] RE: Update call with BPA

(b) (6) [redacted]

Next week, Monday & Tuesday mornings are open. Wednesday-Friday is out because (b) (6) [redacted] (b) (6) [redacted] so that block of time is out while I take him over and cheer him on.

Monday, October 2nd I can present between 9 AM & 1 PM, Tuesday, October 3rd, between 9-12 AM, 1-2 PM, and 3-4 PM.

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Let me know if any of these dates work for your folks; if not, we can try to find something else that will work.

From: David Welch

Sent: Wed Sep 27 16:55:44 2017

To: Bodi,Lorri (BPA) - E-4

Subject: [EXTERNAL] Re: Hold for Kintama SARS Presentation

Importance: Normal

Hi Lori-

It would be great if it can be set up from your end as an actual WebEx, but last time I just called in to a speakerphone at BPA and stepped through the slides as a series of PowerPoint slides saved as a PDF. I thought it worked well. (Jeff Stier and Christine Petersen sat through it, so you could solicit their views).

On a separate issue, I take it the presentation to you and Elliot for November has been cancelled. If this is not going to be rescheduled for after Thanksgiving, can I suggest the three of us meet anyway? There are some very high level discussion points about what is wrong in the Columbia that is worth having. If I am right, then the Columbia Basin could be generating MANY hundreds of millions of dollars in additional revenue per annum and improving salmon conservation as well. However, getting regional biologists to agree that they have been wrong for decades is going to take some serious leadership at a senior level. I can help with the science, but without broad support from all of the senior leadership in the region, I don't see any change in direction happening-- people are too invested in the status quo to admit they might have been wrong in the first place.

I would like to outline this reasoning and propose a course of action.

David

David Welch
M: +[redacted]
Kintama Research Services
Sent from my iPhone

> On Sep 27, 2017, at 11:42 AM, Bodi,Lorri (BPA) - E-4 <florrainebodi@bpa.gov> wrote:
>
> David, are you setting up webex for this or shall I?
> <meeting.ics>

From: David Welch

Sent: Fri Sep 29 21:13:53 2017

To: Petersen,Christine H (BPA) - EWP-4; Aswea Porter; Erin Rechisky

Subject: [EXTERNAL] RE: questions

Importance: Normal

Attachments: Raymond (EffectsofHydroelectricDevelopment-1988).pdf; Raymond (Effect of Dams and Impoundments on Snake River Chinook and Steelhead-TAFS 1979).pdf

Hi Christine—Sorry, I did not press "send" on the email below—It is almost complete, but for expediency I am sending it now, in a not quite finished state.

My initial quick response is below.

David

P.S. Aswea, much of the details will rely on you, so please read on!! J .

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, September 26, 2017 2:43 PM

To: Aswea Porter; Erin Rechisky; David Welch
Subject: questions

Hi,

I did have a couple of hopefully quick questions – while working with Jeff Stier to write some summary paragraphs from your last deck of slides. In Jeff's opinion, the geographical comparison between regions is the first or primary point we would like to make in our 'proposed action' for NOAA's biological Opinion. However, when we lay out the background of why the Snake River SARs have been of special interest for the past 20 years, and why several regional salmon managers point to fixed SAR targets of at least 2%, and up to 6% for recovery to historical productivity ranges – they are using the pre 1990s SARs. We can openly acknowledge the influence of ocean cycles such as the PDO which influence all subregions.

Anyway – many of the SAR time series you found extend back over 20 years and many do not. Can you tell me which one in the list among Snake or upper Columbia Chinook reflects the Raymond freeze brand mark-recapture? How many years did that study run?***[DW>] I have attached the Raymond papers. The earlier paper says 1966-1975, the later one 1962-1984. Only the earlier paper used freeze branding, and that seems to be used solely(?) to produce in-river estimates of smolt survival through the hydropower dams, not smolt-to-adult return rates. (I'm still reviewing!) .*** It does seem to show the decline from the early 60s to late 70s which is almost a point to be made on its own. We know that before 1977 ocean conditions were better, and PDO has also been high in parts of the 2000s. Does including time series that are weighted towards years with high or low PDO raise or decrease their overall SAR mean? Eyeballing it, it looks like each subregion has a mixture of long and shorter time series. The plot where you divide SAR by the regional mean for each year solves all the considerations by year and is very useful, but I was looking at the means for each subpopulation which can be influenced by which decade

You have Snake River wild spring, Snake River wild hatchery combined spring, and Snake River hatchery spring on the list, each with different number of years. I assume these do not overlap as far as tagging, but just the populations themselves? There are tributary wild traps, hatchery fish tagged at the hatchery with either CWT or PIT, and then NOAA intercepts fish at Lower Granite dam of mixed hatchery wild origin and gives them tags.

You have Yakima River wild spring (11 yrs) and John Day river wild (14 years). What period of years do they have SAR for? It is interesting that this is all they have, given that they were debating Snake and John Day SArs since the early 2000s.

I will ask Aswea to send you our draft "Table 1" for the paper. The final version will probably be pared down but the draft should include the year range used for each population, as well as the location (probably latitude & longitude), but I don't think we have put in a georeference as yet.

Are the Alaska, Northern BC and Puget Sound populations hatchery origin? All are reviewed by the Pacific Salmon Commission for consistent method? This is helpful as a way of explaining that there was QA/QCd without citing minor details of how SAR was estimated.

As far as I know, all of SE Alaska & N BC datasets are for wild populations, but this is just my hunch. Puget Sound may be a mix of both, but I don't have the Draft Table 1 at hand, so when Aswea sends that, we can look more closely. My expectation is that essentially all are hatchery-based SAR estimates because of the difficulty of CWT tagging enough wild smolts to produce a useful estimate. (Remember: with CWTs, the smolts would have to be individually captured prior to tagging as smolts). We will need to go back to our PSC contact to try to ascertain smolt origin for the Transboundary stocks and others to be certain—it is certainly something that needs to be in the finalized Table 1.

We are using the PSC SAR estimates "as is"… the issue is that each agency (& each hatchery reporting

SARs within a reporting agency) will have their own "flavor" as to how they generate their survival estimates. We just don't have the time or resources to delve into every population and "vet" their results. One of the reasons why we want to use the Pacific Salmon Commission's estimates is that these are collated by the two countries under a formal bilateral treaty, and therefore should be treated as a serious obligation to produce "best effort" data by all of the parties to the treaty. (The DART data, by way of contrast, is spotty: there are a few years of survival reported for a number of populations, but very few consistent time series which we can use.. and because that system/analysis framework cannot generate survival estimates for BC or Alaska, we are not relying on it for most of our work). So, yes, there is certainly "**as strong as could be expected*****" QA/QC for the PSC data as it is a key data product generated under the bilateral treaty. That being said, there will no doubt be calls for closer inspection of the SAR data once our paper comes out by those who want to believe that the Snake River survivals must be lower. One of my outstanding questions that I need to get an answer from those involved in the PSC Chinook process is whether we can get error estimates on the CWT-based SAR estimates.***

Thank you

Christine

From: Petersen,Christine H (BPA) - EWP-4

Sent: Mon Oct 02 11:23:09 2017

To: David Welch

Cc: Aswea Porter

Subject: RE: questions

Importance: Normal

Hello,

Thank you very much. No problem at all.

For Wednesday, I said that 90 min would be preferable to 1 hour, so they are trying to start at 1:30-3 rather than at 2. Is this okay? Marcella is getting a Webex link right now.

Also – in order to distribute materials ahead of time, will you be using the presentation you had for NOAA, or will you have any changes as of today?

Thanks,

Christine Petersen

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Saturday, September 30, 2017 6:58 AM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Aswea Porter
Subject: [EXTERNAL] Fwd: questions

Christine-- sorry! This email from Aswea had been sent to me on Thursday, but I hadn't seen it amongst all the other unread ones.

I am forwarding it now to you. See the question Aswea asks about your intended meaning on one point-- some clarification would be good from you here

David

David Welch, Kintama Research

Tel: +1 (250) 729-2600 x223

Cell: (b) (6) [redacted]

Sent from my iPad

Begin forwarded message:

From: Aswea Porter <Aswea.Porter@kintama.com>
Date: September 28, 2017 at 09:39:35 PDT
To: David Welch <David.Welch@kintama.com>
Subject: RE: questions

Hi D,

There are few questions from Christine to field here. I've started. Can you review what I've written and then we can take it from there?

~A

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September-26-17 19:13
To: Aswea Porter; Erin Rechisky; David Welch
Subject: questions

Hi,

I did have a couple of hopefully quick questions – while working with Jeff Stier to write some summary paragraphs from your last deck of slides. In Jeff's opinion, the geographical comparison between regions is the first or primary point we would like to make in our 'proposed action' for NOAA's biological Opinion. However, when we lay out the background of why the Snake River SARs have been of special interest for the past 20 years, and why several regional salmon managers point to fixed SAR targets of at least 2%, and up to 6% for recovery to historical productivity ranges – they are using the pre 1990s SARs. We can openly acknowledge the influence of ocean cycles such as the PDO which influence all subregions.

Anyway – many of the SAR time series you found extend back over 20 years and many do not. Can you tell me which one in the list among Snake or upper Columbia Chinook reflects the Raymond freeze brand mark-recapture? How many years did that study run?

Here are the stocks from the Raymond study and the timeframe over which it extended.

Region3

Stock

Rear

Race

From

To

UCOL

Mid-Columbia River Hatchery Spring Chinook

H

Spr

1972

1984

UCOL

Mid-Columbia River Wild Hatchery Combined Summer Chinook

WH

Sum

1968

1983

UCOL

Mid-Columbia River Wild Hatchery Combined Spring Chinook

WH

Spr

1972

1984

UCOL

Mid-Columbia River Wild Hatchery Combined Steelhead

WH

NA

1962

1984

UCOL

Mid-Columbia River Wild Spring Chinook

W

Spr

1962

1984

UCOL

Mid-Columbia River Wild Summer Chinook

W

Sum

1962

1968

SNAK

Snake River Hatchery Spring Chinook

H

Spr

1966

1984

SNAK

Snake River Hatchery Steelhead Chinook

H

NA

1967

1984

SNAK

Snake River Wild Hatchery Combined Spring Chinook

WH

Spr

1966

1984

SNAK

Snake River Wild Hatchery Combined Steelhead

WH

NA

1967

1984

SNAK

Snake River Wild Spring Chinook

W

Spr

1964

1984

SNAK

Snake River Wild Steelhead

W

NA

1964

1984

SNAK

Snake River Wild Summer Chinook

W

Sum

1964

1984

It does seem to show the decline from the early 60s to late 70s which is almost a point to be made on its own. We know that before 1977 ocean conditions were better, and PDO has also been high in parts of the 2000s. Does including time series that are weighted towards years with high or low PDO raise or decrease their overall SAR mean? Eyeballing it, it looks like each subregion has a mixture of long and shorter time series. The plot where you divide SAR by the regional mean for each year solves all the considerations by year and is very useful, but I was looking at the means for each subpopulation which can be influenced by which decade

She's asking us to break the analysis out into PDO period which we have been planning to do. To discuss.

You have Snake River wild spring, Snake River wild hatchery combined spring, and Snake River hatchery spring on the list, each with different number of years. I assume these do not overlap as far as tagging, but just the populations themselves? There are tributary wild traps, hatchery fish tagged at the hatchery with either CWT or PIT, and then NOAA intercepts fish at Lower Granite dam of mixed hatchery wild origin and gives them tags.

What do you think she means? The stocks she lists are all from Raymond, but they have similar numbers of year (see table above). The wild-hatchery-combined group is a combined estimate using the wild and hatchery fish that are also presented. Should we remove the combined group to avoid repetition?

You have Yakima River wild spring (11 yrs) and John Day river wild (14 years). What period of years do they have SAR for? It is interesting that this is all they have, given that they were debating Snake and John Day SArs since the early 2000s.

Yakima has 11 years of data 2002-2013. John Day has 14 years of data 2000-2013. These are FPC estimates and were calculated only since the CSS was established. They are not in DART. Should we seek additional sources for these 2 stocks?

Are the Alaska, Northern BC and Puget Sound populations hatchery origin? All are reviewed by the Pacific Salmon Commission for consistent method? This is helpful as a way of explaining that there was QA/QCd without citing minor details of how SAR was estimated.

We don’t know. This was something to ask Gayle.

Thank you

Christine

From: David Welch

Sent: Mon Oct 02 14:34:47 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Aswea Porter; Erin Rechisky

Subject: [EXTERNAL] Re: questions

Importance: Normal

Hi Christine-

The specific need is to have someone quite familiar with the geographic location of all the CRB hatcheries AND a good statistical head on their shoulders review our identification of SAR estimates derived from matching comparable release groups of CWT and PIT abased SARs. We aren't looking for statistical advice, per se, but rather help to make sure that we haven't done something incorrect in the match-up; it gets complex because the population or hatchery names aren't exactly the same in the PSC, DART, and FPC datasets, and because we need to also consider what to compare to SARS for yearling Fall Chinook... subyearlings are easy to decide on, but the (likely) fundamental differences in the marine life history of Fall and Spring Chinook means that the SARS for yearling Fall Chinook and yearling Spring Chinook probably wouldn't be the same, no matter how geographically close the release locations are.

We aren't quite ready to have that discussion as yet, but could be in a couple of weeks I think. It would probably take a maximum of a couple of days for someone, perhaps just a day if we can lay out the tables and the issues well enough.

Josh would be a good choice, in my opinion.

David

David Welch, Kintama Research
Tel: +1 (250) 729-2600 x223
Cell: [redacted]
Sent from my iPad

On Oct 2, 2017, at 14:16, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Thanks a lot.

Based on what David said over the phone, are you still looking for someone familiar with Columbia basin hatcheries or hatchery databases to interview? Josh Murauskas could be a candidate, but let me know the nature of the request a little better and I might ask Brady Allen or think of some more names.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, September 29, 2017 9:14 PM
To: Petersen,Christine H (BPA) - EWP-4; Aswea Porter; Erin Rechisky
Subject: [EXTERNAL] RE: questions

Hi Christine—Sorry, I did not press “send” on the email below—It is almost complete, but for expediency I am sending it now, in a not quite finished state.

My initial quick response is below.

David

P.S. Aswea, much of the details will rely on you, so please read on!! J .

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, September 26, 2017 2:43 PM
To: Aswea Porter; Erin Rechisky; David Welch
Subject: questions

Hi,

I did have a couple of hopefully quick questions – while working with Jeff Stier to write some summary paragraphs from your last deck of slides. In Jeff's opinion, the geographical comparison between regions is the first or primary point we would like to make in our 'proposed action' for NOAA's biological Opinion. However, when we lay out the background of why the Snake River SARs have been of special interest for the past 20 years, and why several regional salmon managers point to fixed SAR targets of at least 2%, and up to 6% for recovery to historical productivity ranges – they are using the pre 1990s SARs. We can openly acknowledge the influence of ocean cycles such as the PDO which influence all subregions.

Anyway – many of the SAR time series you found extend back over 20 years and many do not. Can you tell me which one in the list among Snake or upper Columbia Chinook reflects the Raymond freeze brand mark-recapture? How many years did that study run?***[DW>]   I have attached the Raymond papers. The earlier paper says 1966-1975, the later one 1962-1984. Only the earlier paper used freeze branding, and that seems to be used solely(?) to produce in-river estimates of smolt survival through the hydropower dams, not smolt-to-adult return rates. (I'm still reviewing!) .*** It does seem to show the decline from the early 60s to late 70s which is almost a point to be made on its own. We know that before 1977 ocean conditions were better, and PDO has also been high in parts of the 2000s. Does including time series that are weighted towards years with high or low PDO raise or decrease their overall SAR mean? Eyeballing it, it looks like each subregion has a mixture of long and shorter time series. The plot where you divide SAR by the regional mean for each year solves all the considerations by year and is very useful, but I was looking at the means for each subpopulation which can be influenced by which decade

You have Snake River wild spring, Snake River wild hatchery combined spring, and Snake River hatchery spring on the list, each with different number of years. I assume these do not overlap as far as tagging, but just the populations themselves? There are tributary wild traps, hatchery fish tagged at the hatchery with either CWT or PIT, and then NOAA intercepts fish at Lower Granite dam of mixed hatchery wild origin and gives them tags.

You have Yakima River wild spring (11 yrs) and John Day river wild (14 years). What period of years do they have SAR for? It is interesting that this is all they have, given that they were debating Snake and John Day SArs since the early 2000s.

I will ask Aswea to send you our draft "Table 1" for the paper. The final version will probably be pared down but the draft should include the year range used for each population, as well as the location (probably latitude & longitude), but I don't think we have put in a georeference as yet.

Are the Alaska, Northern BC and Puget Sound populations hatchery origin? All are reviewed by the Pacific Salmon Commission for consistent method? This is helpful as a way of explaining that there was QA/QCd without citing minor details of how SAR was estimated.

As far as I know, all of SE Alaska & N BC datasets are for wild populations, but this is just my hunch. Puget Sound may be a mix of both, but I don't have the Draft Table 1 at hand, so when Aswea sends that, we can look more closely. My expectation is that essentially all are hatchery-based SAR estimates because of the difficulty of CWT tagging enough wild smolts to produce a useful estimate. (Remember: with CWTs, the smolts would have to be individually captured prior to tagging as smolts). We will need to go back to our PSC contact to try to ascertain smolt origin for the Transboundary stocks and others to be certain—it is certainly something that needs to be in the finalized Table 1.

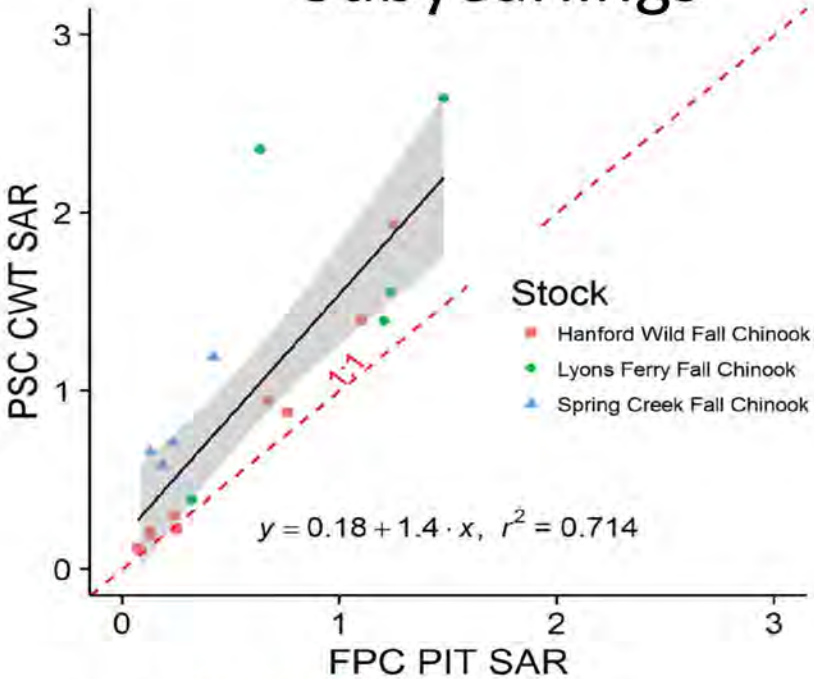
We are using the PSC SAR estimates "as is"… the issue is that each agency (& each hatchery reporting SARs within a reporting agency) will have their own "flavor" as to how they generate their survival estimates. We just don't have the time or resources to delve into every population and "vet" their results. One of the reasons why we want to use the Pacific Salmon Commission's estimates is that these are collated by the two countries under a formal bilateral treaty, and therefore should be treated as a serious obligation to produce "best effort" data by all of the parties to the treaty. (The DART data, by way of contrast, is spotty: there are a few years of survival reported for a number of populations, but very few consistent time series which we can use.. and because that system/analysis framework cannot generate survival estimates for BC or Alaska, we are not relying on it for most of our work). So, yes, there is certainly "**as strong as could be expected*****" QA/QC for the PSC data as it is a key data product generated under the bilateral treaty. That being said, there will no doubt be calls for closer inspection of the SAR data once our paper comes out by those who want to believe that the Snake River survivals must be lower. One of my outstanding questions that I need to get an answer from those involved in the PSC Chinook process is whether we can get error estimates on the CWT-based SAR estimates.***

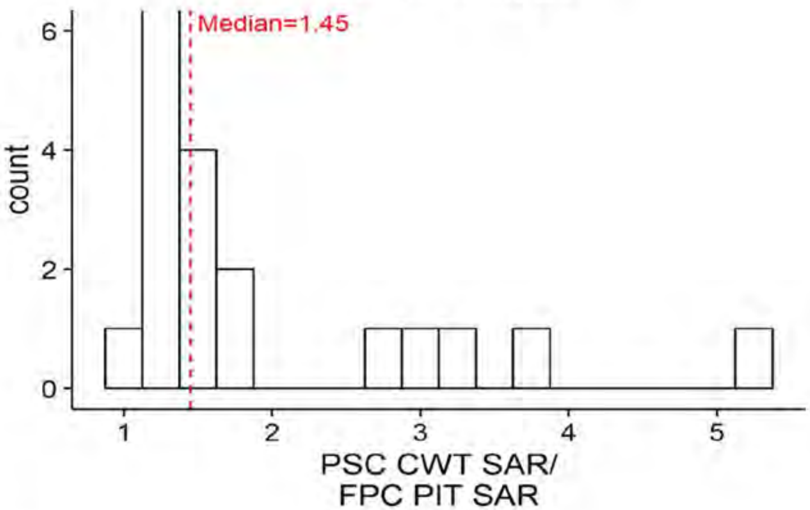
Thank you

Christine

DIRECT COMPARISON: PSC vs FPC SARs

Subyearlings



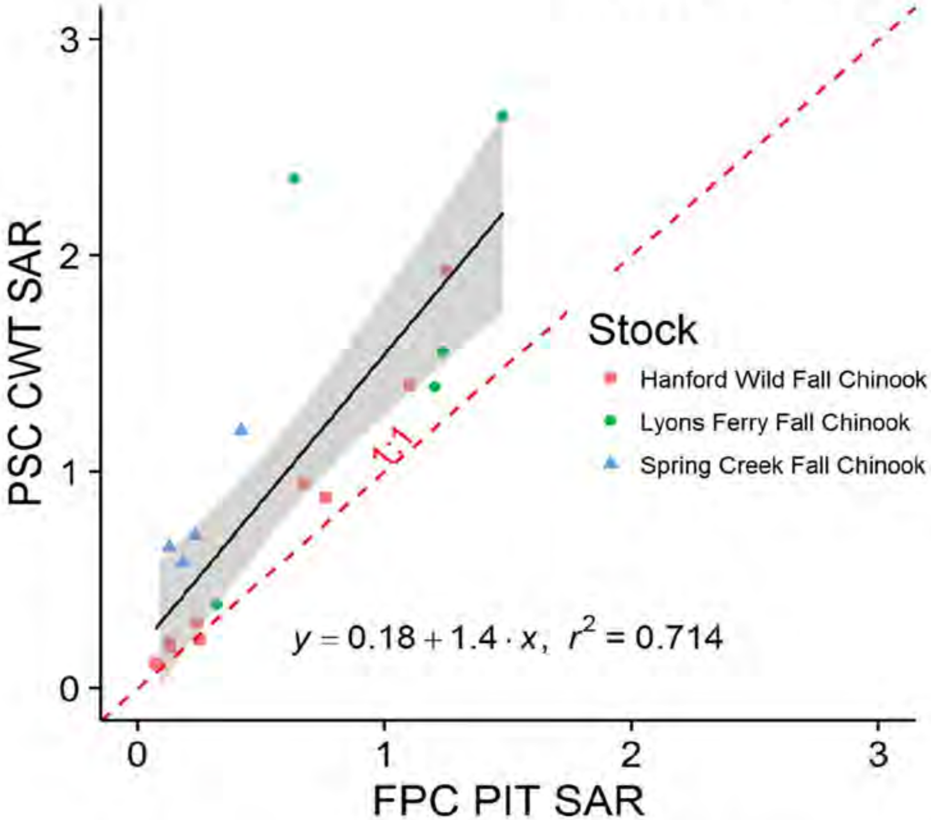


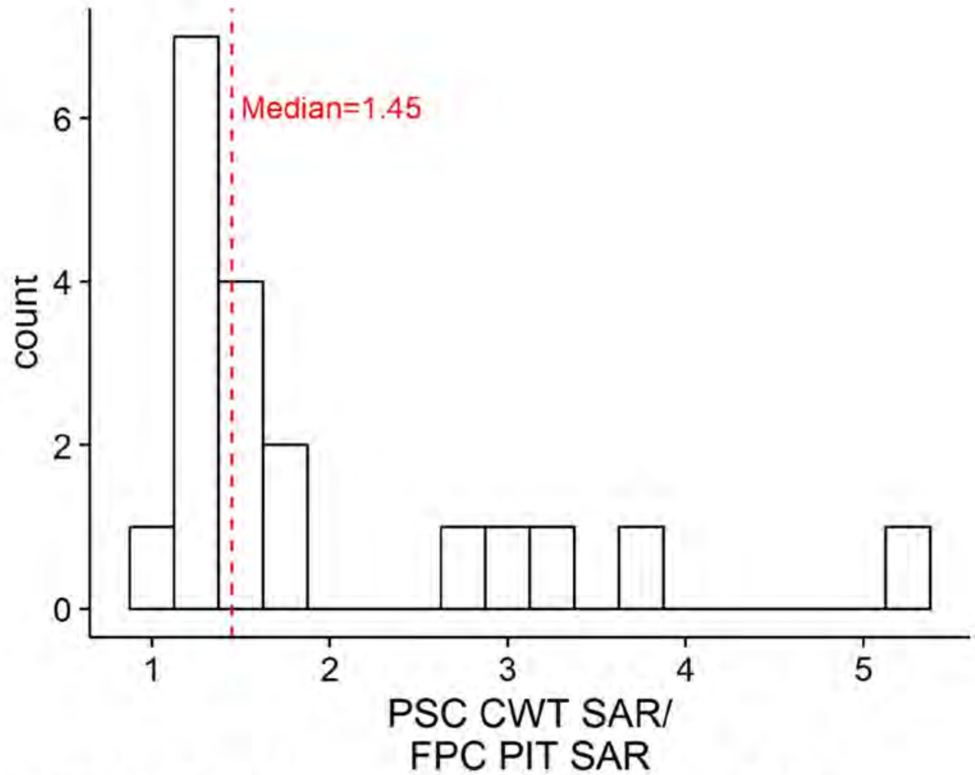
Yearlings

NO DATA

NO DATA

PSC CWT vs PIT SAR Methodologies (Direct Method)

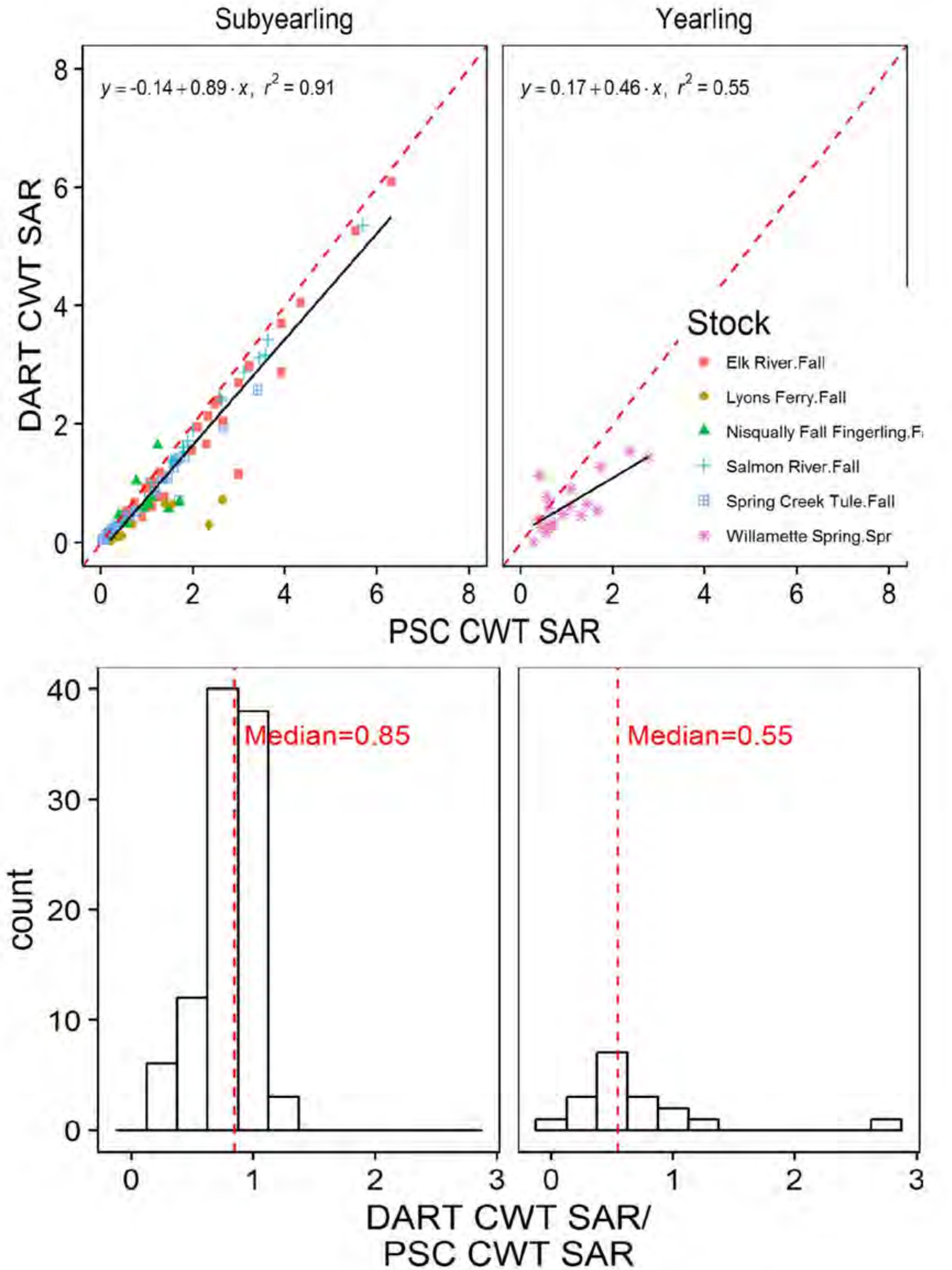




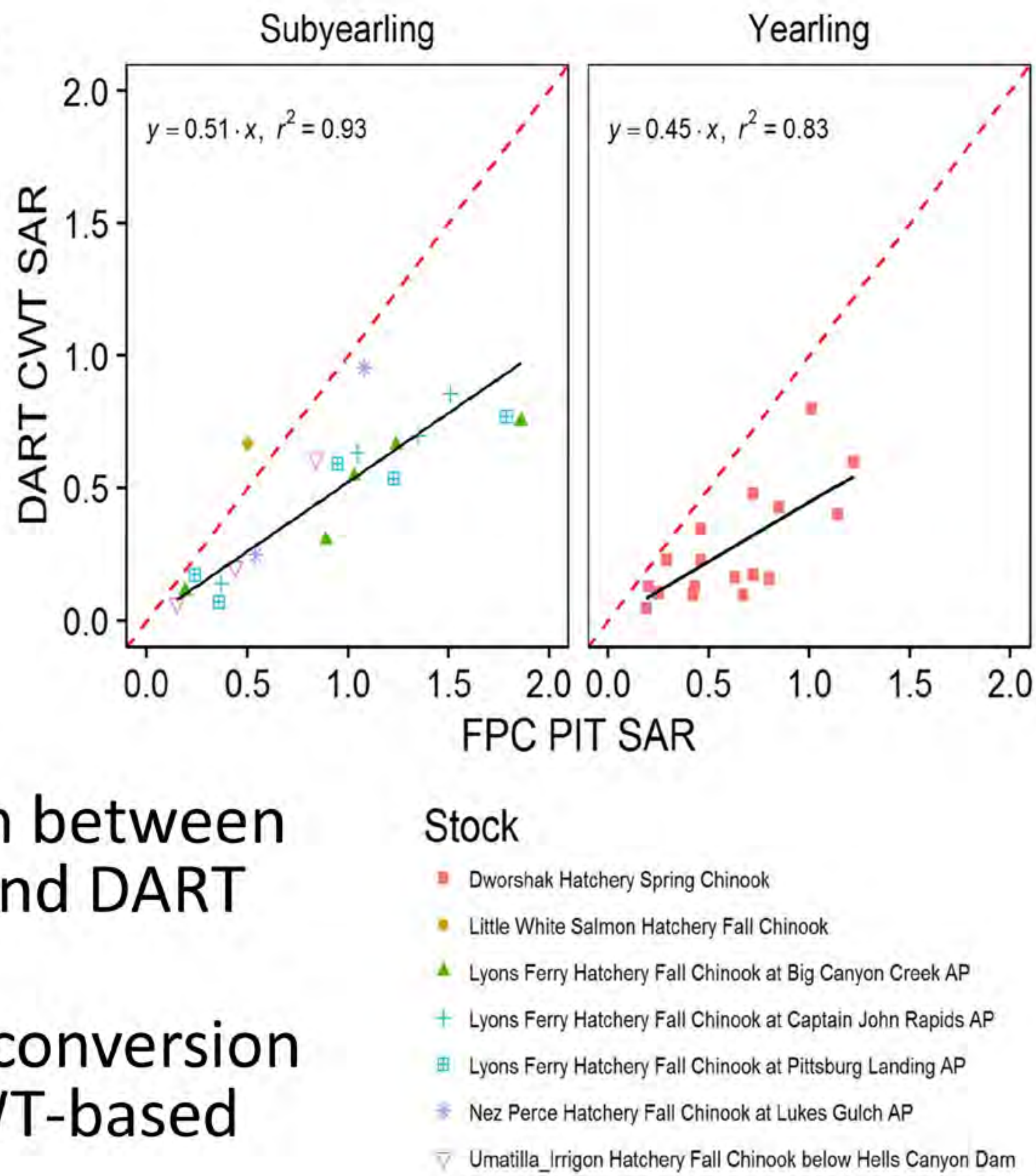
- Compared CWT & PIT Fall Chinook SARs for the same year ***<u>and the same stock</u>***
- On average, PSC CWT SARs are ~1.4X FPC's PIT-tag based SARs
- (*Recall: PSC adds in harvest, includes all survival losses from smolt release location to adult enumeration site*)

A) PSC CWT SARs vs DART CWT SARs

- No direct comparison of PSC & FPC SARs available for Yearlings
- We can develop a "convoluted" estimate using DART as an intermediate.



B) FPC PIT SARs vs DART CWT SARs



- This gives us a conversion between FPC PIT-tag based SARs and DART CWT-based SARs
- The prior slide gave us a conversion between DART & PSC CWT-based SARs
- So…

THE INDIRECT METHOD (USING MEDIAN VALUES FOR ALGEBRAIC SIMPLICITY):

Subyearlings:

- $SAR_{Dart}=0.85*SAR_{PSC}$
- $SAR_{Dart}=0.51*SAR_{FPC}$

So:

- $SAR_{PSC}=(0.51/0.85)*SAR_{FPC} \approx 0.6*SAR_{FPC}$

Yearlings:

- $SAR_{Dart}=0.45*SAR_{FPC}$
- $SAR_{Dart}=0.55*SAR_{PSC}$

So:

- $SAR_{PSC}=0.45/0.55*SAR_{FPC} \approx 0.8*SAR_{FPC}$

Reality Check:

YEARLINGS:

- Direct Method: **No Data**
- Indirect Method:

  $SAR_{PSC} \approx 0.8*SAR_{FPC}$ (Close to 1:1)

SUBYEARLINGS:

- Direct Method: $SAR_{PSC} \approx 1.4*SAR_{FPC}$
- Indirect Method: $SAR_{PSC} \approx 0.6*SAR_{FPC}$
- Results don't match, but are "close" to a 1:1 relationship, suggesting that FPC & PSC SAR data on average are not hugely different (work in progress)

Kintama Update to BPA

19 September 2017

KINTAMA

What we are Reporting

- Results primarily confined to Chinook in this update
  - Subyearling & yearling populations separated
- We show a few steelhead results to indicate the same general conclusions will likely hold more broadly
- ***<u>Important Update:</u>*** Comparison of the CWT vs PIT tag database analyses to make the SAR comparisons as robust as possible.

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Primary Results

The broad coast-wide analysis of SARs leads to very different perspective from the current view in the Columbia River basin:

1) SARs in all regions are falling, starting in the early-mid 1970s
2) For CR basin stocks, only MCOL yearlings SARs are higher than Snake River SARs- and only two MCOL populations (***<u>not all</u>***).
3) For Yearling Chinook, "raw" Snake River SARs same as Upper & Lower Columbia & are higher than Puget Sound, Strait of Georgia, North-Central BC
   - Little or no evidence for "delayed mortality" in Snake River Chinook
4) When "raw" data are corrected for methodological differences between CWTs & PIT tags, Snake River populations ***<u>do not appear to</u>*** have lower survival than other stocks not migrating through the Snake River dams
5) Data are consistent with a coast-wide northern expansion with time of a region of poor ocean survival, progressively encompassing more stocks (even Alaska now affected!)
6) A deleterious effect caused by the Columbia dams is not evident.

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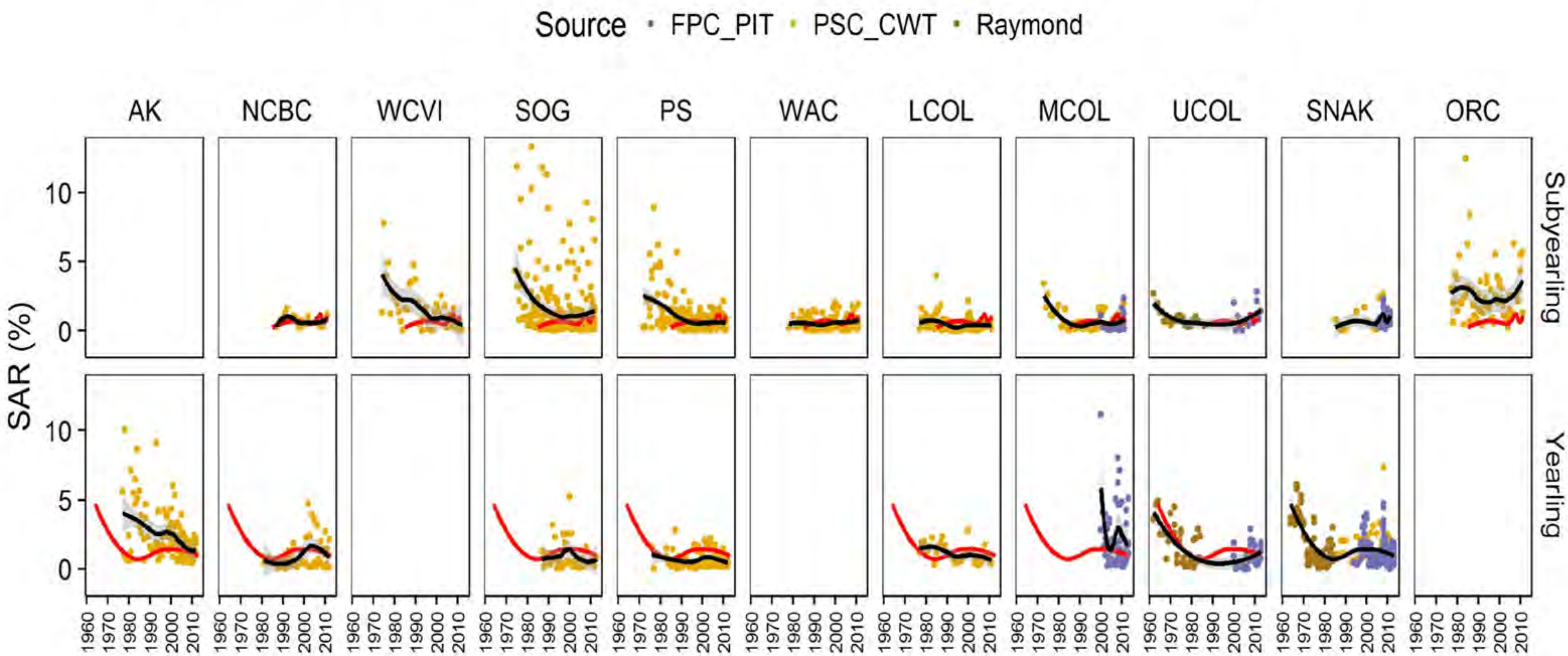
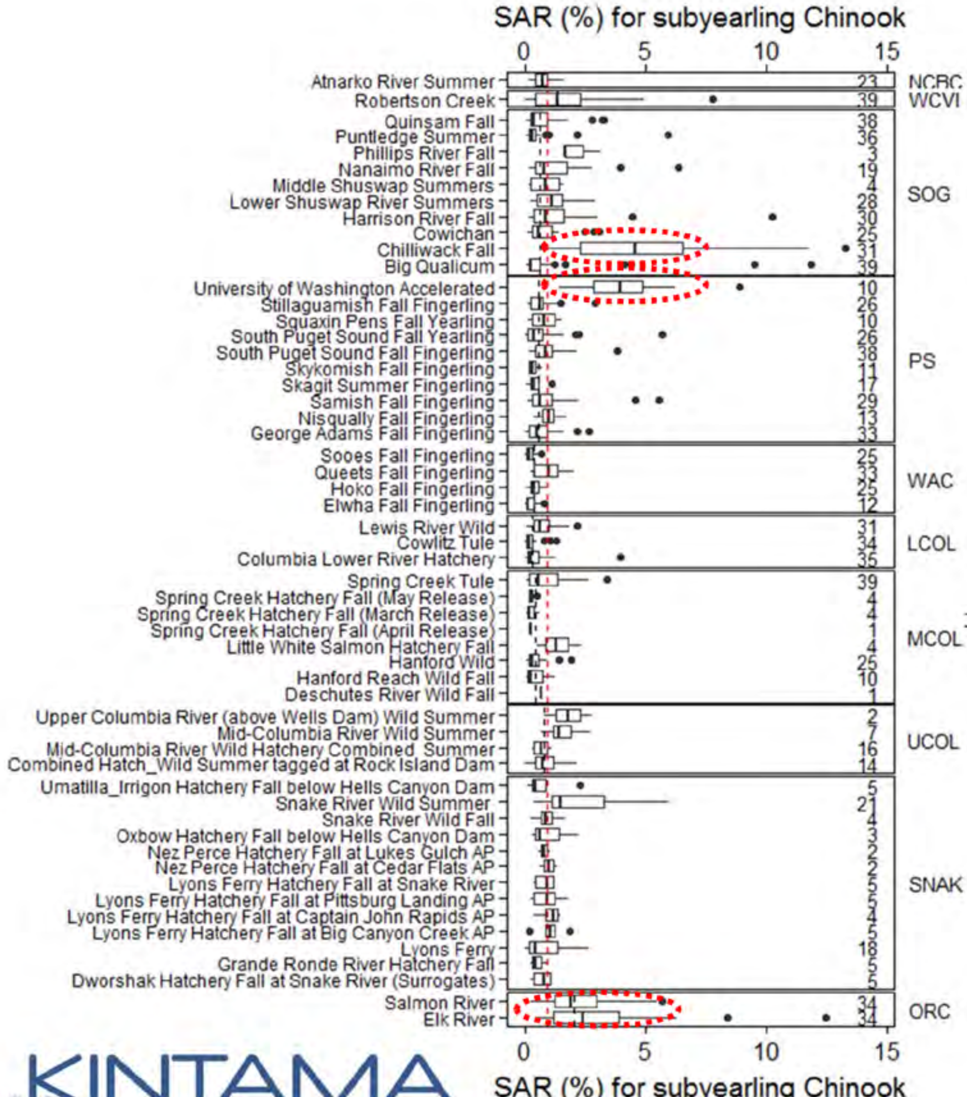
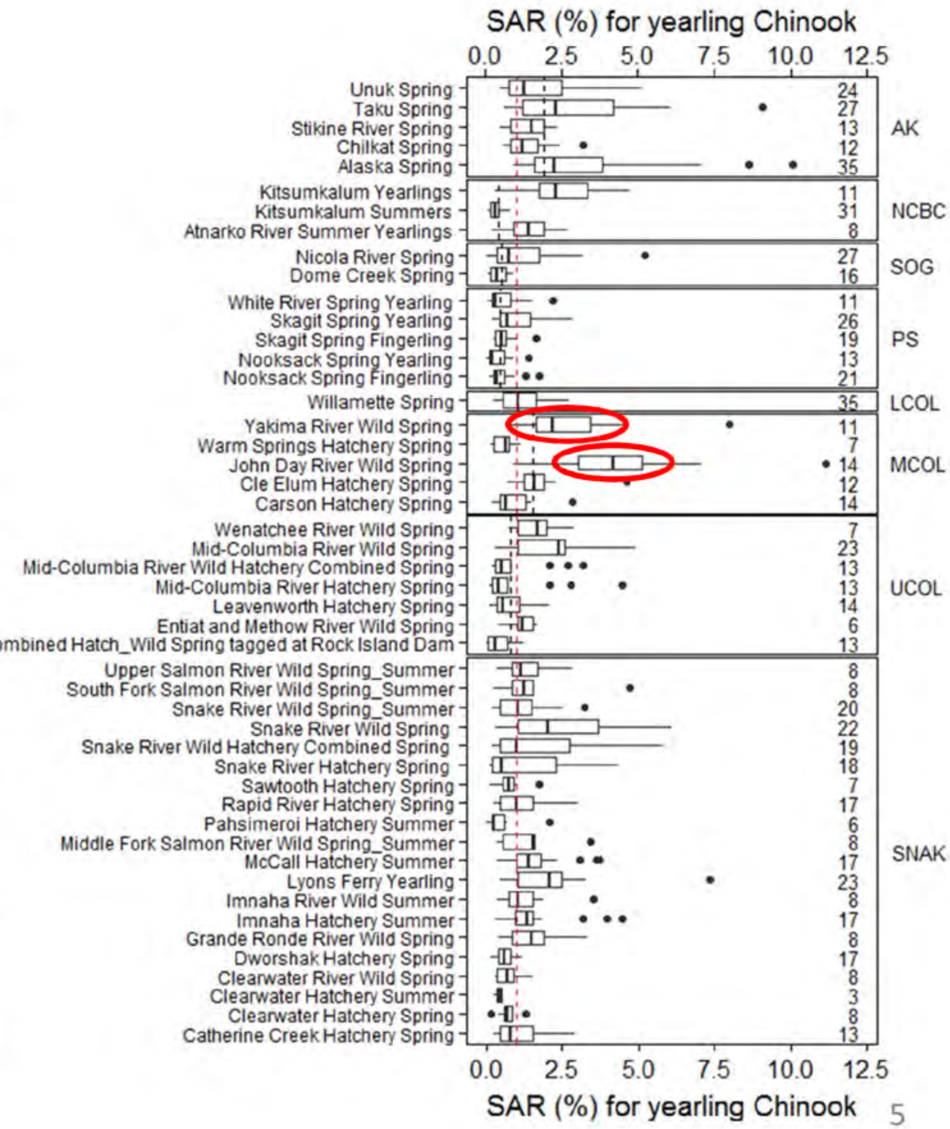
Chinook-All SAR Data by Region



- Plotted SARS against time, split out by regions (columns) & Chinook life history types (rows)
- LOWESS trend line (black) fitted to the SAR data. Snake River trend line (red) overplotted on all panels to facilitate comparison.

Stock-Specific Chinook SARS-All Years





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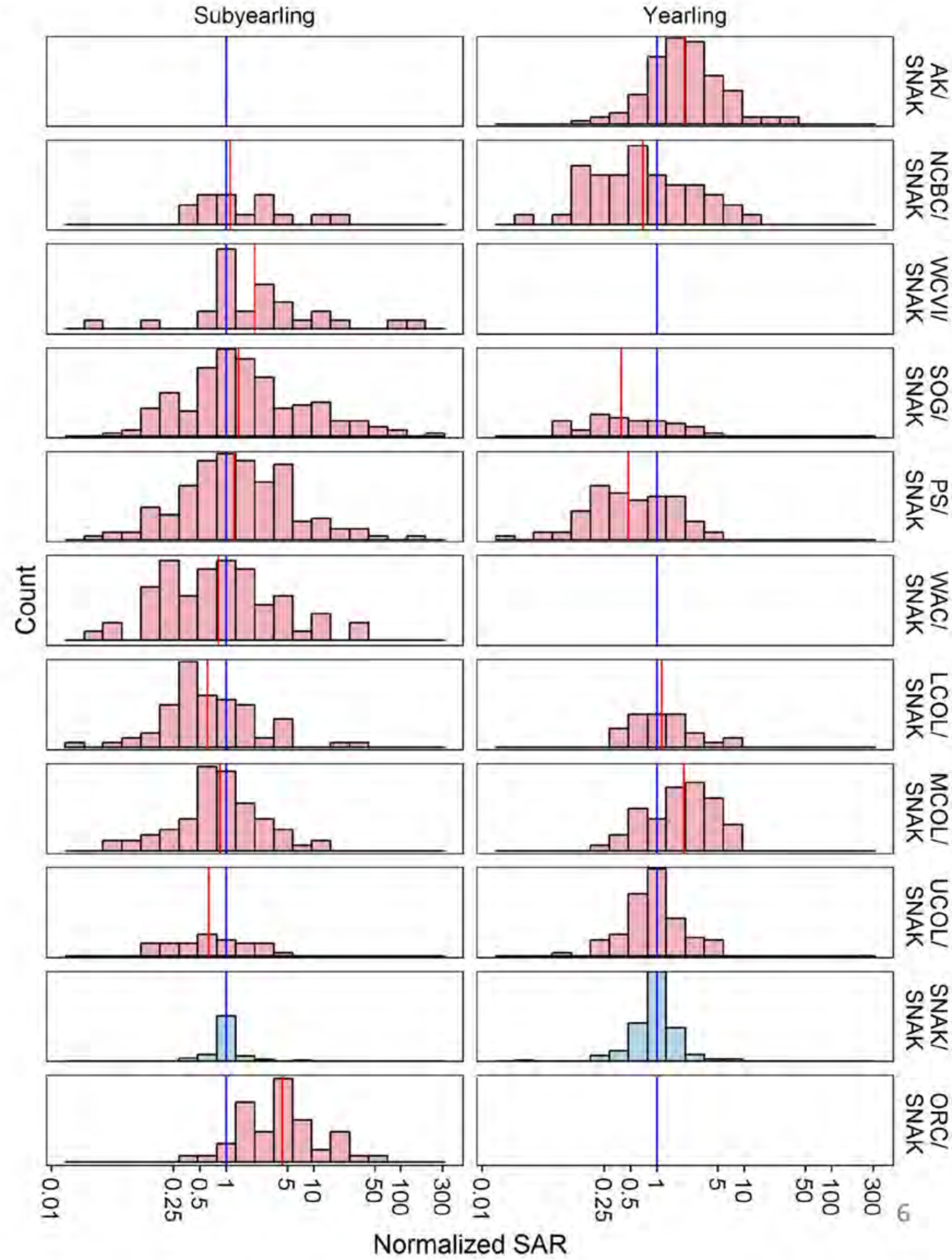
Comparison of Regional SARs
(Region X/Snake)

- Divided annual SARs for Region X by the Snake River median SAR for the same year: SAR_x/SAR_{Snake}
- Plotted the results as a frequency histogram
- Snake River is in blue



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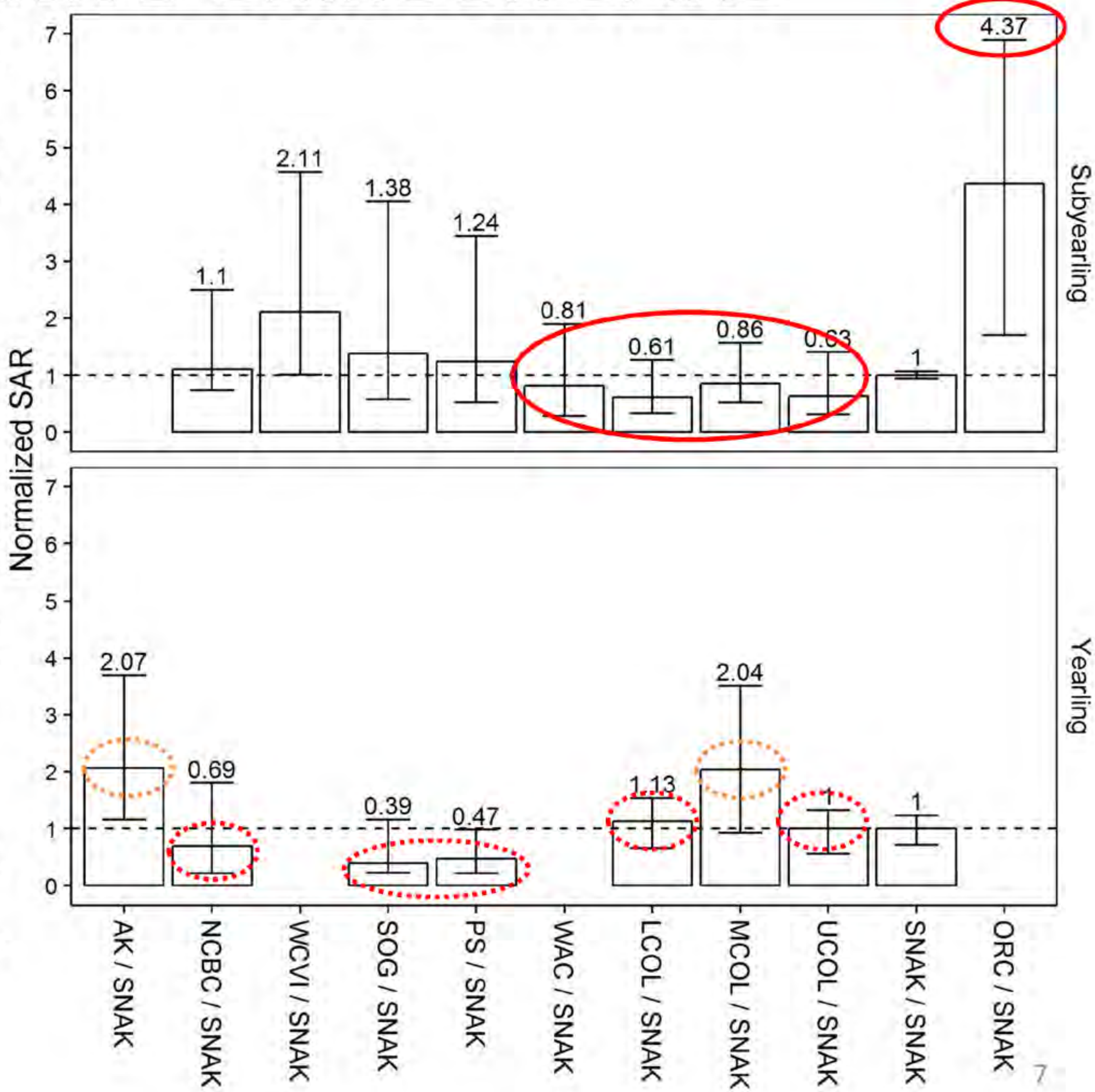
Relative Chinook SARS

1. Same data as prior slide, just different presentation (error bars are 25 & 75 percentiles)
2. For subyearlings:
   1. Oregon Coast Chinook have SARS 4.37X Snake River.
   2. But Upper/Mid/Lower Columbia River SARS are **lower** than Snake River subyearling SARS, as are WAC (Washington Coast).
3. For Yearling Chinook:
   1. Snake River SARs same as Upper & Lower Columbia & higher than Puget Sound, Strait of Georgia, North-Central BC
4. Only Mid-Columbia & Alaska have higher SARs than Snake River (& recall Alaskan SARs have fallen to Snake River levels in recent years)



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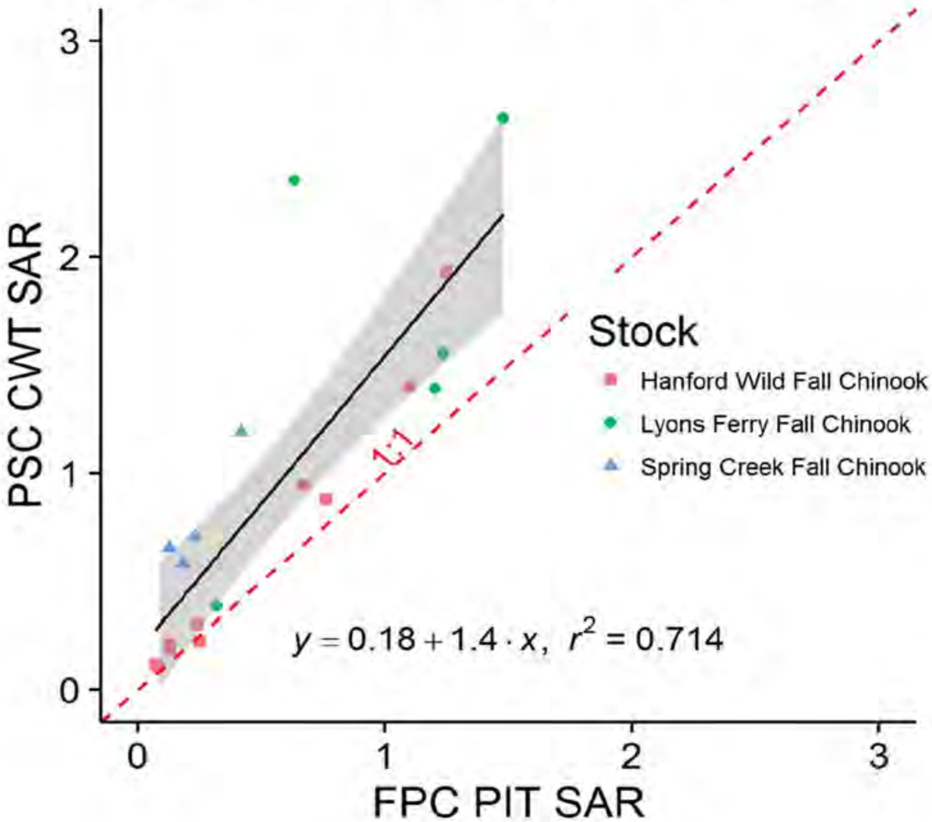
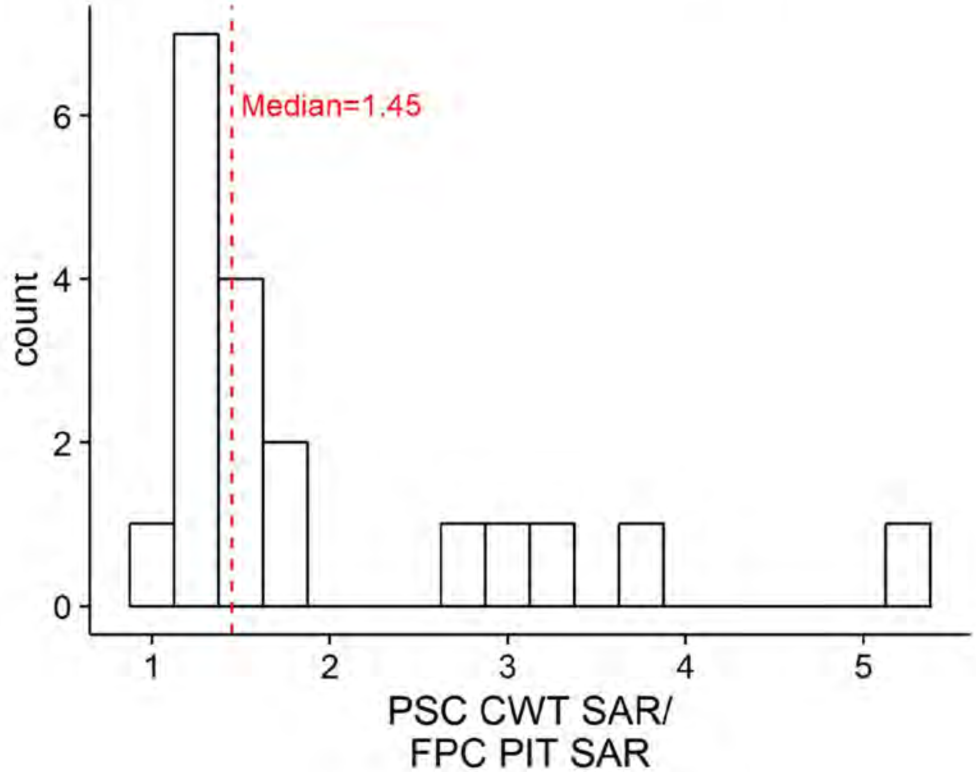
Major Uncertainties

- Regional SARs derived by different methodologies
  a) In Columbia, early data from Raymond
  b) CWT survival data (PSC):
     i. Survival calculated from smolt release to adult return to spawning grounds
     ii. Corrected for harvest in sport & commercial fisheries
  c) FPC survival data is based on PIT tags:
     i. Survival calculated from smolts reaching a dam to adults returning to a dam
     ii. Excludes smolt survival "pre-dams" and adult survival "post-dams".
     iii. Not corrected for harvest in sport & commercial fisheries

PSC CWT vs FPC PIT SAR Methodologies

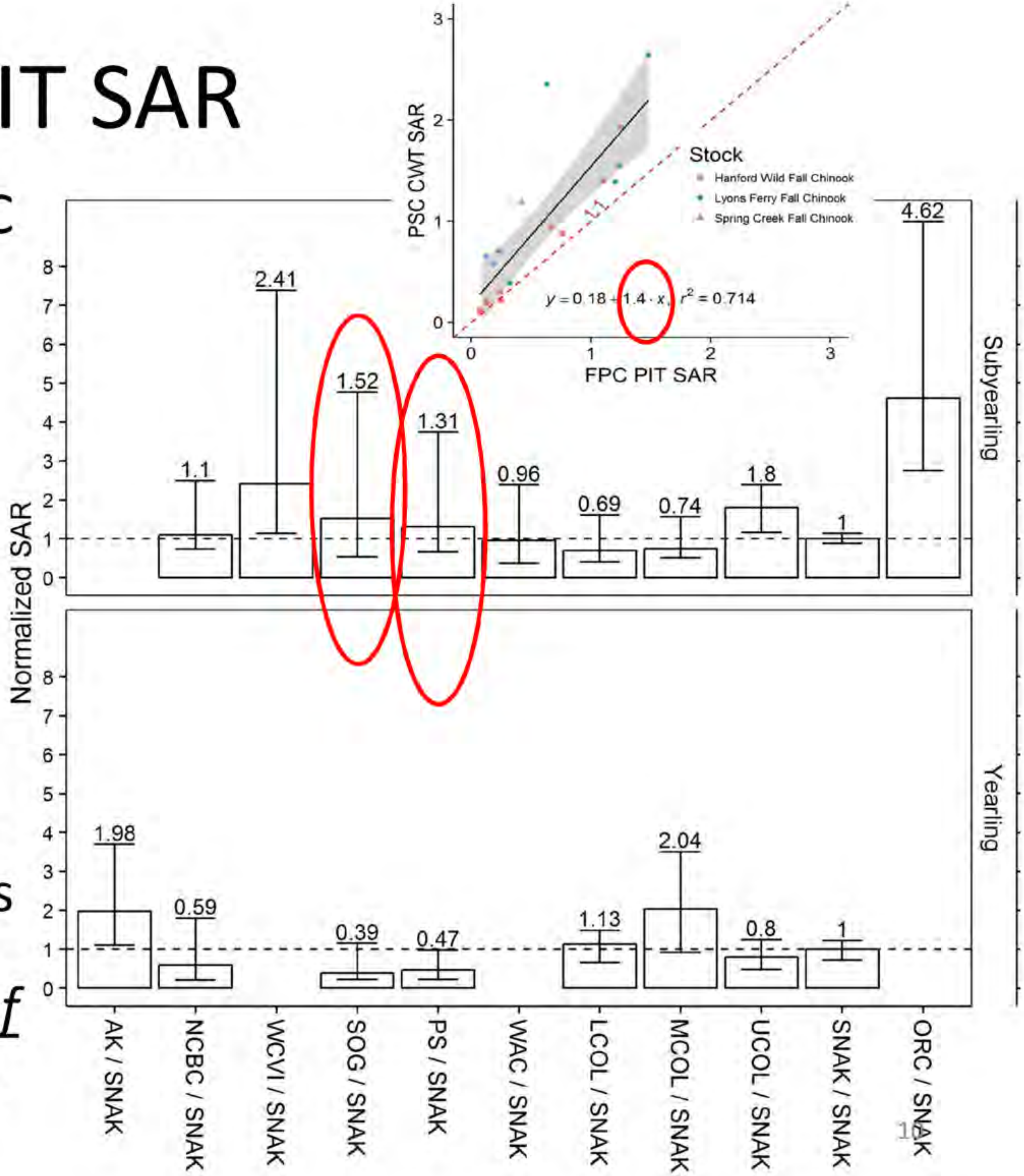




- Compared CWT & PIT tag derived Fall Chinook SARs for the same year ***<u>and the same stock</u>*** (few stocks available to make this comparison)
- On average, PSC CWT SARs are ~1.4X FPC's PIT-tag based SARs
- (*Recall: FPC adds in harvest, includes all survival losses from smolt release location to adult enumeration site*)

PSC CWT vs PIT SAR

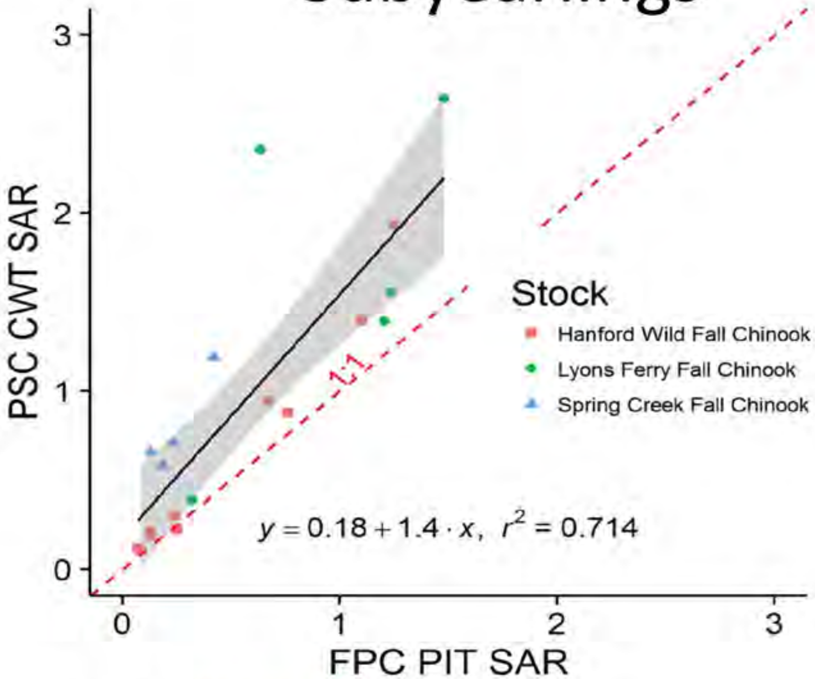
- For Fall Chinook, PSC CWT SAR values ≈1.45X FPC SAR values
- This is about what the CWT vs PIT SAR ratios are for the Salish Sea:
  - SOG/SNAK=1.5
  - Puget/SNAK=1.3
- Results suggest that Snake River Fall SARs are *__about the same as in other regions of coast without dams__*

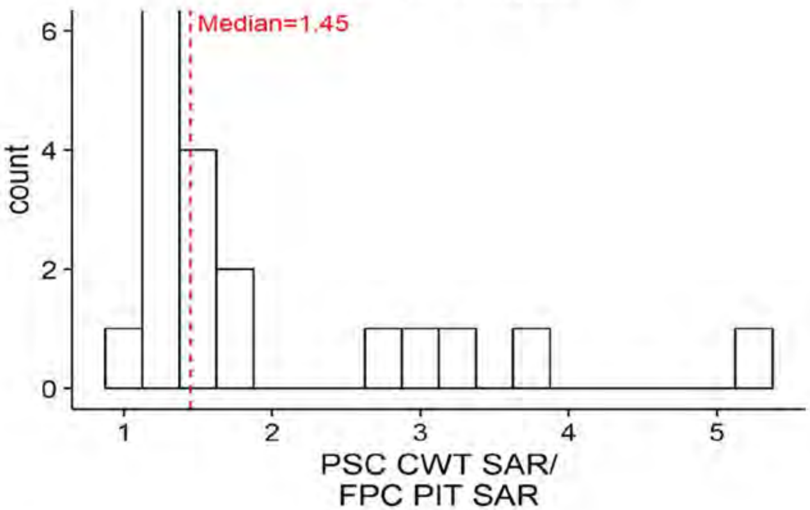


Current Work (in Progress!)

DIRECT COMPARISON: PSC vs FPC SARs

Subyearlings



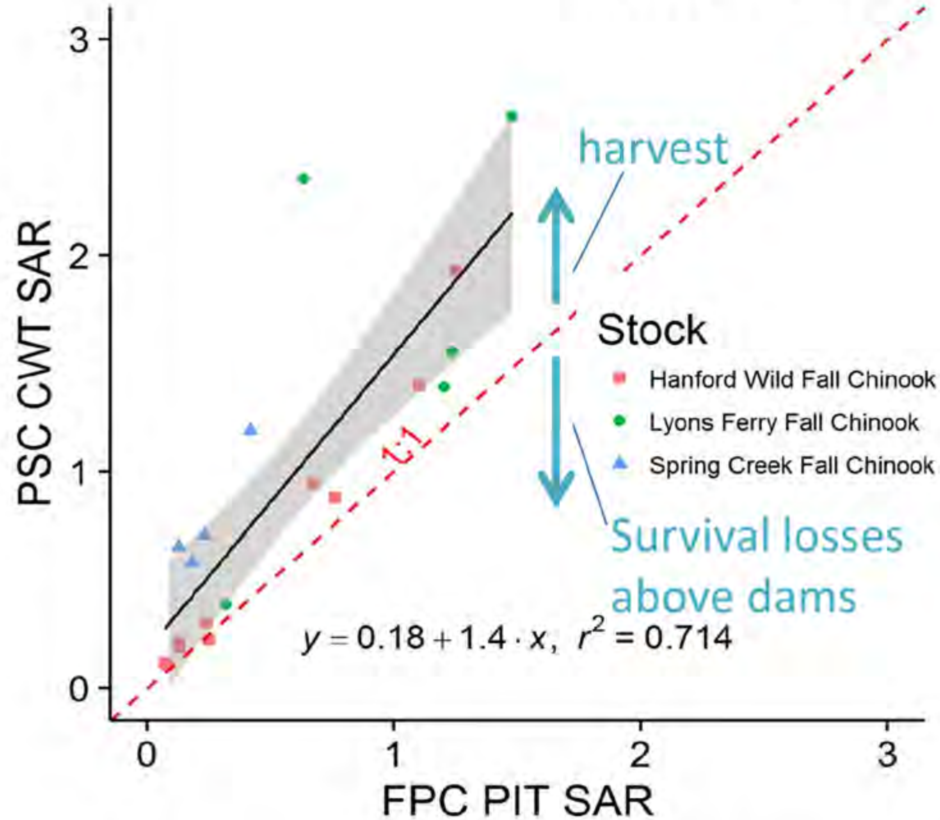


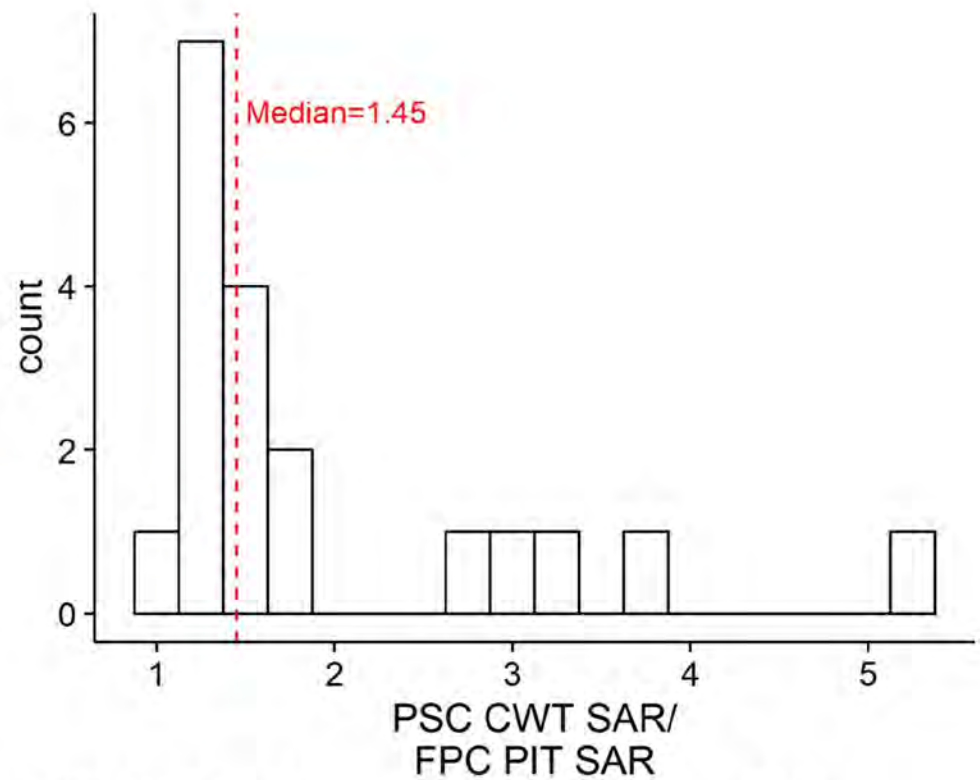
Yearlings

NO DATA

NO DATA

PSC CWT vs PIT SAR Methodologies (Direct Method)





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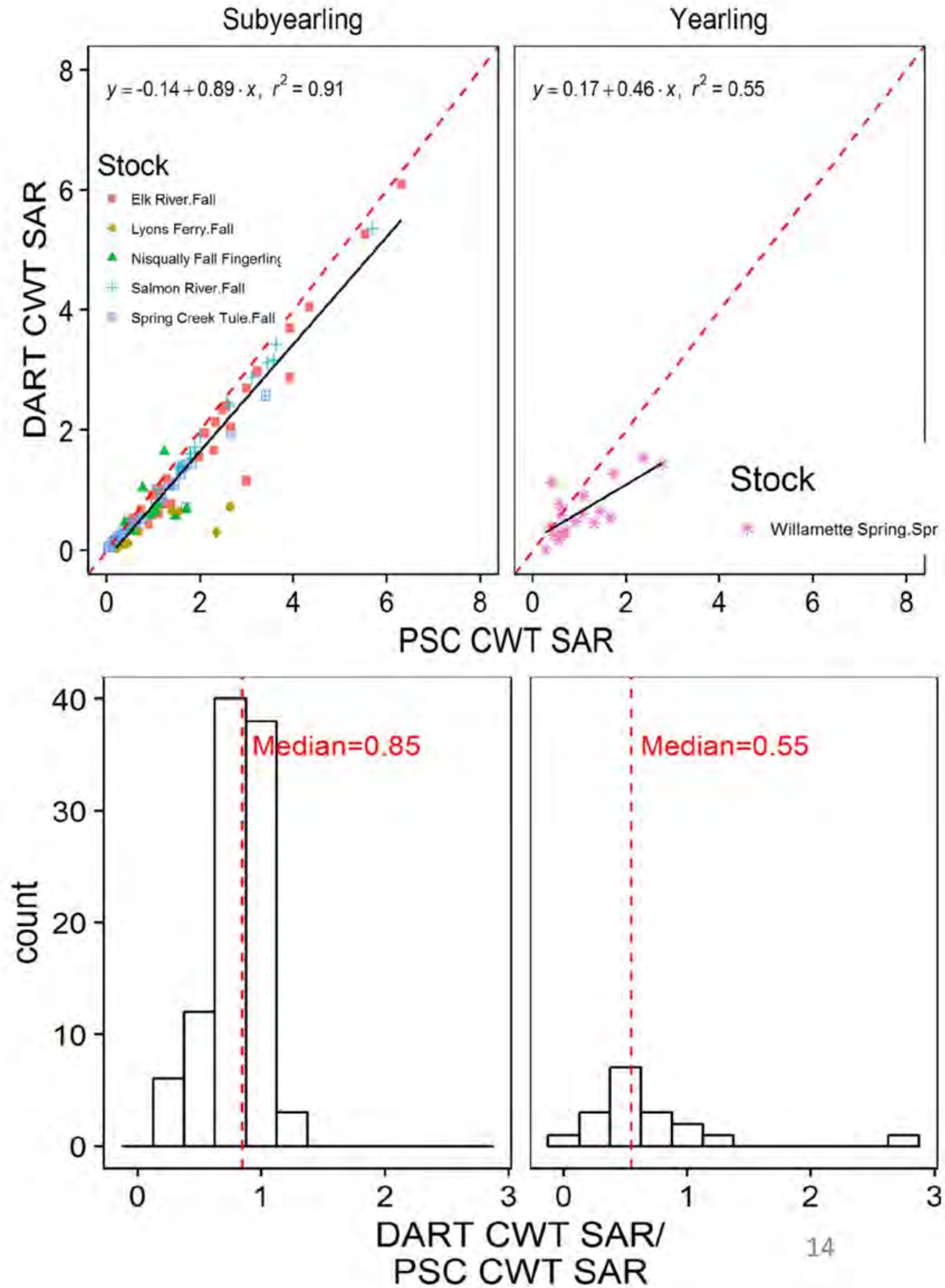
- No direct comparison of PSC & FPC SARs available for Yearlings
- We can develop a "convoluted" estimate using DART as an intermediate.



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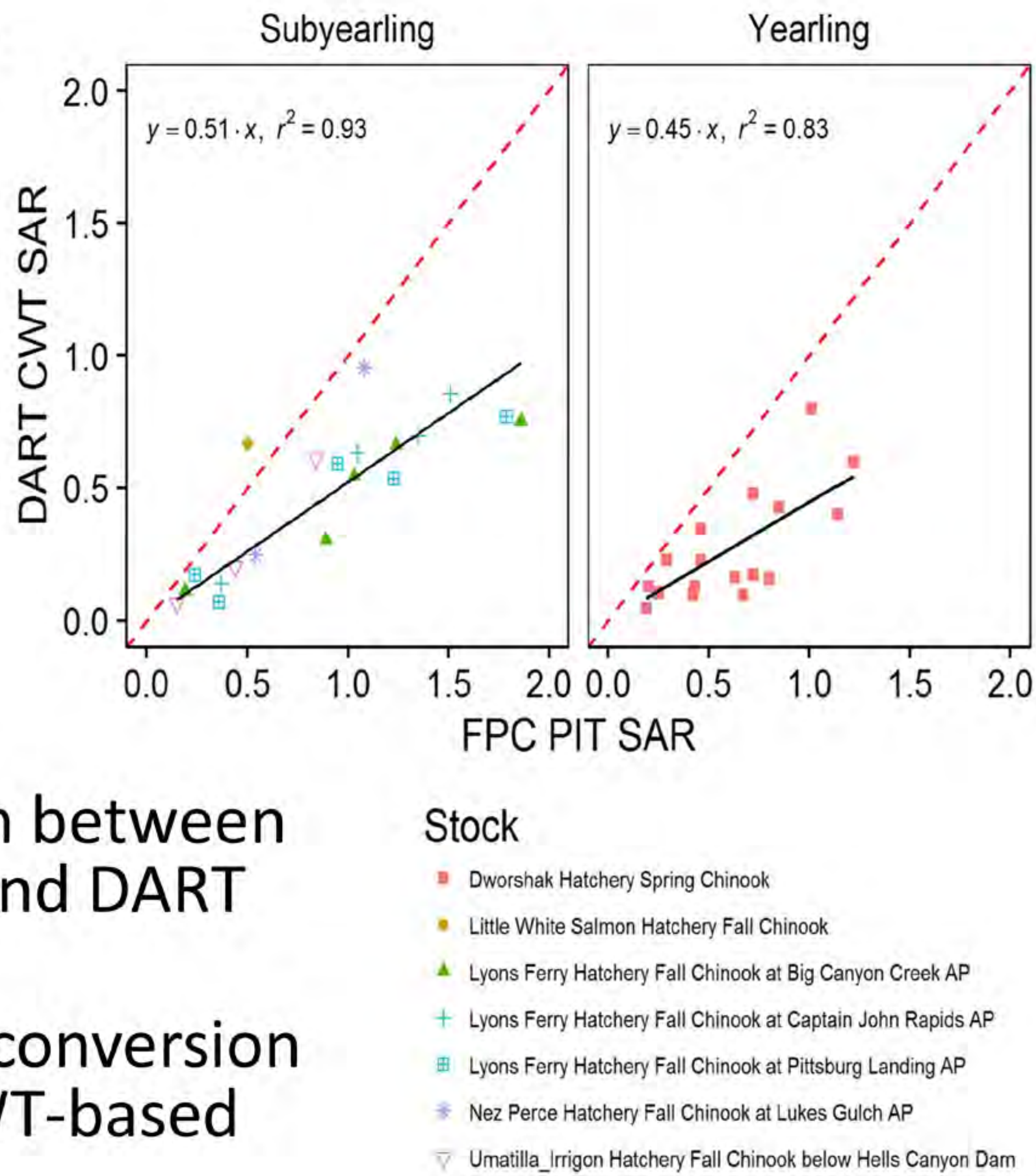
B) FPC PIT SARs vs DART CWT SARs



- This gives us a conversion between FPC PIT-tag based SARs and DART CWT-based SARs
- The prior slide gave us a conversion between DART & PSC CWT-based SARs
- So…

The Indirect Method (using median values for algebraic simplicity):

Subyearlings:

- $SAR_{Dart}=0.85*SAR_{PSC}$
- $SAR_{Dart}=0.51*SAR_{FPC}$

So:

- $SAR_{PSC}=(0.51/0.85)*SAR_{FPC} \approx 0.6*SAR_{FPC}$

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Reality Check:

YEARLINGS:

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  $SAR_{PSC} \approx 0.8 * SAR_{FPC}$ (Close to 1:1)

SUBYEARLINGS:

- Direct Method: $SAR_{PSC} \approx 1.4 * SAR_{FPC}$
- Indirect Method: $SAR_{PSC} \approx 0.6 * SAR_{FPC}$
- Results don’t match, but are “not far off” a 1:1 relationship, suggesting that FPC/PIT & PSC/CWT SAR data are not hugely different (work in progress)
- Incorporating the large variability evident in the scatterplots is crucial

Current Conclusions/Next Steps

- Snake River SARs "*look to be*" similar to other regions, but we are not yet certain *how similar*
- Refine data, switch to Fall & Spring categories rather than Subyearlings & Yearlings
- Combine (messy!) CWT vs PIT tag conversion factors with SAR time series to inform the question: *"How likely is it that Snake River SARs are actually lower than SARS in other regions lacking dams?"*

Questions

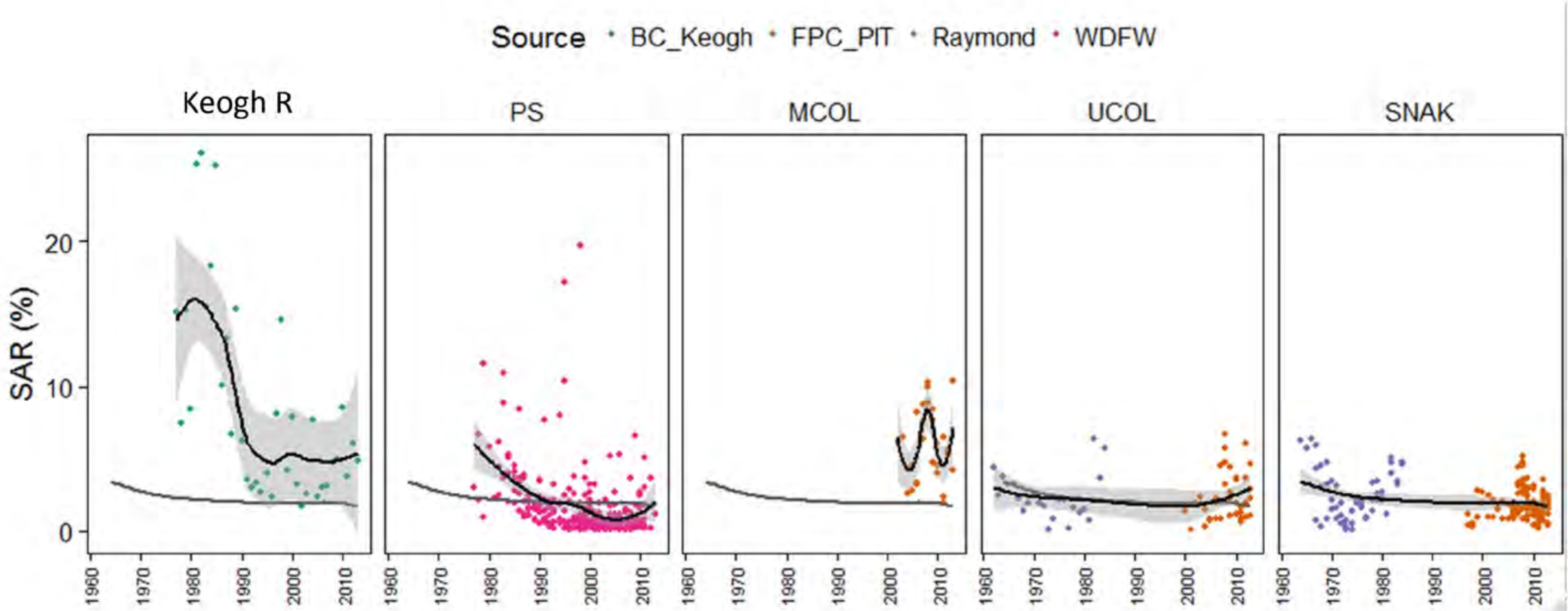
1) What analyses can we add that will better address the legal (& social/economic) issues that you face?
2) What do you see as the important uncertainties that we need to address?
3) As we work this up for publication, can you provide any other thoughts or guidance?

KINTAMA

Steelhead Results
(Different Species, Similar Story)

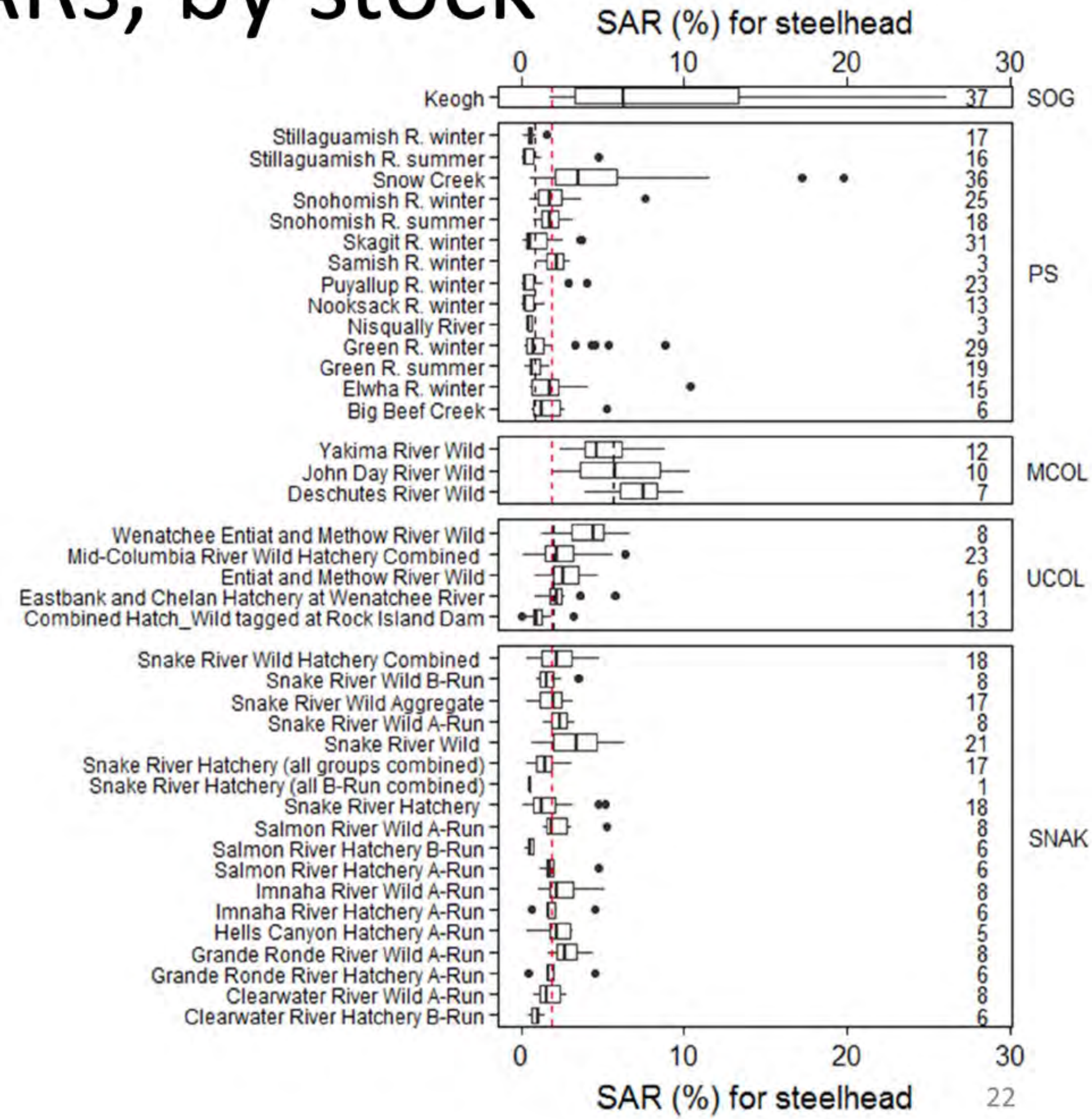
KINTAMA

Steelhead-Available SAR Time Series



KINTAMA

Steelhead SARs, by stock



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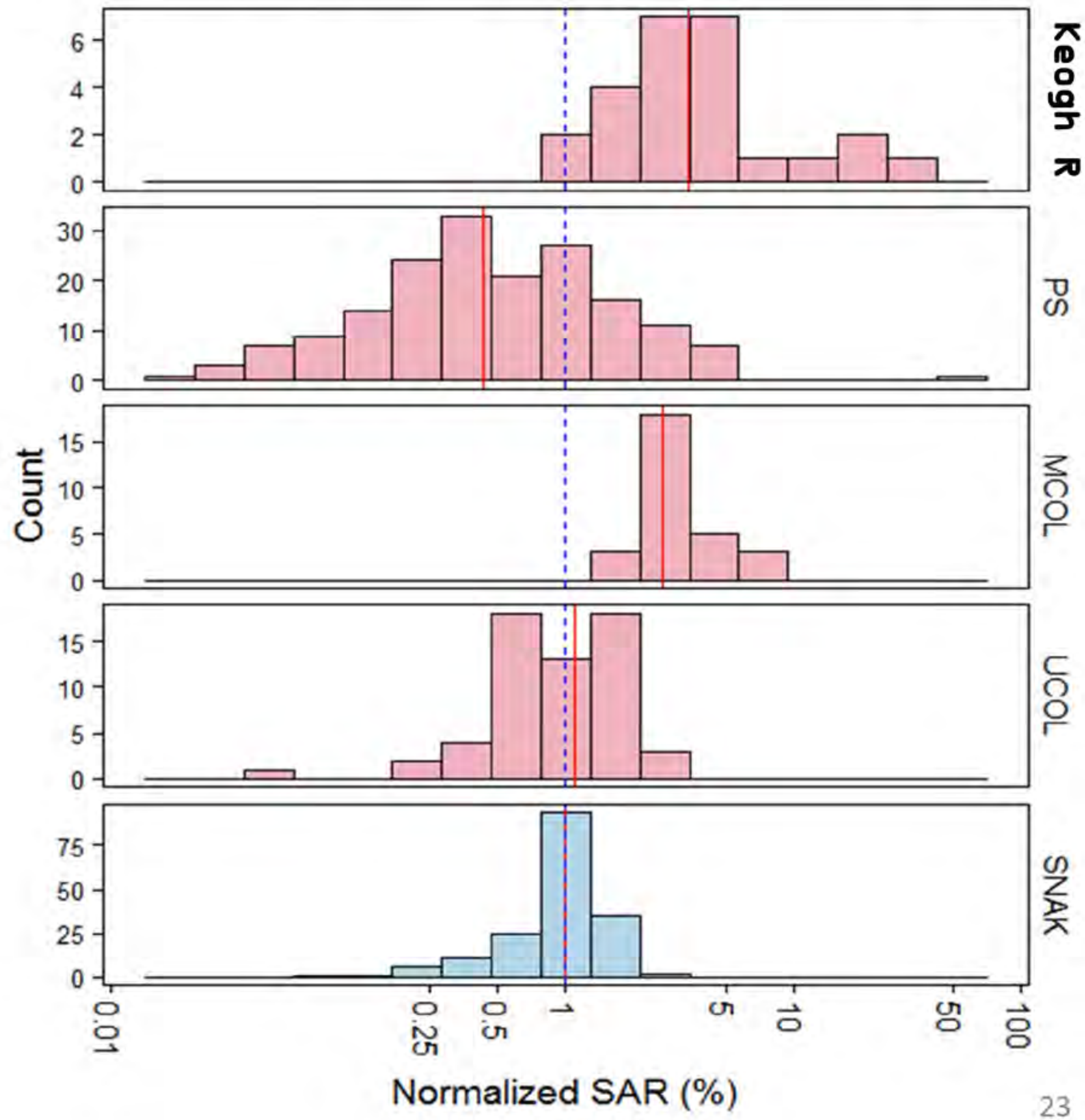
Steelhead-Normalized SARs (All Years)



KINTAMA

Kintama Update to BPA

19 September 2017

KINTAMA

What we are Reporting

- Results primarily confined to Chinook in this update
  - Subyearling & yearling populations separated
- We show a few steelhead results to indicate the same general conclusions will likely hold more broadly
- ***Important Update:*** Comparison of the CWT vs PIT tag database analyses to make the SAR comparisons as robust as possible.

KINTAMA

Primary Results

The broad coast-wide analysis of SARs leads to very different perspective from the current view in the Columbia River basin:

1) SARs in all regions are falling, starting in the early-mid 1970s
2) For CR basin stocks, only MCOL yearlings SARs are higher than Snake River SARs- and only two MCOL populations (***<u>not all</u>***).
3) For Yearling Chinook, "raw" Snake River SARs same as Upper & Lower Columbia & are higher than Puget Sound, Strait of Georgia, North-Central BC
   - Little or no evidence for "delayed mortality" in Snake River Chinook
4) When "raw" data are corrected for methodological differences between CWTs & PIT tags, Snake River populations ***<u>do not appear to</u>*** have lower survival than other stocks not migrating through the Snake River dams
5) Data are consistent with a coast-wide northern expansion with time of a region of poor ocean survival, progressively encompassing more stocks (even Alaska now affected!)
6) A deleterious effect caused by the Columbia dams is not evident.

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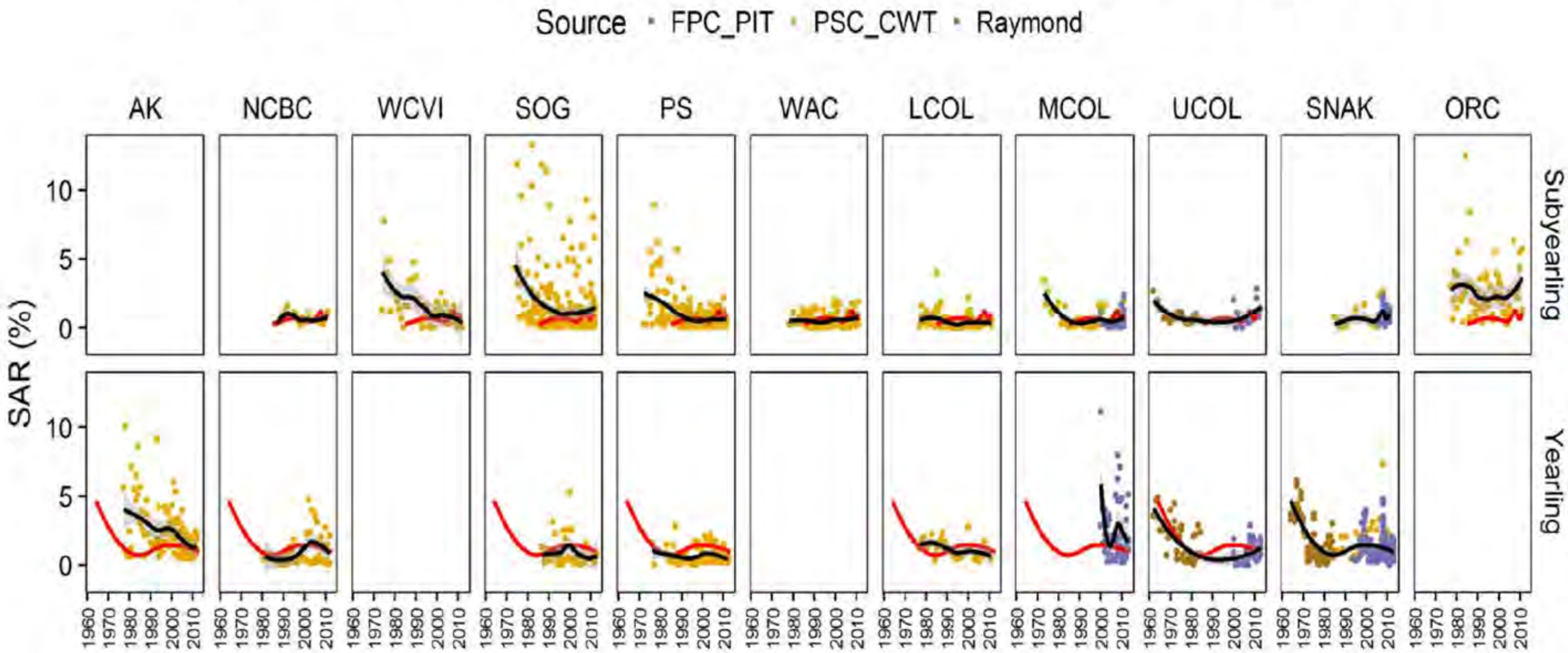
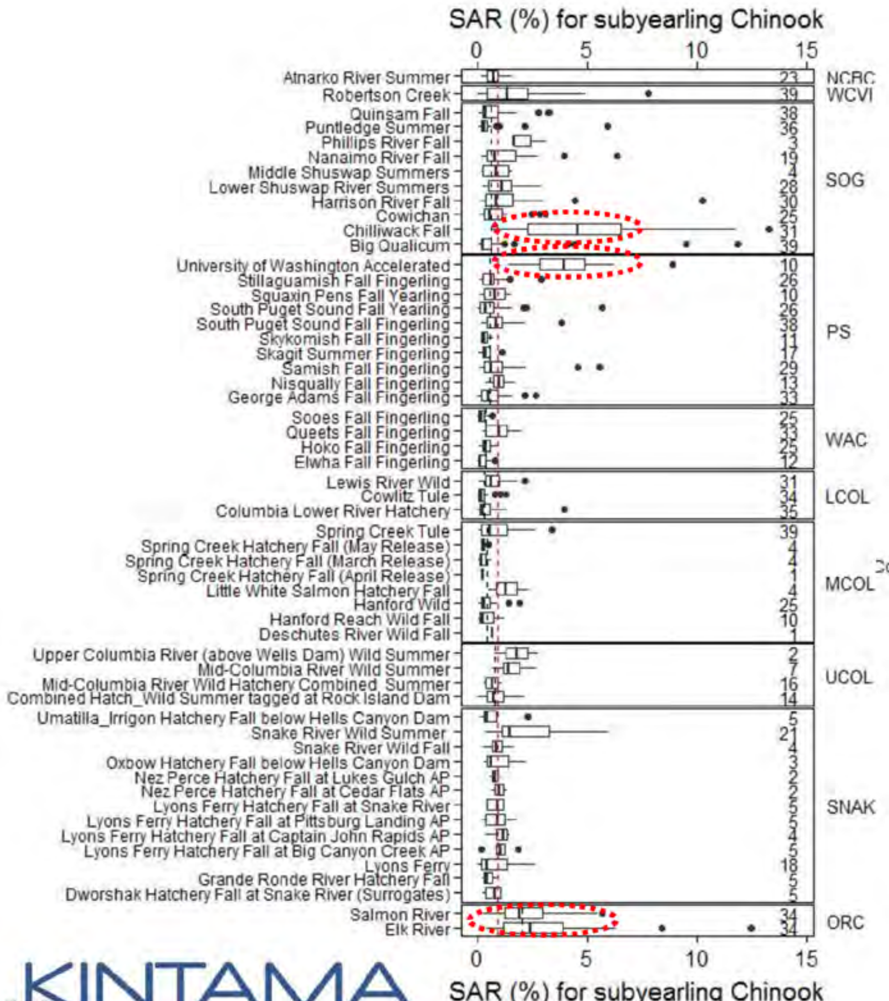
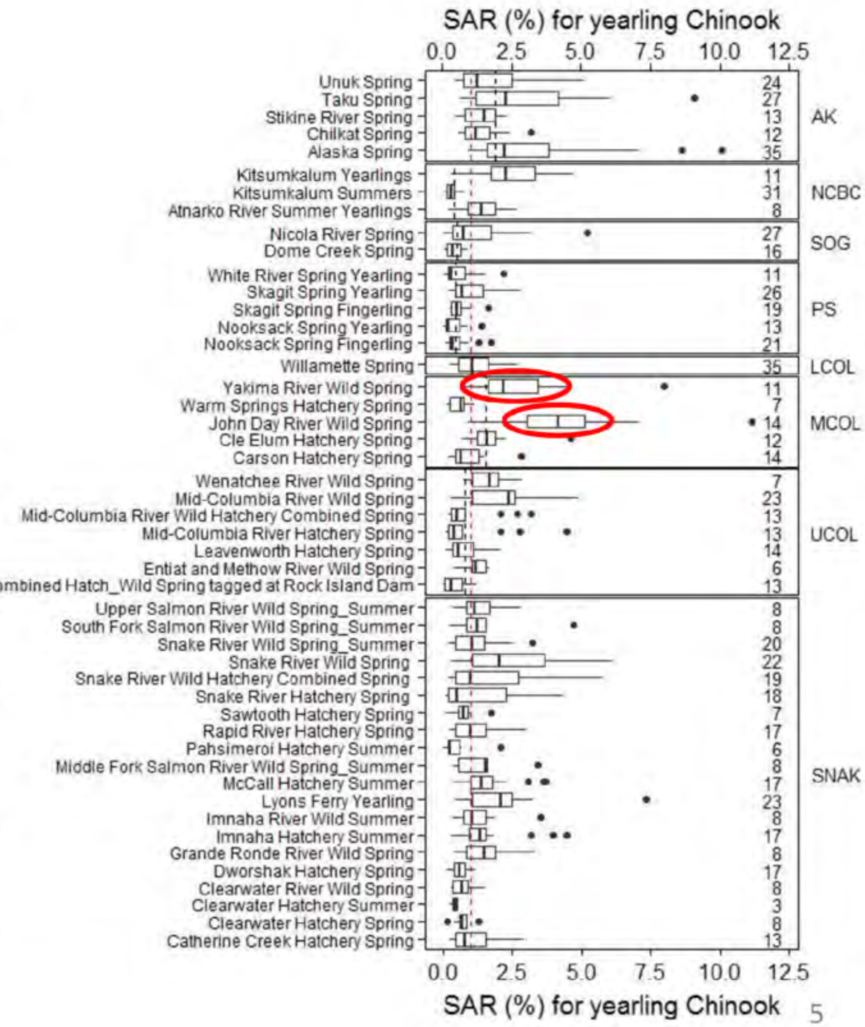
Chinook-All SAR Data by Region



- Plotted SARS against time, split out by regions (columns) & Chinook life history types (rows)
- LOWESS trend line (black) fitted to the SAR data. Snake River trend line (red) overplotted on all panels to facilitate comparison.

Stock-Specific Chinook SARS-All Years





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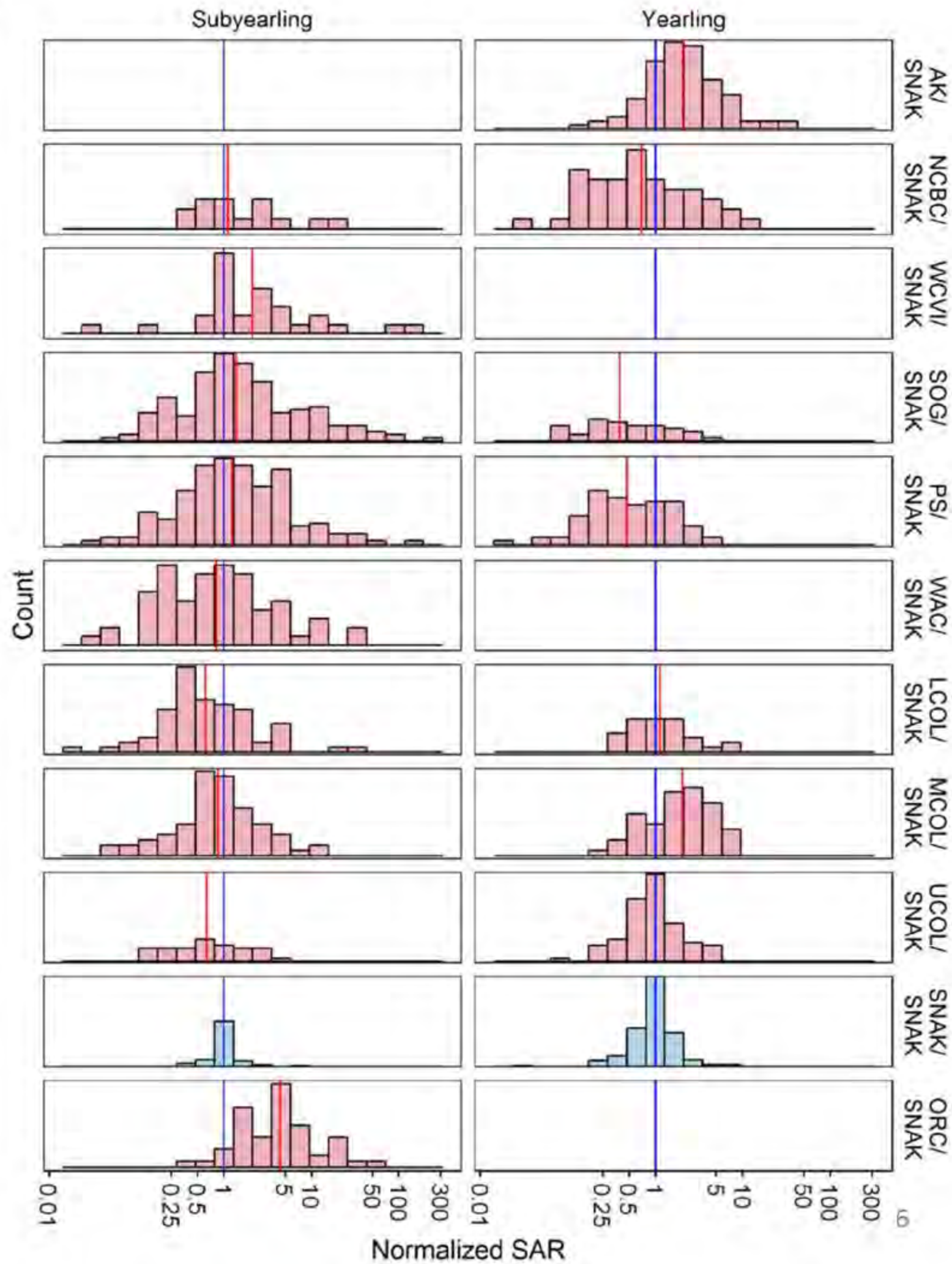
Comparison of Regional SARs
(Region X/Snake)

- Divided annual SARs for Region X by the Snake River median SAR for the same year: SAR_x/SAR_{Snake}
- Plotted the results as a frequency histogram
- Snake River is in blue



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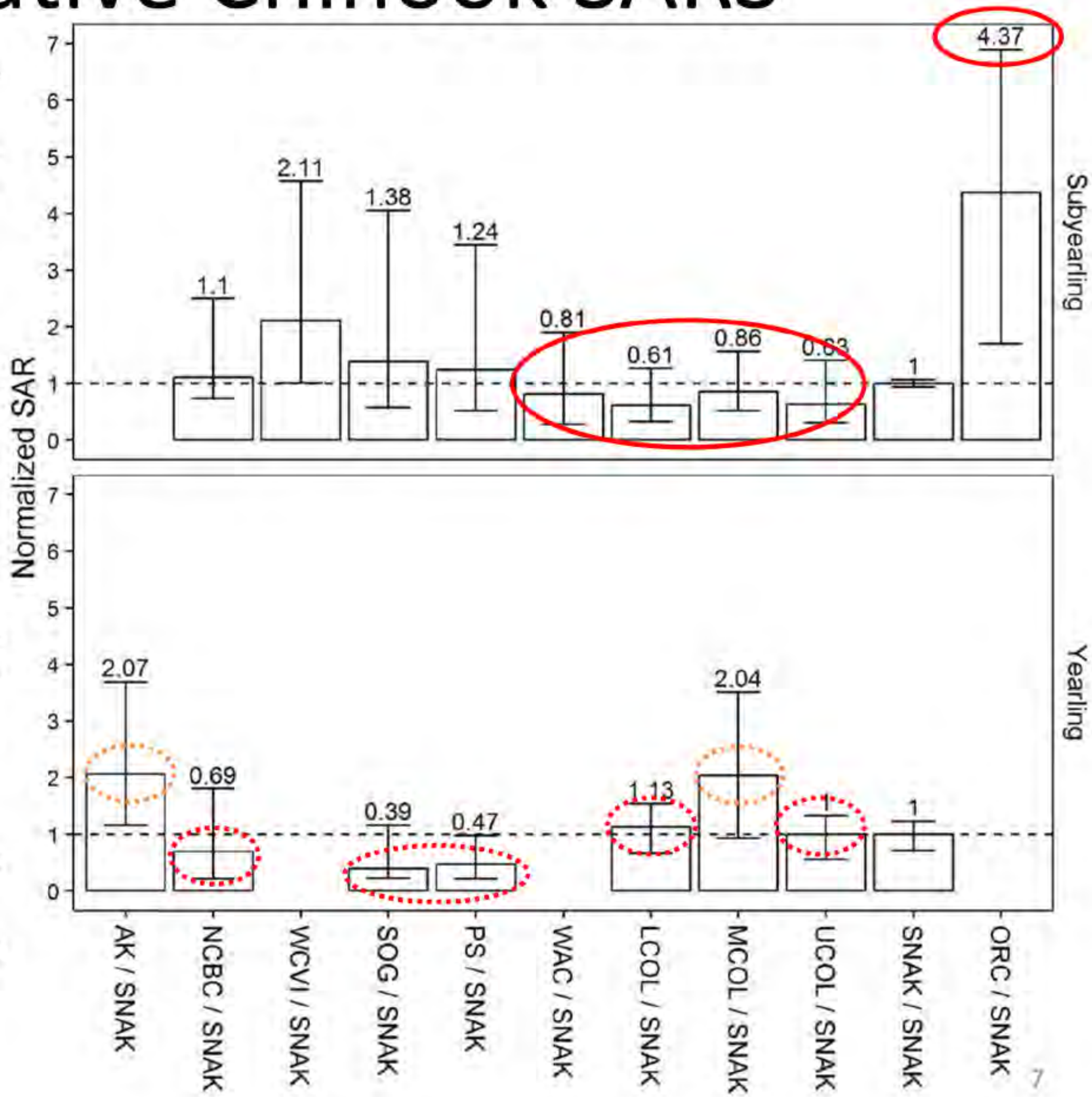
Relative Chinook SARS

1. Same data as prior slide, just different presentation (error bars are 25 & 75 percentiles)
2. For subyearlings:
    1. Oregon Coast Chinook have SARS 4.37X Snake River.
    2. But Upper/Mid/Lower Columbia River SARS are **lower** than Snake River subyearling SARS, as are WAC (Washington Coast).
3. For Yearling Chinook:
    1. Snake River SARs same as Upper & Lower Columbia & higher than Puget Sound, Strait of Georgia, North-Central BC
4. Only Mid-Columbia & Alaska have higher SARs than Snake River (& recall Alaskan SARs have fallen to Snake River levels in recent years)

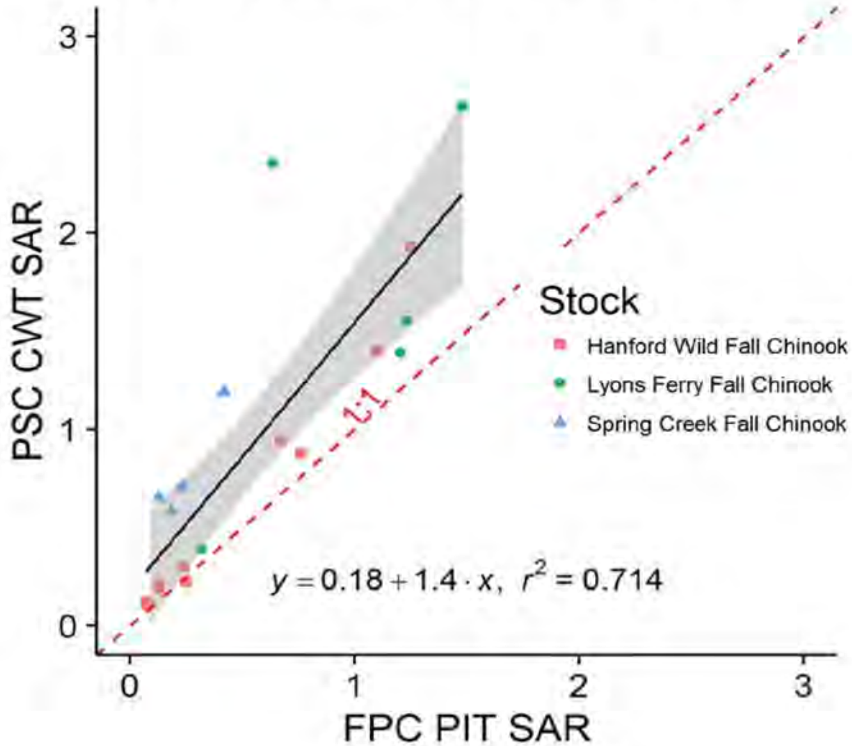


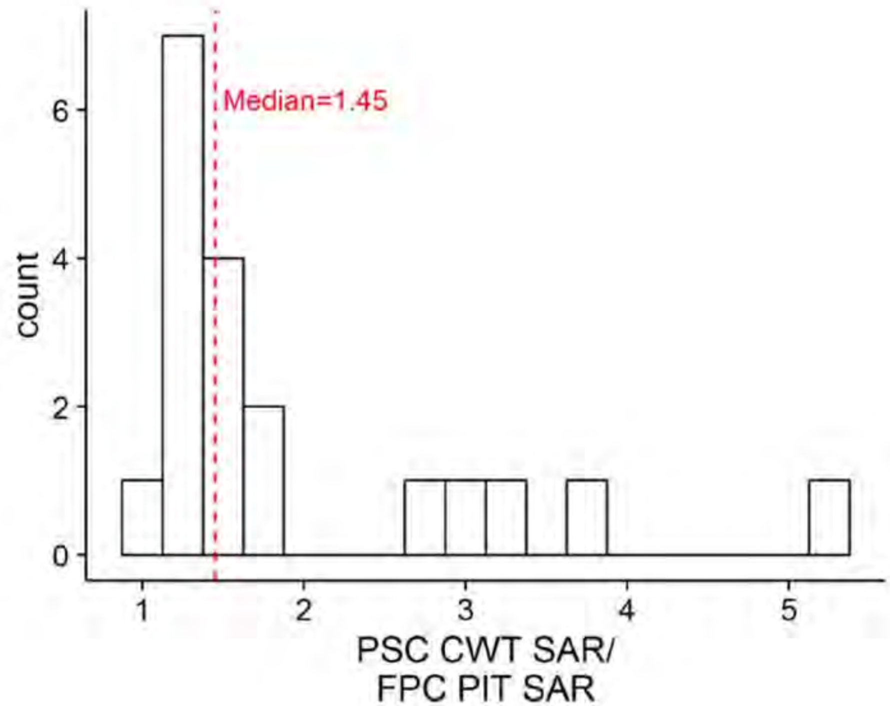
25403482 BPA-2021-00513-F 2401

Major Uncertainties

- Regional SARs derived by different methodologies
  a) In Columbia, early data from Raymond
  b) CWT survival data (PSC):
     i. Survival calculated from smolt release to adult return to spawning grounds
     ii. Corrected for harvest in sport & commercial fisheries
  c) FPC survival data is based on PIT tags:
     i. Survival calculated from smolts reaching a dam to adults returning to a dam
     ii. Excludes smolt survival “pre-dams” and adult survival “post-dams”.
     iii. Not corrected for harvest in sport & commercial fisheries

PSC CWT vs FPC PIT SAR Methodologies

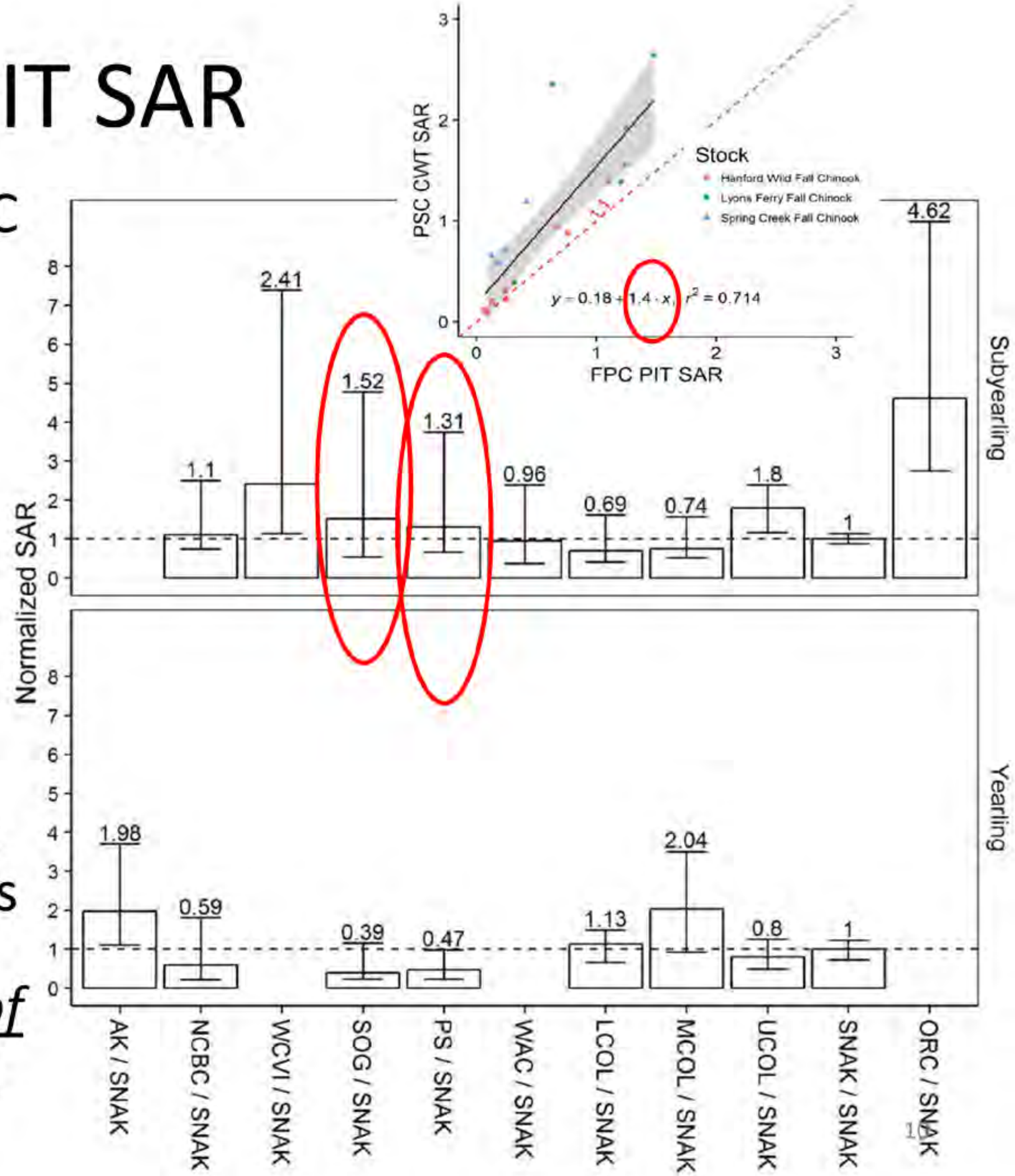




- Compared CWT & PIT tag derived Fall Chinook SARs for the same year ***and the same stock*** (few stocks available to make this comparison)
- On average, PSC CWT SARs are ~1.4X FPC's PIT-tag based SARs
- (*Recall: FPC adds in harvest, includes all survival losses from smolt release location to adult enumeration site*)

PSC CWT vs PIT SAR

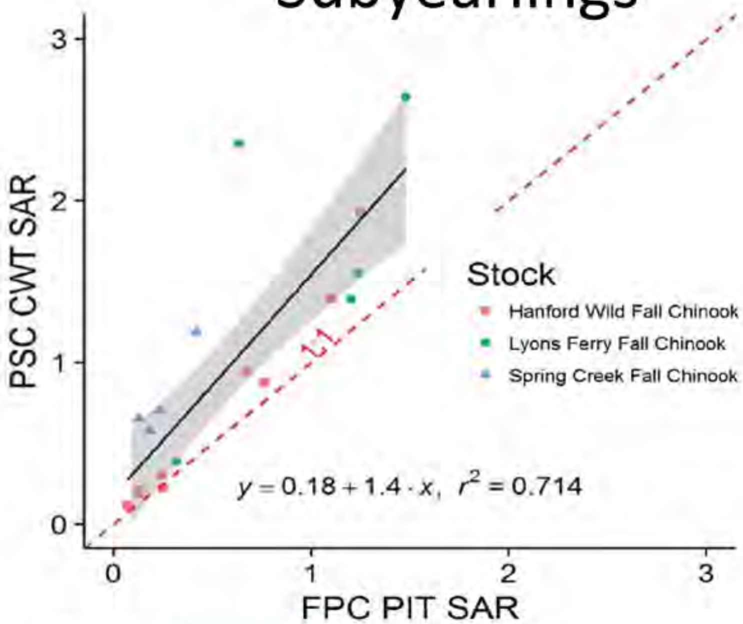
- For Fall Chinook, PSC CWT SAR values ≈1.45X FPC SAR values
- This is about what the CWT vs PIT SAR ratios are for the Salish Sea:
  - SOG/SNAK=1.5
  - Puget/SNAK=1.3
- Results suggest that Snake River Fall SARs are <u>*about the same as in other regions of coast without dams*</u>

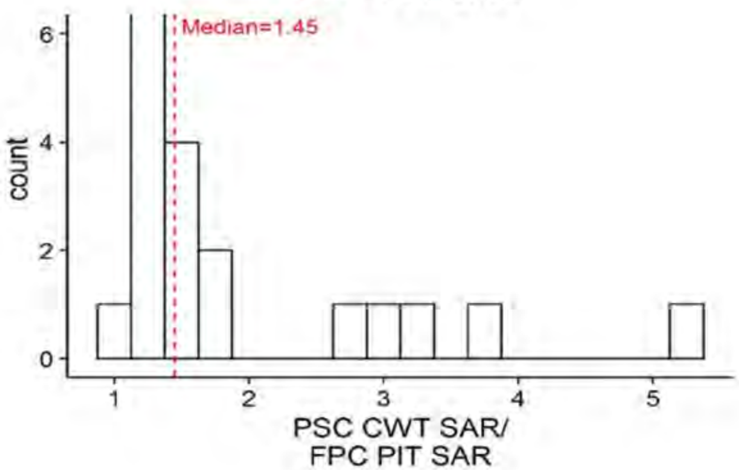


Current Work (in Progress!)

DIRECT COMPARISON: PSC vs FPC SARs

Subyearlings



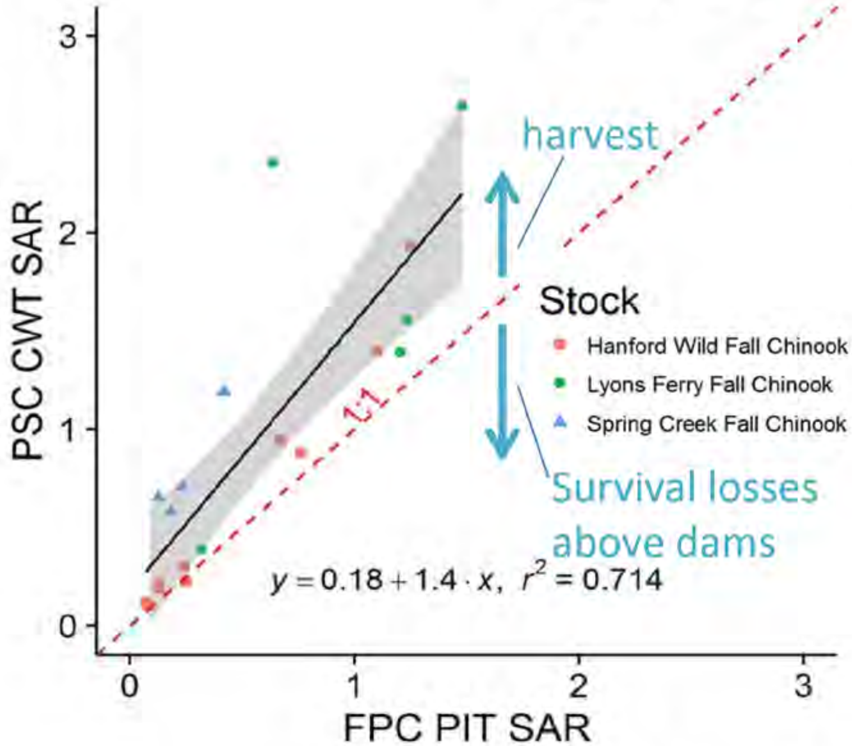


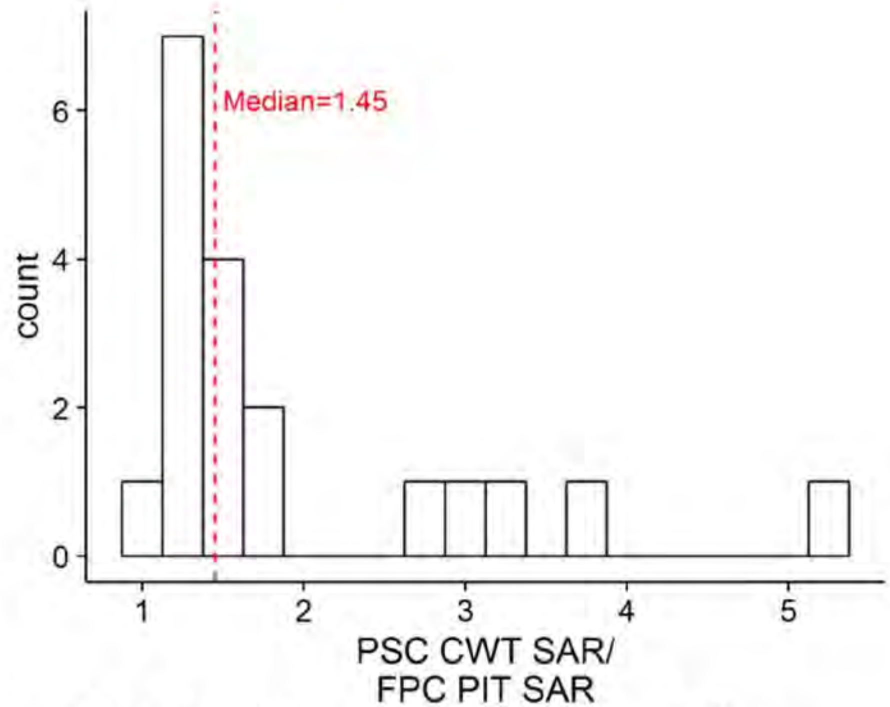
Yearlings

NO DATA

NO DATA

PSC CWT vs PIT SAR Methodologies (Direct Method)

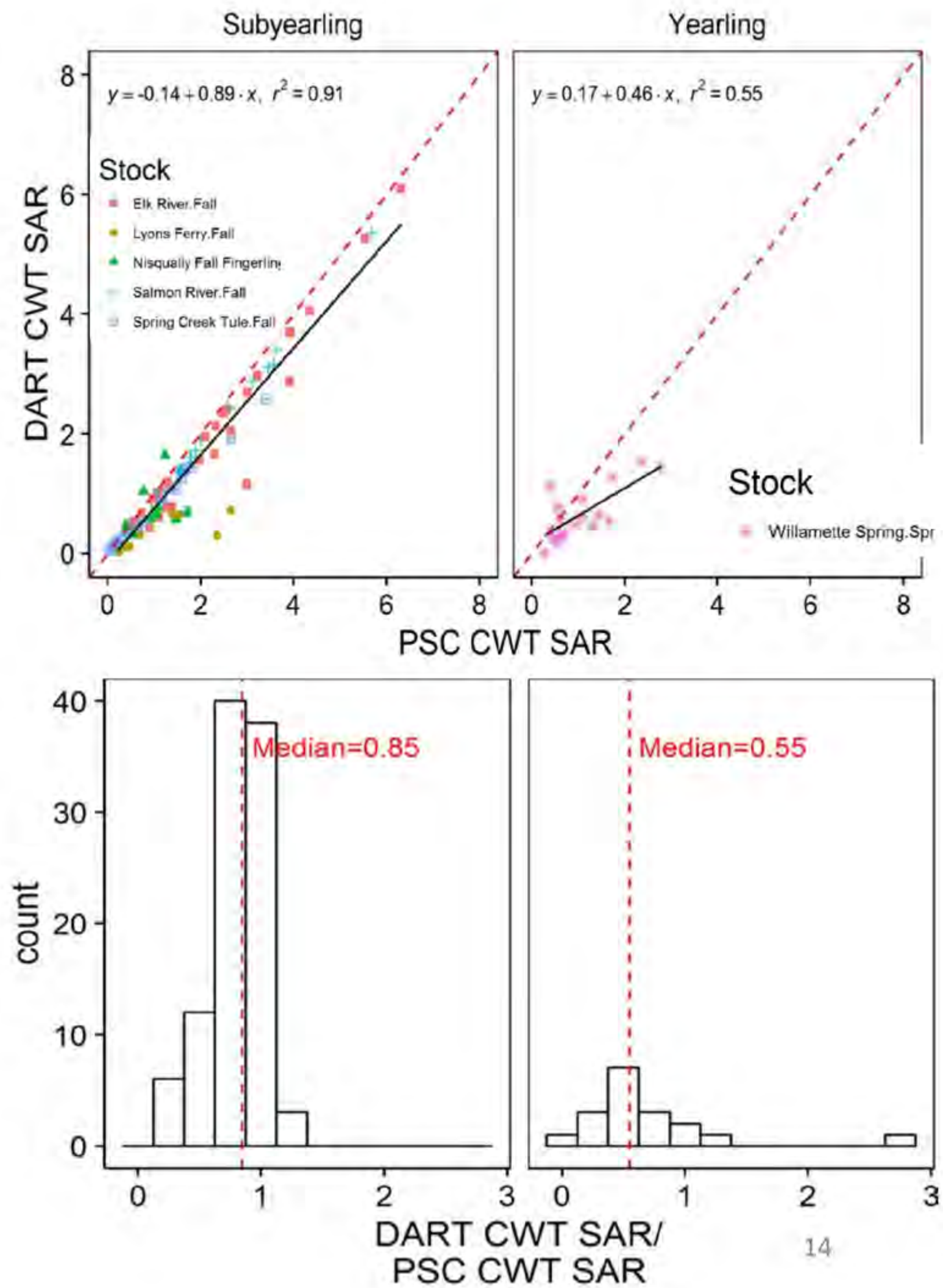




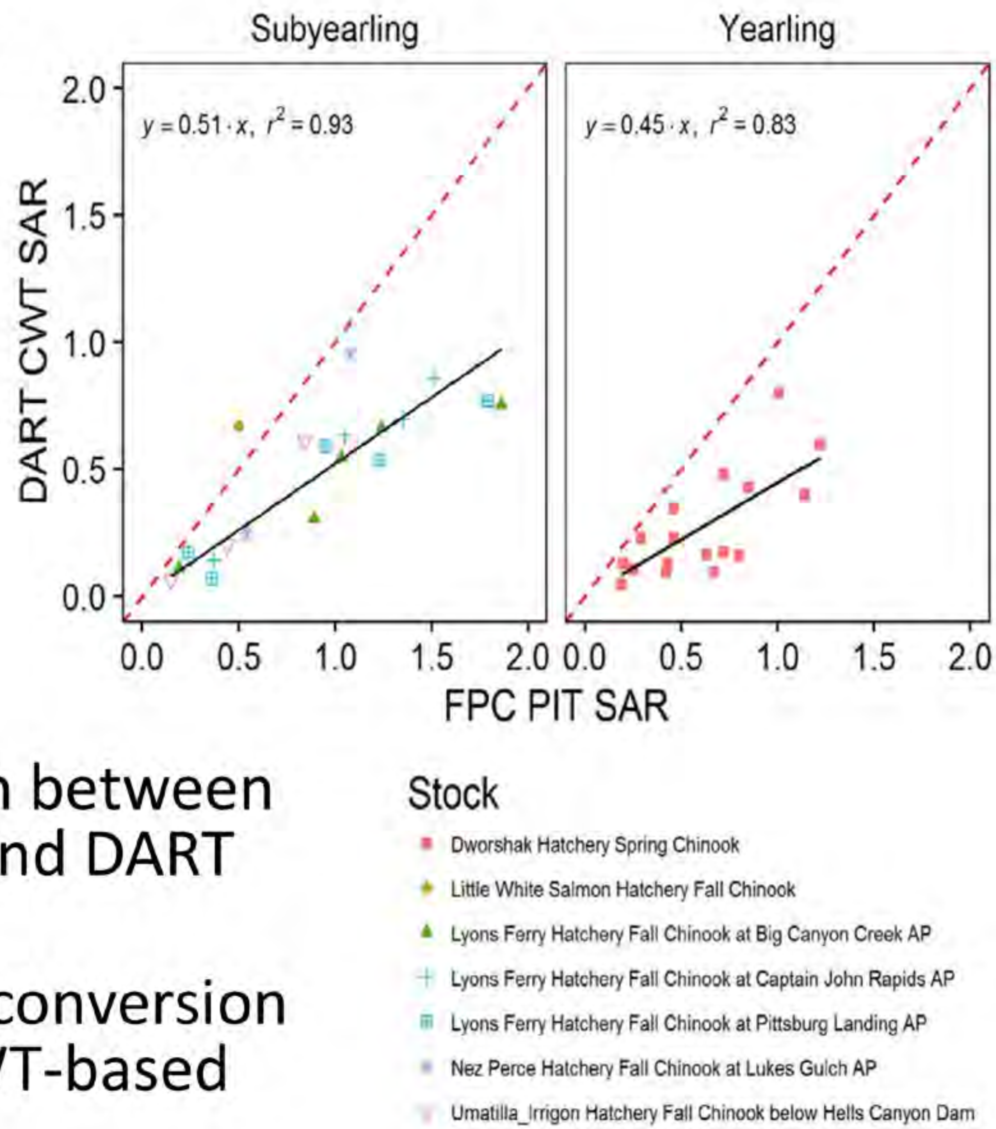
- Compared CWT & PIT Fall Chinook SARs for the same year ***<u>and the same stock</u>***
- On average, PSC CWT SARs are ~1.4X FPC's PIT-tag based SARs
- (*Recall: PSC adds in harvest, includes all survival losses from smolt release location to adult enumeration site*)

A) PSC CWT SARs vs DART CWT SARs

- No direct comparison of PSC & FPC SARs available for Yearlings
- We can develop a "convoluted" estimate using DART as an intermediate.



B) FPC PIT SARs vs DART CWT SARs



- This gives us a conversion between FPC PIT-tag based SARs and DART CWT-based SARs
- The prior slide gave us a conversion between DART & PSC CWT-based SARs
- So…

THE INDIRECT METHOD (USING MEDIAN VALUES FOR ALGEBRAIC SIMPLICITY):

Subyearlings:

- $SAR_{Dart}=0.85*SAR_{PSC}$
- $SAR_{Dart}=0.51*SAR_{FPC}$

So:

- $SAR_{PSC}=(0.51/0.85)*SAR_{FPC} \approx 0.6*SAR_{FPC}$

Yearlings:

- $SAR_{Dart}=0.45*SAR_{FPC}$
- $SAR_{Dart}=0.55*SAR_{PSC}$

So:

- $SAR_{PSC}=0.45/0.55*SAR_{FPC} \approx 0.8*SAR_{FPC}$

Reality Check:

YEARLINGS:

- Direct Method: **No Data**
- Indirect Method:

  $SAR_{PSC} \approx 0.8 * SAR_{FPC}$ (Close to 1:1)

SUBYEARLINGS:

- Direct Method: $SAR_{PSC} \approx 1.4 * SAR_{FPC}$
- Indirect Method: $SAR_{PSC} \approx 0.6 * SAR_{FPC}$
- Results don't match, but are "not far off" a 1:1 relationship, suggesting that FPC/PIT & PSC/CWT SAR data are not hugely different (work in progress)
- Incorporating the large variability evident in the scatterplots is crucial

Current Conclusions/Next Steps

- Snake River SARs "*look to be*" similar to other regions, but we are not yet certain *how similar*
- Refine data, switch to Fall & Spring categories rather than Subyearlings & Yearlings
- Combine (messy!) CWT vs PIT tag conversion factors with SAR time series to inform the question: *"How likely is it that Snake River SARs are actually lower than SARS in other regions lacking dams?"*

Questions

1) What analyses can we add that will better address the legal (& social/economic) issues that you face?
2) What do you see as the important uncertainties that we need to address?
3) As we work this up for publication, can you provide any other thoughts or guidance?

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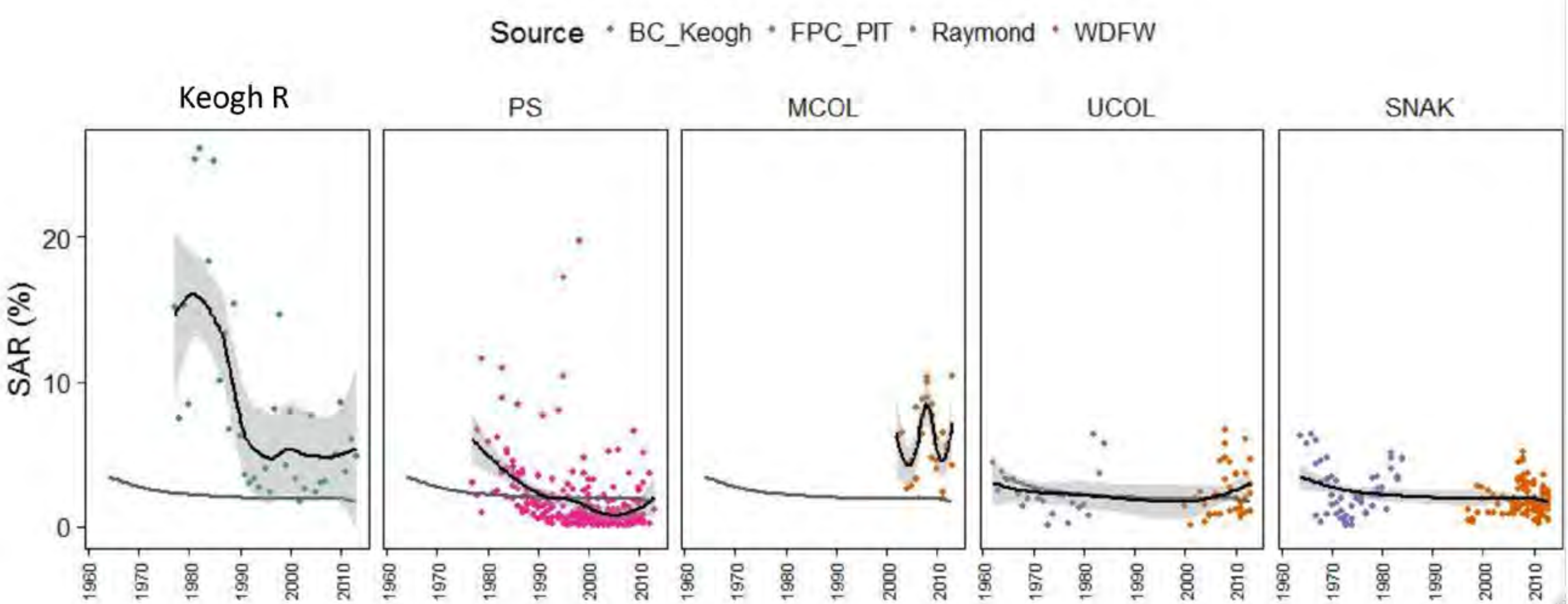
Steelhead Results
(Different Species, Similar Story)

Steelhead-Available SAR Time Series



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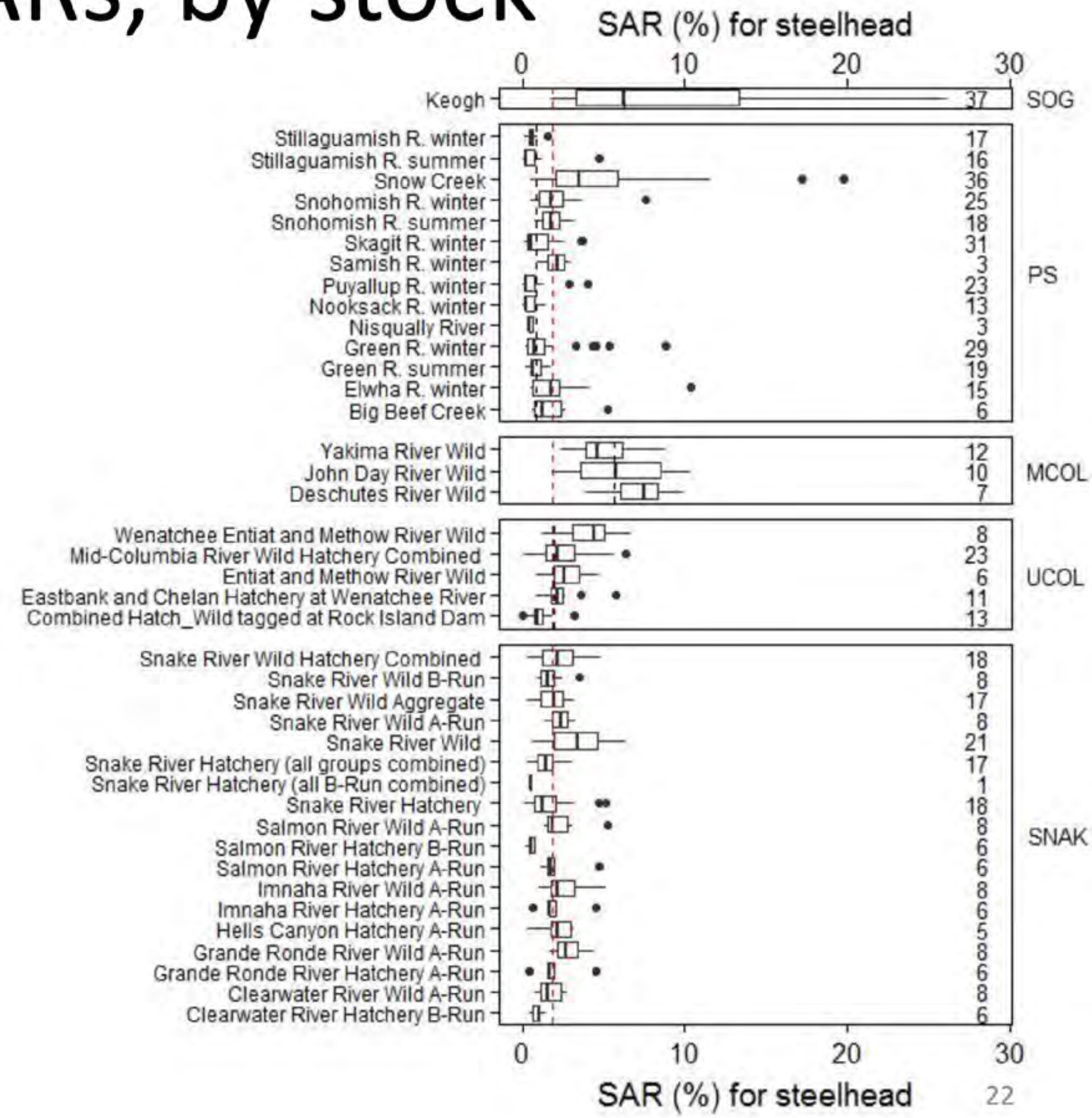
Steelhead SARs, by stock



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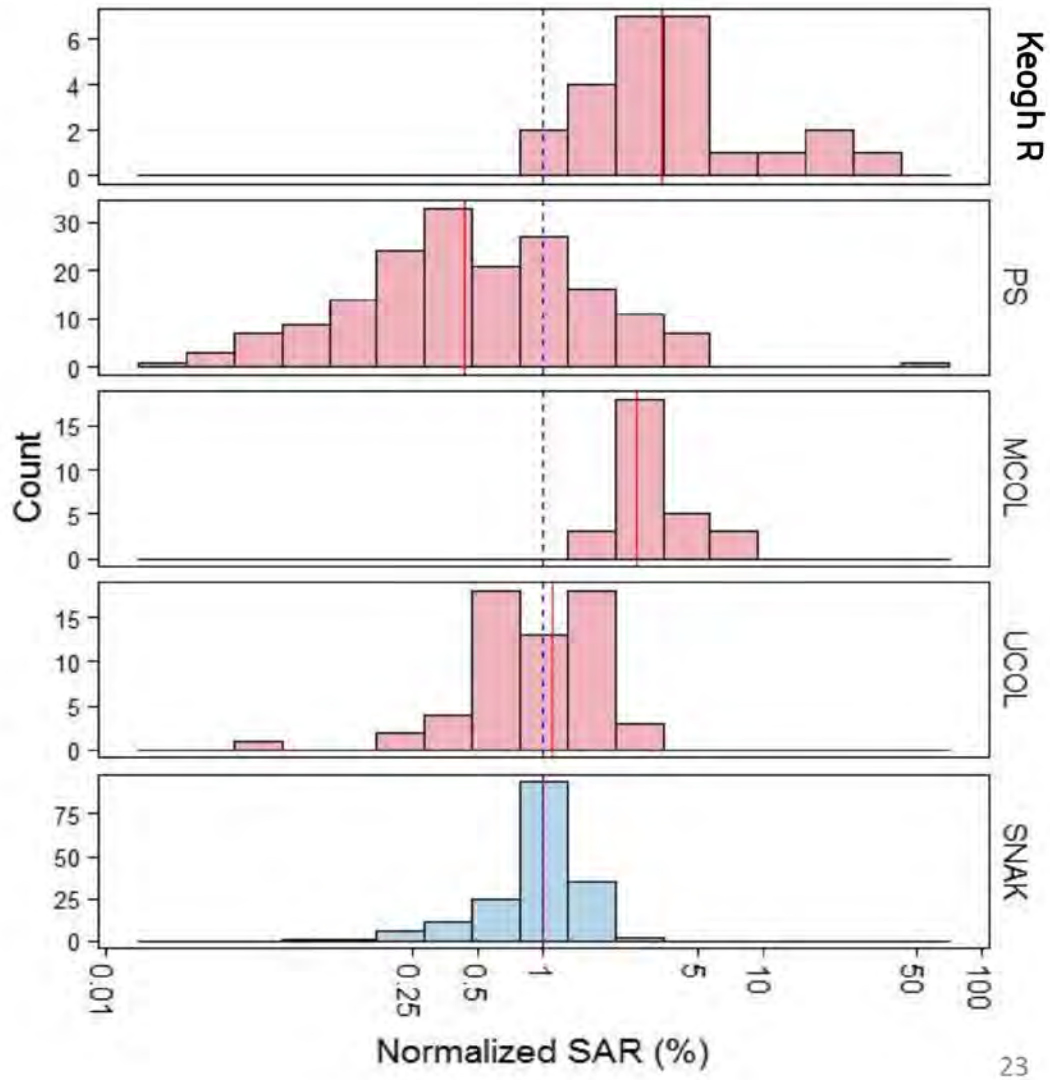
Steelhead-Normalized SARs (All Years)



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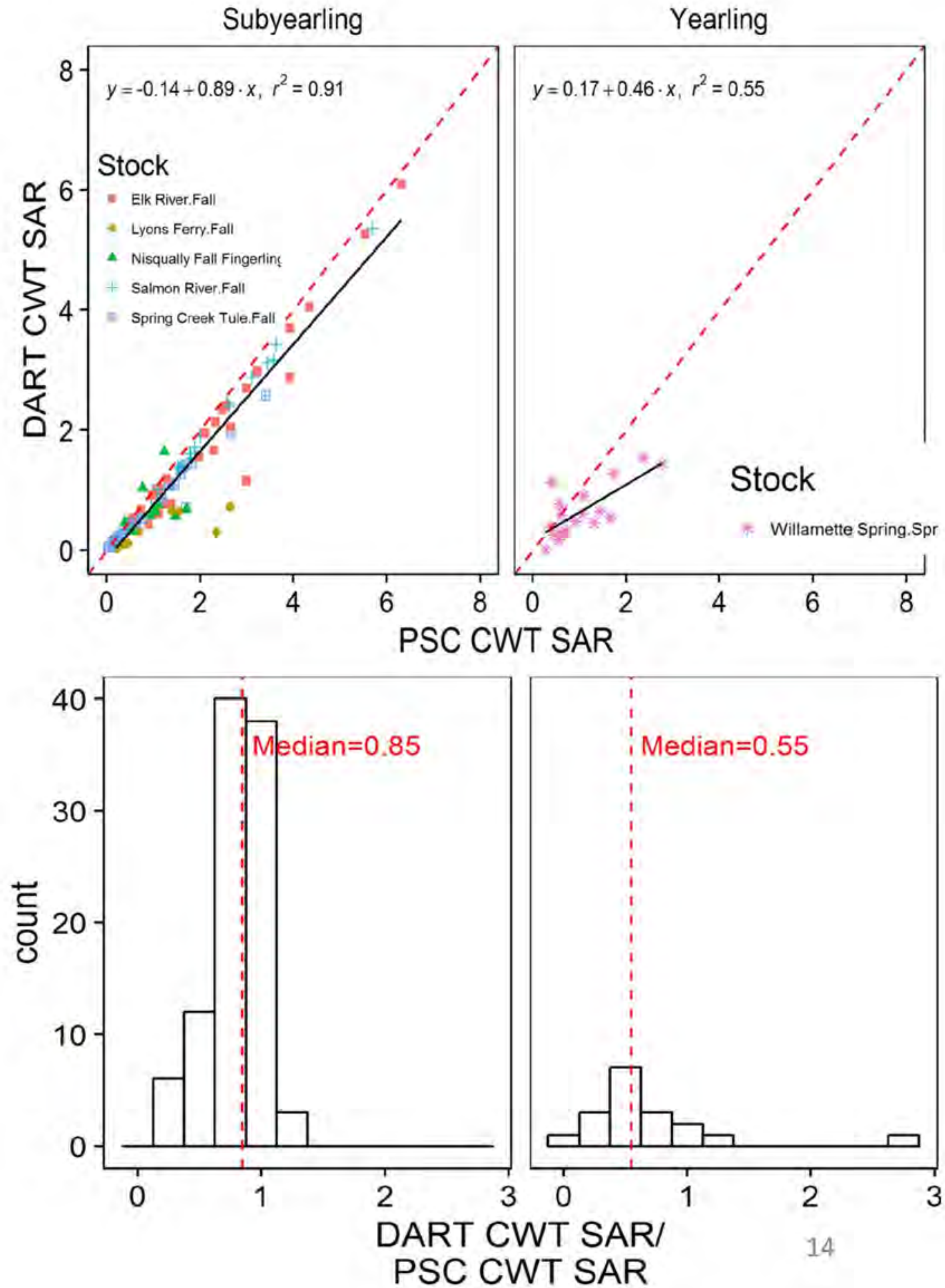


From: David Welch

Sent: Wed Oct 04 13:16:21 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Aswea Porter; Erin Rechisky

Subject: [EXTERNAL] RE: Touching base...

Importance: Normal

Thanks—I had a look in the PSC Chinook Technical Committee's report, and it seems quite definitive that these are Springs, not Falls… they are referred to as such (Table 2.1) and the clincher (for me, anyway) is that the exploitation rate is only 11%. By way of contrast, Fall-type Chinook in the Columbia River have exploitation rates ranging between 40~60%... 4 to 6 times larger.

Perhaps what is happening Is that the "young of the year" are migrating downstream to some freshwater area where they hold overwinter until they become yearlings?

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, October 04, 2017 12:55 PM
To: David Welch
Cc: Aswea Porter; Erin Rechisky
Subject: RE: Touching base...

Looks promising.

Also – let me look for something more authoritative on Willamette Spring Chinook hatchery practices. Before the dams and the fish ladder at Willamette falls, this was known to be a spring timed group that would often makes its way substantially to the estuary in its first year of life. The obstacle of the falls is what exerted pressure for spring run timing. However, I know that the various hatcheries do a mix of subyearling and yearling release, and in the tributaries, we know that a lot of wild juveniles are going out as spring and also large fall subyearlings, and as full yearlings due to the reservoirs. The reason they go downstream is searching for food rather than a strong smoltification pattern in July like your typicall fall Chinook.

Christine

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Oct 06 13:43:35 2017

To: David Welch

Subject: RE: Tomorrow's presentation

Importance: Normal

Attachments: Paragraphs describing Kintama study.docx

Hi David,

Let's see – attached is what I had before your presentation. While watching it, my coworkers seemed to be very receptive to the trend through time, whereas earlier I had heard them say that the geographical pattern is what we really need to capture. Talking with Jeff, we still have a lot of work to do to find how to introduce and place this in the Biological Assessment document (which other coworkers are developing – I don't really understand the tone , and whether we should actually use persuasive language or just neutrally cite studies.). You will see that I felt that we really should set up your study by referring back to a list of studies and policy debates that came before it, which clearly make Snake River steelhead and Chinook the center of focus. I need to discuss with them how the rest of the document is reading, and whether we should more thoroughly review the past 20 years of policy and research.

A good example is the NOAA Snake river delayed mortality study that I link to there. They never produced a final report but presented at AFS in Portland. The data raised new patterns related to year effects. Jennifer Gosselin and Jim Anderson find the data useful for their fish condition and carryover effects research. I reminded people at a Corps research forum that this 7-year study had occurred and many of them didn't recall, because it took a few years for final adult returns.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, October 05, 2017 12:05 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: Tomorrow's presentation

Hi Christine-

This would be a good time to send the text on that you mention below. Also, fyi, a week Saturday (14 October) I will be away for a week. I hope to keep up with my emails while (b) (6) [redacted] but I can't be sure. (I do hope to get some further BPA-related writing done while away from the office!). So anything important that we should discuss should be planned for before or after that one week period (14-22 October).

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, October 03, 2017 4:21 PM
To: David Welch

Cc: Aswea Porter
Subject: RE: Tomorrow's presentation

Hi,

This is fine.

I don't want to slow you down today, but we have some text description of our reading of your project results so far. I'm waiting for coworkers to edit it to match the tone of their Proposed Action document. After your presentation, we might do a small update and then ask you to review what we are saying.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, October 03, 2017 4:00 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Aswea Porter
Subject: [EXTERNAL] Tomorrow's presentation

Hi Christine—

Just a heads up that I am working on incorporating some new material ("work in progress") to the presentation for tomorrow.

It is going a bit slower than I had hoped, because I am trying to make it fairly clear and simple without misleading anyone.

If I held off sending you the presentation until, say, 8 AM tomorrow, does this create a problem for anyone?

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile (b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

{Paragraphs describing Kintama study}

There has been a long running policy debate in the Columbia basin over the contrast in smolt-to-adult return (SAR) and productivity (recruits/spawner) rates among mid-Columbia populations of Chinook and steelhead and populations returning to the Snake River (Schaller et al. 1999, Levin and Tolimieri 2001, Hinrichsen and Fisher 2009, Welch et al. 2008, Rechisky et al. 2009, Schaller et al. 2013, Rechisky et al. 2013). SAR has been measured back to the 1960s with mark-recapture methods, and later with coded wire tags, and PIT tags. SAR estimated from the first mainstem dam to adult return at Bonneville has been consistently higher for wild populations in the John Day, Yakima, and Deschutes Rivers (Schaller and Petrosky 2007, Petrosky and Schaller 2010). A hypothesis of delayed mortality due to injuries and stress resulting from passage of multiple dams was proposed to explain the pattern of consistently lower SARs for Snake River populations which must pass eight mainstem run-of-river dams, compared with the mid-Columbia populations which pass three (Schaller et al. 2007, Budy et al. 2002. To address this hypothesis, NOAA carried out a seven year study to determine whether migration through Snake River dams and reservoirs causes extra mortality in spring Chinook salmon smolts; one treatment of juveniles collected at Lower Granite Dam were trucked and released below Ice Harbor dam, while other treatments were allowed to travel in-river, or were trucked and released below Lower Granite Dam (BPA #2003-041-00).

In response to this policy debate, Welch et al (in draft) set out to broadly compare rates of SAR through time, between the Snake River area and other subregions of the species range. Smolt to adult survival rates (SAR) were surveyed for spring and fall Chinook and steelhead for subregions of the west coast excluding California. The Pacific Salmon Commission database provided a set of time series of SAR based on coded wire tag (CWT) for populations in SE Alaska, North Coast British Columbia, West Coast Vancouver island, Strait of Georgia (including Fraser River populations), Puget Sound,Washington Coast, Oregon Coast, the Lower Columbia, Middle Columbia, Upper Columbia and Snake River. These are quality controlled and estimated with consistent methods including correction for sports and commercial harvest. In the Columbia basin, additional SAR estimates based on mark recapture were available from 1962-1984 (Raymond 1988), and PIT based SAR estimates became available for some populations starting in the 1990s.

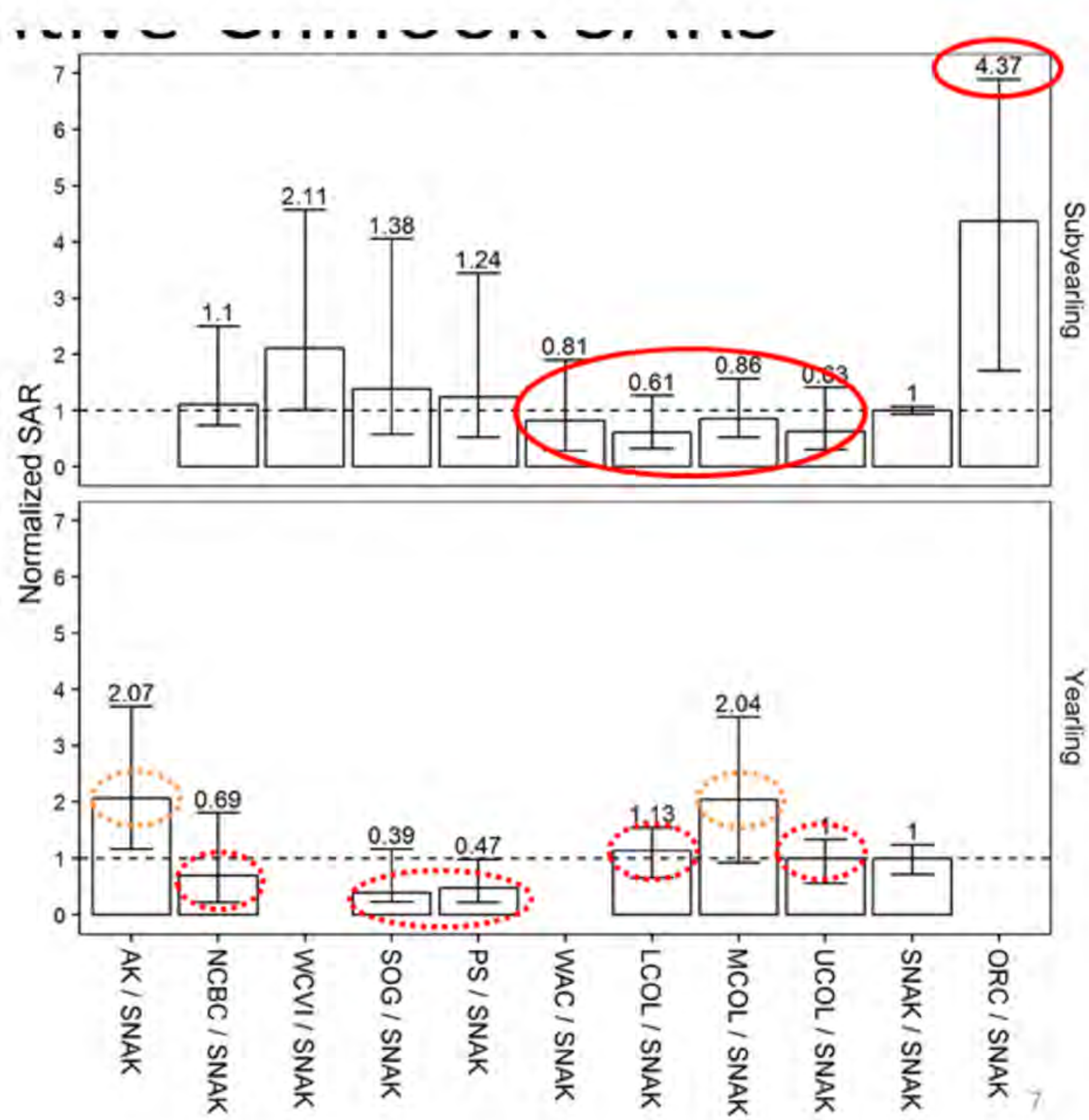
Averaged across years, SAR for yearling Chinook fell in a similar range for Snake, Upper Columbia and Lower Columbia populations. Columbia Basin SARs were higher on average than Puget Sound, the Strait of Georgia, and North Central British Columbia. The mean SAR, normalized by year, was higher for SE Alaska populations and the mid-Columbia populations. A deleterious effect caused by the Columbia dams is not evident. Among the mid-Columbia group, two of five populations (wild John Day and wild Yakima River) have shown substantially higher average SAR than the Snake River region. The other three fell below the Snake mean (Cle Elum, Carson, and Warm Springs hatcheries). The other regions show a similar pattern; a handful of populations showed substantially higher SAR than the regional average despite sharing roughly the same geographic area and migration distance to the ocean. Factors unique to each subpopulation/release group may contribute to the pattern of variance- hatchery rearing practices, run timing, genetically influenced ocean migrations, or freshwater experience.

Among subyearling Chinook, the mean Snake River SAR was higher than the Lower Columbia, Middle Columbia and Washington Coast, and fell in a somewhat lower range than

Puget Sound, North Coast British Columbia and Strait of Georgia. SAR for West Coast Vancouver Island subyearlings was substantially higher than the other subregions, and the two Oregon Coast populations (Elk River, Salmon River) displayed the highest mean SAR in the dataset (4.37X the Snake mean). Overall, this pattern is not consistent with a pattern of delayed mortality, where interior populations in the Snake and Upper Columbia would be expected to show predictably higher SAR than the Middle- and Lower Columbia and coastal populations. Similar to yearling Chinook, a small number of populations spanning geographic subregions showed consistently higher SAR, including Chilliwack Fall and the University of Washington Accelerated hatchery program.

Steelhead show a similar pattern, although fewer subregions had SAR series available. The mean SAR for the Snake River fell in a similar range as the Upper Columbia, while the Middle Columbia was substantially higher (wild Yakima, wild John Day and wild Deschutes populations). The 37-year SAR time series for the Keogh River hatchery population in British Columbia has sometimes exceeded 10%, and falls in the same average range at the middle Columbia. The average for the Puget Sound, made of mostly winter steelhead populations, was lower than among other subregions.

SAR estimated with coded wire tags from hatchery release to adult return at the hatchery covers a different distance of migration than SAR estimated with PIT primarily in the Columbia basin, measured from detection at the first mainstem dam to return at either Bonneville or a dam upstream. For fall Chinook, both CWT and PIT based SARs were available for several hatchery groups in the Columbia Basin; on average, CWT SAR averaged 1.45x the corresponding PIT based SAR. Accounting for the uncertainty added by SAR estimated with these methods adds no evidence that Snake River fall Chinook SARs are worse than other regions of the coast.



Hinrichsen, R. A., & Fisher, T. R. (2009). Inferences on the latent mortality of Snake River spring–summer-run Chinook salmon using spawner–recruit models. *Transactions of the American Fisheries Society*, *138*(6), 1232-1239.

Levin, P. S., & Tolimieri, N. (2001, November). Differences in the impacts of dams on the dynamics of salmon populations. In *Animal Conservation forum* (Vol. 4, No. 4, pp. 291-299). Cambridge University Press.

Petrosky, C. E., & Schaller, H. A. (2010). Influence of river conditions during seaward migration and ocean conditions on survival rates of Snake River Chinook salmon and steelhead. *Ecology of Freshwater Fish*, *19*(4), 520-536.

Rechisky, E. L., Welch, D. W., Porter, A. D., Jacobs, M. C., & Ladouceur, A. (2009). Experimental measurement of hydrosystem-induced delayed mortality in juvenile Snake River spring Chinook salmon

(Oncorhynchus tshawytscha) using a large-scale acoustic array. *Canadian Journal of Fisheries and Aquatic Sciences*, *66*(7), 1019-1024.

Rechisky, E. L., Welch, D. W., Porter, A. D., Jacobs-Scott, M. C., & Winchell, P. M. (2013). Influence of multiple dam passage on survival of juvenile Chinook salmon in the Columbia River estuary and coastal ocean. *Proceedings of the National Academy of Sciences*, *110*(17), 6883-6888.

Schaller, H. A., Petrosky, C. E., & Langness, O. P. (1999). Contrasting patterns of productivity and survival rates for stream-type chinook salmon (Oncorhynchus tshawytscha) populations of the Snake and Columbia rivers. *Canadian Journal of Fisheries and Aquatic Sciences*, *56*(6), 1031-1045.

Schaller, H. A., & Petrosky, C. E. (2007). Assessing hydrosystem influence on delayed mortality of Snake River stream-type Chinook salmon. *North American Journal of Fisheries Management*, *27*(3), 810-824.

Schaller, H. A., Petrosky, C. E., & Tinus, E. S. (2013). Evaluating river management during seaward migration to recover Columbia River stream-type Chinook salmon considering the variation in marine conditions. *Canadian Journal of Fisheries and Aquatic Sciences*, *71*(2), 259-271.

Welch, D. W., Rechisky, E. L., Melnychuk, M. C., Porter, A. D., Walters, C. J., Clements, S., ... & Schreck, C. (2008). Survival of migrating salmon smolts in large rivers with and without dams. *PLoS Biology*, *6*(10), e265.

Kintama Brief to NOAA

12 October 2017

What we are Reporting

- Results primarily confined to Chinook
  - Subyearling & yearling populations separated
- We show a few steelhead results to indicate the same general conclusions will likely hold more broadly
- Comparison of the CWT vs PIT tag database analyses to make the SAR comparisons as robust as possible.

KINTAMA

Primary Results

The broad coast-wide analysis of SARs leads to very different perspective from the current view in the Columbia River basin:

1) SARs in all regions are falling, starting in the early-mid 1970s
2) For CR basin stocks, only MCOL yearlings SARs are higher than Snake River SARs- and only two MCOL populations (***not all***).
3) For Yearling Chinook, “raw” Snake River SARs same as Upper & Lower Columbia & are higher than Puget Sound, Strait of Georgia, North-Central BC
   - Little or no evidence for “delayed mortality” in Snake River Chinook
4) When “raw” data are corrected for methodological differences between CWTs & PIT tags, Snake River populations ***do not appear to*** have *“markedly”* lower survival than other stocks not migrating through the Snake River dams
5) Data are consistent with a coast-wide northern expansion with time of a region of poor ocean survival, progressively encompassing more stocks (even Alaska now affected!)
6) A deleterious effect caused by the Columbia dams is not evident.

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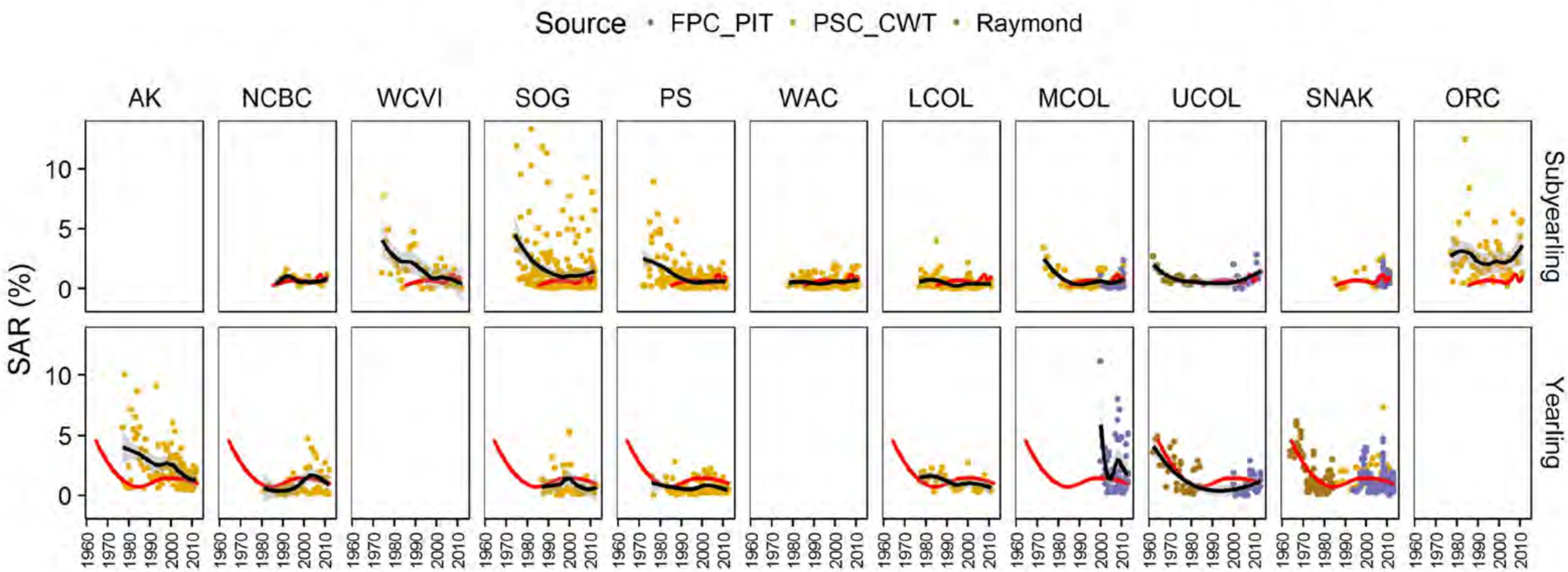
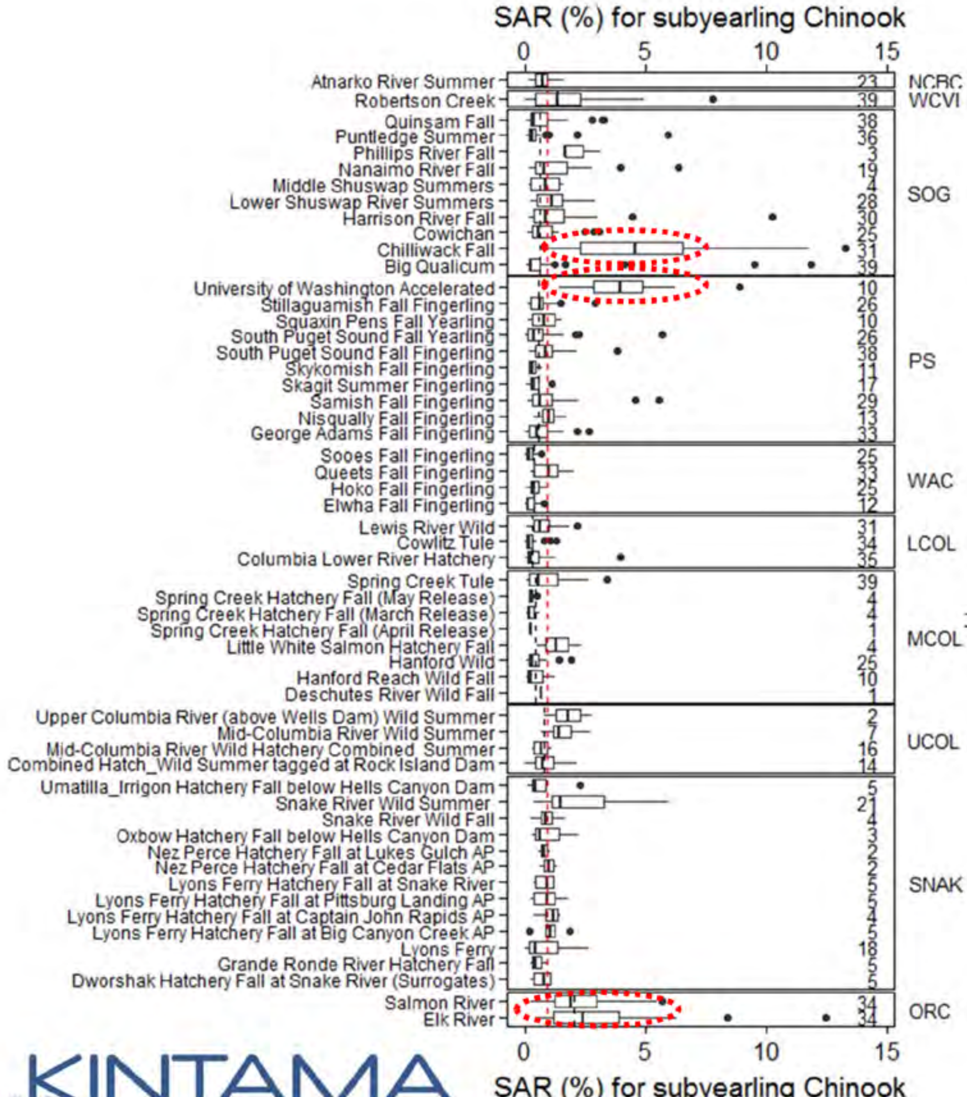
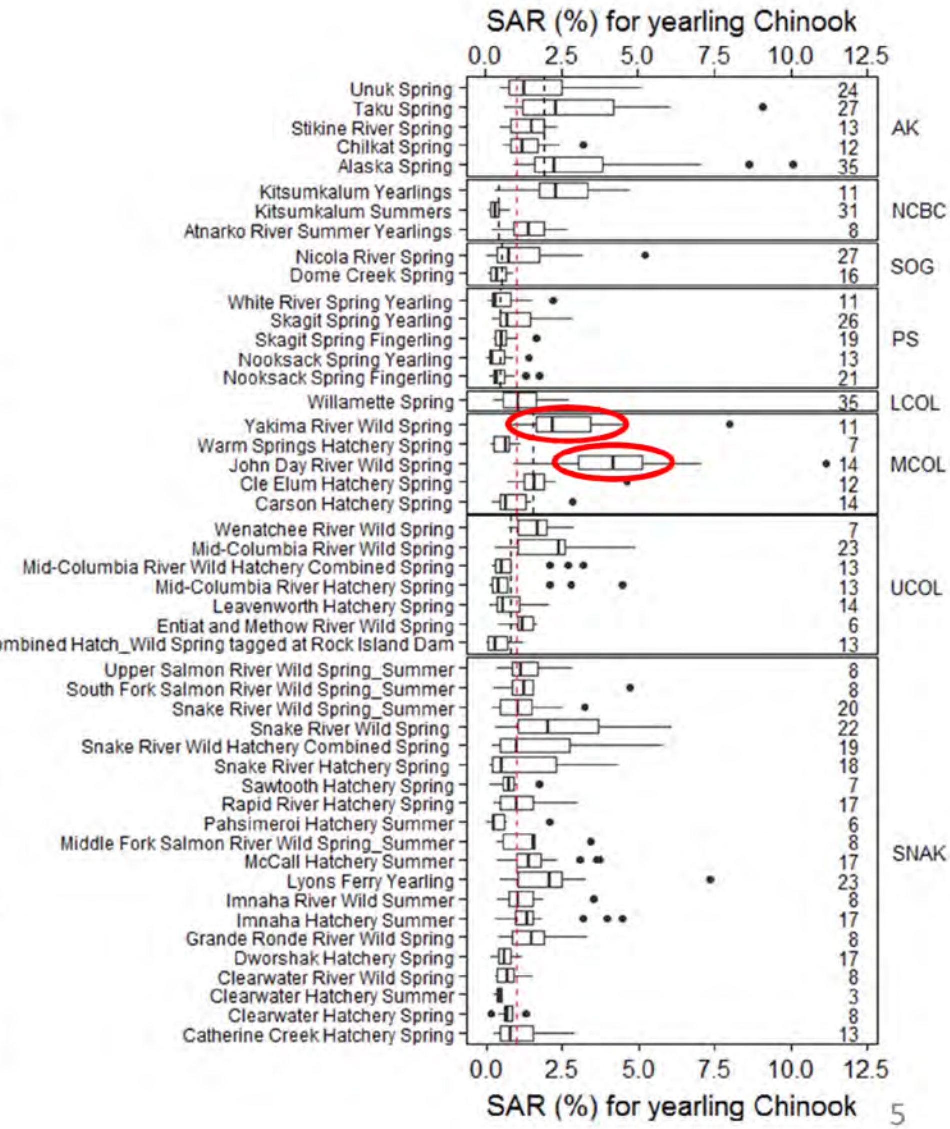
Chinook-All SAR Data by Region



- Plotted SARS against time, split out by regions (columns) & Chinook life history types (rows)
- LOWESS trend line (black) fitted to the SAR data. The Snake River trend line (red) is plotted on all panels to facilitate comparison.

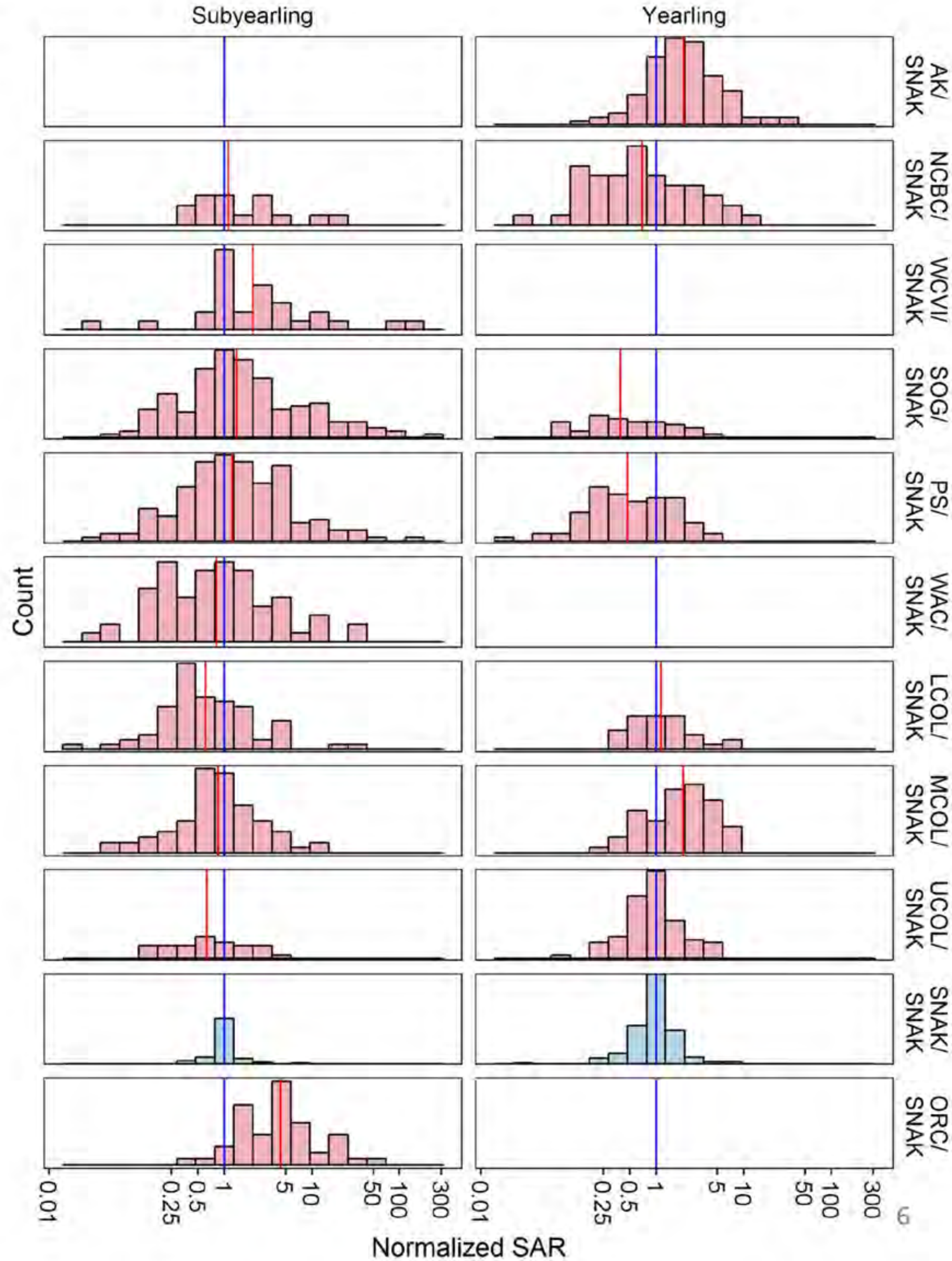
Stock-Specific Chinook SARS-All Years





Comparison of Regional SARs
(Region X/Snake)

- Divided annual SARs for Region X by the Snake River median SAR for the same year: SAR_x/SAR_{Snake}
- Plotted the results as a frequency histogram
- Snake River is in blue



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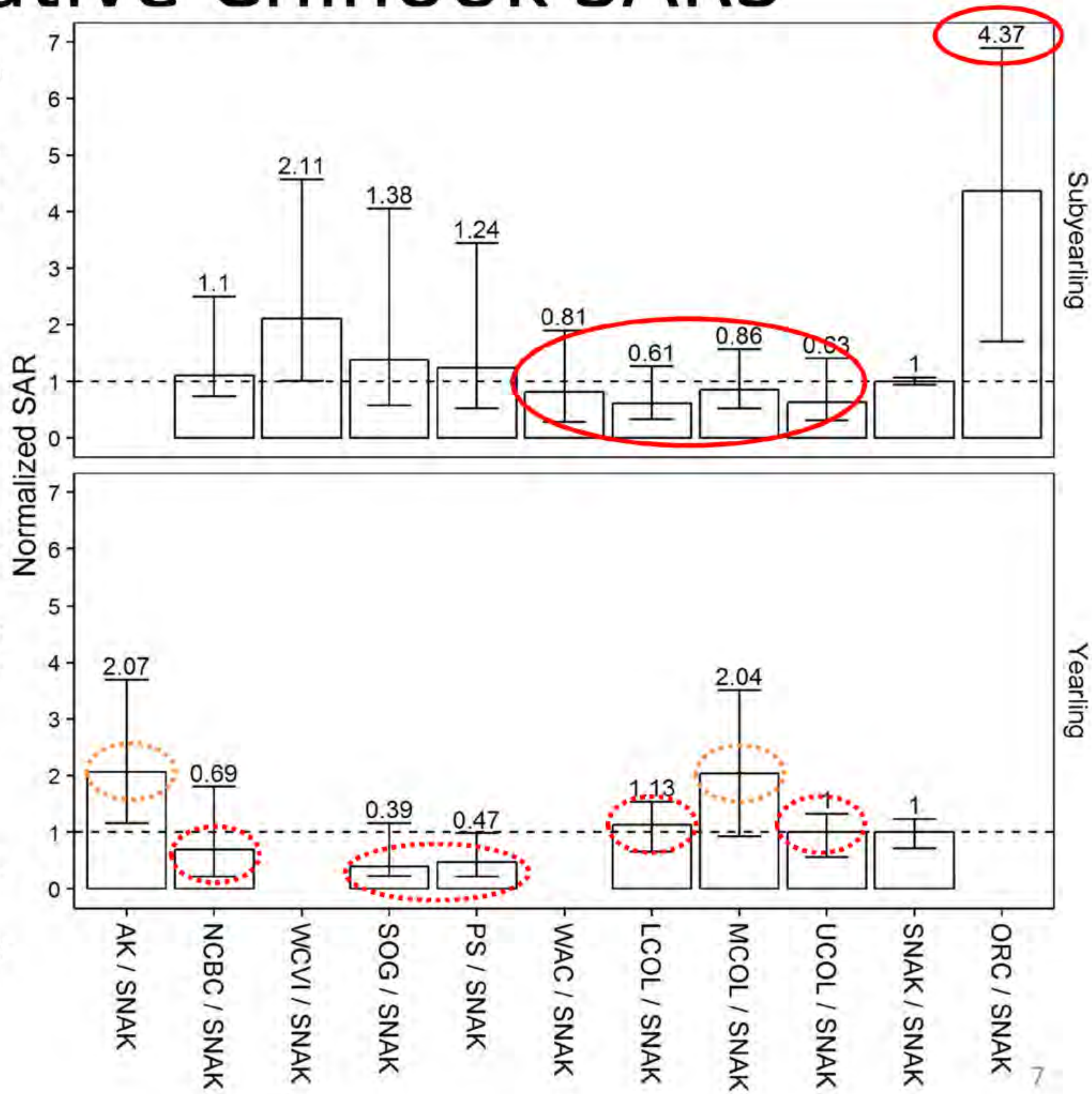
Relative Chinook SARS

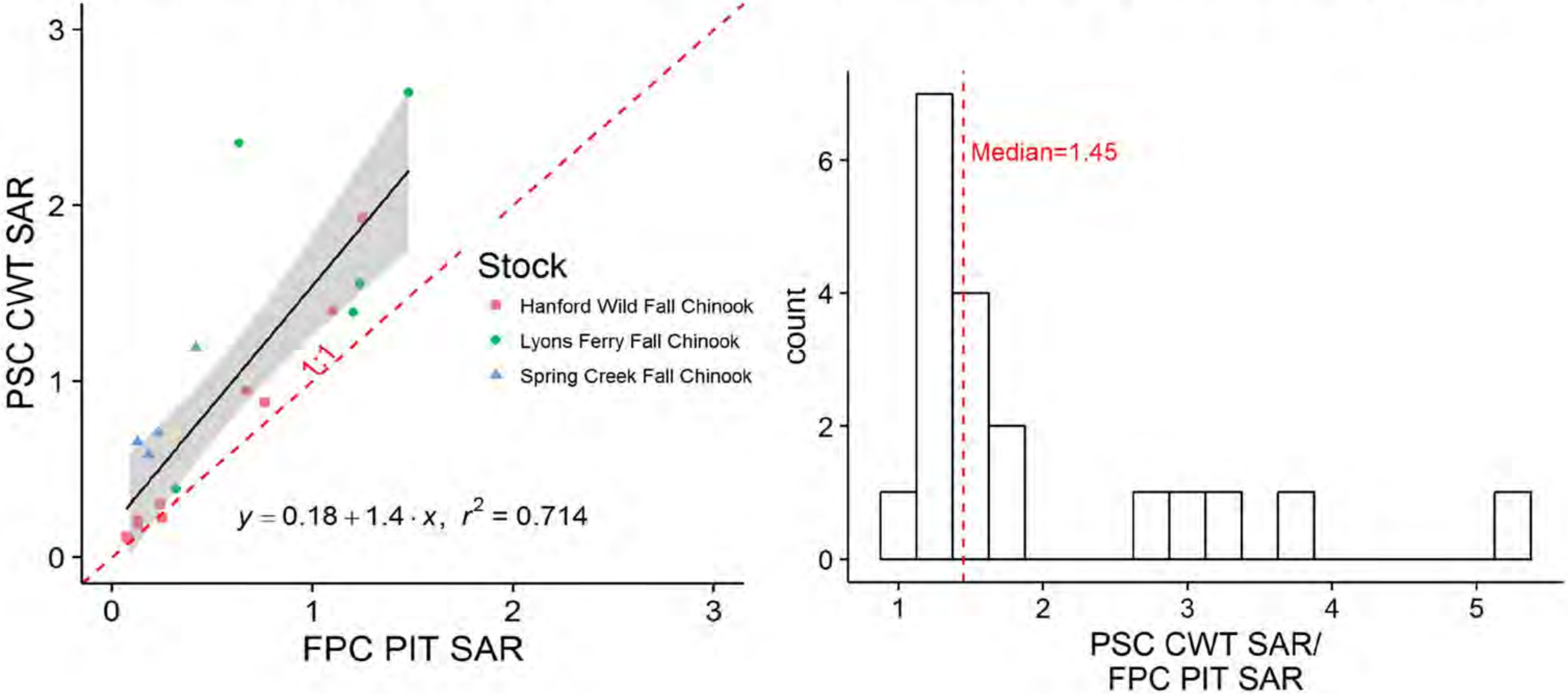
1. Same data as prior slide, just different presentation (error bars are 25 & 75 percentiles)
2. For subyearlings:
   1. Oregon Coast Chinook have SARS 4.37X Snake River.
   2. But Upper/Mid/Lower Columbia River SARS are **lower** than Snake River subyearling SARS, as are WAC (Washington Coast).
3. For Yearling Chinook:
   1. Snake River SARs same as Upper & Lower Columbia & higher than Puget Sound, Strait of Georgia, North-Central BC
4. Only Mid-Columbia & Alaska have higher SARs than Snake River (& recall Alaskan SARs have fallen to Snake River levels in recent years)



Major Uncertainties

- Regional SARs derived by different methodologies
  a) In Columbia, early data from Raymond
  b) CWT survival data (PSC):
     i. Survival calculated from smolt release to adult return to spawning grounds
     ii. Corrected for harvest in sport & commercial fisheries
  c) FPC survival data is based on PIT tags:
     i. Survival calculated from smolts reaching a dam to adults returning to a dam
     ii. Excludes smolt survival "pre-dams" and adult survival "post-dams".
     iii. Not corrected for harvest in sport & commercial fisheries

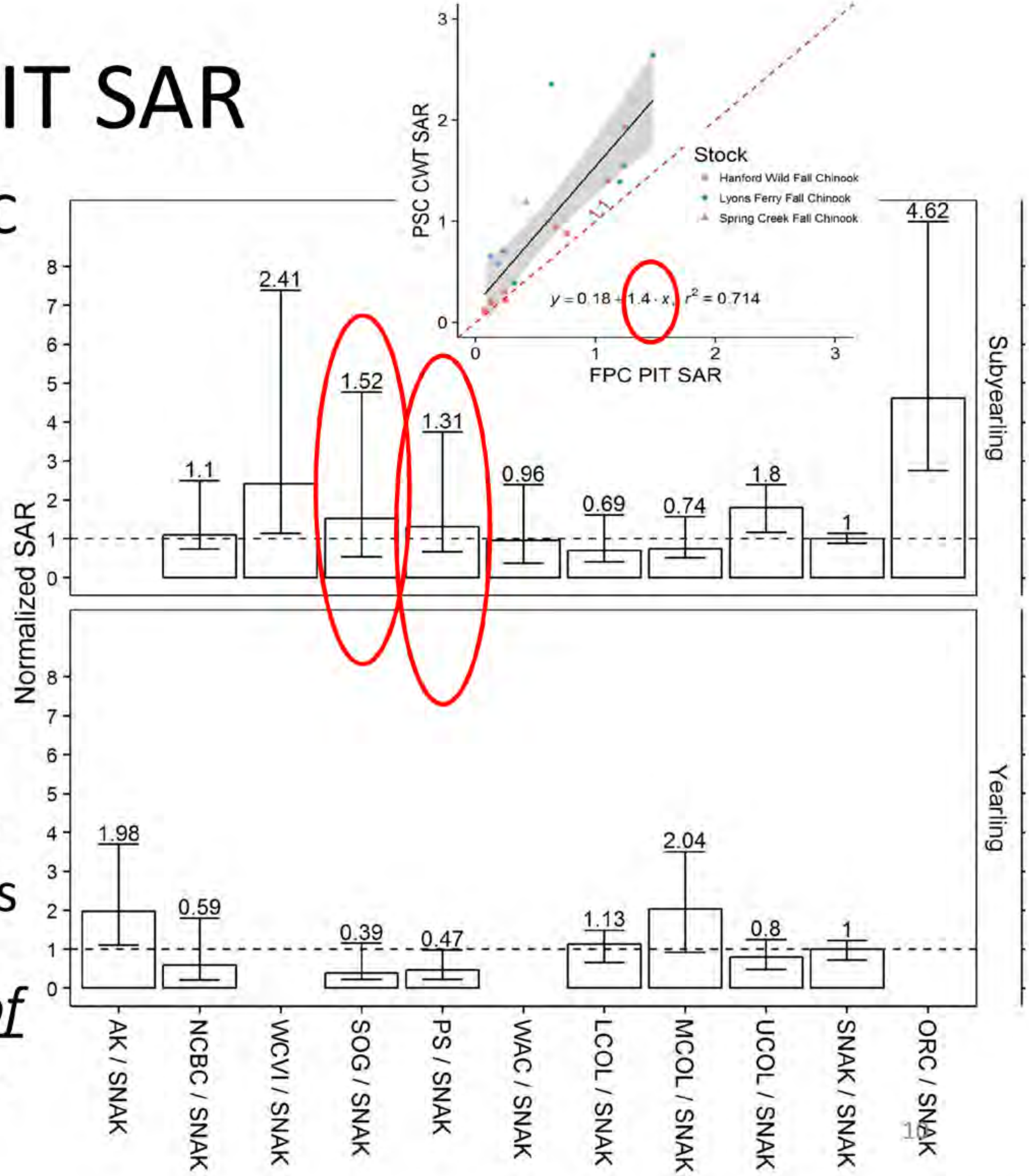
PSC CWT vs FPC PIT SAR Methodologies



- Compared CWT & PIT tag derived Fall Chinook SARs for the same year ***<u>and the same stock</u>*** (few stocks available to make this comparison)
- On average, PSC CWT SARs are ~1.4X FPC's PIT-tag based SARs
- (*Recall: FPC adds in harvest, includes all survival losses from smolt release location to adult enumeration site*)

PSC CWT vs PIT SAR

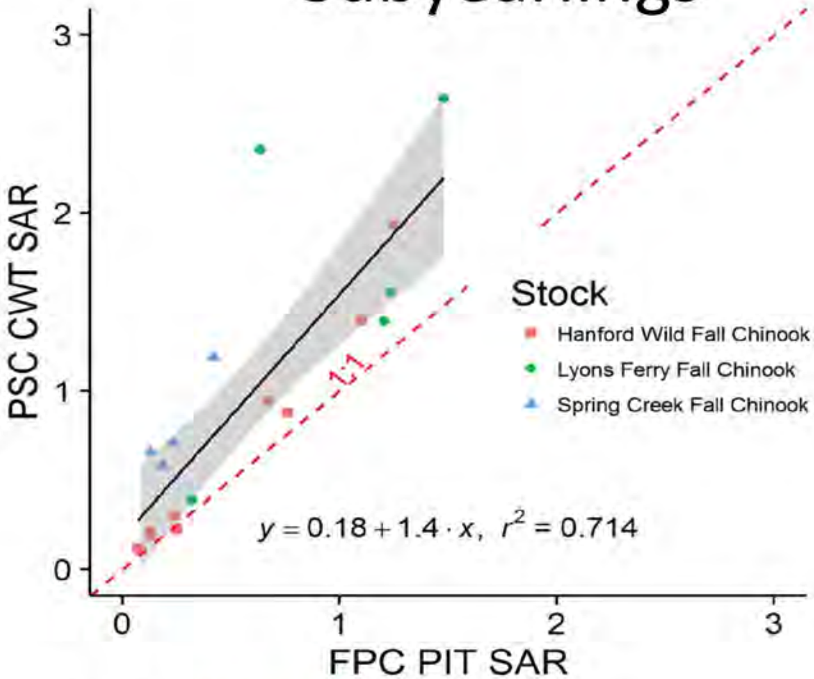
- For Fall Chinook, PSC CWT SAR values ≈1.45X FPC SAR values
- This is about what the CWT vs PIT SAR ratios are for the Salish Sea:
  - SOG/SNAK=1.5
  - Puget/SNAK=1.3
- Results suggest that Snake River Fall SARs are *__about the same as in other regions of coast without dams__*

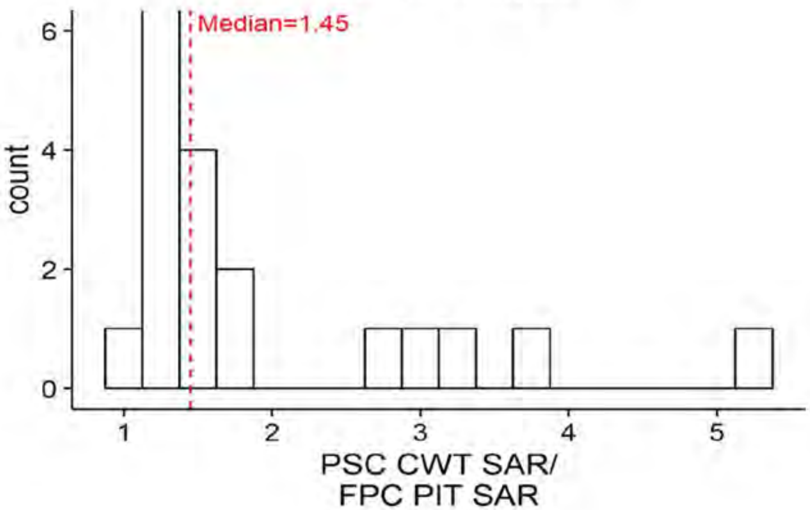


Current Work (in Progress!)

DIRECT COMPARISON: PSC vs FPC SARs

Subyearlings



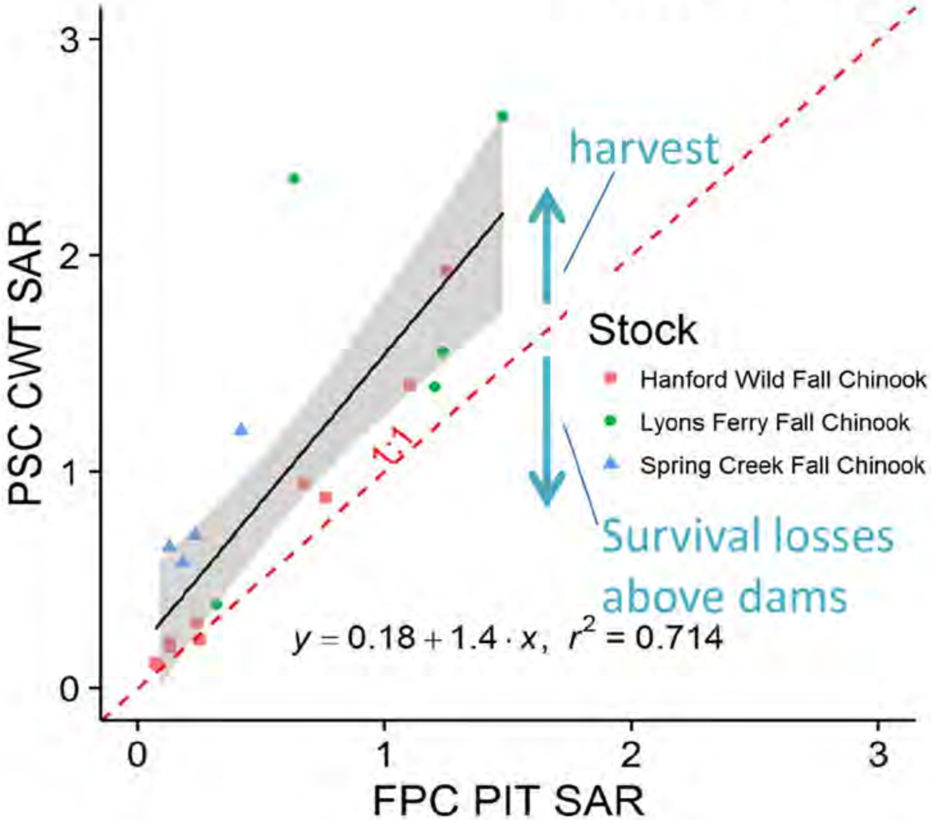


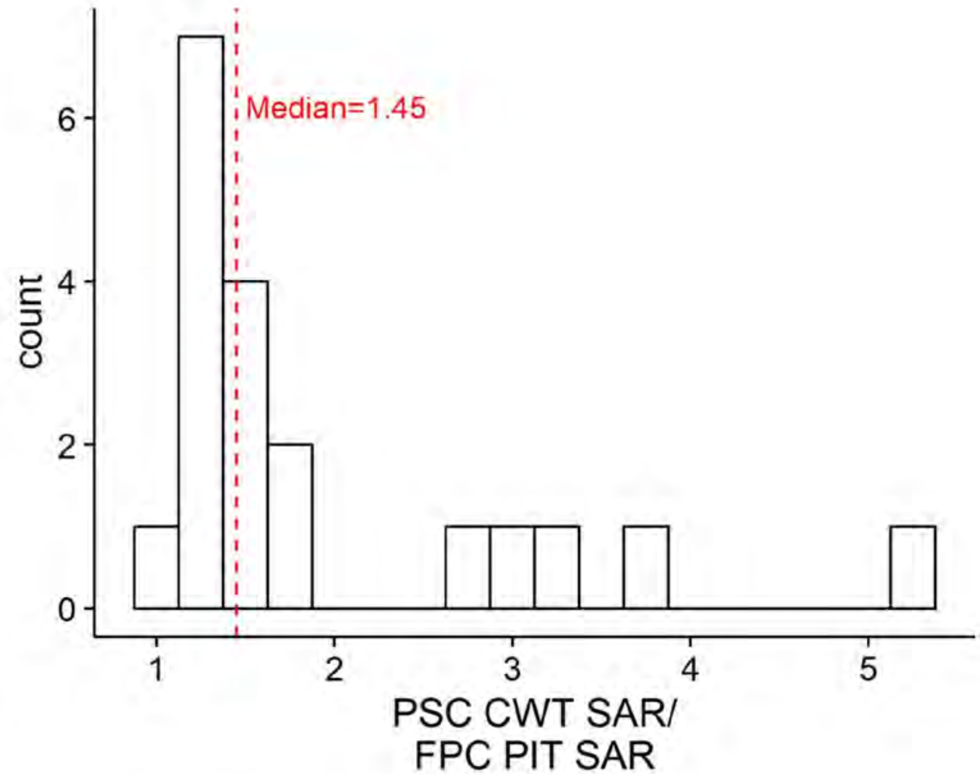
Yearlings

NO DATA

NO DATA

PSC CWT vs PIT SAR Methodologies (Direct Method)

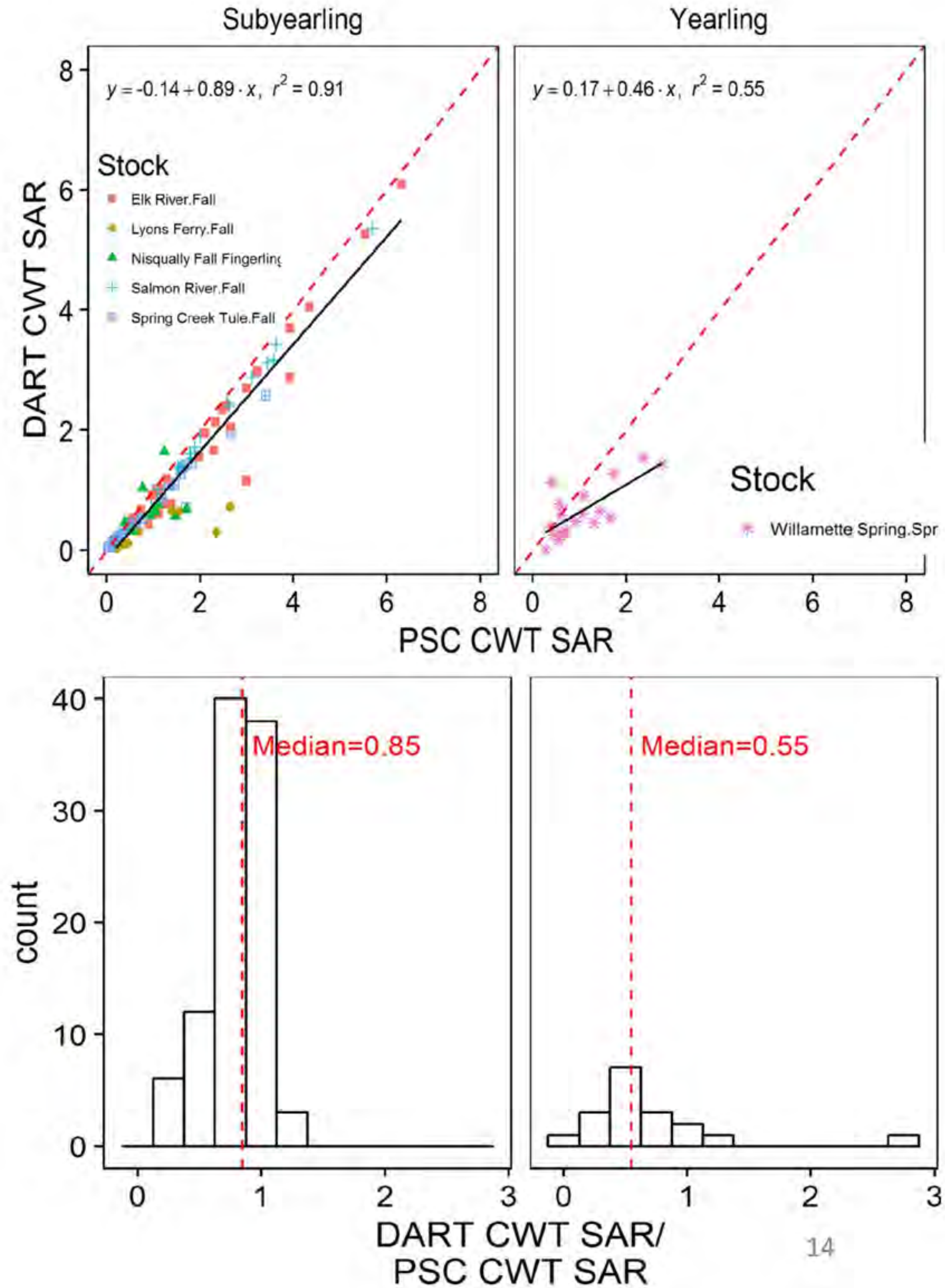




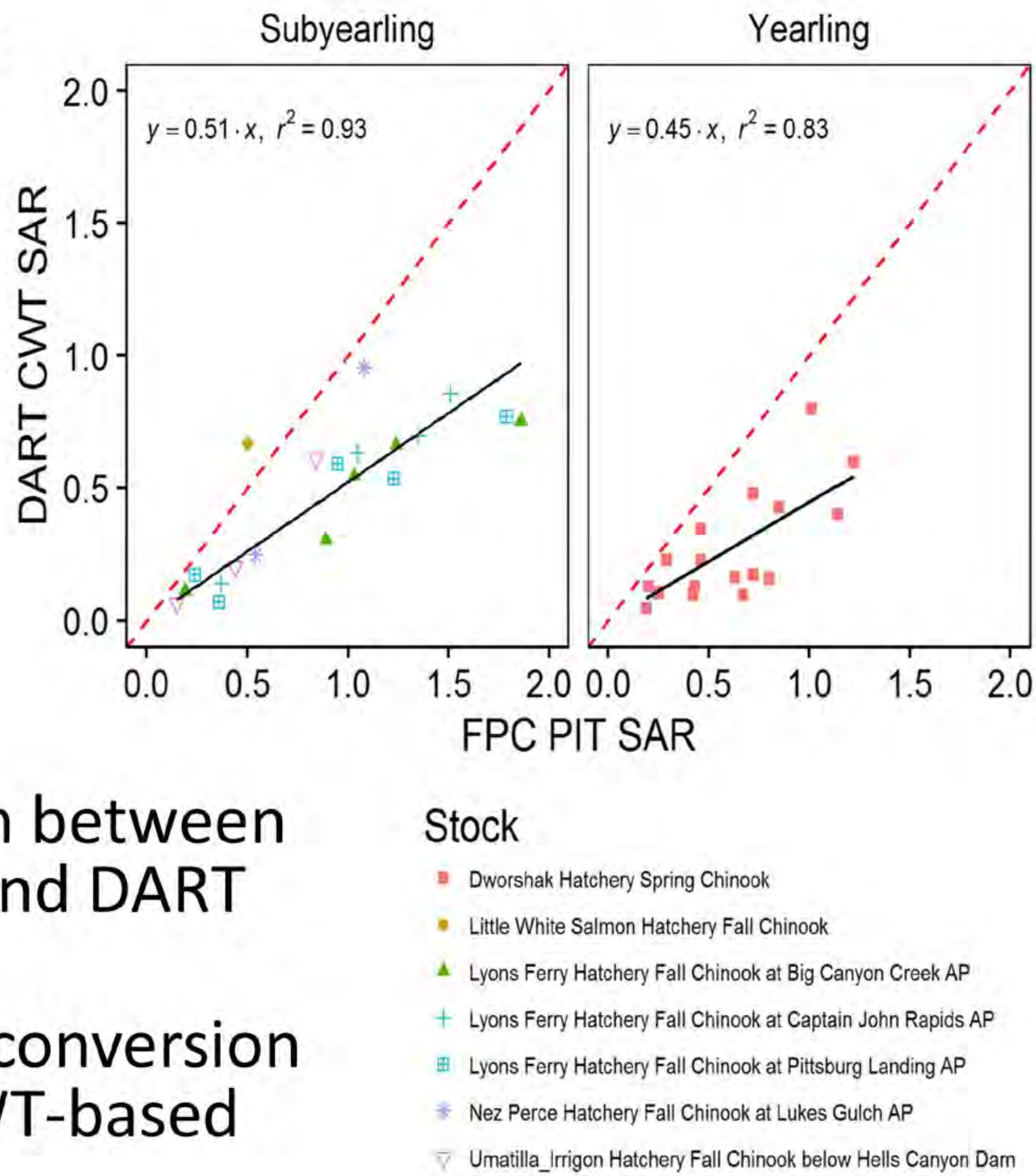
- Compared CWT & PIT Fall Chinook SARs for the same year ***<u>and the same stock</u>***
- On average, PSC CWT SARs are ~1.4X FPC's PIT-tag based SARs
- (*Recall: PSC adds in harvest, includes all survival losses from smolt release location to adult enumeration site; FPC PIT-tag estimates exclude these factors*)

A) PSC CWT SARs vs DART CWT SARs

- No direct comparison of PSC & FPC SARs available for Yearlings
- We can develop a “convoluted” estimate using DART as an intermediate.



B) FPC PIT SARs vs DART CWT SARs



- This gives us a conversion between FPC PIT-tag based SARs and DART CWT-based SARs
- The prior slide gave us a conversion between DART & PSC CWT-based SARs
- So…

The Indirect Method (using median Values for algebraic simplicity):

Subyearlings:

- $SAR_{Dart}=0.85*SAR_{PSC}$
- $SAR_{Dart}=0.51*SAR_{FPC}$

So:

- $SAR_{PSC}=(0.51/0.85)*SAR_{FPC} \approx 0.6*SAR_{FPC}$

Yearlings:

- $SAR_{Dart}=0.55*SAR_{PSC}$
- $SAR_{Dart}=0.45*SAR_{FPC}$

So:

- $SAR_{PSC}=0.45/0.55*SAR_{FPC} \approx 0.8*SAR_{FPC}$

Reality Check:

YEARLINGS:

- Direct Method: **No Data**
- Indirect Method:

  $SAR_{PSC} \approx 0.8 * SAR_{FPC}$ (Close to 1:1)

SUBYEARLINGS:

- Direct Method: $SAR_{PSC} \approx 1.4 * SAR_{FPC}$
- Indirect Method: $SAR_{PSC} \approx 0.6 * SAR_{FPC}$
- Results don't match, but are "not far off" a 1:1 relationship, suggesting that FPC/PIT & PSC/CWT SAR data are not hugely different (work in progress)
- Incorporating the large variability evident in the scatterplots is crucial

Current Conclusions/Next Steps

- Snake River SARs "*look to be*" similar to other regions, but we are not yet certain *<u>how similar</u>*
- Refine data, switch to Fall & Spring categories rather than Subyearlings & Yearlings
- Combine (messy!) CWT vs PIT tag conversion factors with SAR time series to inform the question: *"How likely is it that Snake River SARs are actually lower than SARS in other regions lacking dams?"*
- *Our current thinking is that it may never be possible to get a "near-perfect" general conversion ratio between PIT & CWT-based SAR estimates:*
  - *Harvest rates vary between stocks depending upon marine migration route, return timing, and regulatory decisions choosing which stocks to target or protect*
  - *Survival "above the dams" cannot be the same… distance from release to the top dam varies widely, predators/river dynamics vary…*
- A philosophical question: Is it simply enough to note that Snake River SARS are "about the same" as other regions to change thinking, or does it really have to be statistically "proven"… *and what if it can't be?!*

Questions

1) What analyses can we add that will better address the legal (& social/economic) issues that you face?
2) What do you see as the important uncertainties that we need to address?
3) As we work this up for publication, can you provide any other thoughts or guidance?

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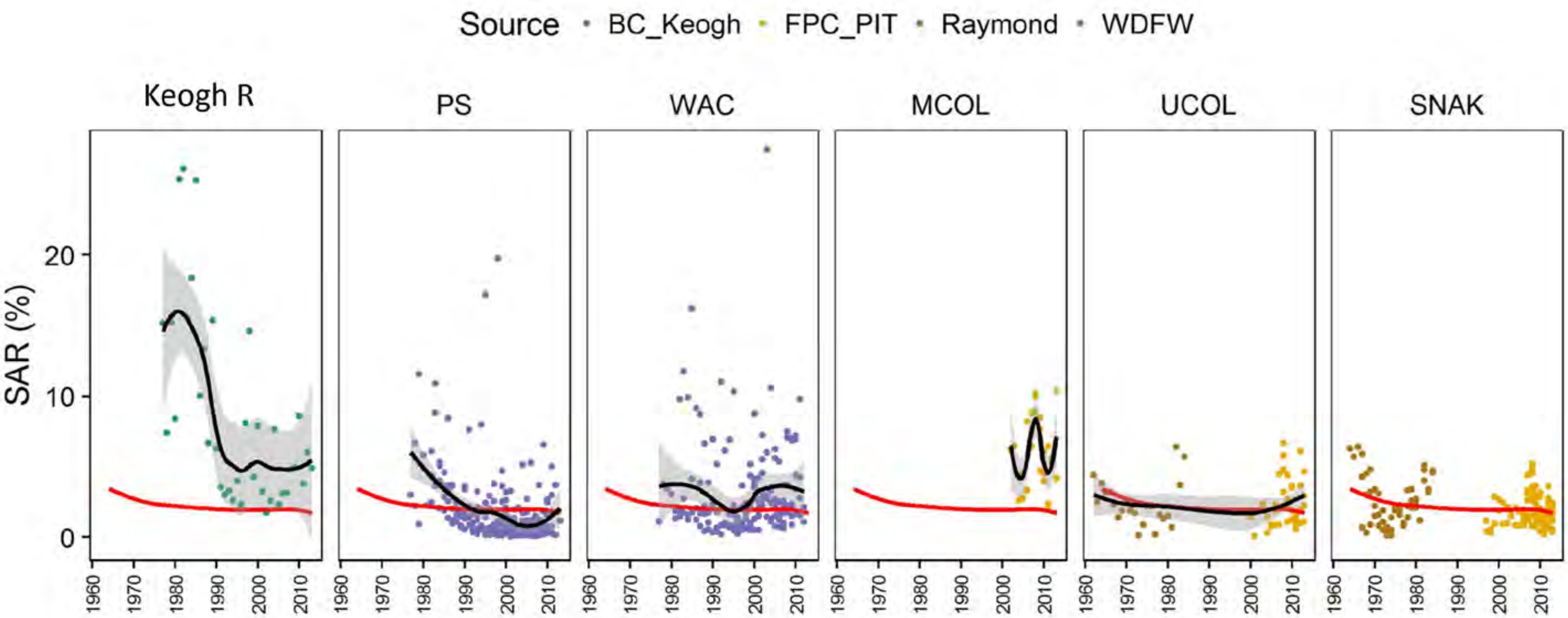
Steelhead Results
(Different Species, Similar Story)

KINTAMA

Steelhead-Available SAR Time Series



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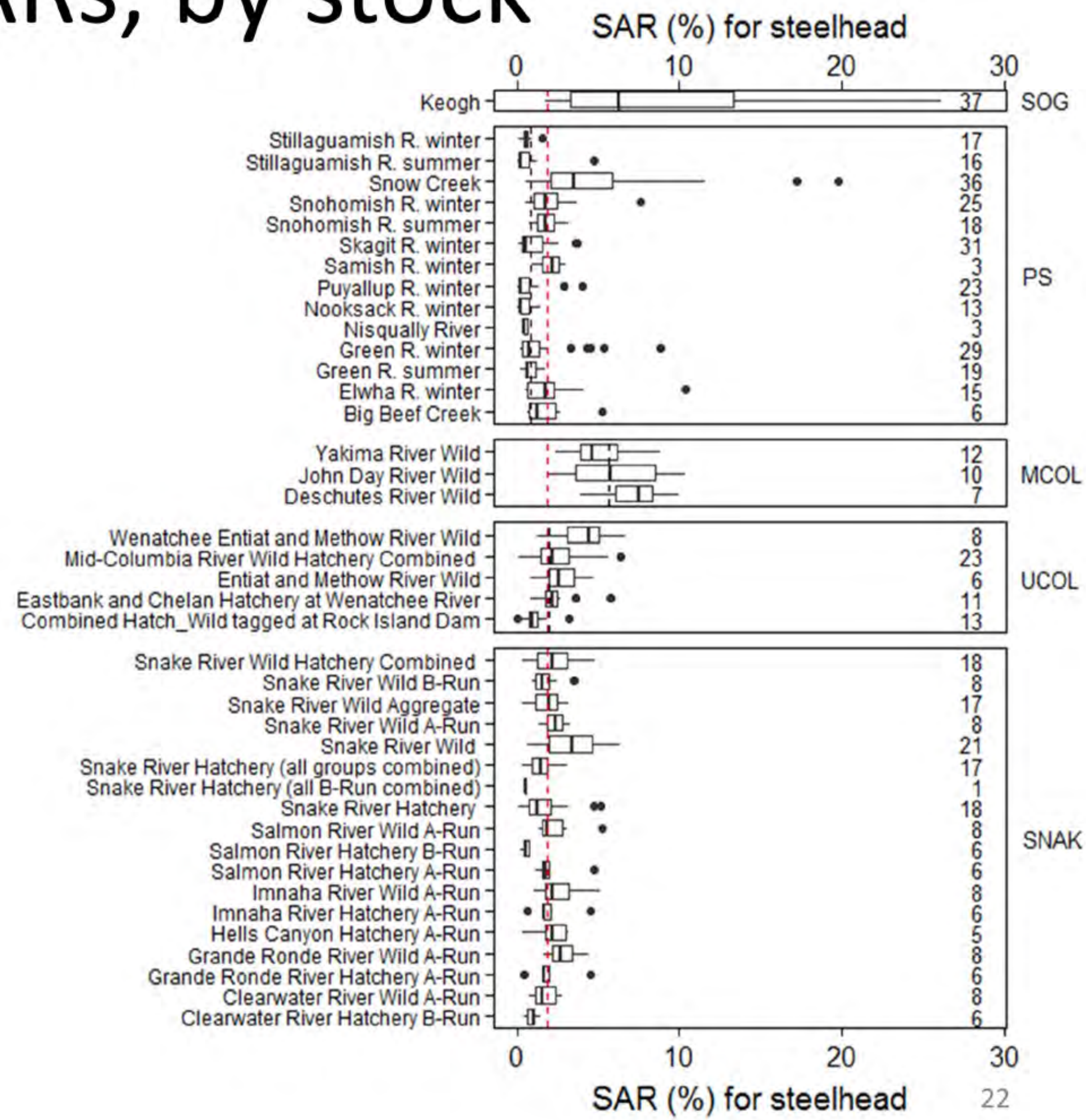
Steelhead SARs, by stock



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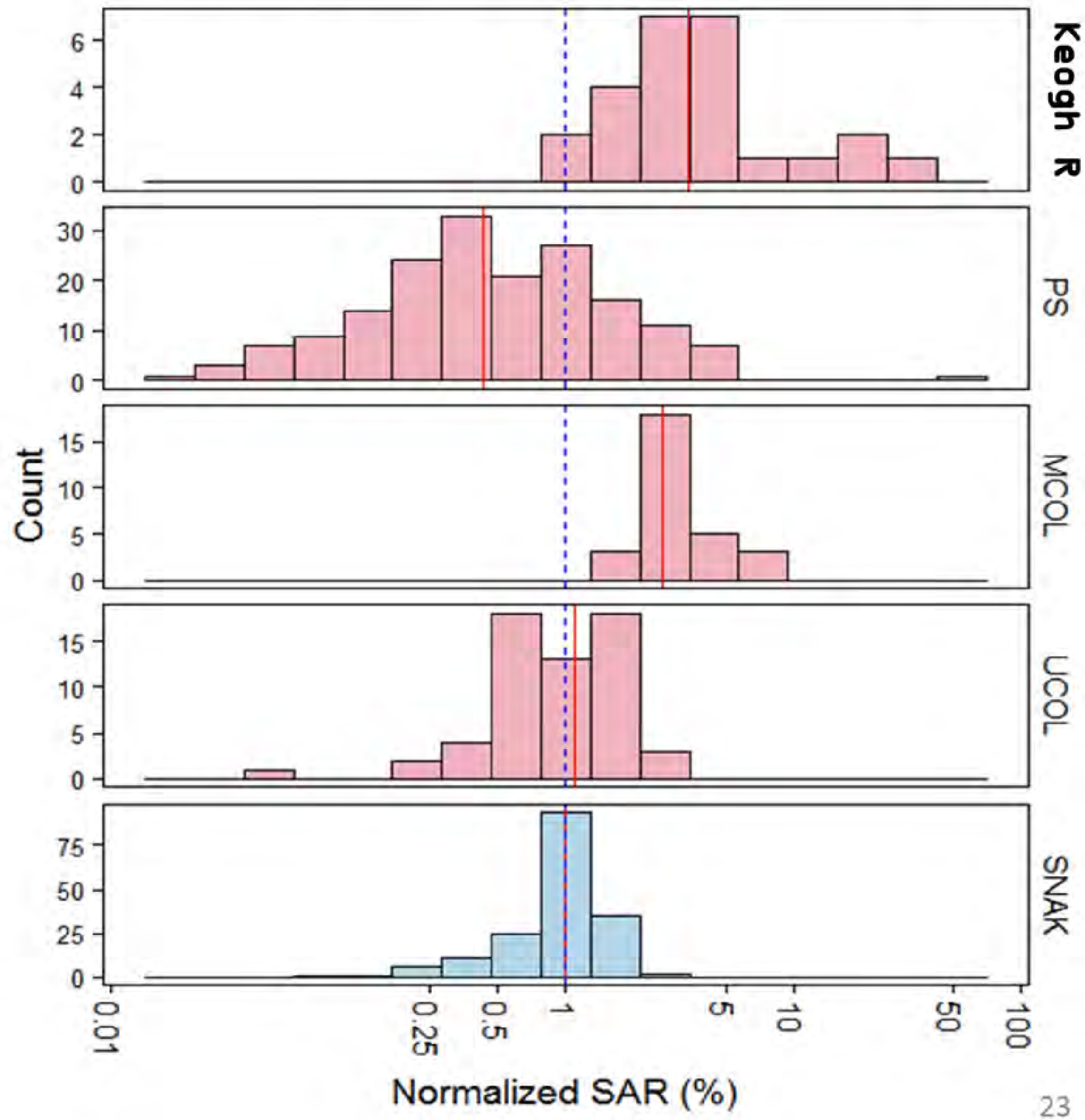
Steelhead-Normalized SARs (All Years)



KINTAMA

From: David Welch

Sent: Tue Oct 17 21:38:57 2017

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] RE: presentation

Importance: Normal

Thanks Christine—

We have sent Tom the two data sets for the Upper Columbia that he mentioned had higher productivity (well, one of the two; the other one we sent may or may not be the one that he was mentioning). Tom said he couldn't look at that this week, which is fine, but I will be back next week when I think he will be able to get at it and will try to follow up with him. Tom's comment here was an important one, I thought—I have heard these sort of anecdotal comments about higher productivity stocks quite a lot in the past, and was surprised to see such similar survival to the Snake River in our dataset when we got into the analysis.

It is important that we try to nail this down because the easiest way for our work to be discredited will be for someone opposed to the findings to say… "*Oh, the data is fundamentally flawed, so the whole thing should just be ignored*". This is why I am so keen to put the datasets out in front of knowledgable experts NOW, so that any serious errors can be picked up and vetted asap.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, October 17, 2017 11:24 PM
To: Erin Rechisky; David Welch; Aswea Porter
Subject: presentation

Hi all,

Let's see – I realize David is traveling this week. I wanted to mention that I was able to listen in on the webinar you did with NOAA.

I think it was well received overall. Here is what I generally heard them say. Rich Zabel asked why the Snake River was the common reference region. I would say that it actually makes the data easier to present, but you do need to introduce the debate over the hypothesis that Snake River populations have depressed smolt to adult survival. Most of the potential audience has heard of the hypothesis. Tom Cooney had an interesting remark that there were anecdotes that historical lifetime productivity for Snake populations was higher than other subregions. If I reflect on this, this might have to mean that early juvenile survival would be higher in order to explain such a pattern – due to either temperature patterns or habitat quality. After all, there are a lot of places where salmon are not present, and places where they are. If it were due to higher SAR for the far interior population, it would have to result from timing or the migration pathway? There were a couple questions about individual populations and the details of the time series you had. This would take a lot of time to address what years and the PSC methods in a paper, but could come up again.

Christine

From: David Welch

Sent: Tue Oct 17 21:54:20 2017

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: presentation

Importance: Normal

Oh, and one more thing—I left Aswea and Erin off this part of the response just to keep them focused on the science and not the politics.

One of the NOAA staff members emailed me afterward and complimented me on the work, but suggested that we change the focus so that we weren't comparing the various time series to the Snake River. I think that this reflects some unease in the community simply because so many people's lives and work focus is tied up on finding out "*what is wrong with the Snake River populations*", and some discomfort with being confronted with the possibility that the answer might be "*nothing.. Snake River survival is just like lots of other populations"!*

I bring this comment up simply as an example of how group think gets started… people are uneasy with the implications of a result like what we seem to be finding, and then urge not being too strong and direct in our statements in the analysis, simply because we might not be right. As a result, over time people forget about the bigger policy issues and the key results for policy gets buried or forgotten. No one is exercising any coercion here, simply saying to shift the focus of the comparison to the fact that survival is going down everywhere (the trends, not the comparison with the Snake River), but if we were to do this the biggest implication (that everywhere may now be more or less at the level of the Snake River) would be lost. I saw this a lot in government circles when I was in DFO, where people confronted with a surprising result would soft peddle it "*in case we are wrong*"; then, when a year or so later it was clear that whatever the issue was persisted, then there was an unspoken desire to bury it because someone higher up might ask why they hadn't been more on the ball and identified the issue earlier!

Politics in large organizations is an interesting beast, as I think that you appreciate…there is a great deal of groupthink, and a fear of sticking out one's neck in case there was a possibility of being proved wrong (or of making waves)

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, October 17, 2017 11:24 PM
To: Erin Rechisky; David Welch; Aswea Porter
Subject: presentation

Hi all,

Let's see – I realize David is traveling this week. I wanted to mention that I was able to listen in on the webinar you did with NOAA.

I think it was well received overall. Here is what I generally heard them say. Rich Zabel asked why the Snake River was the common reference region. I would say that it actually makes the data easier to present, but you do need to introduce the debate over the hypothesis that Snake River populations have depressed smolt to adult survival. Most of the potential audience has heard of the hypothesis. Tom Cooney had an interesting remark that there were anecdotes that historical lifetime productivity for Snake populations was higher than other subregions. If I reflect on this, this might have to mean that early juvenile survival would be higher in order to explain such a pattern – due to either temperature patterns or habitat quality. After all, there are a lot of places where salmon are not present, and places where they are. If it were due to higher SAR for the far interior population, it would have to result from timing or the migration pathway? There were a couple questions about individual populations and the details of the time series you had. This would take a lot of time to address what years and the PSC methods in a paper, but could come up again.

Christine

From: David Welch

Sent: Tue Oct 24 16:50:23 2017

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] FW: Quick check in..

Importance: Normal

FYI—I'm back from my week away. With luck, Tom will decide that the concerns he voiced earlier with some of the data are not correct, but I won't know until I hear back!

David

From: David Welch
Sent: Tuesday, October 24, 2017 4:48 PM
To: tom.cooney@noaa.gov
Cc: Aswea Porter
Subject: Quick check in..

Hi Tom—

You had mentioned you had some concerns with the Columbia River Chinook SAR time series that I displayed, and that some of the stocks you were most familiar with had higher SARS than we were reporting.

Aswea sent you an extraction of some of the relevant data series about 10 days ago, and you indicated then that you might not be able to look at them for a week or so.

I am just reminding you of your concern, and wondered if you had a chance to look further into the matter? I am hoping that we will have a good first draft of the report prepared in the next month or so, and obviously if there are problems with the underlying data it is best if we address them as soon as possible.

Kind regards,

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

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From: David Welch

Sent: Tue Oct 31 15:40:25 2017

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: NOAA Presentation...

Importance: Normal

Thanks. I would like to see the summary data showing that in-river survival has increased but adult conversion has declined, if you can share it. (Also, not sure how you are defining “adult conversion” but that may be semantics).

If you can bring it up with Tom next week, that would be great—My calendar reminder just popped up 20 minutes ago, reminding me to chase him down, because he hasn’t responded. (This would be the fourth request from me, so I will re-schedule my reminder till the 3rd of November (a week Friday). That should give him some time to actually do what I asked, which is pretty simple).

I am of two minds wrt the FPC data request. Once we get it, we have a lot of work to do to use it, but we don’t really have any easy way to cite it other than “FPC, personal communication” or “FPC, memo to C. Petersen, BPA”. Using it will make our life easier (the data is cleaner and more consistent), but the problem with it is that if we focus on that dataset there is always the possibility of throwing up a smoke screen by someone arguing that it isn’t the “real” survival data, which the FPC uses in the CSS report.

So I am of two minds. I would suggest letting the request ride; you have made a formal request for the data, so presumably it will eventually be forthcoming. If you think that they have accidentally dropped the ball and just absolutely forgotten to provide it, then I would suggest asking them again so that they can have a fair shot at providing it. (But given your very formalized request structure, I would be surprised if the request isn't logged). We would like to have access to it, but more as supporting info… making the primary comparison in our paper against a data set lacking in any formal provenance or prior analysis could prove problematic.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, October 31, 2017 3:14 PM
To: David Welch
Subject: FW: NOAA Presentation...

Thanks David

Sorry for the delayed response. I will see Tom next Tuesday at their lifecycle model meeting, and will bring it up. He is known for juggling a lot of projects. We also didn't get the FPC data and I have not recently inquired into that.

Jas on Sweet and I are current writing something for the BA comparing compass and CSS survival forecasts so we are pulling this from various old reports. Since 2007, in river survival has increased but adult conversion has declined.

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: David Welch <David.Welch@kintama.com>
Date: 10/26/17 2:27 PM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Subject: [EXTERNAL] FW: NOAA Presentation...

Just following up with Tom Cooney (again)—he had expressed some surprise that one or two of the non Snake River SAR time series should show higher survival than we were reporting during the NOAA presentation, but so far I haven't been able to get any further information from him.

No need to do anything—just letting you know that we are doing our best to address any concerns!

David

From: David Welch
Sent: Thursday, October 26, 2017 2:24 PM

To: tom.cooney@noaa.gov
Subject: FW: NOAA Presentation...

Hi Tom—

Just jogging your memory on this (& sorry for being a pest!). If possible, I would like to discuss with you why you think that the SARs data we may be using are understating survival for some of the non-Snake River stocks.

I am re-attaching the data Aswea sent to you 10 days ago. Give me a call when convenient to discuss any concerns, as I would like to address any possible issues as soon as possible.

Regards, David

From: David Welch
Sent: Friday, October 13, 2017 10:44 AM
To: 'tom.cooney@noaa.gov'
Subject: FW: NOAA Presentation...

Hi Tom--

I appreciate you taking the time to look at the data-- it is obviously critical that we get this analysis as correct as possible. I am going to be in Malta next week, but my schedule Is wide open for several weeks starting on the 23rd. I would like to discuss your thoughts further at that time; meantime, here is the data set that we are using.

Regards, David

David Welch, Ph.D.

kintamav_RGB

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Regards,

David Welch

From: Aswea Porter
Sent: Friday, October 13, 2017 8:47 AM
To: David Welch
Subject: RE: NOAA Presentation...

Hi D,

Here is the dataset and plot for Hanford. Priest Rapids Dam is at the boundary between the MCOL and UCOL regions and we don't have a dataset specifically tagged at this dam. I've attached the info for Rock Island Dam instead in case that's the one of interest.

~A

From: David Welch
Sent: October-12-17 20:51
To: Aswea Porter
Cc: Erin Rechisky
Subject: NOAA Presentation...

I thought it went well. We had two sorts of helpful comments: (1) Use more sophisticated statistical methods (specifically, Dynamic Factor Analysis rather than LOWESS), which I will have to think about.

Second, Tom Cooney of NOAA expressed some concerns that a couple of the PSC CWT datasets showed much lower survival than he had expected: Specifically, Hanford Reach and Priest Rapids.

Could you extract those two data sets and send them to me as an Excel file and as a scatterplot of SAR vs time (one for each of the two populations). I will send them on to Tom and we will try to dig into what might be the issue!

Now to go back and refresh my memory on DFA…

d

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

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From: David Welch

Sent: Mon Nov 06 19:21:57 2017

To: Bodi,Lorri (BPA) - E-4

Subject: [EXTERNAL] Kintama-Talk with Lori Bodi & Bryan Mercier (7 Nov 2017).pptx

Importance: Normal

Attachments: Kintama-Talk with Lori Bodi & Bryan Mercier (7 Nov 2017).pptx

Hi Lori-

In order to frame some of Tuesday's discussion, I am attaching a few key slides. It is not necessary to review them before our discussion tomorrow, but if you & Bryan do have the time, the points they make are the following:

1) There is a coast-wide crisis in salmon survival; this is not restricted to the Snake/Columbia River system, and the survival collapse up in Alaska is just as bad as experienced in the Columbia River, but isn't widely appreciated. (The same statement applies to steelhead, coho, and at least some populations of sockeye). "Fixing" freshwater isn't the solution if Alaska with its prime habitat has the same problem.

2) The work Kintama previously did for BPA pretty effectively found no evidence for a significant effect of multiple dam passage (or transportation) on adult Chinook returns.

3)	Left incomplete is the glaring reason that transportation and other initiatives haven't really been effective—survival rates in the ocean aren't any better than in the hydrosystem, so interventions designed to move the smolts out faster (spill, transport, reservoir drawdown) simply move them into an inhospitable ocean, not improve their fate, and at great financial cost to the ratepayers.

4)	The reason survival is bad is because something is broken in the ocean. And without knowing why, people are grasping at straws and variously blaming the dams (in the US) and (in BC) salmon aquaculture (the last couple of slides).

I don't have Bryan Mercier's email address, so if you see this before our call tomorrow, could you please forward a copy?

I have kept these slides very informal because I am looking to simply frame the broader discussion.

Regards, David

David Welch, Ph.D.

kintamav_RGB

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From: Bodi,Lorri (BPA) - E-4

Sent: Tue Nov 07 16:56:34 2017

To: David Welch

Cc: Mercier,Bryan K (BPA) - EW-4

Subject: RE: [EXTERNAL] RE: Can't call in!!

Importance: Normal

Thanks David. Here is Bryan's email.

-------- Original message --------
From: David Welch <David.Welch@kintama.com>
Date: 11/7/17 4:17 PM (GMT-08:00)
To: "Bodi,Lorri (BPA) - E-4" <florrainebodi@bpa.gov>
Subject: [EXTERNAL] RE: Can't call in!!

Lori—

Thanks for your time today—interesting that we both independently used the term cognitive dissonance to describe the current situation.

I realized that I forgot one of the most important points that I wanted to make. If I am right about the nearby coastal ocean having a huge impact on juvenile salmon survival, there is potentially a very large economic payoff for the US Treasury with little downside for salmon conservaton. This is because if people haven't correctly incorporated what is determining survival, then boosting survival by manipulating flow in a different way (or, equivalently, demonstrating that there is very little effect of flow on net survival because of ocean survival rates) potentially frees up a lot of flexibility and revenue generation on the power generation side.

You would have to engage the power production folks on this to run the numbers, but I suspect that there could be clean power producing opportunities on the order of $50M~$100M per year if a lot of the current constraints could be shown to not be benefitting salmon.

Food for thought!

I quickly looked for Bryan's email address, but didn't find it, so if you think this is of potential interest to discuss, please pass it on.

David

From: Bodi,Lorri (BPA) - E-4 [mailto:florrainebodi@bpa.gov]
Sent: Tuesday, November 07, 2017 2:04 PM
To: David Welch; Renner,Marcella P (BPA) - E-4
Subject: RE: Can't call in!!

PLEASE JUST CALL MY DIRECT NUMBER 503 230-3076

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, November 7, 2017 2:02 PM
To: Bodi,Lorri (BPA) - E-4 <florrainebodi@bpa.gov>; Renner,Marcella P (BPA) - E-4 <mprenner@bpa.gov>
Subject: [EXTERNAL] Can't call in!!
Importance: High

Lori, Marcella—

I am trying to call in to the number I was given, but Verizon is telling me there is no meeting.

Can you please call me?

Thanks, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

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P Please consider the environment before printing this e-mail

From: David Welch

Sent: Thu Nov 23 10:04:14 2017

To: tom.cooney@noaa.gov

Cc: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] FW: NOAA Presentation...

Importance: High

Attachments: Extract_Hanford_RIS.xlsx

Hi Tom-

Christine had mentioned that she had seen you at a meeting a couple of weeks ago, and said that you would be busy putting something together until about now.

We are now in the process of trying to write up the whole analysis, so this would be a very good time to try to explore your concerns about the level of survival we are recording (see my summary of your original comments at the bottom of this email train to refresh your memory). Otherwise, we are about to go into an extended period of write-up, and I would very much like to ensure that any concerns about data quality are addressed first.

If this is not a good time to discuss your comments following my presentation to NOAA staff in early October, please advise as to a date that will work better for you, so I am not simply pestering you.

Regards,

David

kintamav_RGB

Office: (250) 729-2600

Mobile: [redacted]

From: David Welch
Sent: Thursday, October 26, 2017 2:24 PM
To: tom.cooney@noaa.gov
Subject: FW: NOAA Presentation...

Hi Tom—

Just jogging your memory on this (& sorry for being a pest!). If possible, I would like to discuss with you why you think that the SARs data we may be using are understating survival for some of the non-Snake River stocks.

I am re-attaching the data Aswea sent to you 10 days ago. Give me a call when convenient to discuss any concerns, as I would like to address any possible issues as soon as possible.

Regards, David

From: David Welch
Sent: Friday, October 13, 2017 10:44 AM
To: 'tom.cooney@noaa.gov'
Subject: FW: NOAA Presentation...

Hi Tom--

I appreciate you taking the time to look at the data-- it is obviously critical that we get this analysis as correct as possible. (b) (6) [redacted] but my schedule Is wide open for several weeks starting on the 23rd. I would like to discuss your thoughts further at that time; meantime, here is the data set that we are using

Regards, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

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Regards,

David Welch

From: Aswea Porter
Sent: Friday, October 13, 2017 8:47 AM
To: David Welch
Subject: RE: NOAA Presentation...

Hi D,

Here is the dataset and plot for Hanford. Priest Rapids Dam is at the boundary between the MCOL and UCOL regions and we don't have a dataset specifically tagged at this dam. I've attached the info for Rock Island Dam instead in case that's the one of interest.

~A

From: David Welch
Sent: October-12-17 20:51

To: Aswea Porter
Cc: Erin Rechisky
Subject: NOAA Presentation...

I thought it went well. We had two sorts of helpful comments: (1) Use more sophisticated statistical methods (specifically, Dynamic Factor Analysis rather than LOWESS), which I will have to think about.

Second, Tom Cooney of NOAA expressed some concerns that a couple of the PSC CWT datasets showed much lower survival than he had expected: Specifically, Hanford Reach and Priest Rapids.

Could you extract those two data sets and send them to me as an Excel file and as a scatterplot of SAR vs time (one for each of the two populations). I will send them on to Tom and we will try to dig into what might be the issue!

Now to go back and refresh my memory on DFA…

d

David Welch, Ph.D.

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From: David Welch

Sent: Thu Dec 07 10:53:24 2017

To: Mercier,Bryan K (BPA)

Subject: [EXTERNAL] Possible Funding for Comparing Ocean vs Freshwater survival rates...

Importance: Normal

Bryan-

I am just following up with you after our phone call with Lori on November 7th. To remind you of the conversation, you said you would speak with our COTR, Christine Petersen, about adding back in the piece of work that had to be dropped because of financial limitations.

In my opinion, this currently unfunded piece of work is critical to BPA changing the debate—documenting the similarity in smolt survival rates in the coastal ocean and in the hydrosystem will bring into sharp focus the current failure to think about what happens to smolts if they are "flushed" out of the system faster. Right now people say that survival is higher for smolts arriving at Bonneville Dam sooner (high water years, for example), but ignore what happens to those smolts after they pass below Bonneville; it is logically incorrect to say that survival is "higher in high flow years" (as is currently done), because this assumes that no smolts die after passing Bonneville.

What we will be able to demonstrate with the additional funding & existing data is that:

(1) survival rates are roughly equal between the ocean and hydrosystem, so a real conservation benefit is only

possible in years when ocean survival is better.

(2) that there is a deep logical flaw in how people think about survival in the hydrosystem… they forget to scale by travel time to standardize the results. Survival is not necessarily better in years of higher flow; what is (largely) happening is that in years of high flow salmon reach Bonneville Dam sooner. Failing to correct for this means that the claimed benefits of high flow are overstated.

(3) We will be able to show why transportation has never worked as expected, and it likely has nothing to do with "differential-delayed mortality"… it is just that people forgot to take into account what survival was in the ocean when they transported them around the dams. Much of the money spent on research to find out why transported fish don't have better SARs was misplaced because people just never considered whether survival would be better in the ocean after they get there.

These are all elements of the same issue, but illustrate why there is a glaring gap in how people are currently thinking about salmon conservation.

Regards, David Welch

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile: (b) (6) [redacted]

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From: David Welch

Sent: Wed Dec 13 09:03:00 2017

To: tom.cooney@noaa.gov

Cc: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] FW: NOAA Presentation...

Importance: High

Attachments: Extract_Hanford_RIS.xlsx

Hi Tom—

Christine mentioned that you were retiring in the next couple of months-congratulations!

I know you must be very busy with wrapping things up, but I would really appreciate your guidance into what you thought was odd in the survival estimates from the presentation we prepared for NOAA last fall—at the current time, we are progressing with our write-up of the analysis we did, but I am concerned that you have suggested there might be an error in the raw data (or something "odd", anyway).

To refresh your memory, I believe that your specific comment was that you thought one of the Columbia stocks (Hanford) should have had higher survival relative to the Snake River stocks than we were showing in our data. Beyond that, I have no firm idea as to what specifically might be the concern—which makes it hard to know what to look for!

Could you please either advise what your concern was or that you won't have time to look into this prior to retirement.

Best regards, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile(b) (6) [redacted]

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Sent: Thursday, November 23, 2017 10:04 AM
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Cc: Petersen,Christine H (BPA) - EWP-4
Subject: FW: NOAA Presentation...
Importance: High

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David

kintamav_RGB

Office: (250) 729-2600

Mobile: (b) (6) [redacted]

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David Welch, Ph.D.

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David Welch

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Subject: RE: NOAA Presentation...

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Sent: October-12-17 20:51
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Subject: NOAA Presentation...

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From: David Welch

Sent: Wed Dec 13 09:03:51 2017

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: draft study

Importance: Normal

Thanks, Christine—

Interesting politics going on! I must admit that I have been buried in the details of work on the BPA contract (and another one on this side of the border—although Erin is taking the primary lead on that work), so I hadn't been following the Columbia Basin Bulletin in the last few weeks.

A few quick points:

1) Tom Cooney has never gotten back to me… frustrating, because he said he has "concerns" about some of the survival values we outlined, but hasn't given me ***any*** details about what I should look for to try to address. There is no way for me to go forward and pro-actively look for potential issues unless he actually gives me something concrete… which he hasn't.

2) I have emailed him at least three times since our September presentation about this. (The last time was 23

November). You have indicated below that Tom is retiring in a couple of months, which I didn't know. At this point I guess that all I can do is to email him again and send him the same information yet again—I will CC you. But if possible, I would now appreciate some help with this—if there is an issue with some of the data, it is getting to the point where we might have to do significant back tracking in the writing we have been doing if there is a problem—but so far, I have nothing concrete to deal with.

3) I am hoping to have a solid first draft done by the end of January. It's a bit early to be more certain of my timeline at this point, but that is where things look to be heading. Let me know if there is something specific that I can provide that might be helpful sooner rather than later.

Thanks, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, December 07, 2017 4:24 PM
To: David Welch
Subject: draft study

Hi David,

I have not checked in with you recently. Were you hopefully able to exchange data with Tom Cooney? He does appear to be really busy.

Jeff Fryer was nice enough to invite me to a Portland meeting with about half Canadian/Okanagan attendees where they were scoping out potential for doing a mid-Columbia sockeye model. Scott Akenhead (said he knew you and had good things to say) and Kim Hyatt had some of the more impressive presentations. Scott had been able to parse some differences between the Wenatchee and Osoyoos populations – which tend to be bunched together for statistics such as freshwater survival even though they have different run timing and spawning. Rishi Sharma told me he might take on a few tasks that Cooney has when he retires in a couple months but not the SPS database stuff, and he will also still be doing some ocean work.

You might want to be generally aware of some of the turmoil in court right now – BPA is supposedly proceeding as though everything is on the original schedule but the Corps has actually stopped work on some pieces of the Biological Assessment. It struck me that we could actually use a two month extension on the BA – I am not on the BA team and only saw the document for the first time 2 or 3 weeks ago, but Jason Sweet and I were asked to write up some Compass vs. CSS background for our proposed version of the high TDG spill test – which is going ahead this coming spring, in 2019 (hopefully as a somewhat legitimate experiment mostly designed by Steve Smith of NOAA) but also is expected to be continued by the judge for several years into the future. We have not completed this part yet, and major subjects such as transportation which were handed to the Corps are pretty much advocating for a rollover of the status quo. Hence, I think we could easily benefit from a couple more months time. Still – there will be dialog back and forth with NOAA as they are expected to start their BiOp in January. I also need to circle around with Jeff Stier and see what he is adding, pertaining to your study. There is not a long list of references for the BA, but rather, there are some selective insertions of data tables and figures to make a key point.

http://www.cbbulletin.com/439901.aspx

Christine Petersen

From: David Welch

Sent: Wed Jan 10 14:34:30 2018

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] RE: Draft summary [& A Wording Correction]

Importance: Normal

No worries on this, and thanks for the clarification on both points.

We will stand by.

Best, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, January 10, 2018 2:33 PM
To: David Welch; Erin Rechisky; Aswea Porter
Subject: RE: Draft summary [& A Wording Correction]

Hi,

Yes – I definitely meant 'correctly' or accurately characterize your study – that must have been a typo or autocorrect error.

For contacting FPC, I just asked a few folks here to weigh in because someone might have a strong opinion about it. You, or anyone, is free to independently contact them at any time of course, but there might be some contract language where BPA would want to stick up for data accessibility and so forth. Give us a day for our folks to respond.

Talk to you soon,

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, January 10, 2018 12:21 PM
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky; Aswea Porter
Cc: David Welch
Subject: [EXTERNAL] RE: Draft summary [& A Wording Correction]

Hi Christine—

Happy New Year—I hope that you had a good break over Christmas and the new year with your family. I was travelling home on the 8^{th} & 9^{th}, so I could not easily respond to your email.

Erin's initial response gave you a quick sense of where things are. I can work to draft an abstract this week, but it will probably be Friday before I can share it with you—I need to both draft it and work with Aswea and Erin to get the draft wording right—as we are in the process over the next few weeks of trying to further write up the data analysis and refine what we are doing, the initial draft abstract will be a work in progress; the final wording in the abstract will have to follow on the completion of the paper, of course.

1) One comment or note of caution—as we have discussed before, the requirements for publication in the peer-reviewed literature requires that we maintain our scientific independence from BPA while at the same time making sure that our results & conclusions are available and useful—but without undue influence from the funder. This is always a challenge, and there is no one perfect way to make sure that happens, but I think that there is a typo in your sentence below. You say "Jeff Stier may also work with you regarding correcting characterizing the results of your study". I think you meant to type "*correctly characterize the results of your study*" (not "*correcting*"!), but I would appreciate you responding to explicitly clarify your meaning here—in my past experience people who are requesting emails under FOI legislation may choose to deliberately mis-characterize such ambiguous statements in the most unfavourable light possible, so I would appreciate an email response from you clarifying your intended meaning. As previously agreed to, we are happy to answer questions and enter into discussions about what the analysis means or clarify ambiguities, but we will apply our best efforts to the analysis—we will not attempt to correct them or otherwise spin them in support of a predetermined outcome.

2) On your second point, I think that the data request to the FPC has gone unanswered for so long now that the best course of action is probably for me to write Michelle de Hart directly and explain that you had requested the data on our behalf for an analysis that we are doing. I think that if I request it directly for Kintama's use that will elicit a response and we can then hopefully actually get the data. However, the delivery of the requested data is very late in the analysis (and, in any case, won't have a clearly trackable scientific provenance, unlike the survival data published in the CSS reports), so we are likely going to add it in as a "Supplementary Info" section to give some sense to the reader (and us!) as to what level of survival losses occur prior to the PIT-tagged smolts reaching the dams. I don't think that there is enough time left in the budget to completely re-work the analysis using an unproven and unpublished dataset, and I think using it as the primary dataset will raise major unanswered

questions concerning how that data will relate to the published CSS survival estimates… and we just don't have the time to do all of the checks needed. Do you agree with this course of action?

3) I am in the office for the rest of the month and happy to answer any questions concerning the daily survival rate proposal.

Best, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, January 08, 2018 11:48 AM
To: David Welch; Erin Rechisky; Aswea Porter
Subject: Draft summary

Hello,

Happy New year.

I haven't checked in, in the last couple of weeks. (I have not heard anything back from FPC regarding the data request reminder).

Let's see – someone asked if you have a draft abstract for your paper? Or is there a presentation which you think might capture the most recent progress with your project.

Jeff Stier may also work with you regarding correcting characterizing the results of your study. We are still working on the BA or 'proposed action', with the deadline shifted forwards two months as some elements were stalled in court. Likewise, it looks like the major Environmental Impact Statement effort will be delayed by 2-3 months. It is a welcome period for helping catch up on some other activities.

Later this month I will review the third part of your original proposal with our budget team (the daily survival rates concept that you originally started working on). I will need to contact you to get updated potential budget numbers and project description.

Thank you

Christine Petersen

(503)230-4695

From: Erin Rechisky

Sent: Tue Jan 16 12:06:17 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Milestone "Oct-Dec 2017 (10/1/2017 - 12/31/2017)" is due in 5 days

Importance: Normal

Hi Christine,
I submitted the status report.
I also asked David about the abstract. He will continue to work on it this afternoon and get something to you soon.
Erin

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: January 16, 2018 10:28 AM
To: Erin Rechisky
Subject: RE: Milestone "Oct-Dec 2017 (10/1/2017 - 12/31/2017)" is due in 5 days

Hi Erin,

Sorry for not getting back to you about this.

In the administer contract section - these are for you. It is simpler than it looks. Probably not much was required this quarter for those so it is easy to check off.

What are the ones you are behind on... the targeted draft paper date? Just put a simple comment saying behind schedule, and it is fine as long as we have a brief communication on it - which is the purpose of these status reports. We have a lot of habitat restoration projects in our program, so the quarterly checkins are designed to prompt us to reassess schedules etc. and we just move deadlines forward.

By the way, do you have a draft abstract for your study - to help Jeff Stier summarize it accurately for our assessment document that we will give to NOAA by the end of February? He was asking for something like this last week. He has the earlier powerpoint.

Thanks!

Christine

-----Original Message-----
From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Monday, January 15, 2018 12:51 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] FW: Milestone "Oct-Dec 2017 (10/1/2017 - 12/31/2017)" is due in 5 days

Hi Christine,
Our status report is due today. Please see below. I have to leave the office now but will get back to this tonight at home.

Erin

-----Original Message-----
From: Erin Rechisky
Sent: January 12, 2018 2:28 PM
To: 'Petersen,Christine H (BPA) - EWP-4'
Subject: FW: Milestone "Oct-Dec 2017 (10/1/2017 - 12/31/2017)" is due in 5 days

Hi Christine,
We are behind schedule on 4 tasks specified in the Status report. What do you recommend I put in the submitter comments column?
Also, there are 2 within the Administer Contract section. Is that for you?
Thanks,
Erin

-----Original Message-----
From: donotreply@cbfish.org [mailto:donotreply@cbfish.org]
Sent: January 10, 2018 2:00 AM
To: Erin Rechisky
Subject: Milestone "Oct-Dec 2017 (10/1/2017 - 12/31/2017)" is due in 5 days

Dear Erin,

Milestone "Oct-Dec 2017 (10/1/2017 - 12/31/2017)" of work element "185 - Periodic Status Reports for BPA" on contract #75025 under project #1996-017-00 ("Technical and Analytical Support for ESA Activities/Issues") is due on Jan 15, 2018.

If you feel this email has reached you in error, please contact your COTR, Christine Petersen (chpetersen@bpa.gov).

Thank you,

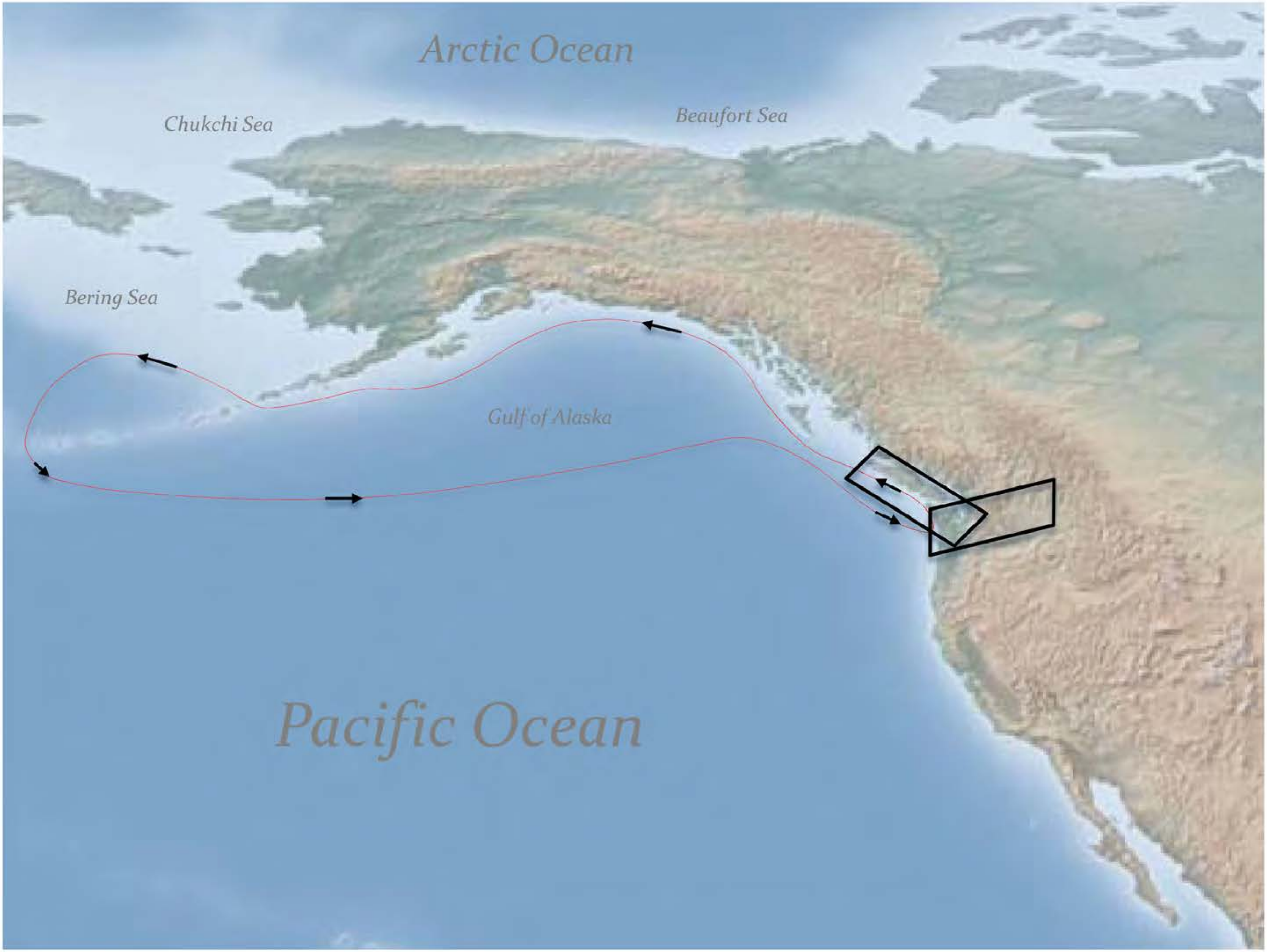
Environment Fish and Wildlife
Bonneville Power Administration

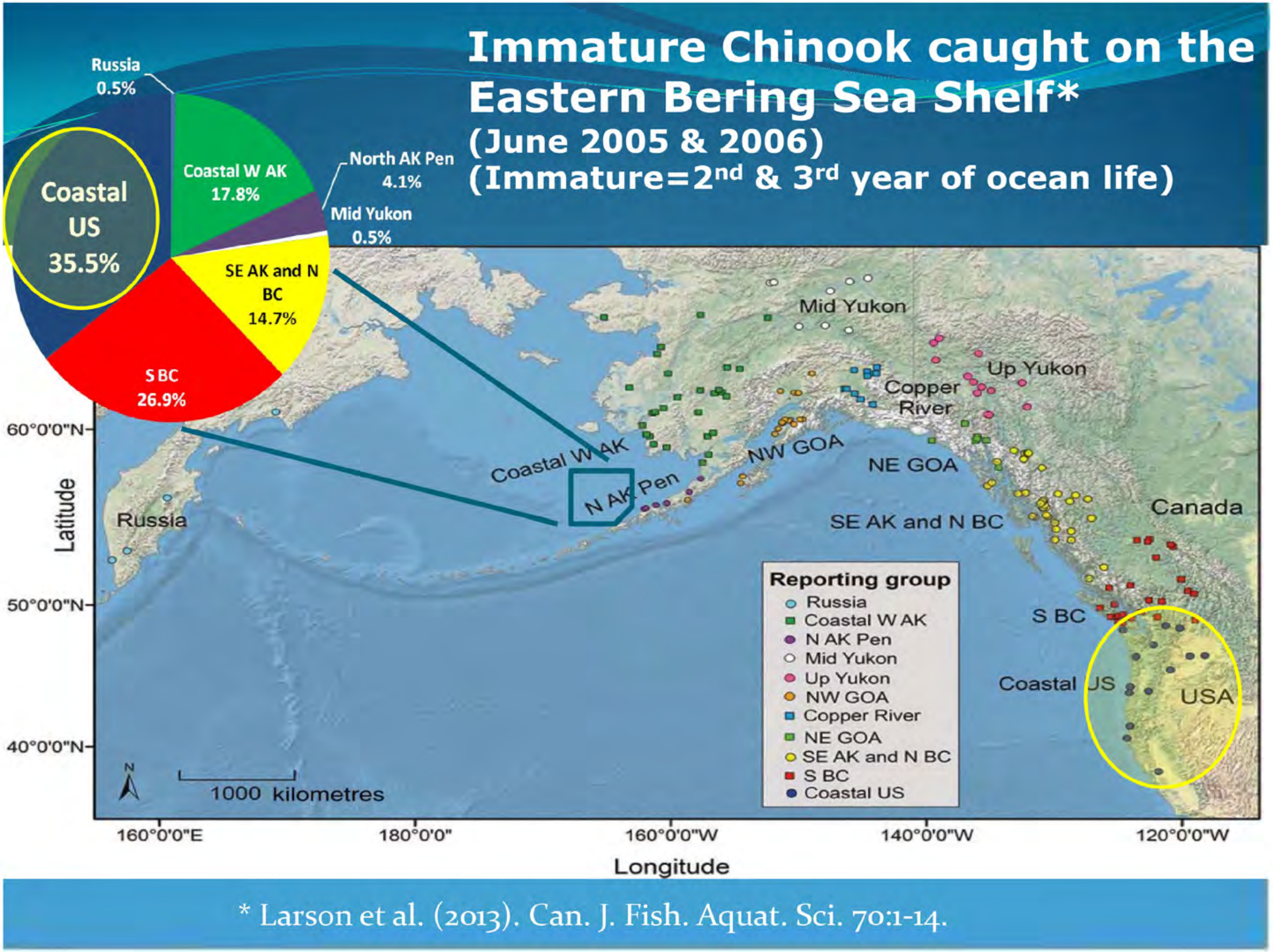
Outline

1. Setting the Scene—The Environmental Forecast
2. SAR Comparison: Columbia vs Everywhere Else
3. Large River Comparison: Fraser vs Columbia Rivers
4. Managing Hydrosystem Survival
5. Budgets/Timeline

David Welch
david.welch@kintama.com
(b) (6) [redacted]

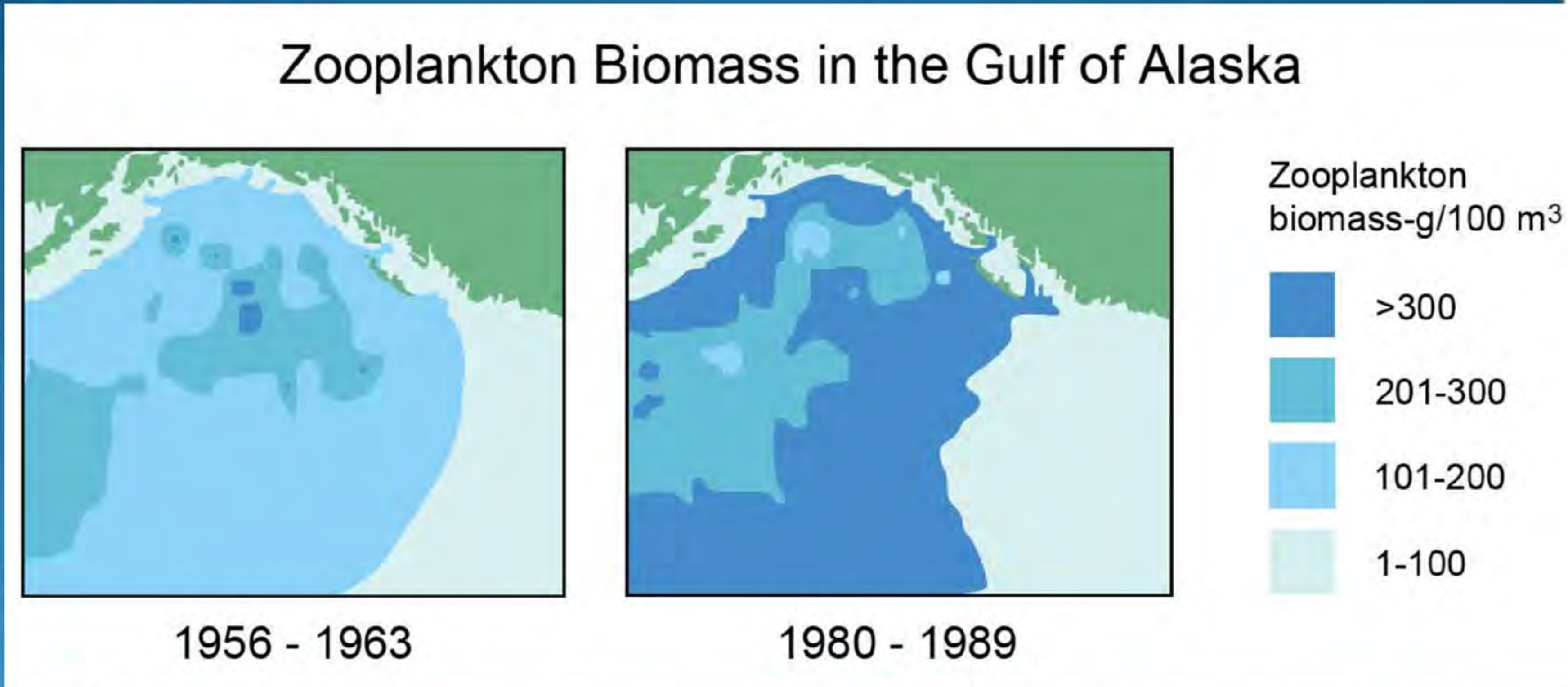
KINTAMA


Arctic Ocean
Chukchi Sea
Beaufort Sea
Bering Sea
Gulf of Alaska
Pacific Ocean



Immature Chinook caught on the Eastern Bering Sea Shelf*
(June 2005 & 2006)
(Immature=2nd & 3rd year of ocean life)
Russia 0.5%
Coastal W AK 17.8%
North AK Pen 4.1%
Mid Yukon 0.5%
Coastal US 35.5%
SE AK and N BC 14.7%
S BC 26.9%
Mid Yukon
Up Yukon
Copper River
Coastal W AK
N AK Pen
NW GOA
NE GOA
SE AK and N BC
Canada
Russia
S BC
Coastal US
USA
Reporting group
Russia
Coastal W AK
N AK Pen
Mid Yukon
Up Yukon
NW GOA
Copper River
NE GOA
SE AK and N BC
S BC
Coastal US
60°0'0"N
50°0'0"N
40°0'0"N
Latitude
160°0'0"E
180°0'0"
160°0'0"W
140°0'0"W
120°0'0"W
Longitude
1000 kilometres
N
* Larson et al. (2013). Can. J. Fish. Aquat. Sci. 70:1-14.

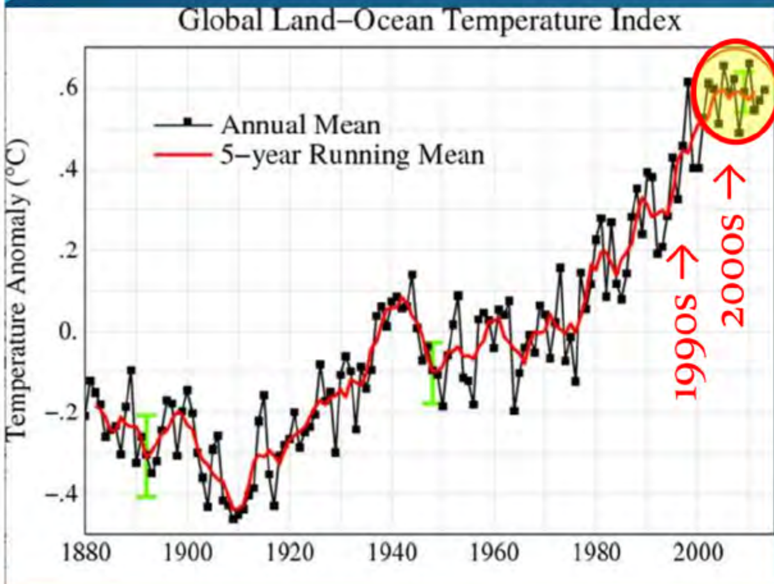
Big, Long-Term Changes Are Occurring in the Ocean

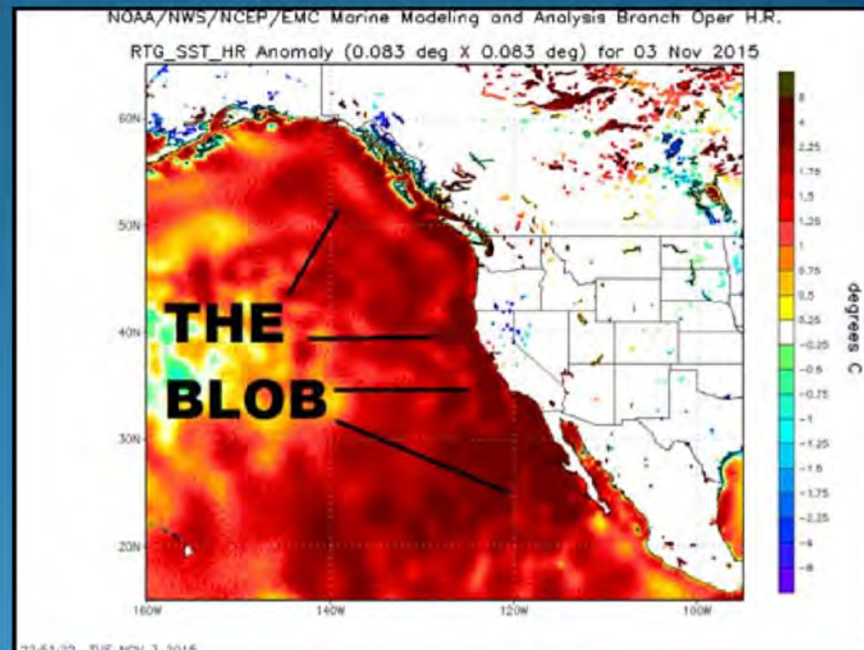


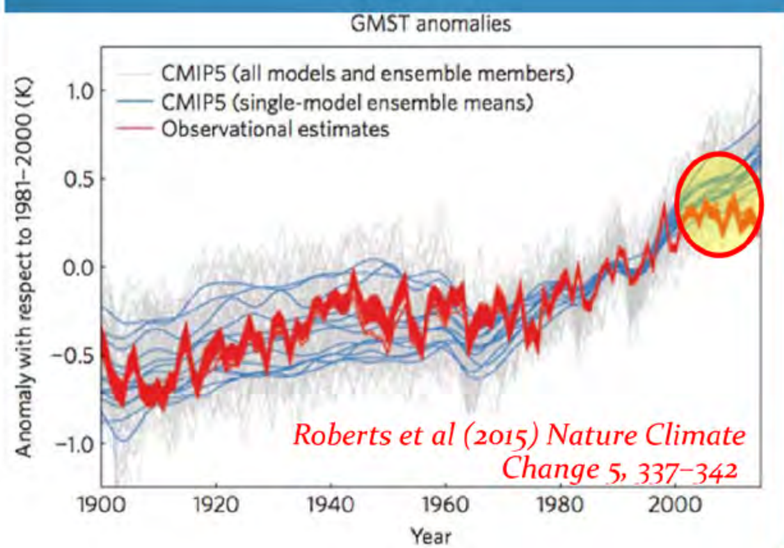
- Plankton far more abundant in the 80s than the 1950s & 60s
- 1980s corresponds to a period when salmon stocks from many (not all) regions increased

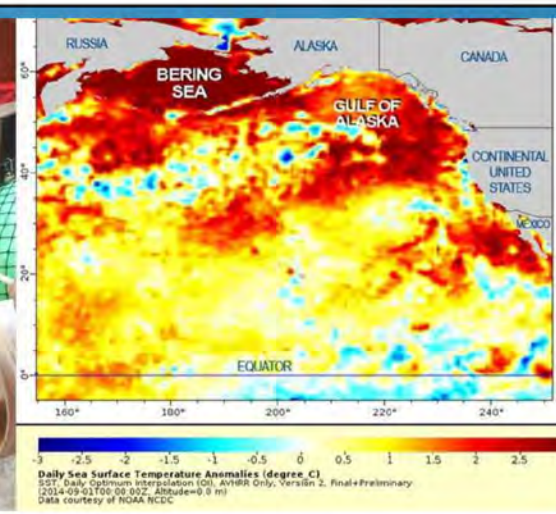
Brodeur, R. D., & Ware, D. M. (1992). *Fisheries Oceanography, 1(1), 32-38.*

The Future of Salmon is Hot & Sunny



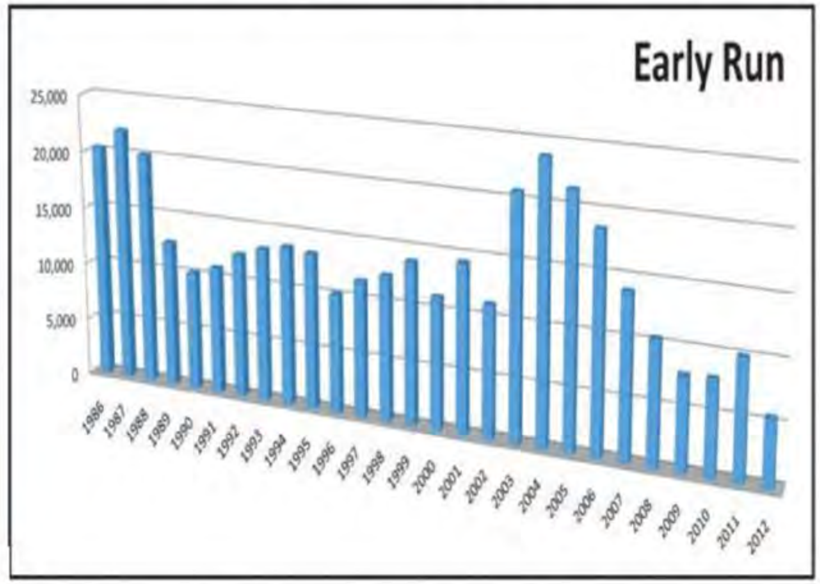


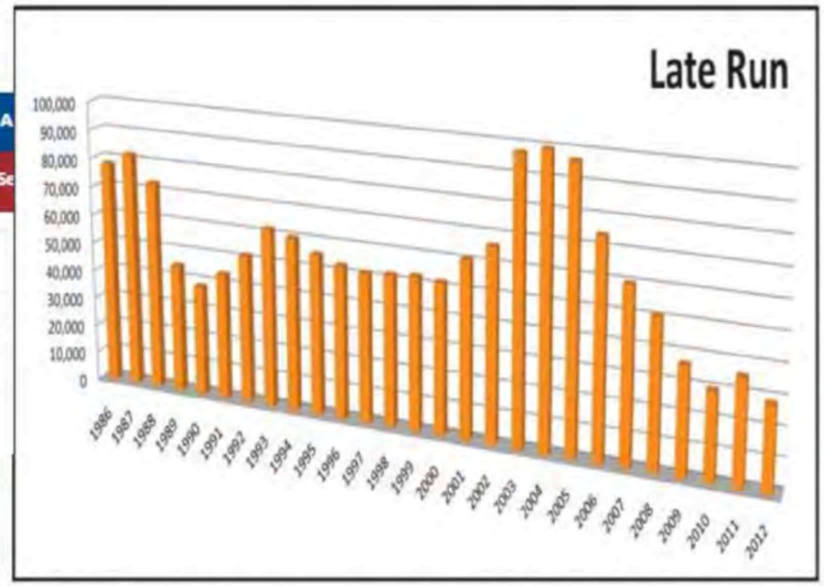




Chinook Resource Problems are Not Limited to the Pacific North-West

Kenai River King Salmon returns 1986-2012





Source: Alaska Department of Fish and Game 2013 interim escapement goal report, run estimates using a state-space model

ALASKA Journal of Commerce

HOME OIL & GAS FISHERIES CONSTRUCTION TRANSPORTATION TECH & TELECOM POLITICS A

Book of Lists Top Forty Under 40 Money Mining Health Opinion Movers & Shakers Special Se

Alaska Journal / November-Issue-1 2013 / Kings in cycle: Salmon follow boom and bust patt...

Kings in cycle: Salmon follow boom and bust pattern

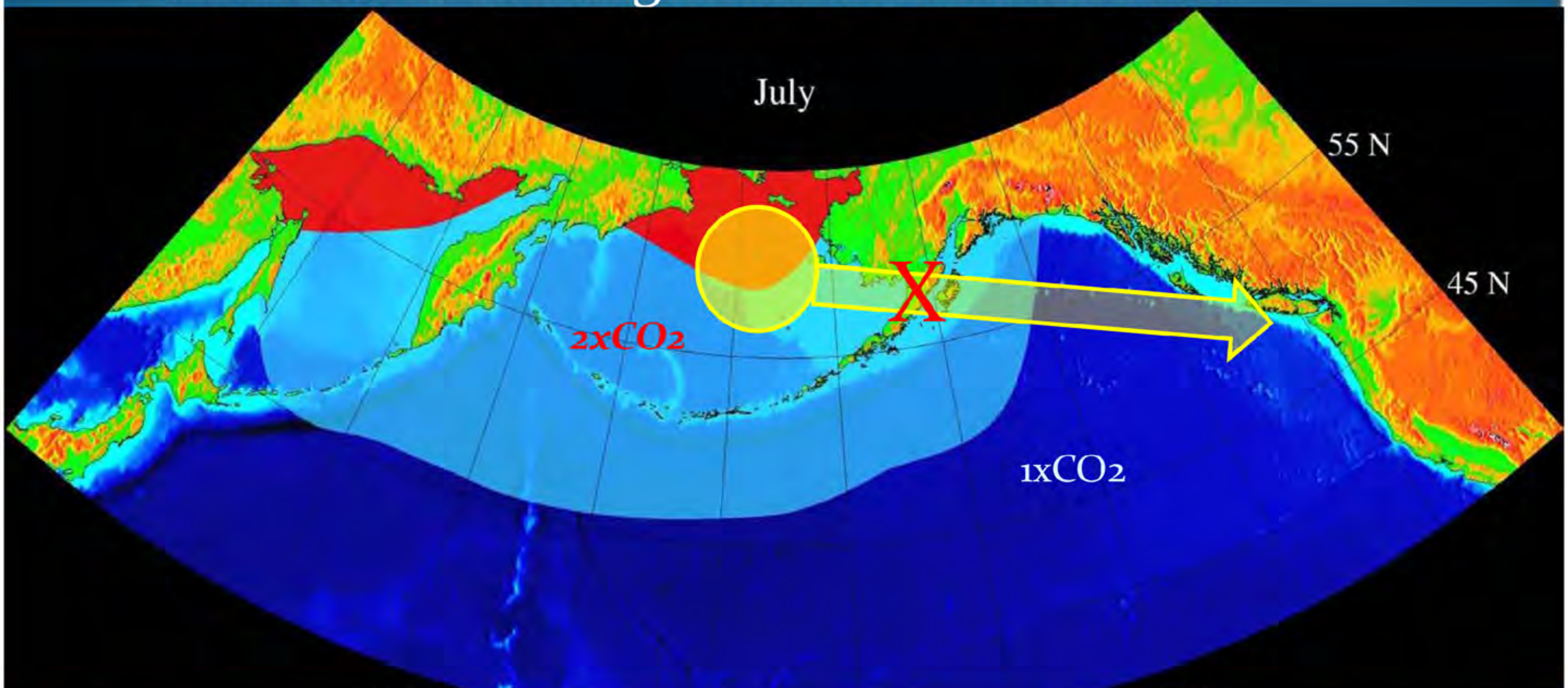
By: Rashah McChesney and Molly Dischner, Morris News Service-Alaska

Posted: Thu, 10/31/2013 - 7:04am

Source: http://www.alaskajournal.com/Alaska-Journal-of-Commerce/November-Issue-1-2013/Kings-in-cycle-Salmon-follow-boom-and-bust-pattern/

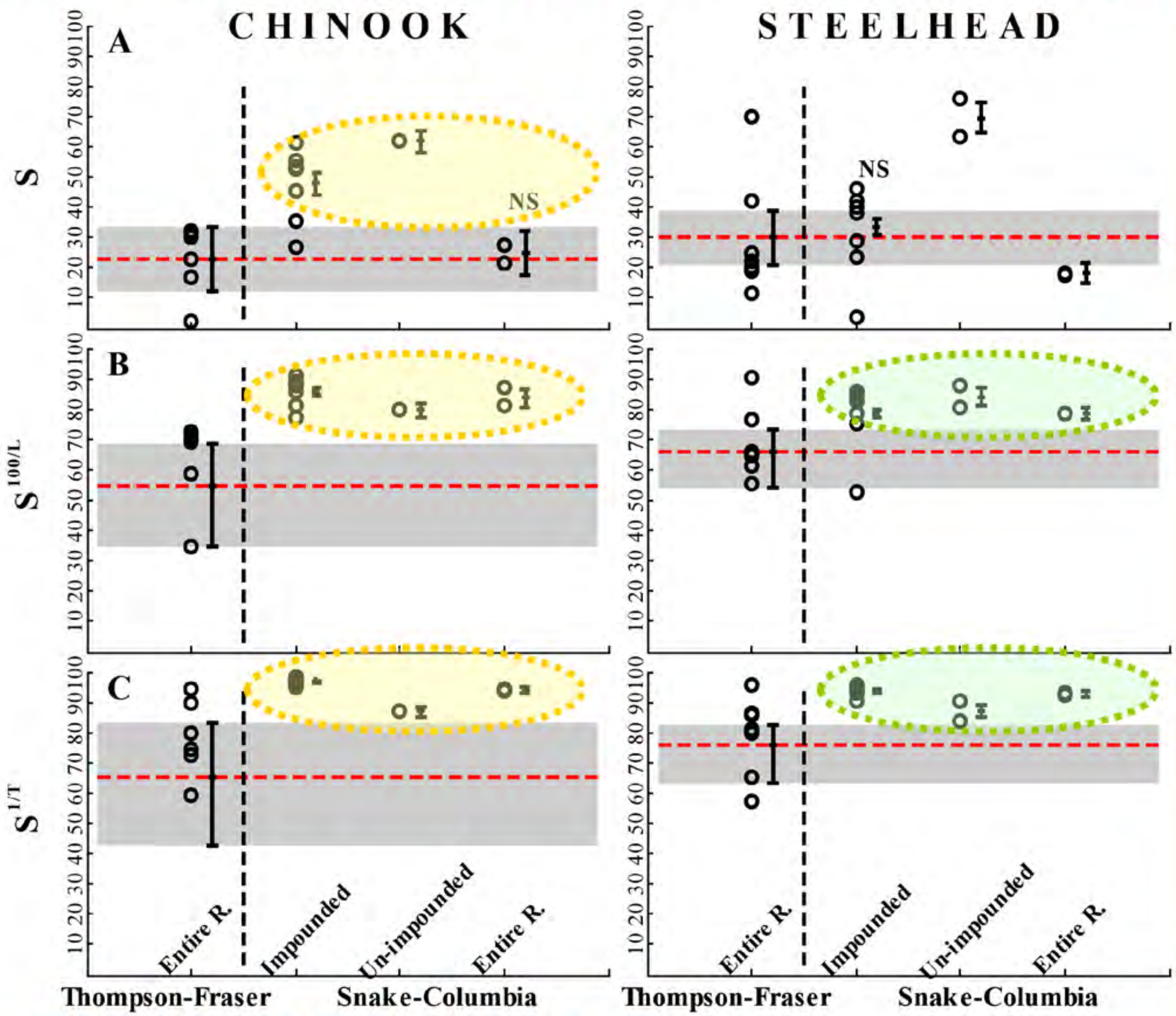
Global Warming-The Long Term View

- The details of how juvenile salmon migrate to the Bering Sea and then back to freshwater as adults may be critical to whether or not migration can be successful.



Welch, *et al* (1998). Thermal limits and ocean migrations of sockeye salmon : *Long-term consequences of global warming. Can. J. Fish. Aquatic Sci. 55:937-948.*

2008 “Large-Rivers” Paper: Thompson-Fraser v. Snake-Columbia Smolt Survivals



Welch et al (2008) PLoS Biology 6(10):e265

Survival To River Mouth

Survival per 100 Km

Survival per Day

In most comparisons, survival in the impounded section of the Snake-Columbia R was higher than in the lower river or the un-dammed Fraser

2008 “Large-Rivers” Paper: Thompson-Fraser v. Snake-Columbia Smolt Survivals

An Update Needed.

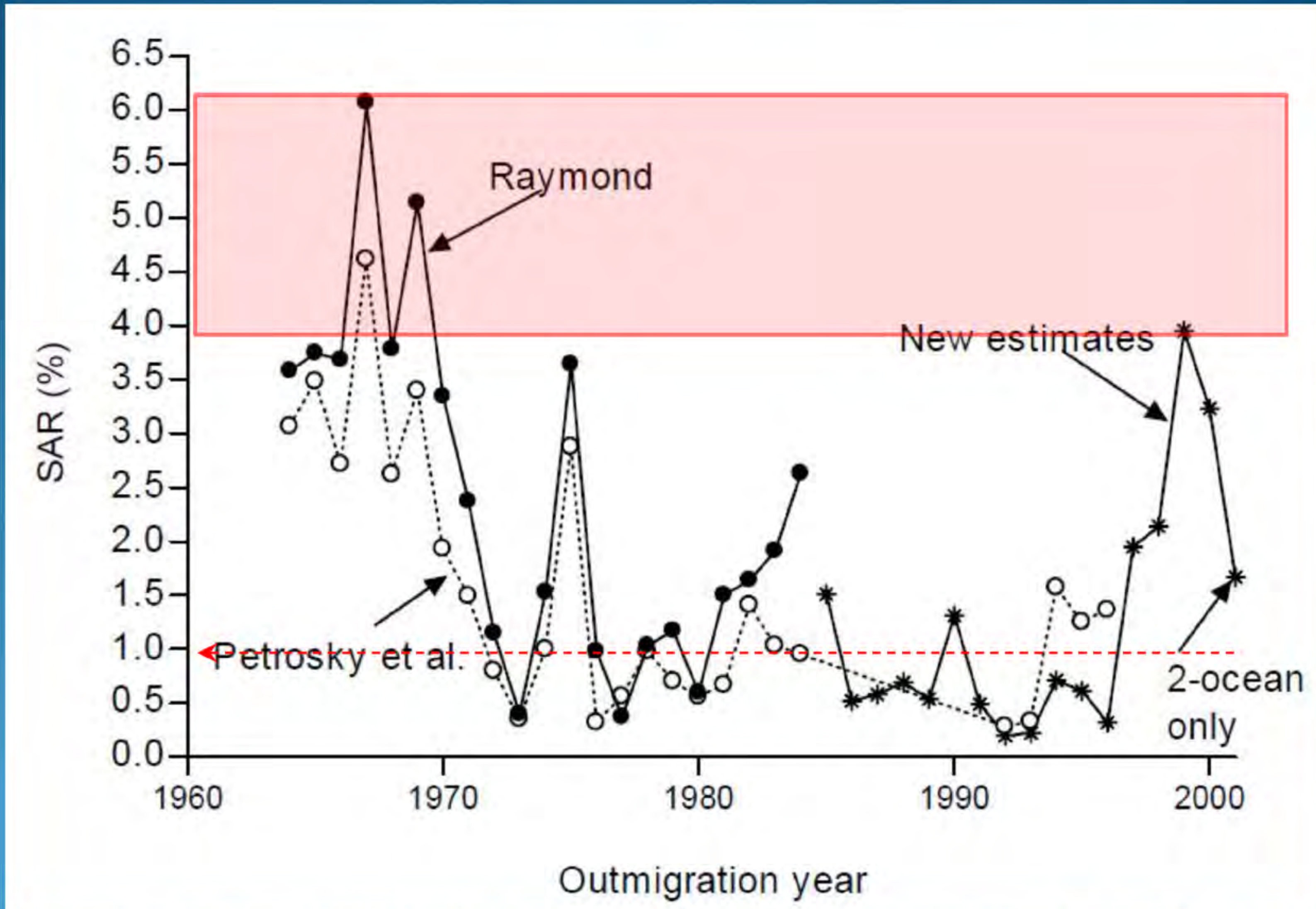
We now have tributary survival data for 3 Fraser River Populations showing that much of the survival loss is confined to the tributary, not the Mainstem

- Cultus Lake sockeye (2004-07)
- Chilko Lake sockeye (2009-16)[a,b]
- Chilko Lake Chinook (2016 only)

[a] Joint work with Scott Hinch/UBC
[b] Trib/mainstem data for 2011+12 only

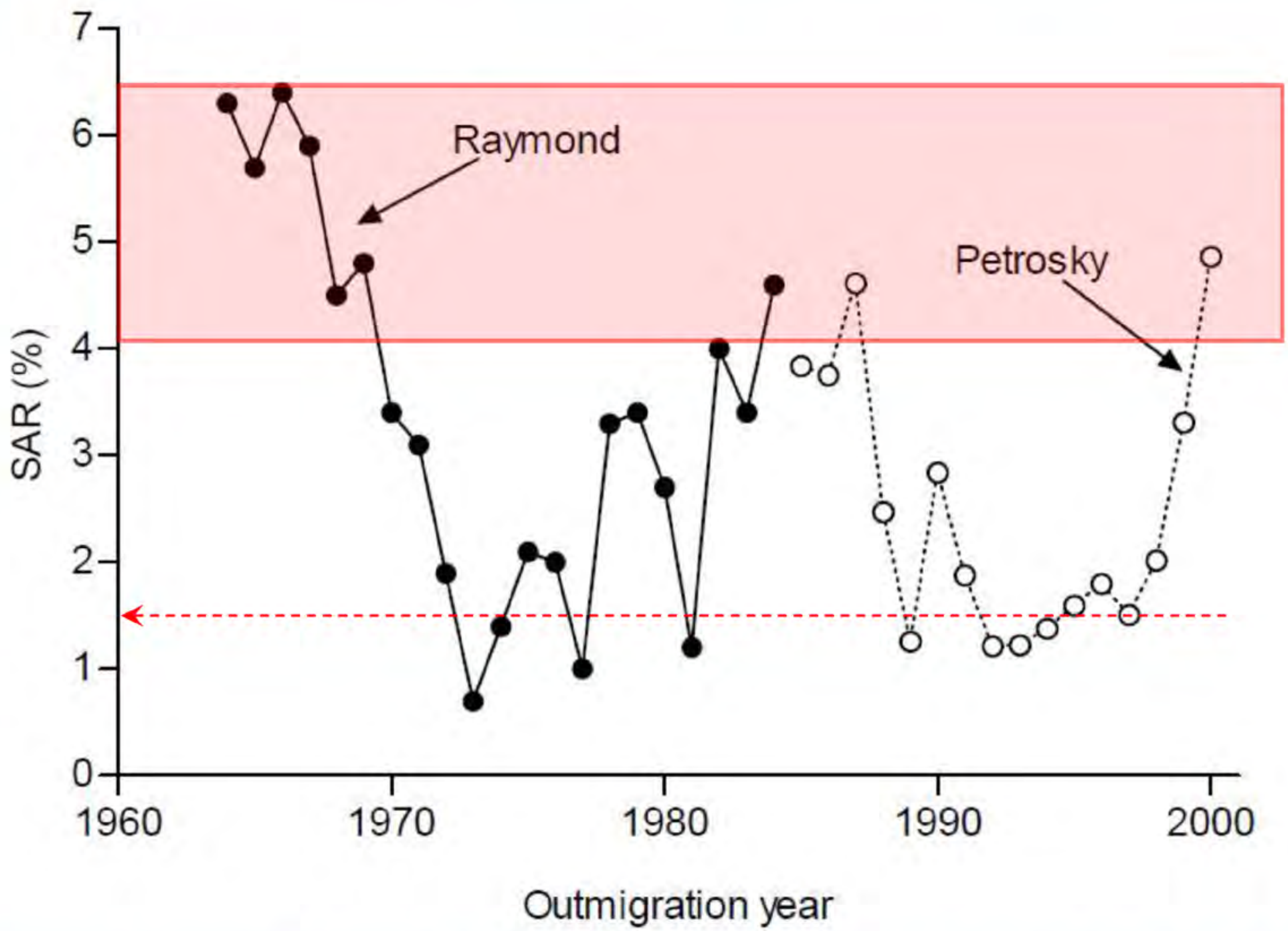
Columbia R SARS

Wild Snake River Spring Chinook SARS



Source: Williams et al (2005) NOAA Technical Memorandum NMFS-NWFSC-63 **Effects of the Federal Columbia River Power System on Salmonid Populations** (Fig. 2, p. 10)

Wild Snake River Steelhead SARS



Source: Williams et al (2005) NOAA Technical Memorandum NMFS-NWFSC-63 **Effects of the Federal Columbia River Power System on Salmonid Populations** (Fig. 4, p. 12)

Survival to Adult Return(SAR)

The product of survival through multiple habitats:

$$SAR=S1 \cdot S2 \cdot S3 \cdot .... \cdot S_{Late\ Marine}$$

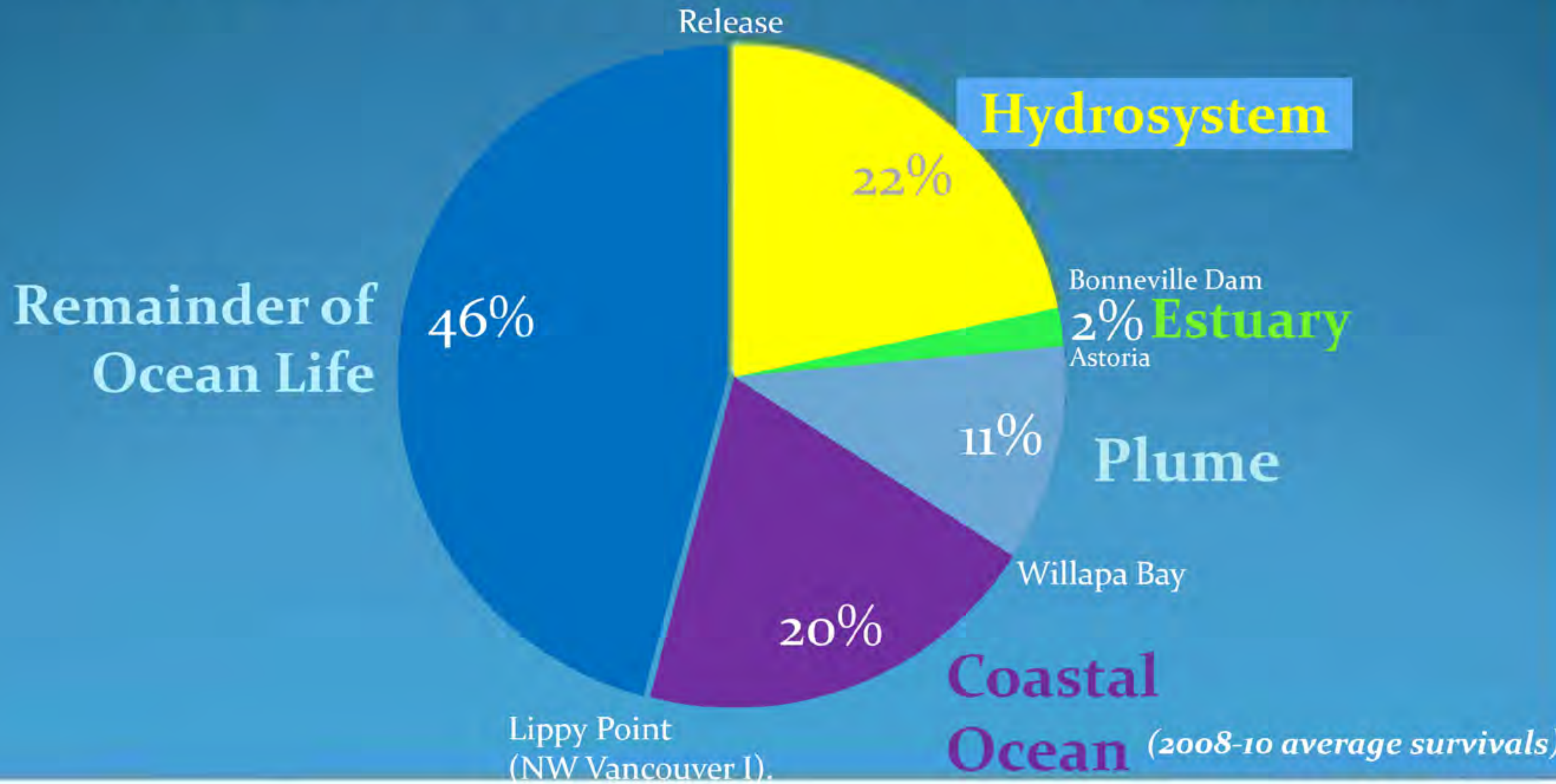
- It seems reasonable that many life history segments are key drivers of adult numbers, since:

ADULT RETURN=# Smolts Out • SAR

$$=\#Smolts \cdot S1 \cdot S2 \cdot S3 \cdot .... \cdot S_{Late\ Marine}$$

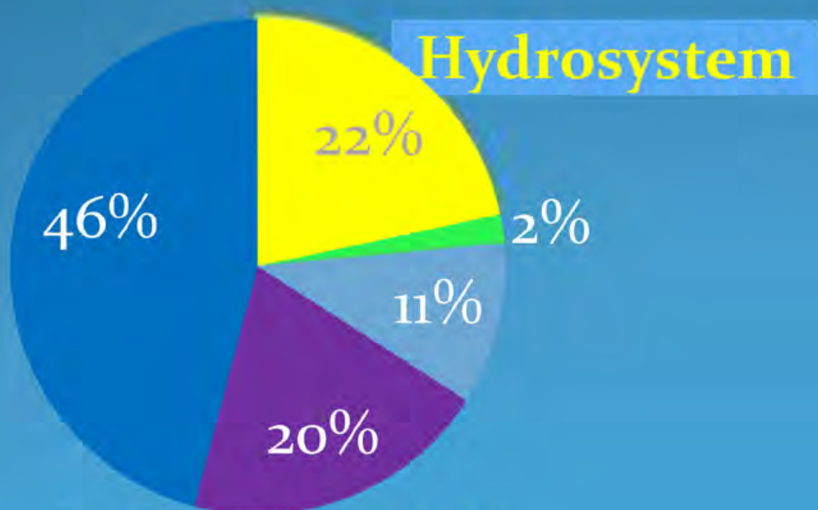
Where is Columbia River Survival Determined?

- Acoustic tag-based survival estimates indicate that majority of Chinook survival is determined at sea; hydrosystem & estuary have smaller roles compared to the ocean (Plume, Coastal Ocean, & "Remainder of Ocean").



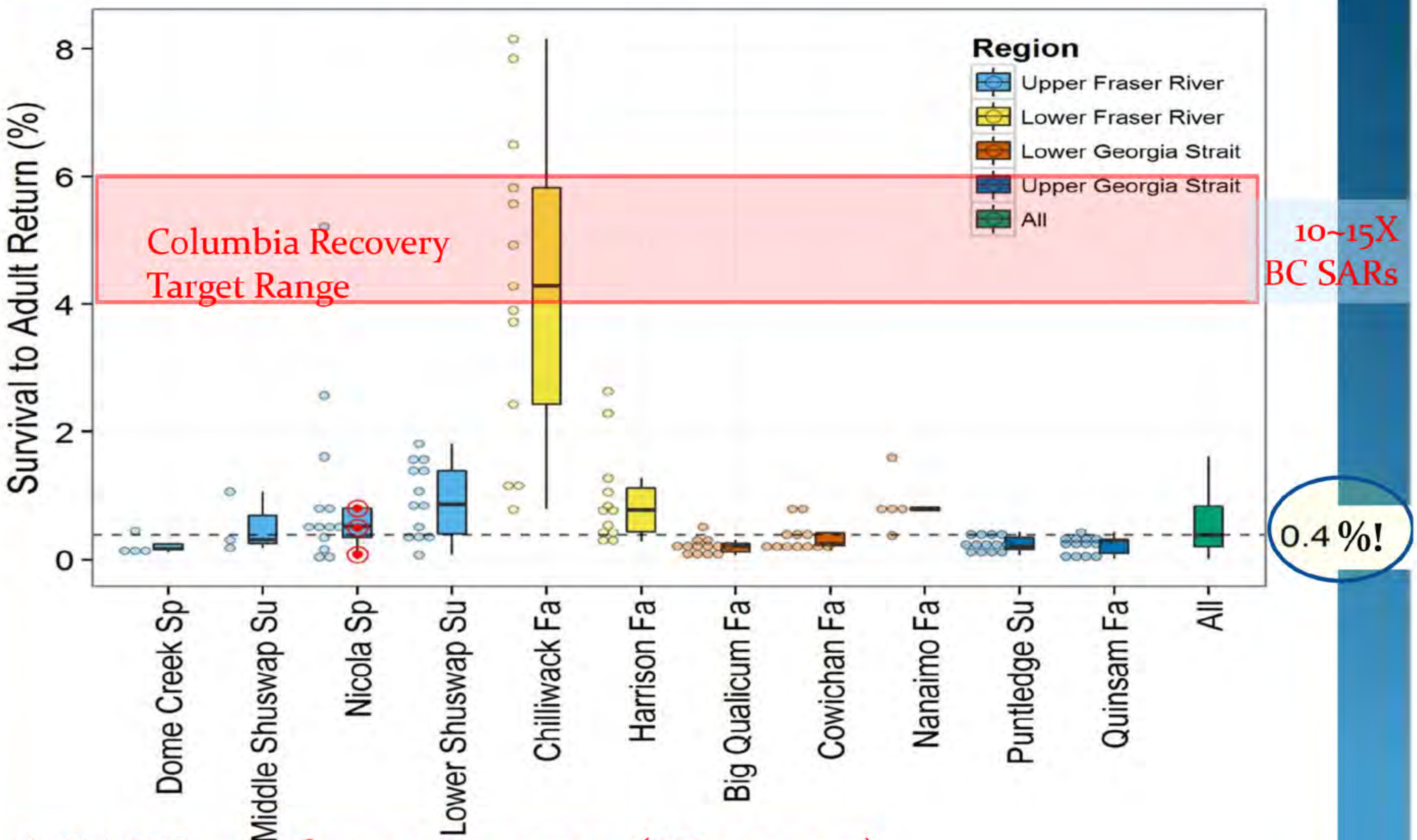
Where Are Columbia River Survivals Determined?

- We Can Now Quantify Relative Importance of Events Happening in the Ocean to SARs
- A Major Implication is that Studies Based on Statistical Correlation of SARS with Various Environmental Conditions have almost No Statistical Power… Thus Negligible Credibility



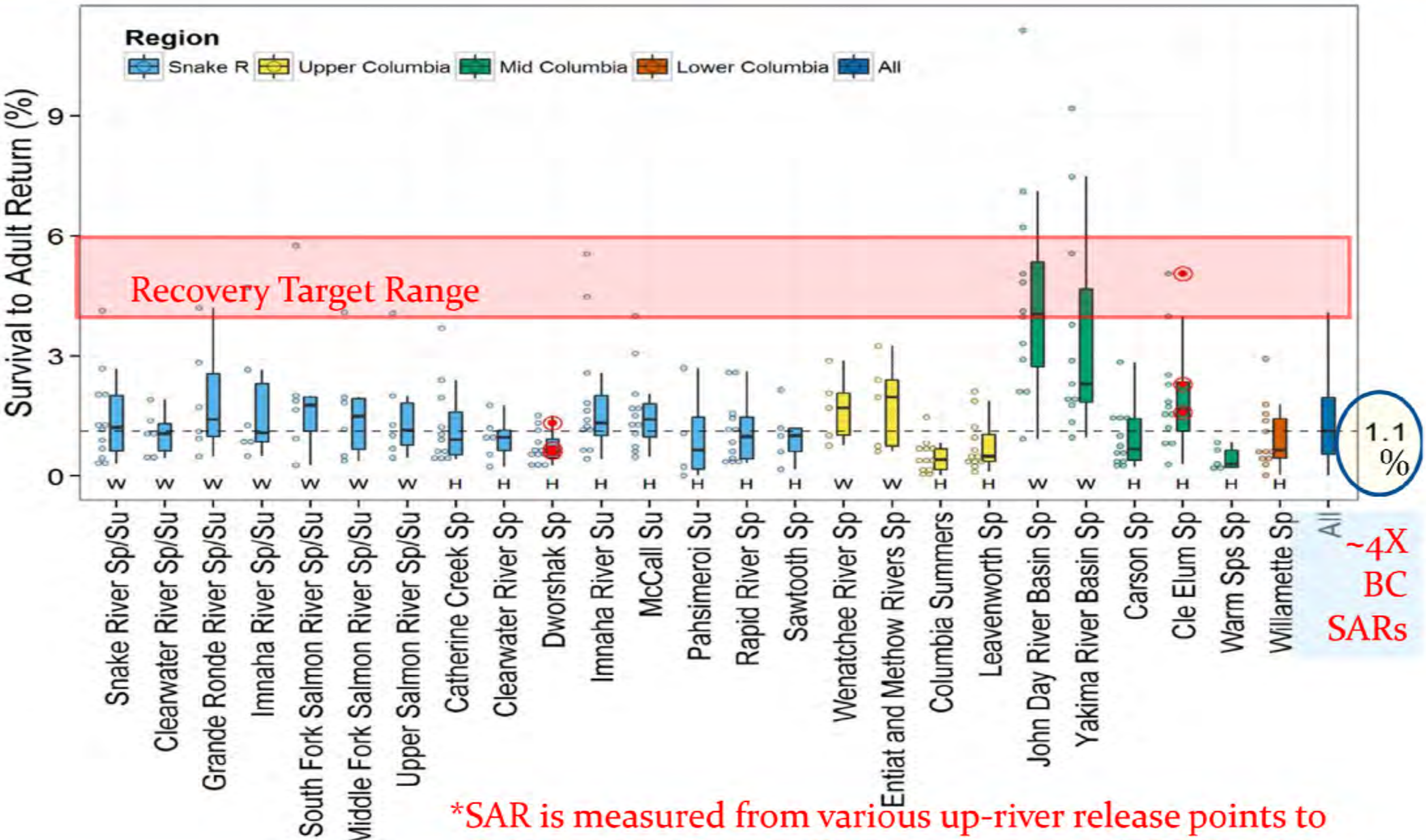
(2008-10 average survivals)

BC Chinook SARs



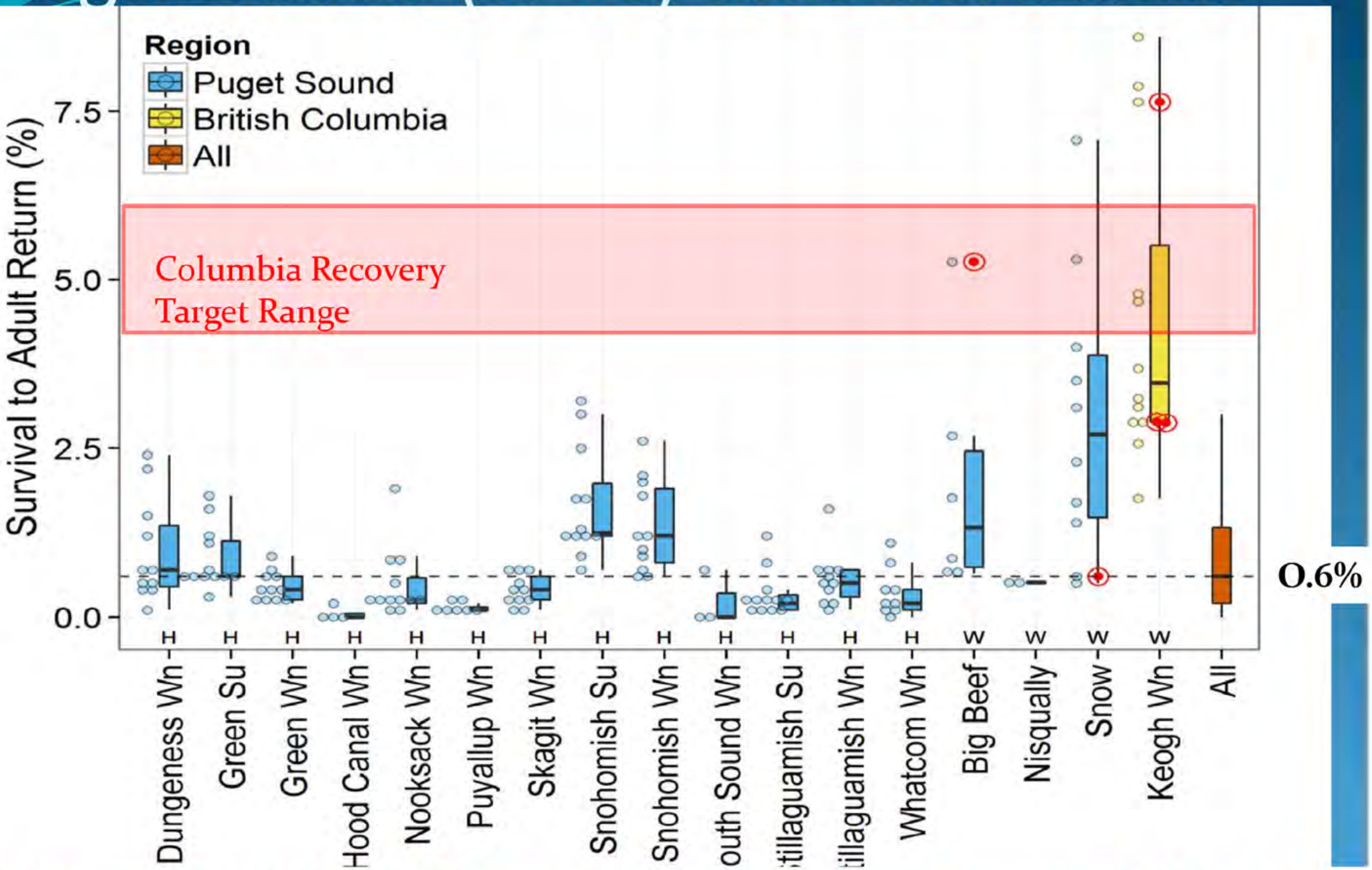
* SARS are for 2000-2012 (Kintama).

Columbia River Chinook SARs



*SAR is measured from various up-river release points to adult return at Bonneville Dam, 2000-2011 (FPC Data)

Puget Sound (& BC) Steelhead SARS



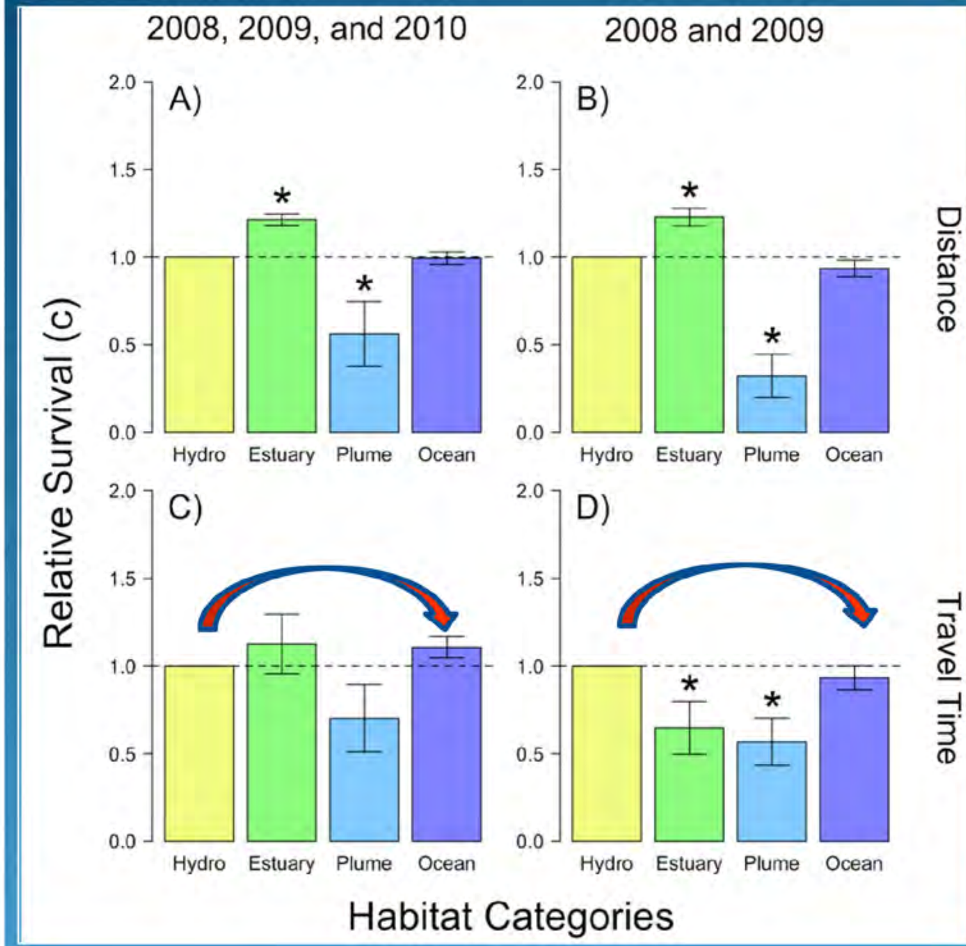
* Puget Sounds SARS are for various years, 2000 & later

Implications

- For BC Chinook stocks to "rebuild" to the Columbia level, SARS will have to increase 300-400%.
- To achieve the Columbia's Rebuilding Goals, BC Chinook SARs would have to increase 1,000~1,500%.
- Strongly suggests that the Columbia has the wrong perspective: It will not be possible to rebuild to current SAR targets (the 1960s) if other regions can't.
- Suggests (again) that the major issue is a common problem in the ocean.

Ocean vs Freshwater Survival

Ocean vs Freshwater Survival



- Measured hydrosystem and coastal ocean survival rates are similar; $S_{FW} \approx S_{Ocean}$

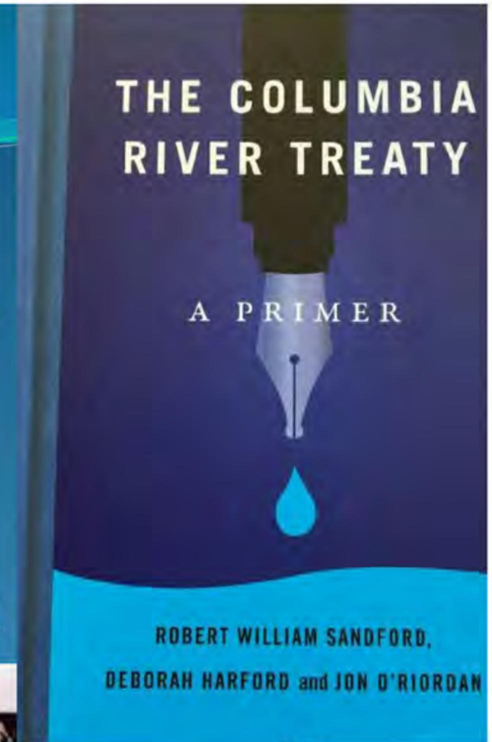
- This means that moving smolts out of the river faster will not necessarily benefit salmon conservation, but may just change where the smolts die: ➔ *"no net benefit".*

- There are important management implications; hydropower operations could potentially be shaped differently, easing some current constraints on power generation without hurting salmon conservation

Perspective

- Manipulating the hydrosystem for salmon (spill, drawdown, breach) is in essence a trade-off:
  - Smolts spend less time in the river…
  - … & more time in the ocean
  - Whether this improves conservation depends entirely on the implicit assumption that the ocean is the better environment

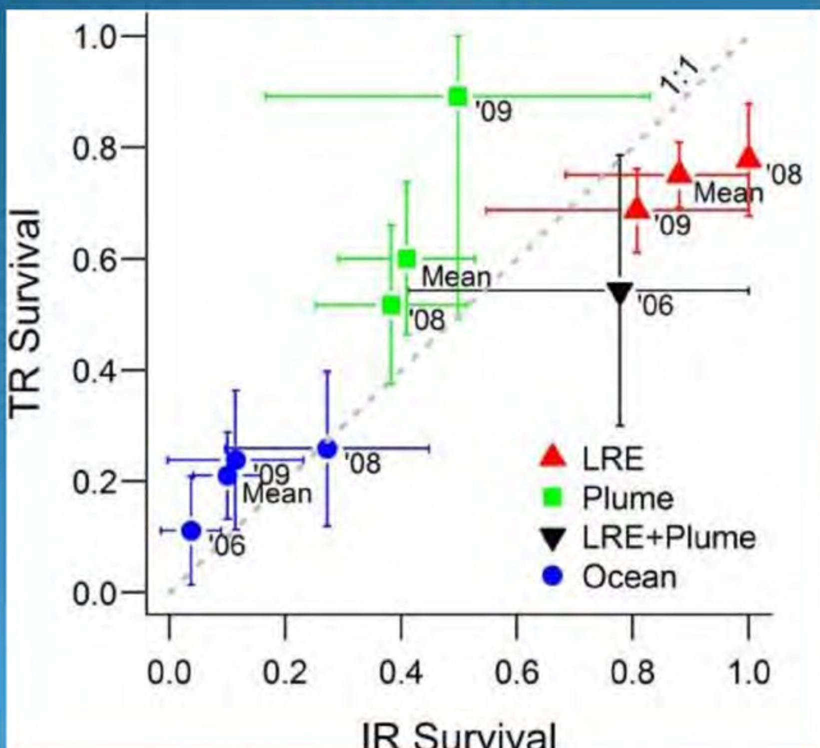
Out of the frying pan and into the fire



"Delayed Mortality" & "Differential-Delayed (Transport) Mortality" Show Role of Ocean

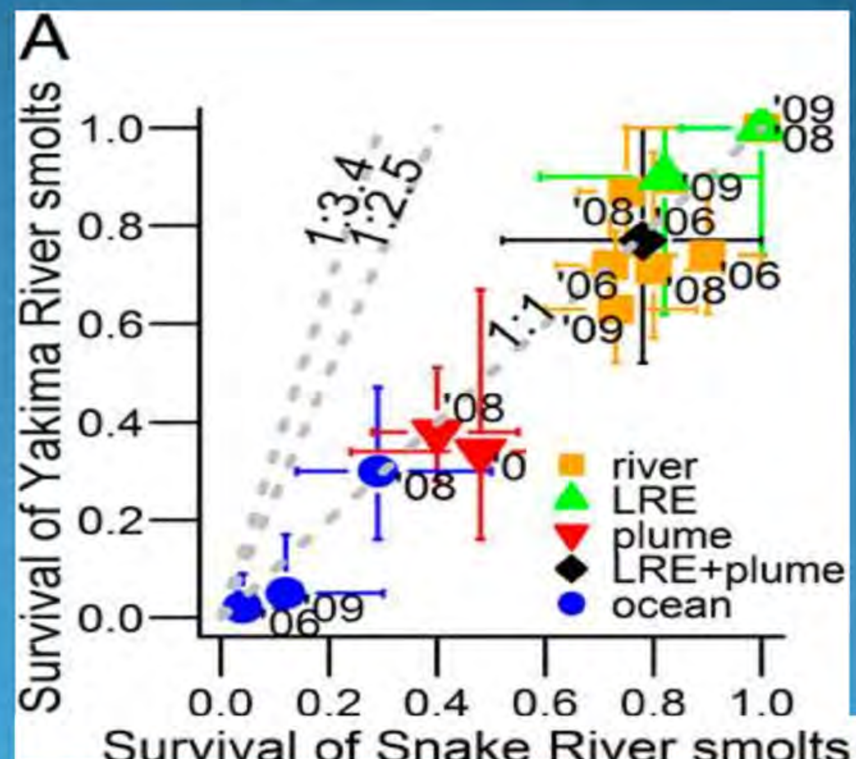
- *Transport findings can only occur if $S_{ocean} \approx S_{Hydrosystem}$*

Transport vs In-River Survival



Rechisky *et al* (2012). *Nature Sci. Reports*
doi:10.1038/srep00448

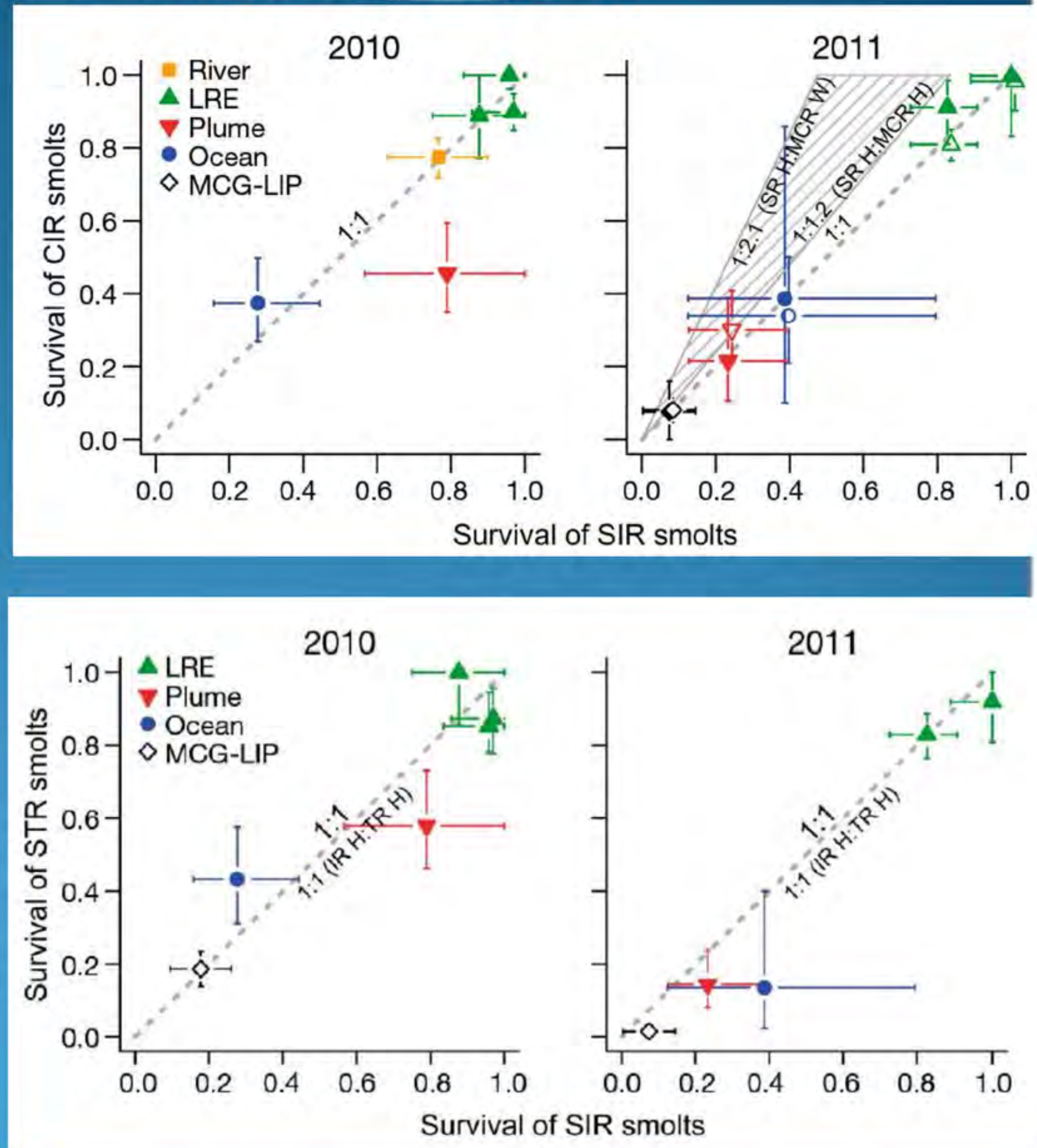
4 vs 8 Dam Survival



Rechisky *et al* (2013). *Proc. Nat. Acad. Sci. USA*
doi:10.1073/pnas.1219910110

Follow-Up DM & DDM Studies

- In 2010 & 2011 extended studies to smolts randomly selected at John Day & Bonneville Dams
- Stock ID done afterwards from DNA
- No survival differences found
- Study extends delayed mortality results to include upper Columbia stocks
- New studies covered "most" of the size range of migrating smolts



Rechisky et al (2014). *Mar. Ecol. Prog. Series, 496, 159–180 doi:10.3354/meps10692*

A Comparison of the Coast-Wide Decline in Marine Survival of West Coast Chinook and Steelhead: A Slow-Moving Catastrophe in the Making?

(A selection of near-final figures follow the text of the extended abstract)

D.W. Welch, A.D. Porter, E.L. Rechisky

Kintama Research Services

Extended Abstract

We collated smolt-to-adult (SAR) survival data for Chinook and steelhead originating from the west coast of North America (Alaska, British Columbia, Washington, Oregon, and Idaho) to examine the temporal and geographic patterns of variation in survival. The longer time series all revealed a similar sharp decline of roughly 4-5 fold in SARs. The initiation of the decline began earlier (mid-1970s) in the south and later in the north (1990s), but Chinook SARs are now at similar low levels (~1%) for most regions of the west coast.

Comment [DWW1]: Final value to be specified once the analysis is complete.

Although the initial decline first began in more populous southern regions (and was therefore attributed to those regions having the greatest anthropogenic impacts to freshwater habitat) survival has dropped sharply even in the most northerly regions (SE Alaska, Northern BC) with nearly pristine freshwater habitat. Because of methodological differences in the SARS datasets (PIT tags used in the Columbia River basin and coded wire tags used elsewhere) and the statistical uncertainty inherent in measuring survival when SARs drop to current levels (ca. 1%), it is not possible to compare absolute SAR levels from different regions with high precision. However, within the limitations of the data, regional survival comparisons now suggest that Chinook SARs are essentially equal through most of the Pacific northwest (SE Alaska to the Columbia River basin) and that steelhead SARs in the Columbia and Snake Rivers are similar to or higher than steelhead SARs for Strait of Georgia and Puget Sound populations.

Although the SAR also incorporates some components of freshwater survival experienced during smolt downstream migration and the adult upstream return migration, we demonstrate that the decline in SAR is occurring during the ocean phase. Because the observed drop in survival is much larger than can be compensated for by even the complete cessation of harvest, the conventional management approach of restricting fisheries to manipulate harvest rates is insufficient to compensate. In contrast to earlier work suggesting that salmon survival in northern and southern regions would oscillate out of phase as the Pacific Decadal Oscillation (PDO) switched between warm and cold periods, no region has seen significant recovery in survival; all of the regional time series can best be characterized as a general downward trend punctuated by occasional periods of rough stasis (but no recovery).

This raises important scientific and policy issues: anthropogenic impacts frequently singled out for major impacts on salmon survival, such as dams in the Columbia River or salmon farming (aquaculture) in British Columbia, may be of much lesser impact than originally thought because the same decline is also seen in regions lacking these specific activities. The most parsimonious explanation for the coastwide collapse appears to be a progressive northward geographic expansion in the region of

poor salmon survival, although it is unclear whether this primarily affects outward migrating smolts (as usually assumed), returning adults, or both. The extent and the nature of this pattern of decline have been broadly under-appreciated by all agencies, and the widespread implicit assumption that survival will eventually recover in some form of PDO-like oscillation out of a period of "bad" years may not occur.

Poor ocean survival will force hard choices on agencies ill-equipped to make them. The traditional response to the salmon crisis has been to redouble efforts in freshwater by increasing staff to identify freshwater problems and increasing expenditures on fixing freshwater habitats further, leaving the ocean survival problem unaddressed. We provide three case studies from Alaska, British Columbia, and Washington-Oregon (the Columbia River) to support this. In each case, once the conclusion was reached that the problem likely lay in the ocean a decision was made that re-focussed work on freshwater issues rather than addressing ocean survival. This apparently illogical decision is readily understood given the sociological situation (highly trained freshwater staff and an extensive and supportive freshwater research infrastructure, coupled with little understanding of how to begin addressing the ocean issues, which are perceived as too vast to be tractable). This repeated response is evidence of both widespread cognitive dissonance (inability to recognize the true problem, despite the available evidence) and groupthink in how salmon biologists have been trained to address resource problems (falling back on traditional behaviors of searching for freshwater issues to study and/or "fix", hoping that they will work).

Our analysis also provides an important perspective on the frequent assumption that increased dam passage reduces adult returns (delayed mortality). The difference in SARS between some Chinook populations in regions lacking dams (e.g., the lower Fraser River) is larger than the difference in SARs between some mid-Columbia and Snake River populations that migrate through four or eight dams, respectively. In addition, there are other Mid-Columbia Chinook populations that do not migrate through the Snake River dams but that also have SARS similar to populations from the Snake (or Upper Columbia River) regions. Finally, large-scale geographic differences in SARs are also evident between several regions of the coast lacking dams, suggesting that persistent survival differences may have a significant genetic determinant, perhaps due to differences in marine migration pathways. Identifying why some populations have much better survival at sea than others would be a fruitful area of future research, and could contribute to improved salmon management.

What can be done?

There are two ways fisheries agencies and NGOs can break this repeating cycle: (i) explicitly demonstrate how continuing to focus on freshwater problems will improve salmon conservation if the problem is in fact in the ocean, which should help improve effectiveness of current research efforts, and (ii) subject proposed future freshwater habitat interventions (improving habitats, increasing allocations to freshwater research on salmon) to a cost-benefit analysis to demonstrate that they can substantially compensate for reduced marine survival. In our view, at least some proposed freshwater interventions may actually be harmful to salmon conservation, while many others may simply be ineffective and therefore a poor use of resources.

A meta-analysis assessing the effect of freshwater interventions on survival would be helpful, as would a cost-benefit analysis of whether the true effect achieved justified the costs. Otherwise, failing to address the marine survival issues directly is likely to result in continued stop-gap actions that allow past conservation practices to continue into the future while failing to address the marine problems.

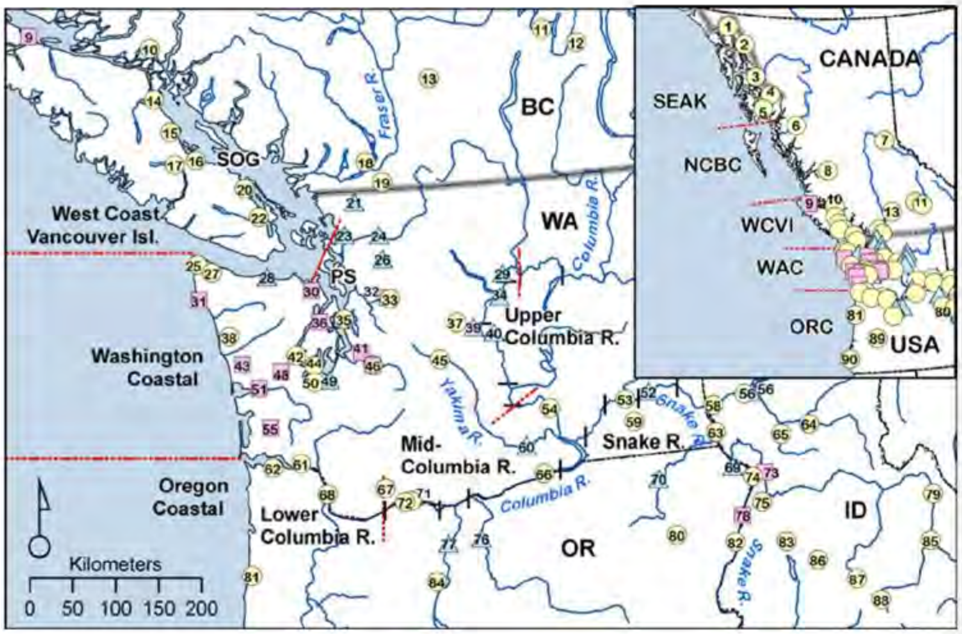


Figure 1. Map of salmon survival time series used in the analysis. Numbers inside symbols are keyed to the populations in Table 1; yellow circles indicate Chinook populations, blue triangles steelhead, and pink squares indicate a location with data for both species. Acronyms: SEAK (SE Alaska/Northern British Columbia Transboundary Rivers); NCBC (North-Central British Columbia); WCVI (West Coast Vancouver Island); WAC (Washington Coastal); ORC (Oregon Coastal); SOG (Strait of Georgia); PS (Puget Sound).

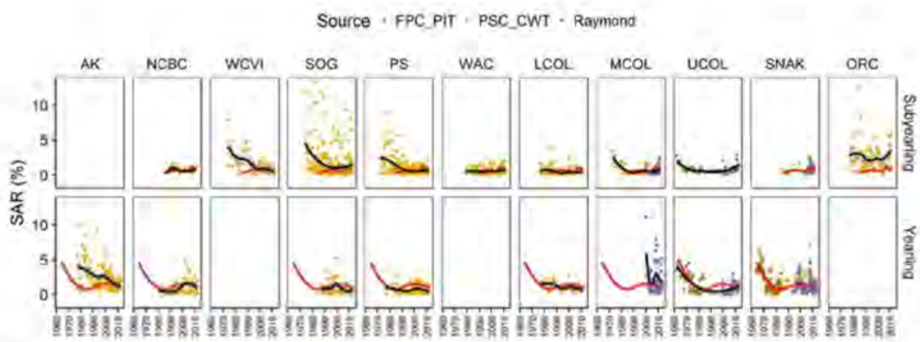


Fig. 2. Comparative time series of smolt to adult survival (SAR) data for west coast Chinook stocks (excluding California); times are the ocean entry year. Top row: subyearlings; bottom row: yearlings. Regions are oriented from north (left) to south (right). Gold dots are SAR measurements based on CWT tags (PSC database), brown dots are SARs reported by Raymond (1968, 1979, 1988(all three papers?), and violet dots are SARs based on PIT tags (CSS, 20??). A Lowess curve of survival and associated 95% confidence interval (shaded region)using all available data for each panel is shown as a black line; the Lowess curve for the Snake River survival is shown in red and is overplotted to facilitate comparison. (The smoothing parameter was set to α=??). Blank panels indicate regions where the life history type does not occur (for example, Fall (subyearling) Chinook do not occur in Alaska, while Spring (yearling) Chinook do not occur in the low elevation streams on the west coast of Vancouver Island or Oregon coast.

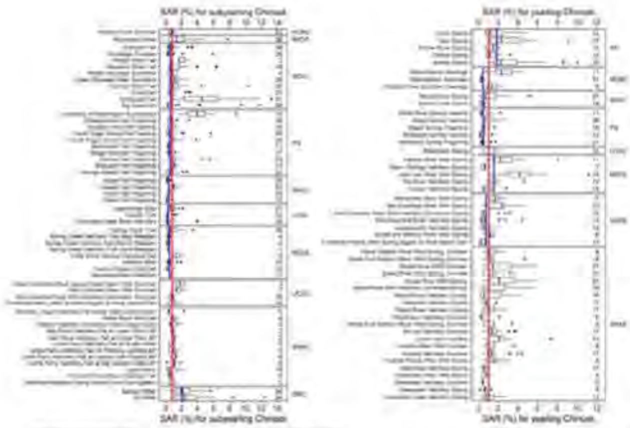


Fig. 3. Box and whisker plot of SARs by population (all available years). The black horizontal line within each bar is the median of the SAR data available for that population. Median survival across all available data for each panel (geographic region) is shown as a blue line; median Snake River survival is shown as a red line and overplotted on all panels for comparison. The number of years of data is shown to the right.

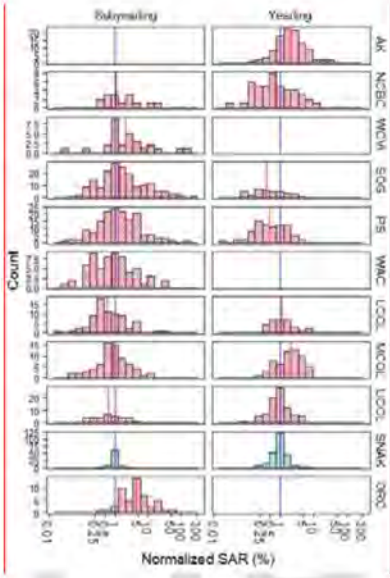


Fig. 4. Normalized SARs, obtained by dividing each individual SAR estimate (i.e., for each stock and each year) by the median SAR calculated across all available Snake River SARs for that year. As in the prior plots, Columbia & Snake River SAR estimates based on CWTs do not include pre-dam survival. Snake River SAR is overplotted in blue. Note the logarithmic scale on the x-axis. *(Probably need to show tick marks as 2X, 4X, 8X, 16X, & ½X , ¼X, $^{1}/_{8}$X, $^{1}/_{16}$X, to facilitate visual comparison).* For Chinook, the graph shows the roughly normal (Gaussian) distribution of SARs once log-transformed .

Comment [DWW2]: Need to reverse this colour scheme.. in the prior plots, the Snake River survival curve (LOWESS in Fig.2, median in Fig. 3) is in red, the other stocks in blue. Now we have reversed this, and have the Snake River data * median in blue... it should be red for consistency.

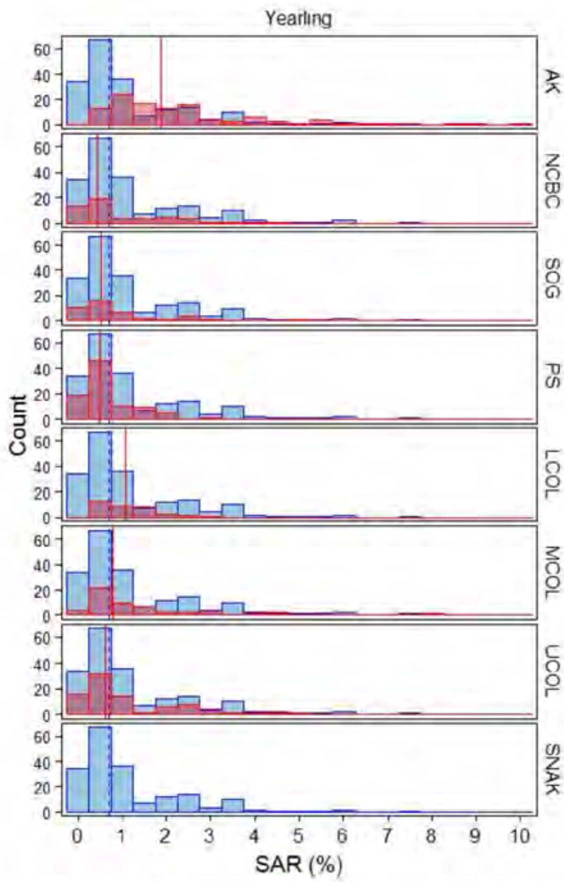


Fig. 5. Comparison of estimated SARs, all years. Conventional PIT-tag based SAR estimates have been multiplied by estimated smolt survival from release to the first dam encountered for Snake River populations. Survival values for other regions remain the same as in previous graphs, i.e., CWT or PIT-tag based SARs from hatchery release (or wild smolt tagging location) to adult return.

Steelhead

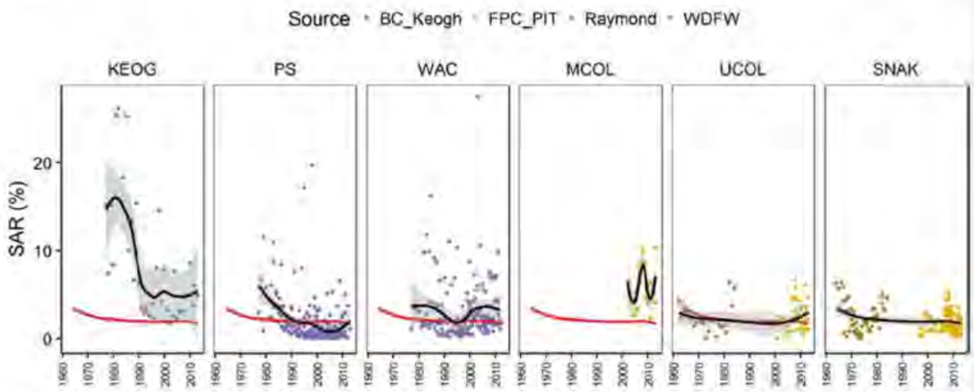


Fig. 6. Time series of steelhead SARS, plotted against ocean entry year. The Snake River LOWESS trend line is superimposed in red on the other regions for ease of comparison. *(expand caption)*

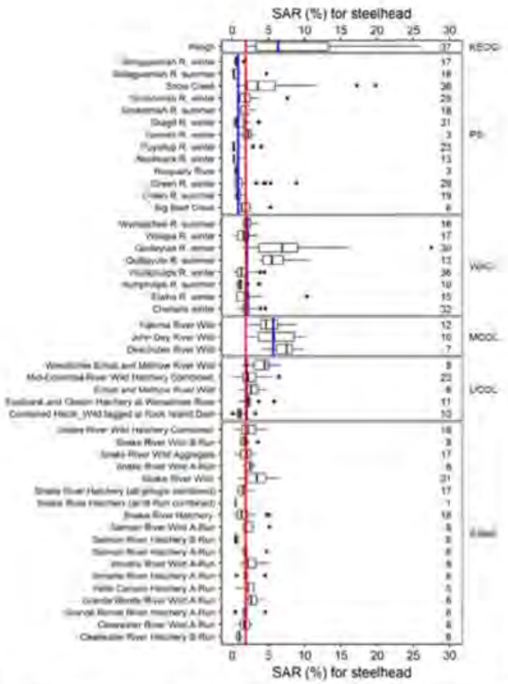


Fig. 7. Interpretation of this box & whisker plot of steelhead SARS similar to that of the prior Chinook plot. (Included just to show that the conclusions for steelhead will broadly parallel what we have found for Chinook).

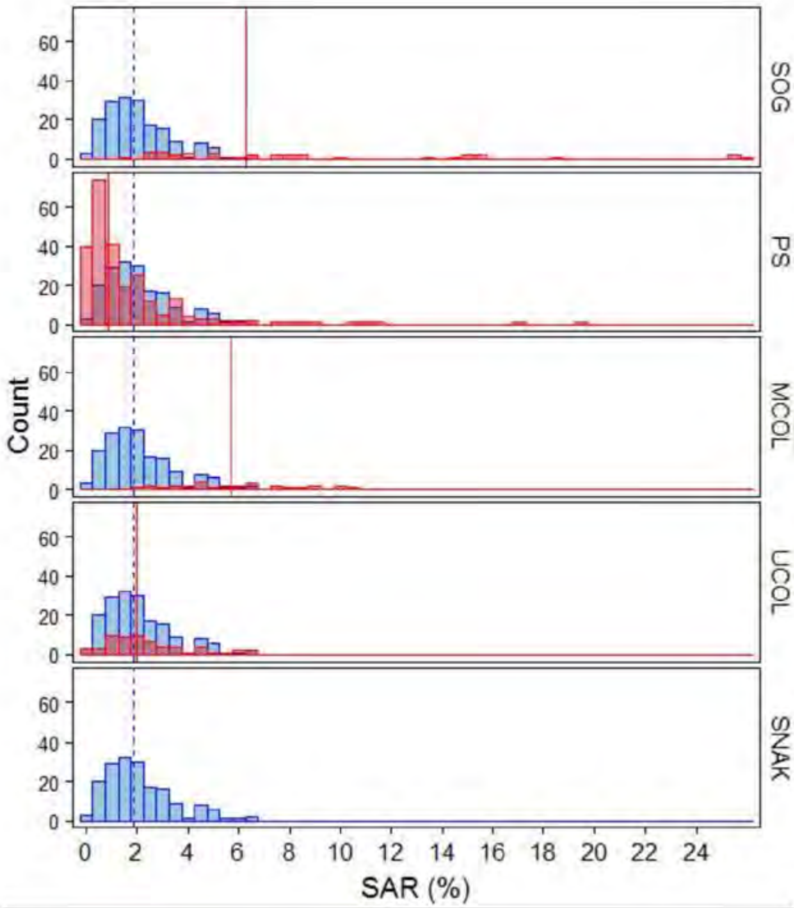


Fig. 8. Frequency distribution of steelhead SARs.

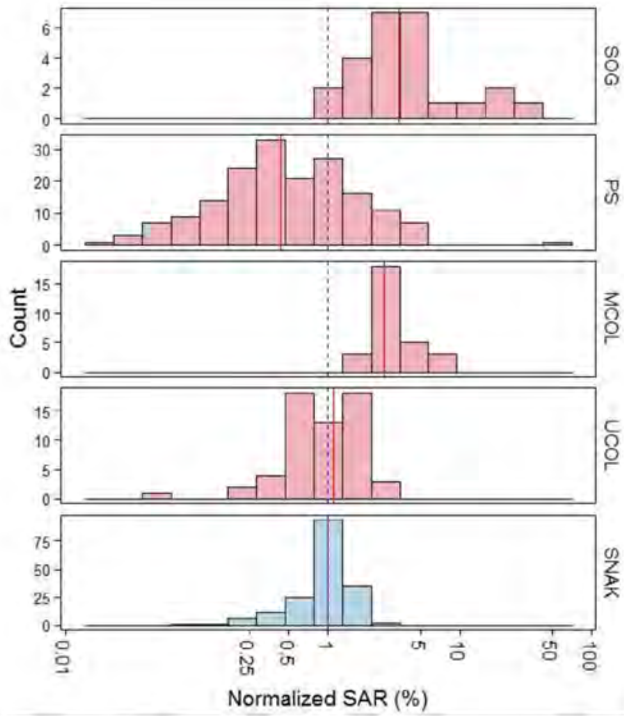


Fig. 9 Normalized steelhead SARs.

From: Petersen,Christine H (BPA) - EWP-4

Sent: Mon Jan 29 12:25:53 2018

To: David Welch; Erin Rechisky; Aswea Porter

Subject: RE: Extended abstract & figures...

Importance: Normal

Hi,

Let's see – I spoke with Jeff Stier. You already provided us the extended abstract, but his request is if you could write a few sentences in your own words about how you would characterize or compare Snake River Chinook (yearling&subyearling) SARs to the other regions. On my own, I am struggling with saying we want to define the question as asking how the Snake ranks against other regions because a rank doesn't capture the magnitude of difference (although it is easier to show that a subregion is in the bottom or top half), and Jeff's original question was whether we could accurately state that Snake River SAR is equal to or above average for the west coast. Yet here you have to also choose the normalized vs. simple group average in your Fig 3 and 4.

We think 2000-to-present would be a good way to capture the 'recent' period to be contrasted with the longer term because 2009-present or shorter segments wouldn't have that many years or could reflect a phase of the ocean. Yet it would be a different pattern that extending back to 1960s because your study showed that SARs declined at different rates among the subregions.

Thank you

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, January 24, 2018 8:52 PM
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky; Aswea Porter
Subject: [EXTERNAL] RE: Extended abstract & figures...

Hi Christine-

Yes, I agree with you that the varying length of the time series can potentially affect the details of how the ordering comes out.

I will discuss this with Aswea (Erin being in Wenatchee this week, giving her talk), but before Aswea and I get too far into the weeds on this, perhaps you can have a discussion with your colleagues in BPA.

Here is the issue: Originally I had thought that we would break the data into several regimes (Start-1977, 1978-1989, 1990-2008, 2009-most recent year) in order to deal with the different survival levels inherent in different regimes (and, ideally, demonstrate this quantitatively). However, I think that the volume of graphs and analysis would just overwhelm the reader to little real benefit. The variable length of the survival time series available adds another issue to the complexity.

I think that one approach to limiting this plethora of graphs would be just to note that as we go backwards in time there are fewer time series contributing to the various geographic data sets that we can show and that the drop out of individual populations may contribute to changes in ranking of the regions' survival values. So my question is, given what BPA's interest seems to be from your question below, what if we do a final figure for the most recent period (either 2009 to present or 2000 to present) and then compare the ranking of Snake River SARs to other regions for the most recent time period? (I'm inclined to do it for 2000 forward, to give a time period representing lots of years, and a time period when (I think) ALL time series should be fully represented).

Would this be helpful? Have a discussion and then let us know—one caution is that we don't want to potentially selecting data that fits a particular storyline, so we should make an a priori judgment on what range of years of data to use and then stick to it, so that we are not potentially stacking the deck in favour of one result or another.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, January 24, 2018 11:01 AM
To: David Welch; Erin Rechisky; Aswea Porter
Subject: Fwd: Extended abstract & figures...

Hi,

Making a statement like 'Snake river SARs rank high or are above average compared to other regions of the west coast' would be something our managers might like to stay based on your paper, with wording worked out for yearling vs subyearling Chinook types.

Your paper presents SAR as a multi year average for pops in a region (fig 3), normalized across years, and the time frequency distribution (fig 5).

There are some subtle differences in rank order that we should clarify before making a statement based on the box and whiskers plot.

Among yearlings, Snake populations fall below Alaska and mid Columbia in figure 4. Lowe Columbia with one group is approximately equal to the Snake. But in figure 5, that Willamette spring group falls a bit higher than mid Columbia. Is it still safe to say more moderately that Snake has above average SSR, or also, that the Snake average is only exceeded by mid Columbia and SE Alaska?

Of course, the time dimension is important. The populations are unequally weighted for length of time series. Of course, we would probably be most interested in referring to a recent rank among regions for this type of assertion, so we should focus on figure 4?

With subyearlings, the means or rank of he Snake vs other subregions in figures 3 and 4 is different for SOG and Puget Sound, in the way I'm looking at it. Would you focus on figure 3 or 4 for claiming generally that Snake has 'higher SAR than' either a west coast average or a specific list. WCVI is a single population. The time series length of populations is probably the factor explaining the rank order shift.

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: "Stier,Jeffrey K (BPA) - E-4" <jkstier@bpa.gov>
Date: 1/24/18 9:48 AM (GMT-07:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Subject: RE: Extended abstract & figures...

It's hard to be sure, but trying to read the box sand whiskers chart it appears that Snake River chinook have among the highest SARs on the west coast. Would you check with Kintama to be sure that is a fair statement?

From: David Welch

Sent: Wed Jan 31 17:30:52 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] Re: wording for SAR decline

Importance: Normal

Hi Christine I've been on the road today and part of yesterday and I just got your email and had a chance to look at it I will when I get home tonight about seven I'll try to have a first look at this tonight and draft something and I'll get something back to you tomorrow morning I hope

(Made with voice dictation hope it comes through clear!)

D

David Welch
M: [redacted]
Kintama Research Services
Sent from my iPhone

On Jan 31, 2018, at 11:53 AM, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

Let's see – I thought I'd share a couple paragraphs we might use, derived from your abstract. I am actually going to snip off one section that Jeff wrote which amounts to policy, so that it doesn't feel like we're trying to influence your conclusions to your paper (but was basically saying that we offer your paper as background, but we are not specifically proposing changing regional management).

I have my comments to the side. I think the second bullet point might deserve the most attention. All of the regions with time series extending back to the 60s do have this 4-5 X decline, however if we look at your figure 2 and really focus on language, there are a number of subregions that have data starting in the 1990s and appear to start at a SAR range that we deem low (around 1% for spring Chinook. We could use the Northwest Power & Conservation Council document that defines 1% SAR as low or inadequate for recovery), and remains in that range. I would also say that for spring Chinook, the Alaskan SARs seem to start around 5% in the '80s and decline to 2%. The missing data is what the SAR range for each of these subregions where data only starts in the 80s or 90s or 2000, and can only speculate what the scale of decline would be from the 50s or 60s.

Do you think your final draft of the paper will help us clarify this second bullet point?

Thanks

Christine P.

Kintama Research is preparing to submit a paper for publication and peer review that examines smolt-to-adult return rates (SARs) for salmon and steelhead emerging from west coast river systems (Alaska, British Columbia, Washington, Oregon and Idaho). Their goal was to review the temporal and geographic variations in survival using a reasonably common currency.

Kintama's coast-wide analysis of SARs provides a perspective that will seem counter-intuitive to many in the Columbia River basin. Their draft findings are summarized below.

- SARs for all regions along the west coast are falling. This phenomenon began in the early to mid-1970s [CHP1] .

- The longer time series revealed a sharp decline of 4-5 fold [CHP2] in SARs for all stocks. Chinook salmon SARs are now at similar levels (~1%) for most regions of the west coast.[CHP3]

- For Columbia River basin stocks, only Mid-Columbia (steelhead?) yearlings are higher than Snake River Chinook salmon SARs, and that is only the case for two populations [CHP4] in the Mid-Columbia.

- For yearling Chinook, "raw" Snake River SARs are about the same as Upper and Lower Columbia SARs and are higher than Puget Sound, Strait of Georgia (including the undammed Fraser River), and North Central British Columbia.

- When "raw" data are corrected for methodological differences between coded wire tags and PIT tags, Snake River populations do not appear to have lower survival than stocks that do not migrate through Snake River dams. Furthermore, Kintama researchers find no evidence for delayed mortality in Snake River Chinook salmon.

Kintama researchers caution that it is not possible to compare absolute SAR levels from different regions with high precision. That said, these draft findings suggest that Chinook SARs are essentially equal through most of the northwest Pacific (SE Alaska to the Columbia River basin) and that steelhead SARs in the Columbia and Snake Rivers are similar to or higher than steelhead SARs for Strait of Georgia and Puget Sound populations.

[CHP1]Could add, that the decline started earlier in the southern part of the range, in the 1990s in Alaska.

[CHP2]This is what they stated and the scale that visually appears true for several of the subregions with data back to the 1970s. But they said they would have a precise estimate in the draft in a week or two.

When I look at figure 2, I see some subregions that started at about 1% SAR in the 1980s and stay at this level, not declining (Washington Coast, far lower Columbia, North coast, BC for example for subyearlings)

Maybe we should talk to Kintama how to carefully word this so that we can say that some subregions have SAR series that started at a low level and didn't decline as much. Maybe we should ask if they think it results from the SAR series only started after a decline happened the previous decade?

[CHP3]This is how Welch et al. stated it in their abstract. SE Alaska and Mid-Columbia were the regions with yearling Chinook SAR above 1%, closer to 2%.

You mention steelhead in the paragraph below and I think the claim that Snake River is definitely not below average is very supportable.

[CHP4]I would say “two of five populations”

From: David Welch

Sent: Thu Feb 01 09:26:35 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: wording for SAR decline

Importance: Normal

Sorry for the delay, Christine-- A LONG drive back last night in horrible weather after picking up a receiver from a fisherman (the caught it in their commercial fishing gear).

Once I got home I had to download the data and put a copy on the server (to keep it safe) and then sent out a short summary email to our collaborators reporting on what we had found (which was cool!). At that point I went to bed and forgot to review your email!

Am working on that right now… more soon.

d

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, January 31, 2018 11:53 AM
To: David Welch; Aswea Porter; Erin Rechisky

Subject: wording for SAR decline

Hi,

Let's see – I thought I'd share a couple paragraphs we might use, derived from your abstract. I am actually going to snip off one section that Jeff wrote which amounts to policy, so that it doesn't feel like we're trying to influence your conclusions to your paper (but was basically saying that we offer your paper as background, but we are not specifically proposing changing regional management).

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You mention steelhead in the paragraph below and I think the claim that Snake River is definitely not below average is very supportable.

I would say "two of five populations"

From: David Welch

Sent: Tue Feb 06 11:21:58 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: wording for SAR decline

Importance: Normal

I am working from home today (b) (6) [redacted]

I should be here all day, so call at your convenience. (Or I can call you, if you give me a time).

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, February 06, 2018 11:21 AM
To: David Welch
Subject: RE: wording for SAR decline

Hi, I am at the Willamette presentations at Oregon state University, but I could see if there is a moment where I could call. Would noon or early afternoon work? What is your number?

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: David Welch <David.Welch@kintama.com>
Date: 2/6/18 11:12 AM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Subject: [EXTERNAL] RE: wording for SAR decline

Hi Christine-

I was just going to call you. Do you have time for a call?

Let me know a time that works.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]

Sent: Tuesday, February 06, 2018 10:47 AM
To: David Welch
Subject: RE: wording for SAR decline

Hi, sorry for the delay.

Yes- that is nice that they told you about the receiver. At Bonneville dam NOAA is contemplating a lot of new PIT antenna concepts such as dangling hydrofoil attached to barges, and attached to pilings but they inevitably will have stress tests with logs and complex countercurrents.

Yes, at a glance, it doesn't surprise me that the means are different from medians when you also break it up by years because even though you have dozens of populations, some of the subregions have only have a few, or only a few long series.

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------

From: David Welch <David.Welch@kintama.com>
Date: 2/1/18 9:12 PM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Subject: [EXTERNAL] RE: wording for SAR decline

Hi Christine-

Apologies on the delay responding. I asked Aswea to run some numbers for me this morning, comparing the ratio of survivals in the first five years of the Snake River & Alaska time series with the last 5 years, to get some idea of what the actual ratios were of S_{Early}/S_{Recent}. Unfortunately, we got a weird result for the Alaska stocks when we used the median rather than the mean Survivals. We are checking into this right now, but I don't want to send something until we get the issue sorted out—my hunch is that the issue has something to do with the Alaska time series having 5 river systems contributing in the recent 5 yr time period and only two river systems at the start, but right now I don't know.

The issue is of broader importance because it raises the possibility that if we report using the median value we may get a very different result from the mean; if so, we need to be very careful what reporting metrics we use in the paper.

I'm sorry for the delay, but all I can say at this point is that we need to really sort this issue out before we potentially mislead you folks with an incorrect metric or incorrect interpretation! I will be working on this with Aswea tomorrow (Friday), but have to leave for the airport about 12:30—(b) (6) [redacted] celebration, and will be back late on Sunday. I'm not sure how much I will be able to work on this during the weekend while I am away because of the family issues. I am hoping I will have a first cut at understanding what is causing the problem tomorrow morning, but I can't promise.

Here is what the SAR ratios currently looks like; note the striking differences in the interpretation if we use the medians for the Alaska case, but not the Snake River case.

SAR Ratio

Region

First Years

Last Years

Mean

Median

Means

Medians

AK

1977

1981

3.29

1.22

2.6

1.1

AK

2008

2012

1.28

1.16

SNAK

1964

1968

4.07

3.70

4.3

4.5

SNAK

2009

2013

0.94

0.83

Note that for SNAK the first and last data time series were calculated using different methods: The first period was data by Raymond which has freeze brands, fewer populations, compensation for harvest, and starts at Ice Harbour or Lower Monumental and ends at Ice Harbour on return. The last period is from the FPC and was done with PIT tags for the area between Lower Granite and return to Lower Granite.

For AK, the included populations expanded from Taku and Alaska Spring to also include Chilkat, Stikine, and Unuk.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, January 31, 2018 11:53 AM

To: David Welch; Aswea Porter; Erin Rechisky
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I would say "two of five populations"

From: David Welch

Sent: Mon Feb 12 09:51:51 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] Short Summary Abstract for BPA (12 Feb 2018)-FINAL.docx

Importance: Normal

Attachments: Short Summary Abstract for BPA (12 Feb 2018)-FINAL.docx

Christine—Here is an edited summary of your colleague's original bullet points. We made extensive changes over a couple of weeks so the version with track changes on was a mess, so this is the cleaned-up version. I can send you the edited version if you want to see it.

I have also added in an initial section on how we need to treat the data… this is why sending the abstract back to you was so delayed—I belatedly realized that just cavalierly analyzing the data by comparing means or medians might potentially mislead the study, so I had to think very carefully about what we had done and the mathematical demographic implications. Fortunately, in the end I concluded that it was defensible to use average SAR values (simple means) and medians to compare SARs between regions, and I outline the reasons below. We will flesh this reasoning out in the paper more fully, but I added this section below to clarify why we can use means and medians.

I am working from home today; it is a stat holiday here in BC [redacted] However, I will be working on the BPA report all day [redacted] so feel free to give me a call at the house to discuss if you like [redacted] Cell doesn't reliably work at the house).

David

I have my comments to the side. I think the second bullet point might deserve the most attention. All of the regions with time series extending back to the 60s do have this 4-5 X decline, however if we look at your figure 2 and really focus on language, there are a number of subregions that have data starting in the 1990s and appear to start at a SAR range that we deem low (around 1% for spring Chinook. We could use the Northwest Power & Conservation Council document that defines 1% SAR as low or inadequate for recovery), and remains in that range. I would also say that for spring Chinook, the Alaskan SARs seem to start around 5% in the '80s and decline to 2%. The missing data is what the SAR range for each of these subregions where data only starts in the 80s or 90s or 2000, and can only speculate what the scale of decline would be from the 50s or 60s.

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David Welch

Treatment of Data

The expected survival experienced by a population may be substantially higher than what calculations based on the simple average of the untransformed time series would suggest.
SAR data for salmon are likely log-normally distributed; i.e., a time series of SAR data, S_t, will have the form $S_t = e^{\mu+\sigma Z_t}$, where μ and σ are respectively the mean and standard deviation of $\log_e(S)$, and Z_t is the standard normal variable. This is important because the log-normal distribution is skewed, exhibiting occasional (rare) high survivals which increases the expected value above the mean. As a result, the expected value of

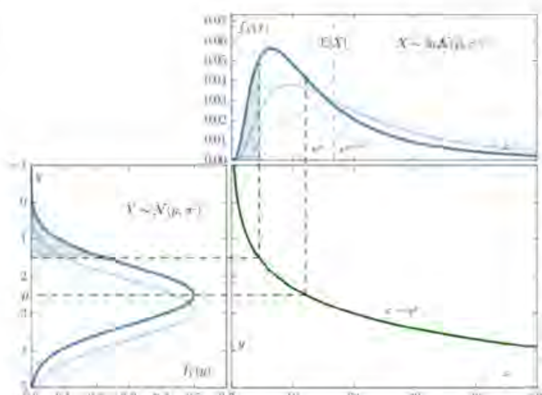

Figure 1. Relationship between the mean, median, and expected value for the normal and log-normal functions. By StijnDeVuyst - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=53714670

a log-normally distributed SAR time series is neither the simple mean $\bar{S} = \frac{1}{n}\sum_{t=1}^{n} S_t$ nor μ, but rather $\mathrm{E}(\mathrm{S_t}) = \mathrm{e}^{\mu+\sigma^2/2}$ (in fact, the median value is $S_{median} = \mathrm{e}^{\mu}$; see Fig. 1 and https://en.wikipedia.org/wiki/Log-normal_distribution).

When comparing survival time series between regions some important but subtle differences should therefore be borne in mind. We have opted to use the median and the simple average of the untransformed SAR data in a number of key comparisons because this is what most prior studies report, and therefore what most policy makers and fisheries managers are likely comfortable interpreting. For example, the NWPPC has set a rebuilding target of 2%-6% for SARs and deemed 1% SARs (the current average) to be inadequate, but did not define how these values should be calculated.

However, when the distribution of SARs are compared between two regions *i, j* using medians, if these are found to be the similar, the implication is then that $\mu_i = \mu_j$; this does not, however, imply that either the simple means $\bar{S}$ or the expected values $\mathrm{E}(\mathrm{S_t}) = \mathrm{e}^{\mu+\sigma^2/2}$ are equal. For these reasons, we use both measures of central tendency

$$\bar{S} = \frac{1}{n}\sum_{t=1}^{n} S_t,$$

$$S_{median} = e^{\mu}$$

in our analysis, and not the expected mean values of the log-normal distribution $\mathrm{E}(\mathrm{S_t}) = \mathrm{e}^{\mu+\sigma^2/2}$, owing to the more complex definition and lack of easy interpretation , which the (simple) mean and the median readily impart.

Kintama Research is preparing to submit a paper for publication and peer review that examines smolt-to-adult return rates (SARs) for salmon and steelhead emerging from west coast river systems (Alaska, British Columbia, Washington, Oregon and Idaho). Their goal was to review the temporal and geographic variations in survival using a reasonably common currency—the Chinook and steelhead SARs reported by regional agencies.

Kintama's coast-wide analysis of SARs provides a perspective that will seem counter-intuitive to many in the Columbia River basin. Their draft findings are summarized below.

- SARs for many regions along the west coast are falling.
- The timing of the start of the decline is geographically determined.
- SARs declined concurrently in southern regions such as the Snake and Upper Columbia Rivers starting in the 1960s , and later in more northern regions.
- SARs for west coast Vancouver Island, Puget Sound, and Strait of Georgia subyearling (Fall) Chinook stocks dropped sharply in the 1970s and 1980s and then stabilized at similar low levels to those occurring for Snake River subyearlings.

- In Alaska a pronounced decline in yearling (Spring) Chinook SARs began after 2000, with SARs also falling to levels similar to the Snake River Spring Chinook.
- The longer time series all reveal a sharp decline of up to 4-fold in SARs.
- The ratio of average SAR in the first and last five years of the available time series shows a 4.3-fold decline for Snake River Chinook (1964-68 vs 2009-13) and 2.6-fold for SE Alaska Chinook (1977-81 vs 2008-12).
- Both average and median Chinook salmon SARs reported by the various fisheries agencies contributing data are now at similar levels (~1%) for most regions of the west coast.
- Comparing Columbia River basin stocks, SARs for only two of five populations of Mid-Columbia yearling Chinook are higher than Snake River Chinook salmon SARs; the other three populations have median SARs similar to or lower than Snake River values.
- For yearling Chinook, Snake River SARs for recent years are about the same as Upper and Lower Columbia SARs and are higher than those reported for Puget Sound, Strait of Georgia (including the undammed Fraser River), and North-Central British Columbia.
- When "raw" data are corrected for methodological differences between coded wire tags and PIT tags, Snake River populations do not appear to have lower survival than stocks not migrating through Snake River dams. Furthermore, Kintama researchers find no evidence supporting the delayed mortality theory for Snake River Chinook salmon.

Kintama researchers caution that it is not possible to compare absolute SAR levels from different regions with high precision. That said, these draft findings suggest that Chinook SARs are now essentially equal through most of the northwest Pacific (SE Alaska to the Columbia River basin) and that steelhead SARs in the Columbia and Snake Rivers are similar to or higher than steelhead SARs for Strait of Georgia and Puget Sound populations. The authors conclude that the similar pattern of decline to very low levels of survival in all regions of the coast points to a common ocean driver. If this is correct, then modification of the dams will not increase SARs, because salmon survival is not better in regions lacking dams.

From: Petersen,Christine H (BPA) - EWP-4

Sent: Tue Feb 13 11:31:33 2018

To: David Welch

Subject: RE: Short Summary Abstract for BPA (12 Feb 2018)-FINAL.docx

Importance: Normal

Thanks David,

I shared this with everyone and Jeff will modify the language that he uses in our BA accordingly. Our BA will be given to NOAA at the end of February, and then we transition to a different set of activities as NOAA gets busy doing their own analyses, with some communications with the agencies as they proceed.

Talk to you soon

Christine P.

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Monday, February 12, 2018 9:52 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] Short Summary Abstract for BPA (12 Feb 2018)-FINAL.docx

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David

From: David Welch

Sent: Wed Mar 21 10:16:29 2018

To: Petersen,Christine H (BPA) - EWP-4

Cc: Aswea Porter; Erin Rechisky

Subject: [EXTERNAL] Re: PA

Importance: Normal

Hi Christine

I am travelling today, but here is my initial thought about how best to support your request.

My first thought is perhaps a custom figure to complement Figure 1... perhaps a box and whisker chart showing regional SARS since 2000 for all data for all regions? This would facilitate comparing median SARS of the Snake with all other regions in a time period when all regions have essentially equal temporal coverage and is most important from a policy perspective. You could incorporate this in your own work as the primary Kintama figure with a reference to the location map playing second fiddle (if needed) to show what the geographic areas are.

This wasn't going to be part of the paper because it had already gotten to be a very fat manuscript, but on reflection perhaps we should put it in the paper as a multi-part figure with the stacked vertical panels showing the Box & Whisker comparison plots by regime periods: pre-1977, 1978-1989, 1990-1997(?), and post 1998. As with the other figures we can draw a horizontal red line to show the Snake R median value to facilitate comparison. There will have to be two side by side vertical panels for subyearling and yearling smolts.

Aswea, Erin, your thoughts?

David Welch, Kintama Research

Tel: +1 (250) 729-2600 x223
Cell: [redacted]
Sent from my iPad

On Mar 21, 2018, at 09:30, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi David,

How is everything going?

FYI – our Proposed Action document still seems to be in process (it was originally due at the end of the year). We have Jeff Stier's one page summary from your study. Lorri Bodi asked if there was a single summary figure such as a map that had mean SAR rates embedded in it somehow. Maura and I looked, and it seems like it would be awfully busy to try to modify the current map figure that you have to do that – and you would also need to pick a single SAR measure (either the normalized mean, or the average of simple means for each subregion). We think that at minimum we should use the map with probably the time normalized mean chart as the primary second figure, with a clear caption to explain it- in addition to Jeff's summary text.

I have not been around during the remainder of the discussions of the proposed action which center around a specific proposal for operation of the hydrosystem, and a habitat action effectiveness 'pilot study' that uses Tom Cooney's model to evaluate impacts and benefits from hydrosystem and a suite of habitat actions in the Grand Ronde watershed (and extrapolated to the rest of the Snake).

Christine Petersen

(503)230-4695

From: David Welch

Sent: Thu Mar 22 16:00:20 2018

To: Petersen,Christine H (BPA) - EWP-4

Cc: Aswea Porter; Erin Rechisky

Subject: [EXTERNAL] Kintama Summary Chinook Figure for BPA (22 March 2018).docx

Importance: Normal

Attachments: Kintama Summary Chinook Figure for BPA (22 March 2018).docx

Hi Christine—

Please find attached a summary figure of our analysis showing west coast Chinook SARs broken out by regime periods.

This figure turned out to be strikingly more informative than I had initially anticipated—it really makes it clear how the high SARs seen in the early part of the record have dropped down to similar low levels in the most recent time period for all regions… essentially the same data as in our LOWESS trend line data figure, but splitting by regime period allows a much clearer understanding of what time periods & regions have data, and what the relevant SARs are.

I think this is a great summary. I would pair it for your purposes with our Figure 1 (the map), since that shows the precise demarcation of regions we used.

Please let me know if your colleagues have any questions or comments. I think we will put this figure into the paper we are currently trying to wrap up.

Regards,

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

Nanaimo, BC, Canada

Office: (250) 729-2600 Mobile: (b) (6) [redacted]

Skype: david.welch.kintama

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www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Mar 23 13:59:11 2018

To: David Welch

Cc: Aswea Porter; Erin Rechisky

Subject: RE: Kintama Summary Chinook Figure for BPA (22 March 2018).docx

Importance: Normal

Thank you very much.

I like how this turned out and shared it with Jeff Stier, Greg Smith, Maura Moody for the BA. It might be one of the better ways to summarize all the information in the map because the font of the text doesn't have to be so small to show each population or hatchery, and we aren't required to explain how you normalized by the annual mean because instead you added the four time periods. I will let you know if there is any feedback. I have been spending so much more time on the environmental impact statement and its various meetings that I am out of touch with the recent changes with the BA. I do know that they keep meeting with NOAA on the habitat action effectiveness pilot study piece.

How is everything coming with the paper? Have you decided where you might want to submit it?

Have a nice weekend

Christine Petersen

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, March 22, 2018 4:00 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Aswea Porter; Erin Rechisky
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P Please consider the environment before printing this e-mail

From: David Welch

Sent: Tue May 15 13:44:50 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: RE: Ruggerone and Irvine

Importance: Normal

Attachments: Updated Survival table from Surv of Fraser v Snake.xlsx

Thursday/Friday is fine. As a heads up, I would also like to discuss the budget with you. I have prepared the April invoice and this taps out the entire budgeted amount we had asked for to do the paper, (including the 20% I had reserved for stick-handling it through the review process!). This is not a cry for more money, as I am committed to finishing the paper up for BPA and my failure to be more efficient in completing the document should not be dumped on BPA. However, it would be useful to move on the contract for the other component, which had originally been planned for as the first piece (comparison of ocean vs freshwater survival rates). This is actually the more important paper in my own mind, because it explains why past & current conservation strategies for salmon in the Columbia River basin aren't being successful, and will tie a lot of disparate pieces into one coherent whole (and give a very different flavour to why Columbia River salmon are in trouble).

If you have your laptop open (you won't be able to read this off your phone), take a look at the Table of survival (Column H) & survival per 100 km travelled (Column J) that we have compiled in the attached Excel spreadsheet for the current paper. (The tab "Table 2"; Chinook are at the top, steelhead at the bottom). This is the full list of published west coast studies on smolt survival in rivers that we have been able to find to date (a few numbers remain to be filled in).

What you will see is that published smolt freshwater survival estimates for Columbia River stocks are not anomalously low compared to other populations elsewhere in rivers without dams, and in fact are rather high (especially when distance is taken into account; Column J). Although a lot of the survival estimates are from Kintama's own work, there are a number of survival estimates for steelhead in Puget Sound and the Oregon coast that others have done and these too are much lower than what is reported for the Columbia River basin.

So this piece is being added to the draft paper. The paper will in essence say:

1) Published SARs for Columbia River basin (Snake River) smolts are as high or higher than for anywhere else on the west coast, and

2) Published downstream survival estimates for Columbia River basin smolts (and especially survival rates per 100 km) are better than almost all other rivers on the west coast.

The reason the paper as a whole is taking so long is trying to frame these results in such a way that we can demonstrate that biologists continue to "blame" freshwater factors (and especially the dams) for poor survival when in fact the problem is shared coast-wide and is in the ocean.

I should be in the office about 11 AM on Thursday and in all day on Friday as well.

Best, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, May 15, 2018 9:26 AM
To: David Welch

Subject: RE: RE: Ruggerone and Irvine

Oops.. I think that is the autocorrect function. It tends to correct and misspell the word 'redd' unless I catch ut.

I'm sorry I haven't been able to call.

Would Thursday or friday be a good time?

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Talk with you soon

Christine

Sent from my Verizon 4G LTE smartphone

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Date: 5/10/18 4:36 PM (GMT-08:00)
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What does "*activersatile*" mean? J

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The upshot of this is that the Willamette's survival would appear to be twice as large as those stocks where harvest rates were high, but this would be simply an artifact from having excluded harvest. We won't make a big issue of it in our paper (because it is massive already), but a lot of the puzzling survival patterns that the FPC emphasizes may well be a dual artifiact of excluding pre-dam smolt survival and excluding ocean harvest.

"*Curious and curiouser, said the Cheshire cat*"!

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, May 10, 2018 4:25 PM
To: David Welch
Subject: RE: Ruggerone and Irvine

Hi

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Jeff referred to the Environmental Impact statement process which will be very activersatile in the second half of the year. The position of the NOAA BiOp and proposed action are legally murky because despite the fact that the documents are being written, the judge issued some orders declaring that 2021 is the 'legal' BiOp, because he requires the EIS to be completed.. and it is a drawn out process with multiple public comment periods.

We put a placeholder for your second paper in our technical services queue, and I would like for Jeff Stier to advocate for it because he is on the committee that prioritizes the budget requests from hatchery, hydro, habitat, monitoring teams here. Jeff said it would be great to see the paper before the end of May, if you are able (short of finalizing details with coauthors).

I should be in the office all of tomorrow for a quick call. I will be in Seattle some of next week.

Talk to you soon

Christine Petersen

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I am just putting the final touches on the complete manuscript—Aswea got back to me this morning with "Final" figures and I am just reviewing them right now—we have had to look closely at some of the survival time series because there is always going to be an issue of how to aggregate yearling vs subyearling populations in the data analysis, and we swapped in or out some time series because of potential issues of being accused of "deliberately" including stocks that might lead to misleading results—it really is a difficult question to determine what to include or exclude and then be able to convey the reasons in the Methods section succinctly.

I wonder if you have time to call and touch base? I will bring you up to speed on where we are. I have also held off on putting in an invoice last month while trying to get the manuscript completed, but we have just about drawn down all allocated funds, even though I did not charge BPA for quite a lot of my time while I was reading up on a number of background issues that are relevant to the paper.

I was also wondering if could start the work for the contract extension to support the next manuscript (comparison of ocean vs freshwater survival rates) while we try to get the current manuscript out to the co-authors. Getting their possible involvement as authors is going to be tricky & take a good while because the manuscript is long and I am unsure whether either of the two government folks who helped us get the survival time series wrapped up are going to be entirely happy having their names associated with the paper—they may get A LOT of heat from their organizations for putting their names on a paper saying that everywhere has the same survival problem, so there is something wrong with our current management approach! This may be just one of those third rail problems where people just don't want to take the heat of being identified as saying the obvious.

I am around this week if you want to call.

Regards, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, May 07, 2018 4:04 PM
To: Erin Rechisky; Aswea Porter; David Welch
Subject: Ruggerone and Irvine

Hi,

How is it going?

This recent paper got a bit of attention, although many of Ruggerone's papers have this theme of hatchery and wild salmon competition.

https://onlinelibrary.wiley.com/doi/10.1002/mcf2.10023

Christine P.

From: David Welch

Sent: Thu May 17 10:53:52 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] Re: Ruggerone and Irvine

Importance: Normal

Hi Christine

I'm running a bit late, as the ferry back from Vancouver to Nanaimo hasn't left yet. You can give me a call whenever is convenient for you, and I can answer if my cell can pick up the signal-there is a small area mid-crossing where the signal may drop, but as I'm not sure when we will leave, I can't forecast the time!

David Welch, Kintama Research
Tel: +1 (250) 729-2600 x223
Cell: (b) (6) [redacted]
Sent from my iPad

On May 17, 2018, at 10:28, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

> Hi David
>
> Let's see, I had hoped to get Jeff Stier involved in a call but I have not been able to track him down today after I was in the meeting in Seattle yesterday.
>
> If he asked our budget team to go ahead with this paper for FY18 funds, they would be likely to proceed with it.

FY19 is still in the midst of being plotted out.

Jeff should be interested in the per 100 km measure because he asked Charlie Paulsen recently to update the PIT based above-LGR per kilometer survival estimates from hatcheries and wild traps- which was a measure NOAA initially looked at during path. I was just looking at the six years of NOAA below Bonneville studies in Ludington the two McMichael et al... the changing study design from year to year makes it someone complicated to identify the best metric or reach.

If you are in after 11, maybe I could do a quick check in?

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: David Welch <David.Welch@kintama.com>
Date: 5/15/18 1:45 PM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Subject: [EXTERNAL] RE: RE: Ruggerone and Irvine

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Christine P.

From: David Welch

Sent: Fri May 18 16:40:43 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] The tag 2% rule...

Importance: Normal

Attachments: Brown_et_al(Effect of Acoustic Tags on Chinook & Steelhead-the 2% Rule Revisited-2006).pdf

Christine—

This paper by the PNNL folks concluded that tag burdens of 6% up to almost 10% of body weight caused little impact on the smolts.

This fits with our results, where we found that our double tagged (PIT+acoustic tag) smolts returned at the same rate of the PIT tagged Dworshak smolts (0.5% SAR). This finding for our tagged smolts is a big deal because it lends credence to the other paper we would like to complete, which shows that survival in the ocean may be worse than survival in the hydrosystem in at least some years.

Best, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

755 Terminal Ave N, Nanaimo BC

V9S 4K1 Canada

Office: (250) 729-2600 Mobile(b) (6) [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

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WORKING TITLE

The Coast-Wide Collapse in Marine Survival of West Coast Chinook and Steelhead: Simply a Slow-Moving Catastrophe or a Deeper Failure?

Running head: Coast-wide Survival of Chinook & Steelhead

Authors and addresses:

D.W. Welch[(1)], A.D. Porter, E.L. Rechisky ***(Other authors have not yet been approached, but may be added)***

Kintama Research Services, 4737 Vista View Cr., Nanaimo, B.C. Canada V9V 1N8

[(1)]**Corresponding Author** david.welch@kintama.com **Orcid ID: 0000-0001-8851-5436**

Key words: Chinook, Steelhead, Columbia River, Snake River, marine survival, hydropower, dams, delayed mortality, aquaculture, climate change

Abstract

Large decreases in the survival of many salmon populations are now evident across much of western North America and in the North Atlantic. We collated smolt-to-adult (SAR) survival data for Chinook and steelhead originating from the west coast of North America (excluding California) to examine the variation in survival. The longer time series all reveal a similar sharp decline of roughly 4-5 fold in SARs. The initiation of the decline began earlier (mid-1970s) in the south and later in the north (1990s), but a striking result is that Chinook and steelhead SARs have collapsed to similar low levels (~1%) for most regions of the west coast. Although the decline began earlier in more populous southern regions and was therefore originally attributed to those regions having greater anthropogenic impacts to freshwater habitat, survival dropped sharply even in northern regions with nearly pristine freshwater habitat. Regional comparisons show that Chinook SARs are now essentially equal through most of the Pacific northwest (Columbia River basin to SE Alaska) and steelhead SARs in the Columbia and Snake Rivers are similar to or higher than Salish Sea (Puget Sound) populations. These results raise important scientific and policy issues: anthropogenic impacts frequently singled out for major impacts on salmon survival, such as dams in the Columbia River or salmon farming (aquaculture) in British Columbia, may play much less of a role than originally thought because the same survival decline is also seen in regions lacking these activities. The most parsimonious explanation for the coast-wide collapse appears to be a progressive northward geographic expansion in the ocean region of poor salmon survival, although it is unclear whether this primarily affects outward migrating smolts (as usually assumed), returning adults, or both; however, we outline puzzling anomalies in this simple explanation that defy easy explanation. The geographic extent and magnitude of this pattern of decline has been broadly under-appreciated by all management agencies until recently, and the widespread implicit hope that survival will eventually recover as some form of PDO-like oscillation out of a period of "bad" years seems unlikely to occur given the general increases in ocean temperature observed. Because ocean temperatures are forecast to increase much further, the future of most salmon populations is bleak. We discuss some actions that may improve salmon science and management in future and highlight limitations in our knowledge of the marine phase that is hampering more successful management.

(397 words)

Introduction

The total abundance of salmon in the North Pacific has now reached record levels [3-5]. However, a dramatic contrast in the winners and losers is obscured by this milestone. Most of the increased abundance is as a result of increases in the lowest valued species (pink and chum salmon) in northern regions. However, essentially all west coast North American Chinook populations (including Alaska) are now performing poorly with dramatically reduced marine survival [7]. The situation is similar for most southern populations of coho [8], steelhead [9], and sockeye; [10-13]. These poorly performing species are of higher economic value and the preferred focus of First Nations, sport, and commercial fisheries. Although the actually causes of poor salmon survival are currently very poorly understood, they come at a time when the widening geographic gap in regional salmon returns–generally increasing at high latitudes while collapsing in the south—means that current management is clearly even less successful than it would be considered if northern stocks had merely remained stable over the time frame under consideration.

The geographic pattern of declines in salmon abundance (greatest problems in the south, least to the north) were originally assumed to reflect a freshwater anthropogenic cause because of the greater degree of terrestrial (i.e., freshwater) habitat modification obvious in the more populated southern regions of the west coast [14, 15], but the growing appreciation of ocean climate changes [16-18] has brought a greater awareness of the role of the ocean in influencing salmon survival. As [19] noted almost two decades ago, "*It is becoming increasingly clear that understanding the relationship between the marine environment and salmon survival is central to better management of our salmonid resources*" (p. 2374). Unfortunately, our scientific understanding of what events are occurring in the marine phase remain severely limited, and thus has resulted in little change in management strategy apart from the essential first step of reducing harvest rates in the face of falling marine survival. The recent recognition of the decline in Chinook returns across essentially all of Alaska [20, 21] and the Canadian portion of the Yukon River [22], where anthropogenic freshwater habitat impacts are generally recognized as negligible compared to other regions of North America, is another example of how simple explanations looking at freshwater habitat changes are not necessarily correct; if freshwater habitat disruption across this vast swathe of relatively pristine territory is severe enough to seriously impact salmon productivity, then there is little hope that freshwater habitat in more southern regions can be "fixed" to support a newly productive environment for salmon.

The same widespread problem of declining survival is also evident for the Atlantic Ocean, where both Atlantic salmon [23] and eels [24, 25] are in sharp decline. As well, both eulachon [26] and lamprey [27] have undergone sharp unexplained declines along the Pacific west coast of North America. In the case of eels, eulachon, and lampreys, the authors attribute the problem to likely marine-related factors, not freshwater. This point is particularly persuasive for eulachon because of the very short freshwater phase in the life cycle [26].

In this paper we examine the temporal and geographic pattern of changes in smolt to adult survival (SAR) for Chinook (*O. tshawytscha*) and steelhead (*O. mykiss*) for western North America, excluding California. We use the term SARs and marine survival interchangeably, because the majority of the SAR is determined in the ocean (see text and downstream freshwater survival values listed in Table 2; marine survival must be much lower than the measured freshwater survival component of the SAR to achieve the observed SARs). In the Columbia River, the Northwest Power and Conservation Council's Fish and Wildlife Program (NPCC) set rebuilding targets for smolt to adult return rates (or SARS) at 2%-6% [1], p. 4), roughly the survival observed in the 1960s prior to the completion of the 8-dam Federal Columbia River Power System (FCRPS) [28, 29]. The NPCC SAR objectives did not specify the points in the life cycle where Chinook smolt and adult numbers should be estimated. However, one extensive analysis for Snake River spring/summer Chinook was based on SARs calculated as adult and jack returns to the uppermost dam (Marmorek et al. 1998): "*Median SARs must exceed 4% to achieve complete certainty of meeting the 48-year recovery standard, while … A median of greater than 6% is needed to meet the 24-year survival standard with certainty*" (p. 41).

With current SARS on the order of ca. 1%, migratory-phase life cycle survival would have to increase 200%-600% (two- to six-fold) to achieve these targets. Increases of this magnitude are large and it is unclear whether this level of rebuilding can be achieved.

Unfortunately, owing perhaps the combined lack of current understanding about how to address marine survival issues and pessimism about how improved understanding of the marine phase could advance conservation, progress on addressing and incorporating ocean impacts on salmon dynamics has been slow. As we show in our review of several case studies, even when the overriding role of marine survival is identified there is still a strong predilection by to preferentially search out freshwater factors to study and attempt to manipulate. This has resulted in the failure to directly address the marine survival problem and has led to a piece-meal and rather uncritical approach that identifies widely accepted freshwater stressors as being responsible for the problems evident in specific populations. In our view, a large part of the difficulty lies in some of the fundamental underlying assumptions that the community makes as to the nature of the core problem. Because these assumptions are part of our training and professional ethos, they are particularly difficult to recognize or question. Nevertheless, given the widespread geographic range and magnitude of the collapse in survival that is now evident, we view it as urgent that assumptions about causative agents be carefully assessed for their validity, both because of the ubiquity of the decline in marine survival and because it is clear that current management has not been successful in reversing the wane of salmon along the Pacific coast. Although there are a few success stories (e.g., Upper Columbia River sockeye salmon, which unexpectedly returned at much higher adult abundances than was expected in 2009-2017), the reason for higher return rates is opaque—it is not shared by Upper Columbia River Chinook returns, for example, while most sockeye populations in the directly adjacent Fraser River Basin have continued to decrease sharply [11, 13]. In our view, this reflects our fundamental scientific ignorance as to why particular populations have suddenly done well (or poorly) in the ocean. However, rather than being pessimistic about the possibilities for improved management, we view the few anomalous successes as case studies we might eventually learn from…why do these populations do better by the time their adults return from the ocean?

Methods

Data Sources

The primary data providing information on Pacific salmon survival rates are based on mark-recapture estimates of survival, with the "marks" usually implanted tags–either coded wire tags (CWT) or passive integrated transponder (PIT) tags. The basic tag technologies are well described elsewhere [30-33], but for current purposes the key issue is that PIT tags are long-lived but extremely short distance radio frequency tags that can successfully transmit their unique ID code only when within <0.5 m of a detector. Although there are some recent exceptions, the short detection range and requirement to power the detector essentially limits the use of PIT tags for salmonid survival studies covering the migratory phase of the life cycle to the Columbia River dams. All survival data based on PIT tags and reported in this paper are taken from the Fish Passage Center's Comparative Salmon Survival Study (CSS; [1]; See Supplementary Table S1 and Fig 1 for the location of populations used in the analysis).

Fig 1. Map of salmon survival time series used in the analysis. Numbers inside symbols are keyed to the populations in Table 1; yellow circles indicate Chinook populations, pink squares steelhead, and blue triangles indicate a location with data for both species. Acronyms: SEAK (SE Alaska/Northern British Columbia Transboundary Rivers); NCBC (North-Central British Columbia); WCVI (West Coast Vancouver Island); WAC (Washington Coastal); ORC (Oregon Coastal); SOG (Strait of Georgia); PS (Puget Sound).

In contrast, CWT technology dates back to the 1960s. A review is provided by [34] and the application of the methodology to coastal marine migrations of coho and Chinook is described by [35, 36] and to measuring harvest and survival by [21, 37, 38]. Because the tag is implanted in the nose cartilage of smolts, the tag must be dissected and read after capture, ensuring the death of that particular tagged animal. CWT technology provides the basis for the Pacific Salmon Commission's Chinook survival database used for coast-wide management of Chinook salmon under the Pacific Salmon Treaty. We have used this database as the source of Chinook survival data for all regions outside the Columbia River basin; CWT-based survival data is also available for a few stocks located in the Columbia River basin as well.

Survival data for Snake River Chinook populations from the 1960s and 1970s is available from [2, 28, 29], which was based on branding of the fish. [2], p. 3 noted that "*From the positive relation found between rates of return of adults and survival rates of smolts, it was apparent that mortality of smolts migrating downriver through the dam complex was the main cause of the decline in Snake River salmon and steelhead runs (Raymond 1979)*", a view that has become common amongst salmon biologists. Despite the different marking technology, we have included this data in our analysis because of the unique importance of the Raymond study, which documented the high SARs occurring in the 1960s and early years of the 1970s, prior to the completion of the Snake River dams and a marine regime shift.

The two major tagging technologies available, PIT & CWT, are therefore largely geographically discrete, with most recent survival data from the Columbia River based on PIT tag technology and most survival data for other regions based on CWT data. (Some data for the Columbia River basin is available that is based on CWTs). Between-region survival comparisons must therefore recognize the potential for differences in the two technologies to influence estimated survival, as we next describe.

PIT Tags

PIT tag estimates of SARs are taken directly from Table xx of [1]. Because returning adults must ascend fish ladders with PIT tag detectors, essentially all adults returning can be censused (ignoring tag shedding). Dividing these values by the estimated number of smolts migrating downstream in the brood year provides an estimate of the SAR. Published SAR estimates differ from CWT-based estimates in three ways: (i) they exclude losses to harvest (lowering survival relative to what is estimated in the PSC database), (ii) they exclude losses occurring from smolt release to encountering the first dam in the migration path (raising survival), and (iii) they exclude losses occurring from the time the returning adults migrate past the last dam until they reach the spawning grounds (raising survival). We comment further on the potential impact below.

Comment [DWW1]: Aswea – Please fill in.

CWT Tags

The precise technical methods of counting the number of CWT-tagged adults returning back to each population is not documented in the PSC database by the various provincial, state, and federal agencies contributing survival data. However, these agencies generally operate hatcheries or (in a few cases) rotary screw traps to estimate downstream smolt numbers for wild stocks. For hatcheries (which generate the bulk of the survival time series for both species), CWT-based survival estimates are calculated by dividing the estimated number of maturing adults of various ages returning back to the spawning grounds or hatchery over time by the number of smolts released in the year of ocean entry. (The ADF&G Chinook Salmon Research Team (2013) gives a useful summary of the tag and recapture approach used in the Transboundary Rivers of SE Alaska and Northern British Columbia for wild Chinook stocks).

Chinook

We divided the Chinook SAR data (defined below) into subyearling ("Fall") and yearling ("Spring") run types. Unlike steelhead, there are important ecological differences between these two life history types which likely influence survival (See review by [39], and references therein). Subyearling smolts migrate to the ocean within a few months of hatching in the spring, while yearlings outmigrate after completing one or more full years of life in freshwater, and are thus significantly larger at ocean entry. The yearling and subyearling smolt life history types generally correspond with adult run timing (Spring or Fall), but the linkage between the season adults return to freshwater prior to spawning and survival is somewhat subjective. (We include "Summer" runs with Spring runs, as both groups generally produce yearling smolts).

Spring and Summer (yearling) populations are largely found in high altitude headwater tributaries of large river systems penetrating well into the interior of the continent such as the Columbia & Fraser Rivers, and are the only Chinook life history type reported for Alaskan rivers [40, 41]. In contrast, Fall (subyearling) populations are widely found in low gradient coastal streams or in the lower mainstem of major rivers but are absent from Alaska. Early work [42] suggested an ancient genetic divide between Spring (Stream-Type) and Fall (Ocean-Type) Chinook, with yearling Chinook smolts primarily produced by adult runs returning to freshwater in the spring or summer and then holding in freshwater without feeding until spawning in the autumn.

Stream-Type yearling Chinook are also thought to eventually move offshore and become purely open ocean residents for much of the marine phase, and thus essentially immune to harvest by fisheries until their return, while Ocean-Type Chinook are known to remain as long-term residents of the continental shelf and thus exposed to commercial and sport harvest in coastal marine waters over multiple years [39]. As a result, saltwater harvest of yearling Spring runs is generally low, and essentially only occurs in or near the mouth of the natal river, presumably because maturing Spring Chinook accurately migrate directly back to their river systems from the offshore, providing little opportunity for harvest except on the continental shelf near the river mouth prior to reaching freshwater. In contrast, the survival of shelf-resident subyearling (Fall) populations is presumably more reduced because coastal fisheries can potentially harvest these animals over several years of marine life.

Complicating this simple picture, many hatcheries now hold subyearling (Fall) Chinook for an additional year before releasing them as larger yearling smolts. This breaks the simple linkage between migration behaviour and size or age at ocean entry. Thus some yearling production is of smolts that presumably remain shelf-resident for several years because their intrinsic genetic make-up dictates this behaviour despite their larger (and older) age at release. [39] also document regional differences in migration distribution between lower Columbia River and upper Columbia-Snake River Stream-Type yearling populations which they attribute to possibly greater interbreeding between Spring and Fall run individuals in the lower Columbia River; [43] similarly present evidence from breeding trials that the yearling/subyearling smolting pattern follows simple Mendelian genetic rules in crosses of Ocean-Type and Stream-Type adults (with the added twist that the sex of the parent also influences the result). More recent work [44] has potentially identified a single gene in both Chinook and steelhead that controls early (spring or summer) re-entry of Chinook and steelhead that then mature in freshwater prior to spawning in the autumn; whether and how this gene might also influence marine migration behaviour is unknown.

The lack of clarity in how to best aggregate the data while taking into account of these potentially complex interactions resulted in our decision to simply aggregate the SAR data in our analyses by the recorded age at smoltification (or hatchery release) as either yearlings or subyearlings. However, given the importance that we discuss below of the potential influence of the smolt migration pathways, harvest, and the resulting SAR on conservation efforts, further analysis of the factors controlling migration behaviour in the ocean is clearly needed.

In this paper we have opted to aggregate smolt returns by life history type (yearling vs subyearling) for simplicity, but note that it would be valuable to disentangle the role of size at release from genetically determined differences in migration pathways on survival. Unfortunately, a rigorous assessment of the genetic origins of each hatchery program would almost certainly require a genetic determination of whether each hatchery program was releasing Fall or Spring Chinook, and would need to take into account whether or not hybrid populations had been created; it is completely unclear whether the offspring of an inadvertent hybridization between a Fall and a Spring Chinook parent would rear offshore or on the shelf.

CWT vs PIT tag based survival estimates also differ in that CWT-based estimates produced by the PSC incorporate an explicit estimate of stock-specific losses due to commercial and sport fishing harvest, whereas PIT-tag based estimates do not. Harvest of Spring (stream-type) yearling Chinook salmon occurs only around the river mouth and in-river at the time the maturing adults return to freshwater from the ocean, presumably because Spring Chinook migrate offshore and rear in off-shelf pelagic waters of the open North Pacific prior to maturation and return. However, because Fall (ocean-type) subyearling Chinook appear to remain resident in continental shelf waters for the duration of the marine phase of their life history, they are subject to harvest over multiple years as both immature fish and as maturing adults migrating (typically) back south along the continental shelf to reach their rivers of origin.

This forms one important difference between the available survival datasets for Chinook, because published PIT-tag based estimates of survival for many Columbia River basin stocks are based on adult returns to the river and do not account for losses to harvest. However, this database represents many years of investment in high quality data for Columbia River stocks and has formed the basis for many important contributions to the debate concerning the drivers of poor Columbia River returns and we therefore included it in the analysis.

In contrast, estimates of survival available from the coastwide Chinook survival database produced by the Pacific Salmon Commission (PSC) explicitly incorporate harvest estimates into the survival estimates. As a result, PIT-tag based estimates of survival exclude harvest while CWT-based estimates include harvests, biasing the former low relative to the latter; it should be noted, however, that this issue is likely to be especially important for Fall runs. With the restriction of harvest in recent decades, this concern becomes of lesser concern. However, complicating matters, published PIT-tag based estimates ((McCann et al. 2016) also report survival for the migratory phase as smolts surviving to reach a particular dam in the Columbia River basin until the adults return several years hence and are enumerated at a dam. This therefore excludes losses of smolts from hatchery release to the first dam encountered as well as adult losses on the upstream migration between the last dam where they are enumerated and the spawning grounds. In a nutshell, published PIT-based survival estimates for the Columbia River basin are biased high relative to actual migratory phase survival because these estimates exclude the initial and final phases of the migration period, and biased low because they exclude harvest (which varies in potential influence between large for Fall (subyearling) and low for Spring (yearling) stocks). Some of the PSC's CWT-based survival estimates are also biased low to some degree because they too exclude some migratory survival in the initial and final phases of the migration upstream of the enumeration points for smolts and adults; however, at least for hatchery-reared populations smolt numbers used in the denominator of the survival estimate are estimated at the time of release from the hatchery, and therefore exclude the possibility of migratory losses prior to census.

Transboundary populations in the SE Alaska/Northern BC region are of interest because all of the survival time series derived for these yearling (Spring) Chinook populations are wild origin, with no hatchery contribution. In this case, survival is estimated similar to the PIT tag approach in the Columbia River, and is based on application of mark-recapture models to CWT tagging of downstream migrating smolts and upstream migrating adults in the river's mainstem (see [20] for a concise description of the Alaskan methodology). Similar to the PIT-tag estimates for the Columbia, this excludes migratory phase losses upstream of the census sites.

Offshore (pelagic) harvest of Spring Chinook is likely negligible because a convention banning high seas fishing beyond the 200 mile EEZ of Pacific Rim countries was signed in 1992 (http://www.npafc.org/new/about_convention.html) and enforcement patrols consistently find only limited treaty violations by illegal driftnet vessels and only in the far western Pacific, well beyond the known ocean distribution of North American Chinook stocks [45, 46] (but possibly not steelhead). Some harvest of Chinook occurs in the groundfish fisheries of the Bering Sea, with current evidence suggesting that Pacific northwest populations form ca. 1/3rd of Chinook catches in the Bering Sea/Aleutian Islands region [47], although our understanding of the marine movements and survival of Chinook and steelhead are admittedly still very limited.

Ideally, migratory phase survival would be measured either from ocean entry (i.e., river exit) or from initiation of smolt migration for subyearlings or from downstream migration the overwinter freshwater holding areas for yearlings until adult return to the spawning grounds, with corrections for losses to harvest. However, given the nature of the current survival data on the migration phase, we have chosen not to attempt to normalize the data to a common standard and focus on the broader conservation issues facing Chinook (and steelhead). For this reason it should be noted that the strongest comparisons are within individual survival time series (the coast-wide declining trends in survival) because these will be based on the most consistent methodologies, while comparison between populations will be less reliable because of differences in where each populations is censused to measure survival over the migration phase.

Steelhead

Unfortunately, although many steelhead rivers and hatcheries are located in B.C., adult returns have not been accurately enumerated and thus prevent direct estimation of survival. As a result, survival (SAR) data for British Columbia is restricted to the Keogh River, where a weir located within ca. 300m of the ocean has monitored wild steelhead

SARs since 1977 [48] (Fig 1). However, it is known that the survival trends evident for the Keogh River are mirrored in adult returns for the province as a whole, with some differences between geographic regions [49-51] (Despite the lack of survival data, it is broadly recognized that adult steelhead returns have been falling for decades (e.g., [51, 52]) and are now at record lows; for example, the Thompson and Chilcotin tributaries of the upper Fraser River now each have adult steelhead returns of less than 200 adults [53], despite being of similar size and biogeoclimatic zone to the Snake River).

For Washington State outside the Columbia River basin, steelhead survival (SAR) data were collected and reported by [9] for Puget Sound (Washington State), as well as a number of locations along the coasts of Juan de Fuca Strait, and the outer (western) WA coast. SAR data for the Columbia and Snake Rivers were taken from [1]. We are unaware of steelhead SAR data for Alaska or coastal Oregon rivers.

Comment [DWW2]: Aswea: Did Nealla also provide further data, I think. Was there a source paper we can cite for these or was everything from the Kendall et al (2017) report??

The migration of steelhead is poorly understood, but it is thought that they may migrate directly offshore soon after the smolts reach saltwater [54]. Virtually nothing is known of their marine migration, although the open ocean distribution extends as a band bounded by specific maximum and minimum sea temperatures across the North Pacific [55]. This suggests that (similar to Spring Chinook) maturing steelhead may return directly from the offshore to their natal river and be little exposed to commercial fisheries operating in continental shelf waters except those lying on the direct migration path from the offshore. In freshwater maturing adult steelhead may be exposed to harvest from sport anglers.

Differences between CWT and PIT Tag Survival Estimates

Two surprising conclusions from our work are that Chinook and steelhead survival have now converged to similar low levels for almost all regions of the west coast and that Snake River Chinook and steelhead survival are not abnormally low compared to other regions, despite the presence of many dams in the migration path. Survival for each stock is measured over slightly different parts of the life history depending upon the technology used and as a result incorporates different contributors to survival. These in turn influence the measured values which we are comparing. We outline these issues here, as they are important to understanding their potential influence on the survival measurements.

The PSC database records the number of adults surviving as the sum of adults returning at all ages, uninflated for losses to natural mortality for Chinook remaining at sea for longer than two years. This value will therefore somewhat underestimate smolt to saltwater age 2 survival because of the partial loss of some sub-adults that would have matured at older ages but died prior to maturation. However, the total mortality occurring over the migratory phase of the life history (the SAR), is now ca. 1%, or $M_{Total}=4.5$.

[56] suggested that the loss due to natural mortality between age two and older ages was perhaps $M=0.46\ yr^{-1}$, or only 10% of M_{Total}. Current estimates of age-specific natural mortality are even smaller: age 2, 40%; age 3, 30%; age 4, 20%; and age 5 and older 10%;

[38], p. 8. Consequently, not correcting for additional natural mortality losses occurring between Age 2 and older ages is unlikely to introduce significant error into the SAR estimates; a similar consideration applies to the PIT-tag based survival estimates as well, so for purposes of comparison, this point is perhaps moot, but is included for completeness.

Importantly, in the Pacific Salmon Commission's Chinook Technical Committee SAR estimates the estimated commercial and sport harvest of the different age groups is added to the escapement estimates. Thus harvest is added to escapement to generate the estimated SAR for CWT-based estimates.

In contrast, PIT tag based survival estimates for the Columbia River basin do not incorporate losses due to harvest [1]; see p. 95). Survival estimates using PIT tags will therefore underestimate survival relative to the PSC's CWT-based survival estimates depending upon the magnitude of the catch. Harvest rates are substantial for Fall (Ocean-Type) subyearling stocks, which remain over the continental shelf and exposed to fisheries for several years of marine life [39]. Harvest rates are lower for yearling (Stream-Type) populations which appear to feed in the open-ocean during the immature phase, where they are invulnerable to fisheries. For example, the PSC (Table 2.7) reports average annual stock-specific harvest rates of 29-62% for Strait of Georgia (Fall (or Ocean-Type)) stocks, for example, with harvest rates declining over time [38]. For some Spring (Stream-Type) Chinook, which apparently quickly migrate across the continental shelf from the offshore North Pacific back to their natal rivers [39], harvest rates are much lower (at the extreme, Willamette Spring Hatchery Chinook are reported as having only a 11% mean harvest rate; see Table 2.10 of [38]).

Differences in how harvest is handled between the PIT tag-based estimates (CSS) and the CWT-based estimates (PSC) mean that PIT tag-based survival estimates may thus underestimate SARs relative to CWT-based estimates from roughly 10% to 60% or more. This difference will also vary over time as Chinook harvest rates were restricted as marine survival decreased. As a result of the declining harvest fraction, the PIT-tag based survival estimates will better approximate CWT-based estimates in recent years when the two SAR estimates appear to converge. However, there is no simple way to fully reconcile published survival estimates.

In this report we do not attempt to correct for these differences in how harvest affects Chinook survival because our most important conclusions seem to be robust to these differences, but it is also important to recognize that these methodological differences do exist and influence survival estimates. In summary, published PIT-tag based survival estimates for Chinook [1] exclude the migratory-phase smolt and returning adult survival process occurring upstream of the dams (biasing survival high relative to the PSC estimates, which generally measure survival from smolt release to adult return), and exclude losses to harvest (biasing survival low). These processes have opposite effects on published PIT-tag based SAR estimates.

Comment [DWW3]: We could place into an SI the analysis we did showing that CWT to PIT tag conversion coefficients varied in the 0.8~1.2 range (relative to perfect correspondence of 1.0).

However, although we put a lot of work into trying to do that analysis, my sense in retrospect I'm not sure it I that important to the final analysis and certainly makes a long paper even longer. Do you think we should add it in as an SI?

For steelhead survival comparisons, interception (harvest) in marine fisheries is unpublished but generally viewed as being very low.

I worked on updating the SARS figures this morning using the decisions we recently made about the CWT stocks. I know you dont' want to go down this road far, but i'd like to double check again with you because it takes awhile to update the map and figures when changes are made.

The PSC CWT survival data include a number of experimentally manipulated hatchery stocks. We chose to exclude a number of populations from consideration and document this decision here for completeness.

Atnarko River – We retained subyearlings (ATN) but excluded yearlings (ATY) because they are not in Table 2.1 and are a primarily subyearling stock. The yearlings are a hatchery contribution only (source = Velez-Espino et al).

Kitsumkalum – We retained the yearlings (KLY) but removed the sub-yearlings (KLM) because KLM is released as fry so survivals are fry-to-adult (David Willis, DFO, personal comm.).

Lyons Ferry – We retained the subyearlings (LYF) but removed the yearlings (LYY) because the stock is predominately subyearling migrant and the yearlings are a hatchery manipulation (Larrie LaVoy, NOAA, personal comm.).

Nooksack Spring and Skagit Spring– We retained both subyearlings and yearlings because the stock is naturally a mix of both (Larrie LaVoy, NOAA, personal comm.).

South Puget Sound Fall -- ? Both subyearlings and yearlings are in Table 2.1 but natural production is only fingerlings.

Squaxin Pens Fall Yearling-- ? Don't know about this one. Falls are usually subyearlings.

Comment [DWW4]: Aswea—As indicated in a prior comment, we need to sequester this material in a Supplementary Table, so that our decisions to include/exclude are documented. However, we need very little justification in the SI—just a statement of what we did. Can you move this material there and complete, please? (The Author Instructions for POS Biology state that the SI material s will be published "as is" and will not be edited)

Treatment of Data

SAR data for salmon are log-normally distributed [57]; i.e., a time series of SAR data, S_t, will have the form $S_t = e^{\mu+\sigma Z_t}$, where μ and σ are respectively the mean and standard deviation of $\log_e(S)$, and Z_t is the standard normal variable $Z \sim N(\mu, \sigma)$. This is important because the log-normal distribution is skewed, exhibiting occasional rare high survivals which increases the expected value above the mean. As a result, the expected value of a log-normally distributed SAR time series is neither the simple mean $\bar{S} = \frac{1}{n}\sum_{t=1}^{n} S_t$ nor μ, but rather $\mathrm{E}(\mathrm{S}_t) = \mathrm{e}^{\mu+\sigma^2/2}$ (in fact, it is the median value of the log-normal distribution that is related to μ, as $S_{median} = \mathrm{e}^{\mu}$). Calculating the average of the untransformed survival data, although often reported, does not have a simple statistical interpretation.

When comparing survival time series between regions some important but subtle differences should therefore be kept in mind. We have opted to use the median (equivalent to the "geometric mean", used in some literature) as well as the simple average $\overline{S}$ of the untransformed SAR data in a number of key comparisons. The simple average is what many prior studies report, and therefore what most policy makers and fisheries managers are likely comfortable interpreting. For example, the NWPPC has set a rebuilding target of 2%-6% for SARs and deemed 1% SARs (roughly the current average) to be inadequate, but did not define how SAR values should be calculated.

However, when the distribution of SARs are compared between two regions *i, j* then if the medians are found to be the similar, the implication is then that $\mu_i = \mu_j$ and that the simple means of the log-transformed data are also equal; this does not, however, imply that the expected values $\mathrm{E}(\mathrm{S}_t) = \mathrm{e}^{\mu+\sigma^2/2}$ are equal because this value also depends on the variance of the time series. For these reasons, we use both measures of central tendency

$$\overline{S} = \frac{1}{n}\sum_{t=1}^{n} S_t,$$
$$S_{median} = e^{\mu}$$

in our analysis, and not the expected mean values of the log-normal distribution $\mathrm{E}(\mathrm{S}_t) = \mathrm{e}^{\mu+\sigma^2/2}$, owing to the more complex definition and lack of easy interpretation, which the (simple) mean and the median readily impart.

Precision of survival estimates

The standard error on a binomial proportion, survival, is $SE(S) = \sqrt{S(1-S)/N}$. The precision of a survival estimate, ϕ(S), degrades as survival decreases, because

$$\Phi(S) = \frac{\mathrm{SE}(\mathrm{S})}{S} = \sqrt{\frac{1-S}{S \cdot N}}$$

In the limit as survival approaches either 1 or zero,

$$\lim_{S \to 1} \Phi(S) = 0$$
$$and$$
$$\lim_{S \to 0} \Phi(S) = \infty$$

The relative uncertainty in a survival estimate with a given sample size increases without bound as survival decreases towards zero. With survival values now at 1% or less, the relative precision of a survival estimate now relative to several decades ago when survival was in the 5-6% range is

$$\frac{\Phi(S_1 = 0.01)}{\Phi(S_2 = 0.06)} = \sqrt{\frac{(1-S_1)/(S_1 N)}{(1-S_2)/(S_2 N)}} = \sqrt{\frac{S_2}{S_1}\frac{(1-S_1)}{(1-S_2)}} \approx \sqrt{\frac{S_2}{S_1}}.$$

In this numeric example, where survival falls from 6% at the start of the record to 1% at the end, the uncertainty relative to the point estimate increases almost 2.5-fold ($\sqrt{6}$). (Taking into account that both the number of outgoing smolts and the number of returning adults is not known without error, as is implicitly assumed in using the binomial probability distribution, the actual uncertainty will be even larger when these uncertainties are taken into account). It is interesting to note that should survival fall from the current ca. 1% level to 0.1%-- a ten-fold further decline—it would in fact be difficult to recognize this massive decline in survival (a fall as large as the decline from 100% to 10% or 10% to 1% survival) because of the limited precision with which survival can be measured at these low levels. Thus for both purely mathematical reasons as well as the methodological differences between tagging approaches listed in the prior section, it is likely infeasible to obtain a perfect conversion ratio between survival estimates calculated using different methodologies (PIT vs CWT) or even between river systems using the same technical methods because the distance downstream migrating smolts and upstream migrating adults travel in freshwater before reaching a location where they are censused will vary with the stock and the agency measuring survival.

We therefore caution that it is unlikely that a single consistent conversion factor between CWT and PIT tag-based SAR estimates can be derived, because survival losses incurred upstream of the initial and final census point for calculating SARs can vary substantially between rivers and between populations within a river system. Only hatchery releases can potentially reach this technical standard of measuring survival over the entire migratory phase of the life history, and only if adult enumeration takes place on the spawning grounds (or at the hatchery). Nevertheless, the question of whether survival for other regions of the west coast has now fallen to as low as the Snake River Chinook and steelhead is of critical importance for policy reasons because the current low survival of Snake River stocks is viewed as anomalously low.

Results

Chinook

1. Coast-Wide Survival

Survival for a varying range of years are available, with data for the Columbia River extending back to the 1960s (Fig 1; S1 Table). In essentially all regions where time series extend back to the 1970s or earlier, survival to adult return has substantially decreased with time (Fig 2). The large drop in SARs for yearling Snake River stocks Chinook first reported by [2, 28] from the 1960s to approximately the mid-1970s, the time period when Snake River dams were completed, is evident. However, although

Fig 2. Time series of smolt to adult survival (SAR) data for west coast Chinook stocks (excluding California). Top row: subyearlings; bottom row: yearlings. Regions are oriented from north (left) to south (right). Gold dots are SAR measurements based on CWT tags (PSC database), brown dots are SARs reported by Raymond (1988), and violet dots are SARs based on PIT tags [1]. A loess curve of survival and associated 95% confidence interval (shaded region) using all available data for each panel is shown as a black line (the smoothing parameter was set to α=0.75); the loess curves for Snake River subyearling and yearling survival are overplotted in red on all panels to facilitate comparison. Blank panels indicate regions where the life history type does not occur (for example, Fall (subyearling) Chinook do not occur in Alaska, while Spring (yearling) Chinook do not occur in the low elevation streams on the west coast of Vancouver Island or Oregon coast). The major regime shift years of 1977, 1989, and 1998 are indicated by vertical lines.

the timing varies with region, the collapse in Spring Chinook survival is also evident in other regions with long time series (Upper Columbia River yearlings and—notably—Alaskan yearling stocks from SE Alaska), and is also evident in the longer time series for subyearling Chinook (west coast Vancouver Island, the Strait of Georgia, and Puget Sound).

From the time of the major regime shift in 1977 forwards no substantial recovery in SARs is evident in any region. Although Raymond (and many subsequent authors) ascribed the cause of the drop in survival to dam construction, the decline in SARs with time is also seen in many regions not affected by the construction of the FCRPS. As more monitoring programs were brought on in the 1980s, SARS for all these regions was either declining or essentially fluctuating around a low mean value closely approximating the Snake River SARs (red lines) in all regions apart from the Oregon Coast; here, SARs were also roughly flat over time but at a persistently higher mean level relative to the Snake.

Strikingly, no region outside the Columbia River now achieves the Columbia River basin's official SAR recovery targets of 2%-6%. The Alaskan stocks attained these target survival levels in the early 1980s, but since that time Alaskan SARS have fallen below the Columbia River basin rebuilding targets as well, and in recent years have reached the current survival rates of Columbia basin stocks.

2. Regional Survival Differences

When population specific data for all available years are compared by region (Fig 3), median Snake River yearling (Spring) Chinook SAR is higher than the regional median SARs for Puget Sound, Strait of Georgia, and Northern & Central BC; median survival for the Upper and Lower Columbia River populations are virtually identical. Regional SARs are higher than the Snake River yearling values only for two regions: the mid-Columbia River region and Alaska. Within a few of these geographic regions striking

Fig 3. Box and whisker plot of SARs by population (all available years). The black horizontal line within each bar is the median of the SAR data available for each population. Median survival across all available data for each region is shown as a blue line; median Snake River survival for all populations combined is shown as a red line and overplotted on all panels for comparison. The number of years of data is shown to the right. To save space abbreviated population names are used here along with the map code from Figure 1; the full names for the populations are listed in Table S1.

population-specific differences are also evident, which we consider later.

For subyearlings (Fall Chinook), Snake River SARs are similar to or higher than survival in all regions of the coast apart from coastal Oregon (ORC) and the west coast of Vancouver Island (Fig 3). As the time series plot (Fig 2) makes clear, the higher median survival evident for west coast Vancouver Island (Robertson Creek) Chinook relative to the Snake River may not actually due to persistently better SARs but rather that the longer time series of data for Robertson Creek extends back to the period of particularly high SARs in the 1970s that is lacking for Snake River subyearling Chinook (we consider this possibility later). Two subyearling hatchery populations from farther north (underwater-University of Washington Accelerated Fall Chinook- in Puget Sound and Chilliwack Fall Chinook from the Strait of Georgia (lower Fraser River)) are also of note because the strikingly large survival difference (up to ~4X) of these stocks relative to the majority of populations in each region. The higher median SAR for the Mid-Columbia region is similarly due to two specific yearling populations (Yakima and John Day) with three other hatchery-derived populations having decidedly lower SARs; these latter populations have SARS that are consistent with both Snake River and Lower Columbia River median SARs.

3. Relative Survival (Scaled by Snake River)

The regional-scale aggregation of SAR data provides a useful overview of survival between regions, but important population-specific differences in survival are potentially obscured because when SARs are low small numerical differences may in fact reflect large differential impacts on survival. For example, when regional SARs are only 1%, a population-specific SAR of 0.5% actually represents a population whose survival rate is only half that of the other populations; this is as large a difference as survival through the entire 8 dam FCRPS (50-60%). In addition, regional comparisons may be distorted because of time trends in survival and differing lengths to the time series.

The potential influence of these factors can be reduced by normalizing the SAR estimates. In Fig 4 we have done so by dividing each annual SAR estimate by the median of all Snake River SAR data available in the same year (Fig 4). This approach removes the potential confounding of survival comparisons caused by trends in SAR. When data for all available years are compared in this way, median Snake River yearling Chinook SARS are higher than Puget Sound and the Strait of Georgia, and virtually indistinguishable from those in the Lower Columbia River (Willamette R) and the Upper Columbia River. Only normalized SARs for mid-Columbia, North &

Fig 4. Normalized Chinook SARs. Values are calculated by dividing individual SAR estimates for each stock and each year by the median Snake River SAR for the same year and aggregating by region. Vertical lines show the median SAR for the Snake River (red) and other regions (blue). Note the logarithmic scale on the x-axis. As in the prior plots, Columbia & Snake River SAR estimates based on PIT tags do not incorporate above-dam survival (or harvest).

Central BC, and SE Alaskan populations of Spring Chinook are higher than the Snake River populations.

The situation is similar for subyearling Chinook when normalized SARs are compared, except here the nearly 5-fold higher survival of the two Oregon coast stocks and the roughly 3-fold higher SAR for the Robertson Creek population (west coast Vancouver

Comment [DWW5]: Aswea: Please check the exact numeric ratio & put it in here if it is appreciably different from what I wrote—I eyeballed this value from the graph you produced.

Island) are notable; Snake River SARs for Fall Chinook are either just marginally higher than (Upper Columbia, Strait of Georgia) or closely equivalent to SARs observed for all other regions with data (Mid and Lower Columbia; Washington Coast, Puget Sound, North-Central BC).

Comment [DWW6]: ***Points to put in Delayed Mortality Discussion:***

1)A major point, I think, is that MCOL SARs are lower for Fall Chinook and higher for only 2 of 5 Spring Chinook populations; if there was a real relationship with the number of dams smolts migrate through, we should expect to see the SAR difference be evident for both life history types.

2)SARs for yearling Chinook from Puget Sound, Strait of Georgia, and north-central BC are all lower than for the Snake River, and thus for the Columbia River basin as a whole.

3)This raises questions about the validity of the delayed mortality theory (more dam passage results in lower marine survival) and also on whether Columbia River recovery targets are realistic (if rivers without dams cannot achieve the survival achieved by Columbia River basin populations with dams, how will Columbia River basin biologists achieve these targets?).

4)The subyearling pattern is somewhat more complicated than that of yearling Chinook, but we think that the lack of a consistent relationship with dam passage is notable (shouldn't there be one if there is delayed mortality?), as are the similar survival levels to the Strait of Georgia stocks. The Strait of Georgia includes quite a number of stocks from the Fraser River, a river of similar size to the Columbia, but which lacks dams lying along the smolt migration pathway.

4. Survival by Regime

Significant changes in ocean productivity are known to impact salmon populations on time scales ranging from decades to centuries (see the Discussion). An alternative approach to comparing survival normalized by year is to break the survival data into recognized ocean regime periods: ocean entry by smolts in 1977 and earlier years, 1978-89, 1990-98, and 1999 or later. The results (Fig 5) essentially mirror prior analyses, with Snake River yearling survival dropping after the 1977 regime shift, Alaskan yearling Chinook survival falling after the 1990 regime shift, and only the Alaskan, north-central BC, and Mid-Columbia populations remaining (slightly) higher than the Snake River populations; Upper and Lower Columbia, Puget Sound, Strait of Georgia, and north-central BC populations all have similar or lower survival. A very similar pattern of response is evident for subyearling Chinook, except here it is only the Oregon Coastal populations that have persistently higher survival; the progressive collapse in survival across regimes is notable, particularly for those regions whose survival data extends back to the pre-1977 period.

Fig 5. Comparison of Chinook SARs by regime periods (pre-1977, 1978-1989, 1990-1998, and post 1998). Boxes and whiskers have the conventional interpretation; the horizontal red line shows the Snake R median SAR value for each regime to facilitate comparison. Sample sizes are shown above each group.

Steelhead

6. Coast-Wide Survival

Data on steelhead survival (SAR) are more geographically limited than for Chinook,

Fig 6. Steelhead SARS, plotted against ocean entry year. Regions are oriented from north (left) to south (right); the Keogh R (KEOG) is situated on the NE tip of Vancouver Island (BC). Gold dots are SAR measurements based on PIT tags [1], brown dots are SARs reported by Raymond [2], and violet dots are SARs based on CWT tags. A loess curve of survival and associated 95% confidence interval (shaded region) using all available data for each panel is shown as a black line (the smoothing parameter was set to α=0.75); the Snake River loess curve is shown in red and over plotted on all other panels to facilitate comparison. B.C. steelhead survival data are only available for the Keogh River (see [6] for description of the monitoring program). The major regime shift years of 1977, 1989, and 1998 are indicated by vertical lines.

but share many of the same features (Fig 6). Prior to the 1977 regime shift, data is only available for the Upper Columbia River and Snake Rivers. In these regions, there is little evidence of a change in survival before or after 1977 (when both FCRPS dam construction was completed and a major marine regime shift occurred). A sharp decline is evident in Puget Sound, Washington Coast, & Keogh R (NE Vancouver Island) steelhead SARs after ocean entry year 1990, the time of the next ocean regime shift, but a corresponding decline in Columbia basin steelhead survival is not. (Although SAR (survival) data is not available for B.C. stocks other than the Keogh R, the pattern of adult returns to B.C. rivers closely matches Keogh R survival, supporting the view that the Keogh pattern applies more broadly; see [51]). Washington outer coast (WAC) SARS are slightly higher than those for the Snake River (as is Keogh), while Puget Sound SARs drop to substantially lower values after 1990.

7. Regional Survival Differences

Similar to Chinook, the same pattern of a few steelhead populations having anomalously high survival is evident, with three mid-Columbia River and two Washington Coast populations having similarly high median SARs (Fig 7). However, the median SARs for all steelhead populations in a given geographic region are indistinguishable from Snake River SARs (Upper Columbia, Washington Coast) or lower (Puget Sound). Only the median SARs for the mid-Columbia River region and the Keogh River are appreciably higher than the median Snake River survival.

Fig 7. Box and whisker plot of steelhead SARs by population (all available years). Population names are listed in Table S1. The black horizontal line within each bar is the median of the SAR data available for that population. Median survival across all available data for each geographic region is shown as a blue line; median Snake River survival for all populations combined is shown as a red line and overplotted on all panels for comparison. The number of years of data is shown to the right.

A very similar conclusion is evident when annual SAR estimates for individual stocks are normalized by the Snake River median survival values in each year (Fig 8). This pattern becomes particularly clear when the steelhead SAR data are disaggregated by regimes (Fig 9), where both the large drop in Keogh R SARs over time is evident, as is the remarkably similar or lower SARs for Puget Sound, Washington Coast, and the Upper Columbia River relative to the Snake River in all regime periods; only the mid-Columbia River region stands out as having higher SARs.

Fig 8. Normalized steelhead SARs, obtained by dividing each individual SAR estimate (i.e., for each stock and each year) by the median SAR calculated across all available Snake River SARs for that year. The median Snake River SAR is overplotted in red. Note the logarithmic scale on the x-axis.

Fig 9. Comparison of steelhead SARs by regime periods: pre-1977, 1978-1989, 1990-1998, and post 1998. Boxes and whiskers have the conventional interpretation; the horizontal red line shows the Snake R median SAR value for each regime to facilitate comparison. Sample sizes are shown above each group.

In-River Smolt Survival

SAR data measures survival over almost the entire migration phase, from the beginning of smolt migration downstream until the adults return from the ocean several years later. These measurements therefore conflate freshwater survival with marine survival. To assess what are "normal" freshwater survival levels for smolts migrating downstream, we collated all published studies for west coast North American rivers (Table S2) and compared downstream smolt survival and survival scaled for distance travelled (Fig 10). The results show that all river systems have roughly similar levels of survival to the river mouth, and that smolt survival during migration down the Columbia and Snake Rivers is not unusually low despite the presence of many dams in the migration pathway.

Fig 10. Freshwater smolt survival during downstream migration for Chinook and steelhead for west coast North American rivers. Top row compares survival from release to river mouth (and intermediate locations in the case of the Columbia). Bottom row compares survival per 100 km of migration distance. The data for each region is shown twice, as a box and whisker plot and adjacent to this a jittered dot plot; error bars are ±1 SE, where reported (see Table S2 for data and sources). In each panel a dashed horizontal line indicates the median Columbia River or Snake River survival value to facilitate comparison with other river systems.

Discussion

Our analysis shows that over time SARs (smolt to adult survival) have declined to reach approximately the same low level for almost the entire west coast of North America–with a few important exceptions that we discuss later. Although we do not have direct measurements of survival for Chinook stocks west of SE Alaska or steelhead north of Vancouver Island, the collapse in adult returns of Chinook to the rest of Alaska [20, 21] shows the broad region that the conservation crisis extends over.

The advent of acoustic telemetry has resulted over the past two decades in a broad range of river systems where smolt survival (i.e., from release to ocean entry) has been assessed. Our analysis of studies reporting freshwater smolt survival during the downstream migration phase indicates that survival is high and of roughly similar magnitude in most rivers, but that when scaled for migration distance the Columbia River smolts have the highest survival rates (Fig 10). This result is important because it isolates the location of the conservation problem as being primarily in the ocean (see below) although, the results do indicate that the river mouth is a perilous location for smolts because survival rates scaled by distance are extremely low in rivers where distance to the mouth is short. Freshwater losses (presumably to predators) must be concentrated near the river mouth to result in such disproportionately low survival rates.

Occam's Razor dictates that any coherent theory consistent with the large drop in marine survival (SARs) to similar low levels should be applicable to all populations. We are unable to identify a fully consistent mechanism of action, but some explanations (anthropogenic freshwater habitat disruptions) are clearly more problematic than others (climate-related changes in the ocean).

Conventional logic holds that if average survival (SAR) of Chinook or steelhead was 4%-6% in regions without dams, then the four- to six-fold lower survival of Columbia River populations (currently ca. 1%) would be clear evidence that the Columbia River dams were the cause of poor survival. The obvious conclusion would then be that removing or modifying dams lying in the migration path of Snake River basin populations should increase SARS four- to six-fold, achieving rebuilding targets. This is a common argument. Yet the same logic, which has implicitly guided much conservation thinking, clearly cannot be used in reverse—presumably no one would rationally argue that constructing 8 dams in the Fraser River would quadruple salmon returns (raising median Chinook survival in the years since 2000 from a mere 0.3% in the Fraser River to the Snake River's current 1.1%).

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That conventional wisdom does not work in reverse suggests a deeper problem in how biologists and conservationists think about current salmon problems. A wide range of west coast rivers lacking dams now have similar or worse reported survival than the Snake River, both in terms of adult return rates and as downstream smolt survival when migration distance is accounted for. We interpret this as evidence for a fundamental flaw in our biological understanding of the conservation factors actually controlling salmon productivity. Earlier work reported roughly similar freshwater survival rates in the Columbia and Fraser Rivers [58]. Our compendium of telemetry studies for a wide range of west coast rivers also shows similar levels of overall smolt survival to the Columbia River (Fig 10 and Table S2); downstream smolt survival within the Columbia River is clearly not anomalously low relative to other river systems as widely assumed and in fact can be viewed as quite high when the greater distances Columbia River smolts spend migrating are considered. Downstream smolt survival in freshwater is also quite high relative to the marine phase. With SARs now around 1% and smolt survival in rivers around 20-50% or higher (Table S2, Fig 10), at least $1/2 \sim 1/5^{th}$ of smolts survive to leave freshwater, so only $1/50^{th} \sim 1/20^{th}$ of smolts surviving to leave the river are returning from the sea. Clearly, marine survival is far lower than freshwater survival.

Despite this, great effort still continues to be placed on addressing the effects of dams within the Columbia River basin, even if survival in other river systems lacking dams is similar. As we discuss below, this freshwater focus is broadly evident in west coast salmon conservation efforts, with a strong bias towards ignoring or minimizing the marine impacts and focusing on a search for freshwater habitat problems.

A similar logic seems to have guided the argument that "delayed mortality" caused by dam passage results in poor ocean (or estuary) survival for Snake River smolts. Spring Chinook smolt survival through the 8-dam FCRPS ranges from 50-60% (Tables A.1 and A.2 of [1]), so even eliminating all sources of freshwater mortality during downstream migration—direct impacts of the dams on survival, predation, and possible losses from disease—could only increase SARS by a factor of 0.5^{-1}-0.6^{-1}, or ca. 1.7-2 fold. These levels are still well below rebuilding targets. Further, because a significant fraction of the downstream loss is due to predation by birds [59] and fish [60], unless all predatory wildlife species are eliminated even an increase to 1.7-2% SARs is unrealistic.

The mathematical inability of even perfect hydrosystem survival to achieve minimum rebuilding targets likely underlies the logic that delayed mortality caused by the dams occurs in the ocean, rather than searching directly for intrinsic differences in ocean biology of the different salmon populations. This unstated gap between what is theoretically achievable and what must be achieved in practice for Columbia River recovery is presumably the reason why delayed mortality is considered important for Snake River stocks [1, 61-65], although direct experimental tests using size-matched controls found no evidence for a survival difference to as far away as Vancouver Island ([66-68]).

Despite frequent statements about the importance of a particular life history stage based on the low survival in that stage, unfortunately the profound implications of the overall decline in salmon SARS to ca. 1% largely go unrecognized. For example, even a 50% decline in survival in a particular life history stage requires a total of N=6.6 sequential phases of 50% survival to reduce SARs to 1% (because $0.5^{6.6}=0.01$). From this perspective, survival through a migration segment such as the entire FCRPS with an at-worst survival of roughly 50% contributes only 1/6.6=15% to determining the SAR.

Conventional conservation thinking focusing on freshwater habitat can likely be traced back to two separate events occurring in the 1970s. The first was the passage of the U.S. Endangered Species Act in 1973, with its strong focus on protecting and preserving habitat as the paramount priority for conservation [69]. Unfortunately, "habitat" is ill-defined for migratory animals such as salmon which occupy many different habitats as they complete their life cycle. The second event, occurring just four years later but unappreciated at the time, was a major regime shift in ocean climate in 1977 which had impacts on a wide range of marine fish stocks (including salmon) across the entire west coast of North America [70, 71].

Salmon, as well as other anadromous fish such as lamprey and eulachon, migrate widely across a complex landscape composed of many successive freshwater and marine habitats; even something as simple as the number of distinct habitats each salmon population occupies over the marine phase is currently unknown. The number of returning adults is therefore successively affected by changes in survival in a complete sequence of freshwater and marine habitats, most of which are poorly understood, as the product $SAR=S_1 \bullet S_2 \bullet S_3 \bullet \ldots S_n$. If survival drops to 1/10th of its original value in any one of these habitats the SAR will also decline equivalently unless density-dependent factors occurring at some later point in the life history buffer the impact on returns. (We consider further the contribution of density-dependent factors in the Conclusions).

Overall, the collated coast-wide data shows that marine survival began declining earliest in the south and then the region of poor marine survival progressively expanded farther north along the coast at or following the time of each regime shift; in the last decade even SE Alaska has Chinook survival little different from than experienced by Snake River Chinook (Fig 2). Obviously, almost none of the rivers outside the Columbia have dams, so the argument that the Snake River stocks' poor performance is due to the completion of the Federal Columbia River Power System (FCRPS) is inconsistent with the broader data. As we will discuss, many other "single factor" reasons for poor salmon survival along the west coast also suffer from the same logical flaw that survival now seems to be poor everywhere.

The Habitat Problem

Wasser et al [72] cite this blanket statement: "*Anadromous salmonids (Oncorhynchus sp.), which hatch in fresh water, migrate to the ocean, and then return to their natal waterways to breed, are threatened primarily by habitat loss from dams and overfishing (SOS 2011)*" (Lines 98-101 of the SI). The sentiment underpinning this statement is widespread. However, we view the reality as more nuanced: Fall (ocean-type) Chinook harvest levels of 50%-70% that were formerly sustainable (i.e., a harvest of one-half to two-thirds of returning adults) are no longer sustainable because marine survival dropped 4-5 fold over the past few decades—far larger. Consider a situation where the entire harvest effort was doubled (say, by doubling the number of years that salmon remain at sea before maturing, so that the same fisheries operate twice over on the animals and the animals remain equally vulnerable to fishing over this time period). This would reduce escapements to only $(0.5)^2$ to $(0.7)^2$ (25%-49%) of the level achieved without fisheries. This is still substantially better than the decrease in SARs resulting from the collapse in marine survival. Clearly, when this level of loss is repeated over successive generations, it is only due to poorly understood compensatory density-dependent processes that salmon populations have not collapsed to much smaller sizes than currently persist.

Statements about the major role of particular factors as driving salmon declines (dams in the Columbia River or salmon farming in British Columbia) must therefore be assessed critically because salmon from other regions lacking these particular factors also return from the ocean with very poor marine survival. Thus dams or salmon aquaculture may contribute as habitat issues to overall losses, but the essential policy debate is whether modifying their operation will (1) materially contribute to improving salmon returns and (2) whether proposed courses of action are actually credible given the primary influence of ocean conditions.

We view it as critical that the roles of various proposed deleterious impacts on salmon returns be rigorously quantified, rather than simply identified as important without careful thought about other potential contributing factors. If this is not done, competing economic activities may be unfairly blamed for the ongoing collapse of several important salmon species and unrealistic expectations placed on what various recovery options may actually achieve. This is not simply restricted to dam removal in the Columbia River basin or banning open-net salmon aquaculture in British Columba; [73] state that "*Low availability of Chinook salmon appears to be an important stressor among these fish-eating whales as well as a significant cause of late pregnancy failure, including unobserved perinatal loss... Results point to the importance of promoting Chinook salmon recovery to enhance population growth of Southern Resident killer whales.*" Policy options for promoting recovery thus need to recognize that the wide geographic footprint of poor salmon survival likely implies that efforts focused on "fixing" possible contributing factors specific to some regions are unlikely to be effective. At the very least, these efforts should be held to a significant standard (see below): (a) clearly demonstrating a real and substantive improvement and (b) demonstrating a clear benefit relative to the costs of the proposed action.

Although it is common to invoke a critical period in the early life history as determining adult salmon recruitment, and thereby simplifying the scientific problem, we believe that the reality is different—an X-fold decline in survival at any point in the life cycle will result in an exactly equivalent X-fold decline in adult recruitment unless density-dependent processes occur at some later point in the life history to moderate the response. Furthermore, an approximately 5-fold increase in seal populations over the same time period has been documented [74, 75] and predation by seals and other marine mammals on salmonids is now demonstrated to both occur and be of major concern in a number of west coast regions [74-77]. It is not unreasonable to assume that potential impacts of marine mammals on salmon survival may actually be more important in the final marine phases of the life history rather than the early marine period.

Several influential publications surveyed the conservation problems with Pacific salmon stocks [14, 15], and noted that the problems were greatest to the south and least in the north (i.e., British Columbia and Alaska). Not unreasonably for the time, the authors suggested this north-south trend was primarily a result of greater anthropogenic disturbance in southern regions owing to larger human populations and therefore greater freshwater habitat disruption. Reflecting the generally limited understanding of the impact of ocean regime shifts of the time, little discussion was made of potential ocean influences, which were lumped in with "*Other natural or manmade factors affecting continued existence*" [14](p.8). Yet profound large-scale declines in ocean-mediated survival were occurring for many purely marine species as well as salmon [78], and these too appear to have a south-north latitudinal gradient, but with the spatial footprint of poor survival expanding further up the coast with time (e.g., [51]).

The more recent regimes shifts in 1989 and 1998 were more quickly recognized by the marine community [16-18, 79, 80] but substantive connections to the issues concerning freshwater habitat and salmon conservation have been slow to develop. As a result, current research into salmon conservation issues has developed into stovepipes with relatively little interaction between the two groups: freshwater researchers argue that even if the real cause of the survival decline can be identified, little can be done to improve ocean survival so the primary focus should be on protecting, conserving, and improving freshwater habitat to maintain this habitat for when ocean conditions again turn favourable. Unfortunately, marine researchers initially could only offer large-scale correlation between changes in ocean climate and adult survival, not mechanistic understanding that could lead to substantial predictive capability or (most critically) insight into how salmon returns might be improved. A key finding from our current work is that although the implicit assumption of *cyclical* variation in ocean conditions is widespread (i.e., oscillations), the data is better defined as a series of ever-declining survival stanzas. While very long period cycles in salmon abundance are evident from lake cores e.g., [81-83] the troubling decline in survival recorded in the SAR data over the past half century seems most consistent with society's entry into the Anthropocene [84], and the seemingly inexorable further increases in greenhouse gas induced warming that is expected as a result.

Acceptance of the presumed magnitude of the impact of Columbia River dams on Columbia River salmon returns can be traced to Raymond [2, 28, 29], who documented large-scale declines in adult salmon returns through the 1960s and 1970s, a period when the FCRPS was completed with the construction of the Snake River dams.

However, Raymond was also working in a time when the impact of ocean climate was not recognized; many of Raymond's contemporaries in fact argued that because of the size of the ocean, it was presumably a stable environment (Kees Groot; pers. comm.).

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However, the same major decline in survival since the 1977 regime shift can also be seen in British Columbia, the period when the first real measurements of SARs started. Perhaps the best measurements demonstrating the magnitude of the drop in British Columbia SARs was reported by [85]. In the early 1970s SARs for Strait of Georgia coho of $\overline{S} = 20.8\%$ (SE: ±0.5%) and $S_{median} = 17.2\%$ were obtained in extensive experimental hatchery releases (6 replicates of each of 3 size classes of smolts in each of 3 months (April, May, & June)) [85]. The magnitude of these survival levels (ca. one in five smolts surviving to return as adults) justified Canada's decision to fund the Salmon Enhancement Program (SEP), a major investment in hatcheries. Yet less than two decades after the start of SEP in 1977, average coho SARs for the nearby Big Qualicum hatchery had dropped from 28.6% (1973-77 ocean entry years) to 5.6% (1990-99) and then to 1.5%(2000-2012) (data from [8, 86]). As a result, average survival rates dropped from 1 in 3.5 smolts in the 1970s to 1 in 67 smolts—survival dropped to 1/20[th] of the initial value. (See [8] for a detailed description of the decline over time in Strait of Georgia coho SARs).

To place the magnitude of this change in perspective, by the 2000s coho SARs in the Strait of Georgia were the equivalent to surviving through a sequence of $n = \log(S_{2000s})/\log(S_{70s}) = 3.3$ successive survival periods, each equivalent to the entire survival process experienced in 1973-77. The changes in the environment that occurred were thus the equivalent to the coho remaining at sea for 60 months (5 yr) instead of 1.5 yr while experiencing the total mortality rates (natural and fishing) experienced in the 1970s.

The pattern of variation in SARS along the west coast of North America is most simply explained as both a progressive worsening of marine survival over time and simultaneously a geographic northward expansion of the region of poor ocean survival. However, several puzzling aspects to this pattern need to be addressed. Because Ocean Type (Fall) Chinook are believed to remain shelf-resident for their entire marine phase while Stream Type (Spring) Chinook migrate north on the shelf before eventually moving off-shelf (or into the Bering Sea/Aleutian Island region), this would suggest that the area of poor marine survival might be restricted to the coastal shelf off Washington, British Columbia, and SE Alaska. However, complicating a clear understanding of the drivers, the large-scale collapse in adult Chinook returns includes the Yukon and Kuskokwim Rivers (draining into the Bering Sea) and the Kenai River (Cook Inlet) [20-22, 87, 88]. This suggests that either the area of poor marine survival is now simultaneously large or that all stocks congregate at some point in the marine phase into a more geographically confined region where their survival is all similarly affected. The evidence that Fall (subyearling) Chinook stocks only migrate as far north as SE Alaska after one or more years at sea (and that Strait of Georgia and Puget Sound coho remain resident in southern BC waters for their entire marine lifespan) suggests that the conditions leading to poor marine survival are thus likely geographically widespread because western Alaska Spring Chinook are not known to migrate to the shelf region off SE Alaska or BC.

Several important differences in SARs point to important directions for future study. A few stocks within specific rivers have SARs 3-4-fold higher than nearby stocks. At the extreme, the Chilliwack stock of Fall (subyearling) Chinook has a median SAR of ca. 4%, an order of magnitude greater than other Strait of Georgia stocks. Understanding why only a few populations consistently have high SARs when returning from the ocean as adults could pay large dividends in understanding what differences in ocean experience result in a few populations remaining productive while many others have essentially collapsed.

This stock-specific difference in marine survival was previously interpreted as evidence for delayed mortality reducing survival of Snake River stocks relative to some mid-Columbia (Yakima, John Day) populations because of the greater number of dams the Snake River populations must pass through [63, 64, 89]. However, several other mid-Columbia populations have survival quite similar to Snake River populations and different from the John Day and Yakima populations, despite also having limited dam passage (Fig 3). At least two populations outside the Columbia River basin also have far greater SARs than other nearby populations (Chilliwack Fall Chinook and UW Accelerated Fall hatchery releases). Large differences in SARs between different hatcheries rearing Spring Chinook have also been noted, and ascribed to possible rearing differences [90]. However, genetic differences may underlie persistent differences in many life history traits of Spring Chinook [91]. These differences could include control over migration pathways leading some populations to migrate to marine areas supporting higher survival.

In the context of the delayed mortality theory, the unusually high survival of the John Day and Yakima yearling Chinook populations relative to Snake River populations and a similar pattern for steelhead is also seen in other geographic regions not involving any dam passage. The apparent relationship of possible delayed mortality related to the degree of dam passage therefore disappears when a broader range of populations is brought into the comparison and is also not evident when mid-Columbia River subyearling populations are examined (Fig 3). The most parsimonious explanation is thus not stress from greater dam passage but rather something intrinsically different in the marine phase of the life history. Rechisky et al [66] measured essentially identical migration speeds and survival for size-matched cohorts of tagged Dworshak and Yakima Spring Chinook to the northern tip of Vancouver Island, some 485 km beyond the mouth of the Columbia River. However, a month later only smolts from the Dworshak (Snake River) stock were detected arriving on the SE Alaskan subarray, located some 1,000 km further to the north, and still migrating at the same speed of roughly 1 BL/sec; it is unknown why no Yakima smolts were detected.

Understanding the differences in the marine migration pathways that could lead some populations to rear in more favourable ocean regions would be an important advance in our understanding of the currently opaque marine phase. As Peterman and Dorner [13] remarked for sockeye, "*Further research should focus on mechanisms that operate at large, multiregional spatial scales, and (or) in marine areas where numerous correlated sockeye stocks overlap*". The markedly higher SARs evident for Oregon coastal Chinook relative to most other populations (Fig 2) is probably also important in this context. Nicholas and Hankin [92] (Table 2) report that Fall Chinook from the Salmon and Elk rivers in Oregon are north migrating stocks and that Oregon coastal stocks show variation in ocean migration "*with some migrating north, some south, and one stock has a mixed north and south ocean migration*" [14]. Lending credence to the possibility that ocean migration pathways may influence productivity, the authors reported that the few "south migrating" Fall Chinook stocks were all characterized as having "depressed" runs in 1988 (prior to the 1989 regime shift), whereas the "north migrating" runs all had no or increasing abundance trends.

It seems plausible that specific salmon populations have genetically determined migration behaviours that allow them to home to distinct feeding grounds within the North Pacific, some of which result in better survival ([93]). Batten et al [94] identified at least 10 geographically distinct plankton communities evident in a single transect across the North Pacific that were temporally stable across years and demonstrated that seabird communities showed similarly distinct and geographically coherent patterns. Similarly, an analysis of tufted puffin communities [95] found that different forage fish communities were present in different sub-regions of the Aleutian Chain. Thus geographically stable and distinct biological communities exist within the North Pacific Ocean, including the pelagic offshore region. Salmon populations homing to different feeding grounds could therefore have very different fates if these regions develop differently over time, for which there is at least some experimental evidence [96-98].

A critical policy question concerns whether the FCRPS as currently operated is having any significant effect on limiting recovery of listed fish stocks under the ESA, or whether it is the impact of ocean conditions that limits recovery. The available evidence indicates that smolt survival during downstream freshwater migration is not higher in rivers without hydropower dams (Fig 10 and Table S2) and that a number of much shorter coastal rivers have even lower survival than is experienced through the Columbia River hydrosystem, particularly when survival is scaled by distance travelled. Overall, given that recovery targets are specified in terms of attained SARs, current evidence indicates that Snake River SARs are roughly equal to (or better) than those currently achieved in the nearby Salish Sea region including the Fraser River, a region where dams are absent. It therefore seems unlikely that recovery can be achieved without an improvement in ocean survival. Unfortunately, current scientific knowledge is simply insufficient to understand how to promote this.

Our limited knowledge of the marine phase of the life history of salmon precludes a full explanation of how the coast-wide decline in SARs to similar levels developed; however, we speculate that it is chiefly driven by either a northward expansion of a region of coastal (continental shelf) waters unfavourable for juvenile Chinook and steelhead after ocean entry or by populations of both species migrating at a later stage of the marine life cycle to such a region of poor survival. We consider both in turn.

In the first scenario, those populations whose smolts remain longest in regions of poor marine survival should have the poorest SARs. Assuming that the region of poor survival progressively expanded from south to north along the coast roughly at the time of successive regime shifts, this produces several testable hypotheses. For example, Salish Sea Chinook populations may have lower survival than adjacent outer coast stocks (west coast Vancouver Island, coastal Washington) either because they remain resident for a longer time period in coastal marine waters, for which there is some evidence [99], resulting in greater exposure, or because survival rates per unit time are lower than along the outer continental shelf waters (poorer survival). In either case, the key prediction would be that stocks with lower SARs should have greater exposure poor ocean conditions in southern regions. These mechanisms could also act together to reduce survival, and would not have to be exclusive. Although our understanding of population-specific differences in marine migration routes is currently very limited, especially for steelhead, there is now some developing evidence for differential salmon survival in the sea; e.g., [100-103]).

In this context, the anomalously low survival of the Dworshak population relative to other Snake River Chinook stocks is particularly noteworthy; mean survival from Lower Granite Dam to adult return over the 2000-2015 period was only 0.58% for the Dworshak Hatchery stock versus 1.28% for McCall Hatchery and 1.29% for Imnaha Hatchery fish ([1], Tables B.16, B.22, & B.24). The Dworshak SAR is thus less than ½ the other two populations' SARs, and thus substantially lower than the smolt survival experienced during migration through the entire 8-dam FCRPS (50-60%). Understanding why such large population-specific survival differentials develop at sea could provide important insight into why differential survival is present by the time of adult return.

Columbia River Chinook salmon are known to be seasonally present in the Bering Sea and to overwinter in the Gulf of Alaska [47]. Because all Snake River populations migrate through the same set of dams, one explanation for the low survival of the Dworshak population could be a feeding migration to an area of the North Pacific (or Bering Sea) whose relative survival prospects was as poor as downstream passage through the 8 dam FCRPS. Clearly, our tenuous understanding of where Chinook and steelhead migrate to in the ocean, how long they remain in various regions of the North Pacific Ocean and Bering Sea (let alone how these patterns differ between important populations with serious conservation concerns) needs urgent improvement if appropriate conservation strategies are to be formulated under increasing climate change.

One puzzling aspect of the survival patterns we have documented concerns the similar SARs of northern and southern Chinook populations. Juvenile Chinook from southern regions should be migrating northwards through coastal marine regions of poor survival for longer time periods than northern populations. This should result in poorer survival for southern populations. That reported west coast SARs seem to have almost all dropped to roughly the same level is inconsistent with this simple mechanism. We do not have a satisfactory explanation. On possibility is that despite the widespread acceptance that adult recruitment is determined in an early critical period, high predation by marine mammals is occurring as maturing salmon aggregate and return to their home rivers; there is now ample evidence for substantial increases in marine mammal abundance and presumably predation [74-76]. Ohlberger et al [104] reviewed the decline in size and age-structure of Chinook across western North America. They noted that consistent with the adult predation hypothesis, the decline was most pronounced in the older age groups in some (but not all) regions of the eastern Pacific. Recent work has also demonstrated that in fish large females may confer much higher high fitness on their offspring than was previously believed [105]; the geographically widespread decline in salmon growth over time seen for multiple species by the mid-1990s, and which was potentially attributed to the growth of hatchery production [106] has apparently continued. The continued increases in pink salmon has also been shown to affect plankton populations [107] and reduce survival of at least one marine seabird (shearwaters) [108, 109].

Monitoring salmon survival and population trends—particularly survival—is clearly critical to making informed management decisions. However, simply monitoring populations is insufficient. Recent work in BC has documented a substantial decline in monitoring effort in north-central BC, and the authors argue that improving monitoring is critical to salmon conservation [110]. However, the previously substantial monitoring effort has in our view been insufficient to develop a coherent management response. Obviously, if agencies cannot respond to the already available data indicating a widespread collapse in marine survival of salmon populations then it is unclear why simply increasing monitoring effort further will lead to a more effective response, as opposed to simply a more certain definition of the extent of the collapse in marine survival; clearly, greater monitoring alone does not necessarily lead to an improved outcome. To illustrate the point, we present three case studies.

Case Studies

The data analyzed in this paper demonstrates that there has been a coast-wide decline in survival for Chinook and (probably) steelhead and that the cause of the low SARs must predominantly be located during the marine phase of the life history because downstream smolt survival in freshwater is relatively high. We now review three case studies to illustrate the past operational response to falling salmon populations after the determination was made that marine survival was driving the decline: (i) Rivers-Smith Inlet sockeye (Central B.C.); (ii) Columbia River Chinook and steelhead; (iii) Upper Fraser steelhead.

Rivers and Smith Inlet Sockeye (B.C.)

The Rivers-Smith Inlet sockeye complex formed the second largest sockeye fishery in British Columbia for much of the last century (the Fraser River being the largest), with adult harvest levels averaging around 1M sockeye for six decades (1910-1970). The Rivers and Smith Inlet populations are located in adjacent watersheds in the remote central coast region of BC, a region with very little anthropogenic impact.

Escapement data available from the 1950s forward showed that escapement remained stable until the 1970s [111], so recruitment overfishing did not occur during this period. Following the 1977 regime shift, productivity of both Rivers and Smith Inlet sockeye suddenly collapsed. A number of reports document the collapse [111-116]. Probably because of the isolated location and the lack of any other nearby significant salmon fisheries, management decisions to reduce harvest to essentially zero were promptly taken and were maintained through the 1980s. Despite harvest being curtailed the population did not recover, as standard fisheries theory would predict, although escapements remained high because of the prompt management action. However, following the next regime shift in 1989 escapement levels then fell to record lows in both river systems because with the fishery already stopped there was no further action possible to compensate for the second drop in survival. In several years during the 1990s marine survival was near zero [114]. There was also evidence that additional nearby sockeye stocks also were impacted similarly [116].

A study of the management response to the collapse [111] detailed the reasons for rejecting a freshwater cause for the collapse (including using data extending back over half a century to demonstrate that pre-smolt abundance in the lake was above the long-term mean). The authors noted that *"Poor marine survival is the most parsimonious* *explanation for the declining fry-to-adult survival in Owikeno Lake, particularly in light of coincident declines in sockeye salmon returns per spawner at Long Lake (a nearby pristine watershed) and declines in adult sockeye salmon abundance in other populations to the north of Rivers Inlet."*

The second regime shift in 1989 resulted in the collapse of the population from >1 million spawning adults to ca. 9,500 adults by 1999—a collapse to 1/100th of the original population size in just over two decades, despite prompt action being taken to essentially eliminate harvest. The key findings from a joint federal and provincial government technical committee to review the collapse are worth quoting verbatim [112, 114]:

"(1) The drastic declines in abundance appear to be due to an extended period of poor marine survival that cannot be explained by any one event, such as sea-entry during an unusual El Niño year. At least two recent years (1996 and 1997) show signs of near-zero marine survival, but the reasons for those low survival rates are not known at this time.

(2) There is little evidence to suggest that logging or other human activity in either of the drainage basins has had more than small and localized impacts on sockeye spawning and rearing. The simultaneous declines in both basins – i.e., in Owikeno, where there has been extensive logging and in Long Lake, where there has been very little – is convincing evidence that the cause of the declines does not lie in freshwater habitat disturbance".

The Rivers-Smith Inlet study is to our knowledge unique in North America. Not only does it state that the problem lies in the ocean, it also goes on to state that freshwater habitat problems were not contributing—something that is generally not possible to rule out with certainty for most salmon populations.

Strikingly, the committee then went on to recommend necessary research to clarify the cause of the collapse, and regulatory action that might be taken to improve the situation. Despite the conclusions quoted above, marine survival is not cited in any of the research which the various review committees recommended be pursued [112-114]. Instead, the committees recommended three research-related foci:

"(1) determine absolute escapement levels to Owikeno Lake… in order to improve the credibility of stock assessment;

(2) improve the understanding of habitat use… by sockeye juveniles in Owikeno Lake and smolts in the Wannock estuary; and

(3) investigate the status of ocean-type and lake-spawning sockeye, which are less familiar and, although not specifically covered in this plan, may require future intervention". (The committee noted that there was some evidence for an unusual sockeye life history type that went directly to sea without rearing in the lake for a year as pre-smolts (the normal life history pattern) [114]; the other committee reports have similar language).

Strikingly, no mention is made of addressing the marine survival issue that is at the core of the collapse; the reference to improving the understanding of smolt habitat use in the "*Wannock estuary*" mentions that *"sockeye smolts do not appear to rear in these estuaries for much time"* [113]. The report further mentions that there are numerous estuaries within River and Smith Inlets, with varying sizes and importance to salmonids. It is unclear why the Wannock was identified as particularly worthy of investigation, but the report does note that "*approximately 25% of the Wannock estuary was dyked and filled in 1973 for a log dump facility*" (i.e., almost two decades earlier).

The recommendations for Habitat are even more striking:

"*5. Existing conceptual plans for habitat restoration developed by DFO, the provincial Watershed Restoration Program, and other stakeholders should be evaluated for their potential long term benefits to sockeye, and the feasibility of proposed restoration projects should be thoroughly assessed.*

6. Habitat restoration projects could include the reconnection of spawning and early rearing habitats along the margins of floodplains and in side-channels that have been isolated by road construction or degraded by natural and logging-related activities.

7. Any habitat restoration projects that are undertaken should be monitored to determine their benefits for sockeye.

8. DFO and other agencies and stakeholders should continue to collaborate on developing habitat protection strategy during resource development planning processes (e.g., CCLCRMP, Forest Development Plans).

9. The site-specific and cumulative impacts of logging on habitats used by sockeye should be more comprehensively evaluated". [114]; the other committee reports have similar language).

In other words, despite the reports identifying with high certainty that freshwater habitat issues were not contributory, the committees did not attempt to understand what were the marine drivers, and instead advocated a series of actions in freshwater; the recommendation to evaluate the "*site-specific and cumulative impacts of logging*" is particularly problematic because this could result in significant costs for the forest industry and added tasks for fisheries personnel pursuing monitoring that would in essence be "busy work": work that staff knew how to do, but was unlikely to lead to useful progress on the core issues. This preference for actively doing work in freshwater is a repeating feature of salmon management.

Columbia River

Two nearly contemporaneous studies identified the importance of either estuary (lower river) or ocean processes in controlling the poor survival of Snake River salmon. [117] applied a matrix life cycle model to demonstrate that recovery of endangered salmon populations in the Columbia River could only be achieved by improving survival in the lower river/estuary or in the coastal ocean and that (similar to our own argument above) even raising main stem survival to 100% would not prevent extinction. [118] in a review of the PATH (Plan for Analyzing and Testing Hypotheses) process, stated "*Importantly, we found that the different models' estimate of the survival rate of in-river migrants through the hydropower system, a hotly debated value, was NOT an important determinant of overall life cycle survival. Rather, the key uncertainties that emerged from these sensitivity analyses were related to the cause of mortality in the estuary and ocean*".

Probably owing to the lack of any direct information on juvenile survival in the lower Columbia River and estuary regions, two initiatives were then funded: (a) the development of the bespoke JSATS acoustic telemetry system [119] and (b) directed research using commercially available telemetry equipment to formally test the delayed mortality theory in the lower river and coastal ocean [66, 68, 120]. Both approaches established that survival was very high in the lower river below Bonneville Dam, lower (but still high) in the estuary/plume region (the coastal region lying immediately off the mouth of the Columbia River) [66, 120-124], and lowest in the coastal ocean extending from the Columbia River plume to the NW tip of Vancouver Island [66, 68, 120].

The important revelation of both initiatives was that survival was high in the lower river and estuary. However, no further action was undertaken to understand why ocean survival was low or to establish the relevance for salmon conservation and hydrosystem management. Further work to measure ocean survival and directly address the conclusions of [125] and [117] was not carried out; once the ocean phase was identified as being the likely cause of poor returns, the research focus using acoustic telemetry shifted back to exclusively studying freshwater influences upstream at the hydropower dams. Although several publications have identified the presence of smolts in side channels within the estuary and suggested their potential importance of estuarine wetlands for salmon conservation (e.g., [126-130]), we are unaware of any studies that have actually identified low survival in the estuary... a necessary requisite for improving SARs. In summary, the ocean issues clearly having a major impact on Columbia River salmon management remain unaddressed and research re-focussed on freshwater or lower river/estuary issues although the ability of these initiatives to compensate for poor ocean survival is moot.

Upper Fraser (Thompson & Chilcotin) River Steelhead

Over the last two decades, steelhead returns to the upper Fraser River have dropped precipitously, prompting an emergency assessment of the status of Thompson and Chilcotin River populations in February 2018 [53]. These two major tributaries of the Upper Fraser formerly supported world-famous populations of unusually large steelhead but adult returns have now dwindled to critically low levels. (Unfortunately, no data on survival is available, only adult abundance). However, similar to the Rivers & Smith Inlet case, the parallel decline of adult returns to the Thompson and Chilcotin River populations (79% and 81%, respectively, over the last three generations) is particularly striking and strongly suggestive of a common cause.

The emergency assessment [53] noted for the Thompson River population that *"The number of spawning fish was variable with little trend prior to 2000. Since then, the population has declined dramatically...and is now the lowest on record"*. Only 177 mature fish were observed in the most recent survey, and "*If the current rate of decline persists for another three generations, the number of spawning fish will decline to 37, which is 2.0% of the pre-2000 abundance*".

For the Chilcotin River population, the problem is even worse: "*The 58 mature fish observed in the most recent survey are only 5% of the pre-2000 mean. If the current rate of decline persists for another three generations, the number of spawning fish will decline to 11, which is 0.9% of the pre-2000 abundance*".

The report's conclusions concerning the drivers of the collapse are particularly important, stating: "*Bycatch mortality in commercial Pacific salmon fisheries and <u>declines in marine and freshwater habitat quality</u> are the key factors driving the declines*" (emphasis added). Fisheries interceptions are certainly always a concern when productivity drops, but bycatch levels presumably would have remained sustainable if the 1998/99 regime shift had not caused sharp decreases in marine survival, resulting in pre-2000 interception rates no longer being sustainable. The report continues "*While it is generally considered that the quality of freshwater habitat is declining, the severity of the freshwater habitat-based threats in the Thompson and Chilcotin rivers is not well understood*". (p. 8).

Despite the report stating throughout that "*declines in marine and freshwater habitat quality*" are the key drivers, the Chilcotin River is pristine. In contrast, the Thompson River runs through areas of significant human population density (cities, towns, and substantial numbers of cottages) and substantial agriculture and some forestry. However, the Chilcotin watershed has steep valley walls keeping cattle from the few ranches in the region away from the river and the human population is extremely sparse. Thus if some form of freshwater habitat degradation in the Chilcotin is materially contributing to the degraded status of the steelhead population, there is no realistic prospect that other river systems can be improved to even approach the existing habitat qualities of the Chilcotin. In short, as with the other case studies examined, although it is routine to state that freshwater habitat degradation is a "key factor" behind the decline, the situation in fact suggests the opposite, and that unknown marine factors are the primary drivers, presumably acting similarly to those affecting coho, Chinook, and sockeye in south-central BC.

Critically, there is no evidence that "improving" freshwater habitat could in any real sense change the dire conservation status of Upper Fraser steelhead; because the Chilcotin population (N=58) is in worse shape than the Thompson (N=177), it is hard to rationalize how any freshwater habitat modification can actually help. Given that there may be real economic costs in making such improvements (particularly as the emergency assessment cites their claimed role in the decline), it is imperative that efforts to improve freshwater habitat be critically assessed; otherwise (as in the Rivers-Smith Inlet case) initiating activities in freshwater may be simply a palliative to avoid addressing the marine survival issues.

Overall, these studies demonstrate a consistent pattern: a strong proclivity to not address the unknown drivers of marine survival and to preferentially identify and work on freshwater habitat, even in cases where such problems are unlikely to exist.

Qz1 We have made two broad survival comparisons, one of which is inherently more reliable. The trends in salmon survival over time for a given population should be the most reliable because government agencies employ relatively consistent methodologies (CWTs, PIT tags, mark-recapture techniques). Evidence for large drops in survival over time for individual populations should therefore be most reliable. The less reliable aspect of our analysis is the numerical comparison of SARs in different regions of western North America. SARs are measured by a number of different methods, and there may be no populations that actually measure complete migratory phase survival (i.e., from actual initiation of smolt migration to adult return to the spawning grounds). Because the various enumeration technologies used have specific geographic regions where they are adopted (PIT tags used only in the Columbia (c.f. Table S2)), CWTs more broadly used, but chiefly for hatcheries, and mark-recapture censuses of smolts and returning adults for some wild stocks (particularly in the north, but also the early years of the Snake River time series)), geographic differences in survival are confounded with technological differences (including whether not commercial and sportfish harvest is included in the returns).

Regional comparisons of survival need to recognize these issues, which are rarely discussed. However, despite these complexities, the broad outline of the survival patterns are readily evident in the comparison we report, which we view as reliable because of the massive decline in survival that has occurred over time and the temporal consistency of methods used for individual populations. However, there is certainly further work to potentially do in future to look more closely at hatchery-wild differences in survival, as well as the potential influence of some Fall Chinook populations being included in the yearling category because of hatchery rearing practices.

In summary, the evidence that survival has now dropped to similar absolute levels everywhere along the west coast of North America is surprising but needs to be treated carefully. Because of the methodological differences used in measuring survival in various river systems, we are not claiming that survival is exactly the same in most regions but simply that Chinook and steelhead survival is now closely similar everywhere data exists to make this comparison. A natural inference from this conclusion is that there are important questions about how salmon conservation should best be achieved, and that successful salmon conservation may not necessarily result from current practices.

Conclusions

Salmon are cold water fish living in a rapidly warming world. Despite the best efforts of management agencies to restrict fisheries, even the complete curtailment of all fishing mortality is far from sufficient to compensate for the magnitude of the changes in marine survival that has already occurred in the last half century. The slow response of both management and research initiatives to effectively address the marine survival problem needs to be viewed with some sympathy—the unprecedented magnitude of the decline is difficult for institutional structures to keep up with.

Simply put, there are no easy answers for maintaining Pacific salmon populations [131] and current problems are likely to get much worse. The predicted levels of future warming are far outside anything experienced in either the last 150 years of industrialization or the previous 2.6 million years of the Pleistocene Epoch (with at least eight separate ice ages recorded in the last 800,000 years of the ice core record alone; [132]).

Current CO_2 emission policies are expected to limit warming by 2100 to approximately 3.0°C [133], or more than four times greater warming than the total warming experienced over the past 150 year of the observational record (~0.7°C). Even if all countries meet their commitments under the Paris Agreement, these emissions scenarios will still see global mean temperatures stabilized at 1.5–2.0°C above pre-industrial levels, or ca. 2-3 times the temperature increase so far—and a further increase achieved in only 80 years, not 150 years. Accelerating change is inevitable.

In short, given the slow and erratic response to what is quite possibly a greenhouse gas-related change in salmon survival at sea (warming) or due to ocean ranching (hatchery releases), the likelihood that the fisheries community will identify the correct drivers of the problem and then potentially move to successfully address them is not good; so far, as we have reviewed in our case studies, the response has been to re-double efforts on what we know how to study (freshwater) and to studiously avoid what we currently have little ability to study (the marine phase). There are real economic costs to doing so, with many groups identifying various single issue factors as the underlying problem that needs to be "fixed" (hydropower dams, salmon aquaculture, forestry, land use practices, water rights). These region-specific issues cannot possibly be the driver of the continental-scale response that we document.

The history of North American research on Pacific salmon has been chronicled by [134-136]. Although there have been a number of periods when marine research on North American salmon has been supported, until recently the programs have been largely focused on describing the life history of salmon in specific regions of the continental shelf (no small feat in itself). However, the life history observations so obtained can only be used to infer possible mechanisms affecting overall biology, not test and validate the mechanisms driving survival. This means that the rapid learning characteristic of physics or chemistry, where hypotheses are explicitly tested and important scientific advance occurs when theories are rejected (not merely posited), is unlikely because it is difficult to refute observation-based mechanisms. A key issue here is that if marine survival problems are widespread along the Pacific Coast, mechanisms specific to only some continental shelf regions or adjacent river watersheds likely cannot be the major driver. Because poor marine survival is widespread, research and policy predicated on the assumption that the problems are specific to certain geographic regions is unlikely to be successful.

Widespread declines in survival have previously been reported for Chinook [7], for steelhead [9], for sockeye [11, 13], and (within the Salish Sea) coho [8]. Given the massive investment in restoration and monitoring activities for Pacific salmon, the development of correct conservation analyses and policy planning is critical. Over $1 Billion is now spent annually in the continental United States alone on freshwater habitat restoration [137, 138], and there is great pressure to remove or modify hydropower dams in the Columbia River basin as potentially large contributors to the failure of some salmon runs to rebuild to historical levels of abundance and productivity. Within the Columbia River, the total cost of recent conservation efforts reaches or exceeds ca. 25% of FCRPS annual revenues (including foregone power generation), or >$0.5 Billion per year [139]. Similarly, significant effort in Puget Sound is now placed on removing Columbia River basin dams to help endangered orca populations [73] and in British Columbia on shifting salmon farms to land-based operations to help restore Fraser River salmon populations [140-142]. Clearly, it is important to understand the impact of various anthropogenic impacts (dams, salmon farms, forestry) on the poor salmon returns, but it is also important that the real prospects for improvement as a result of these region-specific actions is carefully assessed.

In the novel "The Sun Also Rises," the character Bill Gorton is asked how he went bankrupt. He replied, "*Two ways. Gradually, then suddenly.*" [143]. The same process appears to be playing out in the ways fisheries science has addressed the marine survival problem for salmon, first by incorrectly diagnosing the problem (poor and worsening ocean survival) and second by failing to change behaviour quickly enough and choosing to maintain a focus largely on freshwater issues (which potentially may inflict significant costs on other economic activities). As with economic bankruptcy, failing to staunch losses and persisting with previous unsuccessful behaviours is a recipe for eventual catastrophic loss. Some positive response is certainly evident, in that harvest from Chinook and steelhead fisheries was substantially restricted (e.g., [38]). However, harvest rates of shelf-resident Fall Chinook were historically in the 50%-60% range, so even the complete elimination of all harvest can only compensate for at most a two-fold decline in marine survival; for Spring Chinook and steelhead, which are much less impacted by saltwater fisheries, the maximum compensation from restricting fisheries is much less.

Moderation of harvest is obviously an essential component of responding to the problem, but it is clearly insufficient because there is evidence of more than ten-fold decline in marine survival over time for at least some populations of Chinook, coho, steelhead, and sockeye (e.g. [8, 86, 144-146]). Perhaps of greater seriousness, the lack of focus on marine survival has resulted in a great deal of focus on anthropogenic impacts (dams, aquaculture, various other economic activities such as forestry) which society may be placing unrealistic expectations on to compensate for a massive drop in marine survival. Clearly, without a better understanding of what is happening at sea, possibly inappropriate policy recommendations seem likely to continue. As we have shown in the case studies, each time salmon research reached the point where it became clear that the survival problem lay at sea, the ensuing response was a shift to re-focus effort on freshwater activities, leaving the marine survival issues unaddressed while often increasing potentially costly freshwater interventions.

The SAR incorporates some components of freshwater survival experienced during smolt downstream migration and adult upstream return migration. However, modern telemetry methods demonstrate that the majority of the SAR (now around 1%) must be determined during the marine phase [58, 66, 120-122, 124, 126, 147, 148]. Because the observed drop in survival is much larger than can be compensated for by even the complete cessation of harvest, the conventional management approach of manipulating harvest by restricting fisheries to compensate is therefore insufficient. In contrast to earlier work suggesting that salmon survival in northern and southern regions would oscillate out of phase as the Pacific Decadal Oscillation (PDO) switched between warm and cold periods [16-18], no region has seen significant recovery in survival; all of the regional time series we have reviewed can best be characterized as a general downward trend punctuated by occasional periods of rough stasis (but no recovery).

Worsening ocean survival will therefore force hard choices. Each of our case studies demonstrate that once programs reached the point where they demonstrated that the problem lies in the ocean the uniform response was to refocus efforts to identify problems in freshwater and to increase expenditures on freshwater habitat remediation and improving stock assessments—essentially to maintain and promote standard activities. This has left the key ocean survival issue largely unaddressed and increased operating costs on other activities such as forestry, hydropower, and aquaculture, possibly unfairly. This apparently illogical behaviour is readily understood given the sociological situation (highly trained and motivated freshwater staff and a usually extensive freshwater research infrastructure, coupled with relatively little capability or understanding of how to begin addressing the ocean issues, which are often perceived as too vast to be tractable).

Festinger [149] was the first to define the term "cognitive dissonance", as an inability to recognize the true problem, despite the evidence. As the case studies demonstrate, salmon biologists have been trained to address resource problems by falling back on traditional behaviors of searching for freshwater issues to study and/or "fix", hoping that they will compensate for poor marine survival. The lack of a rigorous assessment of the appropriateness of these decisions is unfortunate.

Some encouraging small-scale efforts to examine aspects of the marine biology of salmon in specific coastal regions has developed in the last two decades (e.g., [144, 148, 150-152]), but the majority of this work is focused on simply describing aspects of the poorly understood life history of juvenile salmon and is not directly addressing the apparently continental-scale of the survival problem. It is unclear whether (or how) specific geographic efforts can realistically address the overarching problem if almost all regions of the west coast have similarly poor survival. Perhaps of equal concern, there is no clear stopping rule that allows the conclusion to be made that the survival problem is ***not*** occurring in a specific marine life history phase or is not caused by a specific biological issue. For example, although programs looking at the early juvenile phase in saltwater certainly contribute new and interesting science, the continental-scale of the survival problem suggests that relatively small-scale research efforts could continue for many years without necessarily recognizing that the survival problem might actually occur elsewhere in the life history (say, during the adult return migration). In our view, careful thought is needed here. Serious economic restrictions on other activities (forestry, hydropower, aquaculture) may occur that inflict significant economic costs with little prospect for improving salmon survival if the root cause is mis-diagnosed.

With the suggestion that we are already into a 6th mass extinction event [153] and projections of even greater climate changes in the future than have been recently experienced due to increased greenhouse gas emissions, there is a compelling need for scientifically correct advice to support policy makers [154]. We view much of current salmon management as unlikely to lead to either effective policy decisions or salmon recovery. As we have documented, the usual response to salmon declines is to call for better monitoring ("improved understanding") and increased efforts to enhance freshwater habitats. Both responses are deeply ingrained into our professional psyche. However, it is unclear how effective they have been in the past [155, 156] and it is uncertain whether they will be any more successful in the future. As we have shown, even when the evidence ultimately leads to the conclusion that the problem is occurring in the ocean, the response has been to drop further pursuit of marine issues (presumably because they are viewed as "too hard") and to re-focus on finding freshwater factors to address.

It is of particular concern that a recent analysis of conservation concerns for "terrestrial megafauna" [157], the three suggested approaches that the authors suggest countries adopt to improve conservation of global megafauna would be unlikely to help Pacific salmonids: (1) upgrading or expanding domestic protected area networks, with a particular emphasis on conserving large carnivore and herbivore habitat, (2) increase funding for conservation, and (3) 'rewilding' landscapes. Although all of these have analogs to various approaches tried for Pacific salmon, it is far from clear that they would work, and might in fact distract attention from attempting to address the marine problems. Given the very slow recovery of upper Columbia River Spring Chinook populations despite more than 300 freshwater habitat projects having been undertaken [158], it may be time to seriously question whether efforts in one part of the salmon life cycle can actually compensate for serious problems in a different part of the life cycle.

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Comment [DWW9]: No real input so far, so will probably cut. Depending upon whether Gayle Brown & Nealla Kendall are willing to join as co-authors (they might get heat for breaking ranks with gov't agencies on calling out focusing on freshwater habitat restoration), they will either be co-authors or thanked for their help with data.

CRediT (Contributor Roles Taxonomy)

Comment [DWW10]: This is the new recommended format for allocating credit amongst authors in peer-reviewed papers. Feel free to add your initials in parts where you think you contributed significantly and where you deserve specific recognition... this is just a first cut!

Conceptualization, DWW (Lead); Methodology, ADP & DWW; Software, ADP; Validation, ADP; Formal Analysis, ADP, DWW; Investigation, DWW; Resources, Gayle Brown, ?? coauthors?; Data Curation, ADP; Writing – Original Draft Preparation, DWW; Writing – Review & Editing, DWW, ADP, ELR, ???; Visualization, ADP; Supervision, DWW; Project Administration, DWW, ELR; Funding Acquisition, DWW & ELR;

Competing Interests

DWW is President and owner of Kintama Research Services Ltd., an environmental consultancy focused on the development of innovative applications of telemetry to improve fisheries management. ADP and ELR are employed at Kintama. All authors received a financial benefit in the course of conducting this study and their future salaries depend on their continued technical and scientific performance, which includes publication of this study.

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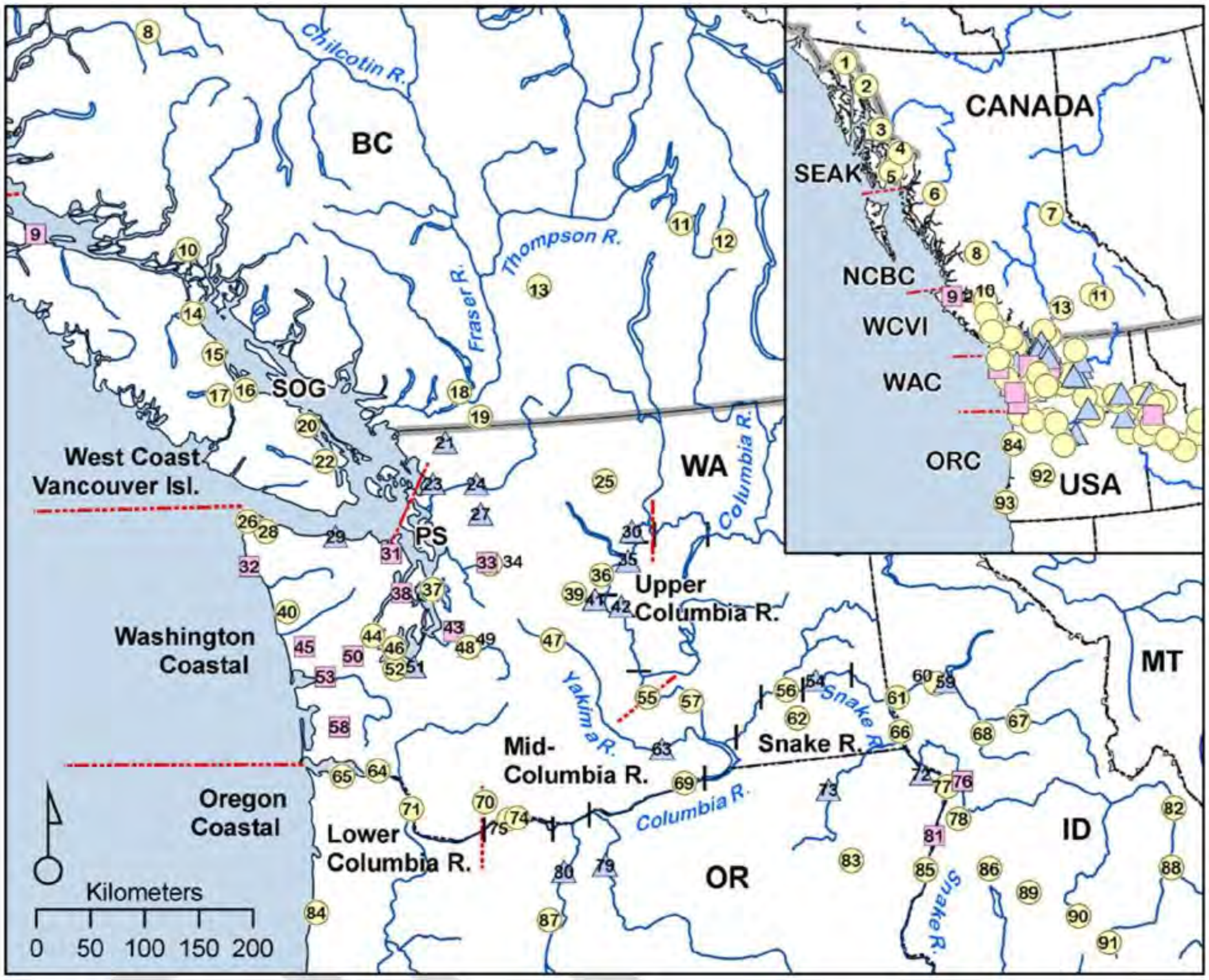

Figure 1. Map of salmon survival time series used in the analysis. Numbers inside symbols are keyed to the populations in Table 1; yellow circles indicate Chinook populations, pink squares steelhead, and blue triangles indicate a location with data for both species. Acronyms: SEAK (SE Alaska/Northern British Columbia Transboundary Rivers); NCBC (North-Central British Columbia); WCVI (West Coast Vancouver Island); WAC (Washington Coastal); ORC (Oregon Coastal); SOG (Strait of Georgia); PS (Puget Sound).

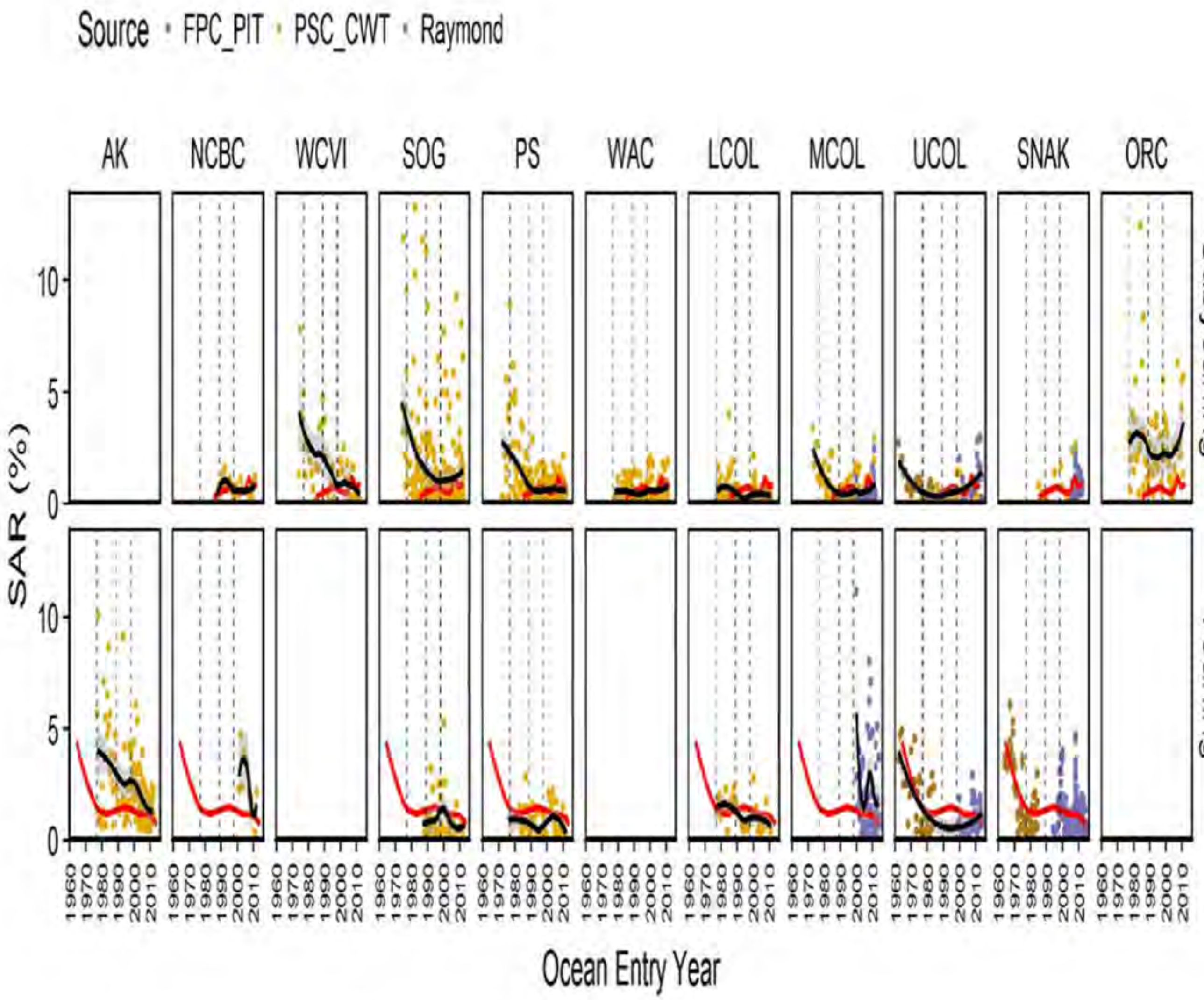

Fig. 2. Time series of smolt to adult survival (SAR) data for west coast Chinook stocks (excluding California). Top row: subyearlings; bottom row: yearlings. Regions are oriented from north (left) to south (right). Gold dots are SAR measurements based on CWT tags (PSC database), brown dots are SARs reported by Raymond (1988), and violet dots are SARs based on PIT tags (McCann *et al.* 2017). A loess curve of survival and associated 95% confidence interval (shaded region) using all available data for each panel is shown as a black line (the smoothing parameter was set to α=0.75); the loess curves for Snake River subyearling and yearling survival is overplotted in red on all panels to facilitate comparison. Blank panels indicate regions where the life history type does not occur (for example, Fall (subyearling) Chinook do not occur in Alaska, while Spring (yearling) Chinook do not occur in the low elevation streams on the west coast of Vancouver Island or Oregon coast). The major regime shift years of 1977, 1989, and 1998 are indicated by vertical lines.

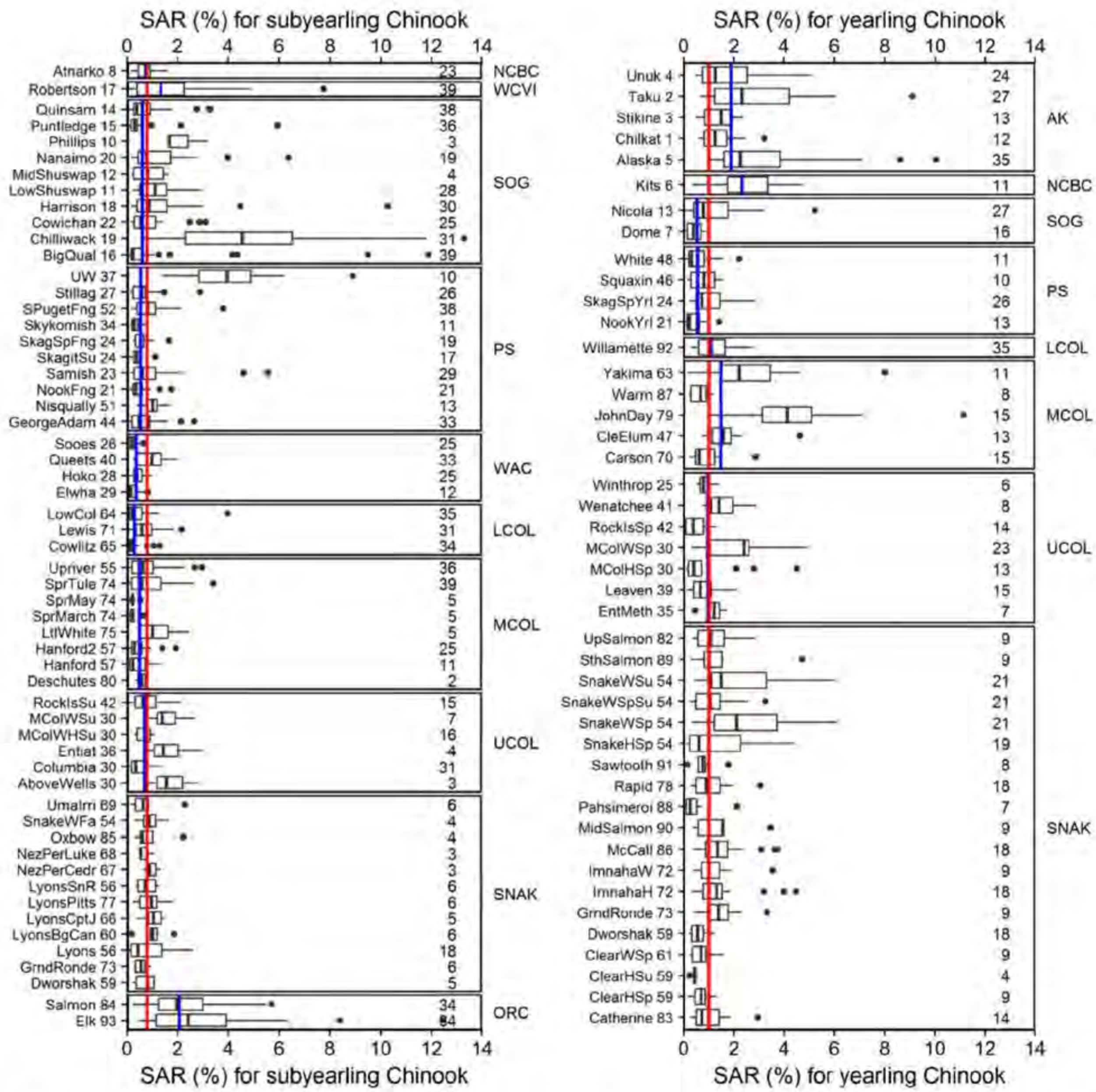

Fig. 3. Box and whisker plot of SARs by population (all available years). The black horizontal line within each bar is the median of the SAR data available for each population. Median survival across all available data for each region is shown as a blue line; median Snake River survival for all populations combined is shown as a red line and overplotted on all panels for comparison. The number of years of data is shown to the right. To save space abbreviated population names are used here along with the map code from Figure 1; the full names for the populations are listed in Table S1.

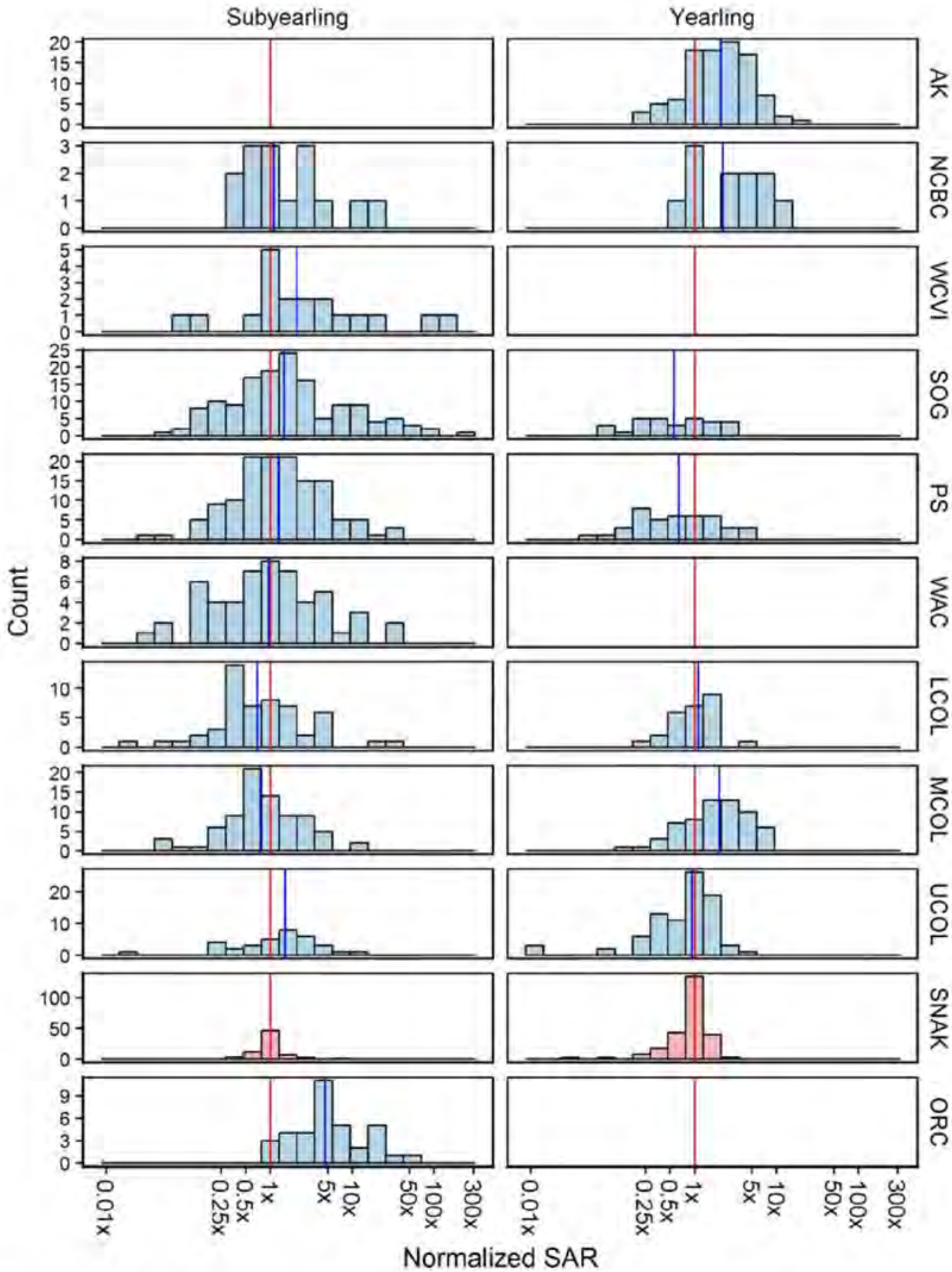

Fig. 4. Normalized SARs, calculated by dividing individual SAR estimates for each stock and each year by the median Snake River SAR for the same year and aggregating by region. Vertical lines show the median SAR for the Snake River (red) and other regions (blue). Note the logarithmic scale on the x-axis. As in the prior plots, Columbia & Snake River SAR estimates based on PIT tags do not incorporate above-dam survival (or harvest).

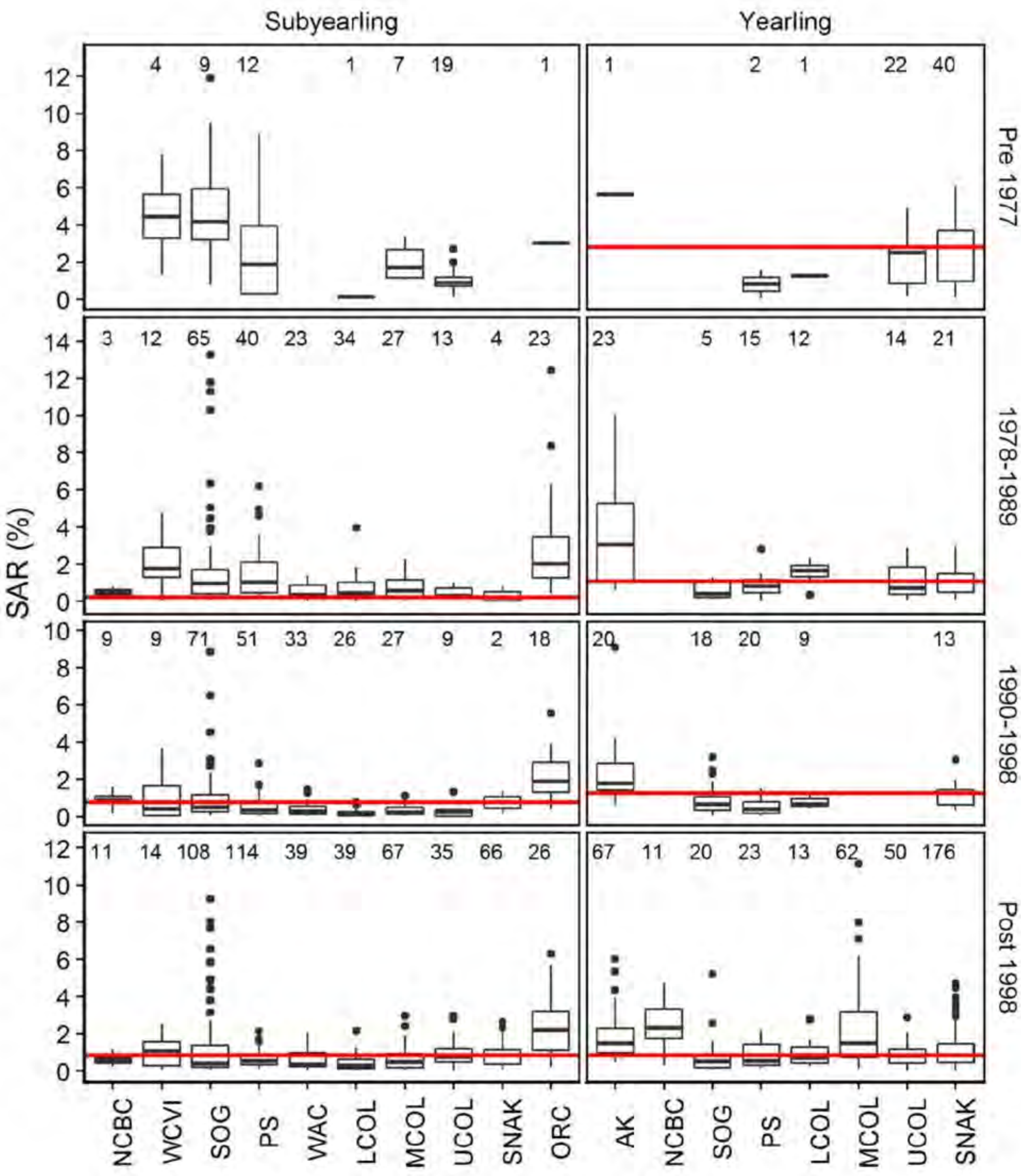

Fig. 5. Comparison of Chinook SARs by regime periods: pre-1977, 1978-1989, 1990-1998, and post 1998. Boxes and whiskers have the conventional interpretation; the horizontal red line shows the Snake R median SAR value for each regime to facilitate comparison. Sample sizes are shown above each group.

Steelhead

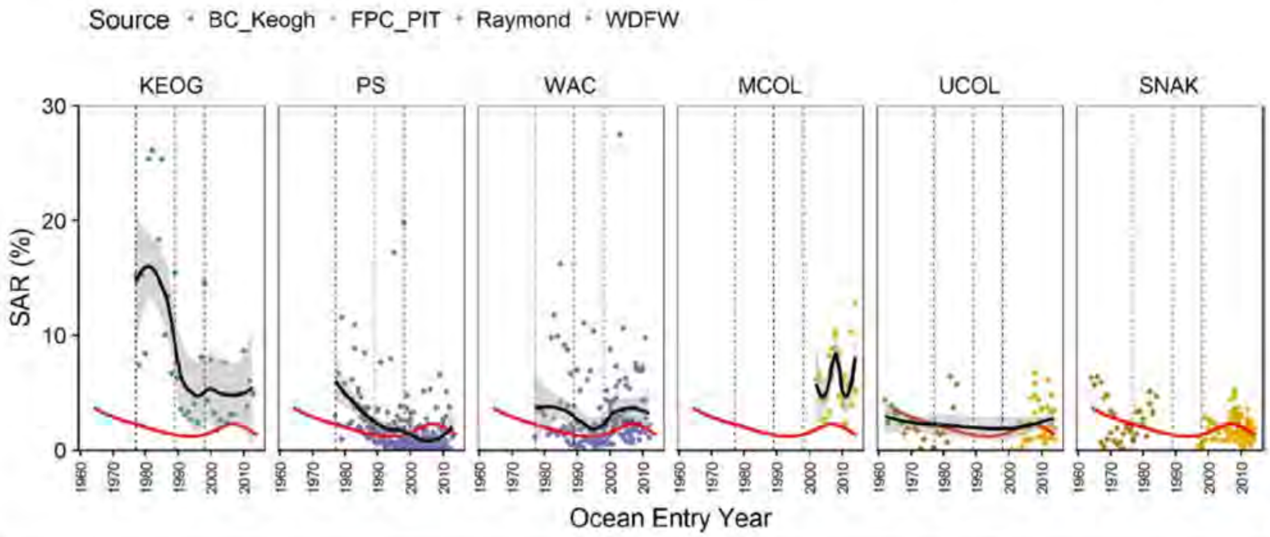

Fig. 6. Steelhead SARS, plotted against ocean entry year. Regions are oriented from north (left) to south (right); the Keogh R (KEOG) is situated on the NE tip of Vancouver Island (BC). Gold dots are SAR measurements based on PIT tags (McCann *et al.* 2017), brown dots are SARs reported by Raymond (1988), and violet dots are SARs based on CWT tags. A loess curve of survival and associated 95% confidence interval (shaded region) using all available data for each panel is shown as a black line (the smoothing parameter was set to α=0.75); the Snake River loess curve is shown in red and over plotted on all other panels to facilitate comparison. B.C. steelhead survival data are only available for the Keogh River (see (Ward *et al.* 2006) for description of the monitoring program). The major regime shift years of 1977, 1989, and 1998 are indicated by vertical lines.

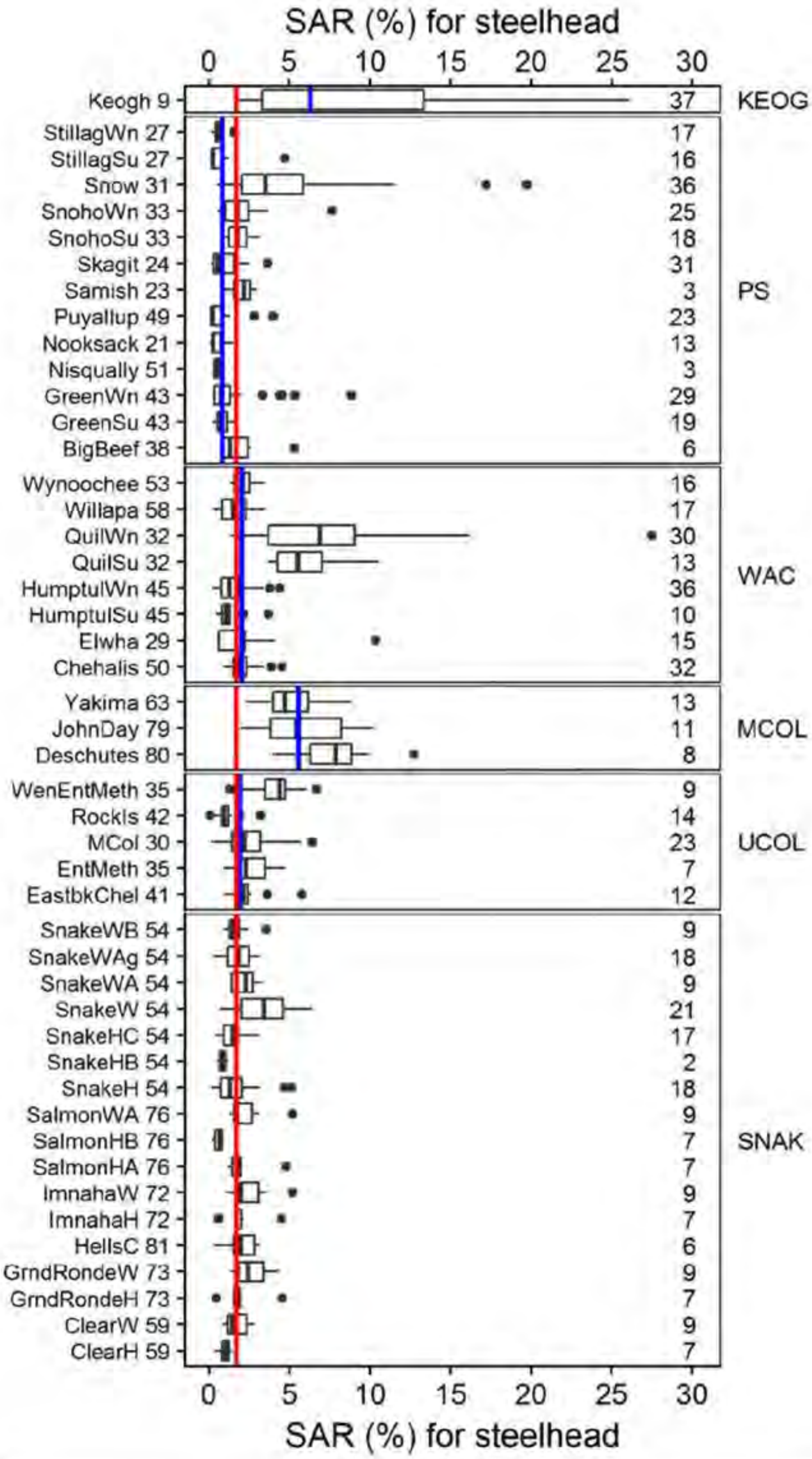

Fig. 7. Box and whisker plot of steelhead SARs by population (all available years). (Population names are listed in Table 1). The black horizontal line within each bar is the median of the SAR data available for that population. Median survival across all available data for each geographic region is shown as a blue line; median Snake River survival for all populations combined is shown as a red line and overplotted on all panels for comparison. The number of years of data is shown to the right.

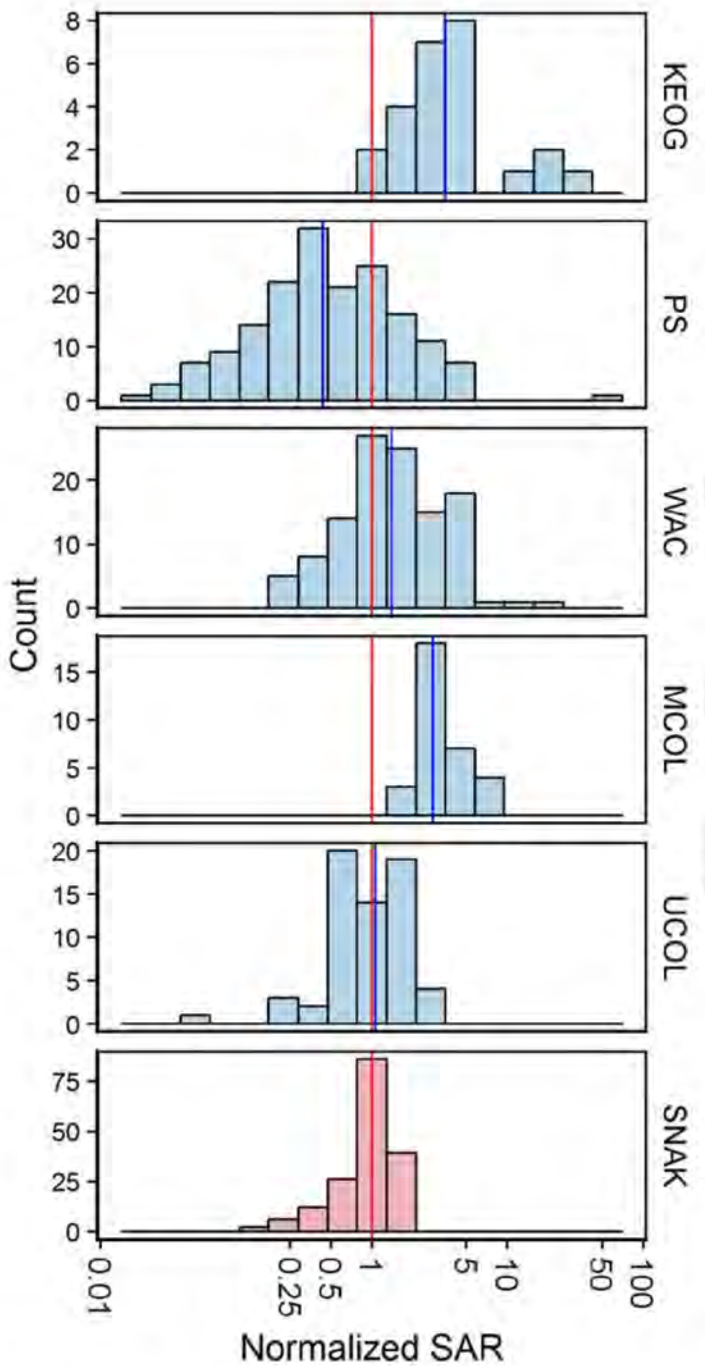

Fig. 8 Normalized steelhead SARs, obtained by dividing each individual SAR estimate (i.e., for each stock and each year) by the median SAR calculated across all available Snake River SARs for that year. The median Snake River SAR is overplotted in red. Note the logarithmic scale on the x-axis.

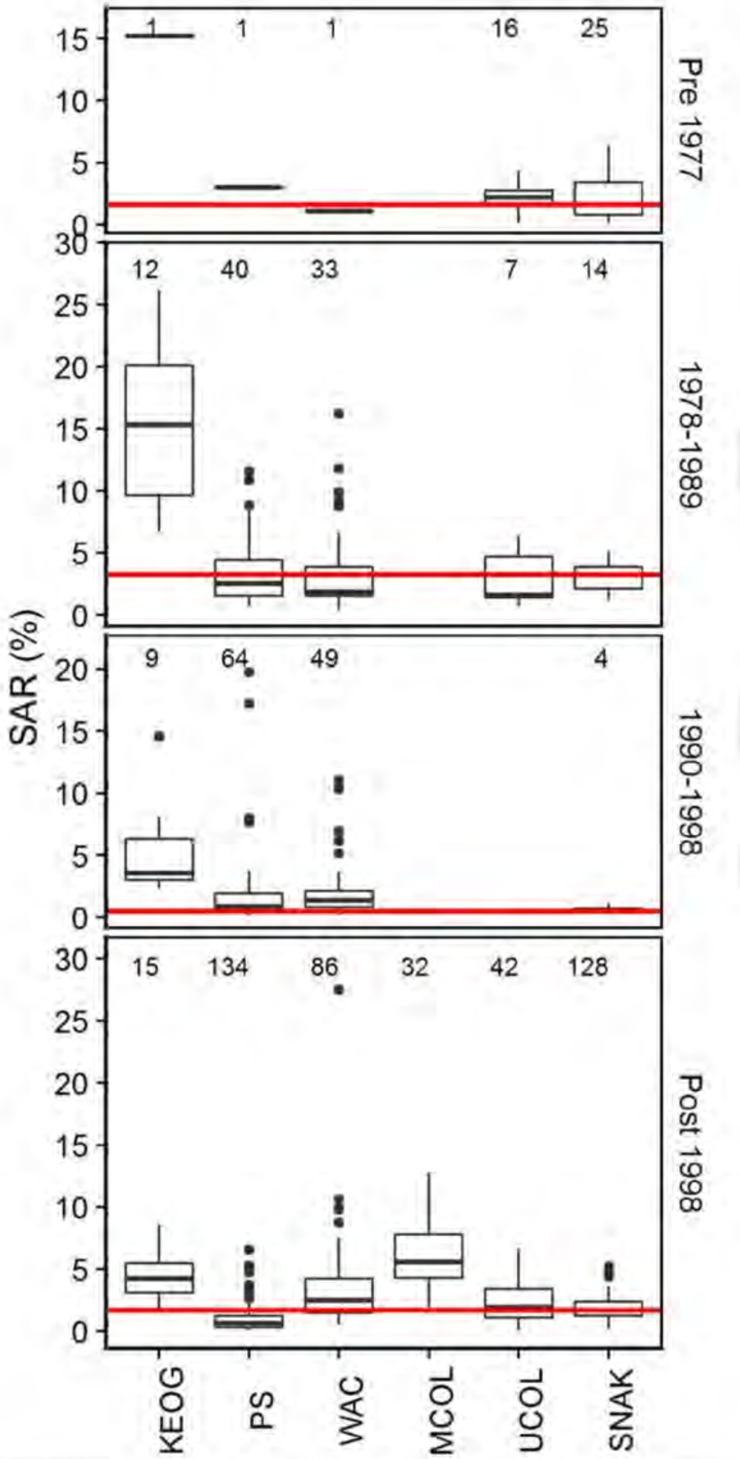

Fig. 9. Comparison of steelhead SARs by regime periods: pre-1977, 1978-1989, 1990-1998, and post 1998. Boxes and whiskers have the conventional interpretation; the horizontal red line shows the Snake R median SAR value for each regime to facilitate comparison. Sample sizes are shown above each group.

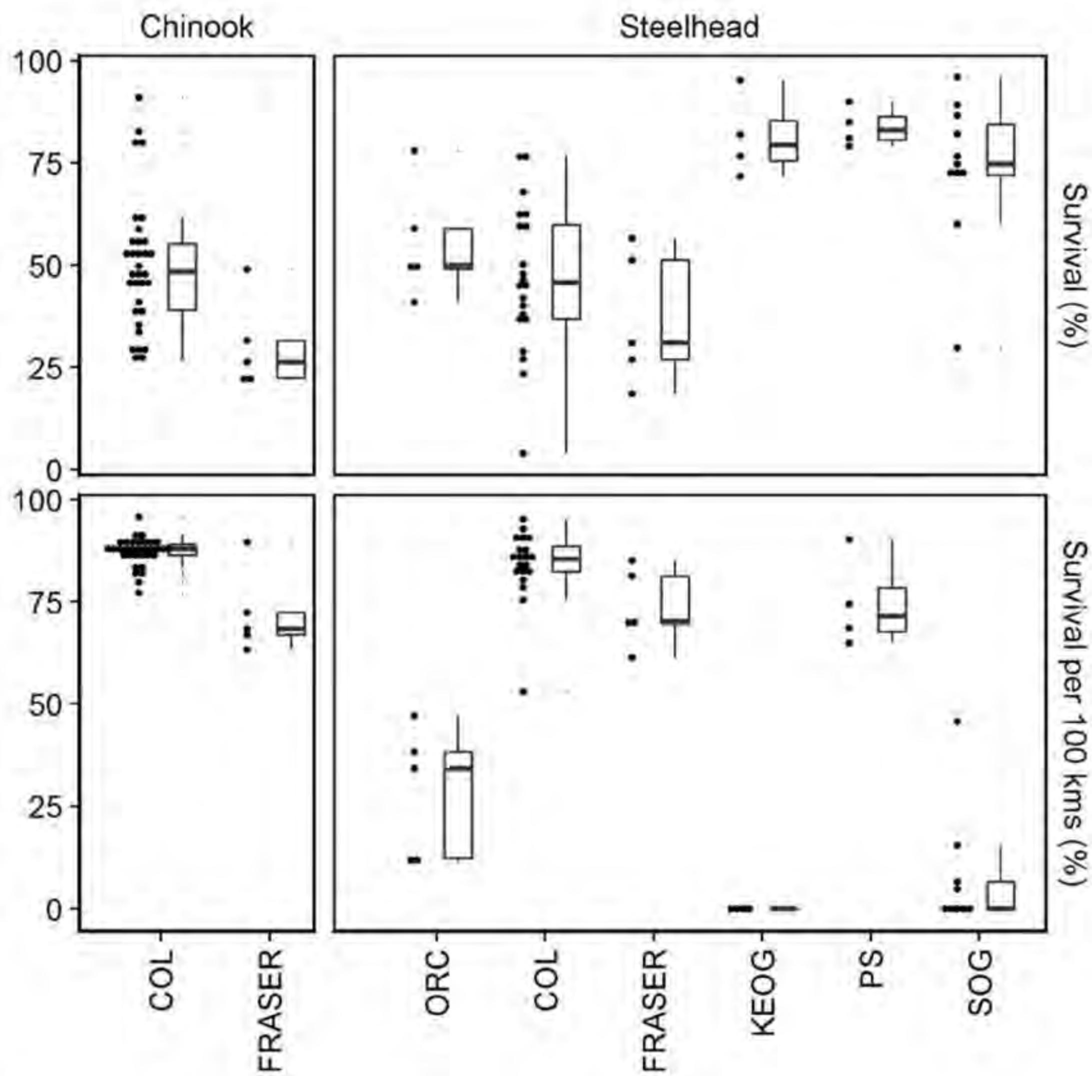

Fig. 10. Downstream smolt survival for Chinook and steelhead for west coast North American rivers. Top row compares survival from release to river mouth (and intermediate locations in the case of the Columbia). Bottom row compares survival per 100 km of migration distance. The data for each region is shown twice, as a box and whisker plot and adjacent to this a jittered dot plot; error bars are ±1 SE, where reported (see Table S2 for data and sources). In the third row survival in several different reaches of the Columbia River is compared, whereas in all other rivers survival is only available to the river mouth. In each panel the dashed horizontal line extends the median Columbia River or Snake River survival value to facilitate comparison with other river systems.

From: David Welch

Sent: Thu Jun 07 19:55:33 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] FW: Draft paper and figures...

Importance: Normal

Attachments: SAR Figures Paper (7 June 2018).docx; Fig 1. Site_map_BPA_SARS_Comparison_v5.tif; Fig 2. SARS_by_year_Chinook.tif; Fig 3. SARS_by_stock_Chinook.tif; Fig 4. Normalized_SARS_histograms_by_region_Chinook.tif; Fig 5. SARS_boxplots_by_regime_region_Chinook.tif; Fig 6. SARS_by_year_Steelhead.tif; Fig 7. SARS_by_stock_Steelhead.tif; Fig 8. Normalized_SARS_histograms_by_region_Steelhead.tif; Fig 9. SARS_boxplots_by_regime_region_Steelhead.tif

Hi Christine-

I asked Aswea to redo all the figures meeting the specific technical format required by PLoS Biology (less two figures still to come).

They look great (see attached). I am sending them on to you in case you have need to use them in any internal discussions. Again, please keep them BPA-Internal for the time being.

I have attached the figure captions in the Word document (which also includes a pasted in earlier copy of these figures—its just not as clean and crisp as the individual figure files will be).

Figure 10, comparing the freshwater survival in all of the west coast rivers, is obviously of major importance. We are doing more work and analysis on this piece of the study and will send along an updated figure (with an additional row of panels) in a few days (See the Word document for the current version).

Best, David

From: Aswea Porter
Sent: Thursday, June 07, 2018 10:08 AM
To: David Welch
Subject: FW: Draft paper and figures...

Hi D,

Here are the figures (minus fig 10) corrected for Plos requirements. Mainly was that I had to reduce the font from 14 to 12 pt, and meet the size requirements. For the map, I converted it from png to tiff (all tiffs with LZW compression as requested).

All look okay?

~A

From: Aswea Porter
Sent: June-07-18 11:25
To: David Welch
Cc: Erin Rechisky
Subject: FW: Draft paper and figures...

Hi D,

Here are some questions about Fig 10.

1) The top row should provide the best estimates available for FW survival. These can then be compared to the SARs to get an idea of the proportion accounted for by FW. Can't use the figure this way in current format because it includes LRE (lower river estuary) survival estimates for the Columbia. The LRE estimates could be put back in for the bottom row of the figure as long as we document this method. Looking at table 2, this means removing 5 data points for CH; and 4 data points for ST (ie plenty of data remaining).

Even with these removed, the start and end points of the survival estimates differ, but this is not a big deal. For estimates ending at BON (bulk of data from PIT tags), we can state that survival in the LRE is high. Most estimates start at a dam which parallels the SARs.

2) Most of the COL estimates are for SNAK (CH: 25 of 28 with the remaining 3 for MCOL; ST: 20 of 21 with the remaining 1 for UCOL). Shall I separate these regions (SNAK, MCOL, UCOL) from COL to match the other figures? Related is that FRASER and SOG are combined in the other figures so we must decide if they should be combined here as well. And just to note that only 3 of the ST regions that have FW surv estimates also have SARS.

3) Will sort the regions to match the other figures.

4) There are missing values in table 2. Should wait to talk with E about this. She told me she was going for over a week. Do you know when she's back specifically? From her calendar it's either Mon or Thurs depending on if she is going to the BC Salmon Farmer's workshop in Comox.

5) Caption says you want to add a horizontal line (as in other figures) to better compare where the SNAK is relative to other regions. This will be the SNAK/COL combined unless we break out the subregions. I'll add line.

-----Original Message-----
From: David Welch
Sent: June-06-18 11:49
To: Aswea Porter
Subject: Re: Draft paper and figures...

Thanks Aswea

Looking forward to reading your comments when I get to the office.

I agree with what you say about the pruning needed!

D

David Welch, Kintama Research

Tel: +1 (250) 729-2600 x223

Cell: (b) (6) [redacted]

Sent from my iPad

> On Jun 6, 2018, at 06:58, Aswea Porter <Aswea.Porter@kintama.com> wrote:

>

> Hi D,

>

> Here are edits for the BPA SARS paper. I'm really excited about it! It could be a key publication for fisheries management (if it doesn't get ignored).

>

> I think the data are presented well, you’ve worked out what you want to say, and have done a tremendous amount of work in getting the literature in order. At this point, the problem is that the paper is long and disorganized. You can dramatically shorten it simply through careful editing so that each point is made and then substantiated only once. This is the type of paper that could be important to the public so I think we should keep the text simple. My comments are fairly high level, but let me know if you could use more help with the outline.

>

> I’ll start changing the figures over to the proper format now.

>

> Best,

> ~Aswea

>

> From: David Welch

> Sent: May-30-18 14:27

> To: Aswea Porter

> Subject: RE: Draft paper and figures...

>

> Thanks, Aswea.

>

> Just heading off to the DFO meeting with Erin.

>

> d

>

> From: Aswea Porter

> Sent: Wednesday, May 30, 2018 9:40 AM

> To: David Welch

> Subject: RE: Draft paper and figures...

>

> I'll start on this now David.

>

> From: David Welch

> Sent: May-30-18 02:03

> To: Aswea Porter

> Subject: Draft paper and figures...

>

> Hi Aswea—

>

> Hope you are continuing to feel better.

>

> Here is the draft paper and the associated figures.

>

> I suggest that you go through the comments first, address them, and then start reading/editing the manuscript.

>

> The switch to numbered footnotes for the references (PLoS Biology format) has resulted in some odd phrasing, as you will see. Feel free to edit if you want (i.e., suggesting some re-wording). Personally I hate numbered references because I don't know what the cited paper is about without flipping to the back!

>

> Best, David

>

> David Welch, Ph.D.

> [kintamav_RGB]

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>

>

> Browse animations of our

> fisheries work on-line: http://kintama.com/media/videos/

>

> P Please consider the environment before printing this e-mail

>

> <Whole Paper (29 May 2018)_AP.docx>

> <SAR Figures Paper (22 May 2018)_AP.docx> <image001.jpg>

From: David Welch

Sent: Fri Jun 08 11:51:21 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: budget

Importance: Normal

Thanks, Christine--

I appreciate you keeping me in the loop on the budget process. Just to re-iterate something I have said many times before, I really do think that the paper we are proposing to write-up next is the really crucial one for BPA and the region. The paper we are just in the process of wrapping up in essence says *"Hey… all these people working on why salmon survival in the Columbia River have never noted that survival is about equally bad everywhere else, so how can you fix what isn't broken?".* What is even more important in my opinion is the paper we need to write next, which can demonstrate that survival rates are about the same (or worse) in the ocean.

Although the data are not perfect (because we did not know how to best design the array we used when we first did the tagging work BPA funded), the data show that survival rates were either about the same in the ocean as in the hydrosystem (in good years-2008) or slightly worse (the other years). What is monumentally important about that is that the management of the Columbia River power system currently just considers flushing the salmon down into the ocean as fast as possible to be the best strategy, but does not consider what the extra time in the ocean does to the salmon. Taking this into account explains why transportation has not been very successful—not because of "differential-delayed mortality" but because putting the animals in the ocean faster doesn't save them from dying from the dams, but just puts them at elevated risk of dying in the ocean—which appears to be equally bad (in the 2000s) and probably worse (back in the 1990s).

Just consider NOAA's report from last year that they found almost no juvenile salmon in the coastal zone off Washington and Oregon in the last year's spring survey. If that becomes the norm under climate change, why would BPA want to continue managing salmon by flushing them down to the ocean faster, says by enhanced spill? Never mind that gas bubble disease might be elevated, if the smolts all die in the ocean because of very poor survival, what possible policy reason can there be for doing something like that?

Best, David

P.S. Well, we were going to go sea kayaking tomorrow, but given the weather reports here (rain), it may just be trying to get ahead of the weeds in the garden! (Assuming it is not a monsoon). J

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, June 08, 2018 11:06 AM
To: David Welch
Subject: budget

Hi David,

Regarding the contract extension – I broke this up into the elements of the extension of the first paper and starting the second paper (so that they could optionally decide to start that with FY19 funds if necessary). There is a meeting scheduled in mid-June where managers were going to review budget requests. I am going to see if they could pick a different time to review this request because I might not be in that day.

I will try to circulate the manuscript with a few more people and stimulate discussion. We are not going to provide feedback comments while you are still in process.

Have a nice weekend – looks like there will be snow in the mountains??

Christine

WORKING TITLE

The coast-wide collapse in marine survival of west coast Chinook and steelhead: simply a slow-moving catastrophe or a deeper failure?

Short title: Coast-wide survival of Chinook and steelhead

Authors and addresses:

David W. Welch(1), Aswea D. Porter, Erin L. Rechisky

Possible additional authors: Nealla Kendall?, Gayle Brown?

Kintama Research Services, 4737 Vista View Cr., Nanaimo, B.C. Canada V9V 1N8

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Key words: Pacific salmon, Chinook, steelhead, Columbia River, Snake River, marine survival, hydropower, dams, delayed mortality, aquaculture, climate change

Abbreviations

BC- British Columbia, Canada

FCRPS- Federal Columbia River Power System

Abstract

Large decreases in the survival of many salmon populations to very low levels are now evident across much of western North America and in the North Atlantic. We collated smolt-to-adult (SAR) survival data for Chinook and steelhead originating from the west coast of North America (excluding California) to examine the variation in survival. The longer time series all reveal a similar sharp decline of roughly 4-5 fold in SARs. The initiation of the decline began earlier (mid-1970s) in the south and later in the north (1990s), but a striking result is that Chinook and steelhead SARs have collapsed to similar low levels (~1%) for most regions of the west coast. Although the decline began earlier in southern regions and was therefore originally attributed to those regions having greater anthropogenic impacts to freshwater habitat, survival dropped sharply even in northern regions with nearly pristine freshwater habitat. Regional comparisons show that Chinook SARs are now essentially equal through most of the Pacific northwest (Columbia River basin to SE Alaska) and steelhead SARs in the Columbia and Snake Rivers are similar to or higher than Salish Sea (Puget Sound) populations. These results raise important scientific and policy issues: anthropogenic impacts frequently singled out for major impacts on salmon survival, such as dams in the Columbia River or salmon farming (aquaculture) in British Columbia, may play much less of a role than originally thought because the same survival decline is also seen in regions lacking these activities. The most parsimonious explanation for the coast-wide collapse appears to be a progressive northward geographic expansion in the ocean region of poor salmon survival, although it is unclear whether this primarily affects outward migrating smolts (as usually assumed), returning adults, or both; however, we outline puzzling anomalies in this simple explanation that defy easy explanation. The geographic extent and magnitude of this pattern of decline has been broadly under-appreciated by all management agencies until recently, and the widespread implicit hope that survival will eventually recover as some form of PDO-like oscillation out of a period of "bad" years seems unlikely to occur. Because ocean temperatures are forecast to increase much further, the future of most salmon populations is bleak. We discuss some actions that may improve salmon science and management and highlight limitations in our knowledge of the marine phase that is hampering more successful management; we also review three case studies demonstrating that the standard response of management agencies to clear demonstration that the problems are driven by ocean conditions and not by freshwater habitat disruption is still to focus almost exclusively on freshwater actions. We argue that this response is widespread and is a result of a combination of group think and cognitive dissonance in how fisheries agencies attempt to deal problems that lie outside of their current capacity.

(397 words)

Introduction

The total abundance of salmon in the North Pacific has now reached record levels [3-5]; however, a dramatic contrast in the winners and losers is obscured by this milestone. Most of the increased abundance is as a result of increases in the lowest valued species (pink and chum salmon) in northern regions. In contrast, essentially all west coast North American Chinook populations (including Alaska) are now performing poorly with dramatically reduced marine survival [7]. The situation is similar for most southern populations of coho [8], steelhead [9], and sockeye [10-13]. These poorly performing species are of higher economic value and the preferred focus of First Nations, sport, and commercial fisheries. Although the actual causes of poor salmon survival are currently very poorly understood, they come at a time when the geographic gap in regional salmon returns is becoming more accentuated. At high latitudes (Alaska and Russia) pink and chum abundances have increased to record levels, at least partly due to major efforts at ocean ranching of these two species (refs). However, salmon returns are collapsing in the south—which means that current management strategies in southern regions are clearly even less successful than they would be considered if northern stocks had merely remained stable over the time frame under consideration.

The geographic pattern of declines in salmon abundance (greatest problems in the south, least to the north) were originally assumed to reflect a freshwater anthropogenic cause because of the greater degree of terrestrial (i.e., freshwater) habitat modification obvious in the more populated southern regions of the west coast [14, 15], but the growing appreciation of ocean climate changes [16-18] has brought a greater awareness of the role of the ocean in influencing salmon survival. As [19] noted almost two decades ago, "*It is becoming increasingly clear that understanding the relationship between the marine environment and salmon survival is central to better management of our salmonid resources*" (p. 2374). Unfortunately, our scientific understanding of the events occurring in the marine phase remains severely limited, and thus has resulted in little change in management strategy apart from the essential first step of reducing harvest rates in the face of falling marine survival. The recent recognition of the decline in Chinook returns across essentially all of Alaska [20, 21] and the Canadian portion of the Yukon River [22], where anthropogenic freshwater habitat impacts are generally recognized as negligible compared to other regions of North America, is another example of how simple explanations looking at freshwater habitat changes are not necessarily correct; if freshwater habitat disruption across this vast swathe of relatively pristine territory is severe enough to seriously impact salmon productivity, then there is little hope that freshwater habitat in more southern regions can be "fixed" to support a newly productive environment for salmon.

The same widespread problem of declining survival is also evident for other species. In the Atlantic Ocean, both Atlantic salmon [23] and eels [24, 25] are in sharp decline. As well, both eulachon [26] and lamprey [27] have undergone sharp unexplained declines along the Pacific west coast of North America. In the case of eels, eulachon, and lampreys, the authors attribute the problem to likely marine-related factors, not freshwater. This point is particularly persuasive for eulachon because of the very short freshwater phase in the life cycle [26].

In this paper, we examine the temporal and geographic pattern of changes in smolt to adult return (SAR) for Chinook (*O. tshawytscha*) and steelhead (*O. mykiss*) for western North America, excluding California. We use the term SAR and marine survival interchangeably, because the majority of the SAR is determined in the ocean (see text and downstream freshwater survival values listed in Table 2; marine survival must be much lower than the measured freshwater survival component of the SAR to achieve the observed SARs). In the Columbia River, the Northwest Power and Conservation Council's Fish and Wildlife Program (NPCC) set rebuilding targets for SARs at 2%-6% ([1], p. 4), roughly the survival observed in the 1960s prior to the completion of the 8-dam Federal Columbia River Power System (FCRPS) [28, 29]. The NPCC SAR objectives did not specify the points in the life cycle where Chinook smolt and adult numbers should be estimated. However, one extensive analysis for Snake River spring/summer Chinook was based on SARs calculated as adult and jack returns to the uppermost dam (Marmorek et al. 1998): "*Median SARs must exceed 4% to achieve complete certainty of meeting the 48-year recovery standard, while ... A median of greater than 6% is needed to meet the 24-year survival standard with certainty*" (p. 41).

With current SARs on the order of ca. 1%, migratory-phase life cycle survival would have to increase 200%-600% (two- to six-fold) to meet these targets and it is unclear whether this level of rebuilding is achievable.

Unfortunately, progress on addressing and incorporating ocean impacts on salmon dynamics has been slow, owing perhaps to the lack of current understanding about how to address marine survival issues and to pessimism about how improved understanding of the marine phase could advance conservation. As we show in our review of several case studies, even when the overriding role of marine survival is identified there is still a strong predilection to preferentially search out freshwater factors to study and manipulate. This has resulted in the failure to directly address the marine survival problem and has led to a piece-meal and rather uncritical approach that identifies widely accepted freshwater stressors as being responsible for the problems evident in specific populations. In our view, a large part of the difficulty lies in some of the fundamental underlying assumptions that the fisheries community makes as to the nature of the core problem. Because these assumptions are part of our training and professional ethos, they are particularly difficult to recognize or question. Nevertheless, given the widespread geographic range and magnitude of the collapse in survival that is now evident, we view it as urgent that assumptions about causative agents be carefully assessed for their validity, both because of the ubiquity of the decline in marine survival and because it is clear that current management has not been successful in reversing the wane of salmon along the Pacific coast. Although there have been a few success stories, the reason for higher return rates is opaque. For example, Upper Columbia River sockeye salmon returned at much higher than expected levels in 2009-2017, but Upper Columbia River Chinook returns did not share this pattern, and most sockeye populations in the directly adjacent Fraser River Basin have continued to decrease sharply [11, 13]. In our view, this reflects our fundamental scientific ignorance as to why particular populations have suddenly done well (or poorly) in the ocean. However, rather than being pessimistic about the possibilities for improved management, we view the few anomalous successes as case studies we might eventually learn from…why do these populations do better by the time their adults return from the ocean?

Results

Chinook

1. Coast-Wide Survival

Survival data for a varying range of years are available, with data for the Columbia River extending back to the 1960s (S1 Table). In essentially all regions where time series extend back to the 1970s or earlier, survival to adult return has substantially decreased with time (Fig 2). The large drop in SARs for yearling Snake River Chinook evident from the 1960s to approximately the mid-1970s, the time period when Snake River dams were completed, was first reported by Raymond [2,28]. However, although

Fig 2. Time series of smolt to adult survival (SAR) data for west coast Chinook stocks (excluding California). Time series of smolt to adult survival (SAR) data for west coast Chinook stocks (excluding California). Left column: subyearlings; Right column: yearlings. Regions are oriented from north (top) to south. Gold dots are SAR measurements based on CWT tags (PSC database), brown dots are SARs reported by Raymond [2], and violet dots are SARs based on PIT tags [1]. A loess curve of survival and associated 95% confidence interval (shaded region) using all available data for each panel is shown as a black line (the smoothing parameter was set to α=0.75); the loess curves for Snake River subyearling and yearling survival are overplotted in red to facilitate comparison with other regions. Blank panels indicate regions where the life history type does not occur (for example, Fall (subyearling) Chinook do not occur in Alaska, while Spring (yearling) Chinook do not occur in the low elevation streams on the west coast of Vancouver Island or Oregon coast). The major regime shift years of 1977, 1989, and 1998 are indicated by vertical lines.

the timing varies with region, the collapse is also evident in other regions with long time series for both yearling (Upper Columbia River and—notably—Alaskan yearling stocks from SE Alaska), and subyearling Chinook (west coast Vancouver Island, the Strait of Georgia, and Puget Sound).

From the time of the major regime shift in 1977 forwards, no substantial recovery in SARs is evident in any region. Although Raymond (and many subsequent authors) ascribed the cause of the drop in survival to dam construction, the decline in SARs with time is also seen in other regions not affected by the construction of the FCRPS. As more monitoring programs were brought on in the 1980s, SARs for all these regions were either declining or essentially fluctuating around a low mean value closely approximating the Snake River SARs (red lines) in all regions apart from the Oregon Coast; here, SARs were also roughly flat over time but at a persistently higher mean level relative to the Snake.

Strikingly, no region outside the Columbia River now achieves the Columbia River basin's official SAR recovery targets of 2%-6%. The Alaskan stocks attained these target survival levels in the early 1980s, but since that time Alaskan SARs have fallen below the Columbia River basin rebuilding targets as well, and in recent years have reached the current survival rates of Columbia basin stocks.

2. Regional Survival Differences

When population specific data for all available years are compared by region (Fig 3), median Snake River yearling (Spring) Chinook SAR is higher than the regional median SARs for Puget Sound, Strait of Georgia, and Northern & Central BC, and is virtually identical to median survival for the Upper and Lower Columbia River populations. Regional SARs are higher than the Snake River yearling values only for two regions: the mid-Columbia River region and Alaska. Within a few of these geographic regions,

Fig 3. Box and whisker plot of SARs by population (all available years). The black horizontal line within each bar is the median of the SAR data available for each population. Median survival across all available data for each region is shown as a blue line; median Snake River survival for all populations combined is shown as a red line and overplotted on all panels for comparison. The number of years of data is shown to the right. To save space abbreviated population names are used here along with the map code from Figure 1; the full names for the populations are listed in Table S1.

striking population-specific differences are also evident, which we consider later.

For subyearlings (Fall Chinook), Snake River SARs are similar to or higher than survival in all regions of the coast apart from coastal Oregon (ORC) and the west coast of Vancouver Island (WCVI; Fig 3). As the time series plot (Fig 2) makes clear, the higher median survival evident for west coast Vancouver Island (Robertson Creek) Chinook relative to the Snake River may not actually be due to persistently better SARs but rather to the longer time series of data for Robertson Creek that extends back to the period of particularly high SARs in the 1970s that is lacking for Snake River subyearling Chinook (we consider this possibility later). Two subyearling hatchery populations from farther north (University of Washington Accelerated Fall Chinook in Puget Sound, and Chilliwack Fall Chinook from the Strait of Georgia (lower Fraser River)) are also of note because of the strikingly large survival difference (up to ~4X) of these stocks relative to the majority of populations in each region. The higher median SAR for yearling Chinook from the Mid-Columbia region is similarly due to two wildpopulations (Yakima and John Day) with three other hatchery-derived populations having decidedly lower SARs; these latter populations have SARs that are consistent with both Snake River and Lower Columbia River median SARs.

3. Relative Survival (Scaled by Snake River)

The regional-scale aggregation of SAR data provides a useful overview of survival between regions. However, important population-specific differences are potentially obscured because small numerical differences may in fact reflect large differential impacts on survival when SARs are low. For example, when regional SARs are only 1%, a population-specific SAR of 0.5% actually represents a population whose survival rate is only half that of the other populations; this is as large a difference as survival through the entire 8 dam FCRPS (50-60%). In addition, regional comparisons may be distorted because of trends in survival over time, and differing lengths to the time series.

The potential influence of these factors can be reduced by normalizing the SAR estimates. In Fig 4, we divided each annual SAR estimate by the median of all Snake River SAR data available in the same year. This approach removes the potential confounding of survival comparisons caused by trends in SAR. When data for all available years are compared in this way, median Snake River yearling Chinook SARs are higher than Puget Sound and the Strait of Georgia, and virtually indistinguishable from those in the Lower Columbia River (Willamette R) and the Upper Columbia River. Only normalized SARs for mid-Columbia, North & Central BC, and SE Alaskan populations of Spring Chinook are higher than the Snake River populations (all just slightly more than 2X higher).

Fig 4. Normalized Chinook SARs. Values are calculated by dividing individual SAR estimates for each stock and each year by the median Snake River SAR for the same year and aggregating by region. Vertical lines show the median SAR for the Snake River (red) and other regions (blue). Note the logarithmic scale on the x-axis. As in the prior plots, Columbia & Snake River SAR estimates based on PIT tags do not incorporate above-dam survival (or harvest).

The situation is similar for subyearling Chinook when normalized SARs are compared, except here the nearly 5-fold higher survival of the two Oregon coast stocks and the roughly 2-fold higher SAR for the Robertson Creek population (west coast Vancouver Island) are notable; Snake River SARs for subyearling Chinook are either just marginally higher (Upper Columbia; Strait of Georgia), marginally lower (Mid Columbia; Lower Columbia),or closely equivalent (Washington Coast, Puget Sound, North-Central BC) to SARs observed for all other regions with data.

4. Survival by Regime

Significant changes in ocean productivity are known to impact salmon populations on time scales ranging from decades to centuries (see the Discussion). An alternative approach to comparing survival normalized by year is to break the survival data into recognized ocean regime periods: ocean entry by smolts in 1977 and earlier years, 1978-89, 1990-98, and 1999 or later. The results (Fig 5) essentially mirror prior analyses, with Snake River yearling survival dropping after the 1977 regime shift, Alaskan yearling Chinook survival falling after the 1990 regime shift, and only the Alaskan, north-central BC, and Mid-Columbia populations remaining (slightly) higher than the Snake River populations post 1998; Upper and Lower Columbia, Puget Sound, Strait of Georgia, and north-central BC populations all have similar or lower survival. A very similar pattern of response is evident for subyearling Chinook, except here it is only the Oregon Coastal populations that have persistently higher survival; the progressive collapse in survival across regimes is notable, particularly for those regions whose survival data extends back to the pre-1977 period.

Fig 5. Comparison of Chinook SARs by regime periods (pre-1977, 1978-1989, 1990-1998, and post 1998). Boxes and whiskers have the conventional interpretation; the horizontal red line shows the Snake R median SAR value for each regime to facilitate comparison. Sample sizes are shown above each group.

Steelhead

6. Coast-Wide Survival

Data on steelhead survival (SAR) are more geographically limited than for Chinook, but share many of the same features (Fig 6). Prior to the 1977 regime shift, data are only available for the Upper Columbia and Snake rivers. Surprisingly, in these regions, there is little evidence of a change in survival before or after 1977 (when both FCRPS dam construction was completed and a major marine regime shift occurred). A sharp decline is evident in Puget Sound, Washington Coast, & Keogh R (NE Vancouver Island) steelhead SARs around ocean entry year 1990, the time of the next ocean regime shift, but a corresponding decline in Columbia basin steelhead survival is not. (Although SAR data is not available for B.C. stocks other than the Keogh R, the pattern of adult returns to B.C. rivers closely matches Keogh R survival, supporting the view that the Keogh pattern applies more broadly; see [51]). Washington outer coast (WAC) SARs are slightly higher than those for the Snake River (as is Keogh), while Puget Sound SARs drop to substantially lower values after 1990.

Fig 6. Steelhead SARs, plotted against ocean entry year. Regions are oriented from north (left) to south (right); the Keogh R (KEOG) is situated on the NE tip of Vancouver Island (BC). Gold dots are SAR measurements based on PIT tags [1], brown dots are SARs reported by Raymond [2], and violet dots are SARs based on CWT tags. A loess curve of survival and associated 95% confidence interval (shaded region) using all available data for each panel is shown as a black line (the smoothing parameter was set to α=0.75); the Snake River loess curve is shown in red and over plotted on all other panels to facilitate comparison. B.C. steelhead survival data are only available for the Keogh River (see [6] for description of the monitoring program). The major regime shift years of 1977, 1989, and 1998 are indicated by vertical lines.

7. Regional Survival Differences

Similar to Chinook, a few steelhead populations have anomalously high survival (three mid-Columbia River and two Washington Coast populations having high median SARs; Fig 7). However, the median SARs for all steelhead populations in a given geographic region are either indistinguishable from Snake River SARs (Upper Columbia, Washington Coast) or lower (Puget Sound). Only the median SARs for the mid-Columbia River region and the Keogh River are appreciably higher than the median Snake River survival. In the case of the Keogh River, freshwater exposure is quite limited owing to the counting fence being located within 300 m of the ocean, presumably increasing SARs relative to Snake River; however, as we show below (Fig 10), freshwater survival losses in the Keogh R mouth are nevertheless appreciable.

Fig 7. Box and whisker plot of steelhead SARs by population (all available years). Population names are listed in Table S1. The black horizontal line within each bar is the median of the SAR data available for that population. Median survival across all available data for each geographic region is shown as a blue line; median Snake River survival for all populations combined is shown as a red line and overplotted on all panels for comparison. The number of years of data is shown to the right.

A similar conclusion is evident when annual SAR estimates for individual stocks are normalized by the Snake River median survival values in each year (Fig 8). This pattern becomes particularly clear when the steelhead SAR data are disaggregated by regimes (Fig 9), where both the large drop in Keogh R SARs over time is evident, as is the similar or lower SARs for Puget Sound, Washington Coast, and the Upper Columbia River relative to the Snake River in all regime periods; only the mid-Columbia and Keogh stands out as having higher SARs.

Fig 8. Normalized steelhead SARs, obtained by dividing each individual SAR estimate (i.e., for each stock and each year) by the median SAR calculated across all available Snake River SARs for that year. The median Snake River SAR is overplotted in red. Note the logarithmic scale on the x-axis.

Fig 9. Comparison of steelhead SARs by regime periods: pre-1977, 1978-1989, 1990-1998, and post 1998. Boxes and whiskers have the conventional interpretation; the horizontal red line shows the Snake R median SAR value for each regime to facilitate comparison. Sample sizes are shown above each group.

In-River Smolt Survival

SAR data measure survival over almost the entire migration phase, from the beginning of smolt migration downstream until the adults return from the ocean several years later. These measurements therefore conflate freshwater survival with marine survival. To assess what are "normal" freshwater survival levels for smolts migrating downstream, we collated all published studies for west coast North American rivers (Table S2) and compared downstream smolt survival and survival scaled for distance travelled (Fig 10). The results show that steelhead from the Fraser, Columbia, and Oregon Coast rivers have roughly similar levels of survival to the river mouth, and that smolt survival during migration down the Columbia and Snake Rivers is not unusually low despite the presence of many dams in the migration pathway. The survival of

Strait of Georgia, Puget Sound, and Keogh R steelhead is clearly higher than steelhead from the Fraser, Columbia, and Oregon Coast rivers. For Chinook, where tagging data is restricted to populations from the upper Fraser and Columbia Rivers (where larger yearling smolts occur), Columbia River survival is higher than is the case in the Fraser.

Fig 10. Freshwater smolt survival during downstream migration for Chinook and steelhead for west coast North American rivers. Update text once revised Fig 10 is produced.

All of the smaller coastal rivers have less extensive watersheds and reported migration distances to the sea after release are typically much shorter than the two major watersheds (the Columbia and Fraser; see Table S2). When freshwater survival is scaled for distance travelled, a roughly similar pattern emerges for Chinook, with all Fraser River survival rates either lower than or equal to those measured in the Columbia River. The pattern is similar for steelhead, with the highest survival rates recorded in the Columbia River and similar but slightly lower survival rates in the Fraser and Puget Sound rivers, and lowest survival rates observed in Oregon Coast, Strait of Georgia, and Keogh River populations.

Discussion

Our analysis shows that over time SARs (smolt to adult survival) have declined to reach approximately the same low level for almost the entire west coast of North America—with a few important exceptions that we discuss later. Although we do not have direct measurements of survival for Chinook stocks west of SE Alaska or steelhead north of Vancouver Island, the collapse in adult returns of Chinook to the rest of Alaska [1, 2] shows the broad region that the conservation crisis extends over.

The advent of acoustic telemetry has resulted in an expanded range of river systems where freshwater smolt survival (i.e., from release to ocean entry) has been assessed over the past 15 years. Our meta-analysis of studies reporting smolt survival during the downstream freshwater migration phase indicates that survival is high and of roughly similar magnitude in most rivers, but that when scaled for migration distance the Columbia River smolts have high survival rates relative to other regions (Fig 10). This result is important because the low value of SARs and relatively high freshwater survival isolates the location of the conservation problem as being in the ocean (see below), although the results do indicate that the river mouth is a perilous location for smolts because survival rates scaled by distance are extremely low in rivers where distance to the mouth is short. Freshwater losses (presumably to predators) must be concentrated near the river mouth to result in such disproportionately low survival rates.

Occam's Razor dictates that any coherent theory consistent with the large drop in survival (SARs) to similar low levels should be applicable to all populations. We are unable to identify a fully consistent mechanism of action, but some explanations (anthropogenic freshwater habitat disruptions) are clearly less likely as explanations of poor salmon survival than others (climate-related changes in the ocean).

The Role of Dams

Direct Mortality

Conventional logic holds that if average survival (SAR) of Chinook or steelhead was 4%-6% in regions without dams, then the four- to six-fold lower survival of Columbia River populations (currently ca. 1%) would be clear evidence that the Columbia River dams were the cause of poor survival. The obvious conclusion would then be that removing or modifying dams lying in the migration path of Snake River basin populations should increase SARs four- to six-fold, achieving rebuilding targets. Yet the same logic, which has implicitly guided much conservation thinking, clearly cannot be used in reverse—presumably no one would rationally argue that constructing 8 dams in the Fraser River would double salmon returns, raising median Chinook survival in the years since 2000 from a mere 0.53% in the Fraser River to the Snake River's current 1%. (Median SAR for all other Strait of Georgia yearling Chinook populations is also 0.53%; none have dams in the migration path).

Despite this, great effort continues to be made to address the effects of dams within the Columbia River basin. As we discuss below, this freshwater focus is broadly evident in west coast salmon conservation efforts, with a strong bias towards ignoring or minimizing the marine impacts and focusing on a search for freshwater habitat problems.

Indirect (Delayed) Mortality

A similar logic seems to have guided the argument that "delayed mortality" caused by dam passage results in poor ocean (or estuary) survival for Snake River smolts. Spring Chinook smolt survival through the 8-dam FCRPS ranges from 50-60% (Tables A.1 and A.2 of [3]), so even eliminating all sources of freshwater mortality during downstream migration—direct impacts of the dams on survival, predation, and possible losses from disease—could only increase SARs by a factor of 0.5^{-1}-0.6^{-1}, or ca. 1.7-2 fold . These levels are still well below rebuilding targets. Further, because a significant fraction of the downstream loss is due to predation by birds [4] and fish [5], unless all predatory wildlife species are eliminated even an increase to 1.7-2% SARs is unrealistic.

The mathematical inability of even perfect hydrosystem survival to achieve minimum rebuilding targets likely underlies the logic suggesting that delayed mortality caused by the dams results in poor ocean survival. This unstated gap between what is theoretically achievable and what must be achieved in practice for Columbia River recovery is presumably the reason why delayed mortality is considered important for Snake River stocks [3, 6-10], despite direct experimental tests using size-matched controls finding no evidence for a survival difference related to dam passage to as far away as Vancouver Island ([11-13]).

Freshwater vs Marine Survival

That conventional wisdom does not work in reverse suggests a deeper problem in how biologists and conservationists think about current salmon problems. A wide range of west coast rivers lacking dams now have similar or worse reported survival than the Snake River, both in terms of adult return rates and as downstream smolt survival when migration distance is taken into account. We interpret this as evidence for a fundamental flaw in our biological understanding of the conservation factors actually controlling salmon productivity. Earlier work reported roughly similar freshwater survival rates in the Columbia and Fraser rivers [14]. Our compendium of telemetry studies for a wider range of west coast rivers also shows similar or lower levels of overall smolt survival to the Columbia River (Fig 10 and Table S2); downstream smolt survival within the Columbia River is clearly not anomalously low relative to other river systems as widely assumed and in fact can be viewed as quite high when the greater distances migrated by Columbia River smolts are considered. Smolt survival during freshwater migration is also quite high relative to the marine phase. With SARs now around 1% and smolt survival in rivers around 20-50% or higher (Table S2, Fig 10), at least $1/2 \sim 1/5^{th}$ of smolts survive to leave freshwater, so only $1/50^{th} \sim 1/20^{th}$ of smolts surviving to leave the river return from the sea. From this perspective, marine survival is thus only $1/10^{th}$ freshwater survival and controls the SAR.

Despite frequent statements about the importance of a particular life history stage based on the low survival in that stage, the profound implications of the overall decline in salmon SARs to ca. 1% largely go unrecognized. For example, even a 50%

decline in survival in a particular life history stage requires a total of N=6.6 sequential phases of 50% survival to reduce SARs to 1% (because $0.5^{6.6}=0.01$). From this perspective, survival through a migration segment such as the entire FCRPS with an (at-worst) survival of roughly 50% contributes only 1/6.6=15% to determining the SAR.

The ESA & Habitat

Conventional conservation thinking for Pacific salmon primarily focuses on addressing freshwater habitat issues. This can likely be traced back to two separate events first occurring in the 1970s. The first was the passage of the U.S. Endangered Species Act in 1973, with its strong focus on protecting and preserving habitat as the paramount priority for conservation [15]. (Canada's Species at Risk Act was enacted in 2003, and was at least partially modeled on the US ESA. The Canadian legislation provided a remarkably broad definition of habitat, which essentially prohibited: "*damaging or destroying the residence of one or more individuals*", with residence defined as "*...a dwelling-place such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles*" ([16], p. 227)).

Unfortunately, "habitat" in both countries is ill-defined for migratory animals such as salmon which occupy many different habitats as they complete their life cycle. The second event, unappreciated at the time, was a major shift in ocean climate in 1977 which had impacts on a wide range of marine fish stocks (including salmon) across the entire west coast of North America [17, 18].

Salmon, as well as other anadromous fish such as lamprey and eulachon, migrate widely across a complex landscape composed of many successive freshwater and marine habitats; even something as simple as the number of distinct habitats each salmon population occupies over the marine phase is unknown. The number of returning adults is therefore successively affected by changes in survival in a complete sequence of freshwater and marine habitats, most of which are poorly understood, as the product $SAR=S_1\bullet S_2\bullet S_3\bullet\ldots S_n$. If survival drops to, say, $1/10^{th}$ of its original value in any one of these habitats, the SAR will also decline equivalently unless density-dependent factors occurring at some later point in the life history buffer the impact on adult returns.

Overall, the collated coast-wide data shows that the decline in marine survival began earliest in the south and then progressively expanded farther north along the coast at or following the time of each regime shift; in the last decade even SE Alaska has Chinook survival close to that experienced by Snake River Chinook (Figs 2 & 5). Obviously, almost none of the rivers outside the Columbia have dams, so the argument that the poor performance of Snake River stocks is primarily due to the completion of the Federal Columbia River Power System (FCRPS) is inconsistent with the broader data. (We are not dismissing the argument that extensive past modifications to the FCRPS have improved freshwater survival, rather, we are suggesting that these improvements are very small relative to the overwhelming influence of the ocean). As we will discuss, many other "single factor" reasons for poor salmon survival along the west coast also suffer from the same logical flaw that survival now seems to be poor everywhere.

The Habitat Problem

Wasser et al [19] cite this blanket statement: "*Anadromous salmonids (Oncorhynchus sp.), which hatch in fresh water, migrate to the ocean, and then return to their natal waterways to breed, are threatened primarily by habitat loss from dams and overfishing (SOS 2011)*" (Lines 98-101 of the SI). The sentiment underpinning this statement is widespread. However, we view the reality as more nuanced: Fall (ocean-type) Chinook harvest levels of 50%-70% that were formerly sustainable (i.e., a harvest of one-half to two-thirds of returning adults) are no longer sustainable because marine survival dropped 4-5 fold over the past few decades. The drop in marine survival is far larger (75-80%) than the possible reductions in harvest rates (50%-70%) can compensate for, so even the complete cessation of fishing is insufficient to compensate. Just how large the gap is is widely unappreciated. To fully compensate and maintain adult escapements, the initially sustainable harvests of the 1970s would have to be as large as the drop in marine survival has been. Algebraically,

$$E_1=N\bullet S_1\bullet(1-h_1)$$

and

$$E_2=N\bullet S_2\bullet(1-h_2).$$

For escapement, E_t, to remain constant in the two time periods implies that

$$\frac{S_2}{S_1}=\frac{(1-h_1)}{(1-h_2)}$$

Or

$$h_1=1-\frac{S_2}{S_1}(1-h_2)$$

The maximum compensation management can make for declining marine survival occurs when all fisheries are curtailed completely (h_2=0). In this case, ceasing or reducing harvest can compensate if the initial rate of sustainable harvest is $h_1 \le 1-\frac{S_2}{S_1}$. Obviously, if marine survival collapses to zero, this result would require the initial harvest rate to be 100% to compensate, but the key feature of this equation is that it is the ratio of the initial to the current period marine survival that determines how large the initial sustainable harvest rate needs to be allow compensation to occur; if marine survival drops by an order of magnitude, as it has in at least some regions, sustainability can only be maintained if the initial sustainable harvest rate was 90%. Taking the Columbia River basin as a less extreme example, marine survival has dropped from perhaps 6% to 1%, so the initial harvest rate would have to be $h_1 \ge 84\%$ to allow full compensation for changing environmental conditions. More typical harvest rates reported by the CTC for the early years of the record (ref) suggest that harvest rates were on the order of 50%-60% for many stocks, implying that complete harvest rate compensation for declining marine survival would only be possible for survival ratios of $S_2/S_1 = 0.4 \sim 0.5$; far less decrease in survival than has actually occurred.

Another way to consider the gravity of the change in marine survival is to consider a situation where the entire harvest effort was doubled (say, by doubling the number of years that salmon remain at sea before maturing, so that the same fisheries operate twice over on the animals and the animals remain equally vulnerable to fishing over this time period). This would reduce escapements to only $(0.5)^2$ to $(0.7)^2$ (25%-49%) of the level achieved without fisheries. This is still substantially higher levels of escapement than the decrease in SARs resulting from the collapse in marine survival. Clearly, when this level of loss is repeated over successive generations, it is only due to poorly understood compensatory density-dependent processes that salmon populations have not collapsed to much smaller sizes than currently persist.

Statements about the major role of particular factors in driving salmon declines (dams in the Columbia River or salmon farming in British Columbia) must therefore be assessed critically because salmon from other regions lacking these particular factors also return from the ocean with very poor marine survival. Thus, dams or salmon aquaculture may contribute as habitat issues to overall losses, but the essential policy debate is whether modifying their operation will (1) materially contribute to improving salmon returns, and (2) whether proposed courses of action are actually credible and cost-effective given the primary influence of ocean conditions.

Case Studies

The data analyzed in this paper demonstrate that there has been a coast-wide decline in survival for Chinook and (probably) steelhead. The cause of the low SARs must predominantly be located during the marine phase of the life history because downstream smolt survival in freshwater is relatively high and therefore could not have fallen much to contribute significantly to the decline in the overall SAR. Although managers have moved to reduce Chinook harvest to partially compensate for the drop and (in the Columbia River) to improve survival at dams, relatively little has been done to determine the cause of the decreased marine survival, and much of the focus has remained on freshwater.

Festinger [20] was the first to define the term "*cognitive dissonance*", describing it as an inability to recognize the true problem, despite the evidence. The history of west coast salmon management suggests that cognitive dissonance may be the reason for the long-term issue of declining salmon stocks being assumed to be caused by primarily freshwater habitat issues, despite the evidence that even if perfect freshwater survival was attained it was mathematically impossible to reverse the decline. (Interested readers should also consult Janis [21] (especially Chapter 8) for an excellent summary of the sociological factors leading to "*groupthink*" and the poor decision making processes that result). We now review three case studies to illustrate the past operational response to falling salmon populations after similar determinations were made that marine survival was driving the decline: (i) Rivers-Smith Inlet sockeye (Central B.C.); (ii) Columbia River Chinook and steelhead; (iii) Upper Fraser steelhead.

Rivers and Smith Inlet Sockeye (B.C.)

The Rivers-Smith Inlet sockeye complex formed the second largest sockeye fishery in British Columbia for much of the last century (the Fraser River being the largest), with adult harvest levels averaging around 1M sockeye for six decades (1910-1970). The Rivers and Smith Inlet populations are located in adjacent watersheds in the remote central coast region of BC where there is little anthropogenic impact.

Escapement data available from the 1950s forward show that escapement remained stable until the 1970s [22], so recruitment overfishing did not occur during this period. Following the 1977 regime shift, productivity of both Rivers and Smith Inlet sockeye suddenly collapsed [22-27]. Probably because of the isolated location and the lack of any other nearby significant salmon fisheries, management decisions to reduce harvest to essentially zero were promptly taken and were maintained through the 1980s. Despite harvest being curtailed, the population did not recover, as standard fisheries theory would predict, although escapements remained high because of the prompt management action. However, following the next regime shift in 1989, escapement levels fell to record lows in both river systems because with the fishery already stopped there was no further action possible to compensate for the second drop in survival. Marine survival was near zero in several years during the 1990s [25]. There was also evidence that additional nearby sockeye stocks also were impacted similarly [27].

A study of the management response to the collapse [22] detailed the reasons for rejecting a freshwater cause for the collapse (including using data extending back over half a century to demonstrate that pre-smolt abundance in the lake was above the long-term mean). The authors noted that *"Poor marine survival is the most parsimonious explanation for the declining fry-to-adult survival in Owikeno Lake, particularly in light of coincident declines in sockeye salmon returns per spawner at Long Lake (a nearby pristine watershed) and declines in adult sockeye salmon abundance in other populations to the north of Rivers Inlet."*

The second regime shift in 1989 resulted in the collapse of the population from >1 million spawning adults to ca. 9,500 adults by 1999—a collapse to 1/100th of the original population size in just over two decades, despite prompt action being taken to essentially eliminate harvest. The key findings from a joint federal and provincial government technical committee to review the collapse are worth quoting verbatim [23, 25]:

"*(1) The drastic declines in abundance appear to be due to an extended period of poor marine survival that cannot be explained by any one event, such as sea-entry during an unusual El Niño year. At least two recent years (1996 and 1997) show signs of near-zero marine survival, but the reasons for those low survival rates are not known at this time.*

(2) There is little evidence to suggest that logging or other human activity in either of the drainage basins has had more than small and localized impacts on sockeye spawning and rearing. The simultaneous declines in both basins – i.e., in Owikeno, where there has been extensive logging and in Long Lake, where there has been very

little – is convincing evidence that the cause of the declines does not lie in freshwater habitat disturbance".

The Rivers-Smith Inlet study is to our knowledge unique in North America. Not only does it state that the problem lies in the ocean, it also goes on to state that freshwater habitat problems were not contributing—something that is generally not possible to rule out with certainty for most salmon populations.

Strikingly, the committee then went on to recommend necessary research to clarify the cause of the collapse, and regulatory action that might be taken to improve the situation. Despite the conclusions quoted above, marine survival is not cited in any of the research which the various review committees recommended be pursued [23-25]. Instead, the committees recommended three research-related foci:

"(1) determine absolute escapement levels to Owikeno Lake… in order to improve the credibility of stock assessment;

(2) improve the understanding of habitat use… by sockeye juveniles in Owikeno Lake and smolts in the Wannock estuary; and

(3) investigate the status of ocean-type and lake-spawning sockeye, which are less familiar and, although not specifically covered in this plan, may require future intervention". (The committee noted that there was some evidence for an unusual sockeye life history type that went directly to sea without rearing in the lake for a year as pre-smolts (the normal life history pattern) [25]; the other committee reports have similar language).

No mention is made of addressing the marine survival issue that is at the core of the collapse; the reference to improving the understanding of smolt habitat use in the "*Wannock estuary*" mentions that *"sockeye smolts do not appear to rear in these estuaries for much time"* [24]. The report further mentions that there are numerous estuaries within River and Smith Inlets, with varying sizes and importance to salmonids. It is unclear why the Wannock was identified as particularly worthy of investigation, but the report does note that "*approximately 25% of the Wannock estuary was dyked and filled in 1973 for a log dump facility*" (i.e., almost two decades earlier).

The recommendations for Habitat are even more striking:

"5. Existing conceptual plans for habitat restoration developed by DFO, the provincial Watershed Restoration Program, and other stakeholders should be evaluated for their potential long term benefits to sockeye, and the feasibility of proposed restoration projects should be thoroughly assessed.

6. Habitat restoration projects could include the reconnection of spawning and early rearing habitats along the margins of floodplains and in side-channels that have been isolated by road construction or degraded by natural and logging-related activities.

7. Any habitat restoration projects that are undertaken should be monitored to determine their benefits for sockeye.

8. DFO and other agencies and stakeholders should continue to collaborate on developing habitat protection strategy during resource development planning processes (e.g., CCLCRMP, Forest Development Plans).

9. The site-specific and cumulative impacts of logging on habitats used by sockeye should be more comprehensively evaluated". [25]; the other committee reports have similar language).

In other words, despite the reports identifying with high certainty that freshwater habitat issues were not contributory, the committees did not attempt to understand what were the marine drivers, and instead advocated a series of actions in freshwater; the recommendation to evaluate the *"site-specific and cumulative impacts of logging"* is particularly problematic because this could result in significant costs for the forest industry and added tasks for fisheries personnel pursuing monitoring that would in essence be "busy work": work that staff knew how to do, but was unlikely to lead to useful progress on the core issues. This preference for actively doing work in freshwater is a repeating feature of salmon management.

Columbia River

Two nearly contemporaneous studies identified the importance of either estuary (lower river) or ocean processes in controlling the poor survival of Snake River salmon. [28] applied a matrix life cycle model to demonstrate that recovery of endangered salmon populations in the Columbia River could only be achieved by improving survival in the lower river/estuary or in the coastal ocean and that (similar to our own argument above) even raising main stem survival to 100% would not prevent extinction. [29] in a review of the PATH (Plan for Analyzing and Testing Hypotheses) process, stated *"Importantly, we found that the different models' estimate of the survival rate of in-river migrants through the hydropower system, a hotly debated value, was NOT an important determinant of overall life cycle survival. Rather, the key uncertainties that emerged from these sensitivity analyses were related to the cause of mortality in the estuary and ocean"*.

Probably owing to the lack of any direct information on juvenile survival in the lower Columbia River and estuary regions, two initiatives were then funded: (a) the development of the bespoke JSATS acoustic telemetry system [30], and (b) directed research using commercially available telemetry equipment to formally test the delayed mortality theory in the lower river and coastal ocean [11, 13, 31]. Both approaches established that survival was high in the lower river below Bonneville Dam and lower (but still high) in the estuary/plume region (the coastal region lying immediately off the mouth of the Columbia River) [11, 31-35]. The Rechisky et al studies extended these results further, showing that survival was even lower in the coastal ocean region extending from the Columbia River plume to the NW tip of Vancouver Island [11, 13, 31].

The important revelation of these initiatives was that survival was high in the lower river and estuary. However, no further action was undertaken to understand why ocean and plume survival was low or to establish the relevance for salmon conservation and hydrosystem management. Further work to measure ocean survival and directly address the conclusions of [36] and [28] was not carried out; once the ocean phase was identified as being the likely cause of poor returns, the research focus using acoustic telemetry shifted back to exclusively studying freshwater survival upstream at the hydropower dams. Although several publications have identified the presence of smolts in side channels within the estuary and suggested the potential importance of estuarine wetlands for salmon conservation (e.g., [37-41]), we are unaware of any studies that have actually identified low survival in the estuary or established the period of residency—necessary requisites for improving SARs. In summary, the ocean issues clearly having a major impact on Columbia River salmon management remain unaddressed and research re-focussed on freshwater or lower river/estuary issues, although the ability of these initiatives to compensate for poor ocean survival is questionable.

Upper Fraser (Thompson & Chilcotin) River Steelhead

Over the last two decades, steelhead returns to the upper Fraser River have dropped precipitously, prompting an emergency assessment of the status of Thompson and Chilcotin River populations in February 2018 [42]. These two major tributaries of the Upper Fraser formerly supported world-famous populations of unusually large steelhead but adult returns have now dwindled to critically low levels. (Unfortunately, no data on survival is available, only adult abundance). However, similar to the Rivers & Smith Inlet case, the parallel decline of adult returns to the Thompson and Chilcotin River populations (79% and 81%, respectively, over the last three generations) is particularly striking and strongly suggestive of a common cause.

The emergency assessment [42] noted for the Thompson River population that "*The number of spawning fish was variable with little trend prior to 2000. Since then, the population has declined dramatically…and is now the lowest on record*". Only 177 mature fish were observed in the most recent survey, and "*If the current rate of decline persists for another three generations, the number of spawning fish will decline to 37, which is 2.0% of the pre-2000 abundance*".

For the Chilcotin River population, the problem is even worse: "*The 58 mature fish observed in the most recent survey are only 5% of the pre-2000 mean. If the current rate of decline persists for another three generations, the number of spawning fish will decline to 11, which is 0.9% of the pre-2000 abundance*".

The report's conclusions concerning the drivers of the collapse are particularly important, stating: "*Bycatch mortality in commercial Pacific salmon fisheries and <u>declines in marine and freshwater habitat quality</u> are the key factors driving the declines*" (emphasis added). Fisheries interceptions are certainly always a concern when productivity drops, but bycatch levels presumably would have remained sustainable if the 1998/99 regime shift had not caused sharp decreases in marine survival, resulting in pre-2000 interception rates no longer being sustainable. The report continues "*While it is generally considered that the quality of freshwater habitat is declining, the severity of the freshwater habitat-based threats in the Thompson and Chilcotin rivers is not well understood*". (p. 8).

Despite the report stating throughout that "*declines in marine and freshwater habitat quality*" are the key drivers, the Chilcotin River is pristine. Although the Thompson River runs through areas of significant human population density (cities, towns, and recreational cottages) as well as substantial agriculture and some forestry, the Chilcotin watershed has steep valley walls keeping cattle from the few ranches in the region away from the river and the human population is extremely sparse and there is negligible forestry. Thus if some form of freshwater habitat degradation in the Chilcotin is materially contributing to the degraded status of the steelhead population, there is no realistic prospect that other river systems can be improved to even approach the existing habitat qualities of the Chilcotin. In short, as with the other case studies examined, although it is routine to state that freshwater habitat degradation is a "key factor" behind the decline, the situation in fact suggests the opposite, and that unknown marine factors are the primary drivers, presumably acting similarly to those affecting coho, Chinook, and sockeye in south-central BC.

Critically, there is no evidence that "improving" freshwater habitat could in any real sense change the dire conservation status of Upper Fraser steelhead; because the Chilcotin population (N=58) is in worse shape than the Thompson (N=177), it is hard to rationalize how any freshwater habitat modification can actually help. Given that there may be real economic costs in making such improvements (particularly as the emergency assessment cites their claimed role in the decline), it is imperative that efforts to improve freshwater habitat be critically assessed; otherwise (as in the Rivers-Smith Inlet case), initiating activities in freshwater may be simply a palliative to avoid addressing the marine survival issues.

Overall, these studies demonstrate a consistent pattern: a strong proclivity to not address the unknown drivers of marine survival and to preferentially identify and work on freshwater habitat, even in cases where such problems are unlikely to exist.

Monitoring salmon survival and population trends—particularly survival—is clearly critical to making informed management decisions; however, simply monitoring populations is insufficient. Recent work in BC documented a substantial decline in monitoring effort in north-central BC, and the authors argue that the situation must be improved if salmon conservation efforts are to be effective [43]. While some degree of monitoring is necessary, we note that the previously substantial monitoring effort was insufficient to develop a coherent management response. Obviously, if agencies cannot respond effectively to the already available data indicating a widespread collapse in marine survival of salmon populations, then it is unclear why simply increasing monitoring effort will lead to a more effective response, as opposed to simply clarifying the extent of the collapse; clearly, greater monitoring alone does not necessarily lead to an improved outcome.

The Magnitude of Decline

We view it as critical that the roles of various proposed deleterious impacts on salmon returns be rigorously quantified, rather than simply identified as important without careful thought about other potential contributing factors. If this is not done, competing economic activities may be unfairly blamed for the ongoing collapse of several important salmon species and unrealistic expectations placed on what various recovery options may actually achieve. This is not simply restricted to dam removal in the Columbia River basin or banning open-net salmon aquaculture in British Columba. Wasser et al [44] state that "*Low availability of Chinook salmon appears to be an important stressor among these fish-eating whales as well as a significant cause of late pregnancy failure, including unobserved perinatal loss... Results point to the importance of promoting Chinook salmon recovery to enhance population growth of Southern Resident killer whales.*" Policy options for promoting recovery thus need to recognize that the wide geographic footprint of poor salmon survival likely implies that efforts focused on "fixing" possible contributing factors specific to some regions are unlikely to be effective. At the very least, these efforts should be held to a significant standard: (a) clearly demonstrating a real and substantive improvement, and (b) demonstrating a clear benefit relative to the costs of the proposed action.

Although it is common to invoke a critical period in the early life history as determining adult salmon recruitment, and thereby simplifying the scientific problem, we believe that the reality is different—an X-fold decline in survival at any point in the life cycle will result in an exactly equivalent X-fold decline in adult recruitment unless density-dependent processes occur at some later point in the life history to moderate the response. An approximately 5-fold increase in seal populations over the same time period has been documented [45, 46] and predation by seals and other marine mammals on salmonids is now demonstrated to both occur and be of major concern in a number of west coast regions [45-48]. It is not unreasonable to assume that potential impacts of marine mammals on salmon survival may actually be more important in the final marine phases of the life history rather than the early marine period.

Salmon Survival and Geography

Several influential publications surveyed the conservation problems with Pacific salmon stocks [49, 50], and noted that the problems were greatest to the south and least in the north (i.e., British Columbia and Alaska). Not unreasonably for the time, the authors suggested this north-south trend was primarily a result of greater anthropogenic disturbance in southern regions owing to larger human populations and therefore greater freshwater habitat disruption. Reflecting the generally limited understanding of the impact of ocean regime shifts of the time, little discussion was made of potential ocean influences, which were lumped in with "*Other natural or manmade factors affecting continued existence*" [49](p.8). Yet profound large-scale declines in ocean-mediated survival were occurring for many purely marine species as well as salmon [51], and these too appear to have a south-north latitudinal gradient, but with the spatial footprint of poor survival expanding further up the coast with time (e.g., [52]).

The more recent regimes shifts in 1989 and 1998 were more quickly recognized by the marine research community [53-57], but substantive connections to the issues concerning freshwater habitat and salmon conservation have been slow to develop. As a result, salmon conservation research has developed into stovepipes with relatively little interaction between the two groups: freshwater researchers argue that even if the real cause of the survival decline can be identified, little can be done to improve ocean survival so the primary focus should be on protecting, conserving, and improving freshwater habitat to maintain this habitat for when ocean conditions again turn favourable. Unfortunately, marine researchers initially could only offer large-scale correlation between changes in ocean climate and adult survival, not mechanistic understanding that could lead to substantial predictive capability or (most critically) insight into how salmon returns might be improved. A key finding from our current work is that although the implicit assumption of *cyclical* variation in ocean conditions is widespread (i.e., oscillations), the data is better defined as a series of ever-declining survival stanzas. While very long period cycles in salmon abundance are evident from lake cores e.g., [58-60] the troubling decline in survival recorded in the SAR data over the past half century seems most consistent with climate change, perhaps caused by society's entry into the Anthropocene [61].

Acceptance of the presumed magnitude of the impact of Columbia River dams on Columbia River salmon returns can be traced to Raymond [62-64], who documented large-scale declines in adult salmon returns through the 1960s and 1970s, a period when the FCRPS was completed with the construction of the Snake River dams. However, Raymond was also working in a time when the impact of ocean climate was not recognized; many of Raymond's contemporaries in fact argued that because of the size of the ocean, it was presumably a stable environment.

The same major decline in survival can also be seen in British Columbia after the 1977 regime shift, the period when the first real measurements of SARs for other west coast regions started. Perhaps the best measurements demonstrating the magnitude of the drop in British Columbia SARs was reported by Bilton et al [65]. In the early 1970s, SARs for Strait of Georgia coho of $\overline{S} = 20.8\%$ (SE: ±0.5%) and S_{median}=17.2% were obtained in extensive experimental hatchery releases (6 replicates of each of 3 size classes of smolts in each of 3 months (April, May, & June)) [65]. The magnitude of these survival levels (ca. one in five smolts surviving to return as adults) justified Canada's decision to fund the Salmon Enhancement Program (SEP), a major investment in hatcheries. Yet less than two decades after the start of SEP in 1977, average coho SARs for the nearby Big Qualicum hatchery had dropped from 28.6% (1973-77 ocean entry years) to 5.6% (1990-99) and then to 1.5% (2000-2012) (data from [66, 67]). As a result, average survival rates dropped from 1 in 3.5 smolts in the 1970s to 1 in 67 smolts—survival dropped to 1/20th of the initial value. (See [66] for a detailed description of the decline over time in Strait of Georgia coho SARs).

To place the magnitude of this change in perspective, by the 2000s coho SARs in the Strait of Georgia were the equivalent to surviving through a sequence of n= $\log(S_{2000s})/\log(S_{70s})$ =3.4 successive survival periods, with each period equivalent to the entire survival process experienced in 1973-77 (a time when intensive sport and commercial fisheries were operating). Whatever the actual change in the environment was, it was thus the equivalent to the coho remaining at sea for 60 months (5 yr) instead of 1.5 yr while experiencing the total mortality rates (natural plus fishing) characteristic of the 1970s.

The Importance of Geography

The pattern of variation in SARs along the west coast of North America is most simply explained as both a progressive worsening of marine survival over time and simultaneously a geographic northward expansion of the region of poor ocean survival. However, several puzzling aspects to this pattern need to be addressed. Because Fall Chinook are believed to remain shelf-resident for their entire marine phase while Spring Chinook migrate north on the shelf before eventually moving off-shelf (or into the Bering Sea/Aleutian Island region), this would suggest that the area of poor marine survival might be restricted to the coastal shelf off Washington, British Columbia, and SE Alaska. However, complicating a clear understanding of the drivers, the large-scale collapse in adult Spring Chinook returns includes the Yukon and Kuskokwim Rivers (draining into the Bering Sea) and the Kenai River (Cook Inlet) [1, 2, 68-70]. This suggests that either the area of poor marine survival is now simultaneously large or that all stocks congregate at some point in the marine phase into a more geographically confined region where their survival is all similarly affected. The evidence that Fall (subyearling) Chinook stocks only migrate as far north as SE Alaska after one or more years at sea (and that Strait of Georgia and Puget Sound coho remain resident in southern BC waters for their entire marine lifespan) suggests that the conditions leading to poor marine survival must be geographically widespread because western Alaska Spring Chinook are not known to migrate to the shelf region off SE Alaska or BC.

Our limited knowledge of the marine phase of the life history of salmon precludes a full explanation of how the coast-wide decline in SARs developed; however, we speculate that it is chiefly driven by either a northward expansion of a region of coastal (continental shelf) waters unfavourable for juvenile Chinook and steelhead after ocean entry or by populations of both species migrating at a later stage of the marine life cycle to such a region of poor survival. We consider both in turn.

In the first scenario, those populations whose smolts remain longest in regions of poor marine survival should have the poorest SARs. Assuming that the region of poor survival progressively expanded from south to north along the coast roughly at the time of successive regime shifts, this produces several testable hypotheses. For example, Salish Sea Chinook populations may have lower survival than adjacent outer coast stocks (west coast Vancouver Island, coastal Washington) either because they remain resident for a longer time period in coastal marine waters, for which there is some evidence [71], resulting in greater exposure, or because survival rates per unit time are lower than along the outer continental shelf waters (poorer survival). This could potentially explain why SE Alaska Chinook stocks still have SARs ~2X Snake River stocks and ~4X Strait of Georgia stocks. Strait of Georgia Chinook stocks remain resident in the Strait of Georgia for multiple months after ocean entry [71, 72], while Snake River stocks steadily migrated north along the outer shelf to Alaska [11].

In either case, a key prediction is that those stocks with lower SARs should have greater exposure to poor ocean conditions in southern regions. The anomalously high SARs of some specific salmon populations (Fig. 3) might provide the basis for an explicit test of this prediction. Although our understanding of population-specific differences in marine migration routes is currently very limited, especially for steelhead, there is now some developing evidence for differential salmon survival in the sea; e.g., [73-76]).

In this context, the anomalously low survival of the Dworshak population relative to other Snake River Chinook stocks is particularly noteworthy; mean survival from Lower Granite Dam to adult return over the 2000-2015 period was only 0.58% for the Dworshak Hatchery stock versus 1.28% for McCall Hatchery and 1.29% for Imnaha Hatchery fish (ref [3], Tables B.16, B.22, & B.24). The Dworshak SAR is thus less than ½ that of the other two populations, lower than Snake River smolt survival experienced during migration through the entire 8-dam FCRPS (50-60%). Understanding why such large population-specific survival differentials develop at sea could provide important insight into why differential survival is present by the time of adult return.

Columbia River Chinook salmon are known to be seasonally present in the Bering Sea and to overwinter in the Gulf of Alaska [77]. Because all Snake River populations migrate through the same set of dams, one explanation for the particularly low survival of the Dworshak population could be a feeding migration to an area of the North Pacific (or Bering Sea) whose relative survival prospects was only one-half that of other regions—i.e., as poor as downstream passage through the 8 dam FCRPS. Clearly, our tenuous understanding of where Chinook and steelhead migrate to in the ocean, how long they remain in various regions of the North Pacific Ocean and Bering Sea (let alone how these patterns differ between important populations with serious conservation concerns) needs urgent improvement if appropriate conservation strategies are to be formulated under increasing climate change.

One puzzling aspect of the survival patterns we have documented concerns the similar SARs of northern and southern Chinook populations. Juvenile Chinook from southern regions should be migrating northwards through coastal marine regions of poor survival for longer time periods than northern populations. This should result in poorer survival for southern populations. That reported west coast SARs seem to have almost all dropped to roughly the same level is inconsistent with this simple mechanism. We do not have a satisfactory explanation. One possibility is that despite the widespread acceptance that adult recruitment is determined in an early critical period, high predation by marine mammals is occurring as maturing salmon aggregate and return to their home rivers; there is now ample evidence for substantial increases in marine mammal abundance and presumably predation [45-47]. Ohlberger et al [78] reviewed the decline in size and age-structure of Chinook across western North America. They noted that consistent with the adult predation hypothesis, the decline was most pronounced in the older age groups in some (but not all) regions of the eastern Pacific. Recent work has also demonstrated that in fish large females may confer much higher fitness on their offspring than was previously believed [79]; the geographically widespread decline in salmon growth over time seen for multiple species by the mid-1990s, and which was potentially attributed to the growth of hatchery production [80] has apparently continued. The continued increases in pink salmon has also been shown to affect plankton populations [81] and reduce survival of at least one marine seabird (shearwaters) [82, 83].

The Importance of Marine Migration Pathways

Several important differences in SARs point to important directions for future study. A few stocks within specific rivers have SARs 3-4-fold higher than nearby stocks. At the extreme, the Chilliwack stock of Fall (subyearling) Chinook has a median SAR of ca. 4%, an order of magnitude greater than other Strait of Georgia stocks. Understanding why only a few populations consistently have high SARs when returning from the ocean as adults could pay large dividends in understanding what differences in ocean experience result in a few populations remaining productive while many others have essentially collapsed.

This stock-specific difference in marine survival was previously interpreted as evidence for delayed mortality reducing survival of Snake River Chinook stocks relative to some mid-Columbia (Yakima, John Day) populations because of the greater number of dams the Snake River populations must pass through [8, 9, 84]. However, other mid-Columbia populations have survival quite similar to Snake River populations and different from the John Day and Yakima populations, despite also having limited dam passage (Fig 3). At least two populations outside the Columbia River basin also have far greater SARs than other nearby populations (Chilliwack Fall Chinook and UW Accelerated Fall hatchery releases). Large differences in SARs between different hatcheries rearing Spring Chinook have previously been ascribed to possible rearing differences [85]. However, genetic differences may underlie persistent differences in many life history traits of Spring Chinook [86]. These differences could include control over migration pathways leading some populations to migrate to marine areas supporting higher survival. (See Byron et al [87] for a recent review of migration differences).

In the context of the delayed mortality theory, the unusually high survival of the John Day and Yakima yearling Chinook populations relative to Snake River populations and a similar pattern for steelhead is also seen in other geographic regions not involving dam passage. The apparent relationship of possible delayed mortality related to the degree of dam passage therefore disappears when a broader range of populations is brought into the comparison and is also not evident when mid-Columbia River subyearling populations are examined (Fig 3). The most parsimonious explanation is thus not stress from greater dam passage but rather something intrinsically different in the marine phase of the life history, with some evidence of differential migratory behavior available [87-98]. Rechisky et al [11] measured essentially identical migration speeds and survival for size-matched cohorts of tagged Dworshak and Yakima Spring Chinook to the northern tip of Vancouver Island, some

485 km beyond the mouth of the Columbia River. However, a month later only smolts from the Dworshak (Snake River) stock were detected arriving on the SE Alaskan subarray, located some 1,000 km further to the north, and still migrating at the same speed of roughly 1 BL/sec; it is unknown why no Yakima smolts were detected.

Understanding the differences in the marine migration pathways that could lead some populations to rear in more favourable ocean regions would be an important advance in our understanding of the currently opaque marine phase. As Peterman and Dorner [99] remarked for sockeye, "*Further research should focus on mechanisms that operate at large, multiregional spatial scales, and (or) in marine areas where numerous correlated sockeye stocks overlap*". The markedly higher SARs evident for Oregon coastal Chinook relative to most other populations (Fig 2) is probably also important in this context. Nicholas and Hankin [100] (Table 2) report that Fall Chinook from the Salmon and Elk rivers in Oregon are north migrating stocks and that Oregon coastal stocks show variation in ocean migration "*with some migrating north, some south, and one stock has a mixed north and south ocean migration*" [49]. Lending credence to the possibility that ocean migration pathways may influence productivity, the authors reported that the few "south migrating" Fall Chinook stocks were all characterized as having "depressed" runs in 1988 (prior to the 1989 regime shift), whereas the "north migrating" runs all had no or increasing abundance trends.

It seems plausible that specific salmon populations have genetically determined migration behaviours that allow them to home to distinct feeding grounds within the North Pacific, some of which result in better survival ([101]). Batten et al [102] identified at least 10 geographically distinct plankton communities evident in a single transect across the North Pacific that were temporally stable across years and demonstrated that seabird communities showed similarly distinct and geographically coherent patterns. Similarly, an analysis of tufted puffin communities [103] found that different forage fish communities were present in different sub-regions of the Aleutian Chain. Thus geographically stable and distinct biological communities exist within the North Pacific Ocean, including the pelagic offshore region. Salmon populations homing to different feeding grounds could therefore have very different fates if these regions develop differently over time, for which there is at least some experimental evidence [104-106].

Ocean Policy

A critical policy question for the Columbia River basin concerns whether the hydropower system as currently operated is having any significant effect on limiting recovery of listed fish stocks, or whether it is the impact of ocean conditions that limits recovery [107]. The available evidence indicates that smolt survival during downstream freshwater migration is not higher in rivers without hydropower dams (Fig 10 and Table S2) and that a number of much shorter coastal rivers have even lower survival than is experienced through the Columbia River hydrosystem, particularly when survival is scaled by distance travelled. Bisbal and McConnaha [107] suggest several ways in which aspects of the freshwater habitat might be manipulated to improve ocean survival. However, overall, given that recovery targets are specified in terms of attained SARs, current evidence indicates that Snake River SARs are roughly equal to (or better) than those currently achieved in the nearby Salish Sea region including the Fraser River, a region where dams are absent it seems unlikely that recovery can be achieved without an improvement in ocean survival. Unfortunately, current scientific knowledge is simply insufficient to understand how to promote this.

Limits to Interpretation

We have made two broad survival comparisons, one of which is inherently more reliable. The trends in salmon survival over time for a given population should be the most reliable because government agencies employ relatively consistent methodologies (CWTs, PIT tags, mark-recapture techniques). Evidence for large drops in survival over time for individual populations should therefore be most reliable. Less certain is the numerical comparison of SARs from different regions of western North America because SARs are measured by a number of different methods. There may be no populations that are actually measured over the complete migratory phase survival (i.e., from actual initiation of smolt migration to adult return to the spawning grounds). Because the various enumeration technologies have specific geographic regions where they are adopted (PIT tags used only in the Columbia (c.f. Table S2)), CWTs more broadly used, but chiefly for hatcheries, and mark-recapture censuses of smolts and returning adults for some wild stocks (particularly in the north, but also the early years of the Snake River time series)), geographic differences in survival are confounded with technological differences (including whether not commercial and sportfish harvest is included in the returns).

Regional comparisons of survival need to recognize these issues, which are rarely discussed. However, despite these complexities, the broad outline of the survival patterns are readily evident in the comparison we report, which we view as reliable because of the massive decline in survival that has occurred over time and the temporal consistency of methods used for individual populations. However, there is certainly further work to potentially do in future to look more closely at hatchery-wild differences in survival, as well as the potential influence of some Fall Chinook populations being included in the yearling category because of hatchery rearing practices, as well as a few hatcheries which apparently release Spring Chinook as subyearlings.

In summary, the evidence that survival has now dropped to similar absolute levels everywhere along the west coast of North America is surprising, but needs to be treated carefully. Because of the methodological differences used in measuring survival in various river systems, we are not claiming that survival is exactly the same in most regions but simply that Chinook and steelhead survival is now closely similar everywhere data exists to make this comparison. A natural inference from this conclusion is that there are important questions about how salmon conservation should best be achieved, and that successful salmon conservation may not necessarily result from current practices.

The Future of Pacific Salmon

Salmon are cold water fish living in a rapidly warming world. Despite the best efforts of management agencies to restrict fisheries, even the complete curtailment of all fishing mortality is far from sufficient to compensate for the magnitude of the changes in marine survival that has occurred in the last half century. The slow response of both management and research initiatives to effectively address the marine survival problem needs to be viewed with some sympathy—the unprecedented magnitude of the decline is difficult for institutional structures to keep up with.

Simply put, there are no easy answers for maintaining Pacific salmon populations [108] and current problems are likely to get much worse. The predicted levels of future warming are far outside anything experienced in either the last 150 years of industrialization or the previous 2.6 million years of the Pleistocene Epoch, with at least eight separate ice ages recorded in the last 800,000 years of the ice core record alone [109].

Current CO_2 emission policies are expected to limit warming by 2100 to approximately 3.0°C [110], or more than four times greater warming than the total warming experienced over the past 150 year of the observational record (~0.7°C). Even if all countries meet their commitments under the Paris Agreement, these emissions scenarios will still see global mean temperatures stabilized at 1.5–2.0°C above pre-industrial levels, or ca. 2-3 times the temperature increase so far—an increase achieved in only 80 years, not 150 years. Accelerating change is inevitable.

Future rates of warming 4-6 times those experienced in the recent past means that further "surprises" in how salmon survival changes (drops) in future is almost inevitable. Given the past slow and erratic response to what is quite possibly a greenhouse gas-related change in salmon survival at sea (warming) or ocean ranching of other salmon species (hatchery releases), the likelihood that the fisheries community will identify the correct drivers of the problem and then move to more successfully address them in future is not good. So far, as we have reviewed in our case studies, the response has been to re-double efforts on what we know how to study (freshwater) and to studiously avoid what we currently have little ability to study (the marine phase). There are real economic costs to doing so, with many groups identifying various single issue factors as the underlying problem that needs to be "fixed" (hydropower dams, salmon aquaculture, forestry, land use practices, water rights). These region-specific issues cannot possibly be the driver of the continental-scale response that we document.

The history of North American research on Pacific salmon has been amply described [111-113]. Although there have been a number of periods when marine research on North American salmon has been supported, until recently the programs have been largely focused on describing the life history of salmon in specific regions of the continental shelf (no small feat in itself). However, these life history observations can only be used to infer possible mechanisms affecting overall biology, not to test and validate the mechanisms driving survival. This means that the rapid learning characteristic of physics or chemistry, where hypotheses are explicitly tested and important scientific advance occurs when theories are rejected (not merely posited), is unlikely because it is difficult to refute observation-based mechanisms. A key issue here is that if marine survival problems are widespread along the Pacific Coast, mechanisms specific to only some continental shelf regions or adjacent river watersheds likely cannot be the major driver. Because poor marine survival is widespread, research and policy predicated on the assumption that the problems are specific to certain geographic regions is unlikely to be successful.

Widespread declines in survival have previously been reported for Chinook [114], for steelhead [115], for sockeye [99, 116], and (within the Salish Sea) coho [66]. Given the massive investment in restoration and monitoring activities for Pacific salmon, the development of correct conservation analyses and policy planning is critical. Over $1 Billion is now spent annually in the continental United States alone on freshwater habitat restoration [117, 118], and there is great pressure to remove or modify hydropower dams in the Columbia River basin as potentially large contributors to the failure of some salmon runs to rebuild to historical levels of abundance and productivity. Within the Columbia River, the total cost of recent conservation efforts reaches or exceeds ca. 25% of FCRPS annual revenues (including foregone power generation), or >$0.5 Billion per year [119]. Similarly, significant effort in Puget Sound is now placed on removing Columbia River basin dams to help endangered orca populations [44], and in British Columbia on shifting salmon farms to land-based operations to help restore Fraser River salmon populations [120-122]. Clearly, it is important to understand the impact of various anthropogenic impacts (dams, salmon farms, forestry) on the poor salmon returns, but it is also important that the real prospects for improvement as a result of these region-specific actions is carefully assessed.

In the novel "The Sun Also Rises*",* the character Bill Gorton is asked how he went bankrupt. He replied, "*Two ways. Gradually, then suddenly.*" [123]. The same process appears to be playing out in the ways fisheries science has addressed the marine survival problem for salmon, first by incorrectly diagnosing the problem (poor and worsening ocean survival) and second by failing to change behaviour quickly enough and choosing to maintain a focus largely on freshwater issues (which may inflict significant costs on other economic activities). As with economic bankruptcy, failing to staunch losses and persisting with previous unsuccessful behaviour is a recipe for eventual catastrophic loss. Some positive response is certainly evident, in that harvest from Chinook and steelhead fisheries was substantially restricted (e.g., [124]). However, harvest rates of shelf-resident Fall Chinook were historically in the 50%-60% range, so even the complete elimination of all harvest can only compensate for a two-fold decline in marine survival; for Spring Chinook and steelhead, which are much less impacted by saltwater fisheries, the maximum compensation from restricting fisheries is much less.

Moderation of harvest is obviously an essential component of responding to the problem, but it is clearly insufficient because there is evidence of more than ten-fold decline in marine survival over time for at least some populations of salmon (e.g. [66, 67, 125-127]). Perhaps of greater seriousness, the lack of focus on marine survival has resulted in a great deal of focus on anthropogenic impacts (dams, aquaculture, various other economic activities such as forestry) which society may be placing unrealistic expectations on to compensate for a massive drop in marine survival. Clearly, without a better understanding of what is happening at sea, possibly inappropriate policy recommendations seem likely to continue. As we have shown in the case studies, each time salmon research reached the point where it became clear that the survival problem lay at sea, the ensuing response was a shift to re-focus effort on freshwater activities, leaving the marine survival issues unaddressed while often increasing potentially costly freshwater interventions. We view this as evidence of widespread cognitive dissonance [20] and significant groupthink [21].

The SAR incorporates some components of freshwater survival experienced during smolt downstream migration and adult upstream return migration. However, modern telemetry methods demonstrate that the majority of the SAR (now around 1%) must be determined during the marine phase [11, 14, 31-33, 35, 37, 128, 129]. Because the observed drop in survival is much larger than can be compensated for by even the complete cessation of harvest, the conventional management approach of manipulating harvest by restricting fisheries to compensate is therefore insufficient. In contrast to earlier work suggesting that salmon survival in northern and southern regions would oscillate out of phase as the Pacific Decadal Oscillation (PDO) switched between warm and cold periods [53, 56, 57], no region has seen significant recovery in survival; all of the regional time series we have reviewed can best be characterized as a general downward trend punctuated by occasional periods of rough stasis (but no recovery).

Further worsening of ocean survival will therefore force hard choices. Each of our case studies demonstrate that once programs reached the point where they demonstrated that the problem lay in the ocean the uniform response was to refocus efforts to identify problems in freshwater and to increase expenditures on freshwater habitat remediation and improving stock assessments—essentially to maintain and promote standard activities. This left the key ocean survival issue largely unaddressed and increased operating costs on other activities such as forestry, hydropower, and aquaculture, possibly unfairly. This apparently illogical behaviour is readily understood given the sociological situation of highly trained and motivated freshwater staff and a usually extensive freshwater research infrastructure, coupled with relatively little capability or understanding of how to begin addressing the ocean issues, which are often perceived as too vast to be tractable.

Some encouraging small-scale efforts to examine aspects of the marine biology of salmon in specific coastal regions has developed in the last two decades (e.g., [125, 129-132]), but the majority of this work is focused on simply describing aspects of the poorly understood life history of juvenile salmon and is not directly addressing the apparently continental-scale of the survival problem. It is unclear whether (or how) specific geographic efforts can realistically address the overarching problem if almost all regions of the west coast have similarly poor survival. Perhaps of equal concern, there is no clear stopping rule that allows the conclusion to be made that the survival problem is ***not*** occurring in a specific marine life history phase or is not caused by a specific biological issue. For example, although programs looking at the early juvenile phase in saltwater certainly contribute new and interesting science, the continental-scale of the survival problem suggests that relatively small-scale research efforts could continue for many years without necessarily recognizing that the survival problem might actually occur elsewhere in the life history (say, during the adult return migration).

With the suggestion that we are already into a 6th mass extinction event [133] and projections of even greater climate changes in the future than have been recently experienced due to increased greenhouse gas emissions, there is a compelling need for scientifically correct advice to support policy makers [134]. We view much of current salmon management as unlikely to lead to either effective policy decisions or salmon recovery. As we have documented, the usual response to salmon declines is to call for better monitoring ("improved understanding") and increased efforts to enhance freshwater habitats. Both responses are deeply ingrained. However, it is unclear how effective they have been in the past [135, 136] and it is uncertain whether they will be any more successful in the future. As we have shown, even when the evidence ultimately leads to the conclusion that the problem is occurring in the ocean, the response has been to drop further pursuit of marine issues and to re-focus on finding freshwater factors to study.

Given the very slow recovery of upper Columbia River Spring Chinook populations despite more than 300 freshwater habitat projects having been undertaken [137], it may be time to seriously evaluate whether efforts in one part of the salmon life cycle can actually compensate for serious problems in a different part of the life cycle.

Methods

Data Sources

The primary data providing information on Pacific salmon survival rates are based on mark-recapture estimates of survival, with the "marks" usually implanted tags--either coded wire tags (CWT) or passive integrated transponder (PIT) tags. The basic tag technologies are well described elsewhere [1-4].

CWT technology dates back to the 1960s. A review is provided by [5] and the application of the methodology to coastal marine migrations of coho and Chinook is described by [6, 7] and to measuring harvest and survival by [8-10]. Because the tag is implanted in the nose cartilage of smolts, the fish must be dissected to recover the tag after capture, ensuring the death of that particular tagged animal and preventing further study of the movements of that individual. CWT technology provides the basis for the Pacific Salmon Commission's Chinook survival database used for coast-wide management of Chinook salmon under the Pacific Salmon Treaty [10]. We have used this database as the source of Chinook survival data for all regions outside the Columbia River basin and for a few stocks located in the Columbia River basin (Table S1). The data is contributed by the various governments (provincial, state, and federal agencies) responsible for conducting the individual monitoring programs.

In contrast, systematic survival data based on PIT tags first came into widespread use in the Columbia River Basin in 1997 (Table S1). PIT tags are long-lived but extremely short distance radio frequency tags that can successfully transmit their unique ID code only when within <0.5 m of a detector. Although there are some very recent exceptions in small rivers, the very short detection range essentially limits the use of PIT tags in salmonid survival studies to the Columbia River dams, which channel sufficient tagged individuals close to the detectors to generate useful results. All survival data based on PIT tags and reported in this paper are taken from the Fish Passage Center's Comparative Salmon Survival (CSS) Study (McCann et al [11]; see Table S1 for a summary of the populations used in the analysis).

Earlier survival data for Snake River Chinook populations from the 1960s and 1970s is available from Raymond [12], who noted that "*From the positive relation found between rates of return of adults and survival rates of smolts, it was apparent that mortality of smolts migrating downriver through the dam complex was the main cause of the decline in Snake River salmon and steelhead runs*", a view that has become common amongst salmon biologists. We have included this data in our analysis because Raymond's pioneering studies [12-14] are of unique importance owing to the documentation of the high SARs occurring in the 1960s and early years of the 1970s, a time period prior to the completion of the Snake River dams and the 1977 marine regime shift, and because they defined the focus for much subsequent work in the Columbia River basin to improve survival.

Differences Between Data Sources

The two major tagging technologies available, PIT & CWT, are therefore largely geographically discrete, with most recent survival data from the Columbia River based on PIT tag technology and most survival data for other regions based on CWT data. Although rarely discussed, survival comparisons must recognize that differences in the two technologies determine what aspects of migration-phase survival are estimated, as we next describe. (Raymond's [12] early survival analysis was based on direct estimation of the number of smolts migrating downstream past Snake River dams, and dividing this value into the number of adults returning several years later; see Raymond [12] for details; as such, comments on the extent of the migration path monitored also apply to this early study).

CWT Tags

The precise technical methods of counting the number of CWT-tagged adults returning back to each population is not documented in the Pacific Salmon Commission (PSC) database by the various provincial, state, and federal agencies contributing survival data. However, these agencies generally operate hatcheries or (in a few cases) rotary screw traps to estimate downstream smolt numbers for wild stocks. For hatcheries, CWT-based survival estimates are calculated by dividing the estimated number of maturing adults of various ages returning back to the spawning grounds or hatchery over time by the number of smolts released in the year of ocean entry. (ADF&G [9] provides a useful summary of the mark-recapture approach used in the Transboundary Rivers of SE Alaska and Northern British Columbia for wild Chinook stocks).

The PSC database provides several estimates of survival. In this study, we used survival data calculated as the sum of adults returning at all ages, uninflated for losses to natural mortality for Chinook remaining at sea for longer than two years because these values are most similar to the CSS PIT-tag based survival estimates [11]. Survival estimated using this procedure slightly underestimates true survival to ocean age two because some two year old Chinook destined to mature at older ages die from natural causes prior to maturing and are therefore not enumerated. However, the SAR (survival over the migratory phase of the life history), is now ca. 1%, or an instantaneous total mortality rate of $M_{Total}=4.6$. Ricker [15] suggested that the loss due to natural mortality between age two and older ages was perhaps $M=0.46\ yr^{-1}$, or only 10% of M_{Total}. More recent estimates of age-specific natural mortality are even smaller: age 2, 40%; age 3, 30%; age 4, 20%; and age 5 and older 10%; (ref. [10], p. 8). Consequently, not correcting for natural mortality losses occurring between age 2 and older ages is unlikely to introduce major errors into the SAR estimates, particularly as the majority of Chinook return at ocean age two, and especially so in recent years [16]. (A similar consideration also applies to the PIT-tag based survival estimates, so for purposes of comparison this point is perhaps moot, but we highlight it because of our concern (see Discussion) that fisheries biologists may be underestimating the magnitude of losses at older ages).

PIT Tags

PIT tag estimates of SARs are taken directly from Appendix B of McCann *et al* [11], who reports several different survival estimates. We selected for analysis the SARs covering the greatest extent of the migratory life-history (i.e., adult returns to the highest dam available in the Columbia River basin), and we generally used SAR estimates that included jacks when available. In a few cases SAR estimates with jacks were available but only for a shorter migration segment; in these cases we chose for inclusion in the analysis those SAR data sets representing the longer migration segment but excluding jacks). This has the effect of reducing Columbia River basin survival estimates by preferentially selecting for use SAR datasets excluding jack returns and including more of the in-river migration track. Because Snake River SARs are surprisingly high in our comparison with other regions of the west coast, our choice of not including jacks and measuring survival over a longer distance has the effect of lowering survival and minimizing the differences with out of basin populations.

Because returning adults must ascend fish ladders with PIT tag detectors, essentially all PIT tagged adults surviving to return can be censused (ignoring tag shedding). Dividing these values by the estimated number of tagged smolts reaching the most upstream dam in the year of ocean entry provides an estimate of the SAR. Published PIT-tag based SAR estimates for the Columbia River basin differ from CWT-based estimates in three main ways: (i) they exclude losses to harvest (lowering survival relative to what is estimated in the PSC database), (ii) they exclude losses occurring from smolt release to encountering the first dam in the migration path (raising survival), and (iii) they exclude losses occurring from the time the returning adults migrate past the last dam until they reach the spawning grounds (raising survival). We review these differences in the context of the two major life history groups.

Chinook

Division by Life History Type

We divided the Chinook SAR data (defined below) into subyearling and yearling run types. There are important ecological differences between these two life history types which likely influence survival (See review by [17], and references therein). Subyearling smolts migrate to the ocean within a few months of hatching in the spring, while yearlings outmigrate after completing one or more full years of life in freshwater, and are thus significantly larger at ocean entry and (generally) spend one less year in the migratory phase where survival is monitored. The yearling and subyearling smolt life history types generally correspond with adult run timing ("Spring" or "Fall"), but the linkage between the season adults return to freshwater prior to spawning and survival is somewhat subjective.

Spring (yearling) populations are largely found in high altitude headwater tributaries of large river systems penetrating well into the interior of the continent such as the Columbia & Fraser Rivers, and are the only Chinook life history type reported for Alaskan rivers [18, 19]. In contrast, Fall (subyearling) populations are widely found in low gradient coastal streams or in the lower mainstem of major rivers but are absent from Alaska. Early work [20] suggested an ancient genetic divide between Spring (Stream-Type) and Fall (Ocean-Type) Chinook, with yearling Chinook smolts primarily produced by adult runs returning to freshwater in the spring and then holding in freshwater without feeding until spawning in the autumn.

Harvest & Life History Type

Spring Chinook are also thought to move offshore and become purely open ocean residents for much of the marine phase, and thus essentially immune to harvest by fisheries until their return. As a consequence, offshore (pelagic) harvest of Spring Chinook is likely negligible because a convention banning high seas fishing beyond the 200 mile EEZ of Pacific Rim countries was signed in 1992 (http://www.npafc.org/new/about_convention.html) and enforcement patrols consistently find only a few illegal driftnet vessels in the far western Pacific, well beyond the known ocean distribution of North American Chinook stocks [21, 22] (but possibly not steelhead). However, some incidental harvest of immature and maturing Chinook occurs in the groundfish fisheries of the Bering Sea, with current evidence suggesting that Pacific northwest populations form ca. ⅓ of Chinook catches in the Bering Sea/Aleutian Islands region [23]. Owing to an inability to use the collected fish scales to determine the duration of the freshwater period (and thus discriminate yearling from subyearling animals), it is unclear which life history type the Pacific northwest populations caught in the Alaskan fisheries represent.

Fall Chinook are known to remain as long-term residents of the continental shelf off the west coast of North America and thus exposed to commercial and sport harvest in coastal marine waters over multiple years [17]. Survival of shelf-resident Fall Chinook populations can therefore be significantly reduced by coastal fisheries that can harvest these animals over several years of marine life.

This is important because in CWT-based estimates of survival [10] the commercial and sport harvest of the different age groups is added to the escapement to generate the reported SAR. In contrast, PIT tag based survival estimates for the Columbia River basin do not incorporate losses due to harvest [11]; see p. 95). Columbia River survival estimates using PIT tags will therefore underestimate survival relative to the PSC's CWT-based survival estimates depending upon the magnitude of the catch.

For example, the PSC (Table 2.7) reports average annual stock-specific harvest rates of 29-62% for Strait of Georgia Fall Chinook stocks, for example, with harvest rates declining over time [10]. For some Spring Chinook, harvest rates are much lower (at the extreme, Willamette Spring Hatchery Chinook are reported as having only a 11% mean harvest rate; see Table 2.10 of [10]).

In summary, although rarely emphasized, survival for each stock is measured over slightly different parts of the life history depending upon the tagging technology used, and as a result incorporates different contributors to survival. PIT tag-based survival estimates may underestimate SARs relative to CWT-based estimates from roughly 10% (Spring) to 60% or more (Fall Chinook). This difference has fallen over time as Chinook harvest rates were restricted in response to falling marine survival, with harvest rates being reduced from 50-60% several decades ago to ~10% in recent years (See SI Table Sx). As a result of the declining harvest fraction, the PIT-tag based survival estimates better approximate CWT-based estimates in recent years when the two tag-based estimates of SARs appear to converge. However, there is no simple way to fully reconcile published survival estimates.

In this report we do not attempt to correct for these differences in how harvest affects Chinook survival because our most important conclusions seem robust to these differences, but it is also important to recognize that these methodological differences exist and influence survival estimates.

In reality, this relatively simple picture is more complicated by hatchery rearing practices. Some hatcheries hold subyearling (Fall) Chinook for an additional year before releasing them as larger yearling smolts and a few hatcheries releasing some Spring run Chinook as subyearlings (e.g., Nooksack and Skagit-See Table S?). This breaks the simple linkage between adult run timing, marine migration behaviour (shelf residency) and harvest, and size or age at ocean entry. Thus some yearling production is of smolts that presumably remain shelf-resident for several years because their intrinsic genetic make-up dictates this behaviour despite their larger (and older) age at release. Sharma and Quinn [17] also document regional differences in migration distribution between lower Columbia River and upper Columbia-Snake River Spring yearling populations which they attribute to possibly greater interbreeding between Spring and Fall run individuals in the lower Columbia River. Clarke et al [24] similarly present evidence from breeding trials that the yearling/subyearling smolting pattern follows simple Mendelian genetic rules in crosses of Fall and Spring adults (with the added twist that the sex of the parent also influences the result)! More recent work [25] has potentially identified a single gene in both Chinook and steelhead that controls early (spring or summer) re-entry of Chinook and steelhead that then mature in freshwater prior to spawning in the autumn; whether and how this gene might also influence marine migration behaviour is unknown.

In this paper, we have opted to aggregate smolt returns by age at ocean entry (yearling, subyearling) for simplicity, but note that in future it would be valuable to disentangle the role of age at release from genetically determined differences in migration pathways on survival. Unfortunately, a rigorous assessment of the genetic origins of each hatchery program would almost certainly require a genetic determination of whether each hatchery program was releasing Fall or Spring Chinook, and would need to take into account whether or not hybrid populations had been created; it is a fascinating research question whose answer is completely unclear at the current time to contemplate whether the offspring of an inadvertent hybridization between a Fall and a Spring Chinook parent would rear offshore or on the shelf and how it would get there!

Summarizing, published PIT tag-based survival estimates for the Columbia River basin are biased high relative to actual migratory phase survival because these estimates exclude the initial and final phases of the migration period above the dams, and biased low because they exclude harvest (which varies in potential influence between large for Fall (subyearling) and low for Spring (yearling) stocks). Finally, some of the PSC's CWT-based survival estimates for wild stocks are also biased low to some degree because they exclude some survival losses occurring in the initial and final phases of the migration upstream of the enumeration points for smolts and adults. However, at least for hatchery-reared populations, smolt numbers used in the denominator of the survival estimate are estimated at the time of release from the hatchery, and therefore exclude the possibility of migratory losses occurring prior to census location.

The lack of clarity about how to best aggregate the data while taking into account these potentially complex interactions resulted in our decision to simply group by the recorded age at ocean entry as either yearlings or subyearlings. However, given the importance of the potential relevance of smolt migration pathways, harvest, and the resulting SAR on conservation efforts, further analysis of the factors controlling migration behaviour in the ocean is clearly needed. For these reasons it should be noted that the strongest comparisons are within individual survival time series (the coast-wide declining trends in survival) because these will be based on the most consistent methodologies, while comparison between populations will be less reliable because of differences in where each populations is censused to measure survival over the migration phase. However, the coast-wide convergence of survival in recent years to very low levels at a time when most sport and commercial harvest has been drastically reduced is strong evidence that a common factor is driving the collapse in survival.

Steelhead

Although many steelhead rivers and hatcheries are located in B.C., adult returns have not been accurately enumerated which prevents direct estimation of survival. As a result, SAR data for British Columbia is restricted to the Keogh River (Fig 1), where a weir located within ca. 300 m of the ocean has monitored wild steelhead since 1977 [26]. Despite the lack of SAR data for other populations, it is known that the survival trends evident for the Keogh River are mirrored in adult returns for the province of B.C. as a whole, with some differences evident between geographic regions [27-29] in more recent regime periods. Importantly, it is broadly recognized that adult steelhead returns have been falling for decades (e.g., [29, 30]) and are now at record lows; for example, the Thompson and Chilcotin tributaries of the upper Fraser River now each have adult steelhead returns of less than 200 adults [31], despite being of similar size and biogeoclimatic zone to the Snake River.

For Washington State outside the Columbia River basin, steelhead SARs were collected and reported by [32] for Puget Sound (Washington State), as well as a number of locations along the coasts of Juan de Fuca Strait, and the outer (western) WA coast. SAR data for the Columbia and Snake Rivers were taken from [11]. We are unaware of additional steelhead SAR data for Alaska or coastal Oregon rivers.

The migration of steelhead is poorly understood, but it is thought that they may migrate directly offshore soon after the smolts reach saltwater [33]. Virtually nothing is known of their marine migration, although the open ocean distribution extends as a band bounded by specific maximum and minimum sea temperatures across the North Pacific [34]. This suggests that (similar to Spring Chinook) maturing steelhead may return directly from the offshore to their natal river and be little exposed to commercial fisheries operating in continental shelf waters except those lying on the direct migration path from the offshore. No commercial fisheries target steelhead, so harvest is limited to freshwater sport fisheries and saltwater bycatch in other fisheries. Steelhead survival estimates are not corrected for harvest.

Treatment of Data

SAR data for salmon are log-normally distributed [35]; i.e., a time series of SAR data, S_t, will have the form $S_t = e^{\mu + \sigma Z_t}$, where μ and σ are respectively the mean and standard deviation of $\log_e(S)$, and Z_t is the standard normal variable $Z \sim N(\mu, \sigma)$. This is important because the log-normal distribution is skewed, exhibiting occasional rare high survivals which increases the expected value above the mean. As a result, the expected value of a log-normally distributed SAR time series is neither the simple mean $\overline{S} = \frac{1}{n}\sum_{t=1}^{n} S_t$ nor μ, but rather $E(S_t) = e^{\mu + \sigma^2/2}$ (in fact, it is the median value of the log-normal distribution that is related to μ, as $S_{median} = e^{\mu}$). Calculating the average of the untransformed survival data, although often reported, does not have a simple statistical interpretation.

When comparing survival time series between regions, some important but subtle differences should therefore be kept in mind. We have opted to use the median (equivalent to the "geometric mean" if the data is truly log-normally distributed, $\overline{S}_{Geo} = Exp\left[\frac{1}{n}\sum_{t=1}^{n}\log_e(S_t)\right]$, used in some literature), as well as the simple average $\overline{S}$ of the untransformed SAR data in a number of key comparisons. The simple average is what many prior studies report, and therefore what most policy makers and fisheries managers are likely comfortable interpreting. For example, the NWPPC has set a rebuilding target of 2%-6% for SARs and deemed 1% SARs (roughly the current average) to be inadequate, but did not define how SAR values should be calculated.

However, when the distribution of SARs are compared between two regions *i*, *j* then if the medians are found to be the similar, the implication is then that $\mu_i = \mu_j$ and that the simple means of the log-transformed data are also equal; this does not, however, imply that the expected values $\mathrm{E}(\mathrm{S}_t) = \mathrm{e}^{\mu+\sigma^2/2}$ are equal because this value also depends on the variance of the time series. For these reasons, we use both measures of central tendency

$$\bar{S} = \frac{1}{n}\sum_{t=1}^{n} S_t,$$
$$S_{median} = e^{\mu}$$

in our analysis, and not the expected mean values of the log-normal distribution $\mathrm{E}(\mathrm{S}_t) = \mathrm{e}^{\mu+\sigma^2/2}$, owing to the more complex definition and lack of easy interpretation, which the (simple) mean and the median readily impart.

Precision of survival estimates

The standard error on a binomial proportion, survival, is $SE(S) = \sqrt{S(1-S)/N}$. The precision of a survival estimate, φ(S), degrades as survival decreases, because

$$\Phi(S) = \frac{\mathrm{SE}(\mathrm{S})}{S} = \sqrt{\frac{1-S}{S \cdot N}}$$

In the limit as survival approaches either 1 or zero,

$$\lim_{S\to 1}\Phi(S) = 0$$
$$and$$
$$\lim_{S\to 0}\Phi(S) = \infty$$

The relative uncertainty in a survival estimate with a given sample size increases without bound as survival decreases towards zero. With survival values now at 1% or less, the relative precision of a survival estimate now relative to several decades ago when survival was in the 5-6% range is

$$\frac{\Phi(S_1 = 0.01)}{\Phi(S_2 = 0.06)} = \sqrt{\frac{(1-S_1)/(S_1 N)}{(1-S_2)/(S_2 N)}} = \sqrt{\frac{S_2}{S_1}\frac{(1-S_1)}{(1-S_2)}} \approx \sqrt{\frac{S_2}{S_1}}.$$

In this numeric example, where survival falls from 6% at the start of the record to 1% at the end, the uncertainty relative to the point estimate increases almost 2.5-fold (√6). (Taking into account that both the number of outgoing smolts and the number of returning adults is not known without error, as is implicitly assumed in using the binomial probability distribution, the actual uncertainty will be even larger when these uncertainties are taken into account). It is interesting to note that should survival fall from the current ca. 1% level to 0.1%-- a ten-fold further decline—it would in fact be difficult to recognize this massive decline in survival (a fall as large as the decline from 100% to 10% or 10% to 1% survival) because of the limited precision with which survival can be measured at these low levels. Thus for both purely mathematical reasons as well as the methodological differences between tagging approaches listed in the prior section, it is likely infeasible to obtain a perfect conversion ratio between survival estimates calculated using different methodologies (PIT vs CWT).

We therefore caution that it is unlikely that a single consistent conversion factor between CWT and PIT tag-based SAR estimates can be derived, because survival losses incurred upstream of the initial and final census point for calculating SARs can vary substantially between rivers and between populations within a river system. Only hatchery releases can potentially reach this technical standard of measuring survival over the entire migratory phase of the life history, and only if adult enumeration takes place on the spawning grounds (or at the hatchery). Nevertheless, the question of whether survival for other regions of the west coast has now fallen to as low as the Snake River Chinook and steelhead is of critical importance for policy reasons because the current low survival of Snake River stocks is viewed as anomalously low.

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Competing Interests

DWW is President and owner of Kintama Research Services Ltd., an environmental consultancy focused on the development of innovative applications of telemetry to improve fisheries management. ADP and ELR are employed at Kintama. All authors received a financial benefit in the course of conducting this study and their future salaries depend on their continued technical and scientific performance, which includes publication of this study.

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From: David Welch

Sent: Wed Jun 27 10:54:23 2018

To: Aswea Porter; Erin Rechisky

Cc: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: SE on survival to the estuary

Importance: Normal

Hi Aswea-- Comments below.

I have CCed Christine on this one to remind her that the earlier Fig 10 was a “work in progress”, and that some changes are still being made to it.

David

From: Aswea Porter
Sent: Wednesday, June 27, 2018 8:37 AM
To: Erin Rechisky
Cc: David Welch
Subject: RE: SE on survival to the estuary

Hi E and D,

For Table S2 for the BPA report, I've added in the values Erin and I discussed:

- McMichael reports 2007, 2009, 2010, and 2011 for Columbia R yearling, subyearling and ST
- Healy et al 2017 for Seymour STHD
- Moore et al 2015 for PS ST for all populations ***[DW>] Excellent—thank you!***

Other questions:

1) The Harnish et al 2012 Transactions paper has survivals for yearling and subyearling CH, and for ST between rkms 86 and 8 for 2010 using JSATS. But they are in figure format and are divided into 7 reaches. Skip or email author for overall values? ***[DW>] Please email Ryan. I don't have his email address, but it should be in the paper. In the supplementary Info table, please add a footnote adding that the aggregate survival from rkm 86 to 8 was provided by the senior author.***

2) Dietrich et al and McMichael et al 2010 are based on the same fish JSATS tagged 2010. In email below McMichael recommends using the Dietrich value. ***[DW>] Just use the Dietrich et al value in this case.***

3) Nisqually wild sthd from Moore et al 2015 has multiple release distances for one survival estimate. See Table 1. ***[DW>] Suggest that we just indicate with a footnote that we used the median distance amongst all release sites.***

4) Hostetter et al 2018 Fig 4. has survivals for UCOL STHD 2008 to 2014, but summarized in the text or separately in a figure. Email author for values?***[DW>]   Yes, please. Same comment as for Harnish et al applies.***

5) Anything else we want to add? There are the FPC estimates from LGR to BON.

More complex:

Now I'd like to discuss how to designate the proportion of the river represented by the survival estimates. We will likely need David's input here because this is linked to the message in the paper. My understanding is that we want to indicate the proportion of the mortality in the SAR that occurs in FW—but the FW survival estimates cover differing proportions of the FW migration. I've used designations like "full river", "hydrosystem", "LRE", and "part-river". Of concern is that the SAR also incorporates differing proportions of the FW migration. If we could link the 2, then in some cases it wouldn't matter if the FW survival was only for a portion of the river because it would be the full portion covered by the SAR. However, I don't imagine we can really link them. ***[DW>]   We originally had two goals: (1) Develop a compendium of all available west coast freshwater survival values (excluding California). (2) Assess whether Columbia River freshwater survivals are anomalously low, as widely assumed. If the Columbia River basin was like virtually everywhere else, survival would just be measured form release point(s) to the Columbia River mouth. It is not and "whole river" survival estimates are in fact relatively limited. For that reason a secondary focus (call it a third goal) has developed, although I haven't really articulated it well to you & Erin, I guess. That new goal is to compare in-river survival estimates for various parts of the Columbia River Basin: (a) Hydrosystem, (b) LRE, (c) Whole River. The secondary objective here will be to ask and answer the question "are Columbia River basin survival rates for some parts of the Columbia River basin anomalously low?". That is why I have you working on adding that additional material, to add some context to the survival estimates for the hydrosystem. I can't really assess what to say about the designation "part river" until I see how much data you have accumulated and***

how it is analyzed/what it represents (if it is a hodge-podge of some dam reaches and some lower (or upper) river, it may be best to just leave it out to present a clean and interpretable picture, but I can't say more right now)..

~A

From: Erin Rechisky
Sent: June-25-18 14:38
To: Aswea Porter
Subject: FW: SE on survival to the estuary

From: Geoff McMichael [mailto:geoff@mainstemfish.com]
Sent: April 23, 2018 1:52 PM
To: Erin Rechisky
Subject: Re: SE on survival to the estuary

Erin,

These are a subset. There were 2 studies that year at Granite - a 'tag effects' study and a 'delayed mortality' study.

When searching through all the old reports/data, it was broken amp a million different ways - so using the peer-reviewed number in the Dietrich et al paper is the best way to go.

I went hunting more and found a tech memo which I just put on RG - link here. Contains 2005 and 2006 for CH1.

https://www.researchgate.net/publication/324706324_SynthTechMemo_040407_final

and I just added this one for 2007

https://www.researchgate.net/publication/324706192_A_Study_of_Salmonid_Survival_and_Behavior_through_the_Columbia_River_Estuary_using_Acoustic_Tags_2007

The 2008 report never got done (as far as I can determine by mining my files). We were working with NOAA - and they had reporting responsibility through 2008 - which they were late or failed completely on. We finally got to take the lead on reporting starting in 2009.

Steelhead tagging started in 2009 for post-Bonn estimates, except for the alt barging study we started in 2005. Link below:

https://www.researchgate.net/publication/267268679_PNWD-3702_Alternative_Barging_Strategies_to_Improve_Survival_of_Transported_Juvenile_Salmonids_-_2005

I am sure you have the Harnish et al Transactions paper that has STH numbers. If not - that's on my RG site too.

No consolidated peer-reviewed estimates. Was on the to-do list before I emigrated.

Cheers,

Geoff McMichael

Mainstem Fish Research LLC

geoff@mainstemfish.com

(509)531-8065

http://www.mainstemfish.com

On Apr 23, 2018, at 11:51 AM, Erin Rechisky <Erin.Rechisky@kintama.com> wrote:

Thanks Geoff.

I have included the estimate reported in Dietrich et al. 2016. They report survival in Table 3 as 46.2%. Are these a subset of the fish from the McMichael et al. 2010 paper? Do you recommend that I include both estimates or just the estimate reported in Dietrich et al?

How many years did you estimate survival for steelhead from Bonneville to the estuary? I will include these survival estimates in the table I am putting together. I have 2 PNNL reports which report steelhead survival in 2009 and 2010. Are there more years, or better yet, are these consolidated and reported in a peer reviewed paper?

Thanks,

Erin

From: Geoff McMichael [mailto:geoff@mainstemfish.com]
Sent: April 23, 2018 9:31 AM
To: Erin Rechisky
Subject: Re: SE on survival to the estuary

Hi Erin - I looked for a while - but didn't happen upon the data used to generate that plot. The paper at this link has the data you may be interested in - Table 3.

https://www.researchgate.net/publication/305843252_Survival_and_transit_of_in-river_and_transported_yearling_Chinook_salmon_in_the_lower_Columbia_River_and_estuary

We released tagged steelhead in the Snake in 2012 for tests there - but had no arrays in the estuary that year.

We tagged steelhead at JDA multiple years when arrays were in the estuary (and sometimes plume).

For the 2005 alternative barging study we tagged/released STH at BON that were in a barge from LGR to BON…

Short answer - probably don't have STH data to mouth from upriver locations.

Cheers,

Geoff McMichael

Mainstem Fish Research LLC

geoff@mainstemfish.com

(509)531-8065

http://www.mainstemfish.com

On Apr 18, 2018, at 1:57 PM, Erin Rechisky <Erin.Rechisky@kintama.com> wrote:

Hi Geoff,

I hope you are doing well!

We are putting together a table of freshwater (downstream migration) survival estimates for Chinook and steelhead for a coast-wide survival analysis we are working on. In your 2010 Fisheries paper you report survival for Chinook to the estuary as 41% but the SEs are reported in a figure (Figure 7). Can you please tell me the SE on that survival estimate?

Also, are there any other papers besides the recent Hostetter et al (2017) paper that you know of that reports survival from the upper Columbia or Snake River to the lower estuary for *steelhead*? Did you ever tag steelhead with JSATS tags when the arrays extended into the estuary?

Thanks for your help.

Warm regards,

Erin

Erin Rechisky, PhD

Research Manager

<image003.jpg>

kintama.com

755 Terminal Avenue North• Nanaimo BC V9S 4K1 • Canada

Cell [redacted]

Email: erin.rechisky@kintama.com • Skype: erin_rechisky

From: David Welch

Sent: Thu Jun 28 11:40:07 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Visit

Importance: Normal

Attachments: Welch-Passport.pdf

Thanks, Christine.

That timing should work for me. I have a slight preference for July 23rd or later, but I can make anything work with a little planning on my end.

I have attached a scanned copy of my passport that you can forward to the security folks if you like.

I think that there is value on both speaking directly to Bryan Mercier about some of the "larger" issues (specifically, actions on how to get out of the big hole BPA is in, given the much worse ocean climate changes that are almost certainly coming) and also to present and go over the specific results with a group of science & policy folks. So this is really two meetings. It would be nice if they could be done on one trip, but that may not be feasible. I will leave that up to you; I can come down twice if need be. (Or I could meet Bryan for a breakfast or dinner meeting if that makes sense).

The larger issue is that BPA will, as always, get blamed for the failure of adult runs in the Columbia River. The strategic question is: *"What can be done to reduce hydrosystem costs & improve operating efficiency while still protecting salmon under the ESA?"*. I have some ideas.

The specifics I will present to your larger group are the review of what we have already for you. I will probably present these in reverse order to the way they are presented in the research paper: (a) Smolt freshwater survival in the Columbia River is ***not*** lower than other regions and in fact appears to be about the highest recorded anywhere (excluding California); (b) the coast-wide SAR comparison and review of the implications (again Columbia River stocks are not anomalously low relative to other regions, no delayed mortality, etcetera); (c) the evidence that everywhere along the coast fisheries agencies keep doubling down on doing freshwater work and avoid talking about the marine issues. I will try to reserve some time at the end to discuss the cognitive dissonance/group think issues that psychologists have identified as operating in a wider context, but people's brains may be full by then—and it depends on how much time is made available.

Anything else that you think should be worked in, or de-emphasized?

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, June 28, 2018 10:27 AM
To: David Welch
Subject: Visit

Hi David

A bit of an update. We are still trying to identify some dates to suggest to you, and they will almost certainly be in the second half of July. Working with our administrative assistant, she did want me to verify that the set of people I listed as 'needs to' or should be there are valid because this is what typically makes scheduling a challenge. I am going to try to talk to Bryan Mercier sooner (before he goes out next week) and then negotiating budgets with various tribes and states. He definitely told me he would like to talk to you one on one but it could be feasible for me to brief him on the paper and contract separately or with a 3-4 person conference call, but that you would present to a larger group who are in at the office at BPA.

Also, because of the role of the Dept of Homeland Security at the federal building here, I think I need to submit your name with two week's notice (you probably have dealt with this before).

More later

Christine

Sent from my Verizon 4G LTE smartphone

From: David Welch

Sent: Tue Jul 03 15:51:53 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Visit

Importance: Normal

Sounds good—I will stand by until you have confirmation, then book my travel.

You say below "***I would say that the new subject matter would be all the material in the appendix***". I think we currently have at least 3 appendices, and may be adding a fourth(!). Can you clarify what new subject matter you are referring to, so I can make sure we are on the same page?

My thought would be to present the results in reverse order to the way the paper is written:

1) Present the compendium of freshwater survival values and demonstrate that the poor SARs cannot have a freshwater origin. (Management implications immediately obvious to your folks).

2) Present the comparative SAR analysis (expand on what we have presented before). No evidence for delayed mortality (minor point), and major policy points being that SARs are equal or better for Columbia River stocks than other "geographically nearby" populations: Salish Sea, Washington outer coast, west coast Vancouver Island. I will possibly discuss the reason why SE Alaska/Northern BC stocks are doing slightly better—but I will have to think about this. Two hours is a short time period and there is a lot that can be covered.

3) Possibly discuss (briefly) why the additional piece of work that awaits funding is also important to the policy

arena.

4) Your thoughts on the above? Anything you think I should cover/emphasize based on what your internal discussions have been?

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, July 03, 2018 2:03 PM
To: David Welch
Subject: RE: Visit

Okay – I think I am going to advocate for August 2nd, 9-11am. I talked with our administrative assistant about this and will try to finalize Thursday? When I spoke with our new research manager Jody Lando, she wanted us to discuss more precisely what the topics of the presentation would be because we did have a check in several months ago with a focus on the data and figures.

I would say that the new subject matter would be all the material in the appendix. In my opinion you should remind us of the second paper concept that you originally started with (there has been some turnover of staff here). She also wanted to know how long you expected to work with coauthors to resolve the final text.

When Leah and I were recently speaking with Jim Anderson at UW, we were emphasizing that our policy folks are most interested in understanding how a model or result would have implications for management. You are rather good at making these points.

Hopefully if we can get this on the calendar this week, the time slot will not fill up with various other meetings and obligations.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, June 29, 2018 8:05 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] Re: Visit

July 24th is a Tuesday, not a Friday, so I am not sure what date is under consideration here.

August 2nd certainly works.

Have a great weekend!

David

David Welch, Kintama Research

Tel: +1 (250) 729-2600 x223

Cell: [redacted]

Sent from my iPad

On Jun 29, 2018, at 15:26, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi David,

I am waiting to hear if either Friday the 24th (around 9am) or Thursday Aug 2nd would work for us.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, June 28, 2018 11:40 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: Visit

Thanks, Christine.

That timing should work for me. I have a slight preference for July 23rd or later, but I can make anything work with a little planning on my end.

I have attached a scanned copy of my passport that you can forward to the security folks if you like.

I think that there is value on both speaking directly to Bryan Mercier about some of the “larger” issues (specifically, actions on how to get out of the big hole BPA is in, given the much worse ocean climate changes that are almost certainly coming) and also to present and go over the specific results with a group of science & policy folks. So this is really two meetings. It would be nice if they could be done on one trip, but that may not be feasible. I will leave that up to you; I can come down twice if need be. (Or I could meet Bryan for a breakfast or dinner meeting if that makes sense).

The larger issue is that BPA will, as always, get blamed for the failure of adult runs in the Columbia River. The strategic question is: *“What can be done to reduce hydrosystem costs & improve operating efficiency while still protecting salmon under the ESA?”*. I have some ideas.

The specifics I will present to your larger group are the review of what we have already for you. I will probably present these in reverse order to the way they are presented in the research paper: (a) Smolt freshwater survival in the Columbia River is ***not*** lower than other regions and in fact appears to be about the highest recorded anywhere (excluding California); (b) the coast-wide SAR comparison and review of the implications (again Columbia River stocks are not anomalously low relative to other regions, no delayed mortality, etcetera); (c) the evidence that everywhere along the coast fisheries agencies keep doubling down on doing freshwater work and avoid talking about the marine issues. I will try to reserve some time at the end to discuss the cognitive dissonance/group think issues that psychologists have identified as operating in a wider context, but people’s brains may be full by then—and it depends on how much time is made available.

Anything else that you think should be worked in, or de-emphasized?

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, June 28, 2018 10:27 AM
To: David Welch
Subject: Visit

Hi David

A bit of an update. We are still trying to identify some dates to suggest to you, and they will almost certainly be in the second half of July. Working with our administrative assistant, she did want me to verify that the set of people I listed as 'needs to' or should be there are valid because this is what typically makes scheduling a challenge. I am going to try to talk to Bryan Mercier sooner (before he goes out next week) and then negotiating budgets with various tribes and states. He definitely told me he would like to talk to you one on one but it could be feasible for me to brief him on the paper and contract separately or with a 3-4 person conference call, but that you would present to a larger group who are in at the office at BPA.

Also, because of the role of the Dept of Homeland Security at the federal building here, I think I need to submit your name with two week's notice (you probably have dealt with this before).

More later

Christine

Sent from my Verizon 4G LTE smartphone

From: David Welch

Sent: Fri Jul 06 18:26:06 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Sound like the FPC?

Importance: Normal

One of the things I am hoping to get in the next analysis we do for you (the one awaiting a funding decision) is to put in a short section showing why the statistical power of statistical analyses of in-river flow attributes (spill, flow, TDG…) is extremely low.

The basic point is easily put. In the next paper we will show that freshwater survival processes contribute about 1/7th to determining the adult return (SAR). So 6/7ths of the variability ("noise") comes from processes not in the river but in the ocean. That means that the direct influences of freshwater variability on survival are tiny, and I am expecting that when we do the analysis we will find that there will be negligible statistical power for making the conclusions that are being drawn right now. The conclusion is that statistical work looking at freshwater impacts on survival should be reserved to smolt survival measured to somewhere in the river not on the adults coming back. Big implications because if I am right a lot of the claims for how hydrosystem manipulation might influence SARs will have little credibility.

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, July 06, 2018 5:01 PM
To: David Welch
Subject: RE: Sound like the FPC?

Yes – also junior level people sometimes have a harder time questioning established ideas.

Actually though… I think medicine has a lot of good examples for showing how science tends to work on a human level. You could ask undergraduates to identify the best treatment approach for a disease based on google search vs. peer reviewed papers. The google search will almost certainly bring up remedies which do not work at all. Yet medical science has not solved or discovered everything yet. There are some untested concepts out there which are yet to be proposed, evaluated, and demonstrated to be valid. In the peer review process, a lot of people develop a great reputation for identifying a great new idea and demonstrating that there is some evidence to support it. In some cases it could be hard to initially get through peer review if a new concept seems to be too much of a stretch. After the famous new idea comes in, there are often dozens of papers that apply it to new areas, with confirmation of the hot new hypothesis, sometimes to the point of going overboard. (maybe an example could be discovery and confirmation of various health effects of gut bacteria).

There is a major contradiction in iterations of the CSS model when it is put in forecast mode (it is primarily a retrospective data analysis). The Columbia River Treaty version predicts that higher spring flows due to holding less water back in reservoirs will deliver both higher in-river survival and SAR, especially for steelhead. The new version seems to show a negative or neutral effect of flow on survival. Also – you might notice the scale of SAR on Y axis here – The 2-6% range is certainly higher than recent observations. They have preemptively addressed this as recent talks saying “everyone asks why this is so high… well it’s because our data time series goes back to the 60s when SAR was higher and there were fewer dams”. (and people nod their head with pessimistic agreement). However, if the only variables which stay in the best fit model are spill (PITPH) and water travel time and PDO, the model actually should be showing higher SAR in the recent period due to higher spill. The PDO shows a cycle but not a long term trend. So if you really think about this, they would have to introduce a factor explaining decreasing SAR despite higher spill, by identifying whatever is explaining the ocean SAR decline in your work.

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, July 06, 2018 3:00 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: Sound like the FPC?

Thx. You are right about it taking a lot of time to go through all this!

I did have a quick look at the FRC response to Russ Kieffer's comments. Very quickly I found myself rolling my eyes at the responses—as I mentioned, it is the classic problem in science of different (hidden) starting assumptions. O the FPC dismisses Russ' questions or different expressed opinions because they believe there can't be any different credible way of interpreting the data other than the one that they have come to. So they dismiss the messenger rather than really think long and hard about their own basic assumptions.

Doing so is really hard work, and it probably can't be done internally in a group like the FPC, because the drivers of their group think are so strong—that why I scanned and sent you those three pages out of Janis' book.

Have a great weekend.

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, July 06, 2018 2:18 PM
To: David Welch
Subject: RE: Sound like the FPC?

It would take lots of time to dig through, but here are some memos and regional debates from this past spring.

Delaying early run Chinook is okay because they spawn much later

http://www.fpc.org/documents/memos/10-18.pdf

Arguing against blocks in the spill test

http://www.fpc.org/documents/memos/8-18.pdf

Here, they are dismissing their own smolt monitoring data for gas bubble trauma because of the shallow sampling tanks

http://www.fpc.org/documents/memos/27-18.pd

This was a response to the FPAC call – where the IDFG rep voiced concerns with biased results when it came to adult passage vs juveniles.

http://www.fpc.org/documents/memos/47-18.pdf

June 12, starting at 1:50:00. http://www.fpc.org/documents/fpac_minutes/fpac_minutes_currentyear.html

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, July 06, 2018 12:16 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] Sound like the FPC?

Christine-

Thought you would find this of interest (I cite Janis in the paper we are putting together).

I have scanned the first 3 pages of Chapter 8. Doesn't the description of what predisposes groups towards faulty thinking ("Groupthink" or "Incorrect rationalization") fit the FPC to a tee?

David

kintamav_RGB

Office: (250) 729-2600

Mobile: (b) (6) [redacted]

From: David Welch

Sent: Fri Jul 13 07:00:12 2018

To: Mercier,Bryan K (BPA)

Subject: [EXTERNAL] Second KT meeting on or around August 2nd?

Importance: Normal

Attachments: Fig 10 FW_survivals7-Colour.tif; Fig 4. Normalized_SARS_histograms_by_region_Chinook.tif; Fig 8. Normalized_SARS_histograms_by_region_Steelhead.tif

Bryan-

As you know, I will be travelling down for a 2 hr meeting with some of your biologists & policy people on August 2nd (9-11 am).

You had earlier suggested that you & I should have a separate side meeting as well. I would like to do this. However, I would also suggest that that meeting might also include one or more of BPA's senior power engineers who can speak to the potential revenue benefits of easing back on a number of the current regulatory limitations BPA is facing (demands for increased spill being only the most obvious). The meeting I am proposing would also be of interest to many of your senior Executive staff. (I am sending this to you rather than Lori Bodi because I am not sure if she has retired).

Here is a brief summary of the opportunity for BPA, as I see it, that really goes far beyond the current remit that your biologists and policy folks have. I have felt for many years that there are deep flaws in how salmon biologists approach the conservation issues, coast wide. The current document we have been preparing should make this very clear:

(a) All available freshwater smolt survival estimates show that Snake River smolt survival rates in freshwater are essentially identical to all other Columbia River reaches when scaled by distance and ***higher*** than any other river system we now have data for (Fig. 10, attached);

(b) Smolt-to adult survival (Figs 4 & 8) shows that Snake River ***Adult*** return rates (SARs) are equal to or better than many other areas of the coast that don't have dams. Also the so-called "delayed mortality" theory doesn't really hold water once a broader range of populations is considered.

So the question that has to be asked, then, is how did things go so badly wrong in the Columbia that these points were not recognized years ago? The answer is that there must be a fundamental flaw in how conservation objectives are being pursued in the region and that there should be a major re-think on strategy—it might be possible to do much better.

This leads to the opportunity for your region. If I am correct, what has caused poor adult returns and the failure of many attempts to boost them is that survival rates are not better in the ocean than in freshwater. If true, it can then be rationally argued that mandated hydrosystem operations that flush smolts out to sea faster (read: spill, reservoir drawdown, etcetera) are harmful rather than helpful because they put the smolts into a poorer environment than the river. I would like to lay this out some of with your senior folks and push for funding for the following sequential steps:

(1) Fund the next paper we already are proposing to do ($110K). In it we will demonstrate:

a. That hydrosystem & ocean survival rates are very similar

b. That there is so much ocean survival variation that attempts to statistically relate hydrosystem modifications to adult returns (as opposed to smolt output) have very little statistical power. In short, the analyses aren't credible.

(2) Subsequent to completing (1) fund the design phase for a new acoustic telemetry array, and evaluate whether it should be built using Vemco or JSATs equipment ($200K; completed during the 2018-19 FY). We would then have the ISRP review the design merits & scientific/policy objectives.

(3) If the design passes ISRP review, fund the development of the array (5 years at ~$5M/yr; my best current guess). Kintama will put together a team including multiple US partners to:

a. Precisely measure freshwater and marine survival rates, so that it is clear whether current policy assumptions about mimicking the "natural river" are a good or bad thing or merely ineffective. Once this is established, I project that huge flexibility should be created in operating the hydrosystem, without hurting salmon conservation. This would result in major economic benefits with the FCRPS providing a much larger role as a power source capable of providing rapid base load adjustments at those times when wind or solar can't meet demand.

b. Determine using a rigorous experimental design what levels of TDG result in reduced salmon survival in the field (not the laboratory). These levels are probably lower than people currently believe because predators are probably targeting physically compromised smolts that look fine to a human. Again, big implications for operating the power system.

c. Extend our earlier delayed mortality & differential-delayed mortality results to the smaller smolts we did not test in the earlier work. I personally don't think it is necessary, but I know people still dismiss the past findings because we didn't tag the whole size range of smolts. It is now technically possible to do so.

In all the pushing and shoving that went on in the backrooms during our past work about who was "entitled" to do work in the Columbia, the single biggest error I made was not involving more partners in our work. I don't want to repeat that mistake again. Part of the discussion would be about who to involve—as I see it PNL for sure, and possibly USGS. There also needs to be engagement with legal folks, because what I am suggesting may be outside of current legal thought & jurisprudence. But all of this should be part of a thoughtful discussion about how to build bridges and get people out of the current hole that they have dug themselves concerning the salmon problems in the Columbia River.

In a nutshell—if the dams are a major problem, why are salmon returns everywhere else just as bad or worse? And what will the region do as greenhouse gas induced climate change ramps up and drives salmon returns down everywhere? Given the lack of willingness to recognize these issues earlier, it is not going to be easy to get Columbia River biologists to recognize they made a major mistake years ago.

I am not sure at this late date whether you can organize this meeting now around my other scheduled meeting. I would be happy to meet over dinner the night before if that is easier, but this is an important issue; I am happy to fly down on a separate trip.

Regards, David

David Welch, Ph.D.

kintamav_RGB

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Skype: david.welch.kintama

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www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: David Welch

Sent: Wed Jul 25 12:02:06 2018

To: Mercier,Bryan K (BPA) - EW-4

Cc: Cogswell,Peter (BPA) - E-4; Yarman,Jennifer A (CONTR) - EW-4

Subject: RE: Second KT meeting on or around August 2nd?

Importance: Normal

Yes, that works for me, Bryan—thank you.

Oh, one minor point—perhaps you can have someone make sure that my security pass is valid for the full day. I know that Christine Petersen will be acting as my escort in the morning, but it is possible that your security folks may limit the validity of my pass to the morning only unless advised otherwise.

Regards, David

From: Mercier,Bryan K (BPA) - EW-4 [mailto:bkmercier@bpa.gov]
Sent: Wednesday, July 25, 2018 11:58 AM
To: David Welch
Cc: Cogswell,Peter (BPA) - E-4; Yarman,Jennifer A (CONTR) - EW-4
Subject: RE: Second KT meeting on or around August 2nd?

Thx for the email, David. Yes, Lorri retires next Tuesday, so she will not be available for our meeting.

I'm available on August 2nd at 4pm, if you're able to discuss your thoughts further. I'll invite our acting VP, Peter Cogswell, to attend as well.

Let us know if 4pm works and Jennifer will add it to our calendars

Best,

bkm

Bryan K Mercier

503.230.3991

Facebook-Icon_31x31_v3Flickr-Icon_31x31Instagram-Icon_31x31LinkedIn-Icon_31x31Twitter_31x31YouTube_31x31

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, July 13, 2018 7:00 AM
To: Mercier,Bryan K (BPA) - EW-4
Subject: [EXTERNAL] Second KT meeting on or around August 2nd?

Bryan-

As you know, I will be travelling down for a 2 hr meeting with some of your biologists & policy people on August 2nd (9-11 am).

You had earlier suggested that you & I should have a separate side meeting as well. I would like to do this. However, I would also suggest that that meeting might also include one or more of BPA's senior power engineers who can speak to the potential revenue benefits of easing back on a number of the current regulatory limitations BPA is facing (demands for increased spill being only the most obvious). The meeting I am proposing would also be of interest to many of your senior Executive staff. (I am sending this to you rather than Lori Bodi because I am not sure if she has retired).

Here is a brief summary of the opportunity for BPA, as I see it, that really goes far beyond the current remit that your biologists and policy folks have. I have felt for many years that there are deep flaws in how salmon biologists approach the conservation issues, coast wide. The current document we have been preparing should make this very clear:

(a) All available freshwater smolt survival estimates show that Snake River smolt survival rates in freshwater are essentially identical to all other Columbia River reaches when scaled by distance and ***higher*** than any other river system we now have data for (Fig. 10, attached);

(b) Smolt-to adult survival (Figs 4 & 8) shows that Snake River ***Adult*** return rates (SARs) are equal to or better than many other areas of the coast that don't have dams. Also the so-called "delayed mortality" theory doesn't really hold water once a broader range of populations is considered.

So the question that has to be asked, then, is how did things go so badly wrong in the Columbia that these points were not recognized years ago? The answer is that there must be a fundamental flaw in how conservation objectives are being pursued in the region and that there should be a major re-think on strategy—it might be possible to do much better.

This leads to the opportunity for your region. If I am correct, what has caused poor adult returns and the failure of many attempts to boost them is that survival rates are not better in the ocean than in freshwater. If true, it can then be rationally argued that mandated hydrosystem operations that flush smolts out to sea faster (read: spill, reservoir drawdown, etcetera) are harmful rather than helpful because they put the smolts into a poorer environment than the river. I would like to lay this out some of with your senior folks and push for funding for the following sequential steps:

(1) Fund the next paper we already are proposing to do ($110K). In it we will demonstrate:

a. That hydrosystem & ocean survival rates are very similar

b. That there is so much ocean survival variation that attempts to statistically relate hydrosystem modifications to adult returns (as opposed to smolt output) have very little statistical power. In short, the analyses aren't credible.

(2) Subsequent to completing (1) fund the design phase for a new acoustic telemetry array, and evaluate whether it should be built using Vemco or JSATs equipment ($200K; completed during the 2018-19 FY). We

would then have the ISRP review the design merits & scientific/policy objectives.

(3) If the design passes ISRP review, fund the development of the array (5 years at ~$5M/yr; my best current guess). Kintama will put together a team including multiple US partners to:

a. Precisely measure freshwater and marine survival rates, so that it is clear whether current policy assumptions about mimicking the "natural river" are a good or bad thing or merely ineffective. Once this is established, I project that huge flexibility should be created in operating the hydrosystem, without hurting salmon conservation. This would result in major economic benefits with the FCRPS providing a much larger role as a power source capable of providing rapid base load adjustments at those times when wind or solar can't meet demand.

b. Determine using a rigorous experimental design what levels of TDG result in reduced salmon survival in the field (not the laboratory). These levels are probably lower than people currently believe because predators are probably targeting physically compromised smolts that look fine to a human. Again, big implications for operating the power system.

c. Extend our earlier delayed mortality & differential-delayed mortality results to the smaller smolts we did not test in the earlier work. I personally don't think it is necessary, but I know people still dismiss the past findings because we didn't tag the whole size range of smolts. It is now technically possible to do so.

In all the pushing and shoving that went on in the backrooms during our past work about who was "entitled" to do work in the Columbia, the single biggest error I made was not involving more partners in our work. I don't want to repeat that mistake again. Part of the discussion would be about who to involve—as I see it PNL for sure, and possibly USGS. There also needs to be engagement with legal folks, because what I am suggesting may be outside of current legal thought & jurisprudence. But all of this should be part of a thoughtful discussion about how to build bridges and get people out of the current hole that they have dug themselves concerning the salmon problems in the Columbia River.

In a nutshell—if the dams are a major problem, why are salmon returns everywhere else just as bad or worse? And what will the region do as greenhouse gas induced climate change ramps up and drives salmon returns down everywhere? Given the lack of willingness to recognize these issues earlier, it is not going to be easy to get Columbia River biologists to recognize they made a major mistake years ago.

I am not sure at this late date whether you can organize this meeting now around my other scheduled meeting. I would be happy to meet over dinner the night before if that is easier, but this is an important issue; I am happy to fly down on a separate trip.

Regards, David

David Welch, Ph.D.

kintamav_RGB

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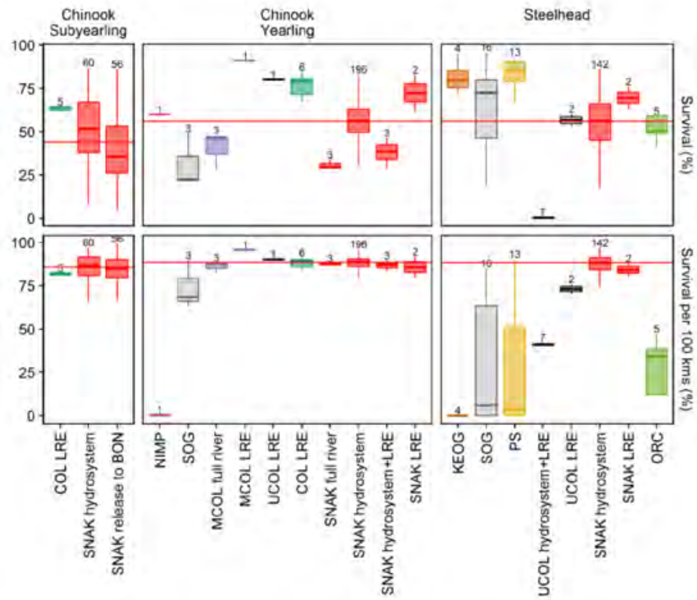
Browse animations of our

fisheries work on-line: **http://kintama.com/media/videos/**

P Please consider the environment before printing this e-mail

Summary of Kintama's Major Findings on Salmon Survival

1. **Downstream Smolt Survival in Freshwater**
    a. Used N=531 published annual survival estimates
    b. Compared Downstream survival estimates & survival per 100 km of migration distance
    c. Downstream survival remarkably similar in all parts of the Columbia River once distance is taken into account; Snake River results not unusually low.
    d. All published Columbia River survival rate estimates substantially higher than all other rivers where data is available.



    e. Data represent a major extension over Welch et al (2008) PLoS Biology paper comparing Fraser & Columbia.
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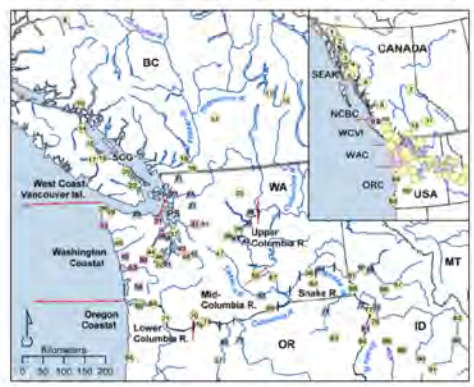
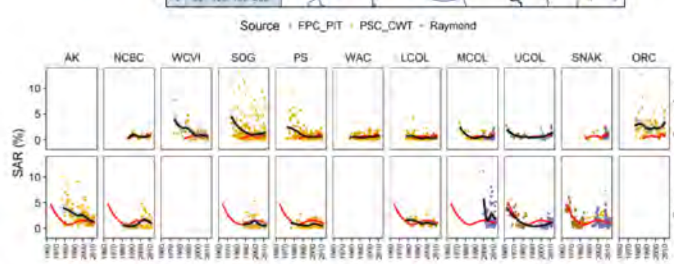
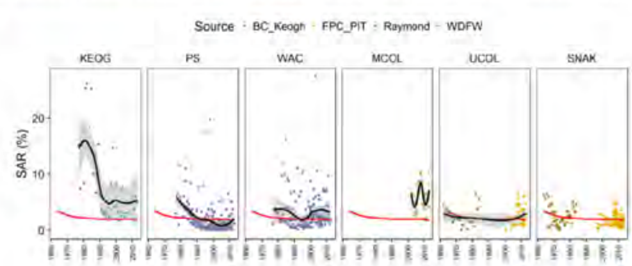


2. **SAR (Smolt to Adult) Survival Comparison**
    a. Data available up to SE Alaska Panhandle.
    b. We excluded California
    c. Used data for Chinook & steelhead.
    d. Trends in SAR time series are multi-faceted
        i. SARs drop earlier (1970s) in the south (Snake River) and later (1990s) in the north (Alaska)
        ii. However, all regions show similar levels of survival (SARs) in recent years.





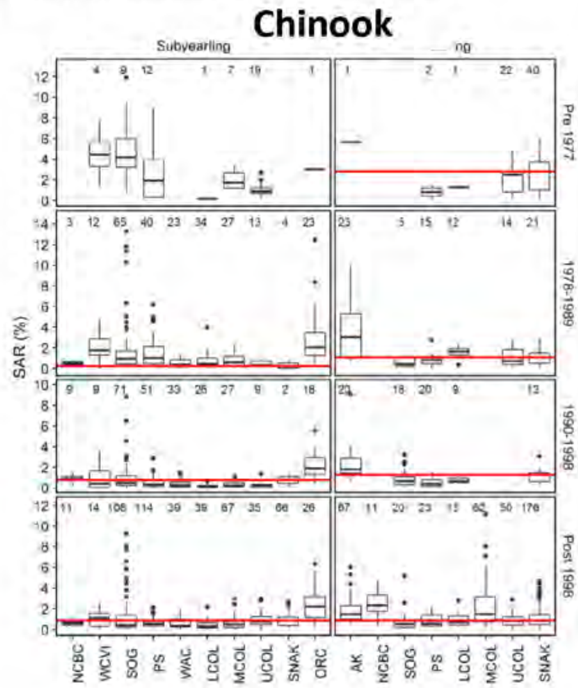
iii. In the full paper we go through a number of ways of comparing relative SARs.

iv. In this version of the comparison, we have broken the SAR data up into time periods corresponding to recognized ocean climate regimes: Pre-1977, 1978-1989, 1990-1998, post 1998.

v. The data are shown as box and whisker plots

vi. The horizontal red line shows the median Snake River SAR for each life history type (subyearling & yearling Chinook & steelhead) within each regime period.

vii. The decline in Snake River SARs with time is obvious for Chinook.



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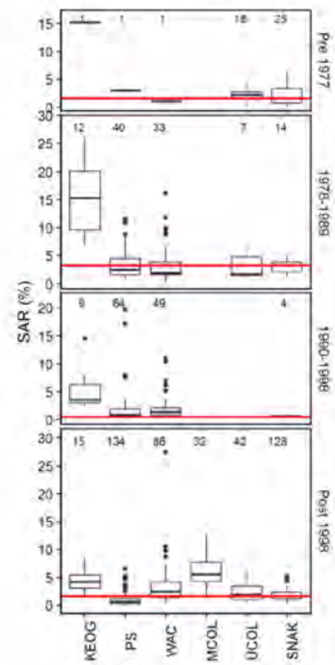

ix. This decline over time is very large for those regions with extensive data... often a 4-6 fold decline (just like the Snake River stocks).

x. Strait of Georgia, Puget Sound, & Washington Coast all have median SARs about the same as, or lower, than Snake River stocks.

xi. The full paper goes into great lengths to put the SAR differences and similarities into context because of some differences in how SARs are measured in different river systems (chiefly CWT vs PIT tag-related difference).

xii. Perhaps a minor detail for today, but nevertheless important in my view, the evidence for delayed mortality vanishes once the broader range of populations is considered—the same striking difference in SARs is seen in regions without any dams, so multiple dam passage is not the only reason that SARs can be persistently low for some populations when compared to other nearby ones➔ Speaks to the role of the ocean (differential survival owing to where specific populations go?)

3. Policy Issues

a. To add?

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Jul 27 16:53:05 2018

To: David Welch

Subject: RE: Kintama-BPA Update (2 August 2018).docx

Importance: Normal

Hi David,

It looks good. The only thing you haven't added are some of the themes of your discussion, such as the implication that further moderate gains in freshwater are not enough to turn around the trend, or possible mechanisms of the decline in the ocean.

By the way, I have sent out an invite asking various staff if they'd like to meet to discuss ideas at 1pm, after lunch (the cafeteria here is reliable). Some people will be working remotely and would call in, but I'd like to get Julie Doumbia there (manager of our environmental impact statement effort) because she will be out that morning.

Have a nice weekend

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, July 27, 2018 3:22 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] Kintama-BPA Update (2 August 2018).docx

Hi Christine—

As promised, here is the draft 2 page outline.

If you have a few moments, could you look at it and see if there is something that I am missing that you think I should address in this summary?

I'm going to set it aside for a few hours then go back tonight and proof read it after I have a chance to clear my head (its been a busy day!!). I can send you a clean copy either later tonight or sometime over the weekend, so you can distribute it on Monday morning. (I haven't put my name or Kintama's logo on it, for example).

Any thoughts much appreciated. If you don't have time, don't worry about it—I will just set this up to send it out as a PDF on Monday morning if I don't hear back first.

Have a good weekend,

David

Summary of Kintama's Major Findings on Salmon Survival
(2 August 2018)

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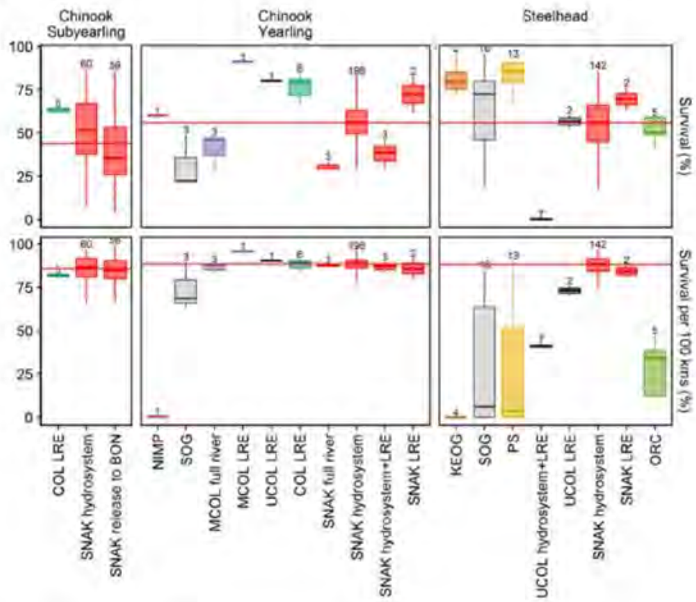

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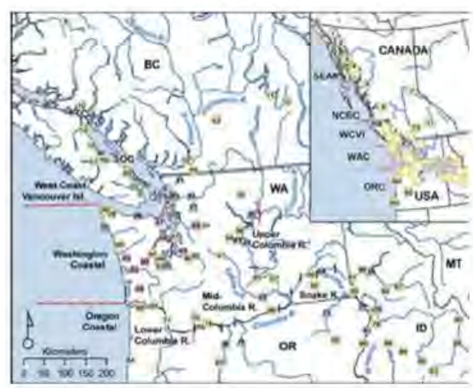

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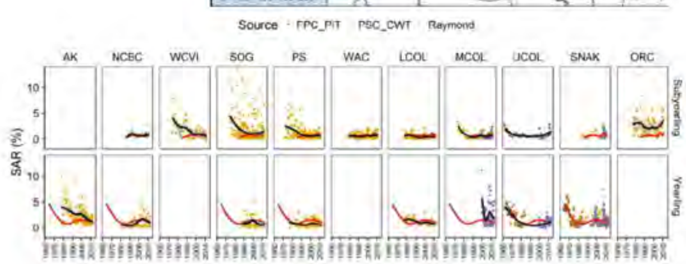

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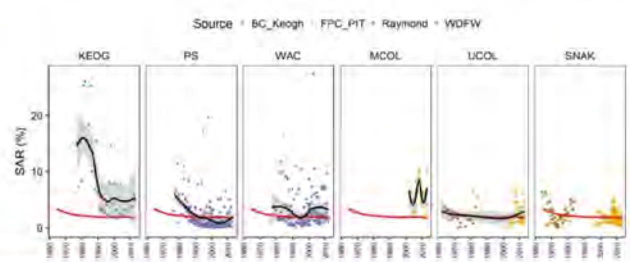

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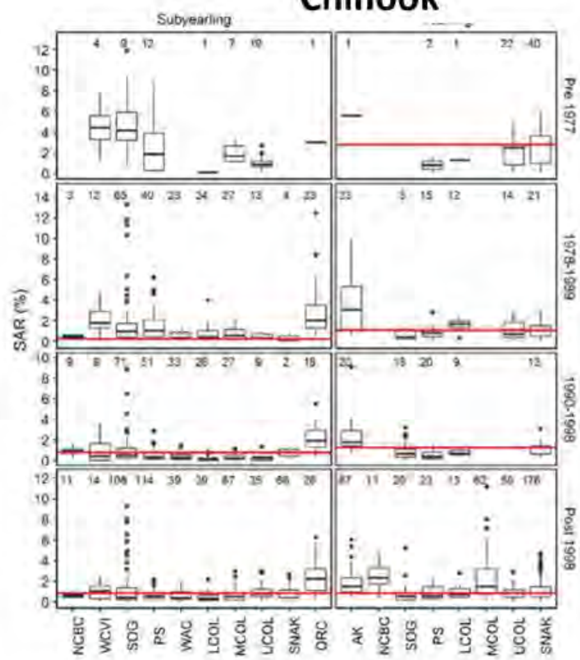

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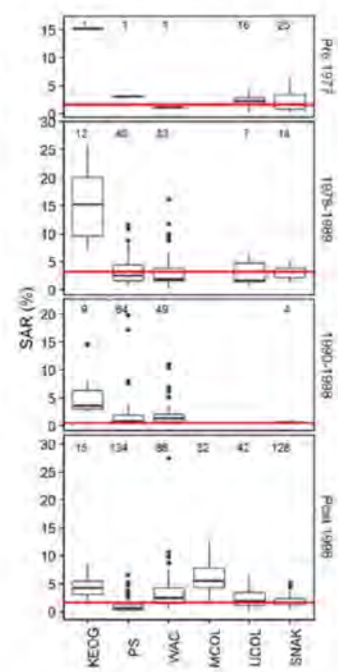

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<u>Summary</u>: There seem to be two major psychological biases going on in Columbia River Salmon Work

a. Cognitive Dissonance (You see the true problem, but reject what you see).
b. Group Think (Many major public policy fiascos have the same origins).

My main point here is that it is mathematically impossible for smolt survival in the FCRPS to be increased sufficiently to attain the recovery standards. This is demonstrable with grade 6 arithmetic (fractions), but is never discussed in salmon circles, probably because of the ongoing psychological biases.

I will outline what I think has happened to cause the problems for the Columbia, and greater flexibility in hydrosystem operations can be achieved while potentially also improving salmon returns.

3. Policy Issues

a. So, why can't Columbia River biologists see the obvious?
   - <u>L.N. Tolstoy:</u> *"The main obstacle to finding the truth is not a lie, but a semblance of truth."*
   - <u>Charles Babbage</u>: *"The errors which arise from the absence of facts are far more numerous and more durable than those which result from unsound reasoning respecting true data."*
   - <u>H.L. Mencken</u>: *"There is always a well-known solution to every human problem—neat, plausible, and wrong."*
   - <u>Marcus Du Sautoy</u>: commenting on Donald Rumsfield's "*3 types of Unknowns*", adds a fourth: "*The unknown knowns*". (The things that you know yet dare not admit to knowing)... the domain of delusion and repressed thoughts. "What We Cannot Know" 2016, p. 11).

b. Recognizing that salmon recovery goals are not achieved elsewhere (regions without dams) obviously means that a major re-think is needed. The (now demonstrable) fact that freshwater smolt survival per 100 km of river travel is as high or higher than anywhere else ***<u>and</u>*** that adult SARs are as good as (almost) anywhere else strongly suggests that it is time for a completely fresh look at the whole salmon problem. In short, the basic assumptions underpinning salmon management & conservation efforts are wrong... so if we hit the reset button and go back to the basics, what would we be doing differently?

c. A suggestion: Critics of our paper will want to dismiss the findings. They should be held to a reasonable professional standard—i.e., showing how errors or uncertainties in the data ***<u>can still support their beliefs</u>***, and not allowed to just argue that there are undefined "concerns" or "uncertainties" with the data or analyses (i.e., they should be required to show that in other regions lacking dams, that the Columbia's desired recovery standards are in fact being achieved and that it is the data that we used that is wrong).

Kintama Update to BPA

2 August 2018

David Welch, Aswea Porter, & Erin Rechisky
Kintama Research Services Ltd.

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Conclusions

- The Columbia River basin does not have a smolt survival problem.
- Rather it has a failure of sufficient adult salmon to return from the ocean.
- This failure is not being significantly driven by freshwater events.
- A consequence of this demonstration (smolt survival ***and*** adult SARs both being comparable to other regions without dams) is that the way the hydrosystem is being managed for salmon conservation is wrong.

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A Question to Frame the Presentation

- Let’s Make the Math Easy.
- Assume hydrosystem survival is “only” 33% (1/3)
- (Actually it is 50%~60% from FPC calculations)
- Where is the survival issue that the region needs to deal with?
- *After all, with 2/3rds of the fish dying in the FCRPS, it’s obviously the dams, right?*

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Answer: The Ocean

- Columbia River SARs are about 1%
- If S_{FW}=33% (or 1/3rd)
- then S_{Ocean}= 1/33.3333…

$$(because\, S_{FW} \cdot S_{Ocean} = \tfrac{1}{3} \cdot \tfrac{1}{33.333} = \tfrac{1}{99.999} = 1\%)$$

  – So in this hypothetical example, freshwater survival is 11X higher (33.3/3) than marine survival.

- In reality, S_{FCRPS} is 50%~60% so the real ratio implies that the ocean is 25X~36X more important than the hydrosystem.

- Q: How did we get to where we are now in the Columbia?
- A: *Cognitive Dissonance.*

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Leon Festinger

THEORY OF COGNITIVE DISSONANCE (1957)

Festinger's conclusion was that "dissonance" (when facts disagree with pre-existing belief) makes the individual psychologically uncomfortable, and the person subconsciously tries to reduce the dissonance and achieve "consonance" (agreement with beliefs)

Festinger, L. (1957). *A Theory of Cognitive Dissonance*. Stanford, Calif., Stanford University Press. 291 pp.

The "Bretz Floods"

The “Bretz Floods”

Columbia River Basalt
Stripped of Loess

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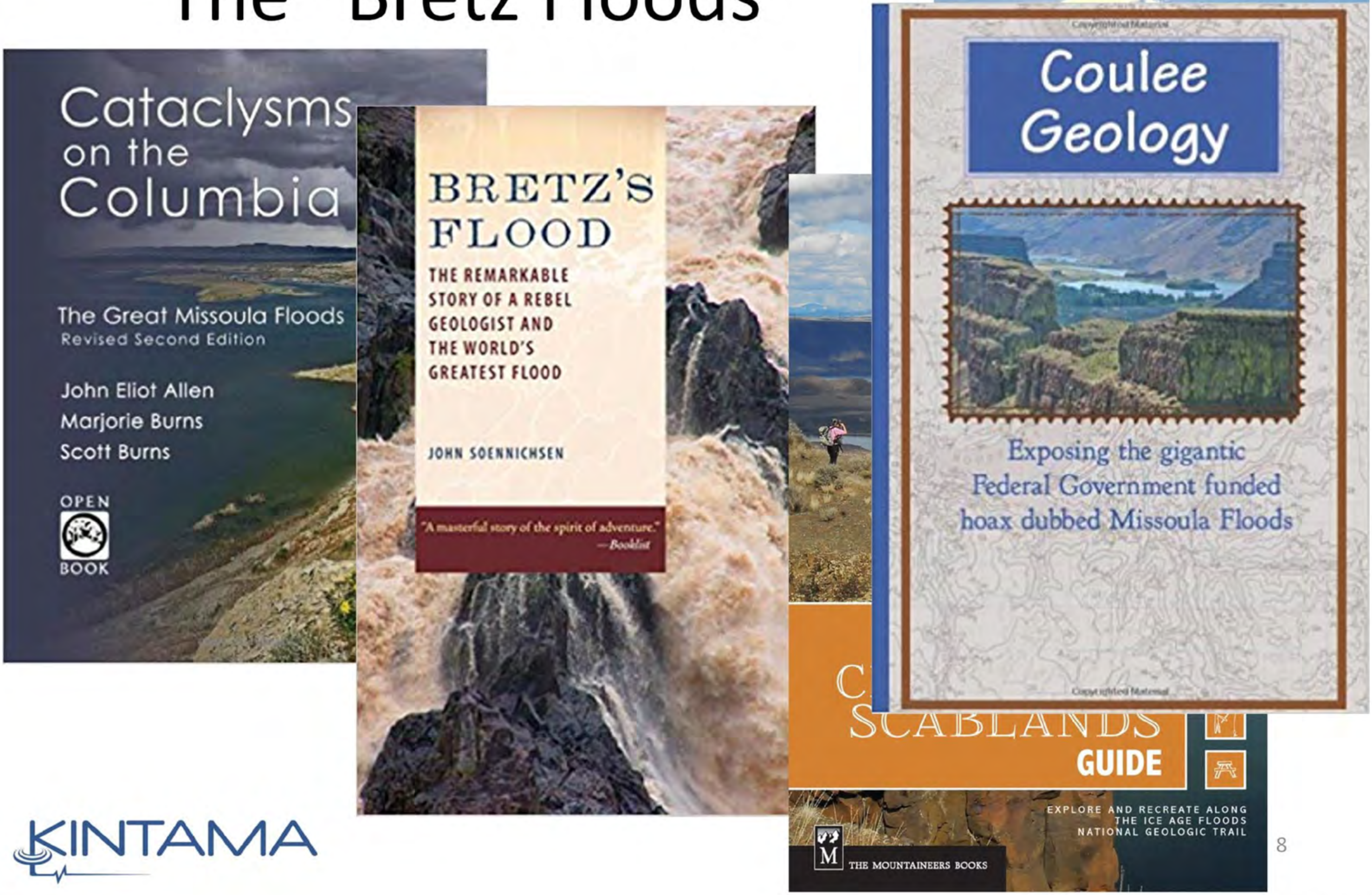
The “Bretz Floods”



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Science is Full of these Examples

- Germ Theory of Disease
- Getting Physicians to Wash Their Hands(!)
- Cholera ("Miasma")
- Plate Tectonics
- The "Ether Theory" (Light/EMR waves propagate through the "ether")

It took decades to change people's minds!

- In each case, a powerful pre-existing lobby (aka "colleagues") had fixed views about what was "logical".
- I believe that both Group Think & Cognitive Dissonance are alive and well in Salmon Science.

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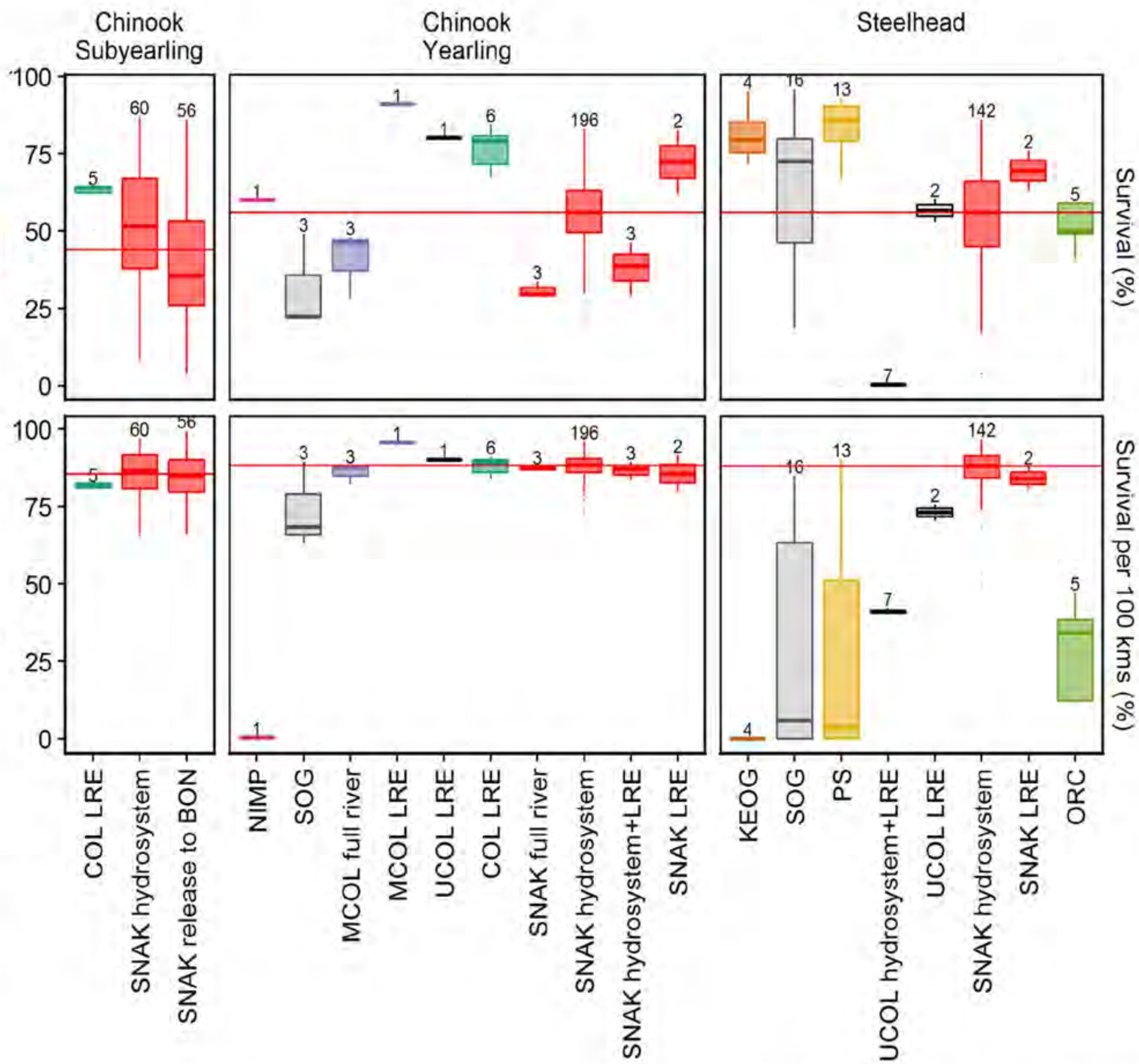
Let's Begin at the Start: Comparing Downstream Freshwater Smolt Survival in Different Rivers

- Used N=531 annual freshwater survival estimates for smolts
- Snake River SARs (red) in the middle of the pack
- When scaled by distance travelled, Columbia hydrosystem survivals are equal or better than other river systems(!)
- Note also the lack of evidence for delayed mortality.



Now Let's Look at the End: Comparing Adult SARs for Different Regions

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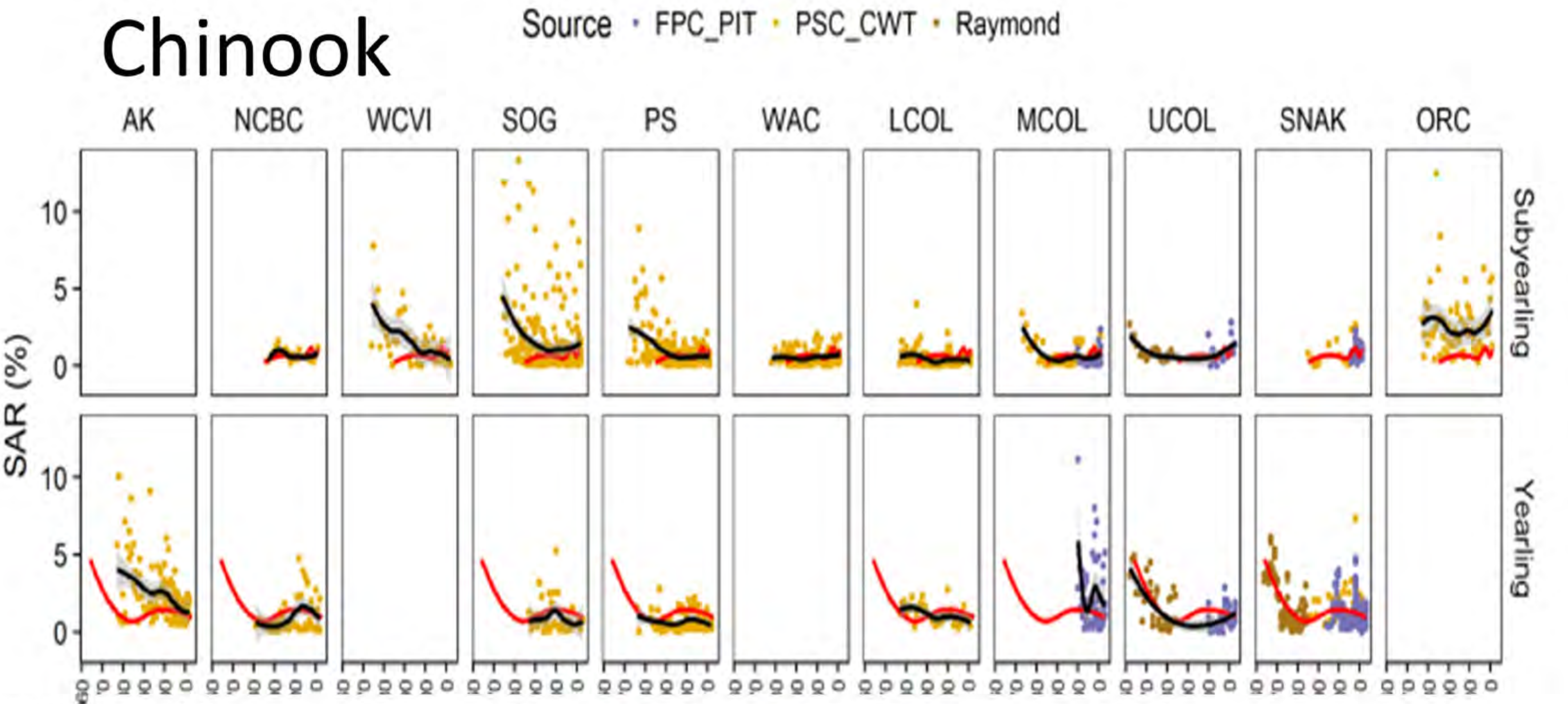
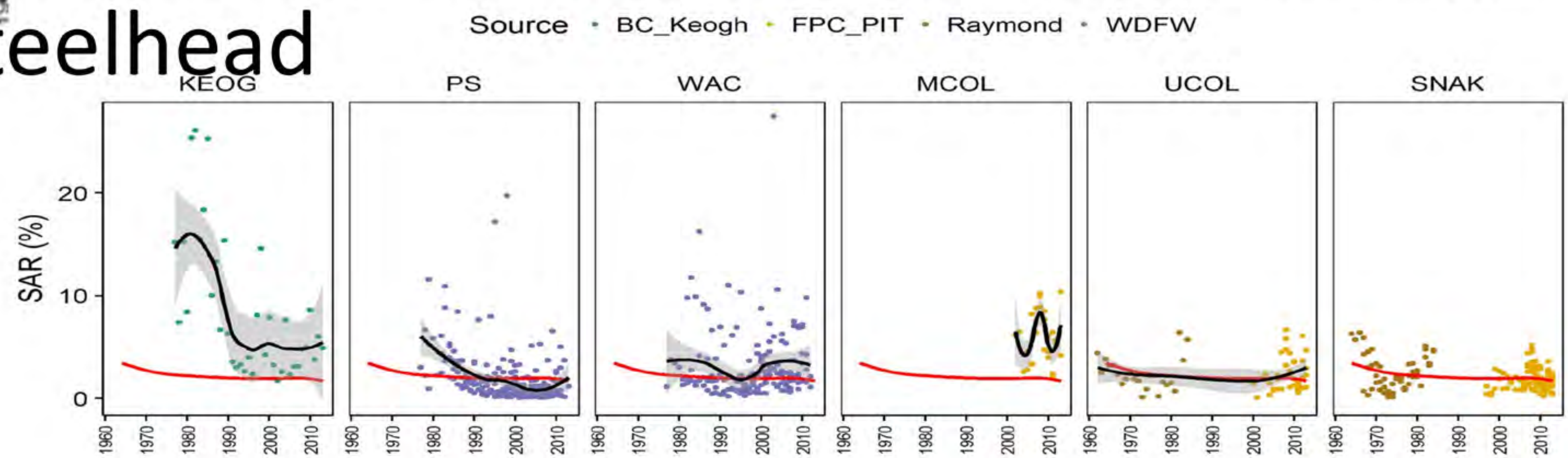
Chinook

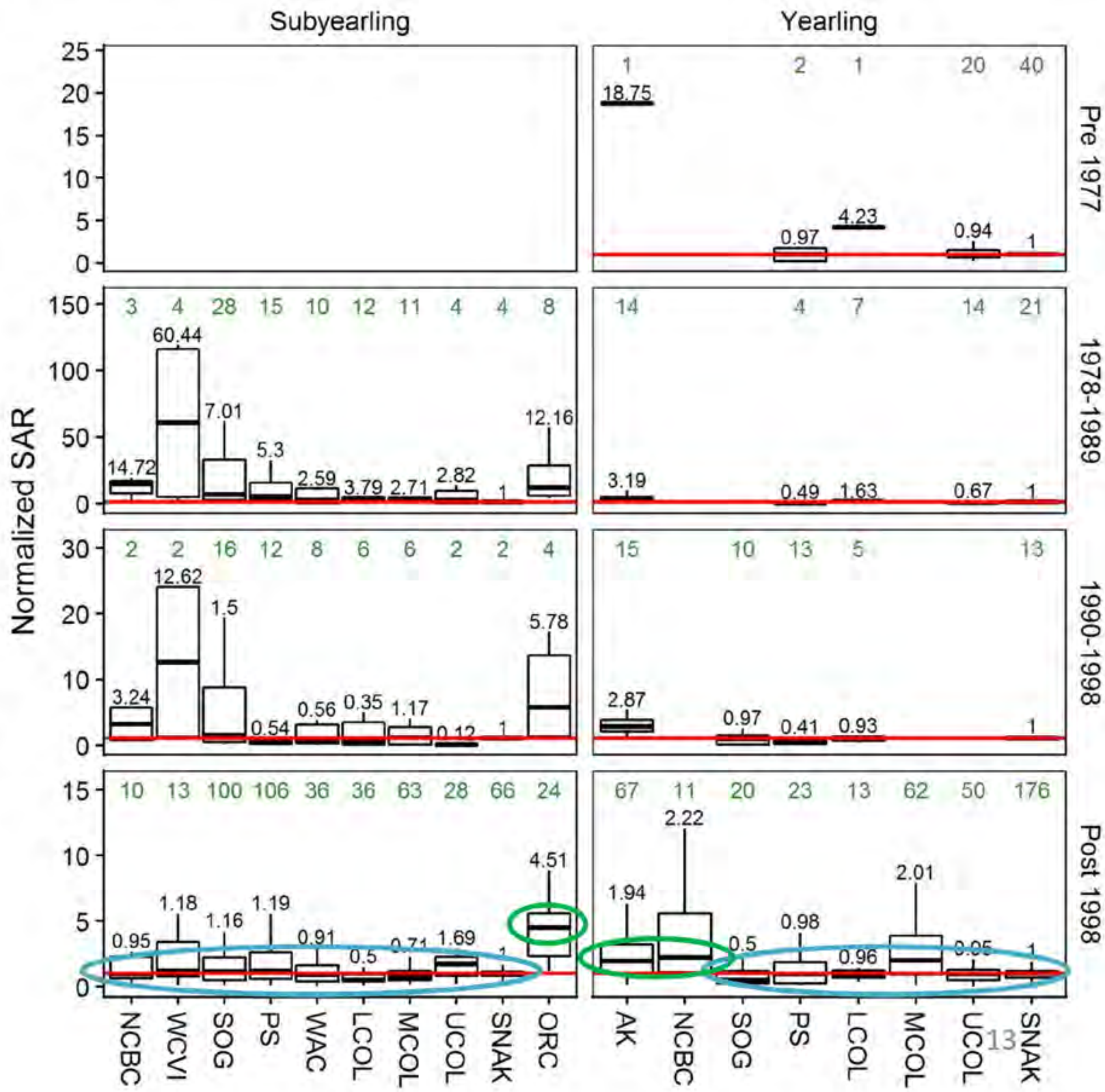


Steelhead



Chinook SARs Normalized by Snake River Median SARs (i.e., Relative Survival)

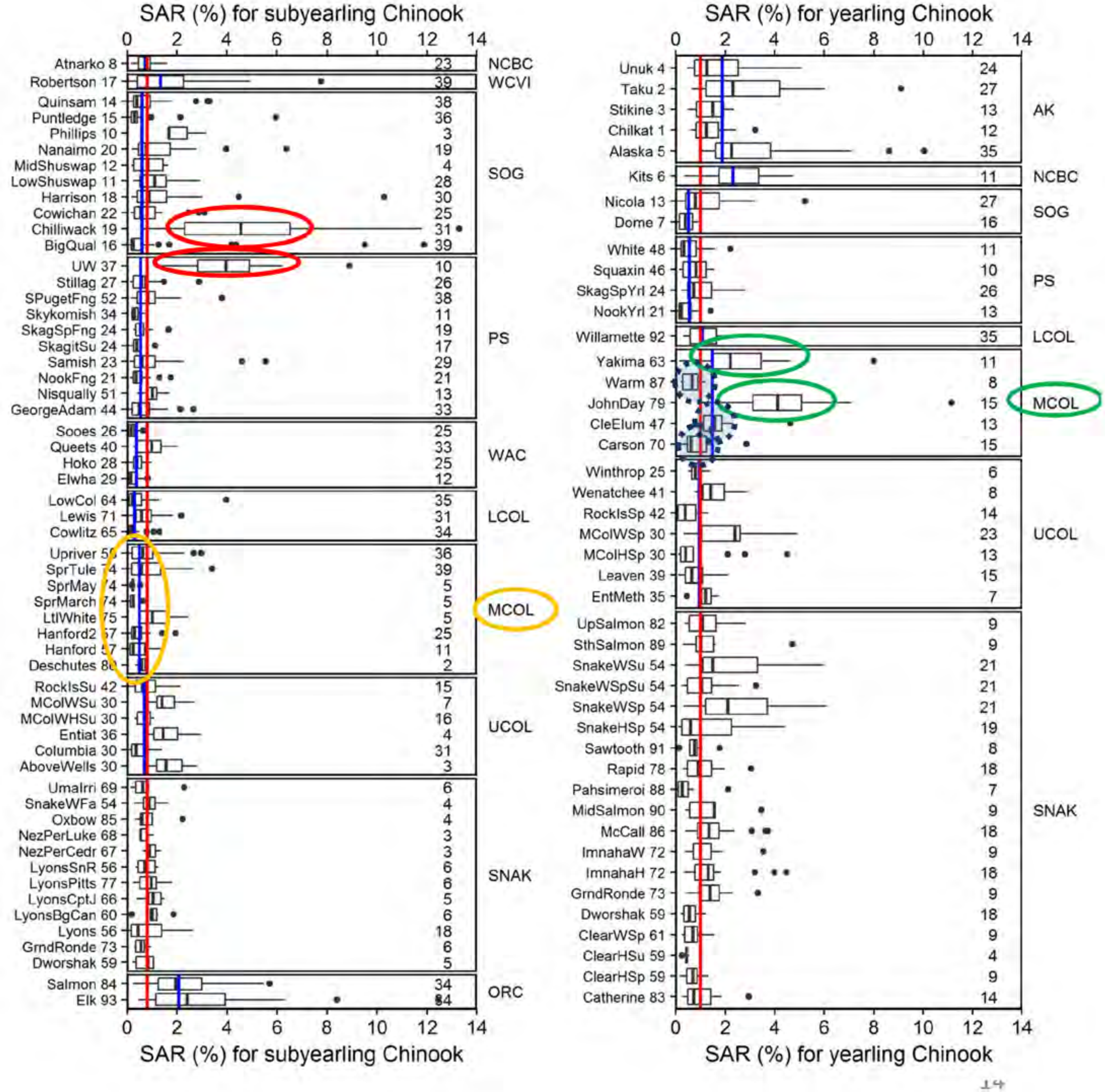
- Compared SARs for the west coast of North America (excl. California)
- SARs are scaled by dividing by annual Snake River values
- So $SAR_{SnakeRiver} = 1$
- The major regional difference in SARs seen in earlier time periods no longer exists
- A few important exceptions: ORC
- Critical: AK & NCBC SAR difference now ***much*** smaller
- How can Columbia "recover" salmon if Alaska can't with its fantastic freshwater habitat?



13

Delayed Mortality

- The data do not support the delayed mortality theory
- Only 2 of 5 MCOL yearling populations have anomalously high SARs
- This pattern is also seen in other areas without any dams
- This differential survival pattern is also not seen for subyearling Chinook—so going through fewer dams does not boost SARs for any of these populations.



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Group Think

- Janis (1972, 1982; Chapter 8) lists 3 main "symptoms" that led to catastrophic Group Think in past policy decisions (or avoided them):
  - Overestimation of the Group's Power & Morality
  - Closed-Mindedness
  - Pressures Toward Uniformity

Janis, I. L. (1982). Groupthink, Psychological Studies of Policy Decisions and Fiascoes (2nd ed.). Boston, Houghton Mifflin Company.

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Policy Aspects

- Well, the Columbia hydrosystem isn't so terrible for salmon after all:
  - Freshwater smolt survival rates better than average
  - Smolt to Adult Survival rates also equal or better to other regions
  - Adult returns are low and likely to go lower because of worsening ocean (climate) conditions

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Changing the Goal Posts

- Kahneman, author of “Thinking Fast and Slow” showed that if we are in a ‘status quo’ position and someone asks us to change to something else, we would need to have 2-3 times the *perceived* benefit before we would consider the change
- So how does BPA change the thinking when the jobs of most biologists (& their colleagues) depends on the status quo– blaming the dams as the source of most problems?

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So What To Do?

- Establish whether survival in the ocean is worse than in the hydrosystem.
  - Buys flexibility in operations.
  - May get a new generation of biologists to be more open-minded about how to manage a bad hand.
  - Should lead to people thinking about how "manipulating" the hydrosystem depends upon what the ocean may do to salmon.
- Science: Move to a *rigorous experimental design* approach with proper treatment & control groups
  - Counteracts the subjective value judgments of "experts" that plagues salmon management.
  - I am thinking here of opinions that increasing TDG past legal limits will give benefits, even if they kill more fish in the short term.

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So What To Do?

- Legal: Not clear to me whether the current legal framework has considered these issues.
  - The hydrosystem is apparently operated at present on the untested and largely hidden assumption that natural, unmodified, systems will yield the best survival ("Mother Nature knows best").
  - This is ***not*** true in the Sacramento River. The worst smolt survival occurs in the migration segments that are most natural. The best survival occurs in river segments with rip-rapped banks. Why?? (Fewer predators)
  - Spill, Transport, Reservoir Draw-Down, Dam Breach might all reduce SARs by placing smolts in the ocean for longer time periods.
  - The legal concept of "take" is well-established under the ESA, but not as applied to the ocean. What if operating the hydrosystem to get the smolts to the ocean faster puts them in greater jeopardy??

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Questions

1) This is a big change in how the effect of the dams on salmon is described.
2) What other analyses can we add that will better address the legal (& social/economic) issues that you face?
3) What do you see as the important uncertainties that we need to address?
4) As we finalize this for publication, can you provide any other thoughts or guidance on relevance?
5) What do we need to do to fairly get the message out?

KINTAMA

From: David Welch

Sent: Wed Aug 01 13:56:04 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: static ocean

Importance: Normal

This would be a great question to ask… you should do so, and I will respond. (I have deliberately not gotten into what the future will bring, but it is catastrophic if the global warming projections are anywhere close to accurate).

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, August 01, 2018 1:38 PM
To: David Welch
Subject: static ocean

Another thought which may be too complicated to include , except perhaps in discussion afterwards:

With regards to the ocean vs. freshwater math, some could present a perspective like "we've always known that both survival rates and variance in the ocean are larger in magnitude than hydrosystem survival, however, ocean survival is static while hydrosystem survival and spawner capacity have had a negative trend and are potentially correctable".

With this, you could ask whether major salmon models include this declining ocean survival rate, or just represent it with a recent 15 year mean. (I believe NOAA's lifecycle model indeed has a nontrending SAR that is only influenced by arrival timing in the estuary. This will be used in the Columbia harvest and hydrosystem biological opinions). What would your work suggest with regards to a future trendline, given that you observed a decreasing trend from the 60s?

Kintama Update to BPA

The coast-wide collapse in marine survival of west coast Chinook and steelhead: simply a slow-moving catastrophe or a deeper failure?

2 August 2018

David Welch, Aswea Porter, & Erin Rechisky

Kintama Research Services Ltd.

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Conclusions

- The Columbia River basin does not have a smolt survival problem.
- Rather it has a failure of sufficient adult salmon to return from the ocean.
- This failure is not being significantly driven by freshwater events.
- A consequence of this demonstration (smolt survival ***and*** adult SARs both being comparable to other regions without dams) is that the way the hydrosystem is being managed for salmon conservation is wrong.

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A Question to Frame the Presentation

- Let's Make the Math Easy.
- Assume hydrosystem survival is "only" 33% (1/3)
- (Actually it is 50%~60% from FPC calculations)
- Where is the survival issue that the region needs to deal with?
- *After all, with 2/3rds of the fish dying in the FCRPS, it's obviously the dams, right?*

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Answer: The Ocean

- Columbia River SARs are about 1%
- If S_{FW}=33% (or 1/3rd)
- then S_{Ocean}= 1/33.3333…

$$(because\, S_{FW} \square S_{Ocean} = {}^{1}\!/_{3} \square {}^{1}\!/_{33.333} = {}^{1}\!/_{99.999} = 1\%)$$

  - So in this hypothetical example, freshwater survival is 11X higher (33.3/3) than marine survival.

- In reality, S_{FCRPS} is 50%~60% so the real ratio implies that the ocean is 25X~36X more important than the hydrosystem.

- Q: How did we get to where we are now in the Columbia?
- A: *Cognitive Dissonance.*

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Leon Festinger

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THEORY OF COGNITIVE DISSONANCE (1957)

Festinger's conclusion was that "dissonance" (when facts disagree with pre-existing belief) makes the individual psychologically uncomfortable, and the person subconsciously tries to reduce the dissonance and achieve "consonance" (agreement with beliefs)

Festinger, L. (1957). *A Theory of Cognitive Dissonance*. Stanford, Calif., Stanford University Press. 291 pp.

The “Bretz Floods”

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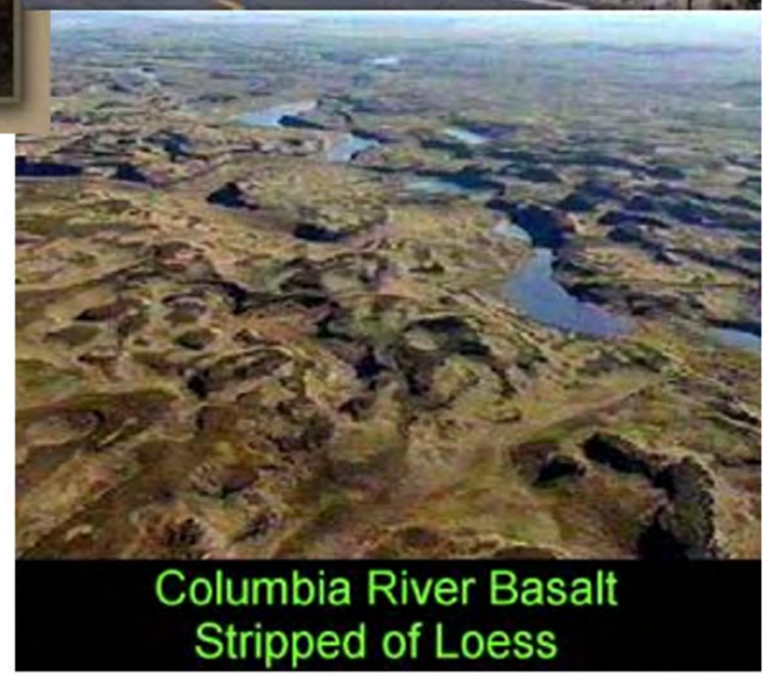
The "Bretz Floods"



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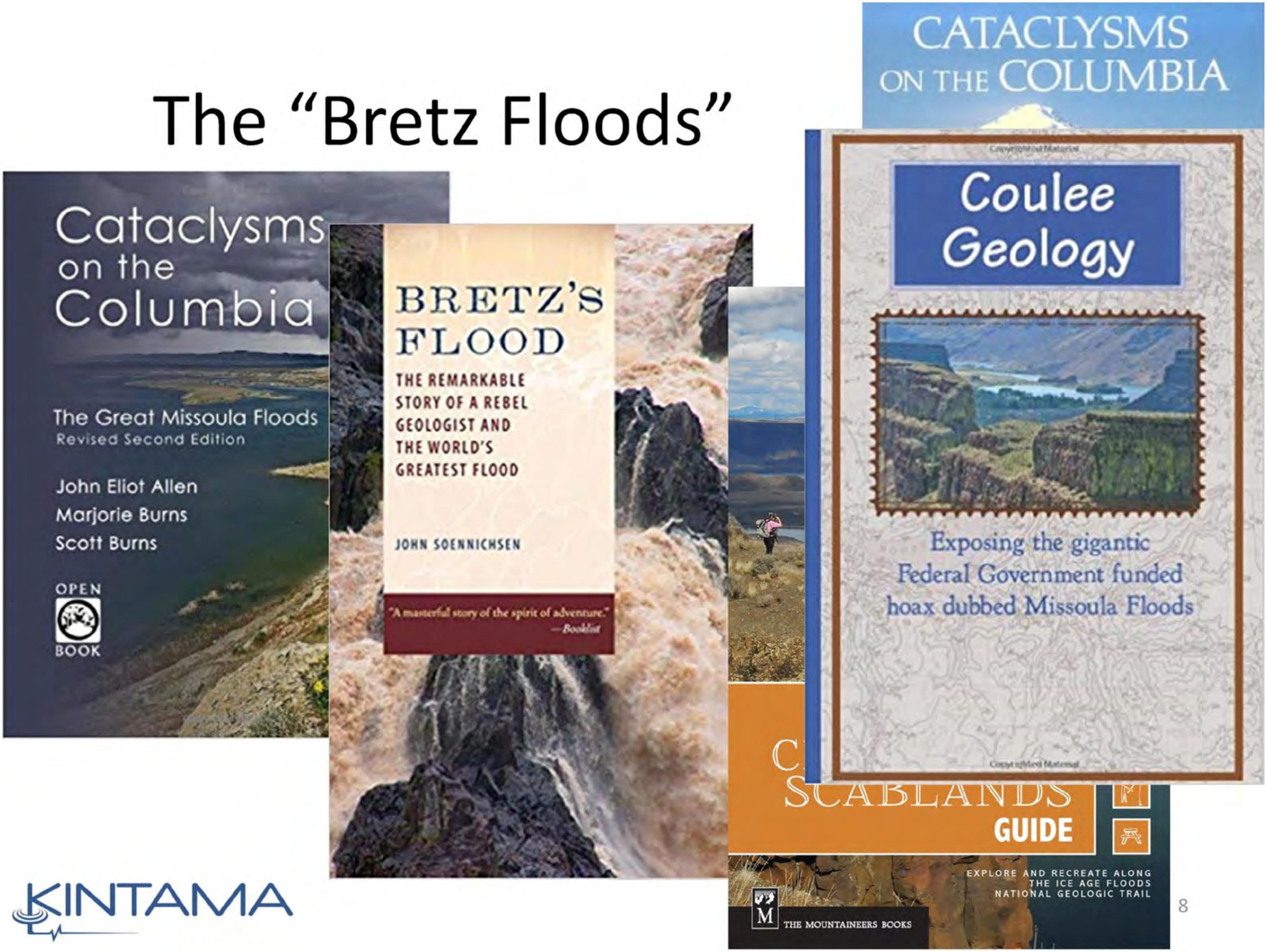
The “Bretz Floods”



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Science is Full of these Examples

- Germ Theory of Disease
- Getting Physicians to Wash Their Hands(!)
- Cholera ("Miasma")
- Plate Tectonics
- The "Ether Theory" (Light/EMR waves propagate through the "ether")

It took decades to change people's minds!

- In each case, a powerful pre-existing lobby (aka "colleagues") had fixed views about what was "logical".
- I believe that both Group Think & Cognitive Dissonance are alive and well in Salmon Science.

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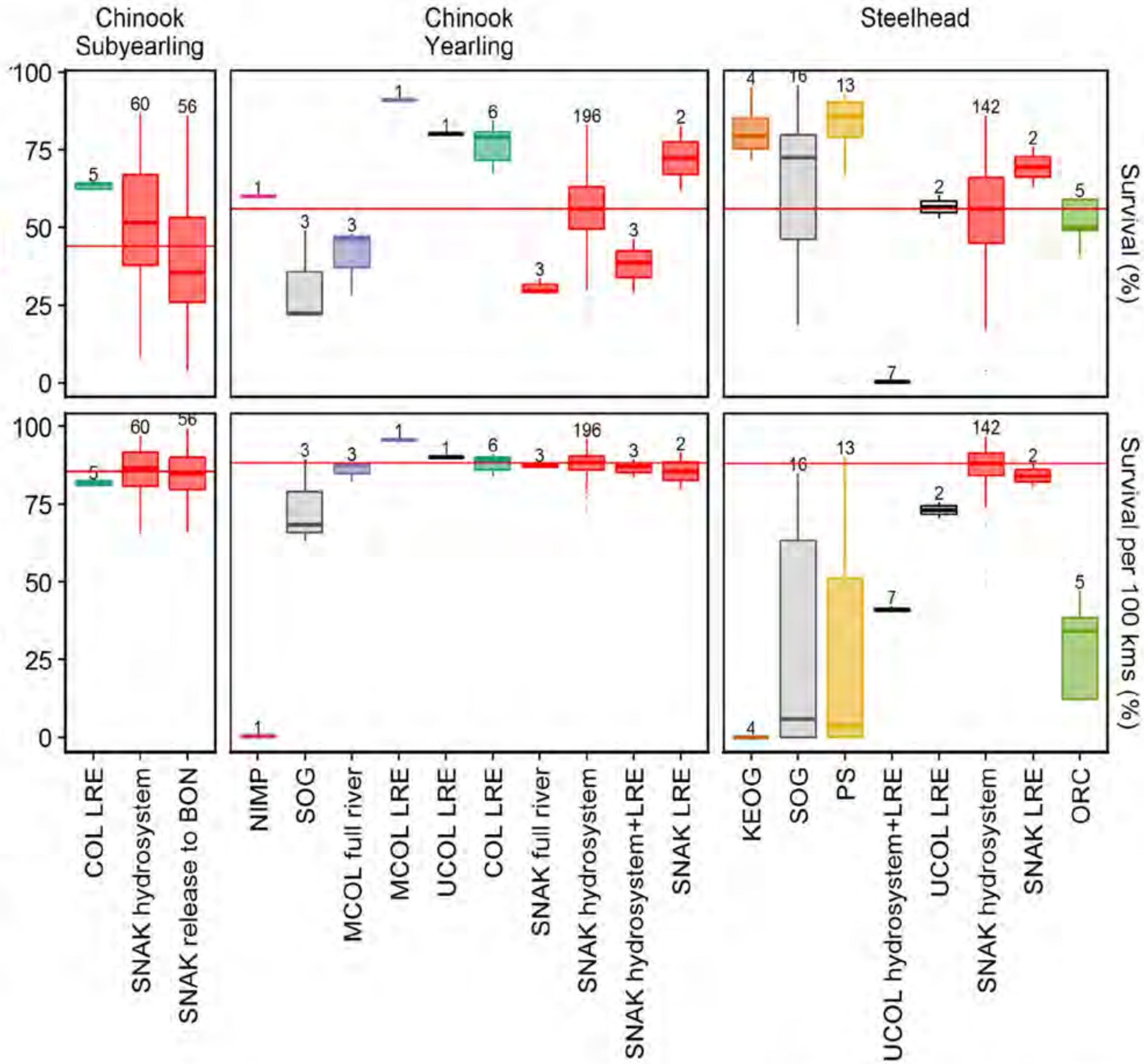
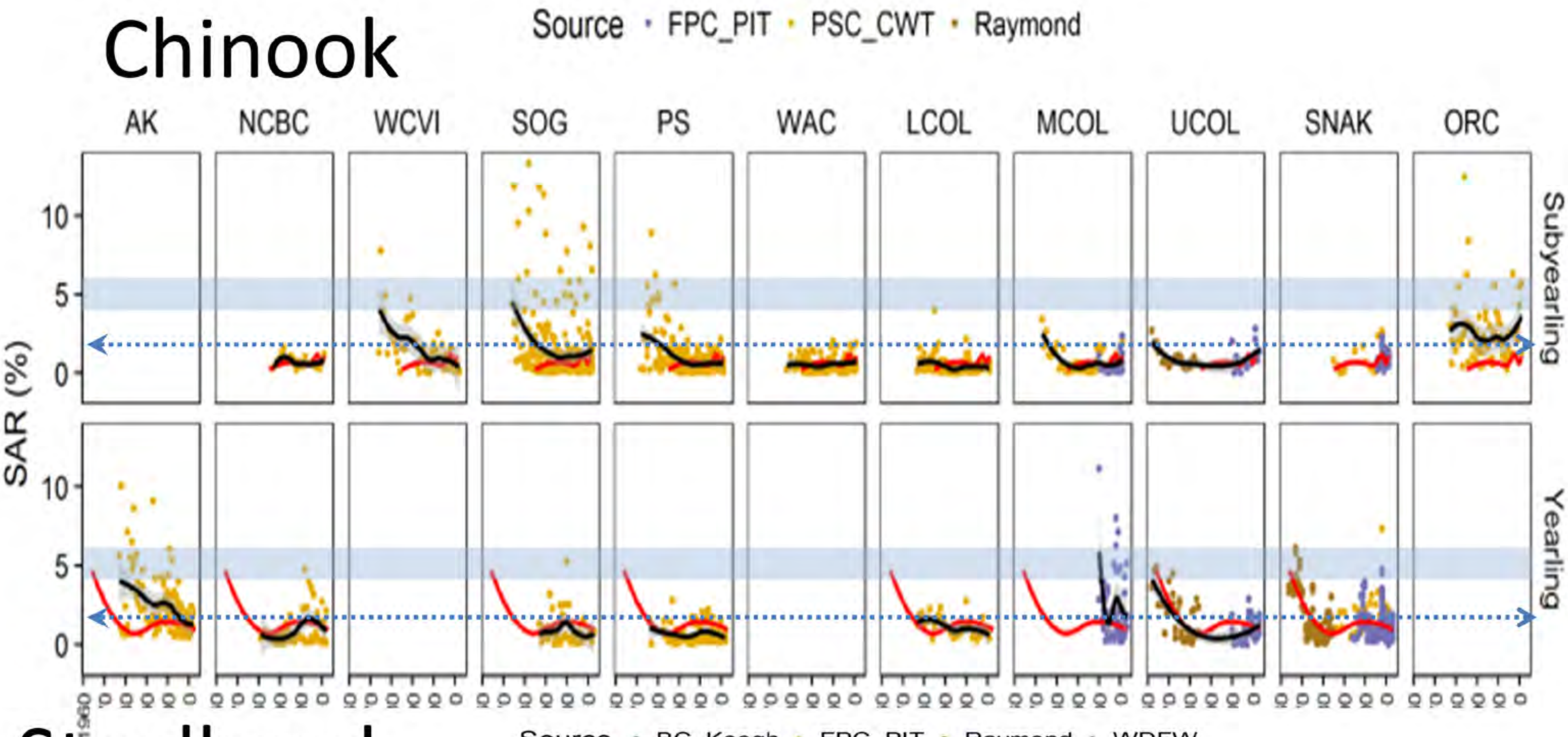
Let's Begin at the Start: Comparing Downstream Freshwater Smolt Survival in Different Rivers

- Used N=531 annual freshwater survival estimates for smolts
- Snake River SARs (red) in the middle of the pack
- When scaled by distance travelled, Columbia hydrosystem survivals are equal or better than other river systems(!)
- Note also the lack of evidence for delayed mortality.

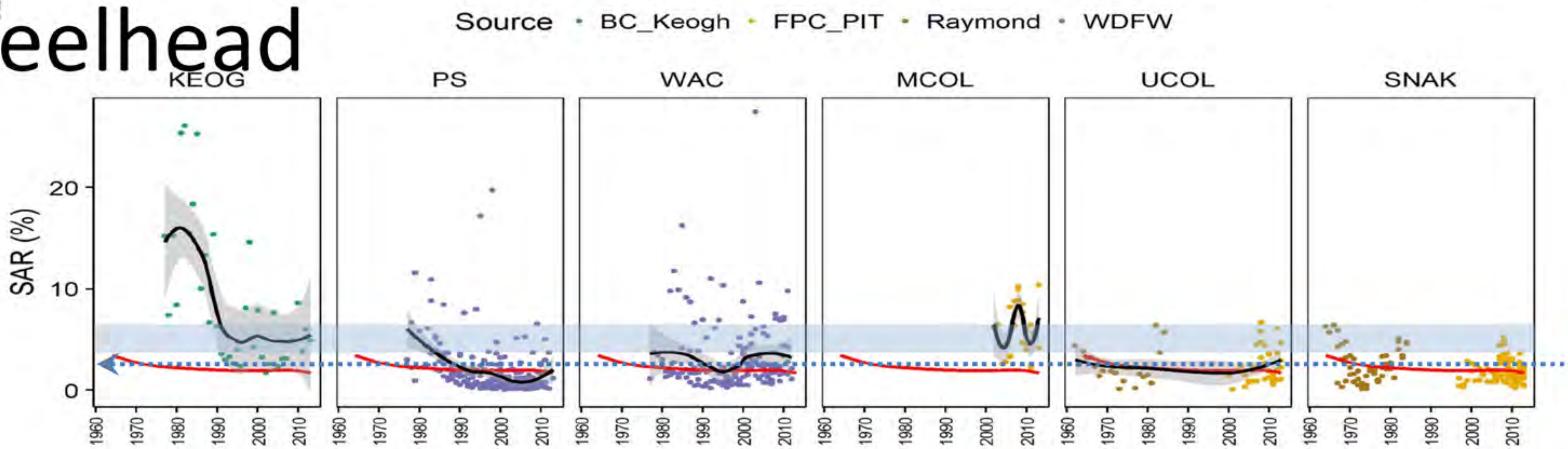


Now Let's Look at the End: Comparing Adult SARs for Different Regions

Chinook

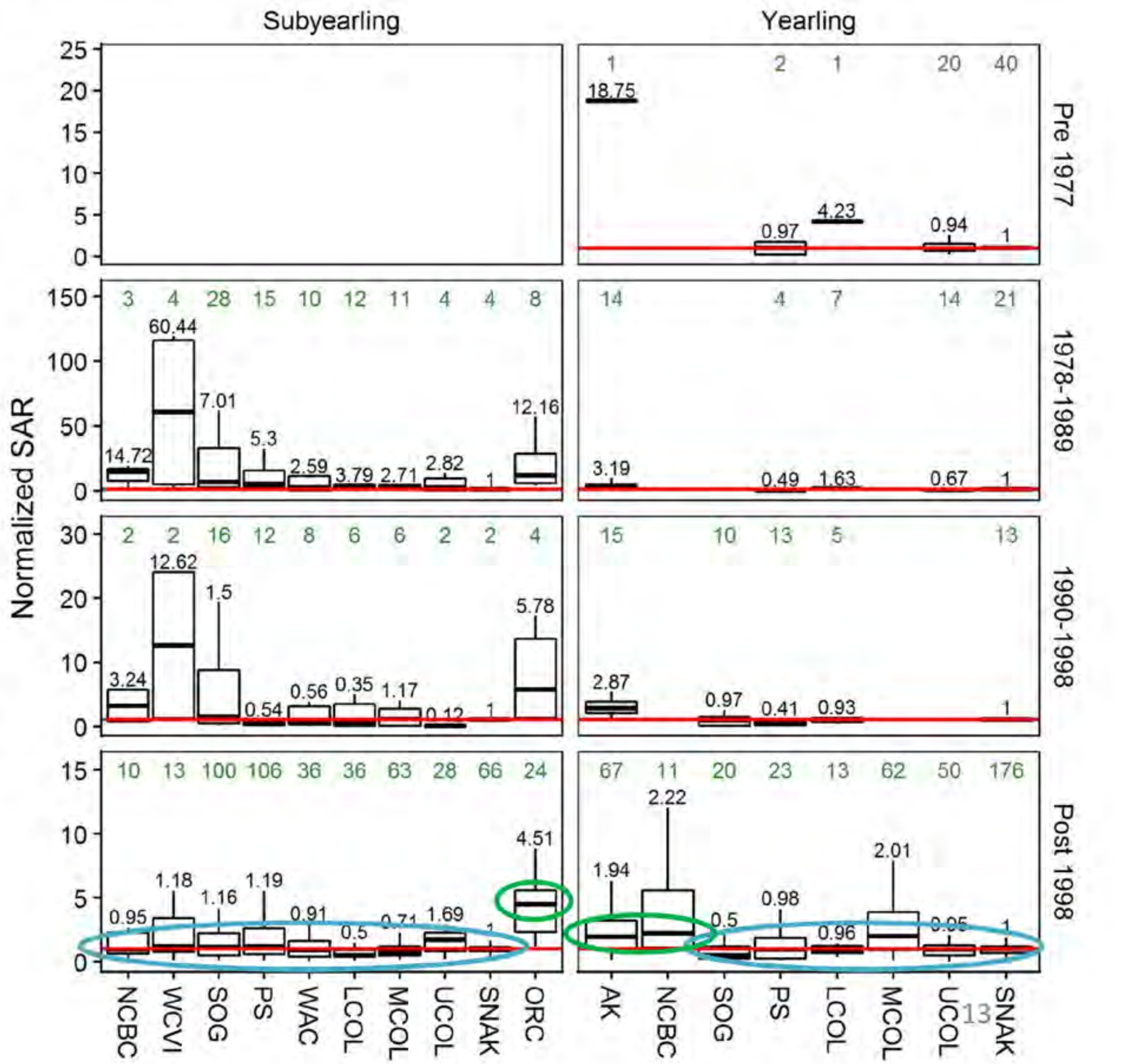


Steelhead



Chinook SARs Normalized by Snake River Median SARs (i.e., Relative Survival)

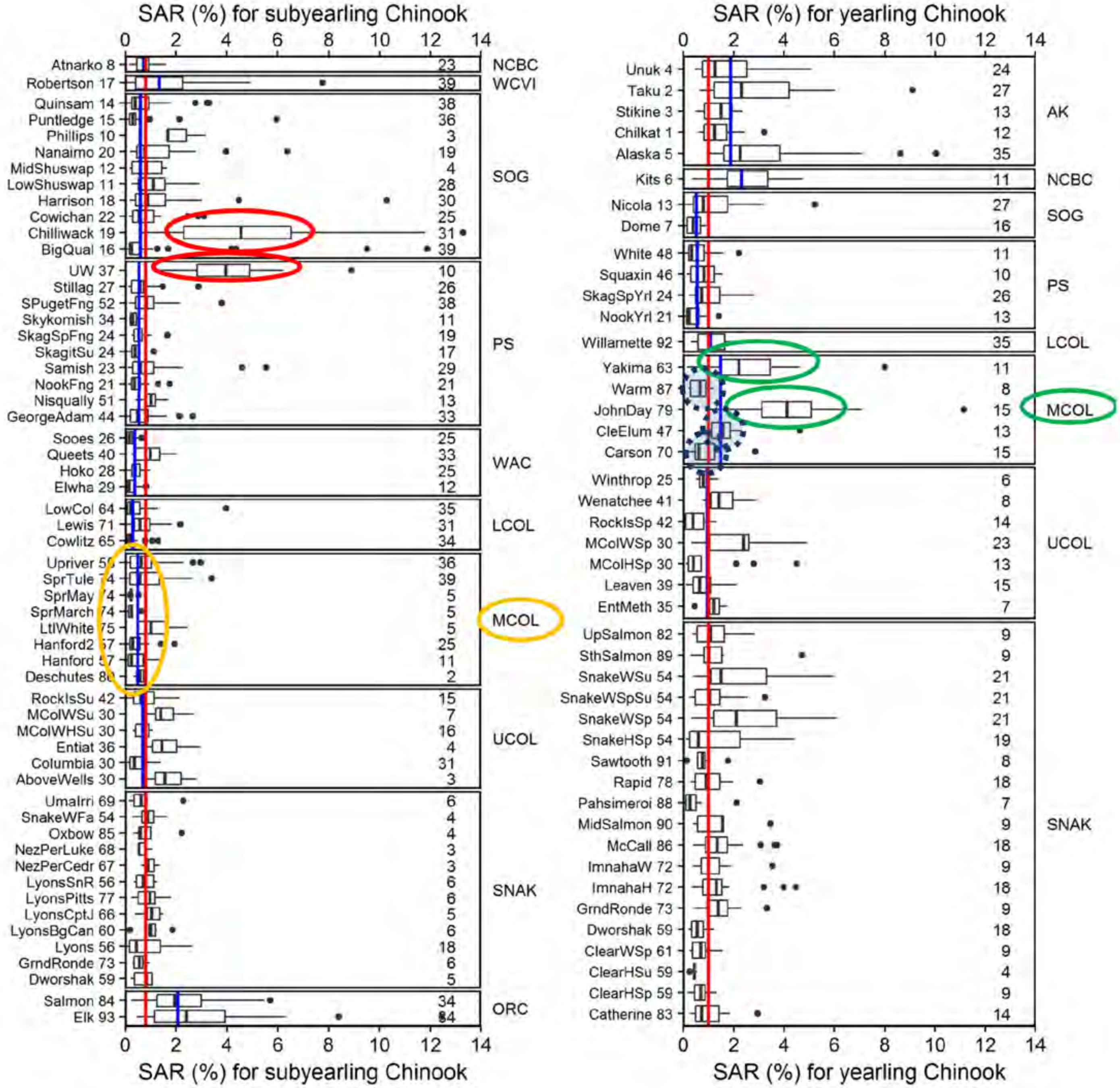
- Compared SARs for the west coast of North America (excl. California)
- SARs are scaled by dividing by annual Snake River values
- So $SAR_{SnakeRiver} = 1$
- The major regional difference in SARs seen in earlier time periods no longer exists
- A few important exceptions: ORC
- Critical: AK & NCBC SAR difference now ***much*** smaller
- How can Columbia "recover" salmon if Alaska can't with its fantastic freshwater habitat?



13

Delayed Mortality

- The data do not support the delayed mortality theory
- Only 2 of 5 MCOL yearling populations have anomalously high SARs
- This pattern is also seen in other areas without any dams
- This differential survival pattern is also not seen for subyearling Chinook—so going through fewer dams does not boost SARs for any of these populations.



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Group Think Case Studies

Our paper includes a review of 3 case studies of "Group Think" in salmon management & research:

1) Columbia River Salmon Management
2) Rivers-Smith Inlet Sockeye (BC)
3) Upper Fraser R Steelhead

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Columbia R Salmon

- Two studies identified the importance of either estuary (lower river) or ocean processes in controlling the poor survival of Snake River salmon.
- Kareiva *et al.* demonstrated that recovery could only be achieved by improving survival in the lower river/estuary or in the coastal ocean. Similar to our own argument, even raising main stem survival to 100% would not prevent extinction.
- Marmorek and Peters' (2001) review of the PATH process: "*Importantly, we found that the different models' estimate of the survival rate of in-river migrants through the hydropower system, a hotly debated value, was NOT an important determinant of overall life cycle survival. Rather, the key uncertainties that emerged from these sensitivity analyses were related to the cause of mortality in the estuary and ocean*"
- Both the JSATS & Kintama studies subsequently found lower river & estuary survival was high
- Further marine work came to an end.


Juneau
Icy Strait
Chatham Strait
Ketchikan
Dixon Entrance
Prince Rupert
Kitimat
Queen
Charlotte
Islands
Hecate Strait
PACIFIC
OCEAN
Chilcotin River
Fraser River
Smith Inlet
Rivers Inlet
Cape Scott
POST I Array 2004 - 2008
(Initial Array Design)
VANCOUVER
ISLAND
Campbell River
Powell River
Nanaimo
Vancouver
Bellingham
Victoria
Port Angeles
Cape Flattery
Kintama Research

Rivers-Smith Inlet Sockeye

- The key findings from a joint federal and provincial government technical committee reviewing the collapse are worth quoting verbatim (Holtby 2000, Anonymous 2001):
- *"(1) The drastic declines in abundance appear to be due to an extended period of poor marine survival that cannot be explained by any one event, such as sea-entry during an unusual El Niño year. At least two recent years (1996 and 1997) show signs of near-zero marine survival, but the reasons for those low survival rates are not known at this time.*
- *(2) There is little evidence to suggest that logging or other human activity in either of the drainage basins has had more than small and localized impacts on sockeye spawning and rearing.* ***<u>The simultaneous declines in both basins – i.e., in Owikeno, where there has been extensive logging and in Long Lake, where there has been very little – is convincing evidence that the cause of the declines does not lie in freshwater habitat disturbance".</u>***

Rivers-Smith Inlet Sockeye

- The Rivers-Smith Inlet study is to our knowledge unique in North America because it both says that ***there is a major*** marine survival problem and ***excludes*** freshwater survival/habitat from playing a significant role

Rivers-Smith Inlet Sockeye

- The committees recommended three research foci:
- *“(1) determine absolute escapement levels to Owikeno Lake… in order to improve the credibility of stock assessment;*
- *(2) improve the understanding of habitat use… by sockeye juveniles in Owikeno Lake and smolts in the Wannock estuary; and*
- *(3) investigate the status of ocean-type and lake-spawning sockeye, which are less familiar and, although not specifically covered in this plan, may require future intervention”.*
- *(*No mention is made of addressing the marine survival issue that was the core problem!*)*

Rivers-Smith Inlet Sockeye

- The recommendations for Habitat are even more striking:
- *"5. Existing conceptual plans for habitat restoration … should be evaluated for their potential long term benefits to sockeye, and the feasibility of proposed restoration projects should be thoroughly assessed.*
- *6. Habitat restoration projects could include the reconnection of spawning and early rearing habitats along the margins of floodplains and in side-channels that have been isolated by road construction or degraded by natural and logging-related activities.*
- *7. Any habitat restoration projects that are undertaken should be monitored to determine their benefits for sockeye.*
- *8. DFO and other agencies and stakeholders should continue to collaborate on developing habitat protection strategy during resource development planning processes (e.g., CCLCRMP, Forest Development Plans).*
- *9. The site-specific and cumulative impacts of logging on habitats used by sockeye should be more comprehensively evaluated"*

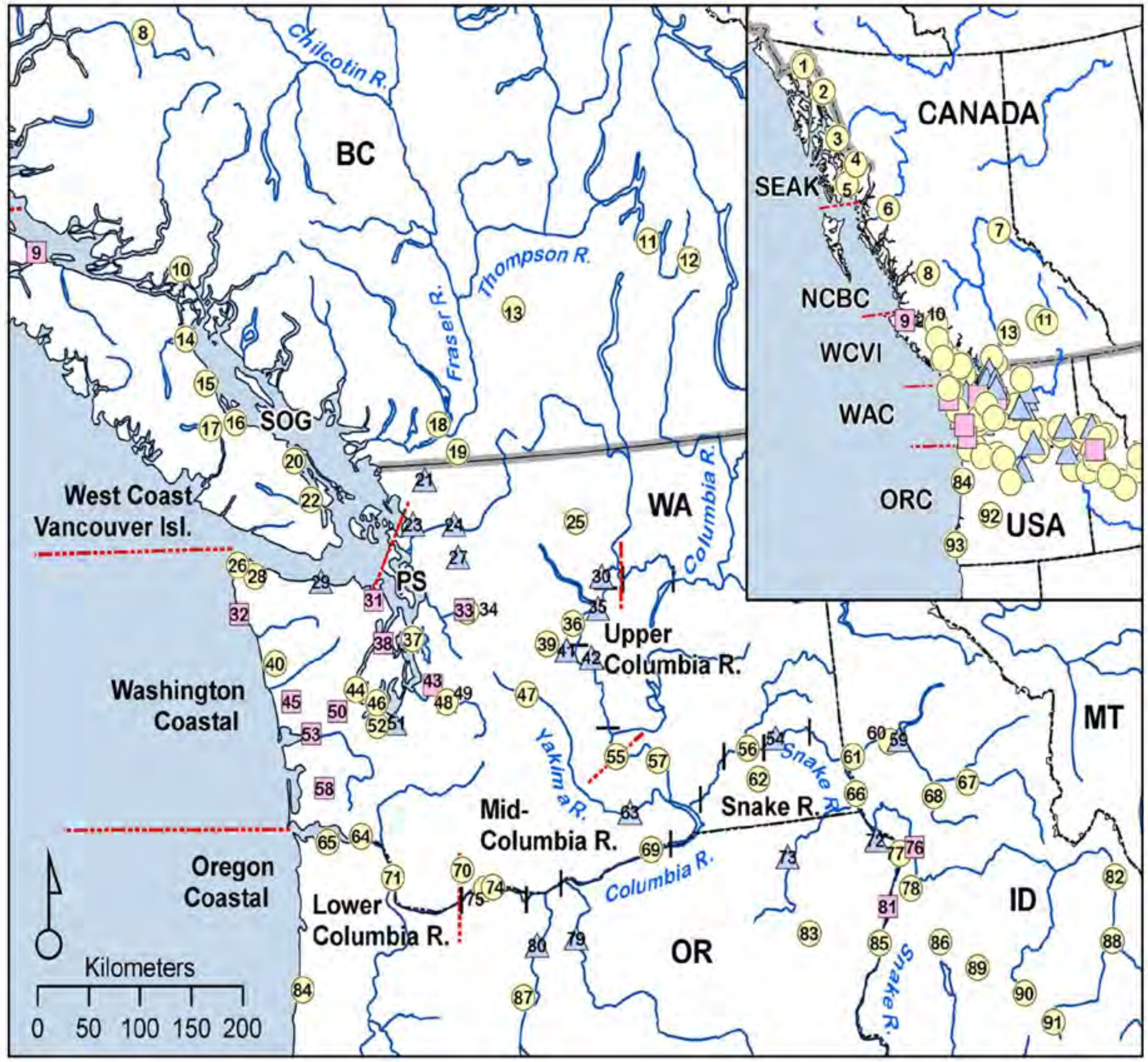
From Our Paper…

- In other words, despite the reports identifying with high certainty that freshwater habitat issues **<u>were not contributory</u>**, the committees did not attempt to understand what were the marine drivers, and instead advocated a series of actions in freshwater; the recommendation to evaluate the "*site-specific and cumulative impacts of logging*" is particularly problematic because this could result in significant costs for the forest industry and added tasks for fisheries personnel pursuing monitoring that would in essence be "busy work": work that staff knew how to do, but was unlikely to lead to useful progress on the core issues. This preference for focusing on work in freshwater is a repeating feature of west coast salmon management.

Upper Fraser Steelhead (Thompson & Chilcotin River)

- In February, an emergency assessment conducted for the federal government by Neilson and Taylor (2018)

- Neilson, J. and E. Taylor (2018). Emergency assessments of the Steelhead Trout (*Oncorhynchus mykiss): Thompson River and Chilcotin River populations (2018). COSEWIC. Ottawa, Government of Canada, Ministry of Environment and Climate Change*: ***26 pp.***



3. Upper Fraser Steelhead (Thompson & Chilcotin River)

- **For the Thompson River population**: *"The number of spawning fish was variable with little trend prior to 2000. Since then, the population has declined dramatically…and is now the lowest on record*". Only 177 mature fish were observed in the most recent survey, and "*If the current rate of decline persists for another three generations, the number of spawning fish will decline to 37, which is 2.0% of the pre-2000 abundance*".
- **For the Chilcotin River population**, the problem is even worse: "*The 58 mature fish observed in the most recent survey are only 5% of the pre-2000 mean. If the current rate of decline persists for another three generations, the number of spawning fish will decline to 11, which is 0.9% of the pre-2000 abundance*".

3. Upper Fraser Steelhead (Thompson & Chilcotin River)

- The report's conclusions state: "*Bycatch mortality in commercial Pacific salmon fisheries and* <u>*declines in marine and freshwater habitat quality*</u> *are the key factors driving the declines*"
- But bycatch was not a problem before the drop in productivity made it a problem
- "*While it is generally considered that the quality of freshwater habitat is declining, the severity of the freshwater habitat-based threats in the Thompson and Chilcotin rivers is not well understood*".

The Chilcotin River has Essentially Pristine Freshwater Habitat

The Chilcotin River has Essentially Pristine Freshwater Habitat

- The Chilcotin Plateau is prime wilderness; vast area, a few hundred people at most, negligible roads or infrstructure
- If the Chilcotin has problematic freshwater habitat, what hope is there for other areas?
- (This doesn’t mean freshwater habitat work shouldn’t be done, but rather that it is uncritically trotted out as something to do, even when thoughtful reflection would suggest it isn’t really likely to be a significant contributor to the problem)
- ➔There is a significant lost opportunity cost as a result

Group Think

- Janis (1972, 1982; Chapter 8) lists 3 main "symptoms" that led to catastrophic Group Think in past policy decisions (or avoided them):
  - Overestimation of the Group's Power & Morality
  - Closed-Mindedness
  - Pressures Toward Uniformity

Janis, I. L. (1982). Groupthink, Psychological Studies of Policy Decisions and Fiascoes (2nd ed.). Boston, Houghton Mifflin Company.

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Policy Aspects

- Well, the Columbia hydrosystem isn't so terrible for salmon after all:
  - Freshwater smolt survival rates better than average
  - Smolt to Adult Survival rates also equal or better to other regions
  - Adult returns are low and likely to go lower because of worsening ocean (climate) conditions

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Changing the Goal Posts

- Kahneman, author of “Thinking Fast and Slow” showed that if we are in a ‘status quo’ position and someone asks us to change to something else, we would need to have 2-3 times the *perceived* benefit before we would consider the change
- So how does BPA change the thinking when the jobs of most biologists (& their colleagues) depends on the status quo– blaming the dams as the source of most problems?

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So What To Do?

- Establish whether survival in the ocean is worse than in the hydrosystem.
  - Buys flexibility in operations.
  - May get a new generation of biologists to be more open-minded about how to manage a bad hand.
  - Should lead to people thinking about how “manipulating” the hydrosystem depends upon what the ocean may do to salmon.
- Science: Move to a *rigorous experimental design* approach with proper treatment & control groups
  - Counteracts the subjective value judgments of “experts” that plagues salmon management.
  - I am thinking here of opinions that increasing TDG past legal limits will give benefits, even if they kill more fish in the short term.

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So What To Do?

– Legal: Not clear to me whether the current legal framework has considered these issues.
  - The hydrosystem is apparently operated at present on the untested and largely hidden assumption that natural, unmodified, systems will yield the best survival ("Mother Nature knows best").
  - This is ***not*** true in the Sacramento River. The worst smolt survival occurs in the migration segments that are most natural. The best survival occurs in river segments with rip-rapped banks. Why?? (Fewer predators)
  - Spill, Transport, Reservoir Draw-Down, Dam Breach might all reduce SARs by placing smolts in the ocean for longer time periods.
  - The legal concept of "take" is well-established under the ESA, but not as applied to the ocean. What if operating the hydrosystem to get the smolts to the ocean faster puts them in greater jeopardy??

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Questions

1) This is a big change in how the effect of the dams on salmon is described.
2) What other analyses can we add that will better address the legal (& social/economic) issues that you face?
3) What do you see as the important uncertainties that we need to address?
4) As we finalize this for publication, can you provide any other thoughts or guidance on relevance?
5) What do we need to do to fairly get the message out?

KINTAMA

From: David Welch

Sent: Fri Aug 03 14:54:42 2018

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] RE:] Kintama Update to BPA (2 August 2018).pptx

Importance: Normal

Yes, sorry about that—apparently it got hung up on my laptop and only got sent once I was back in Wifi range at Kintama this morning and I opened my laptop up. (I got home at 1:00 am this morning because of some flight delays).

Thanks for hosting me. I agree with Peter that it is a puzzle why the Snake River SARs essentially flatlined after the ocean regime shift in 1977… I have a bit of text discussing this in the draft manuscript that Erin is currently reviewing, but I don't think as yet that it's sufficiently clear. In short, I don't think Peter's (very perceptive) point can necessarily been explained from poor juvenile survival as the animals swim north along the shelf. I want to re-work this exact point once I get the text back from Erin (assuming she hasn't already taken me to task for it!)

This is why I was musing at yesterday's meeting about whether it might not actually be something that is decreasing adult survival as the nearly mature adults salmon swim back in from the offshore that explains the pattern of decline in SARs better. (That point I made about a lot of salmon runs give up essentially a whole summer's growth opportunity and instead forego this opportunity and migrate back into freshwater early; there must be strong evolutionary selection against staying in saltwater and feeding for an extra summer, or they wouldn't do it; that pressure is presumably predation).

To expand on this point, my thought here is that if it was marine mammals (or other adult salmon predators) that expand step-wise up the coast at the time of each regime shift, than all spring runs migrating back from the offshore might encounter approximately equal risk of predation by marine mammals as they intersect with the continental shelf region. So that would work as an explanation of the pattern for Spring (yearling) Chinook and steelhead. Complicating this mechanism though is the fact that Fall Chinook that stay ***on*** the shelf for 2-3 years and then migrate linearly back along the shelf to their rivers of origin. As a result, southern Fall Chinook stocks (i.e., the Columbia) should migrate past lots of marine mammal predators as they go, so should have lower SARs. Originally I was thinking this prediction wasn't holding up, but with our more refined analyses showing that SE Alaska/NCBC still have about twice the SARs compared with the Snake River, it is possible that this proposed mechanism is more consistent than I had thought—

I will revisit this once Erin gets the paper back to me.

Thanks, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, August 03, 2018 2:06 PM
To: David Welch
Subject:] Kintama Update to BPA (2 August 2018).pptx

This is the one I received, thanks.

By the way, the feedback from Peter Cogswell was that he was interested in the timing of decline. After a decline from the 4% range from Raymond (a range confirmed as reasonable in other regions), the Snake and Columbia remained flat. When the decline occurred later in other regions due to some factor, why didn't the Columbia also decline further at the corresponding time? Could this help she'd light on what is happening? It might be to challenging to sort out positive and negative impact of multiple factors though.

Christine

Sent from my Verizon 4G LTE smartphone

-------- Original message --------
From: David Welch <David.Welch@kintama.com>
Date: 8/3/18 9:42 AM (GMT-08:00)
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Cc: David Welch <David.Welch@kintama.com>, Erin Rechisky <Erin.Rechisky@kintama.com>
Subject: [EXTERNAL] Kintama Update to BPA (2 August 2018).pptx

Trying again… not sure if last email went!

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Aug 10 14:30:00 2018

To: david.welch@kintama.com

Subject: FW: Bowles & Graves declarations

Importance: Normal

Attachments: 2115_Bowles.pdf; ECF 2139 - Graves declaration.pdf

Hi David,

Here are a pair of declarations for the court case by ODFW and NOAA.

By the way, our managers plan to discuss your proposal later this month. I am prompting them to give me a finance decision regarding the contract extension by next week. It might be very advantageous to use FY18 funds, if possible.

Christine

From: Francis,Rose (BPA) - LN-7
Sent: Tuesday, March 28, 2017 10:45 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: Bowles & Graves declarations

Hi Christine,

Apologies for the delay. As discussed after the Hydro Planning meeting on Monday morning, here are the Bowles and Graves declarations filed in the 2017 injunction proceedings, listed in chronological order:

Bowles first declaration, filed with Oregon's motion for injunction:

Ritchie's first declaration, filed with the federal opposition:

Rose Francis
Office of General Counsel
Bonneville Power Administration
503-230-4967 | rmfrancis@bpa.gov
http://www.bpa.gov

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Aug 10 14:30:46 2018

To: david.welch@kintama.com

Subject: FW: Bowles & Graves declarations

Importance: Normal

Attachments: 2165 - 2017.02.28 Bowles Declaration in Support of Oregon's Motion for Injunction.pdf; 2178-1 Graves.pdf

Second set (these go on forever).

Christine

Bowles' second declaration, filed with Oregon's reply brief (exhibits and attachments not included due to file size but can figure out way to get those to you if helpful):

Ritchie's second declaration, filed shortly before the hearing in response to Bowles 2d:

Rose Francis
Office of General Counsel
Bonneville Power Administration
503-230-4967 | rmfrancis@bpa.gov
http://www.bpa.gov

From: David Welch

Sent: Fri Aug 10 15:30:40 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Bowles & Graves declarations

Importance: Normal

Attachments: Okisollo_SiteMap_2018_Proposal.png; SiteMap_2017.png

Thanks, Christine-

Erin just gave me back her edits on "the BPA paper" late last night. I haven't opened them up yet as I had to go up-island this morning unexpectedly to pick up a piece of lost (& now found!) gear... with this unit back we had 100% recovery of the main array that we put out this year. (See attached, if you are interested—we (Kintama) designed and put out all of the red dots (permanent multi-year receiver subarrays) in 2015, plus blue & pink dots showing temporary subarrays in 2017 & 2018). This design is allowing us to track smolts & measure route preference and survival of smolts as small as 10 cm in the ocean very successfully.

I will have a look at the attachments that you sent sometime this weekend–(b) (6) [redacted]
(b) (6) [redacted]

I will start working on incoproating Erin's edits and will make a decision at that time about next steps—I am contemplating reversing the logical flow in the paper even though this is more work, but I think It makes sense to say (a) Here is the comparison of freshwater smolt survival values showing the Columbia River downstream survivals are not anomalously low, (b) Here is the comparison of adult return rates, showing that they too are not anomalously low, and (c) here is the mathematics demonstrating that it is not realistic for further improvements in hydrosystem survival to materially increase SARs. Then (d) would be… and here is the evidence for widespread cognitive dissonance, which is where salmon biologists continue to advocate for doing work in freshwater even when there own data shows that they can't fix the problem by doing so.

Haven't completely decided to do this, but I think it will make it easier to follow the big picture. If you have any thoughts, feel free to weigh in, but that will be what I will be aiming to do, I think.

So additional funding to support this would be both useful and welcome.

D

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, August 10, 2018 2:30 PM
To: David Welch
Subject: FW: Bowles & Graves declarations

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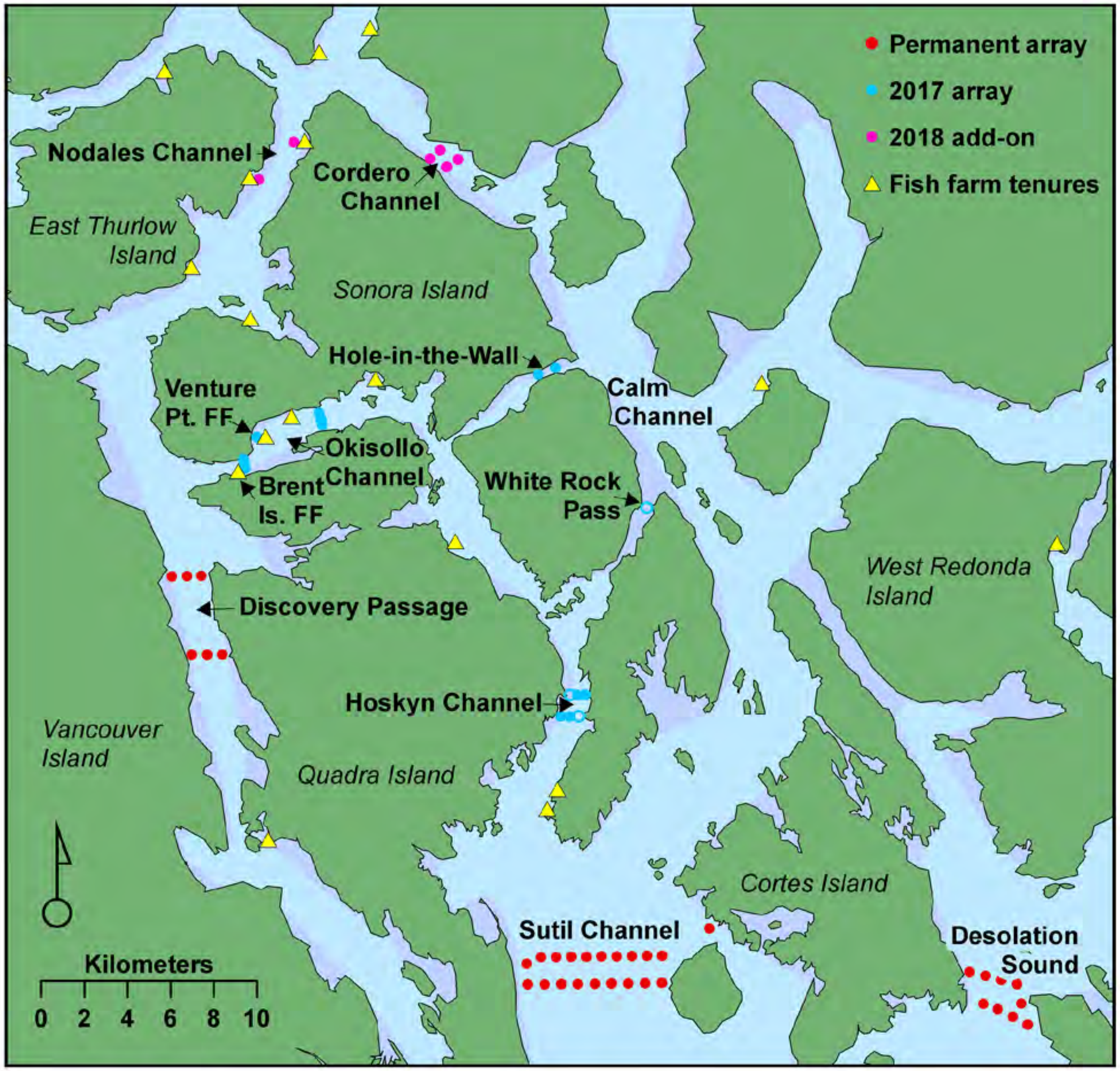
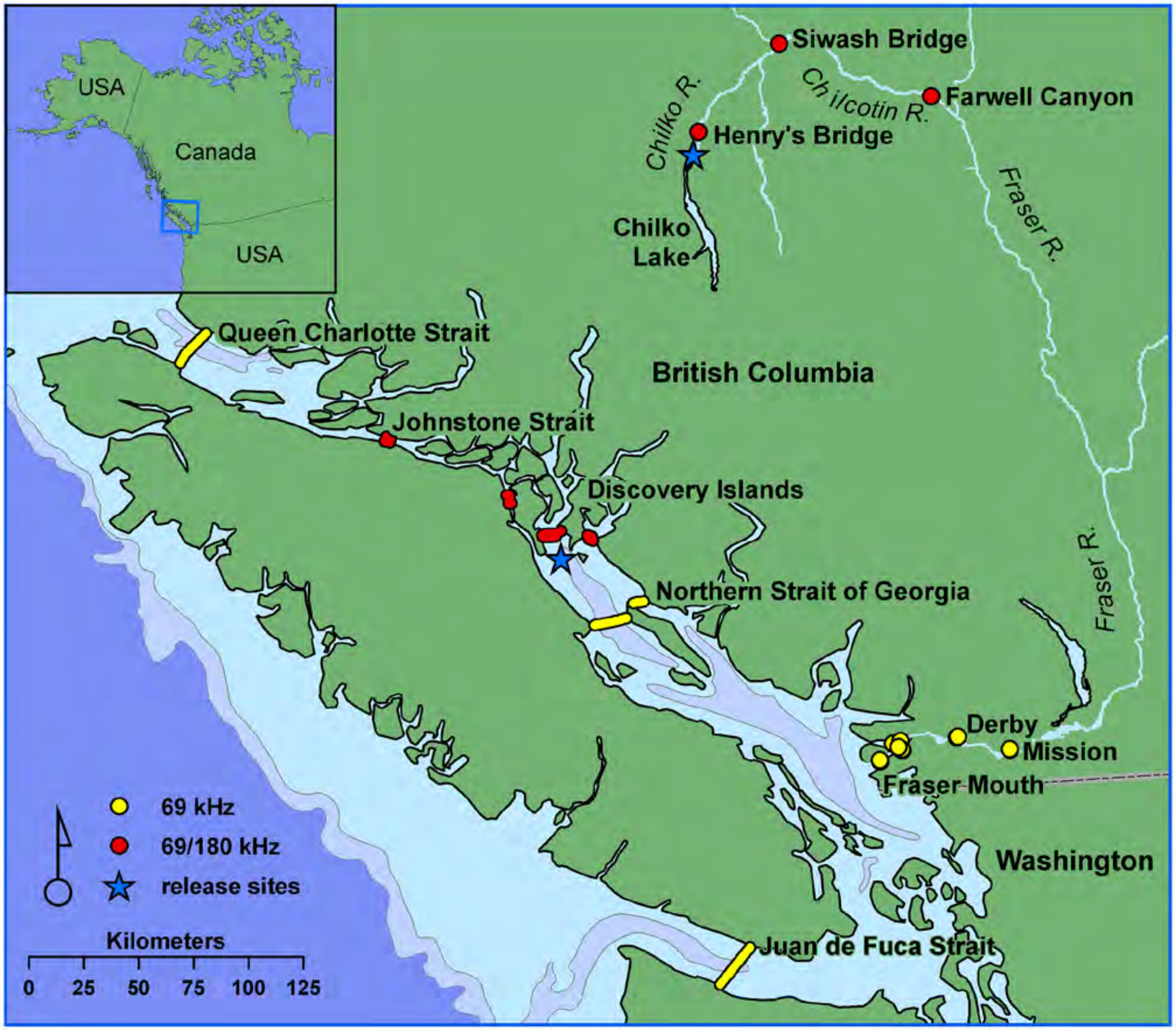

Permanent array
2017 array
2018 add-on
Fish farm tenures
Nodales Channel
Cordero Channel
East Thurlow Island
Sonora Island
Hole-in-the-Wall
Calm Channel
Venture Pt. FF
Okisollo Channel
Brent Is. FF
White Rock Pass
West Redonda Island
Discovery Passage
Hoskyn Channel
Vancouver Island
Quadra Island
Cortes Island
Sutil Channel
Desolation Sound
Kilometers
0 2 4 6 8 10



USA
Canada
USA
Siwash Bridge
Chilko R.
Chilcotin R.
Farwell Canyon
Henry's Bridge
Fraser R.
Chilko
Lake
Queen Charlotte Strait
British Columbia
Johnstone Strait
Discovery Islands
Northern Strait of Georgia
Fraser R.
Derby
Mission
Fraser Mouth
69 kHz
69/180 kHz
release sites
Washington
Kilometers
0 25 50 75 100 125
Juan de Fuca Strait

From: David Welch

Sent: Mon Aug 13 12:49:32 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Alaska Chinook

Importance: Normal

Great—thanks—this is very useful as I hadn't seen this reference.

I have Erin's suggested edits to the paper in hand now, and am currently reviewing them. [redacted] but asked to have a look again at the revised paper once I am finished with it before I send it to Nealla Kendall & Gayle Brown, so it won't go out to the other two for anohter couple of weeks I think.

Over the weekend I read the rebuttals prepared by Bowles and Graves to each other's court submissions that you had sent on Friday (but not the original 400-odd pages of submissions!!). It is pretty easy to see the entrenched positions here, and that neither side is really listening that much to the other side.

Reading this material really brought home the point that a lot of the FPC's conclusions are based on interpreting the ***SARs*** (adult returns) rather than the ***in-river*** smolt survival to Bonneville Dam, which is the direct measurement that can be made with PIT tags—the adult returns are seriously influenced by ocean conditions that have nothing to do with hydrosystem operations, but may still be loosely correlated with freshwater conditions (i.e., correlated but not caused by them). As I result, I have emailed a colleague of mine who works at SFU, Carl Schwarz). Carl is a statistician much in John Skalski's mold and previously did quite a lot of work on statistical power issues.

In the next paper that is up for a funding decision (ie., the paper we originally proposed to do first), I want to make this point:

If the SAR (adult return rate) is ~1%, and $S_{hydrosystem}$ is 50~60%, then

SAR= $(S_{hydrosystem})^N$, which yields N=6.6~9.

This means that the SAR is made up of between 6.6 to 9 successive survival stages, each with a survival magnitude equivalent to what is experienced by the whole hydrosystem. This is important because the N-1 survival periods ***after*** the hydrosystem will also inject variability into the SAR time series and because there are so many of them, it is very likely that they will inject far more variability into the adult SAR time series than will the freshwater factors. As a result, much of the FPC's analysis which focus on correlating freshwater events and SARs should have extremely low statistical power because of this "ocean noise"—almost certainly well below the 80% standard that is accepted in statistics to prevent Type II errors from creeping in. (These Type II errors are the errors where one incorrectly accepts a statistical association as real when it is not… and therefore precisely what the FPC group often report).

I am going to invite Carl on as a co-author if he works with me to quantify how badly statistical power is degraded by using SARs rather than freshwater smolt survival. This part of the new paper should go a long way towards making the case to the courts that correlating SARs with hydrosystem conditions (rather than smolt survival to Bonneville Dam) will be statistically ill-advised and unlikely to reach an acceptable level of statistical power. In essence, the approach used is virtually guaranteed to give statistically spurious results.

Give me a call at the house if you need any further clarification.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, August 13, 2018 12:22 PM
To: Sullivan,Leah S (BPA) - EWP-4; David Welch; Bettin,Scott W (BPA) - EWP-4
Subject: Alaska Chinook

Just found this while trying to find papers on resident orca diet. I'm glad this group is publishing. They are honing in on hatchery competition plus climate:

https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.14315

From: CBFish on behalf of support@cbfish.org

Sent: Mon Aug 13 14:15:42 2018

To: chpetersen@bpa.gov; erin.rechisky@kintama.com

Subject: [EXTERNAL] Status Report Accepted

Importance: Normal

To: Christine Petersen;Erin Rechisky
Cc:

The "Apr-Jun 2018 (4/1/2018 - 6/30/2018)" report for contract #75025 under project #1996-017-00 ("Technical and Analytical Support for ESA Activities/Issues") has recently been accepted by the COTR. You may view the accepted report in Pisces.

If you feel this email has reached you in error, please contact the assigned COTR for this contract, Christine Petersen (chpetersen@bpa.gov).

Thank you,

Environment Fish and Wildlife
Bonneville Power Administration

From: David Welch

Sent: Fri Aug 17 14:08:40 2018

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] RE: September.

Importance: Normal

I believe (well, hope) that Erin can make it in person if you would like our physical attendance. I will just about (b) (6) [redacted]

After I get back on October 10th I am pretty much in town, but (b) (6) [redacted]

I copy Erin for her info— (b) (6) [redacted]

Have a great weekend yourself! I hope it isn't too smoky down around Portland?

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, August 17, 2018 1:38 PM
To: David Welch
Subject: September.

Hi David,

Let's see – sorry to not get back to you regarding several funding requests.

We now have your second paper and contract extension on the agenda for our next tech services review meeting next Wednesday.

Your larger concept for further estuary/plume field work will be discussed by our management later in August as well.

You will probably be contacted soon by Jody Lando or Stacy Humphrey about a BPA research strategy meeting in September where several people who play a technical services role with us will be invited to visit on the same day. I believe this is Sept 28th. Would you be available? I believe an alternate such as Erin would be okay, or possibly calling in. I reminded them that you do not currently have travel money with us, so this amount would need to be added to your contract by us before that date.

Have a nice weekend

Christine

From: Humphrey,Stacy C (CONTR) - EW-4

Sent: Fri Aug 17 16:27:40 2018

To: 'tracy.hillman@bioanalysts.net'; 'al.giorgi@bioanalysts.net'; 'Jack Christiansen'; 'Chuck Peven'; 'cpaulsen@paulsenenvironmentalresearch.com'; 'rich@hinrichsenenvironmental.com'; 'brianm@exelearn.com'; 'timf@fisherfisheries.com'; 'jferguson@anchorqea.com'; 'Phil Roni'; 'jmurauskas@anchorqea.com'; 'skalski@uw.edu'; Jim Anderson; 'disaak@fs.fed.us'; 'david.welch@kintama.com'; Mercier,Bryan K (BPA) - EW-4; Jule,Kristen R (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4; McDonald,Katie M (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4; Scranton,Russell W (BPA) - EWP-4; Allen,Brady (BPA) - EWP-4; Sullivan,Leah S (BPA) - EWP-4; Stier,Jeffrey K (BPA) - E-4; George,Rodrigo (BPA) - EW-4; Donahue,Scott L (BPA) - EWP-4

Cc: Welch,Dorothy W (BPA) - E-4; Karnezis,Jason P (BPA) - EWL-4; Bettin,Scott W (BPA) - EWP-4; Kaplowe,David J (BPA) - EWM-4; Sweet,Jason C (BPA) - PGB-5; Cummings,Adam H (CONTR) - EW-4; Doumbia,Julie A (BPA) - EC-5; Smith,Gregory M (BPA) - EWP-4; Greene,Jacqueline R (CONTR) - EW-4; Zelinsky,Benjamin D (BPA) - A-7; Skidmore,John T (BPA) - EWL-4; Lofy,Peter T (BPA) - EWU-4; L'Heureux,Andre L (BPA) - EWU-4; Welch,Sean P (BPA) - EWL-4; Eagan Moody,Maura (BPA) - EWP-4

Subject: Annual BPA Meeting with Technical Service Contractors - day 1

Importance: Normal

Attachments: Retreat Agenda .pdf

All:

BPA would like to invite you to an annual Technical Service Contractor retreat to be hosted at BPA headquarters in Portland, OR. The retreat serves a few purposes including providing updates on:

1. Recent policy issues that influence our work.
2. Process and contract changes that have been occurring to better align work to BPA priorities.

As requested at last year's retreat, the agenda provides for sharing sessions for contractors to share work with the folks in attendance and provides time for open dialogue amongst you all and BPA staff.

The retreat is scheduled on Wed. Sept. 26 from 12:30-5:00, and again on Thurs. Sept. 27 from 8:30-12:00 at BPA, room 465. We skipped the doodle poll this year since this time of year/week worked well last year and we anticipated it would work well again this year. To maximize your time at HQ, I've asked your points-of-contact within BPA to set up any additional meetings that may benefit from having you at HQ. Please coordinate with them prior to making travel arrangements.

The initial agenda is attached. We are excited to have more time to accommodate the group requests from last year for open dialogue and for sharing work. You will note a series of sharing sessions on the agenda. We are trying something new: these are intended to be opportunities for contractors to share their work with those in attendance and to facilitate cross-pollination. In order to coordinate across a wide body of work and contributors, I've asked BPA staff to connect with many of you on what this may look like. They will reach out in the next couple of weeks to facilitate this. I'm hopeful it evolves into a great learning experience for all.

If you have questions or thoughts on this conversation, please reach out to me or to your respective BPA contract manager, copied on this invite.

Best regards,

Stacy Humphrey
(ContR) CorSource Technology Group
Project Manager | EW-4
Bonneville Power Administration
bpa.gov | P 503-230-3093 | schumphrey@bpa.gov

Technical Service Contractor Retreat

Agenda

Time	Topic	Person
WEDNESDAY SEPT. 26		
• *Contractors to arrive during the morning and have other BPA meetings as needed. Travel should not be made until BPA/Contractors connect to determine if there are pre- or post-retreat meetings desired/scheduled.*		
• *Lunch will be on own*		
12:30 – 12:45	Welcome + Logistics + Agenda Overview	Bryan Mercier and Peter Cogswell
12:45 – 1:15	Introductions	All
1:15 – 2:30	Setting the Stage • Broad policy drivers • RM&E Programmatic overview • SME-focus areas • Discussion	 Bryan Mercier, Peter Cogswell, Kristen Jule Jody Lando H-Leads+ and RM&E SME team members All
2:30 – 2:45	Break	
2:45 – 3:15	Contractor sharing session with Q&A opportunity	Life Cycle Modeling; Paulsen and Hinrichsen
3:15 – 3:45	Contractor sharing session with Q&A opportunity	Welch/Kintama
3:45 – 4:15	Discussion	All
4:15 – 4:45	Contractor sharing session with Q&A opportunity	Fish Data Analysis Tools (Russell and Jody to help structure)
4:45 – 5:00	Recap	Bryan Mercier
5:00	Off-site – Location TBD. No host	All

Time	Topic	Person
THURSDAY SEPT. 27		
8:30 – 8:45	Welcome	Bryan Mercier and Peter Cogswell
8:45 – 9:30	TSC Process changes. Discussion	Katie McDonald, Rachel Kulak, Stacy Humphrey
9:30 – 10:00	Contractor sharing session with Q&A opportunity	Hatchery focus (Kristen, Brady to help structure)
10:00 – 10:45	Contractor sharing session with Q&A opportunity	Hydro focus (Leah and Christine to help structure) (longer session)
10:45 – 11:00	Break	
11:00 – 11:30	Contractor sharing session with Q&A opportunity	Visualization focus (Russell to help structure)
11:30 – 11:55	Open dialogue on next steps and looking forward into FY19	All
11:55 – 12:00	Closing thoughts and next steps	Bryan Mercier
• *Once retreat is complete, contractors may have other BPA meetings as needed. Travel should not be made until BPA/Contractors connect to determine if there are pre- or post-retreat meetings desired/scheduled.*		

From: Humphrey,Stacy C (CONTR) - EW-4

Sent: Fri Aug 17 16:28:23 2018

To: 'tracy.hillman@bioanalysts.net'; 'al.giorgi@bioanalysts.net'; 'Jack Christiansen'; 'Chuck Peven'; 'cpaulsen@paulsenenvironmentalresearch.com'; 'rich@hinrichsenenvironmental.com'; 'brianm@exelearn.com'; 'timf@fisherfisheries.com'; 'jferguson@anchorqea.com'; 'Phil Roni'; 'jmurauskas@anchorqea.com'; 'skalski@uw.edu'; Jim Anderson; 'disaak@fs.fed.us'; 'david.welch@kintama.com'; Mercier,Bryan K (BPA) - EW-4; Jule,Kristen R (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4; McDonald,Katie M (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4; Scranton,Russell W (BPA) - EWP-4; Allen,Brady (BPA) - EWP-4; Sullivan,Leah S (BPA) - EWP-4; Stier,Jeffrey K (BPA) - E-4; George,Rodrigo (BPA) - EW-4; Donahue,Scott L (BPA) - EWP-4; Welch,Dorothy W (BPA) - E-4

Cc: Welch,Sean P (BPA) - EWL-4; Karnezis,Jason P (BPA) - EWL-4; Bettin,Scott W (BPA) - EWP-4; Kaplowe,David J (BPA) - EWM-4; Sweet,Jason C (BPA) - PGB-5; Cummings,Adam H (CONTR) - EW-4; Doumbia,Julie A (BPA) - EC-5; Smith,Gregory M (BPA) - EWP-4; Greene,Jacqueline R (CONTR) - EW-4; Zelinsky,Benjamin D (BPA) - A-7; Skidmore,John T (BPA) - EWL-4; Lofy,Peter T (BPA) - EWU-4; L'Heureux,Andre L (BPA) - EWU-4; Eagan Moody,Maura (BPA) - EWP-4

Subject: Annual BPA Meeting with Technical Service Contractors - day 2

Importance: Normal

Attachments: Retreat Agenda .pdf

All:
BPA would like to invite you to an annual Technical Service Contractor retreat to be hosted at BPA headquarters in Portland, OR. The retreat serves a few purposes including providing updates on:

1. Recent policy issues that influence our work.
2. Process and contract changes that have been occurring to better align work to BPA priorities.

As requested at last year's retreat, the agenda provides for sharing sessions for contractors to share work with the folks in attendance and provides time for open dialogue amongst you all and BPA staff.

The retreat is scheduled on Wed. Sept. 26 from 12:30-5:00, and again on Thurs. Sept. 27 from 8:30-12:00 at BPA, room 465. We skipped the doodle poll this year since this time of year/week worked well last year and we anticipated it would work well again this year. To maximize your time at HQ, I've asked your points-of-contact within BPA to set up any additional meetings that may benefit from having you at HQ. Please coordinate with them prior to making travel arrangements.

The initial agenda is attached. We are excited to have more time to accommodate the group requests from last year for open dialogue and for sharing work. You will note a series of sharing sessions on the agenda. We are trying something new: these are intended to be opportunities for contractors to share their work with those in attendance and to facilitate cross-pollination. In order to coordinate across a wide body of work and contributors, I've asked BPA staff to connect with many of you on what this may look like. They will reach out in the next couple of weeks to facilitate this. I'm hopeful it evolves into a great learning experience for all.

If you have questions or thoughts on this conversation, please reach out to me or to your respective BPA contract manager, copied on this invite.

Best regards,

Stacy Humphrey
(ContR) CorSource Technology Group
Project Manager | EW-4
Bonneville Power Administration
bpa.gov | P 503-230-3093 | schumphrey@bpa.gov

From: David Welch

Sent: Wed Sep 05 21:35:41 2018

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] FW: Season Reflection

Importance: Normal

Interesting early report on the Alaskan salmon situation…. Not that I wish the Alaskans bad luck, but 1976 is coincidentally the last year of the "bad" salmon returns to Alaska. In 1977 the regime shift happened and also ADFG took over from the Feds on salmon management. The rise in salmon returns post-1977 was not surprisingly attributed to better management at the time, though there has been some acknowledgment since then that ocean climate played some beneficial role as well.

From: Shaul, Leon D (DFG) [mailto:leon.shaul@alaska.gov]
Sent: Wednesday, September 05, 2018 5:01 PM
To: Jim Irvine; Beamish, Richard; David Welch; Skip McKinnell; Laurie.Weitkamp@noaa.gov; Richard Alexander; Greg Ruggerone; Jamal Moss - NOAA Federal; Megan McPhee; Milo Adkison; Curry Cunningham; abeaudreau@alaska.edu
Subject: FW: Season Reflection

Since the SEAK pink salmon catch is nearly complete, and it's possible to make at least a rough projection of the season total wild commercial coho catch, I updated the graph showing both parameters back to 1940 – with the pink catch converted to coho scale for comparison based on the (relatively) immutable historic relationship (Pink =

9 Coho^2).

The impression of a poor salmon season has certainly not been a figment of our imagination – both variables (pink and wild coho catch), as well as the scaled average, appear fairly certain to come in under all other years since 1976. The sockeye catch will likely be third lowest since 1888 (not a typo), after 1975 and 2008.

From: Erin Rechisky

Sent: Thu Sep 06 12:26:18 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE:

Importance: Normal

I'm here until 2. Call me when you can.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 6, 2018 12:23 PM
To: Erin Rechisky
Subject:

Hi Erin,

Do you have time this afternoon or tomorrow to chat?

If our accountant has now given us the possibility of going above $42,000 for this first phase through January 31, I would like to know what your preferred pace of work would be this winter. If we add the start of the second paper to this contract modification, we wouldn't want to be too confident about your ability to make progress by Feb 1, but grabbing FY17 funds which we didn't know we had would make things easier than potentially having to stretch out into FY20.

Christine

From: David Welch

Sent: Thu Sep 06 12:48:37 2018

To: Erin Rechisky; Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Fiscal year accounting/ RE: Trip

Importance: Normal

Just to add to what Erin mentioned, in response to your question *"What fraction would be best scheduled for FY2019, starting February 1?"*, I would hazard a guess that 4/5ths of the second paper would be done by then. To be explicit, I would hope that the manuscript would be ready to submit to a journal by Feb 1st, with all co-authors onside for the submission. Once I get a little way into the next paper I will make a preliminary inquiry to the editors at Science, alerting them to the nature of the paper, why it is important, and trying to secure from them a pre-submission agreement that the paper will be accepted for review.

Publication at Science is a long shot, as I suspect that the publication rate is still only running at about 5% (i.e., 95% of all papers are rejected for publication). However, if the Science reviewers agree that it is a good paper, we can probably send the re-formatted manuscript in to another specialty journal with the Science reviews and probably facilitate the acceptance process somewhat. I am optimistic that it will fly at Science because it should be considered a major breakthrough.

David

From: Erin Rechisky

Sent: Thursday, September 06, 2018 12:39 PM
To: Petersen,Christine H (BPA) - EWP-4; David Welch
Subject: RE: Fiscal year accounting/ RE: Trip

Hi Christine,

We hope to have the SAR paper reviewed by co-authors and submitted to the journal by mid-October. Davis is keen on beginning the survival rate paper while we wait for the peer reviews to come back.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 5, 2018 1:57 PM
To: Erin Rechisky; David Welch
Subject: Fiscal year accounting/ RE: Trip

Hi,

That is a good choice – it is just a couple blocks away. There are a lot of buildings under construction in this neighborhood, including an additional hotel by the convention center.

I have another big question to ask you. At the end of our phone call yesterday, I had said I would go talk to our accountant about how to add the $42,000 from our fiscal year 2018 technical services budget to your contract, and

I asked you to please discuss amongst yourselves what would be both a reasonable timeline and a preferred timeline for sending your paper off to a journal and working through peer review, and developing your second paper.

Your 24 month contract started in fiscal year 2017. I assumed that 2017 is over and that we have no unallocated 2017 funds, particularly because we use 'modern corporate accounting' which has an approach of use-it or lose-it when they balance the program budget at the end of the year. Our accountant explained that there were unallocated funds from our FY2017 tech services budget which could be added to your FY2017 contract which ends January 31, and he prefers I would use that first instead of the unspent 2018 funds (which might still be requested for a different use).

Could you explain what season of the year you would have the most time to work on writing? Our managers would prefer that you complete the first paper and have it sent out the door before starting work on the second one. We might want to establish a milestone or goal for that and state it in the statement of work. If it makes sense, we could potentially start work on the second paper before February 1, but I would really like to know how much progress you would make by January 31 so we would establish the best split. I do not want to try to add most or all of the project budget by January 31 which would give you a sharp deadline for completion. What fraction would be best scheduled for FY2019, starting February 1? If we carried it out this way, we would need to add the work element describing the second paper to the statement of work, and allocate funds for it.

Thanks

Christine Petersen

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Wednesday, September 05, 2018 11:39 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: Trip

Hi Christine.

Thanks.

I am staying at the Inn at the Convention Center.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 5, 2018 10:04 AM
To: Erin Rechisky
Subject: Trip

Hi Erin

Do not change your flight. We can schedule any discussion related to your presentation or your area of work for Wednesday evening. Leah Sullivan is very interested to meet you; she has joined us from USGS and Blue Leaf, where she was carrying out JSATs tests for Grant County.

We are trying to plot out how we would like to guide the hydro themed discussion for Thursday. So far, everything comes back to TDG effects and latent mortality.

Which hotel were you going to stay at?

Christine

Sent from VMware Boxer

From: McDonald,Katie M (BPA) - EWP-4

Sent: Thu Sep 06 13:34:30 2018

To: Erin Rechisky (Erin.Rechisky@kintama.com)

Subject: FW: Expanded Kintama SARS & Hinrichsen LCM discussion

Importance: High

-----Original Appointment-----
From: McDonald,Katie M (BPA) - EWP-4
Sent: Thursday, September 06, 2018 1:21 PM
To: McDonald,Katie M (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4; Jule,Kristen R (BPA) - EWP-4; Smith,Gregory M (BPA) - EWP-4; Karnezis,Jason P (BPA) - EWL-4; Petersen,Christine H (BPA) - EWP-4; Zelinsky,Benjamin D (BPA) - A-7; George,Rodrigo (BPA) - EW-4; Sullivan,Leah S (BPA) - EWP-4; Stier,Jeffrey K (BPA) - E-4; Doumbia,Julie A (BPA) - EC-5
Cc: Sweet,Jason C (BPA) - PGB-5
Subject: Expanded Kintama SARS & Hinrichsen LCM discussion
When: Thursday, September 27, 2018 1:15 PM-2:30 PM (UTC-08:00) Pacific Time (US & Canada).
Where: HQ 214(40) + EW Phone Bridge
Importance: High

Hi Team,

Please hold this time in reserve after close of the TSC retreat for a continued & further discussion with Kintama, Rich Hinrichsen, Charlie Paulsen, Tracy Hillman, and Al Giorgi on interpreting and applying results of the Kintama West Coast SARs and the Hinrichsen life cycle modeling/carrying capacity work in our program. In particular it would good to discuss what this could mean for our habitat and hydro programs.

Please confirm your ability to attend~

Thank you,

Katie

From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Sep 06 13:46:56 2018

To: Erin Rechisky (Erin.Rechisky@kintama.com)

Subject: FW: Thurs 1:15

Importance: Normal

From: McDonald,Katie M (BPA) - EWP-4
Sent: Thursday, September 06, 2018 1:46 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: RE: Thurs 1:15

Yes we would as her to fly later in the day on Thursday afternoon to accommodate this meeting.

If we start at 1:15 and Erin could stay till 2PM, to accommodate her 4PM departure time, that would be great! I can't imagine it would take her any more than 20-30 mins on the max (or even fewer on a Uber or Lyft) to get to the airport from BPA HQ.

Our retreat ends at 5PM Wednesday evening – and out of respect of the business day and folks' family schedules

I wouldn't recommend attempting to schedule the meeting after 5PM.

Thanks!
Katie

Katie McDonald,

Tributary Habitat Research, Monitoring & Evaluation (RM&E) Lead

BPA F&W Division | Policy & Planning Group (EWP-4)
M - F: office hours 8-4pm

Office: (503) 230-4056

Cell: (b) (6) [redacted]

kmmcdonald@bpa.gov | 905 NE 11th Avenue | Portland, OR 97232

From: Petersen,Christine H (BPA) - EWP-4
Sent: Thursday, September 06, 2018 1:41 PM
To: McDonald,Katie M (BPA) - EWP-4
Subject: Thurs 1:15

Hi Katie,

I have to try to confirm that Erin Rechisky could attend – she has a flight at 4pm, which she could change, but there were not a lot of options. She did see later that we asked them to reserve flights ***after*** this pre-post planning stuff.

Is there a possibility of holding the discussion or parts of it Wednesday evening?

Basically – based on the time availability of all the other people, should we ask Erin to stay for Thurs afternoon? (the logistics are daunting with all these people).

From: Erin Rechisky

Sent: Fri Sep 07 14:36:23 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: budget

Importance: Normal

Hi Christine,

I wasn't clear. I was asking if you could make the survival rate paper work elements active again. We will not have the paper completed by Jan 31st but that is the end of our contract, so the latest date we could enter would be Jan 31st, if I understand correctly. I can't enter a deliverable date that extends beyond the contract. How do I handle that since the deliverable will be under a different contract number and later in 2019?

Call me if it's easier and faster.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 7, 2018 2:22 PM
To: Erin Rechisky
Subject: RE: budget

Yes – I would say that you might not want to be too overconfident in how much you can accomplish by that date. On BPA's side, leaning earlier actually helps us balance our 2019 budget, but there are many reasons to schedule work into 2019. Jody would like us to have a staged approach, where we plan to have one of these check-in meetings like last month where one or several of you would explain the initial results or paper to a group at BPA.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Friday, September 07, 2018 12:55 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: budget

Yes, sorry about that Christine. It's not trivial to estimate how much we can accomplish over a 3 month period.

Can you un-cancel the survival rate paper Wes and extend the end date to Jan 31, 2019? And then I can modify it (if possible-it's not clear to me). If not, I'll add the WEs as new.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 7, 2018 12:51 PM
To: Erin Rechisky
Subject: RE: budget

I think so, and we definitely were not going to be able to get the CCR over for management approval today. We should strive to get the CCR moving by early next week.

Do you think it will be complicated to add the work element description for the second paper? I would be inclined to mostly un-cancel the existing work element that we cancelled in the first contract modification, however you might have a few sentences to change.

I could try to prep our contract officer Rachel Kulak to expect this. There is always a large number of contracts to work with during September.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Friday, September 07, 2018 12:35 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: budget

Hi Christine,

I was just talking to Aswea about that. We need to make a list of the ongoing projects that we will be working on so we can come up with a realistic estimate for work we can complete on the survival rate paper in Nov-Jan. I looks like we will not have an estimate today.

Is next week ok? (Mon or Tuesday)

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 7, 2018 12:25 PM
To: Erin Rechisky
Subject: budget

Hi Erin

Did you have an updated vision of what split you would anticipate for splitting writing, and peer review tasks between the remainder of this contract period, and after February 1?

With this, I can adjust the contract modification amount. I would also like to run it by Jody Lando or perhaps Kristen Jule so they see how we are planning this.

Christine

From: Erin Rechisky

Sent: Fri Sep 07 16:51:39 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: budget

Importance: Normal

Attachments: DRAFT Budget Kintama CCR2 Sept 2018.xls

Hi Christine,

I don't have definite estimates yet, but I've put together a draft budget assuming we'll invoice for about half of the 46k, the travel, and about 2/3 of the survival rate paper prior to the Jan 31 2018 contract end date.

I added another "personnel" section in this draft so I could keep track of the budget for each paper. It will need to be consolidated in a final version once we estimate the hours next week.

The current draft budget including 2 modifications is $340 k. This leaves $49k for the contract beginning in 2019 ([232k + 47k+ 110k] – $340k= $49k).

Are we getting there? I'll finalize the work hours next week.

Have a good weekend,

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]

Sent: September 7, 2018 2:24 PM
To: Erin Rechisky
Subject: RE: budget

Our finance team told us to start a new contract because they are leaning away from longer terms, and prefer 12 months as the period. It is easier for us to set a milestone by the end, and then copy parts of the work element into the next period.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Friday, September 07, 2018 2:01 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: budget

Hi Christine,

Question: Would extending the current contract for a year and adding all of the WEs make things easier?

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 7, 2018 12:51 PM
To: Erin Rechisky
Subject: RE: budget

I think so, and we definitely were not going to be able to get the CCR over for management approval today. We should strive to get the CCR moving by early next week.

Do you think it will be complicated to add the work element description for the second paper? I would be inclined to mostly un-cancel the existing work element that we cancelled in the first contract modification, however you might have a few sentences to change.

I could try to prep our contract officer Rachel Kulak to expect this. There is always a large number of contracts to work with during September.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Friday, September 07, 2018 12:35 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: budget

Hi Christine,

I was just talking to Aswea about that. We need to make a list of the ongoing projects that we will be working on so we can come up with a realistic estimate for work we can complete on the survival rate paper in Nov-Jan. I looks like we will not have an estimate today.

Is next week ok? (Mon or Tuesday)

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 7, 2018 12:25 PM
To: Erin Rechisky
Subject: budget

Hi Erin

Did you have an updated vision of what split you would anticipate for splitting writing, and peer review tasks between the remainder of this contract period, and after February 1?

With this, I can adjust the contract modification amount. I would also like to run it by Jody Lando or perhaps Kristen Jule so they see how we are planning this.

Christine

SI-3: Direct Comparison of CWT and PIT tag-based SAR Estimates.

We can identify two major systematic differences between the PIT- and CWT-based survival estimates: (1) PIT-based SAR estimate adult survival using those smolts that first survived to reach the topmost dam in the Columbia River hydrosystem and then return as adults to a dam where they are enumerated, while CWT-based SAR estimate adult survival from smolt release from the hatchery or (for wild fish) from an enumeration site in the river after smolt migration starts until adult return to the hatchery or spawning ground. (2) CWT-based survival estimates from the Pacific Salmon Commission (PSC) add the estimated sport and commercial harvest to the adult return to the river, while PIT tag-based survival estimates do not. The first difference (upstream losses not being included in the PIT tag-based analysis) will reduce CWT survival estimates relative to PIT tags, while the latter (harvest) will increase CWT survival.

Overall, it is difficult to predict exactly how the two estimates should combine to influence relative SAR for any given population. In this section we report our attempts to investigate this issue more thoroughly.

To assess the magnitude of the disparity between these two tagging methodologies, we searched the datasets for populations that had both PIT and CWT-based survival estimates for the same smolt outmigration year. We found three populations of subyearling (Fall) Chinook that had both CWT and PIT tag-based survival estimates (Table S3-1), but no matching populations for yearling (Spring) Chinook.

<u>**Sub-Yearling Comparison**</u>

We calculated a conversion factor between the CWT and PIT-based SAR estimates using linear regression on the matched pairs of survival estimates, with the PIT-based estimates as the independent and CWT-based estimates as the dependent variables (Figure S3-1; Table S3-1). The intercept from this relationship was not significantly different from zero (Table S3-2), so we ran the regression again with the intercept set to zero. The resulting slope (Table S3-2) was our conversion factor; the CWT-based SAR estimates were ca.

1.5X larger than the PIT-based estimates for the same stock and year of outmigration. That is, the combined effects of (a) migratory survival by downstream migrating smolts between the hatchery and the top-most dam in the hydrosystem, (b) upstream survival of migrating adults between the top-most dam and the spawning grounds (or enumeration site), and (c) sport and commercial harvest result in CWT-based SAR estimates averaging ca. 150% of the PIT tag-based estimates because the PIT tag-based SAR estimates do not take into account these processes.

Table S3-1. Stocks with SAR estimates for common outmigration years in both the CWT and PIT datasets. The "Stock" fields give the names as accessed from the source. For the PIT-based SARs, the "Stock" field was called "GroupDescription" on download. For PIT-based SAR where more than one release group is listed (i.e., for Spring Creek and Lyons Ferry) we used the mean SAR weighted by the sample size in the regression.

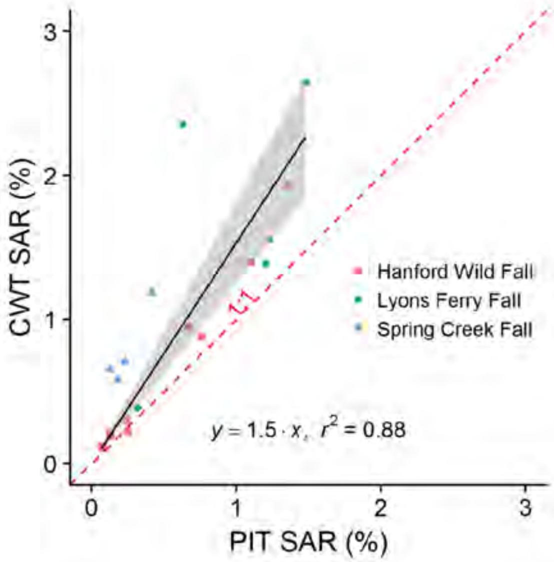
Stock PIT-based	Stock CWT-based	H/W	Years
Hanford Reach Wild Fall Chinook	Hanford Wild	W	2000-2001, 2003-2005, 2007-2011
Spring Creek Hatchery Fall Chinook (March Release) Spring Creek Hatchery Fall Chinook (April Release) Spring Creek Hatchery Fall Chinook (May Release)	Spring Creek Tule	H	2008-2011
Lyons Ferry Hatchery Fall Chinook at Big Canyon Creek Lyons Ferry Hatchery Fall Chinook at Captain John Rapids Lyons Ferry Hatchery Fall Chinook at Pittsburg Landing Lyons Ferry Hatchery Fall Chinook at Snake River	Lyons Ferry	H	2006, 2008-2011

Table S3-2. Results from the linear regression between CWT (dependent) and PIT-tag (independent)-based SAR estimates for subyearling Chinook salmon with matched stocks and years of outmigration.

Model	Variable	Estimate	SE	t value	P	R^2

Model 1	Intercept	0.186	0.151	1.232	0.235	0.697
	Slope	1.341	0.206	6.507	<0.001	
Model 2	Slope	1.535	0.135	11.360	<0.001	0.871

Figure S3-1. Comparative SARs of CWT and PIT tag based SARS estimates for subyearling Chinook salmon with matched stocks and years of outmigration. The red dashed line shows the expected 1:1 relationship if both PIT and CWT based survival estimates were exactly equivalent.



Yearling Comparison

Because we found no matching populations of yearling Chinook in the PIT and CWT-based SAR datasets included in the main paper (see Methods), we approximated a conversion factor using SAR estimates from the University of Washington's DART database as an intermediate step (http://www.cbr.washington.edu/trends/index.php, data provided by Chris Van Holmes and Rich Townsend of U. Washington on Aug 17, 2017). The DART SAR estimates are also based on CWT recoveries, but for clarity we refer to them as "DART" and use "CWT" for the estimates from the PSC reported in the main body of the paper. The DART estimates are not inflated for harvest; methods are documented in (Skalski and Townsend 2005).

We found one population of yearling Chinook that had both DART and PIT tag-based SAR estimates, and a second population that had both DART and CWT SAR estimates (Table S3-3). For each population separately, we used linear regression on the matched pairs of survival estimates with the DART estimates as the dependent variable and the 1) PIT and 2) CWT-based estimates as the independent variable (Figure S3-2; Figure S3-3; Table S3-4). The intercept from both these relationships was not significantly different from zero, so in both cases we repeated the regressions with the intercept set to zero (Table S3-4).

The ratio of the resulting slopes allows us to calculate an overall yearling conversion factor. The DART vs PIT regression had a slope of 0.447, while the CWT vs DART regression yielded a slope of 1.478 (Table S3-4). Their product yields an overall CWT vs PIT tag relationship of 0.447x1.478=0.66. The CWT-based SAR estimates were thus only 2/3rds the PIT-based SAR estimates for yearling Chinook. This should be considered only a rough estimate of the "typical" difference between CWT and PIT tag-based SAR estimates because it is based on only two populations that were from different areas of the Columbia River system; however, the direction of the difference is roughly as expected because the PIT tag survival estimates (McCann et al. 2017) exclude smolt and adult losses above the dams while these are included in the PSC (& DART) SAR estimates. Also, as expected, the DART CWT-based SAR estimates are lower than the PIT tag-based SAR estimates. Neither the DART CWT-based SAR or the PIT tag-based SAR incorporate losses to commercial and sport harvest; the Pacific Salmon Commission's CWT-based SAR estimates used in the main paper include harvest in calculating SARs, which should bring them closer to the PIT tag-based SAR estimates. However, as noted in the main paper, harvest rates of yearling (Spring) Chinook tend to be lower than for subyearling (Fall) Chinook because populations of the latter group remain exposed to fisheries on the continental shelf for several years.

Table S3-3. Stocks with SAR estimates for the same years of outmigration in the 1) PIT and DART, and 2) CWT and DART datasets. The "Stock" fields give the names as accessed from the source. For the PIT-based SARs, the "Stock" field was called "GroupDescription" on download. For the DART-based SARs, the "Stock" field was called "hatchery_location_name". Also for the DART-based SARs, when more than one release location is listed we used the mean SAR weighted by the sample size. Dworshak spring Chinook were released from Dworshak National Fish Hatchery for the PIT-based estimates; release locations were not provided for the CWT-based estimates.

		DART			
Stock PIT or CWT-based		**Stock**	**Release location**	**H/W**	**Years**
PIT	Dworshak Hatchery Spring Chinook	Dworshak Nat. Hatchery	Dworshak Nat. Hatchery	H	1997-2013
CWT	Willamette Spring	Willamette Hatchery	Willamette R M FK-1 Santiam R S FK Molalla R	H	1989-1989, 1996-2011

Table S3-4. Results from the linear regression between DART (dependent) and CWT/PIT tag (independent)-based SAR estimates for yearling Chinook salmon with matched stocks and years of outmigration.

Model	Variable	Estimate	SE	t value	p	R^2
			DART vs PIT			
Model 1	Intercept	-0.023	0.079	-0.291	0.775	0.502
	Slope	0.477	0.115	4.141	<0.001	
Model 2	Slope	0.447	0.050	8.903	<0.001	0.822

CWT vs DART						
Model 1	Intercept	0.268	0.211	1.270	0.222	0.522
	Slope	1.192	0.270	4.421	<0.001	
Model 2	Slope	1.478	0.150	9.842	<0.001	0.842

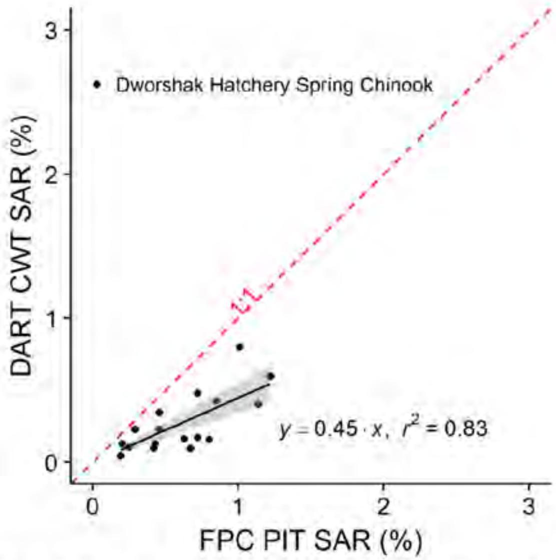


Figure S3-2. Comparative SAR of DART and PIT tag-based SAR estimates for yearling Chinook salmon with matched stocks and years of outmigration. The red dashed line shows the expected 1:1 relationship if both DART and PIT-based survival estimates were equivalent. The derived relationship indicates that the product of migratory survival by downstream migrating smolts after release from the hatchery until arrival at the top-most dam in the hydrosystem *and* multiplied by the survival of the upstream migrating adults above the top-most dam is 45%, as this component of the SAR is excluded from the published PIT tag SAR estimates (McCann et al. 2017).

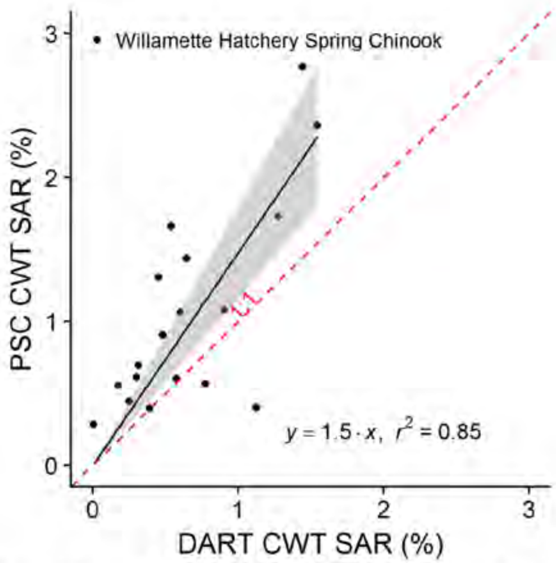


Figure S3-3. Comparative SAR of CWT and DART tag-based SAR estimates for yearling Chinook salmon with matched stocks and years of outmigration. The red dashed line shows the expected 1:1 relationship if both DART and CWT-based survival estimates were equivalent. The higher survival for the PSC's CWT-based SARs is in accord with expectation, as harvest is incorporated into the PSC's SAR estimates but not the DART-based estimates.

References

McCann, J., B. Chockley, E. Cooper, B. Hsu, H. Schaller, S. Haeseker, R. Lessard, C. Petrosky, T. Copeland, E. Tinus, E. V. Dyke, A. Storch and D. Rawding (2017). Comparative Survival Study of PIT-tagged Spring/Summer/Fall Chinook, Summer Steelhead, and Sockeye. 2017 Annual Report. Portland, Oregon.

Skalski, J. R. and R. L. Townsend (2005). Pacific Northwest Hatcheries Smolt-To-Adult Ratio (SAR) Estimation Using Coded Wire Tags (CWT) Data. Portland, OR, U.S. Department of Energy, Bonneville Power Administration. **Prepared by: Columbia Basin Research, School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA. Project No. 1991-051-00; Contract No. 00013690. :** 13 pp.

From: Erin Rechisky

Sent: Fri Sep 21 20:06:44 2018

To: Petersen,Christine H (BPA) - EWP-4

Cc: schumphrey@bpa.gov

Subject: [EXTERNAL] RE: slides

Importance: Normal

Attachments: Kintama BPA Contractors retreat Sept 26 2018.pptx

Hi Christine,

(b) (6) [redacted]

The presentation is attached.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 21, 2018 5:28 PM
To: Erin Rechisky
Cc: Lando,Jody B (BPA) - EWP-4
Subject: slides

Hi Erin,

I hope you're having a nice time in New Hampshire.

Could you please send us a copy of the slides you would like to use by Monday 11am, west coast time, at the latest. Our folks would like to set up the presentations for Wednesday, and plan to review them at this time. Some at BPA (but not the other technical contractors we work with) will have seen David's presentation already, so I wouldn't stress too much about minor details. Your major results figures that you have already shared will tell the story.

Please send slides to Stacy Humphrey: schumphrey@bpa.gov

Have a good weekend

Christine

The Coast-wide Collapse in Marine Survival of West Coast Chinook and Steelhead: Simply a Slow-moving Catastrophe or a Deeper Failure?

Presented by: Erin Rechisky, Kintama Research Services

Introduced by Jody Lando, BPA

Contributors

- David Welch & Aswea Porter- Kintama
- Neala Kendall, WDFW- Steelhead SAR data
- Gayle Brown, Fisheries and Oceans Canada- CWT data from the PSF

Conclusions

- The Columbia River basin does not have a smolt survival problem.
- Rather it has a failure of sufficient adult salmon to return from the ocean.
- This failure is not being significantly driven by freshwater events.
- A consequence of this demonstration (smolt survival ***and*** adult SARs both being comparable to other regions without dams) is that the way the hydrosystem is being managed for salmon conservation is wrong.

Two Alternative Versions of Reality

1. The dams continue to prevent the recovery of CR salmon stocks.
2. The effect of the dams has largely been repaired and the continued failure to recover is due to ocean conditions, which are blamed on the dams.

A Question to Frame the Presentation

- Let's Make the Math Easy.
- Assume hydrosystem survival is "only" 33% (1/3)
- (Actually it is 50%~60% from FPC calculations)
- Where is the survival issue that the region needs to deal with?

- *After all, with 2/3rds of the fish dying in the FCRPS, it's obviously the dams, right?*

Collapse in Marine Survival of Chinook and Steelhead

Answer: The Ocean

- Columbia River SARs are about 1%
- If S_{FW}=33% (or 1/3rd)
- then S_{Ocean}= 1/33.3333…

$$(because\ S_{FW} \square S_{Ocean} = {}^{1}\!/_{3} \square {}^{1}\!/_{33.333} = {}^{1}\!/_{99.999} = 1\%)$$

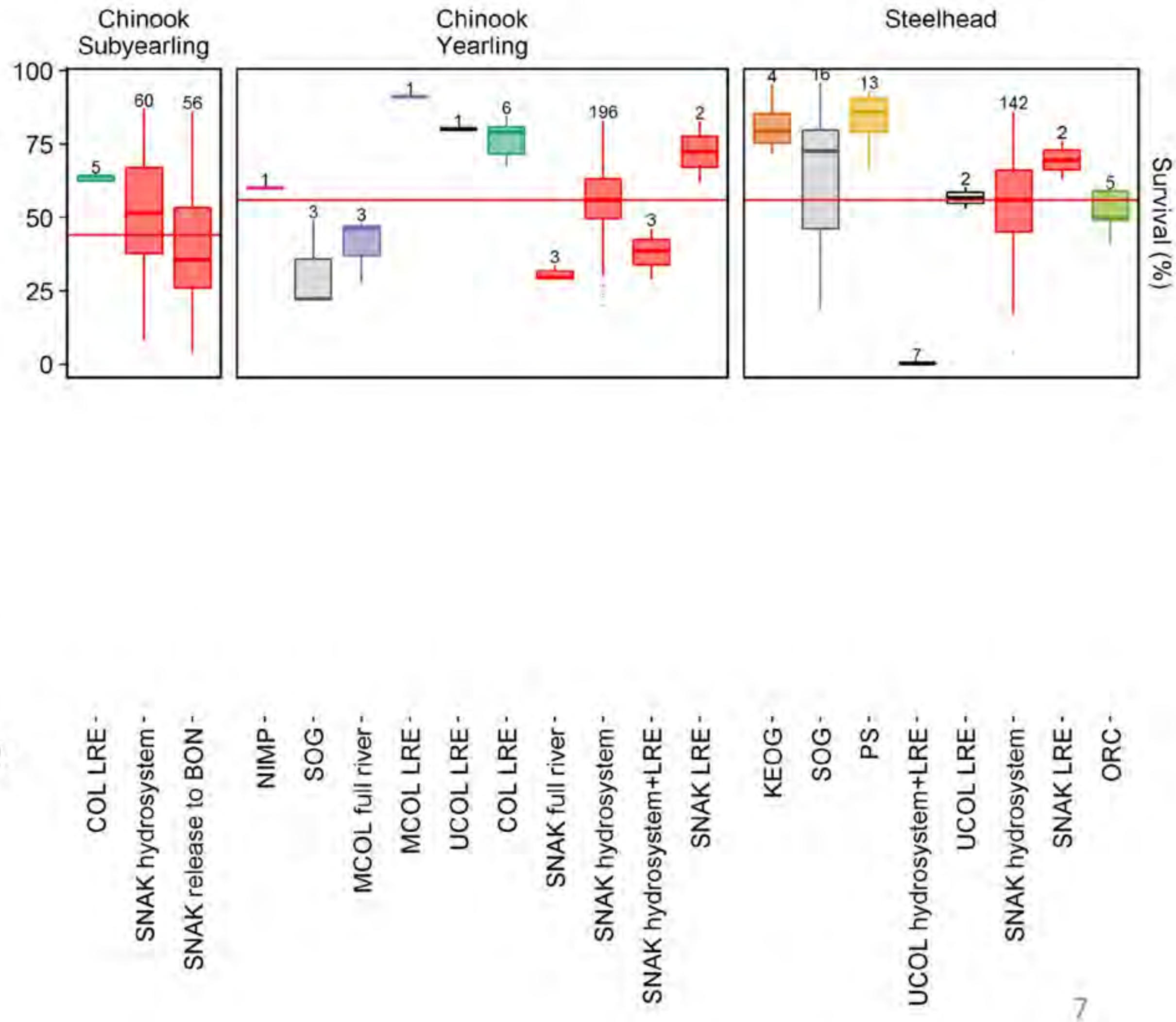
  - So in this hypothetical example, freshwater survival is 11X higher (33.3/3) than marine survival.

- In reality, S_{FCRPS} is 50%~60% so the real ratio implies that the ocean is 25X~36X more important than the hydrosystem.

- Q: How did we get to where we are now in the Columbia?
- A: *Cognitive Dissonance.*

Let's Begin at the Start: Comparing Downstream Freshwater Smolt Survival in Different Rivers

- Used N=531 annual freshwater survival estimates for smolts
- Snake River SARs (red) in the middle of the pack
- When scaled by distance travelled, Columbia hydrosystem survivals are equal or better than other river systems(!)
- Note also the lack of evidence for delayed mortality



Now Let's Look at the End: Comparing Adult SARs for Different Regions (2400 years of data)

Coast-wide SARs Data Sources

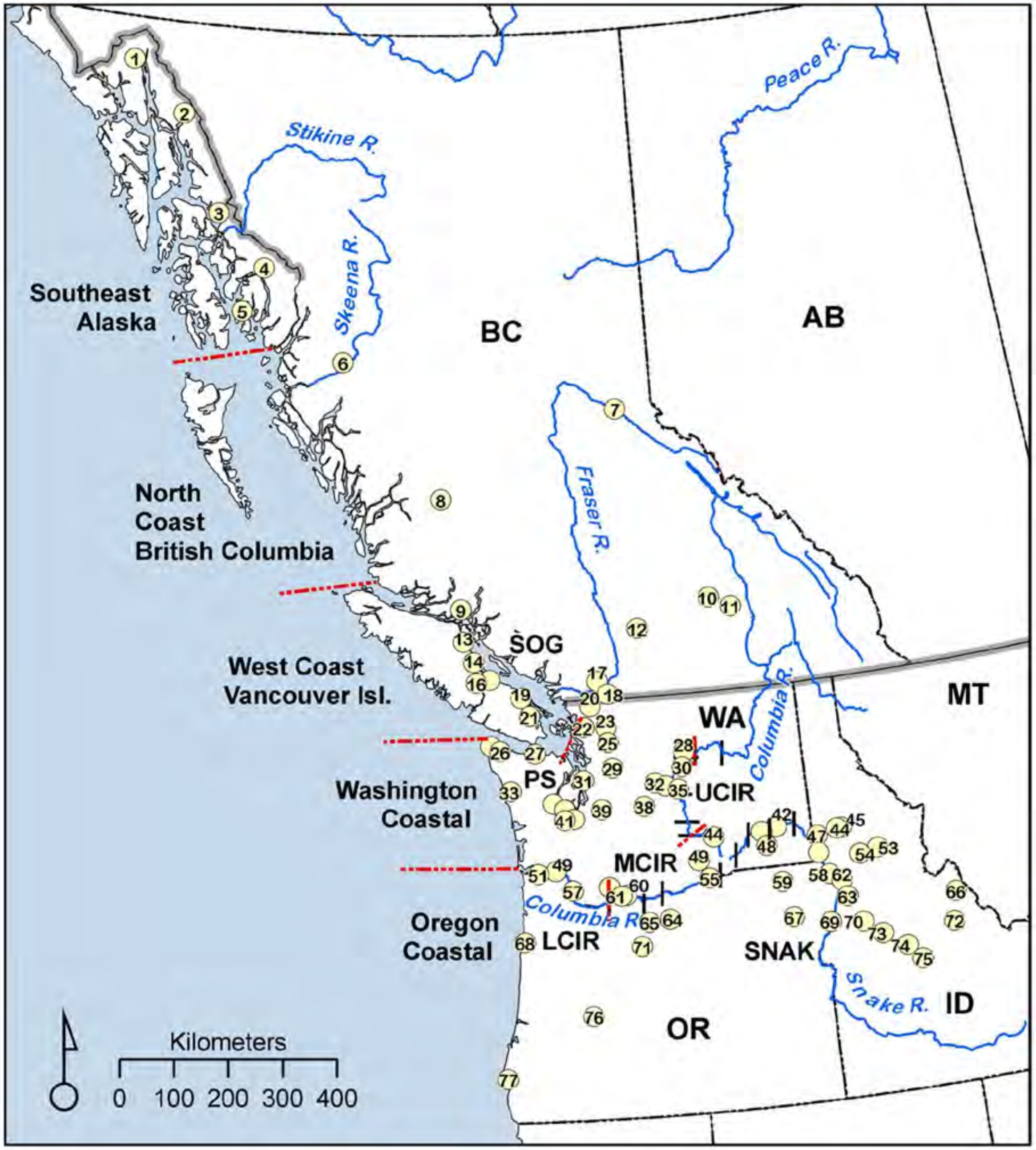
- Pacific Salmon Commission- CWT
  - Southeast AK to OR coast (including Strait of Georgia and Puget Sound)
  - from river/hatchery to return
  - accounts for harvest

- Fish Passage Center- PIT
  - Columbia River Basin
  - most upstream dam and back
  - does not account for harvest (results in underestimate)
  - does not account for release to dam survival (overestimate)

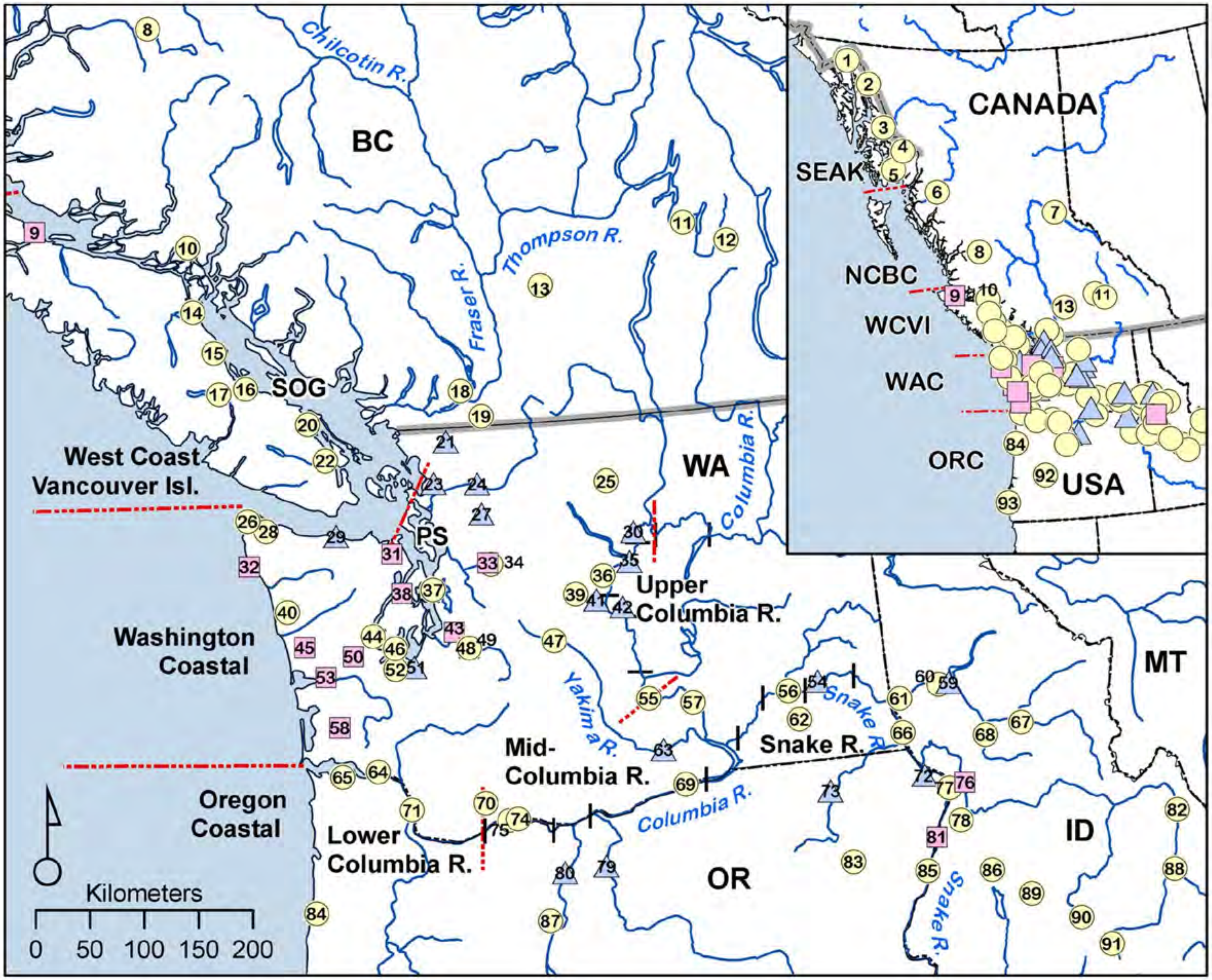

NORTH AMERICAN JOURNAL OF FISHERIES MANAGEMENT

- Raymond (1988)- freeze branding
  - Upper Columbia and Snake R.
  - accounts for harvest

Collapse in Marine Survival of Chinook and Steelhead

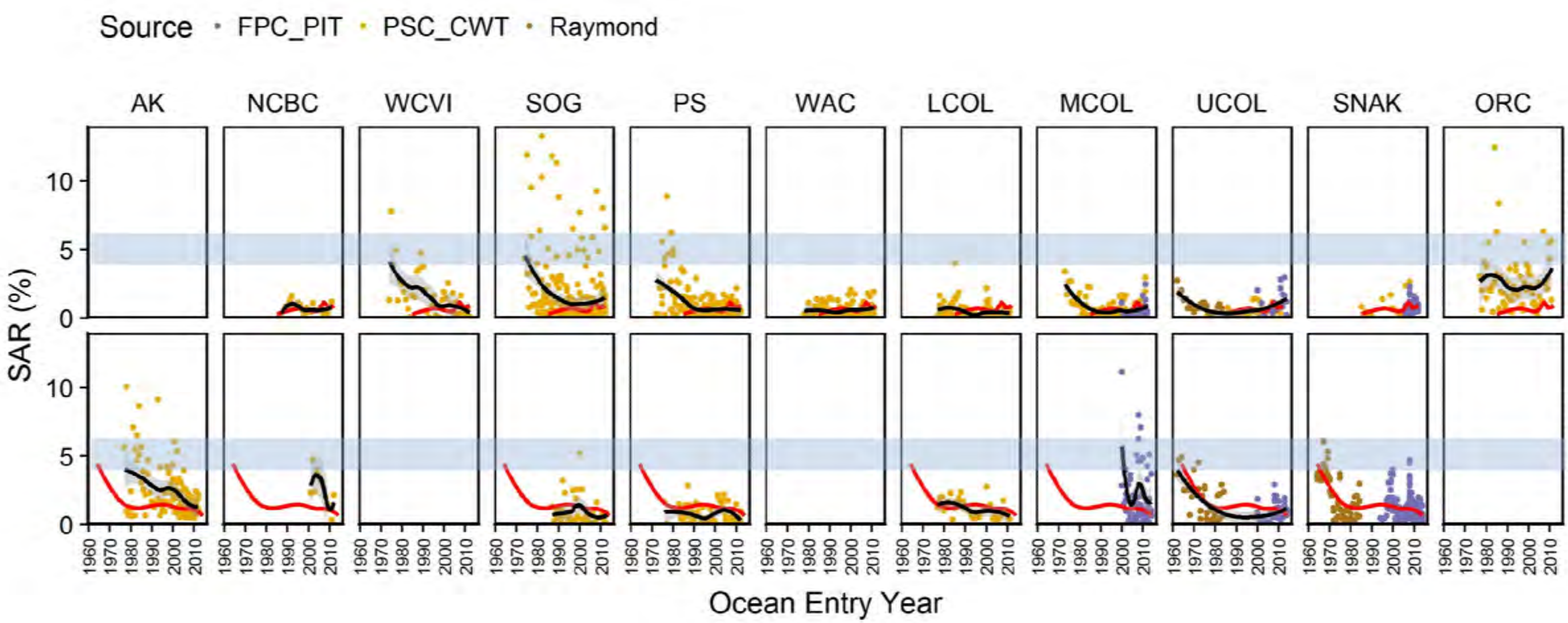


Collapse in Marine Survival of Chinook and Steelhead



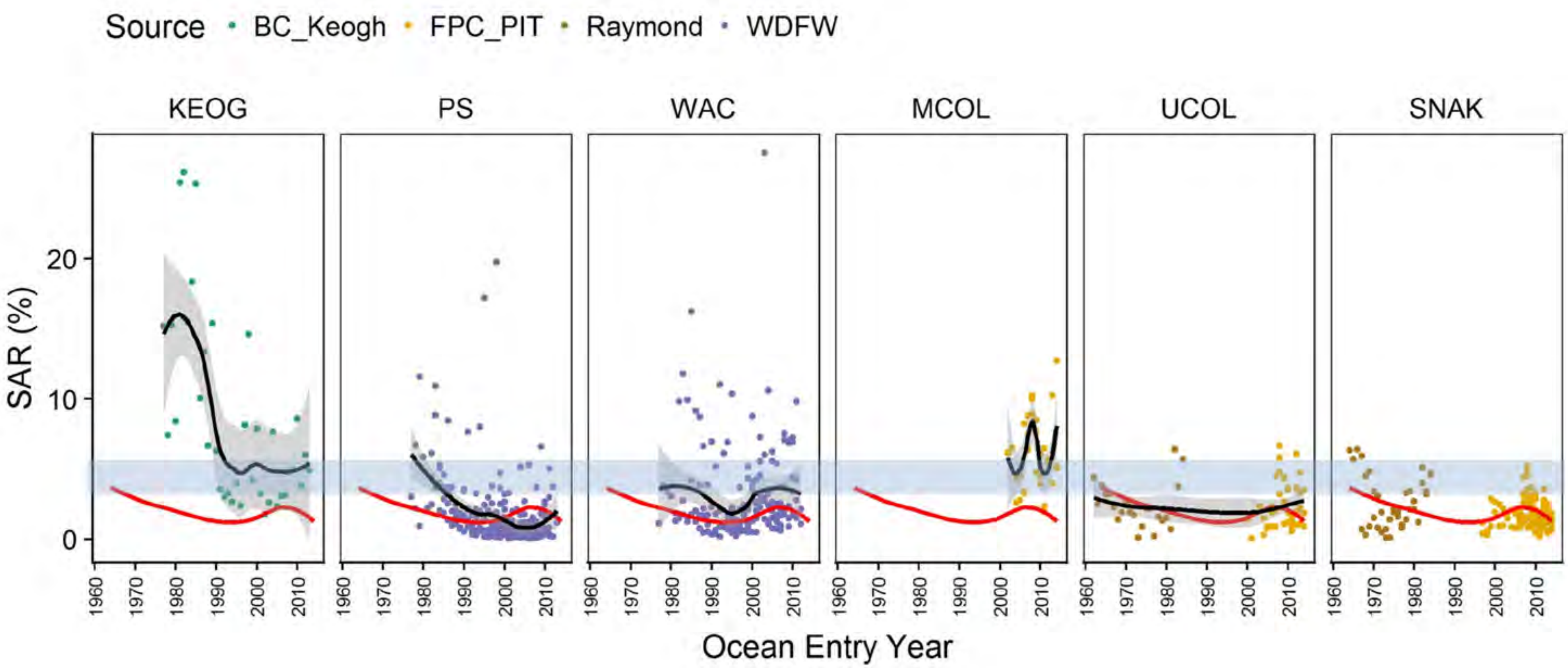
Collapse in Marine Survival of Chinook and Steelhead

Chinook



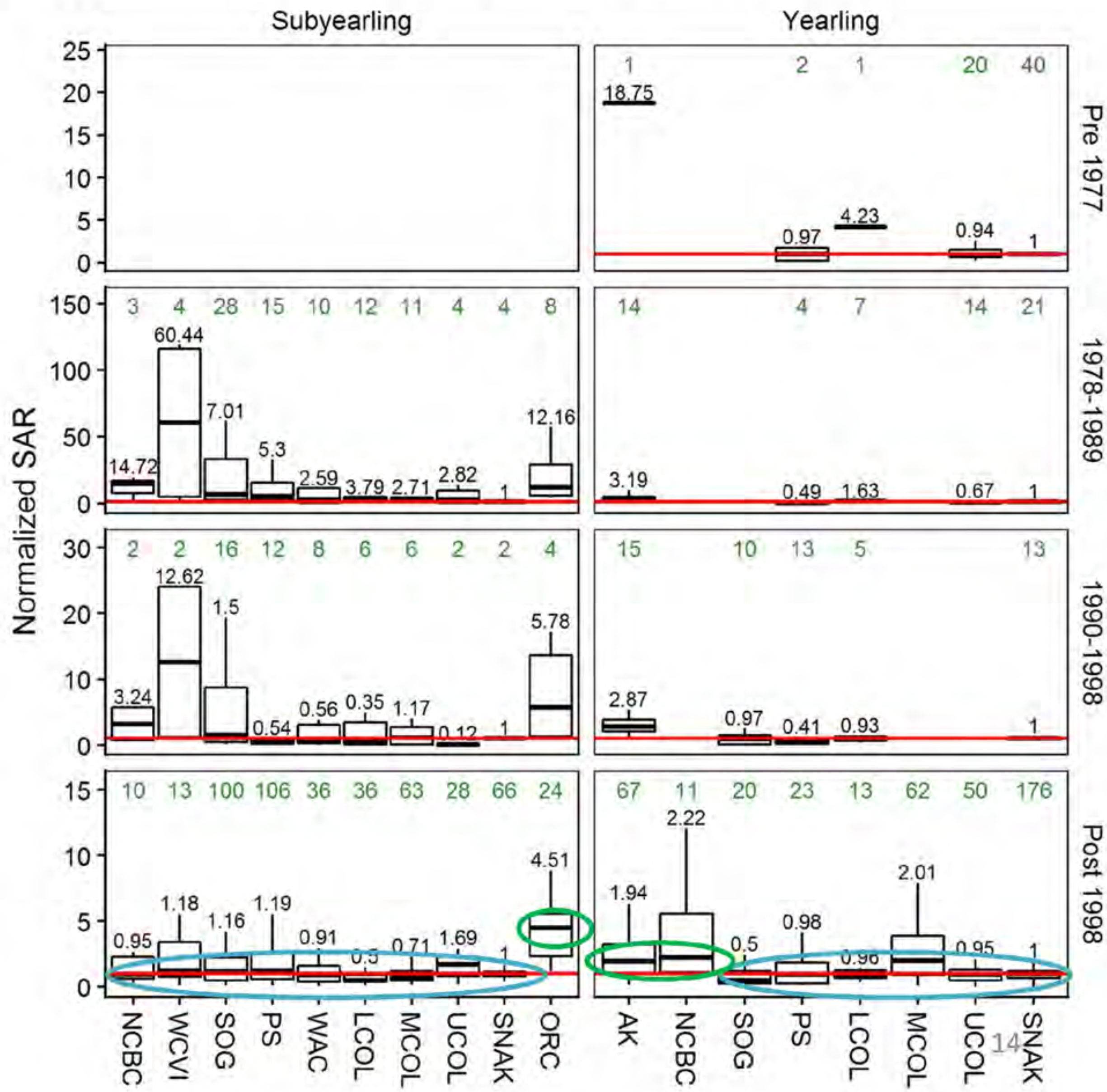
Collapse in Marine Survival of Chinook and Steelhead

Steelhead



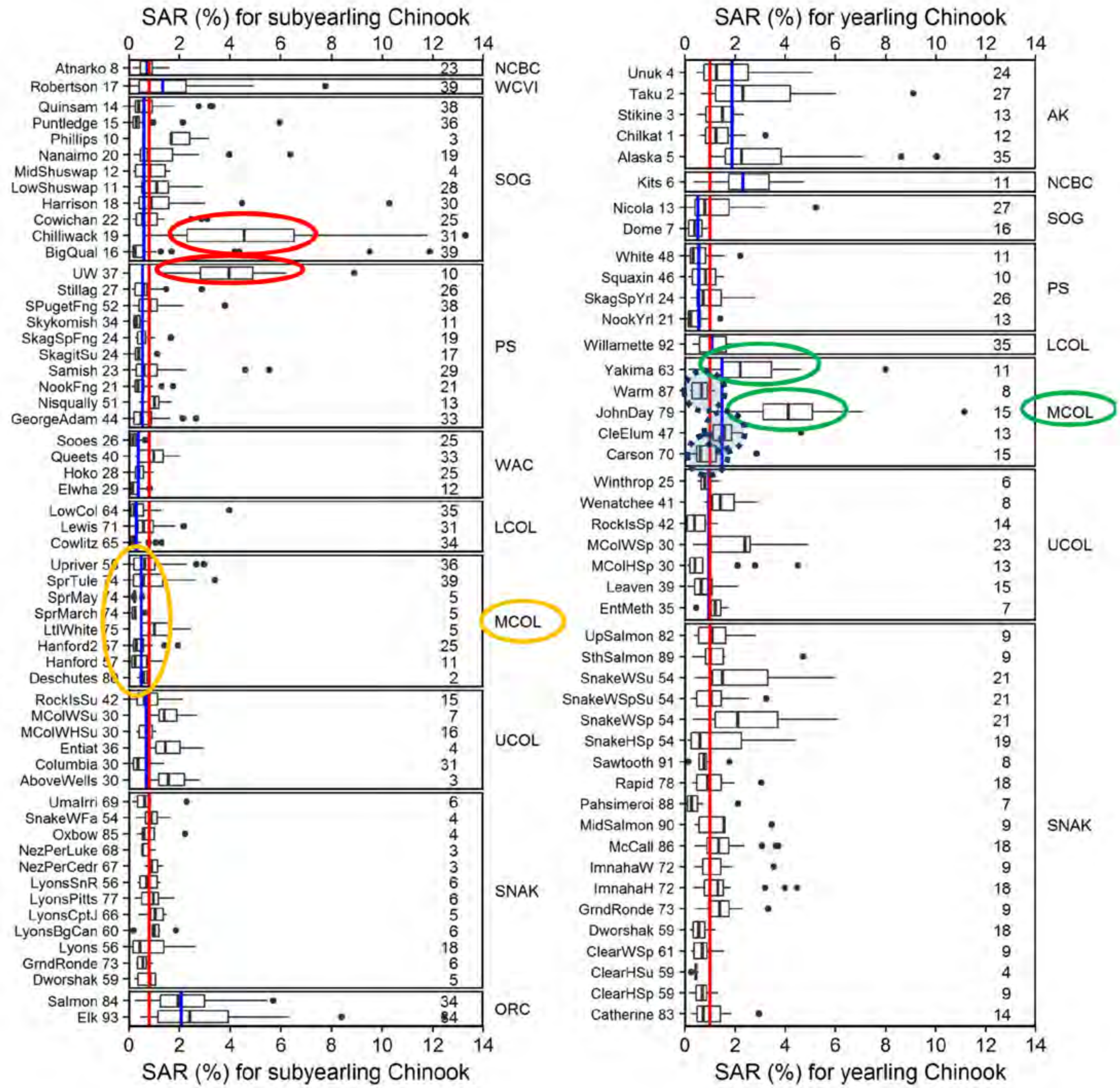
Chinook SARs Normalized by Snake River Median SARs (i.e., Relative Survival)

- Compared SARs for the west coast of North America (excl. California)
- SARs are scaled by dividing by annual Snake River values
- So $SAR_{SnakeRiver}$ =1
- The major regional difference in SARs seen in earlier time periods no longer exists
- A few important exceptions: ORC
- Critical: AK & NCBC SAR difference now ***much*** smaller
- How can Columbia “recover” salmon if Alaska can’t with its fantastic freshwater habitat?



Delayed Mortality

- The data do not support the delayed mortality theory
- Only 2 of 5 MCOL yearling populations have anomalously high SARs
- This pattern is also seen in other areas without any dams
- This differential survival pattern is also not seen for subyearling Chinook—so going through fewer dams does not boost SARs for any of these populations.



Policy Aspects

- Well, the Columbia hydrosystem isn't so terrible for salmon after all:
  - Freshwater smolt survival rates better than average
  - Smolt to Adult Survival rates also equal or better to other regions
  - Adult returns are low and likely to go lower because of worsening ocean (climate) conditions

So What To Do?

- Establish whether survival in the ocean is worse than in the hydrosystem.
  - Buys flexibility in operations.
  - May get a new generation of biologists to be more open-minded about how to manage a bad hand.
  - Should lead to people thinking about how “manipulating” the hydrosystem depends upon what the ocean may do to salmon.
- Science: Move to a <u>*rigorous experimental design*</u> approach with proper treatment & control groups
  - Counteracts the subjective value judgments of “experts” that plagues salmon management.
  - I am thinking here of opinions that increasing TDG past legal limits will give benefits, even if they kill more fish in the short term.

So What To Do?

- Legal: Not clear to me whether the current legal framework has considered these issues.
  - The hydrosystem is apparently operated at present on the untested and largely hidden assumption that natural, unmodified, systems will yield the best survival ("Mother Nature knows best").
  - This is ***not*** true in the Sacramento River. The worst smolt survival occurs in the migration segments that are most natural. The best survival occurs in river segments with rip-rapped banks. Why?? (Fewer predators)
  - Spill, Transport, Reservoir Draw-Down, Dam Breach might all reduce SARs by placing smolts in the ocean for longer time periods.
  - The legal concept of "take" is well-established under the ESA, but not as applied to the ocean. What if operating the hydrosystem to get the smolts to the ocean faster puts them in greater jeopardy?

Current Status and Next Steps

- The paper will be submitted by the end of the year.
- Next steps are to evaluate survival rate in fresh water compared to survival rate in the ocean.

Q & A

From: Petersen,Christine H (BPA) - EWP-4

Sent: Sun Sep 23 12:44:53 2018

To: Erin Rechisky

Cc: Humphrey,Stacy C (CONTR) - EW-4

Subject: RE: slides

Importance: Normal

No problem at all, Erin

(b) (6) [redacted] and the meeting is still several days away. Our folks are going to try to review the agenda timing so that it doesn't go off course right away like the last time we did something like this where we invited several researchers in. Just managing getting people in at our front security desk was hard with people arriving at different times.

I hope you have a nice remainder of the weekend

Christine

Sent from VMware Boxer

On Sep 21, 2018 8:07 PM, Erin Rechisky <Erin.Rechisky@kintama.com> wrote:

Hi Christine,

(b) (6) [redacted]

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Tuesday, September 25, 2018 7:08 PM
To: Humphrey,Stacy C (CONTR) - EW-4
Subject: [EXTERNAL] Re: slides

Hi Stacy,

I'm going to send you an updated presentation in the morning. Will that be ok?

I'll send it by 10.

Thanks,

Erin

------ Original message------

From: Humphrey, Stacy C (CONTR) - EW-4

Date: Mon, Sep 24, 2018 8:53 AM

To: Erin Rechisky;Petersen, Christine H (BPA) - EWP-4;

Subject:RE: slides

Erin,

Thank you!

Stacy Humphrey
(ContR) CorSource Technology Group

Project Manager | EW-4

Bonneville Power Administration
bpa.gov | P 503-230-3093 | schumphrey@bpa.gov

Facebook-Icon_31x31_v3Flickr-Icon_31x31Instagram-Icon_31x31LinkedIn-Icon_31x31Twitter_31x31YouTube_31x31

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Cc: Humphrey,Stacy C (CONTR) - EW-4
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Contributors

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Conclusions

- The Columbia River basin does not have a smolt survival problem.
- Rather it has a failure of sufficient adult salmon to return from the ocean.
- This failure is not being significantly driven by freshwater events.
- Smolt survival and adult SARs are comparable to other regions without dams implying that the hydrosystem could be managed for salmon conservation more effectively.

Two Alternative Versions of Reality

1. The dams continue to prevent the recovery of CR salmon stocks.
2. The effect of the dams has largely been repaired and the continued failure to recover is due to ocean conditions, which are blamed on the dams.

A Question to Frame the Presentation

- Where is the survival issue that the region needs to deal with?
- Let's make the math easy
- Assume hydrosystem survival is "only" 33% (1/3)
  - (Actually it is 50%~60% from FPC calculations)

- *After all, with 2/3rds of the fish dying in the FCRPS, it's obviously the dams, right?*

Collapse in Marine Survival of Chinook and Steelhead

Answer: The Ocean

- Columbia River SARs are about 1%
- If S_{FW}=33% (or 1/3rd)
- then S_{Ocean}= 1/33.3333...

$$(because\ S_{FW} \cdot S_{Ocean} = \tfrac{1}{3} \cdot \tfrac{1}{33.333} = \tfrac{1}{99.999} = 1\%)$$

  – So in this hypothetical example, freshwater survival is 11X higher (33.3/3) than marine survival.

- In reality, S_{FCRPS} is 50%~60% so the real ratio implies that the ocean is 25X~36X more important than the hydrosystem.

- Q: How did we get to where we are now in the Columbia?
- A: *Cognitive Dissonance.*

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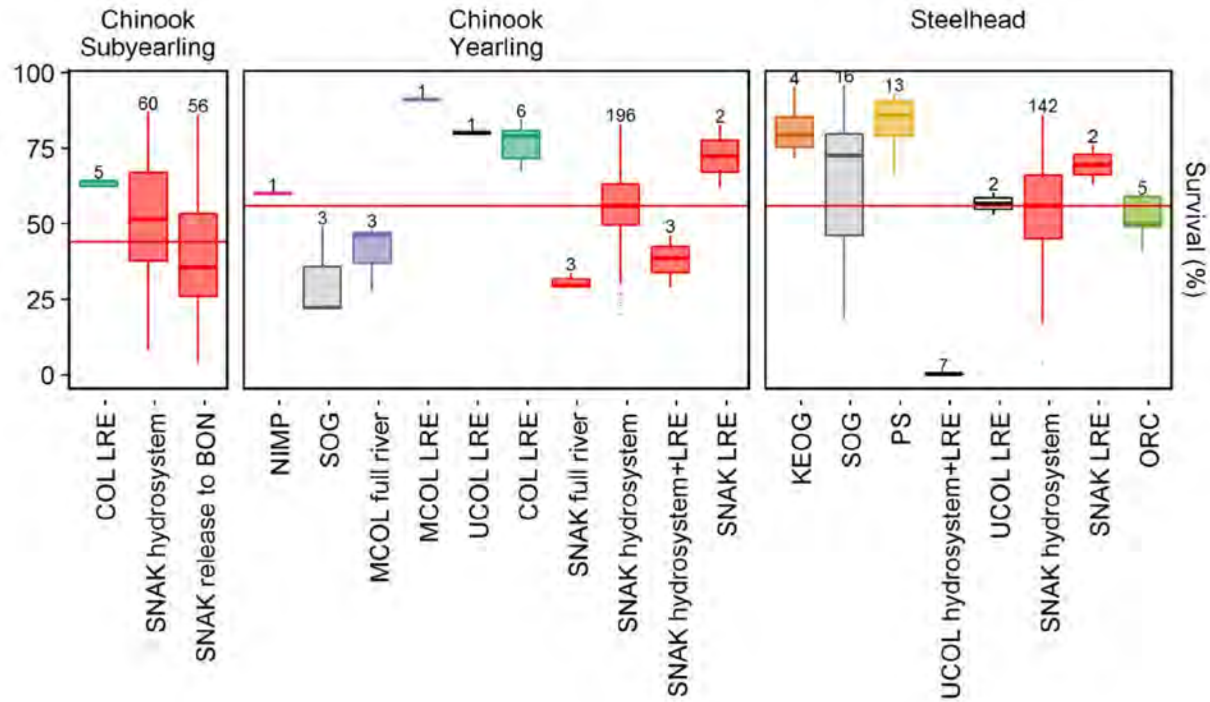

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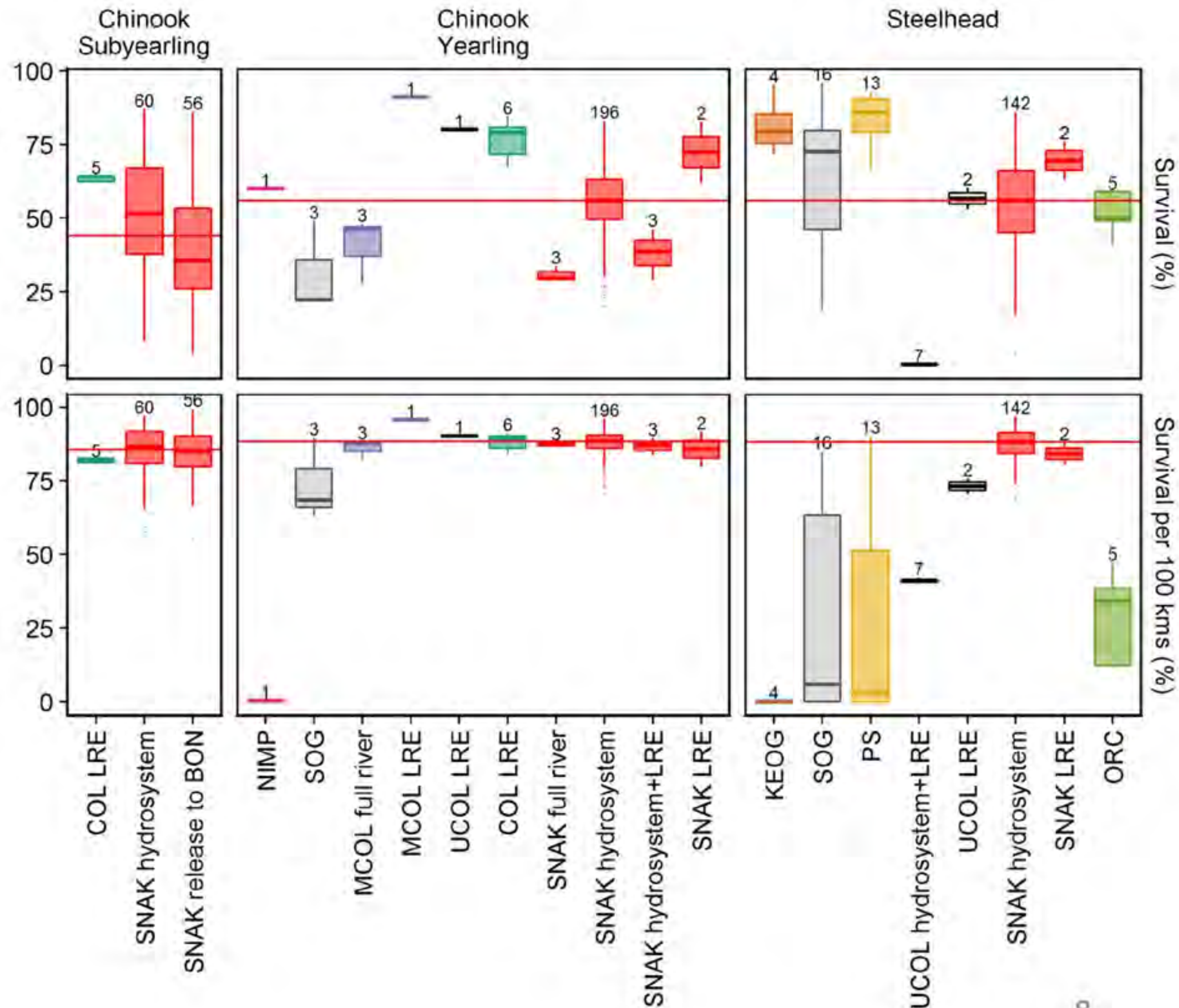
- Snake River SARs (red) in the middle of the pack

When scaled by distance travelled, Columbia hydrosystem survivals are equal or better than other river systems.



Collapse in Marine Survival of Chinook and Steelhead

Now Let's Look at the End: Comparing Adult SARs for Different Regions (2400 years of data)

Coast-wide SARs Data Sources

- Pacific Salmon Commission- CWT
  - Southeast AK to OR coast (including Strait of Georgia and Puget Sound)
  - from river/hatchery to return
  - accounts for harvest
- Fish Passage Center- PIT
  - Columbia River Basin
  - most upstream dam and back
  - does not account for harvest (results in underestimate)
  - does not account for release to dam survival (overestimate)
- Raymond (1988)- freeze branding
  - Upper Columbia and Snake R.
  - accounts for harvest


NORTH AMERICAN JOURNAL OF
FISHERIES MANAGEMENT

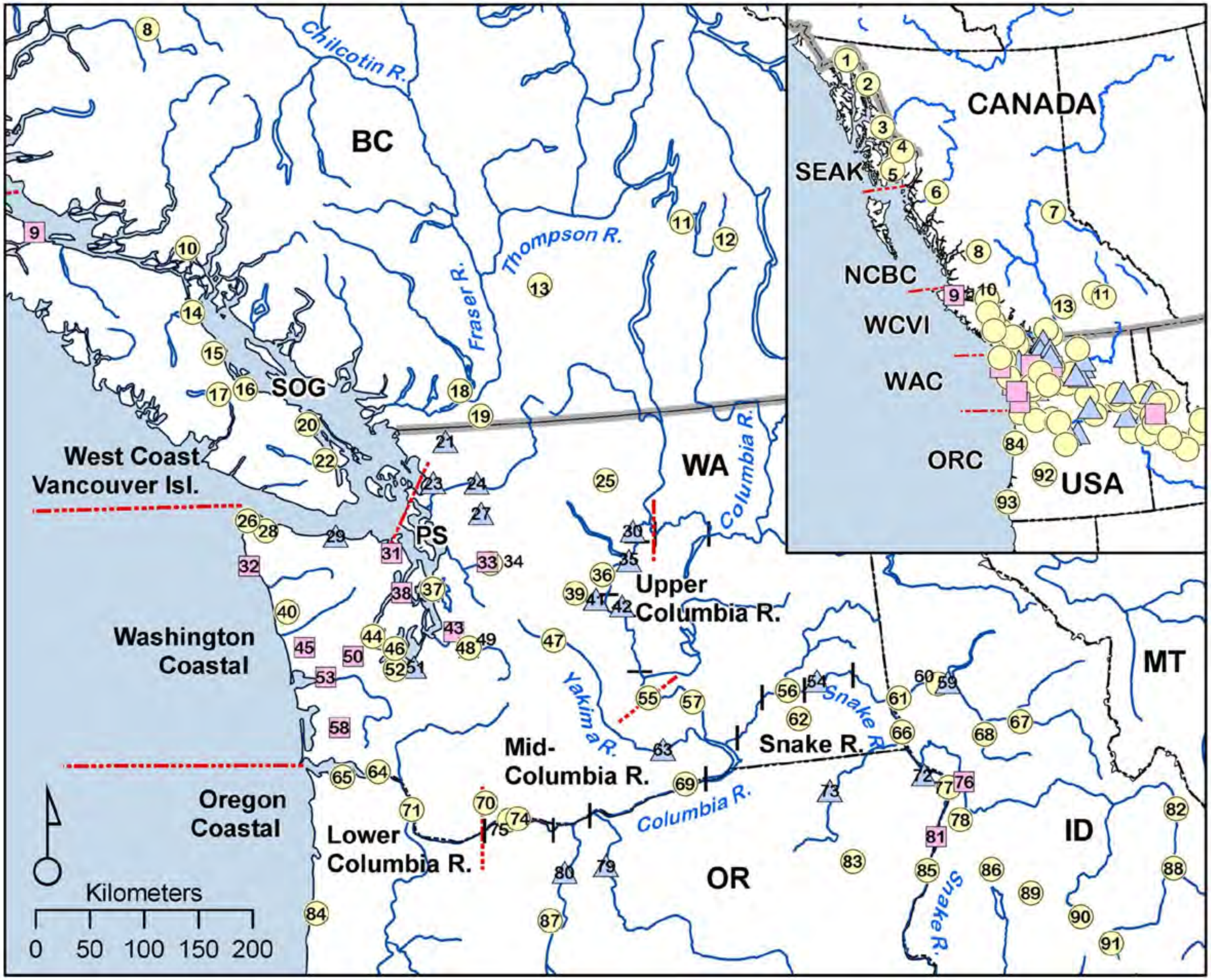
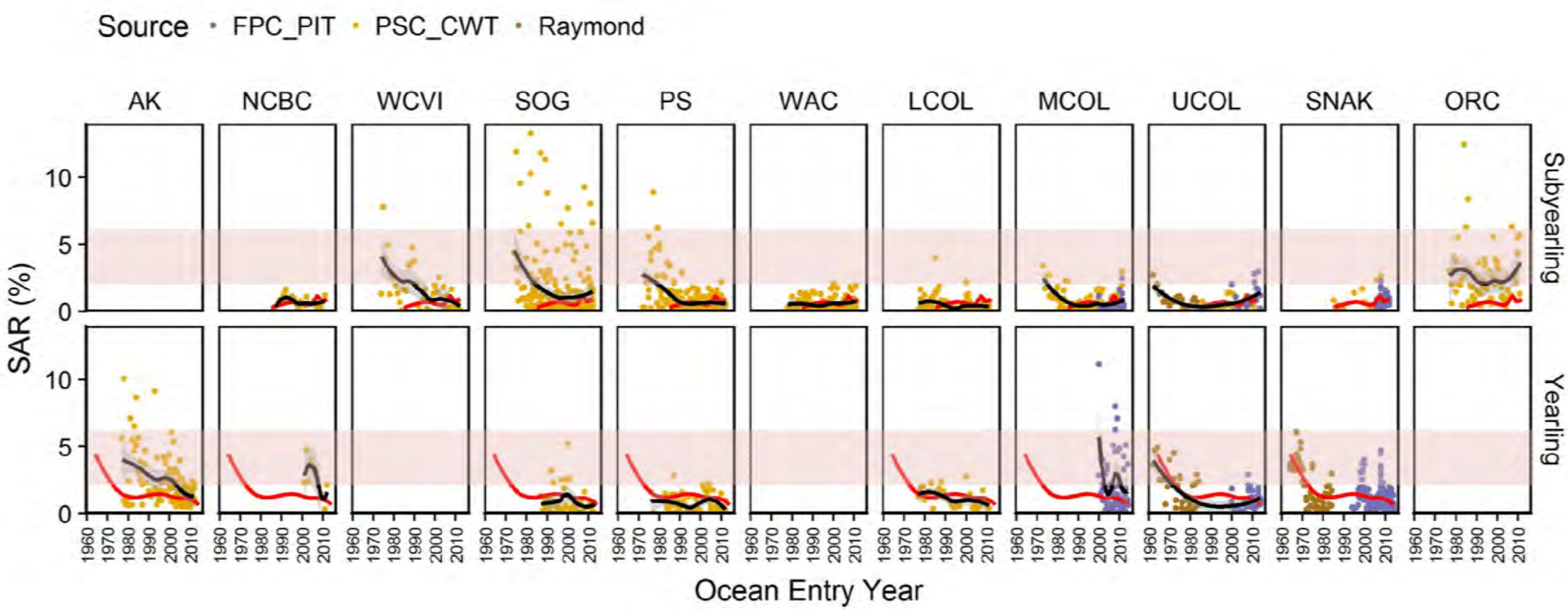


Figure 1. Map of salmon survival time series used in the analyses. Numbers inside symbols are keyed to the populations in Supplementary Table S1; yellow circles indicate Chinook populations, pink squares indicate steelhead, and blue triangles indicate a location with data for both species. Acronyms: SEAK (SE Alaska/Northern British Columbia Transboundary Rivers); NCBC (North-Central British Columbia); WCVI (West Coast Vancouver Island); WAC (Washington Coastal); ORC (Oregon Coastal); SOG (Strait of Georgia); PS (Puget Sound).

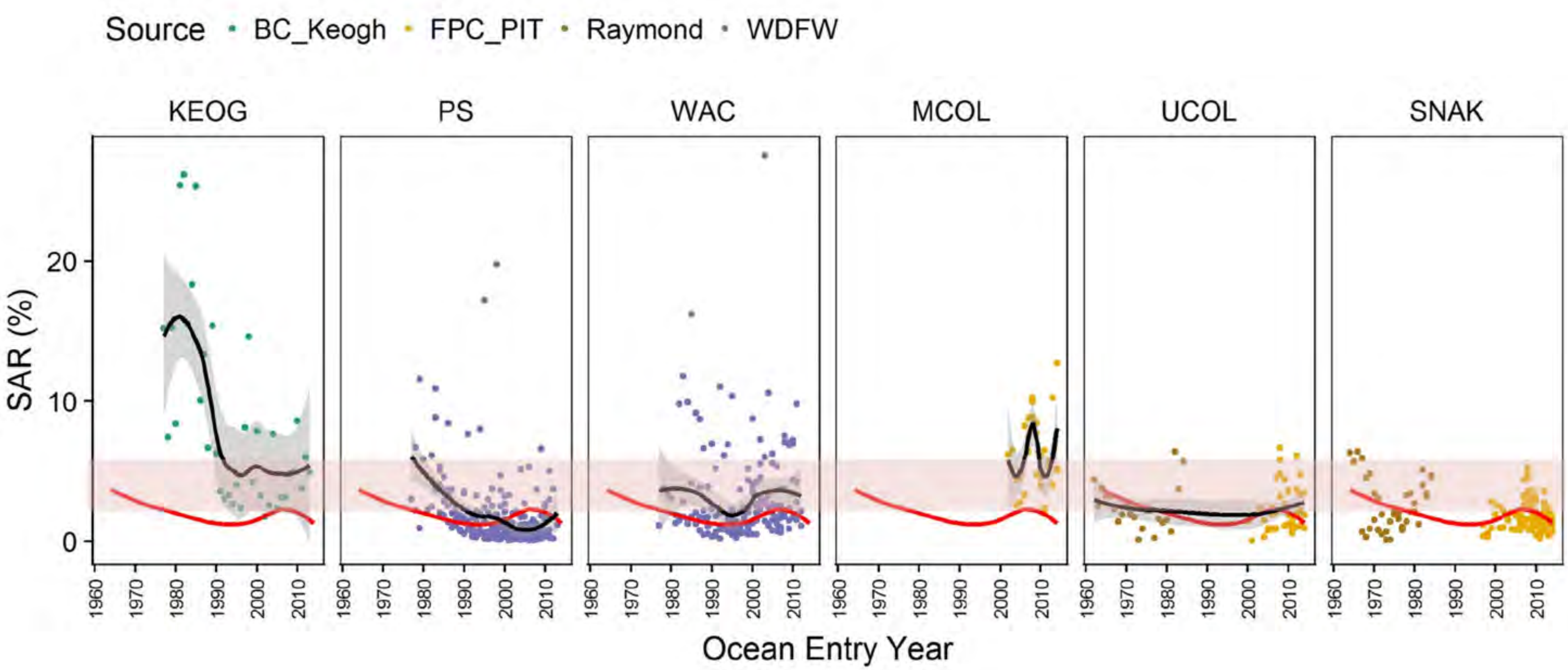
Collapse in Marine Survival of Chinook and Steelhead

Chinook



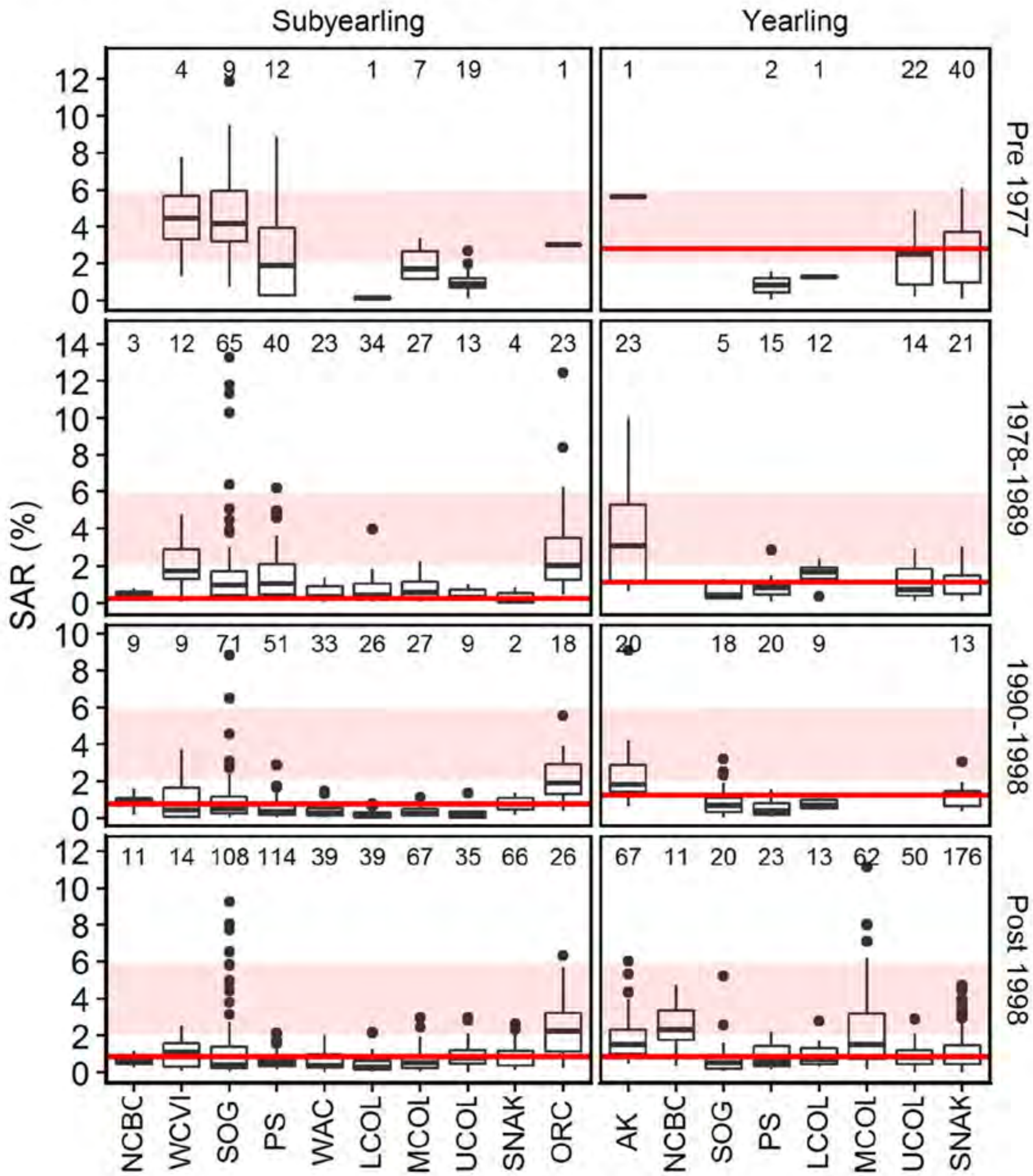
Collapse in Marine Survival of Chinook and Steelhead

Steelhead



Chinook SARs by Regime

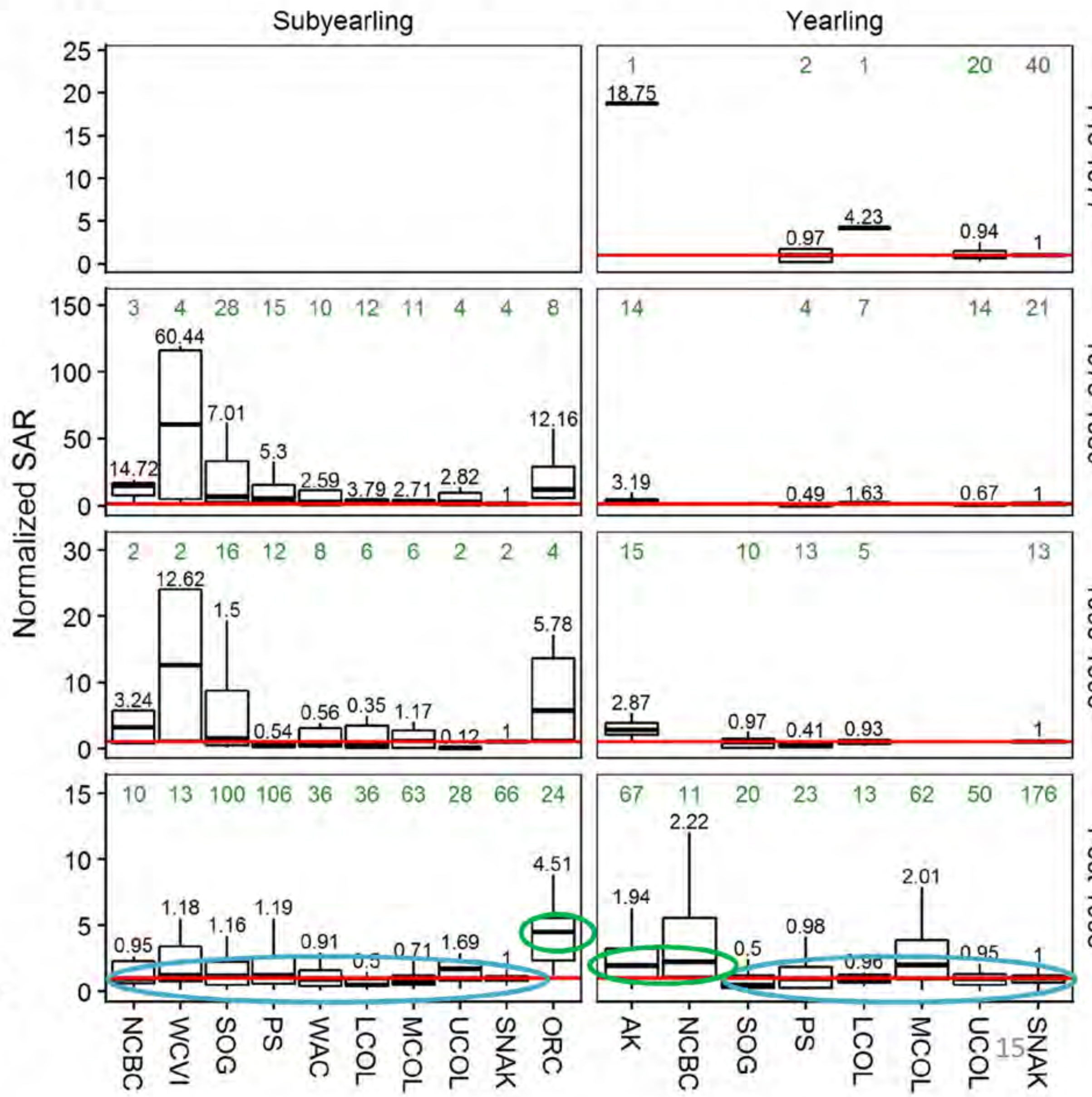
- Red line is the median for Snake River
- Shaded area is 2-6%



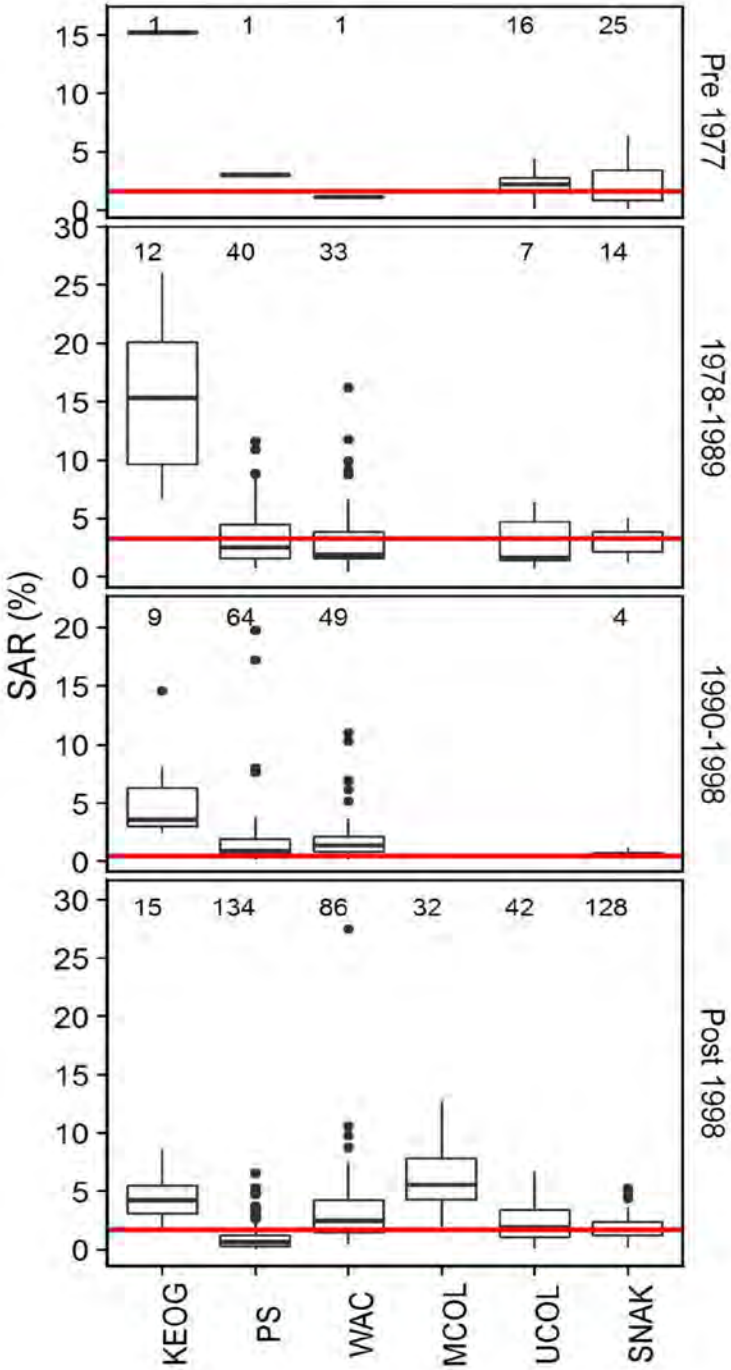
Chinook SARs Normalized by Snake River Median SARs (i.e., Relative Survival)

- SARs are scaled by dividing by annual Snake River values
- So $SAR_{SnakeRiver}$ =1
- The major regional difference in SARs seen in earlier time periods no longer exists
- A few important exceptions: ORC
- Critical: AK & NCBC SAR difference now ***much*** smaller

How can Columbia "recover" salmon if Alaska can't with its fantastic freshwater habitat?

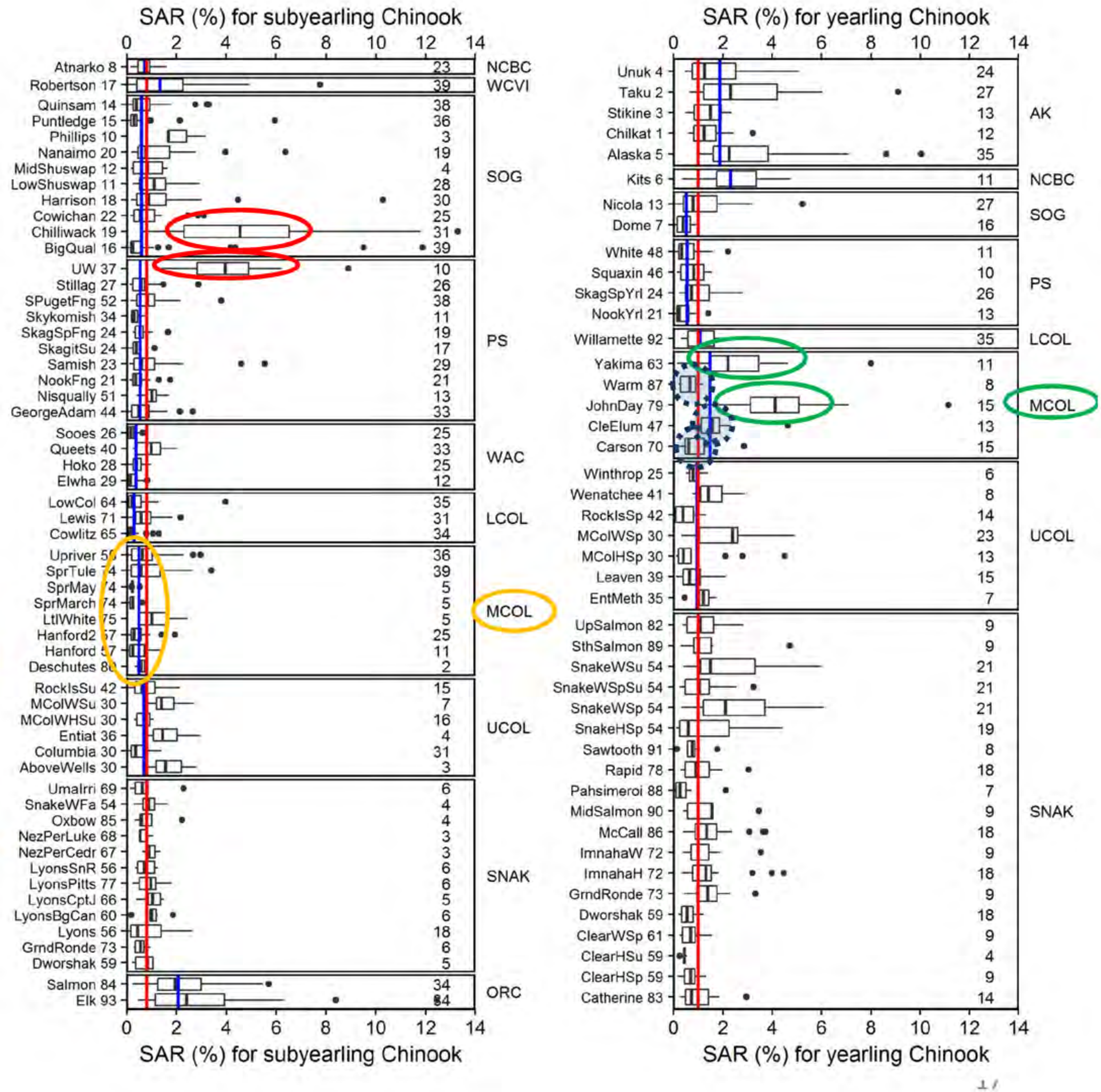


Steelhead SARs by Regime



Delayed Mortality

- The data do not support the delayed mortality theory
- Only 2 of 5 MCOL yearling populations have anomalously high SARs
- This pattern is also seen in other areas without any dams
- This differential survival pattern is also not seen for subyearling Chinook—so going through fewer dams does not boost SARs for any of these populations.



Policy Aspects

- The Columbia hydrosystem isn't so terrible for salmon after all:
  - Freshwater smolt survival rates are better than average
  - Smolt to Adult Survival rates are also equal or better to other regions
  - Adult returns are low and likely to go lower because of worsening ocean (climate) conditions

Policy Aspects

- Legal: It is not clear whether the current legal framework has considered these issues.
  - The hydrosystem is apparently operated on the untested assumption that natural, unmodified, systems will yield the best survival ("Mother Nature knows best").
    - This is ***not*** true in the Sacramento River. The worst smolt survival occurs in the migration segments that are most natural. The best survival occurs in river segments with rip-rapped banks. Why? Fewer predators.
  - Spill, transport, reservoir draw-down, dam breach might all reduce SARs by placing smolts in the ocean for longer time periods.
  - The legal concept of "take" is well-established under the ESA, but not as applied to the ocean. What if operating the hydrosystem to get the smolts to the ocean faster puts them in greater jeopardy?

So What To Do?

- Establish whether survival in the ocean is worse than in the hydrosystem.
  - Should lead to thinking about how "manipulating" the hydrosystem depends upon what the ocean may do to salmon.
  - May get a new generation of biologists to be more open-minded about how to manage a bad hand.
- How? Move to a *rigorous experimental design* approach with proper treatment & control groups
  - Counteracts the subjective value judgments of "experts" that plagues salmon management.
    - For example, increasing TDG past legal limits will give benefits, even if more fish are killed in the short term.

Current Status and Next Steps

- A number of case studies demonstrate that when there is evidence that the ocean is the cause of declines, the response is to work on freshwater issues.
- These results will be submitted to PLoS Biology by the end of the year.
- Next steps are to evaluate survival rate in fresh water compared to survival rate in the ocean.

Q & A

From: David Welch

Sent: Thu Oct 11 17:12:19 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] FW: Chinook & Steelhead Comparative Survival Analysis paper

Importance: Normal

Hi Christine-

Just a quick heads up. Neala has declined co-authorship on the paper (see below), and only made a few comments on the paper, most of which are very minor. It's too bad she is passing on co-authorship, but given the paper doesn't square with established wisdom this may not be too surprising (and may in fact avoid hostile reaction from some of her colleagues).

I will work to review & incorporate these very limited comments (mostly grammatical), but it may be more work for Aswea to bring the data sets fully up to date—I am leaving it for her to make that judgment call. I had also emailed Gayle Brown (DFO) at the same time after I got home yesterday reminding them that I was hoping to have a response soon, so I hope Gayle will respond soon.

I hope to be able to submit the paper to PLoS Biology soon, and then will be able to provide the full manuscript to you and your colleagues without too much concern over "undue influence from the funders".

(b) (6) [redacted] so I think I will work from home tomorrow (Friday) if you want to get hold of me by phone.

Best, David

From: David Welch
Sent: Thursday, October 11, 2018 4:53 PM
To: Aswea Porter
Subject: FW: Chinook & Steelhead Comparative Survival Analysis paper

Hi Aswea—

Neala hasn't modified the paper very much that I can see on my first read-through. Can I ask you to look at the steelhead data she has offered and make a judgment call whether it is worth updating the steelhead figures (and the SI… and the text statements about the number of years of data… sigh!).

It's probably a lot of work for you for little real change to the paper. However, it is probably professionally required for us to do so unless it is a disproportionately large amount of work for just a year or two of extra data. I am leaving it to you to assess the implications and get back to me with that call. Meanwhile, I will work on incorporating what appear to be Neala's very limited suggestions on the text.

Thanks, David

From: Kendall, Neala W (DFW) [mailto:Neala.Kendall@dfw.wa.gov]
Sent: Thursday, October 11, 2018 2:48 PM
To: David Welch
Cc: Erin Rechisky; Aswea Porter
Subject: RE: Chinook & Steelhead Comparative Survival Analysis paper

Hello David and welcome back from your trip; I hope it was a good one.

I have reviewed the Abstract of your manuscript and I went through and looked at specific questions you had related to me. I've been swamped with a bunch of reviews right now (when it rains it pours) so have not had time to review the whole thing, though I had some general comments for the Abstract.

I do not feel that it is appropriate nor necessary for me to a be a coauthor on this paper, but I very much appreciate the kind offer. There are many people at WDFW who collected and analyzed the data that were used to estimate SARs and I'm only the spokesperson.

I also wanted to let you know that steelhead SARs are continuously being revised and updated, so attached is a file with the most updated data for Puget Sound, Strait of Juan de Fuca, and Washington coast wild and hatchery steelhead populations that were collected by WDFW. I also included a note in the paper about a source at Oregon Dept. of Fish and Wildlife for Oregon coast hatchery steelhead SAR data.

Thank you again and please let me know if you have any questions.

Neala

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, September 28, 2018 3:15 PM
To: Kendall, Neala W (DFW) <Neala.Kendall@dfw.wa.gov>; Brown, Gayle <Gayle.Brown@dfo-mpo.gc.ca>
Cc: Erin Rechisky <Erin.Rechisky@kintama.com>; Aswea Porter <Aswea.Porter@kintama.com>
Subject: Chinook & Steelhead Comparative Survival Analysis paper

Dear Neala & Gayle-

At long last, please find attached a complete copy of our manuscript comparing coastwide Chinook & steelhead SARs. As key contributors of data for the study, we would like to offer you the opportunity to join as co-authors. As you will read, the paper is going to be controversial for its conclusions, and unwelcome in some quarters that will prefer to believe that we are collectively already doing the best possible job at managing the populations

The paper is quite long. We intend to submit to PLoS Biology both because of its high credibility and because they are more welcoming than most journals in handling long papers. We have 10 multi-panel figures and three quite extensive SIs (Supplementary Info or “appendices”).

I won’t say anymore about the paper, as I will leave it to you to read and make your own decisions about co-authorship. Please make any edits directly onto the manuscript using track changes in word and add any comments using comment boxes so that we can efficiently deal with your input.

I am going to be away at sea without internet access from today until almost my return to Nanaimo on October 10th, so if you could time your emails to me for that day or after I would appreciate it—that should give you two full weeks to decide if you want to join as co-authors.

In my absence Erin & Aswea (CCed) should be able to handle any questions you may have.

Kind regards,

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

755 Terminal Ave N, Nanaimo BC

V9S 4K1 Canada

Office: (250) 729-2600 Mobile: [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: Erin Rechisky

Sent: Wed Oct 24 09:39:53 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Chinook & Steelhead paper?

Importance: Normal

Thanks for your kind word Christine.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: October 24, 2018 8:59 AM
To: David Welch; Erin Rechisky
Subject: RE: Chinook & Steelhead paper?

(b) (6)

[redacted]

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, October 23, 2018 4:48 PM
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: [EXTERNAL] RE: Chinook & Steelhead paper?

Thanks for the update! Scott Armentrout looks to be very capable, though I do wonder how fast he will want to come to grips with a small group of people saying that we may have the conservation approach to managing Pacific salmon fundamentally wrong after more than half a century of activity?! (And with a surname like Armentrout how can Scott not possibly focus on the freshwater side of things? J)

I'm sorry that Bryan Mercier has departed… from my limited interactions with him I liked him a lot, and I found him a very quick study. Perhaps sometime in January or February we can come down and give a further update on where we are and have a further discussion including Scott? In addition to the two BPA-supported papers I have been working on a separate paper to be aimed at Fisheries with the working title of "21st Century Salmon Management"… it is intended to put a much broader perspective on salmon conservation efforts and to make the point that a number of current restoration initiatives may actually either be ineffective or even harmful without careful consideration to the dynamics of salmon populations. I will fill you in on this if you like… parts of the text are drafted, but the cutting edge graphics for that paper are currently sketched out on the backside of a couple of sheets of waste paper to the right of my keyboard as I type this. (I will also need to inflict it on Erin too, as I haven't been saying too much about it until now).

David

P.S. I will put it on my "to do" list to put in a comment, and will circle around with Erin on that.

(b) (6)
[redacted]

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, October 23, 2018 4:29 PM
To: David Welch; Erin Rechisky
Subject: RE: Chinook & Steelhead paper?

Hi,

That is great that Gayle can participate.

I might intersect with Neala at the NOAA lifecycle modeling meeting in November, although I'm not sure if she's still participating in that.

By the way, I never got back to you regarding the NPCC fish and wildlife program comments – it looks like they extended the deadline to December 13. https://www.nwcouncil.org/fw/program/2018-amendments . It would be a great idea to submit a comment. I do not think nearly as many people will be involved as in the southern resident killer whale public comment process. Every comment is published and they do read them. (It would take forever to even skim the SRKW comments, but it is interesting how various contingents participated, and the vocabulary that they use https://pspwa.app.box.com/s/hzq6yings8w8ju8o4cob18k4jj1u5k91

).

FYI – they have just picked Scott Armentrout as our new program VP (what Peter Cogswell was doing now); he comes from the forest service so he knows large conservation programs but expect him to have some ramp up time of specific projects. Likewise, Bryan Mercier was very impressed by your work but he has left for a leadership opportunity at the BIA. Jody Lando continues to be a big fan of your work, by the way. I believe Ben Zelinsky gave a presentation at a conference about size of a natural resources program vs. efficiency at making changes – there is a relatively high ratio of time spend remaining informed and other bureaucracy so it is harder for all the managers to be responsive to pressing issues because they run out of time in the week to actually read reports and act on them.

https://www.bpa.gov/news/newsroom/Pages/BPA-selects-Armentrout-as-new-executive-VP-of-Environment-Fish-and-Wildlife.aspx

Currently, John Skidmore is in the Bryan Mercier position for the interim. (b) (6) [redacted]

(b) (6) [redacted] but I will keep him informed of your progress.

Talk to you soon,

Christine P.

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, October 19, 2018 4:50 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] FW: Chinook & Steelhead paper?

FYI. Looks like Gayle Brown (DFO) will likely join as a co-author (though it is possible she has still not yet read the manuscript!).

I think I mentioned already that Neala Kendal decided not to (as she was only the "collator" of the steelhead survival datasets), but she just (1 hr ago) provided us with steelhead SAR data updated for the last few years. We will work to update all the graphs (sigh..) and then (I really hope) we can send the manuscript out to the journal. Once we have done so I am happy to freely share with you and your colleagues the preprint.

Have a great weekend!

David

From: Erin Rechisky

Sent: Tue Nov 20 14:27:33 2018

To: Petersen,Christine H (BPA) - EWP-4; David Welch

Subject: [EXTERNAL] RE: [EXTERNAL] FW: Thank you for submitting to PLOS Biology (PBIOLOGY-D-18-01241) - [EMID:8716c1b4cfac9759]

Importance: Normal

Hi Christine,

We have three years of survival data from Kooskia Hatchery to LGR. Do you know if the results were used to help inform the RPAs?

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: November 19, 2018 2:23 PM
To: David Welch
Cc: Erin Rechisky
Subject: Re: [EXTERNAL] FW: Thank you for submitting to PLOS Biology (PBIOLOGY-D-18-01241) - [EMID:8716c1b4cfac9759]

Hi.

Thanks. I wish you the best of luck.

By the way, there were some interesting items in the draft BiOp which I cannot forward (on Dec 7 they could potentially hold it backn remove all references to the block spill test and replace with the 16:8 flexible spill operation which would require a totally different monitoring approach).

Part of the RPA text recommended looking at upstream of Lower Granite survival. They also liked alternative or research approaches to barging.

Christine

Sent from Workspace ONE Boxer

On Nov 16, 2018 3:43 PM, David Welch <David.Welch@kintama.com> wrote:

Hi Christine--

Just a quick heads up- our manuscript was submitted yesterday to PLoS Biology.

Technically, this is a “submission inquiry”, where we send a cover letter explaining what the proposed paper is about and a “rough” combined manuscript with the figures appended, asking if the editors think it is of interest for us to do the formal submission (which involves uploading all the parts separately, I think).

In practice, the manuscript is complete with all the bits already sorted out and in the manuscript. I would be shocked if the editors don’t agree to have the paper reviewed, given the substance of the paper and the cover letter I wrote explaining what the paper is about. I have attached a draft lay language summary of the paper that I also wrote; as you will see, I have written it quite broadly to bring in issues beyond just the dams.

Once I get the journal editors’ ok to submit, I will submit the “full” paper (again?) and select the option to have the pdf manuscript simultaneously released to the bioRchiv preprint server. That should give folks a stable URL to reference and you can distribute it publically for comment as widely as you like, I think.

We should also discuss the issue of whether BPA is interested & willing to contract some professional help to get the paper widely covered in the press, once it passes peer review & reaches publication stage (probably at least 6 months).

Have a good weekend.

David

kintamav_RGB

Office: (250) 729-2600

Mobile: [redacted]

-----Original Message-----
From: em.pbiology.0.5f4892.9a11e52f@editorialmanager.com
[mailto:em.pbiology.0.5f4892.9a11e52f@editorialmanager.com] On Behalf Of PLOS Biology
Sent: Thursday, November 15, 2018 5:29 PM
To: David Welch
Subject: Thank you for submitting to PLOS Biology (PBIOLOGY-D-18-01241) - [EMID:8716c1b4cfac9759]

Dear Dr Welch,

Thank you for submitting your manuscript "The coast-wide collapse in marine survival of west coast Chinook and steelhead: slow-moving catastrophe or a deeper failure?", as a Initial Research Submission to PLOS Biology. Your submission has been assigned the following manuscript number: PBIOLOGY-D-18-01241.

Your paper will now be assessed by the editors to determine whether your manuscript meets the criteria for peer review. We may seek advice from an Academic Editor with relevant expertise. At any stage, you may check the status of your submission by logging into your home page at https://pbiology.editorialmanager.com/ and viewing the "Current Status" heading on the listing for this manuscript.

If you are submitting an Initial Research Submission our initial evaluation is positive, we will contact you to request reviewer suggestions and statements relating to ethical approval, funding, data and competing interests ahead of initiating peer review. For more information, please see the submission guidelines: https://journals.plos.org/plosbiology/s/submission-guidelines#loc-about-the-submission-process This additional information is required to satisfy PLOS' policies and will be made available to editors and reviewers. If you anticipate that you will be unavailable during the next week or two, please provide us with an additional person of contact by return email.

Thank you for submitting your work to PLOS Biology.

Kind regards,

The PLOS Biology Team

Author survey question:

PLOS is conducting a short survey about protocols and reproducibility. Begin the survey by selecting an answer below:

When reading research, is it useful if scientists published their research protocols alongside manuscripts?

Yes, that would be useful

https://surveys.plos.org/s3/pBioAuPublishProtocols?answer=YesUseful

Maybe, this could be useful for some articles

https://surveys.plos.org/s3/pBioAuPublishProtocols?answer=MaybeUseful

No, I don't think this would be useful

https://surveys.plos.org/s3/pBioAuPublishProtocols?answer=NotUseful

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From: David Welch

Sent: Mon Nov 26 15:16:23 2018

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] FW: Your preprint 10.1101/476408 has posted on bioRxiv

Importance: Normal

Attachments: Table S1 (30 Oct 2018).pdf; Table S2 (21 Nov 2018).pdf; SI 3-CWT vs PIT Tag Conversion (25 Sept 2018).docx

Hi Christine-

It has taken close to a week since I submitted the manuscript, but the preprint version of the paper may now be accessed off the bioRxiv server here: https://www.biorxiv.org/content/early/2018/11/26/476408. In quickly looking over the pdf I see that the three supplementary info files (appendices, basically) are missing from the pdf. I have attached them to this email.

As the manuscript is now under review at PLoS ONE, it now seems safe to share it with you. Please feel free to share either this email or just the link below with your colleagues who are interested in reading the full manuscript. The SI files (attached) are probably of interest because the first two provide extensive summary tables of the raw data we accessed to pull together the materials for the analysis.

Regards, David Welch

kintamav_RGB

Office: (250) 729-2600

Mobile: [redacted]

From: noreply@connect.biorxiv.org [mailto:noreply@connect.biorxiv.org]
Sent: Monday, November 26, 2018 2:01 PM
To: David Welch
Subject: Your preprint 10.1101/476408 has posted on bioRxiv

Dear David W Welch,

Your preprint 10.1101/476408 has posted on bioRxiv: http://biorxiv.org/cgi/content/short/476408v1

A portable graphical link to your paper (QR code) can be obtained here: https://connect.biorxiv.org/qr/476408. If the code is placed, for example, on a poster, your paper can be accessed through a mobile device's QR code reader.

If in future a version of this manuscript is published in a journal, bioRxiv will usually automatically link the preprint to the published version within approximately two (2) weeks of journal publication. The corresponding author should receive an email from bioRxiv providing notification that the link has been added. On rare occasions a match is not made because the title or authors have changed. Please wait 2-3 weeks before contacting bioRxiv staff should the link not appear.

The bioRxiv Team

Table S1. Source populations for freshwater survival estimates used in the study. Rear is either H (Hatchery), W (Wild) or U (Unknown). Reach refers to the migration segment spanned by the survival estimates. N is sample size (years of data). Rel: release. The full dataset is available from the authors upon request without restriction.

A. Chinook

Region	Stock	Rear	Smolt Age	Tag Type	Reach	N	From	To	Source
NIMP	Nimpkish	U	1	V7	Rel to mouth: Rkm 8.5 to mouth	1	2006	2006	Welch et al. 2011, Figure 3
SOG	Chilko	H	1	V5	Rel to mouth	1	2016	2016	Rechisky et al. in prep
	Coldwater	H	1	V7	Rel to mouth: Rkm 395 to mouth	1	2006	2006	Welch et al. 2011, Figure 3
	Coldwater	U	1	V7, V9	Rel to mouth: Rkm 331 to mouth	1	2005	2005	Welch et al. 2011, Figure 3
	Nicola	H	1	V7	Rel to mouth: Rkm 331 to mouth	1	2005	2005	Welch et al. 2011, Figure 3
	Nicola	H	1	V9	Rel to mouth: Rkm 368 to mouth	1	2004	2004	Welch et al. 2011, Figure 3
	Spius	H	1	V7	Rel to mouth: Rkm 355 to mouth	1	2006	2006	Welch et al. 2011, Figure 3
COL	Columbia	HW	0	JSATS	LRE: BON to Rkm 8.3	1	2007	2007	McComas et al. 2009, Table 5 and Table 4
	Columbia	HW	0	JSATS	LRE: BON to Rkm 8.3	1	2005	2005	McMichael et al. 2007, Table 4
	Columbia	HW	0	JSATS	LRE: BON to Rkm 8.3	1	2006	2006	McMichael et al. 2007, Table 5
	Columbia	HW	0	JSATS	LRE: BON to Rkm 8.3	1	2010	2010	McMichael et al. 2010, Table ES3
	Columbia	HW	0	JSATS	LRE: Rkm 153 to Rkm 8.3	1	2010	2010	McMichael et al. 2011, Table 3.10
	Columbia	HW	1	JSATS	LRE: BON to Rkm 8.3	1	2007	2007	McComas et al. 2009, Table 5 and Table 3
	Columbia	HW	1	JSATS	LRE: BON to Rkm 8.3	1	2005	2005	McMichael et al. 2007, Table 4
	Columbia	HW	1	JSATS	LRE: BON to Rkm	1	2006	2006	McMichael et al. 2007, Table 5

					8.3				
	Columbia	HW	1	JSATS	LRE: BON to Rkm 8.3	1	2009	2009	McMichael et al. 2010, Table ES1
	Columbia	HW	1	JSATS	LRE: Rkm 153 to Rkm 8.3	1	2009	2009	McMichael et al. 2011, Table 3.4
	Columbia	HW	1	V7	LRE: JDA to Rkm 8	1	2010	2010	Rechisky et al. 2014, Table 3
MCOL	Mid-Columbia	H	1	V7	full river: Rel to Rkm 23	2	2008	2009	Rechisky et al. 2013, Table 1, Figure 3
	Mid-Columbia	H	1	V9	full river: Rel to Rkm 40	1	2006	2006	Rechisky et al. 2009, Table 1
	Mid-Columbia	HW	1	V7	LRE: BON to Rkm 8	1	2011	2011	Rechisky et al. 2014, Table 3
UCOL	Upper Columbia	HW	1	V7	LRE: BON to Rkm 8	1	2011	2011	Rechisky et al. 2014, Table 3
SNAK	Catherine Creek Hatchery Spring Chinook	H	1	PIT	hydrosystem: LGR to BON	16	2001	2016	McCann et al. 2017, Appendix A
	Clearwater Hatchery Spring Chinook	H	1	PIT	hydrosystem: LGR to BON	11	2006	2016	McCann et al. 2017, Appendix A
	Clearwater Hatchery Summer Chinook	H	1	PIT	hydrosystem: LGR to BON	6	2011	2016	McCann et al. 2017, Appendix A
	Clearwater River Wild Spring Chinook	W	1	PIT	hydrosystem: LGR to BON	3	2014	2016	McCann et al. 2017, Appendix A
	Dworshak Hatchery Fall Chinook at Snake River (Surrogates)	H	0	PIT	hydrosystem: LGR to BON	5	2006	2011	McCann et al. 2017, Appendix A
	Dworshak Hatchery Spring Chinook	H	1	PIT	hydrosystem: LGR to BON	20	1997	2016	McCann et al. 2017, Appendix A
	Grande Ronde River Hatchery Fall Chinook	H	0	PIT	hydrosystem: LGR to BON	6	2006	2012	McCann et al. 2017, Appendix A
	Grande Ronde River Wild Spring Chinook	W	1	PIT	hydrosystem: LGR to BON	3	2014	2016	McCann et al. 2017, Appendix A
	Imnaha Hatchery Summer Chinook	H	1	PIT	hydrosystem: LGR to BON	20	1997	2016	McCann et al. 2017, Appendix A
	Imnaha River Wild Summer Chinook	W	1	PIT	hydrosystem: LGR to BON	4	2013	2016	McCann et al. 2017, Appendix A
	Irrigon	H	0	PIT	Rel to BON: Cougar Ck to BON	4	2008	2011	Smith, Steve. Pers. comm. July 20, 2017
	Kooskia Hatchery Spring Chinook	H	1	PIT	hydrosystem: LGR to BON	3	2014	2016	McCann et al. 2017, Appendix A

Lyons Ferry	H	0	PIT	Rel to BON: Big Canyon Ck to BON	6	2006	2012	Smith, Steve. Pers. comm. July 20, 2017
Lyons Ferry	H	0	PIT	Rel to BON: Captain John Rapids to BON	5	2006	2012	Smith, Steve. Pers. comm. July 20, 2017
Lyons Ferry	H	0	PIT	Rel to BON: Cougar Ck to BON	1	2006	2006	Smith, Steve. Pers. comm. July 20, 2017
Lyons Ferry	H	0	PIT	Rel to BON: Pittsburg Landing to BON	6	2006	2012	Smith, Steve. Pers. comm. July 20, 2017
Lyons Ferry	H	0	PIT	Rel to BON: Snake R. at Couse Ck to BON	4	2006	2012	Smith, Steve. Pers. comm. July 20, 2017
Lyons Ferry Hatchery Fall Chinook at Big Canyon Creek AP	H	0	PIT	hydrosystem: LGR to BON	6	2006	2012	McCann et al. 2017, Appendix A
Lyons Ferry Hatchery Fall Chinook at Captain John Rapids AP	H	0	PIT	hydrosystem: LGR to BON	7	2008	2016	McCann et al. 2017, Appendix A
Lyons Ferry Hatchery Fall Chinook at Pittsburg Landing AP	H	0	PIT	hydrosystem: LGR to BON	8	2006	2016	McCann et al. 2017, Appendix A
Lyons Ferry Hatchery Fall Chinook at Snake River	H	0	PIT	hydrosystem: LGR to BON	6	2006	2012	McCann et al. 2017, Appendix A
McCall Hatchery Summer Chinook	H	1	PIT	hydrosystem: LGR to BON	21	1997	2016	McCann et al. 2017, Appendix A
Middle Fork Salmon River Wild Spring_Summer Chinook	W	1	PIT	hydrosystem: LGR to BON	3	2014	2016	McCann et al. 2017, Appendix A
Nez Perce	H	0	PIT	Rel to BON: Cedar Flats to BON	5	2006	2012	Smith, Steve. Pers. comm. July 20, 2017
Nez Perce	H	0	PIT	Rel to BON: Lukes Gulch to BON	6	2006	2012	Smith, Steve. Pers. comm. July 20, 2017
Nez Perce	H	0	PIT	Rel to BON: Nez Perce Hatchery to BON	5	2006	2012	Smith, Steve. Pers. comm. July 20, 2017
Nez Perce	H	0	PIT	Rel to BON: North Lapwai Valley to BON	3	2010	2012	Smith, Steve. Pers. comm. July 20, 2017
Nez Perce Hatchery Fall Chinook	H	0	PIT	hydrosystem: LGR	3	2010	2012	McCann et al. 2017, Appendix A

at Cedar Flats AP				to BON				
Nez Perce Hatchery Fall Chinook at Lukes Gulch AP	H	0	PIT	hydrosystem: LGR to BON	3	2010	2012	McCann et al. 2017, Appendix A
Oxbow	H	0	PIT	Rel to BON: Hells Canyon to BON	5	2006	2012	Smith, Steve. Pers. comm. July 20, 2017
Oxbow Hatchery Fall Chinook below Hells Canyon Dam	H	0	PIT	hydrosystem: LGR to BON	4	2008	2012	McCann et al. 2017, Appendix A
Pahsimeroi Hatchery Summer Chinook	H	1	PIT	hydrosystem: LGR to BON	9	2008	2016	McCann et al. 2017, Appendix A
Rapid River Hatchery Spring Chinook	H	1	PIT	hydrosystem: LGR to BON	20	1997	2016	McCann et al. 2017, Appendix A
Sawtooth Hatchery Spring Chinook	H	1	PIT	hydrosystem: LGR to BON	10	2007	2016	McCann et al. 2017, Appendix A
Snake	H	1	JSATS	hydrosystem+LRE: LGR to Rkm 8	1	2008	2008	Deitrich et al. 2016, Table 3
Snake	H	1	V7	full river: Rel to Rkm 23	2	2008	2009	Rechisky et al. 2013, Table 1, Figure 3
Snake	H	1	V9	full river: Rel to Rkm 40	1	2006	2006	Rechisky et al. 2009, Table 1
Snake	HW	1	JSATS	hydrosystem+LRE: LGR to Rkm 8	1	2008	2008	McMichael et al. 2010
Snake	HW	1	JSATS	hydrosystem+LRE: LGR to Rkm 8.3	1	2006	2006	McMichael et al. 2007, Table 5
Snake	HW	1	PIT	hydrosystem: Snake trap to BON	18	1999	2016	Faulkner et al. 2017, Table 26
Snake	HW	1	V7	hydrosystem+LRE: LGR to Rkm 8	1	2010	2010	Rechisky et al. 2014, Table 3
Snake	U	1	V9	LRE: BON to Rkm 8	1	2004	2004	Welch et al. 2008; Clemens et al. 2009
Snake	HW	1	V7	LRE: BON to Rkm 8	1	2011	2011	Rechisky et al. 2014, Table 3
Snake River Wild Fall Chinook	W	0	PIT	hydrosystem: LGR to BON	6	2006	2012	McCann et al. 2017, Appendix A
Snake River Wild Spring_Summer Chinook	W	1	PIT	hydrosystem: LGR to BON	23	1994	2016	McCann et al. 2017, Appendix A
South Fork Salmon River Wild Spring_Summer Chinook	W	1	PIT	hydrosystem: LGR to BON	3	2014	2016	McCann et al. 2017, Appendix A
Umatilla	H	0	PIT	Rel to BON: Hells	6	2006	2012	Smith, Steve. Pers. comm. July 20, 2017

					Canyon to BON				
	Umatilla_Irrigon Hatchery Fall Chinook below Hells Canyon Dam	H	0	PIT	hydrosystem: LGR to BON	6	2006	2012	McCann et al. 2017, Appendix A
	Upper Salmon River Wild Spring_Summer Chinook	W	1	PIT	hydrosystem: LGR to BON	3	2014	2016	McCann et al. 2017, Appendix A

B. Steelhead

KEOG	Keogh	H		V9	Rel to mouth: Rkm 0.3 to mouth	2	2004	2005	Welch et al. 2011, Figure 3
	Keogh	W		V9	Rel to mouth: Rkm 0.3 to mouth	2	2004	2006	Welch et al. 2011, Figure 3
SOG	Coldwater	W		V7, V9	Rel to mouth: Rkm 57 to mouth	1	2006	2006	Welch et al. 2011, Figure 3
	Coldwater	W		V9	Rel to mouth: Rkm 31-51 to mouth	2	2004	2005	Welch et al. 2011, Figure 3
	Cowichan	H		V9	Rel to mouth	1	2006	2006	Welch et al. 2011, Figure 3
	Deadman	W		V7, V9	Rel to mouth: Rkm 363 to mouth	1	2006	2006	Welch et al. 2011, Figure 3
	Deadman	W		V9	Rel to mouth: Rkm 342 to mouth	1	2005	2005	Welch et al. 2011, Figure 3
	Englishman	W		V9	Rel to mouth: Rkm 2.5 to mouth	3	2004	2006	Welch et al. 2011, Figure 3
	Seymour	H		V7	Rel to mouth	1	2015	2015	Healy et al. 2017, Page 7
	Seymour	H		V9	Rel to mouth	3	2006	2009	Balfry et al. 2011, Table 3
	Seymour	H		V9	Rel to mouth	1	2007	2007	Balfry et al. 2011, Table 3; Welch et al. 2011, Figure 3
	Squamish	H		V9	Rel to mouth: Rkm 15 to mouth	1	2007	2007	Welch et al. 2011, Figure 3
	Squamish	W		V9	Rel to mouth: Rkm 16 to mouth	2	2004	2005	Welch et al. 2011, Figure 3
PS	Big Beef Creek	W		V7, V9	Rel to mouth: Rkm 0.1 to mouth	1	2006	2009	Moore et al. 2015, Figure 3
	Dewatto	W		V7	Rel to mouth: Rkm 0.3 to mouth	1	2007	2007	Moore et al. 2015, Figure 3
	Duckabush	H		V7	Rel to mouth: Rkm	1	2009	2009	Moore et al. 2015, Figure 3

				1.9 to mouth				
	Green	H	V7	Rel to mouth: Rkm 55 to mouth	1	2006	2008	Goetz et al. 2015, Table 3; Moore et al. 2015, Figure 3
	Green	W	V7	Rel to mouth: Rkm 54.5 to mouth	1	2006	2009	Goetz et al. 2015, Table 3; Moore et al. 2015, Figure 3
	Hamma Hamma	H	V7, V9	Rel to mouth: Rkm 2 to mouth	1	2006	2007	Moore et al. 2015, Figure 3
	Nisqually	W	V7, V9	Rel to mouth: Rkm 0-21 to mouth	1	2006	2009	Moore et al. 2015, Figure 3
	Puyallup	H	V7	Rel to mouth: Rkm 55.8 to mouth	1	2006	2009	Moore et al. 2015, Figure 3
	Puyallup	W	V7	Rel to mouth: Rkm 17 to mouth	1	2006	2006	Moore et al. 2015, Figure 3
	Skagit	H	V7, V9	Rel to mouth: Rkm 102 to mouth	1	2008	2009	Moore et al. 2015, Figure 3
	Skagit	W	V7	Rel to mouth: Rkm 10 to mouth	1	2006	2009	Moore et al. 2015, Figure 3
	Skokomish	H	V7	Rel to mouth: Rkm 13.5 to mouth	1	2008	2009	Moore et al. 2015, Figure 3
	Skokomish	W	V7, V9	Rel to mouth: Rkm 13.5 to mouth	1	2006	2009	Moore et al. 2015, Figure 3
UCOL	Upper Columbia	U	PIT	hydrosystem+LRE: RIS to Rkm 75	7	2008	2014	Hostetter et al. 2018, Figure 4
	Upper Columbia	HW	JSATS	LRE: BON to Rkm 8.3	1	2009	2009	McMichael et al 2010, Table ES2
	Upper Columbia	HW	JSATS	LRE: BON to Rkm 8.3	1	2010	2010	McMichael et al 2011, Table 3.7
SNAK	Asotin River Wild Steelhead	W	PIT	hydrosystem: LGR to BON	1	2014	2014	McCann et al. 2017, Appendix A
	Clearwater River Hatchery Steelhead B-Run	H	PIT	hydrosystem: LGR to BON	9	2008	2016	McCann et al. 2017, Appendix A
	Clearwater River Wild Steelhead A-Run	W	PIT	hydrosystem: LGR to BON	2	2013	2014	McCann et al. 2017, Appendix A
	Grande Ronde River Hatchery Steelhead A-Run	H	PIT	hydrosystem: LGR to BON	9	2008	2016	McCann et al. 2017, Appendix A
	Grande Ronde River Wild Steelhead A-Run	W	PIT	hydrosystem: LGR to BON	1	2014	2014	McCann et al. 2017, Appendix A

	Hells Canyon Hatchery Steelhead A-Run	H	PIT	hydrosystem: LGR to BON	8	2009	2016	McCann et al. 2017, Appendix A
	Imnaha River Hatchery Steelhead A-Run	H	PIT	hydrosystem: LGR to BON	9	2008	2016	McCann et al. 2017, Appendix A
	Imnaha River Wild Steelhead A-Run	W	PIT	hydrosystem: LGR to BON	2	2013	2014	McCann et al. 2017, Appendix A
	Salmon River Hatchery Steelhead A-Run	H	PIT	hydrosystem: LGR to BON	9	2008	2016	McCann et al. 2017, Appendix A
	Salmon River Hatchery Steelhead B-Run	H	PIT	hydrosystem: LGR to BON	9	2008	2016	McCann et al. 2017, Appendix A
	Salmon River Wild Steelhead A-Run	W	PIT	hydrosystem: LGR to BON	1	2014	2014	McCann et al. 2017, Appendix A
	Snake	HW	PIT	hydrosystem: Snake Trap to BON	20	1997	2016	Faulkner et al. 2017, Table 29
	Snake	(blank)	V9	LRE: BON to Rkm 23	2	2002	2003	Clemens et al. 2009; Welch et al. 2008, Table 1
	Snake River Hatchery Steelhead (all A-Run combined)	H	PIT	hydrosystem: LGR to BON	9	2008	2016	McCann et al. 2017, Appendix A
	Snake River Hatchery Steelhead (all B-Run combined)	H	PIT	hydrosystem: LGR to BON	9	2008	2016	McCann et al. 2017, Appendix A
	Snake River Hatchery Steelhead (all groups combined)	H	PIT	hydrosystem: LGR to BON	20	1997	2016	McCann et al. 2017, Appendix A
	Snake River Wild Steelhead Aggregate	W	PIT	hydrosystem: LGR to BON	20	1997	2016	McCann et al. 2017, Appendix A
	Snake River Wild Steelhead A-Run	W	PIT	hydrosystem: LGR to BON	2	2013	2014	McCann et al. 2017, Appendix A
	Snake River Wild Steelhead B-Run	W	PIT	hydrosystem: LGR to BON	2	2013	2014	McCann et al. 2017, Appendix A
ORC	Alsea	W	V7	Rel to mouth: Rkm 55 to mouth	1	2009	2009	Romer et al. 2013, Table 2
	Alsea	W	V7, V9	Rel to mouth: Rkm 55 to mouth	1	2007	2007	Romer et al. 2013, Table 2; Johnson et al. 2010
	Nehalam	W	V7	Rel to mouth: Rkm 33 to mouth	1	2009	2009	Romer et al. 2013, Table 2
	Nehalam	W	V9	Rel to mouth: Rkm 33 to mouth	2	2001	2002	Romer et al. 2013, Table 2; Clements et al. 2012, Table 2

Notes

Estimates from Moore et al. 2015 were averaged across years.
Nicola and Spius yearling Chinook: omitted from analysis because tag burden exceeded current best practises (>75% of smolts had fork lengths under 130 mm for V7-tagged and under 140 mm for V9-tagged).
Cowichan steelhead: omitted from analysis because this was the only estimate outside the Columbia River area where the migration segment did not terminate in the river mouth.

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Table S2. Source populations for SAR estimates used in the study; map code is used in Figure 1, Race refers to adult run timing, Rear is either H (Hatchery) or W (Wild) , Jacks indicates whether precocious male returns are included in survival estimates, N is the sample size (years of data). Reach refers to the migration segment over which SARs were estimated (survival from smolt enumeration site to adult enumeration site). See Methods for discussion.

A. Chinook

Region	Stock	Short Name	Map Code	Race	Rear	Smolt Age	Jacks	Reach	N	From	To	Source
AK	Alaska Spring	Alaska	5	Spring	H	1	Y		35	1978	2012	PSC CWT
	Chilkat Spring	Chilkat	1	Spring	W	1	Y		12	2001	2012	PSC CWT
	Unuk Spring	Unuk	4	Spring	W	1	Y		24	1984	2012	PSC CWT
	Stikine River Spring	Stikine	3	Spring	W	1	Y		13	2000	2012	PSC CWT
	Taku Spring	Taku	2	Spring	W	1	Y		27	1977	2012	PSC CWT
NCBC	Atnarko River Summer	Atnarko	8	Summer	H	0	Y		23	1987	2011	PSC CWT
	Kitsumkalum Yearlings	Kits	6	Summer	H	1	Y		11	2001	2012	PSC CWT
WCVI	Robertson Creek	Robertson	17	Fall	H	0	Y		39	1974	2012	PSC CWT
SOG	Big Qualicum	BigQual	16	Fall	H	0	Y		39	1974	2012	PSC CWT
	Chilliwack Fall	Chilliwack	19	Fall	H	0	Y		31	1982	2012	PSC CWT
	Cowichan	Cowichan	22	Fall	H	0	Y		25	1986	2012	PSC CWT
	Dome Creek Spring	Dome	7	Spring	H	1	Y		16	1988	2004	PSC CWT
	Harrison River Fall	Harrison	18	Fall	H	0	Y		30	1982	2012	PSC CWT
	Lower Shuswap River Summers	LowShuswap	11	Summer	H	0	Y		28	1985	2012	PSC CWT
	Middle Shuswap Summers	MidShuswap	12	Summer	H	0	Y		4	2009	2012	PSC CWT
	Nanaimo River Fall	Nanaimo	20	Fall	H	0	Y		19	1980	2005	PSC CWT
	Nicola River Spring	Nicola	13	Spring	H	1	Y		27	1987	2013	PSC CWT
	Phillips River Fall	Phillips	10	Fall	H	0	Y		3	2010	2012	PSC CWT
	Puntledge Summer	Puntledge	15	Summer	H	0	Y		36	1976	2012	PSC CWT
	Quinsam Fall	Quinsam	14	Fall	H	0	Y		38	1975	2012	PSC CWT
PS	George Adams Fall Fingerling	GeorgeAdam	44	Summer/Fall	H	0	Y		33	1973	2011	PSC CWT

	Nisqually Fall Fingerling	Nisqually	51	Summer/Fall	H	0	Y	13	1999	2011	PSC CWT
	Nooksack Spring Fingerling	NookFng	21	Spring	H	0	Y	21	1990	2012	PSC CWT
	Nooksack Spring Yearling	NookYrl	21	Spring	H	1	Y	13	1983	1998	PSC CWT
	Samish Fall Fingerling	Samish	23	Summer/Fall	H	0	Y	29	1975	2011	PSC CWT
	Skagit Spring Fingerling	SkagSpFng	24	Spring	H	0	Y	19	1987	2012	PSC CWT
	Skagit Spring Yearling	SkagSpYrl	24	Spring	H	1	Y	26	1983	2012	PSC CWT
	Skagit Summer Fingerling	SkagitSu	24	Summer	H	0	Y	17	1995	2011	PSC CWT
	Skykomish Fall Fingerling	Skykomish	34	Summer/Fall	H	0	Y	11	2001	2011	PSC CWT
	South Puget Sound Fall Fingerling	SPugetFng	52	Summer/Fall	H	0	Y	38	1972	2011	PSC CWT
	Squaxin Pens Fall Yearling	Squaxin	46	Fall	H	1	Y	10	1987	1998	PSC CWT
	Stillaguamish Fall Fingerling	Stillag	27	Summer/Fall	H	0	Y	26	1981	2011	PSC CWT
	University of Washington Accelerated	UW	37	Fall	H	0	Y	10	1976	1985	PSC CWT
	White River Spring Yearling	White	48	Spring	H	1	Y	11	1976	2012	PSC CWT
WAC	Elwha Fall Fingerling	Elwha	29	Summer/Fall	H	0	Y	12	1983	1995	PSC CWT
	Hoko Fall Fingerling	Hoko	28	Fall	H	0	Y	25	1986	2011	PSC CWT
	Queets Fall Fingerling	Queets	40	Fall	H	0	Y	33	1978	2011	PSC CWT
	Sooes Fall Fingerling	Sooes	26	Fall	H	0	Y	25	1986	2011	PSC CWT
LCOL	Columbia Lower River Hatchery	LowCol	64	Fall Tule	H	0	Y	35	1977	2011	PSC CWT
	Cowlitz Tule	Cowlitz	65	Fall Tule	H	0	Y	34	1978	2011	PSC CWT
	Lewis River Wild	Lewis	71	Fall Bright	W	0	Y	31	1978	2011	PSC CWT
	Willamette Spring	Willamette	92	Spring	H	1	Y	35	1977	2011	PSC CWT

MCOL	Carson Hatchery Spring Chinook	Carson	70	Spr	H	1	N	Rel to BOA	14	2000	2013	FPC PIT
	Carson Hatchery Spring Chinook	Carson	70	Spr	H	1	Y	Rel to BOA	1	2014	2014	FPC PIT
	Cle Elum Hatchery Spring Chinook	CleElum	47	Spr	H	1	Y	MCN to MCA	13	2002	2014	FPC PIT
	Deschutes River Wild Fall Chinook	Deschutes	80	Fall	W	0	Y	Rel to BOA	2	2011	2012	FPC PIT
	Hanford Reach Wild Fall Chinook	Hanford	57	Fall	W	0	N	Rel to BOA	9	2000	2010	FPC PIT
	Hanford Reach Wild Fall Chinook	Hanford	57	Fall	W	0	Y	Rel to BOA	2	2011	2012	FPC PIT
	Hanford Wild	Hanford2	57	Fall Bright	W	0	Y		25	1987	2011	PSC CWT
	John Day River Wild Spring Chinook	JohnDay	79	Spr	W	1	Y	JDA to BOA	15	2000	2014	FPC PIT
	Little White Salmon Hatchery Fall Chinook	LtlWhite	75	Fall	H	0	N	Rel to BOA	3	2008	2010	FPC PIT
	Little White Salmon Hatchery Fall Chinook	LtlWhite	75	Fall	H	0	Y	Rel to BOA	2	2011	2012	FPC PIT
	Spring Creek Hatchery Fall Chinook (March Release)	SprMarch	74	Fall	H	0	N	Rel to BOA	5	2008	2012	FPC PIT
	Spring Creek Hatchery Fall Chinook (May Release)	SprMay	74	Fall	H	0	N	Rel to BOA	5	2008	2012	FPC PIT
	Spring Creek Tule	SprTule	74	Fall Tule	H	0	Y		39	1973	2011	PSC CWT
	Upriver Bright	Upriver	55	Fall Bright	H	0	Y		36	1976	2011	PSC CWT
	Warm Springs Hatchery Spring Chinook	Warm	87	Spr	H	1	N	Rel to BOA	7	2007	2013	FPC PIT
	Warm Springs Hatchery Spring Chinook	Warm	87	Spr	H	1	Y	Rel to BOA	1	2014	2014	FPC PIT
	Yakima River Wild Spring Chinook	Yakima	63	Spr	W	1	Y	MCN to MCA	11	2002	2013	FPC PIT

UCOL	Columbia Summers	Columbia	30	Summer	H	0	Y		31	1976	2011	PSC CWT
	Combined Hatch Wild Spring Chinook tagged at Rock Island Dam	RockIsSp	42	Spr	HW	1	Y	Rel to BOA	14	2000	2014	FPC PIT
	Combined Hatch Wild Summer Chinook tagged at Rock Island Dam	RockIsSu	42	Sum	HW	0	Y	Rel to BOA	15	2000	2014	FPC PIT
	Entiat and Methow River Wild Spring Chinook	EntMeth	35	Spr	W	1	Y	RRE to BOA	7	2008	2014	FPC PIT
	Entiat Hatchery Summer Chinook	Entiat	36	Sum	H	0	Y	RRE to BOA	4	2011	2014	FPC PIT
	Leavenworth Hatchery Spring Chinook	Leaven	39	Spr	H	1	Y	MCN to BOA	15	2000	2014	FPC PIT
	Mid-Columbia River Hatchery Spring Chinook	MColHSp	30	Spr	H	1	Y	first to PRA	13	1972	1984	Raymond
	Mid-Columbia River Wild Hatchery Combined Summer Chinook	MColWHSu	30	Sum	HW	0	Y	first to PRA	16	1968	1983	Raymond
	Mid-Columbia River Wild Spring Chinook	MColWSp	30	Spr	W	1	Y	first to PRA	23	1962	1984	Raymond
	Mid-Columbia River Wild Summer Chinook	MColWSu	30	Sum	W	0	Y	first to PRA	7	1962	1968	Raymond
	Upper Columbia River (above Wells Dam) Wild Summer Chinook	AboveWells	30	Sum	W	0	Y	RRE to BOA	3	2011	2013	FPC PIT
	Wenatchee River Wild Spring Chinook	Wenatchee	41	Spr	W	1	Y	MCN to BOA	8	2007	2014	FPC PIT

	Winthrop Hatchery Spring Chinook	Winthrop	25	Spr	H	1	Y	RRE to BOA	6	2009	2014	FPC PIT
SNAK	Catherine Creek Hatchery Spring Chinook	Catherine	83	Spr	H	1	Y	LGR to GRA	14	2001	2014	FPC PIT
	Clearwater Hatchery Spring Chinook	ClearHSp	59	Spr	H	1	Y	LGR to GRA	9	2006	2014	FPC PIT
	Clearwater Hatchery Summer Chinook	ClearHSu	59	Sum	H	1	Y	LGR to GRA	4	2011	2014	FPC PIT
	Clearwater River Wild Spring Chinook	ClearWSp	61	Spr	W	1	Y	LGR to GRA	9	2006	2014	FPC PIT
	Dworshak Hatchery Fall Chinook at Snake River (Surrogates)	Dworshak	59	Fall	H	0	Y	LGR to GRA	5	2006	2011	FPC PIT
	Dworshak Hatchery Spring Chinook	Dworshak	59	Spr	H	1	Y	LGR to GRA	18	1997	2014	FPC PIT
	Grande Ronde River Hatchery Fall Chinook	GrndRonde	73	Fall	H	0	Y	LGR to GRA	6	2006	2012	FPC PIT
	Grande Ronde River Wild Spring Chinook	GrndRonde	73	Spr	W	1	Y	LGR to GRA	9	2006	2014	FPC PIT
	Imnaha Hatchery Summer Chinook	ImnahaH	72	Sum	H	1	Y	LGR to GRA	18	1997	2014	FPC PIT
	Imnaha River Wild Summer Chinook	ImnahaW	72	Sum	W	1	Y	LGR to GRA	9	2006	2014	FPC PIT
	Lyons Ferry	Lyons	56	Fall Bright	H	0	Y		18	1985	2011	PSC CWT
	Lyons Ferry Hatchery Fall Chinook at Big Canyon Creek AP	LyonsBgCan	60	Fall	H	0	Y	LGR to GRA	6	2006	2012	FPC PIT
	Lyons Ferry Hatchery Fall Chinook at Captain	LyonsCptJ	66	Fall	H	0	Y	LGR to GRA	5	2008	2012	FPC PIT

John Rapids AP											
Lyons Ferry Hatchery Fall Chinook at Pittsburg Landing AP	LyonsPitts	77	Fall	H	0	Y	LGR to GRA	6	2006	2012	FPC PIT
Lyons Ferry Hatchery Fall Chinook at Snake River	LyonsSnR	56	Fall	H	0	Y	LGR to GRA	6	2006	2012	FPC PIT
McCall Hatchery Summer Chinook	McCall	86	Sum	H	1	Y	LGR to GRA	18	1997	2014	FPC PIT
Middle Fork Salmon River Wild Spring Summer Chinook	MidSalmon	90	SpSu	W	1	Y	LGR to GRA	9	2006	2014	FPC PIT
Nez Perce Hatchery Fall Chinook at Cedar Flats AP	NezPerCedr	67	Fall	H	0	Y	LGR to GRA	3	2010	2012	FPC PIT
Nez Perce Hatchery Fall Chinook at Lukes Gulch AP	NezPerLuke	68	Fall	H	0	Y	LGR to GRA	3	2010	2012	FPC PIT
Oxbow Hatchery Fall Chinook below Hells Canyon Dam	Oxbow	85	Fall	H	0	Y	LGR to GRA	4	2008	2012	FPC PIT
Pahsimeroi Hatchery Summer Chinook	Pahsimeroi	88	Sum	H	1	Y	LGR to GRA	7	2008	2014	FPC PIT
Rapid River Hatchery Spring Chinook	Rapid	78	Spr	H	1	Y	LGR to GRA	18	1997	2014	FPC PIT
Sawtooth Hatchery Spring Chinook	Sawtooth	91	Spr	H	1	Y	LGR to GRA	8	2007	2014	FPC PIT
Snake River Hatchery Spring Chinook	SnakeHSp	54	Spr	H	1	Y	GOJ to IHA	5	1970	1974	Raymond

Snake River Hatchery Spring Chinook	SnakeHSp	54	Spr	H	1	Y	ICH to IHA	3	1966	1968	Raymond
Snake River Hatchery Spring Chinook	SnakeHSp	54	Spr	H	1	Y	LGR to IHA	10	1975	1984	Raymond
Snake River Hatchery Spring Chinook	SnakeHSp	54	Spr	H	1	Y	LMJ to IHA	1	1969	1969	Raymond
Snake River Wild Fall Chinook	SnakeWFa	54	Fall	W	0	Y	LGR to GRA	4	2006	2011	FPC PIT
Snake River Wild Spring Chinook	SnakeWSp	54	Spr	W	1	Y	GOJ to IHA	5	1970	1974	Raymond
Snake River Wild Spring Chinook	SnakeWSp	54	Spr	W	1	Y	ICH to IHA	5	1964	1968	Raymond
Snake River Wild Spring Chinook	SnakeWSp	54	Spr	W	1	Y	LGR to IHA	10	1975	1984	Raymond
Snake River Wild Spring Chinook	SnakeWSp	54	Spr	W	1	Y	LMJ to IHA	1	1969	1969	Raymond
Snake River Wild Spring Summer Chinook	SnakeWSpSu	54	SpSu	W	1	Y	LGR to GRA	21	1994	2014	FPC PIT
Snake River Wild Summer Chinook	SnakeWSu	54	Sum	W	1	Y	GOJ to IHA	5	1970	1974	Raymond
Snake River Wild Summer Chinook	SnakeWSu	54	Sum	W	1	Y	ICH to IHA	5	1964	1968	Raymond
Snake River Wild Summer Chinook	SnakeWSu	54	Sum	W	1	Y	LGR to IHA	10	1975	1984	Raymond
Snake River Wild Summer Chinook	SnakeWSu	54	Sum	W	1	Y	LMJ to IHA	1	1969	1969	Raymond
South Fork Salmon River Wild Spring Summer Chinook	SthSalmon	89	SpSu	W	1	Y	LGR to GRA	9	2006	2014	FPC PIT
Umatilla Irrigon Hatchery Fall Chinook below Hells Canyon Dam	UmaIrri	69	Fall	H	0	Y	LGR to GRA	6	2006	2012	FPC PIT
Upper Salmon River Wild Spring Summer Chinook	UpSalmon	82	SpSu	W	1	Y	LGR to GRA	9	2006	2014	FPC PIT

ORC	Elk River	Elk	93	Fall	H	0	Y		34	1978	2011	PSC CWT
	Salmon River	Salmon	84	Fall	H	0	Y		34	1977	2011	PSC CWT

B. Steelhead

Region	Stock	Short Name	Map Code	Race	Rear	Smolt Age	Jacks	Reach	N	From	To	Source
KEOG	Keogh	Keogh	9	Win	W	NA	Y		37	1977	2013	Davies
PS	Big Beef Creek	BigBeef	38	Win	W	NA	Y		6	2005	2010	WDFW
	Green R. summer	GreenSu	43	Sum	H	NA	Y		19	1993	2011	WDFW
	Green R. winter	GreenWn	43	Win	H	NA	Y		29	1982	2010	WDFW
	Nisqually River	Nisqually	51	Win	W	NA	Y		3	2009	2011	WDFW
	Nooksack R. winter	Nooksack	21	Win	H	NA	Y		13	1999	2011	WDFW
	Puyallup R. winter	Puyallup	49	Win	H	NA	Y		23	1984	2006	WDFW
	Samish R. winter	Samish	23	Win	H	NA	Y		3	1977	1979	WDFW
	Skagit R. winter	Skagit	24	Win	H	NA	Y		31	1982	2012	WDFW
	Snohomish R. summer	SnohoSu	33	Sum	H	NA	Y		18	1994	2011	WDFW
	Snohomish R. winter	SnohoWn	33	Win	H	NA	Y		25	1986	2010	WDFW
	Snow Creek	Snow	31	Win	W	NA	Y		36	1978	2013	WDFW
	Stillaguamish R. summer	StillagSu	27	Sum	H	NA	Y		16	1996	2011	WDFW
	Stillaguamish R. winter	StillagWn	27	Win	H	NA	Y		17	1994	2010	WDFW
WAC	Chehalis winter	Chehalis	50	Win	H	NA	Y		32	1981	2012	WDFW
	Elwha R. winter	Elwha	29	Win	H	NA	Y		15	1985	2001	WDFW
	Humptulips R. summer	HumptulSu	45	Sum	H	NA	Y		10	1995	2008	WDFW
	Humptulips R. winter	HumptulWn	45	Win	H	NA	Y		36	1977	2012	WDFW
	Quillayute R. summer	QuilSu	32	Sum	H	NA	Y		13	1999	2011	WDFW
	Quillayute R. winter	QuilWn	32	Win	H	NA	Y		30	1982	2011	WDFW
	Willapa R. winter	Willapa	58	Win	H	NA	Y		17	1994	2010	WDFW
	Wynoochee R. summer	Wynoochee	53	Sum	H	NA	Y		16	1994	2009	WDFW
MCOL	Deschutes River Wild Steelhead	Deschutes	80	Sum	W	NA	Y	BON to BOA	8	2006	2014	FPC PIT

	John Day River Wild Steelhead	JohnDay	79	Sum	W	NA	Y	JDA to BOA	11	2004	2014	FPC PIT
	Yakima River Wild Steelhead	Yakima	63	Sum	W	NA	Y	MCN to MCA	13	2002	2014	FPC PIT
UCOL	Combined Hatch Wild Steelhead tagged at Rock Island Dam	RockIs	42	Sum	HW	NA	Y	Rel to BOA	14	2000	2014	FPC PIT
	Eastbank and Chelan Hatchery Steelhead at Wenatchee River	EastbkChel	41	Sum	H	NA	Y	MCN to BOA	12	2003	2014	FPC PIT
	Entiat and Methow River Wild Steelhead	EntMeth	35	Sum	W	NA	Y	RRE to BOA	7	2008	2014	FPC PIT
	Mid-Columbia River Wild Hatchery Combined Steelhead	MCol	30	NA	HW	NA	Y	first to PRA	23	1962	1984	Raymond
	Wenatchee Entiat and Methow River Wild Steelhead	WenEntMeth	35	Sum	W	NA	Y	MCN to BOA	9	2006	2014	FPC PIT
SNAK	Clearwater River Hatchery Steelhead B-Run	ClearH	59	Sum	H	NA	Y	LGR to GRA	7	2008	2014	FPC PIT
	Clearwater River Wild Steelhead A-Run	ClearW	59	Sum	W	NA	Y	LGR to GRA	9	2006	2014	FPC PIT
	Grande Ronde River Hatchery Steelhead A-Run	GrndRondeH	73	Sum	H	NA	Y	LGR to GRA	7	2008	2014	FPC PIT
	Grande Ronde River Wild Steelhead A-Run	GrndRondeW	73	Sum	W	NA	Y	LGR to GRA	9	2006	2014	FPC PIT
	Hells Canyon Hatchery Steelhead A-Run	HellsC	81	Sum	H	NA	Y	LGR to GRA	6	2009	2014	FPC PIT
	Imnaha River Hatchery Steelhead A-Run	ImnahaH	72	Sum	H	NA	Y	LGR to GRA	7	2008	2014	FPC PIT
	Imnaha River Wild Steelhead A-Run	ImnahaW	72	Sum	W	NA	Y	LGR to GRA	9	2006	2014	FPC PIT
	Salmon River Hatchery Steelhead A-Run	SalmonHA	76	Sum	H	NA	Y	LGR to GRA	7	2008	2014	FPC PIT
	Salmon River Hatchery Steelhead B-	SalmonHB	76	Sum	H	NA	Y	LGR to GRA	7	2008	2014	FPC PIT

Run											
Salmon River Wild Steelhead A-Run	SalmonWA	76	Sum	W	NA	Y	LGR to GRA	9	2006	2014	FPC PIT
Snake River Hatchery Steelhead	SnakeH	54	NA	H	NA	Y	GOJ to IHA	5	1970	1974	Raymond
Snake River Hatchery Steelhead	SnakeH	54	NA	H	NA	Y	ICH to IHA	2	1967	1968	Raymond
Snake River Hatchery Steelhead	SnakeH	54	NA	H	NA	Y	LGR to IHA	10	1975	1984	Raymond
Snake River Hatchery Steelhead	SnakeH	54	NA	H	NA	Y	LMJ to IHA	1	1969	1969	Raymond
Snake River Hatchery Steelhead (all B-Run combined)	SnakeHB	54	Sum	H	NA	Y	LGR to GRA	2	2013	2014	FPC PIT
Snake River Hatchery Steelhead (all groups combined)	SnakeHC	54	Sum	H	NA	Y	LGR to GRA	17	1997	2013	FPC PIT
Snake River Wild Steelhead	SnakeW	54	NA	W	NA	Y	GOJ to IHA	5	1970	1974	Raymond
Snake River Wild Steelhead	SnakeW	54	NA	W	NA	Y	ICH to IHA	5	1964	1968	Raymond
Snake River Wild Steelhead	SnakeW	54	NA	W	NA	Y	LGR to IHA	10	1975	1984	Raymond
Snake River Wild Steelhead	SnakeW	54	NA	W	NA	Y	LMJ to IHA	1	1969	1969	Raymond
Snake River Wild Steelhead Aggregate	SnakeWAg	54	Sum	W	NA	Y	LGR to GRA	18	1997	2014	FPC PIT
Snake River Wild Steelhead A-Run	SnakeWA	54	Sum	W	NA	Y	LGR to GRA	9	2006	2014	FPC PIT
Snake River Wild Steelhead B-Run	SnakeWB	54	Sum	W	NA	Y	LGR to GRA	9	2006	2014	FPC PIT

Sources

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Davies: Investigators interested in accessing the Keogh SAR data should request these data from Dr Trevor Davies, Province of British Columbia, Trevor.Davies@gov.bc.ca

WDFW: Updated dataset provided by Dr Neala Kendall (Pers. Comm.; Neala.Kendall@dfw.wa.gov) that is primarily reported in Kendall, N. W., G. W. Marston and M. M. Klungle (2017). "Declining patterns of Pacific Northwest steelhead trout (*Oncorhynchus mykiss*) adult abundance and smolt survival in the ocean." Canadian Journal of Fisheries and Aquatic Sciences **74**: 1275–1290. DOI: 10.1139/cjfas. Dr Kendall kindly provided an updated steelhead SAR dataset with data for more recent years than was available for her own publication.

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Notes on PSC Data

- Atnarko River Summer Chinook: SARS estimates were available for subyearling and yearling stocks which are abbreviated as ATN and ATY by the PSC respectively. We retained ATN but excluded ATY because Atnarko is primarily a subyearling stock and the yearling releases are a hatchery management practise (Velez-Espino et al. 2011).
- Kitsumkalum River Chinook: SARS estimates were available for subyearling and yearling stocks which are abbreviated as KLM and KLY by the PSC respectively. We excluded KLM but retained KLY because Kitsumkalum is primarily a yearling stock. The subyearlings are released by the hatchery as fry and remain in the river an extra year until they migrate to sea at the same time as their sibling KLM fish (David Willis personnal communication May 2018).
- Lyons Ferry Chinook: SARS estimates were available for subyearling and yearling stocks which are abbreviated as LYF and LYY by the PSC respectively. We retained LYF but excluded LYY because Lyons Ferry is primarily a subyearling stock and the yearling releases are a hatchery management practise (Tommy Garrison personnal communication Jan 2018).

- Nooksack Spring Chinook: SARS estimates were available for subyearling and yearling stocks which are abbreviated as NKF and NKS by the PSC respectively. We retained both because the Nooksack stock naturally a mix of both life-history strategies (Larrie LaVoy personnal communication Jan 2018).
- Skagit Spring Chinook: SARS estimates were available for subyearling and yearling stocks which are abbreviated as SSF and SKS by the PSC respectively. We retained both because the Skagit stock naturally a mix of both life-history strategies (Larrie LaVoy personnal communication Jan 2018).
- South Puget Sound Fall Chinook: SARS estimates were available for subyearling and yearling stocks which are abbreviated as SPS and SPY by the PSC respectively. We retained SPS but excluded SPY because South Puget is primarily a subyearling stock and the yearling releases are a hatchery management practise (Larrie LaVoy personnal communication Jan 2018).
- Yearling/subyearling designations were taken from PSC (2015; Table 2.1) with the following exceptions: 1) Squaxin Pens Fall Chinook and University of Washington Accelerated Chinook were designated using PSC (2005; Table 2.1); and 2) we assumed Stikine Spring Chinook outmigrate as yearlings, and Phillips Fall Chinook outmigrate as subyearlings based on the typical behaviour for their adult run timing (neither stock was listed in PSC (2015)).
- SARS were available in several formats. We used survival data calculated as the sum of adults returning at all ages, uninflated for losses to natural mortality for Chinook remaining at sea for longer than two years because these values are most similar to the CSS PIT-tag based survival estimates.
- We excluded SARS estimates for ocean entry years with incomplete adult returns.

Notes on CSS Data

- For most stocks, SARS are provided with and without jack returns, and with differing start and end points to fish enumeration. When available, we used the estimates that included jacks and that covered the largest portion of the migration. For some MCOL populations, the estimates that included jack returns were available only for the shorter migration segment. In these cases, we used the estimates for the longer migration segment excluding jacks. Includes Spring Creek Hatchery Fall Chinook (5 of 5 years), Little White Salmon Hatchery Fall Chinook (3 of 5 years), Carson Hatchery Spring Chinook (14 of 15 years), Warm Springs Hatchery Spring Chinook (7 of 8 years), and Hanford Reach Wild Fall Chinook (9 of 11 years).
- We excluded SARS estimates for ocean entry years with incomplete adult returns.
- SARS data are referenced to McCann et al. (2017) Appendix B, but were actually downloaded from the Fish Passage Center: http://www.fpc.org/survival/smolttoadult_queries.php. Where there were discrepancies between these data sources, we retained the estimates from the online source.

SI-3: Direct Comparison of CWT and PIT tag-based SAR Estimates.

We can identify two major systematic differences between the PIT- and CWT-based survival estimates: (1) PIT-based SAR estimate adult survival using those smolts that first survived to reach the topmost dam in the Columbia River hydrosystem and then return as adults to a dam where they are enumerated, while CWT-based SAR estimate adult survival from smolt release from the hatchery or (for wild fish) from an enumeration site in the river after smolt migration starts until adult return to the hatchery or spawning ground. (2) CWT-based survival estimates from the Pacific Salmon Commission (PSC) add the estimated sport and commercial harvest to the adult return to the river, while PIT tag-based survival estimates do not. The first difference (upstream losses not being included in the PIT tag-based analysis) will reduce CWT survival estimates relative to PIT tags, while the latter (harvest) will increase CWT survival.

Overall, it is difficult to predict exactly how the two estimates should combine to influence relative SAR for any given population. In this section we report our attempts to investigate this issue more thoroughly.

To assess the magnitude of the disparity between these two tagging methodologies, we searched the datasets for populations that had both PIT and CWT-based survival estimates for the same smolt outmigration year. We found three populations of subyearling (Fall) Chinook that had both CWT and PIT tag-based survival estimates (Table S3-1), but no matching populations for yearling (Spring) Chinook.

<u>Sub-Yearling Comparison</u>

We calculated a conversion factor between the CWT and PIT-based SAR estimates using linear regression on the matched pairs of survival estimates, with the PIT-based estimates as the independent and CWT-based estimates as the dependent variables (Figure S3-1; Table S3-1). The intercept from this relationship was not significantly different from zero (Table S3-2), so we ran the regression again with the intercept set to zero. The resulting slope (Table S3-2) was our conversion factor; the CWT-based SAR estimates were ca.

1.5X larger than the PIT-based estimates for the same stock and year of outmigration. That is, the combined effects of (a) migratory survival by downstream migrating smolts between the hatchery and the top-most dam in the hydrosystem, (b) upstream survival of migrating adults between the top-most dam and the spawning grounds (or enumeration site), and (c) sport and commercial harvest result in CWT-based SAR estimates averaging ca. 150% of the PIT tag-based estimates because the PIT tag-based SAR estimates do not take into account these processes.

Table S3-1. Stocks with SAR estimates for common outmigration years in both the CWT and PIT datasets. The "Stock" fields give the names as accessed from the source. For the PIT-based SARs, the "Stock" field was called "GroupDescription" on download. For PIT-based SAR where more than one release group is listed (i.e., for Spring Creek and Lyons Ferry) we used the mean SAR weighted by the sample size in the regression.

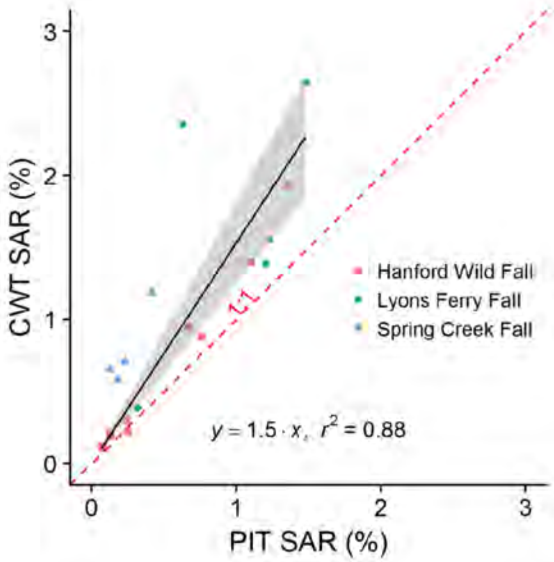
Stock PIT-based	Stock CWT-based	H/W	Years
Hanford Reach Wild Fall Chinook	Hanford Wild	W	2000-2001, 2003-2005, 2007-2011
Spring Creek Hatchery Fall Chinook (March Release) Spring Creek Hatchery Fall Chinook (April Release) Spring Creek Hatchery Fall Chinook (May Release)	Spring Creek Tule	H	2008-2011
Lyons Ferry Hatchery Fall Chinook at Big Canyon Creek Lyons Ferry Hatchery Fall Chinook at Captain John Rapids Lyons Ferry Hatchery Fall Chinook at Pittsburg Landing Lyons Ferry Hatchery Fall Chinook at Snake River	Lyons Ferry	H	2006, 2008-2011

Table S3-2. Results from the linear regression between CWT (dependent) and PIT-tag (independent)-based SAR estimates for subyearling Chinook salmon with matched stocks and years of outmigration.

Model	Variable	Estimate	SE	t value	P	R^2

Model 1	Intercept	0.186	0.151	1.232	0.235	0.697
	Slope	1.341	0.206	6.507	<0.001	
Model 2	Slope	1.535	0.135	11.360	<0.001	0.871

Figure S3-1. Comparative SARs of CWT and PIT tag based SARS estimates for subyearling Chinook salmon with matched stocks and years of outmigration. The red dashed line shows the expected 1:1 relationship if both PIT and CWT based survival estimates were exactly equivalent.



Yearling Comparison

Because we found no matching populations of yearling Chinook in the PIT and CWT-based SAR datasets included in the main paper (see Methods), we approximated a conversion factor using SAR estimates from the University of Washington's DART database as an intermediate step (http://www.cbr.washington.edu/trends/index.php, data provided by Chris Van Holmes and Rich Townsend of U. Washington on Aug 17, 2017). The DART SAR estimates are also based on CWT recoveries, but for clarity we refer to them as "DART" and use "CWT" for the estimates from the PSC reported in the main body of the paper. The DART estimates are not inflated for harvest; methods are documented in (Skalski and Townsend 2005).

We found one population of yearling Chinook that had both DART and PIT tag-based SAR estimates, and a second population that had both DART and CWT SAR estimates (Table S3-3). For each population separately, we used linear regression on the matched pairs of survival estimates with the DART estimates as the dependent variable and the 1) PIT and 2) CWT-based estimates as the independent variable (Figure S3-2; Figure S3-3; Table S3-4). The intercept from both these relationships was not significantly different from zero, so in both cases we repeated the regressions with the intercept set to zero (Table S3-4).

The ratio of the resulting slopes allows us to calculate an overall yearling conversion factor. The DART vs PIT regression had a slope of 0.447, while the CWT vs DART regression yielded a slope of 1.478 (Table S3-4). Their product yields an overall CWT vs PIT tag relationship of 0.447x1.478=0.66. The CWT-based SAR estimates were thus only 2/3rds the PIT-based SAR estimates for yearling Chinook. This should be considered only a rough estimate of the "typical" difference between CWT and PIT tag-based SAR estimates because it is based on only two populations that were from different areas of the Columbia River system; however, the direction of the difference is roughly as expected because the PIT tag survival estimates (McCann et al. 2017) exclude smolt and adult losses above the dams while these are included in the PSC (& DART) SAR estimates. Also, as expected, the DART CWT-based SAR estimates are lower than the PIT tag-based SAR estimates. Neither the DART CWT-based SAR or the PIT tag-based SAR incorporate losses to commercial and sport harvest; the Pacific Salmon Commission's CWT-based SAR estimates used in the main paper include harvest in calculating SARs, which should bring them closer to the PIT tag-based SAR estimates. However, as noted in the main paper, harvest rates of yearling (Spring) Chinook tend to be lower than for subyearling (Fall) Chinook because populations of the latter group remain exposed to fisheries on the continental shelf for several years.

Table S3-3. Stocks with SAR estimates for the same years of outmigration in the 1) PIT and DART, and 2) CWT and DART datasets. The "Stock" fields give the names as accessed from the source. For the PIT-based SARs, the "Stock" field was called "GroupDescription" on download. For the DART-based SARs, the "Stock" field was called "hatchery_location_name". Also for the DART-based SARs, when more than one release location is listed we used the mean SAR weighted by the sample size. Dworshak spring Chinook were released from Dworshak National Fish Hatchery for the PIT-based estimates; release locations were not provided for the CWT-based estimates.

		DART			
Stock	PIT or CWT-based	Stock	Release location	H/W	Years
PIT	Dworshak Hatchery Spring Chinook	Dworshak Nat. Hatchery	Dworshak Nat. Hatchery	H	1997-2013
CWT	Willamette Spring	Willamette Hatchery	Willamette R M FK-1 Santiam R S FK Molalla R	H	1989-1989, 1996-2011

Table S3-4. Results from the linear regression between DART (dependent) and CWT/PIT tag (independent)-based SAR estimates for yearling Chinook salmon with matched stocks and years of outmigration.

Model	Variable	Estimate	SE	t value	p	R^2
			DART vs PIT			
Model 1	Intercept	-0.023	0.079	-0.291	0.775	0.502
	Slope	0.477	0.115	4.141	<0.001	
Model 2	Slope	0.447	0.050	8.903	<0.001	0.822

CWT vs DART						
Model 1	Intercept	0.268	0.211	1.270	0.222	0.522
	Slope	1.192	0.270	4.421	<0.001	
Model 2	Slope	1.478	0.150	9.842	<0.001	0.842

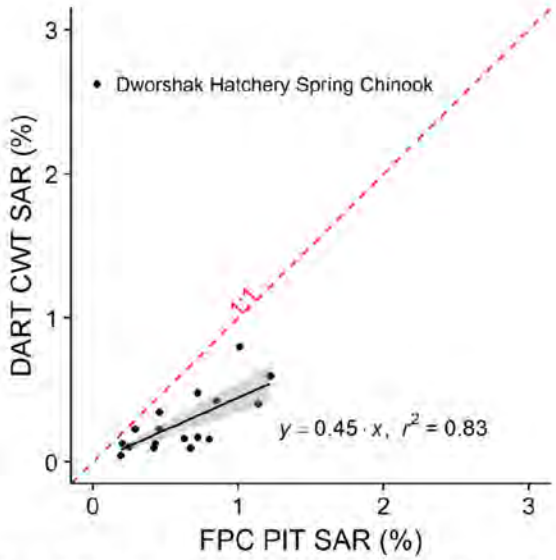


Figure S3-2. Comparative SAR of DART and PIT tag-based SAR estimates for yearling Chinook salmon with matched stocks and years of outmigration. The red dashed line shows the expected 1:1 relationship if both DART and PIT-based survival estimates were equivalent. The derived relationship indicates that the product of migratory survival by downstream migrating smolts after release from the hatchery until arrival at the top-most dam in the hydrosystem *and* multiplied by the survival of the upstream migrating adults above the top-most dam is 45%, as this component of the SAR is excluded from the published PIT tag SAR estimates (McCann et al. 2017).

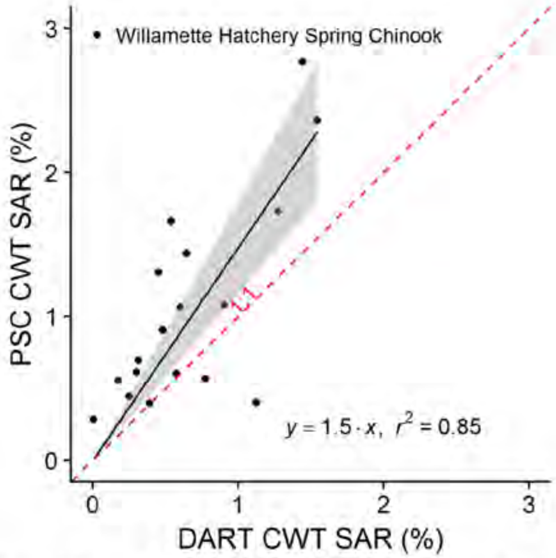


Figure S3-3. Comparative SAR of CWT and DART tag-based SAR estimates for yearling Chinook salmon with matched stocks and years of outmigration. The red dashed line shows the expected 1:1 relationship if both DART and CWT-based survival estimates were equivalent. The higher survival for the PSC's CWT-based SARs is in accord with expectation, as harvest is incorporated into the PSC's SAR estimates but not the DART-based estimates.

References

McCann, J., B. Chockley, E. Cooper, B. Hsu, H. Schaller, S. Haeseker, R. Lessard, C. Petrosky, T. Copeland, E. Tinus, E. V. Dyke, A. Storch and D. Rawding (2017). Comparative Survival Study of PIT-tagged Spring/Summer/Fall Chinook, Summer Steelhead, and Sockeye. 2017 Annual Report. Portland, Oregon.

Skalski, J. R. and R. L. Townsend (2005). Pacific Northwest Hatcheries Smolt-To-Adult Ratio (SAR) Estimation Using Coded Wire Tags (CWT) Data. Portland, OR, U.S. Department of Energy, Bonneville Power Administration. **Prepared by: Columbia Basin Research, School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA. Project No. 1991-051-00; Contract No. 00013690. :** 13 pp.

From: Petersen,Christine H (BPA) - EWP-4

Sent: Tue Dec 04 10:41:08 2018

To: David Welch

Cc: Erin Rechisky

Subject: RE: Recommendations to NWPCC F&W Program

Importance: Normal

Thank you. The council does read all the comments that they receive, although I think the public has a harder time accessing them.

Also, thank you for the early copy of the paper that you submitted to PLoS. I distributed it to several who were interested here, but they do understand that it is under review. I hope you manage to get a good draw of reviewers.

Yes – it is a bit confusing around here still. There are ongoing meetings over the flexible or 'duck' spill concept, and they set a meeting this Friday to discuss with NOAA whether they will remove all references to the Steve Smith 'block' spill survival experiment and insert language that there will be daily averaged higher spill with within-day changes. The researchers who would hypothetically be designing monitoring to address the spill experiment (and any researchers who happen to be doing anything else in the river) don't understand what will happen this spring. And, I just attended one of the coordination meetings for the hydrologists and power planners upstairs, and they do not even understand the proposal or have models for how this will impact transmission and so forth.

So, it is likely that the Biological Opinion will be held back for some rewriting before release. To answer Erin's earlier question, there were some analysis sections under headers for various species, but I did not see any discussion or analysis of survival rates upstream of Lower Granite. However, I was happy to see that it was a recommended research topic under their short section of recommended actions. Someone at NOAA must have put it in (one subtlety is that the regulatory division of NOAA writes the Biological Opinion, but not the Science Center). They also recommended at experimentally trying to improve transportation, and looking at the larger food web for predation rates.

How is your second study coming along? As we approach January, I need to be in contact with Jody Lando regarding a potential check-in with your group. She and Kristen had wanted to do something like this as a milestone before the FY19 renewal contract.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Monday, December 03, 2018 8:40 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] Recommendations to NWPCC F&W Program

Hi Christine-

Just a quick note that I have submitted the attached recommendations to the Power Planning Council to consider during their deliberations on program amendments.

Regards, David

From: Petersen,Christine H (BPA) - EWP-4

Sent: Tue Dec 04 11:53:29 2018

To: David Welch; Erin Rechisky

Subject: hatchery SAR

Importance: Normal

Hi,

I just found this paper, which had been on our radar because Jack Christiansen and Josh Murauskas have highlighted it a lot.

It would be interesting to look at the influence on historical vs contemporary SAR rates. Your study involved the same hatcheries or tag groups, with SAR measured consistently through time. This concept could influence mean SAR for a watershed due to the increasing ratio of hatchery fish raised under a production model where they use warmer than natural temperatures in order to try to achieve a large smolt size by release time.

https://afspubs.onlinelibrary.wiley.com/doi/abs/10.1002/nafm.10186

From: David Welch

Sent: Thu Dec 06 14:39:23 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Thurs

Importance: Normal

Just left a message on your cell's vmail.

I'm available all afternoon—best to call my cell.

David

David

kintamav_RGB

Office: (250) 729-2600

Mobile [redacted]

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, December 06, 2018 2:20 PM
To: David Welch
Subject: Thurs

Hi David,

I got your message. (yesterday was a rare federal holiday which only occurs when mourning a president).

Are you available this afternoon?

I should also be free much of Friday

Christine

From: David Welch

Sent: Thu Dec 06 15:13:57 2018

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] To discuss...

Importance: Normal

Attachments: 20181206114944937.pdf

From: Petersen,Christine H (BPA) - EWP-4

Sent: Mon Dec 24 09:24:52 2018

To: David Welch

Subject: RE: Howard Schaller...

Importance: Normal

Hi
Are you in this morning? I could try to call a bit later today.

Christine

Sent from Workspace ONE Boxer

On Dec 21, 2018 8:00 PM, David Welch <David.Welch@kintama.com> wrote:

> **Thanks. I had hoped to avoid the FPC "buzzsaw" approach to anything that doesn't fit with their worldview until after the paper was published, simply because having the FPC involved in the actual review process may cause a huge amount of work. In Ian Brosnan's paper that documented a possible relationship between high TDG and low subsequent survival in the plume region we had one absolutely vitriolic reviewer that delayed things immensely. (At one point s/he wrote to the editor that we were unethical and the editor should consider rejecting the paper because in our written response to a question they had raised in the prior round of reviews, we had provided information in our response that wasn't already in the manuscript. Whoever the reviewer was apparently felt that if we hadn't explained everything perfectly and in exhaustive detail the first time we submitted the manuscript it could only be because we were unethical. I don't recall the specifics now (and don't want to go back and read through the history of it again), but I marveled at the attitude… the reviewer asked a question,**

we responded to the question with additional information, and then were accused of being "deeply unethical" (or words to that effect) and the paper should be rejected on that basis. Apparently the possibility that we did have integrity and just could look at the data differently and raise a possibility that had not previously been considered was not possible.

These folks play for keeps. (Agnes Lut was aware of some of this if we want the perspective of an adult not directly involved)!

It will be unfortunate if someone from the FPC did get asked to review the paper just because they don't seem to be prepared to accept anything that doesn't fit with their beliefs. However, perhaps this is for just the standard FPC internal review memo that goes onto the FPC website by responding to Oregon with "*As you have requested, we have reviewed…X, which we don't like*". In the submission letter to the journal I provided the names of 13 people I suggested could provide an objective review and asked that three be excluded (see below). I know that Agnes had told me that she thought a woman scientist at the FPC had been the critical reviewer on the earlier TDG paper, but I couldn't recall at the time who that was (I recall now that I think she said it was Margaret Filardo… but now is too late of course).

With luck the FPC hasn't been asked to provide a reviewer for the journal paper, but we shall just wait to see, I suppose.

David

Reviewers to Exclude

We would request that the following scientists be excluded as reviewers, on the basis that they are all on record as members of a group strongly advocating for dam removal as the main course of action for recovering salmon stocks in the Columbia River owing to the perceived "poor" salmon survival: Drs Howard Schaller, Charlie Petrosky, & Steve Haeseker.

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, December 21, 2018 7:20 PM
To: David Welch
Subject: Re: Howard Schaller...

Hi David

Thanks for the information.

Today was somewhat hectic. I was trying to wrap up several things. I will forward you the flexible spill agreement. I only heard the summary the week before, and the Seattle Times article came out a day too early. There is a law regarding insider trading that made it impossible for govt staff to release details before it was public. You could potentially lock in contracts or trade options up or down. Some details are complex to digest- there is an evaluation after 2019 and 2020/21 could have seriously high TDG capsn but leaving Dalles and John day in a separate category and reserving peak hours makes it revenue neutral. A second Seattle Times article promises "the government will be monitoring the success of this operation". I was wondering how? It will be challenging to start anything by April. Many think we need to repeat acoustic tag reach survival studies if PIT detection is so low, so we would need to somehow pressure the Corps. The Washington state budget is recommending killer whale funds and study of whether to raise gas limits for the PUDs. So there are a lot of questions about the next few years.

I have been waiting before contacting you. Katie Mcdonald and Travy Hauser qere contacted by Michele DeHart asking for a copy for your contract, and saying 'we' (don't know if it was her specifically) were asked to review the paper so she wants to see the contract. This is currently with an attorney and our contracting officer, so we were hesitating before telling others or your group about it. I was at FPOM when I saw this email come in and Blane Bellerud of NOAA was not impressed. He seems to accept all of the major results of your paper.

Anyway, I believe one of us was going to ask who they are reviewing forn the journal or for their memo section. The contract may be public to some extent but we want to inquire whether we may remove references to the 2nd paper topic.

Christine

Sent from Workspace ONE Boxer

On Dec 21, 2018 4:56 PM, David Welch <David.Welch@kintama.com> wrote:

Hi Christine-

Sorry we didn't touch base today—I ended up having to run out about 2 pm today to help someone. (We had a major windstorm yesterday, and power is out to a lot of people because of many fallen trees). The storm didn't affect us directly, fortunately.

I just sent the email below to Erin and Aswea, which is self-explanatory… the FPC group will certainly be aware of our paper now, if they weren't already!

I am not sure if you are working on Monday or not. I will be for half the day. However, on December 26th (b) (6) [redacted] (Back January 7th). I may have email during that time, but I am leaving Erin and Aswea working hard in my absence.

So, if it makes sense to touch base, let's do so before Christmas. Otherwise, wishing you and yours a wonderful Christmas break.

Best, David

From: David Welch
Sent: Friday, December 21, 2018 4:24 PM
To: Erin Rechisky; Aswea Porter
Subject: RE: salmon farm news

Just a heads up. Research Gate seems to have automatically flagged our preprint that is under review at PLoS ONE. They just notified me today of a number of people who downloaded the preprint. I don't normally look at that, but for some reason I did today.

One of them is Howard Schaller.

Guess the cat is out of the bag!

d

From: Erin Rechisky
Sent: Friday, December 21, 2018 3:15 PM
To: David Welch; Aswea Porter
Subject: salmon farm news

https://biv.com/article/2018/12/research-finds-bull-trout-seals-major-salmon-predators

https://www.cbc.ca/news/canada/british-columbia/fish-processing-effluent-1.4953322

Erin Rechisky, PhD

Research Manager

cid:image001.jpg@01D1CBC9.88953580

kintama.com

755 Terminal Avenue North• Nanaimo BC V9S 4K1 • Canada

Cell: [redacted]

Email: erin.rechisky@kintama.com • Skype: erin_rechisky

From: Erin Rechisky

Sent: Wed Jan 02 15:51:00 2019

To: David Welch; Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Howard Schaller...

Importance: Normal

Hi Christine,

I was just re-reading your e-mail below and I have a few questions and comments.

Our contract with BPA seems irrelevant to a FPC review of our SAR paper. Have the attorneys and CO made a decision on whether to provide the FPC with it?

Has anyone asked Michelle D. who the review is for? There's nothing on the FPC website as of this afternoon.

I don't see how we can remove references to the second paper (survival rates) since a portion of the budget has been allocated to that paper in our current contract. If sections were redacted, the FPC would certainly come back and request the full contract.

Thank you,

Erin

From: David Welch
Sent: December 21, 2018 8:01 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: RE: Howard Schaller...

Thanks. I had hoped to avoid the FPC "buzzsaw" approach to anything that doesn't fit with their worldview until after the paper was published, simply because having the FPC involved in the actual review process may cause a huge amount of work. In Ian Brosnan's paper that documented a possible relationship between high TDG and low subsequent survival in the plume region we had one absolutely vitriolic reviewer that delayed things immensely. (At one point s/he wrote to the editor that we were unethical and the editor should consider rejecting the paper because in our written response to a question they had raised in the prior round of reviews, we had provided information in our response that wasn't already in the manuscript. Whoever the reviewer was apparently felt that if we hadn't explained everything perfectly and in exhaustive detail the first time we submitted the manuscript it could only be because we were unethical. I don't recall the specifics now (and don't want to go back and read through the history of it again), but I marveled at the attitude… the reviewer asked a question, we responded to the question with additional information, and then were accused of being "deeply unethical" (or words to that effect) and the paper should be rejected on that basis. Apparently the possibility that we did have integrity and just could look at the data differently and raise a possibility that had not previously been considered was not possible.

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Sent: Friday, December 21, 2018 7:20 PM
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Subject: Re: Howard Schaller...

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Sent: Friday, December 21, 2018 3:15 PM
To: David Welch; Aswea Porter
Subject: salmon farm news

https://biv.com/article/2018/12/research-finds-bull-trout-seals-major-salmon-predators

https://www.cbc.ca/news/canada/british-columbia/fish-processing-effluent-1.4953322

Erin Rechisky, PhD

Research Manager

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kintama.com

755 Terminal Avenue North• Nanaimo BC V9S 4K1 • Canada

Cell: (b) (6) [redacted]

Email: erin.rechisky@kintama.com • Skype: erin_rechisky

From: David Welch

Sent: Wed Jan 09 15:51:37 2019

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] RE: Talk to Corps, Reclamation about SAR study

Importance: Normal

Yes, it is wide open for me, at least. (And probably Erin, given the timing given).

It sounds like it could be important. If needed, I can also fly down if it is thought that it would be better presented in person.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, January 09, 2019 3:13 PM
To: David Welch; Erin Rechisky; Aswea Porter
Subject: Talk to Corps, Reclamation about SAR study

Hi,

At a meeting today, our managers discussed communicating with the so called 'Action agencies' before the renewed consultation for the Biological Opinion required under the Endangered Species Act – expected to be completed by April. NOAA and the Fish and Wildlife Service could participate as well if the furlough ends.

Greg Smith asked to inquire if you are available next Wednesday at some time between 9-12 am. They would request a presentation of about 30-45 minutes with up to half an hour for questions. The emphasis should be on methods and results, in order to familiarize the Corps/Reclamation with your data and major patterns. We could follow up to help you better understand the purpose of this meeting. I believe that Jody and Greg plan to share one of your powerpoints from the presentations that you gave to us here in Portland.

Will next Wednesday morning work for a webex based presentation call?

Thanks

Christine Petersen

From: Erin Rechisky

Sent: Wed Jan 09 16:05:40 2019

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] Re: budget

Importance: Normal

Thanks Christine.
Erin

------ Original message------
From: Petersen,Christine H (BPA) - EWP-4
Date: Wed, Jan 9, 2019 3:23 PM
To: Erin Rechisky;
Cc:
Subject:RE: budget

Hi Erin,

You brought up the FY19 contract amount. I see you are right, but I will show you what I did. To get the value to enter in the box in accounting software, I went back to this email in order to remember what we had done.

The contract was $232,000 for the first paper, $110,000 agreed upon for the second paper, and $47,000 agreed for both travel and an extension and unexpected work and effort for the SAR study. This totals $389k. After putting thought into it, you decided on an estimate amount of effort achieved by 1/31/2019 for the second study (which is challenging to assess ahead of time!) and we decided to add a total of $87k with the second modification or $319k total. So $389-$319k is $70k, but we somehow had this $49k number below. It probably came from merging the originally separate budgets for the first and second study together because they are overlapping in time and intending to go to $340k. You will still have some level of effort remaining for peer review for the SAR study. Jody was talking about peer review in our meeting today and how important it might turn out to be for discussing this with NOAA and Corps for their delayed BiOp.

I will change this, and it should update overnight.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Friday, September 07, 2018 4:52 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: budget

Hi Christine,

I don't have definite estimates yet, but I've put together a draft budget assuming we'll invoice for about half of the 46k, the travel, and about 2/3 of the survival rate paper prior to the Jan 31 2018 contract end date.

I added another "personnel" section in this draft so I could keep track of the budget for each paper. It will need to be consolidated in a final version once we estimate the hours next week.

The current draft budget including 2 modifications is $340 k. This leaves $49k for the contract beginning in 2019 ([232k + 47k+ 110k] – $340k= $49k).

Are we getting there? I'll finalize the work hours next week.

Have a good weekend,

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 7, 2018 2:24 PM
To: Erin Rechisky
Subject: RE: budget

Our finance team told us to start a new contract because they are leaning away from longer terms, and prefer 12 months as the period. It is easier for us to set a milestone by the end, and then copy parts of the work element into the next period.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Friday, September 07, 2018 2:01 PM
To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: budget

Hi Christine,

Question: Would extending the current contract for a year and adding all of the WEs make things easier?

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 7, 2018 12:51 PM
To: Erin Rechisky
Subject: RE: budget

I think so, and we definitely were not going to be able to get the CCR over for management approval today. We should strive to get the CCR moving by early next week.

Do you think it will be complicated to add the work element description for the second paper? I would be inclined to mostly un-cancel the existing work element that we cancelled in the first contract modification, however you might have a few sentences to change.

I could try to prep our contract officer Rachel Kulak to expect this. There is always a large number of contracts to work with during September.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Friday, September 07, 2018 12:35 PM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: budget

Hi Christine,

I was just talking to Aswea about that. We need to make a list of the ongoing projects that we will be working on so we can come up with a realistic estimate for work we can complete on the survival rate paper in Nov-Jan. I looks like we will not have an estimate today.

Is next week ok? (Mon or Tuesday)

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: September 7, 2018 12:25 PM
To: Erin Rechisky
Subject: budget

Hi Erin

Did you have an updated vision of what split you would anticipate for splitting writing, and peer review tasks between the remainder of this contract period, and after February 1?

With this, I can adjust the contract modification amount. I would also like to run it by Jody Lando or perhaps Kristen Jule so they see how we are planning this.

Christine

From: Petersen,Christine H (BPA) - EWP-4

Sent: Wed Jan 09 16:19:13 2019

To: David Welch

Subject: RE: Talk to Corps, Reclamation about SAR study

Importance: Normal

Hi,

Thank you.

Greg suggests penciling in the time window, and mentally preparing to do it. We think that it might only be worth a trip if NOAA and USFWS are able to participate because otherwise there might be a second update. They will know better tomorrow

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, January 09, 2019 3:52 PM
To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky; Aswea Porter
Subject: [EXTERNAL] RE: Talk to Corps, Reclamation about SAR study

Yes, it is wide open for me, at least. (And probably Erin, given the timing given).

It sounds like it could be important. If needed, I can also fly down if it is thought that it would be better presented in person.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, January 09, 2019 3:13 PM
To: David Welch; Erin Rechisky; Aswea Porter
Subject: Talk to Corps, Reclamation about SAR study

Hi,

At a meeting today, our managers discussed communicating with the so called 'Action agencies' before the renewed consultation for the Biological Opinion required under the Endangered Species Act – expected to be completed by April. NOAA and the Fish and Wildlife Service could participate as well if the furlough ends.

Greg Smith asked to inquire if you are available next Wednesday at some time between 9-12 am. They would request a presentation of about 30-45 minutes with up to half an hour for questions. The emphasis should be on methods and results, in order to familiarize the Corps/Reclamation with your data and major patterns. We could follow up to help you better understand the purpose of this meeting. I believe that Jody and Greg plan to share one of your powerpoints from the presentations that you gave to us here in Portland.

Will next Wednesday morning work for a webex based presentation call?

Thanks

Christine Petersen

From: Erin Rechisky

Sent: Wed Jan 09 16:52:47 2019

To: David Welch; Petersen,Christine H (BPA) - EWP-4; Aswea Porter

Subject: [EXTERNAL] Re: Talk to Corps, Reclamation about SAR study

Importance: Normal

Looks good for me too.
Erin

------ Original message------
From: David Welch
Date: Wed, Jan 9, 2019 3:51 PM
To: Petersen,Christine H (BPA) - EWP-4;Erin Rechisky;Aswea Porter;
Cc:
Subject:RE: Talk to Corps, Reclamation about SAR study

Yes, it is wide open for me, at least. (And probably Erin, given the timing given).

It sounds like it could be important. If needed, I can also fly down if it is thought that it would be better presented in person.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, January 09, 2019 3:13 PM
To: David Welch; Erin Rechisky; Aswea Porter
Subject: Talk to Corps, Reclamation about SAR study

Hi,

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Greg Smith asked to inquire if you are available next Wednesday at some time between 9-12 am. They would request a presentation of about 30-45 minutes with up to half an hour for questions. The emphasis should be on methods and results, in order to familiarize the Corps/Reclamation with your data and major patterns. We could follow up to help you better understand the purpose of this meeting. I believe that Jody and Greg plan to share one of your powerpoints from the presentations that you gave to us here in Portland.

Will next Wednesday morning work for a webex based presentation call?

Thanks

Christine Petersen

From: David Welch

Sent: Fri Jan 11 12:34:15 2019

To: Petersen,Christine H (BPA) - EWP-4

Cc: Aswea Porter; Erin Rechisky

Subject: [EXTERNAL] Kintama Update to BPA (11 Jan 2019).pptx

Importance: Normal

Attachments: Kintama Update to BPA (11 Jan 2019).pptx

Hi Christine—

I am attaching a copy of the update for you, in case the WebEx link does not work. If you want to go through the presentation prior to the meeting, please press F5 to view the slides and use the space bar to step through it… there are a few slides (esp. the final one) where we have animated the steps so that we can work through the concepts with your group (I hope!).

Erin and I will log on a few minutes before 2, as I am unsure whether the audio will work or I will have to call your mobile and use your speakerphone.

Thx, David

Kintama Check-In

David Welch, Erin Rechisky, & Aswea Porter

11 Jan 2019

Status of the First Paper

The coast-wide collapse in marine survival of west coast Chinook and steelhead: slow-moving catastrophe or a deeper failure?

- Still out for review at PLoS ONE
  - Now over 100 reads of pre-print, mostly via ResearchGate
  - Ray Hilborn forwarded a copy to Lynda Mapes of the Seattle Times
  - Direct feedback so far has been uniformly complimentary
  - FPC asked to review it the preprint by ODFW, review went up on FPC website yesterday (Jan 10th)
    - Their feedback not so complimentary
    - Easily refuted, I think.

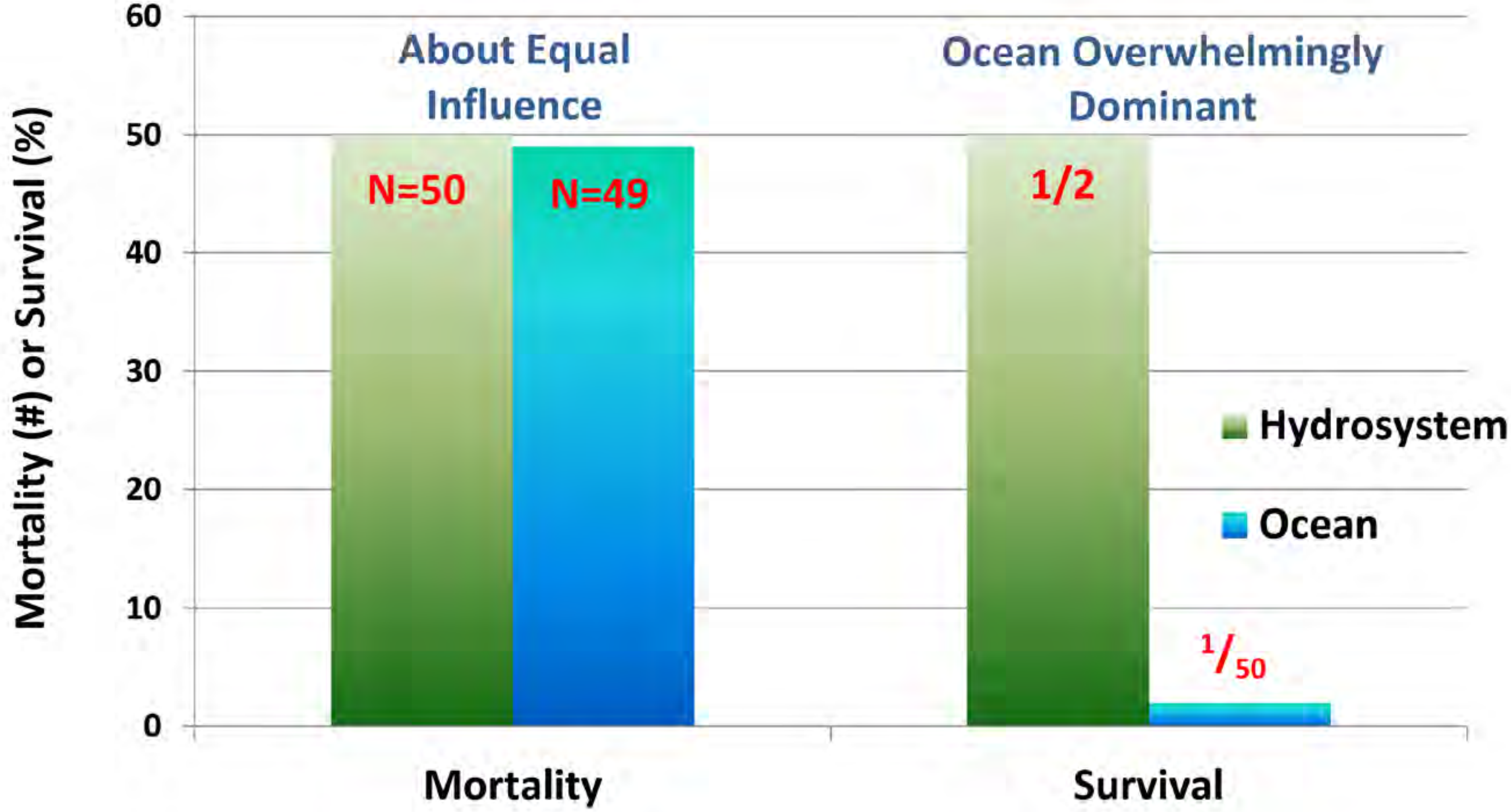
Possible Presentations/Outreach

Where?	Dates	Comment
Idaho AGM, Boise	6-8 March	Abstracts due today!
Oregon AFS AGM, Bend OR	4-8 March	Abstract submission closed in December
WABC AFS AGM, Bremerton	8-11 April	Only DW can attend (Erin presenting in New Orleans)
Ocean Ecology of Salmon/Int. Year of the Salmon, Portland	18-20 May	Only Erin can attend (DW away).

Development of the Second Paper on Survival Rate in the FCRPS and in the ocean

Two Views of Survival

	Smolts at Start	Adults at Return	Loss in Hydrosystem	Loss in Ocean	SAR	Loss Overall
Mortalities	N=100	1	50	49	(100-50-49)/100 = 1%	99%
			Survival in Hydrosystem	**Survival in Ocean**		
Survival	100%	1%	50%	1/50=2%	½ x $^{1}/_{50}$=1%	99%


About Equal Influence
Ocean Overwhelmingly Dominant
Mortality (#) or Survival (%)
60
50
40
30
20
10
0
N=50
N=49
1/2
1/50
Hydrosystem
Ocean
Mortality
Survival

Why the Difference?

- *Adult #s* $= N_0 \times S_1 \times S_2 \ldots \times S_n$
- The SAR is determined as:

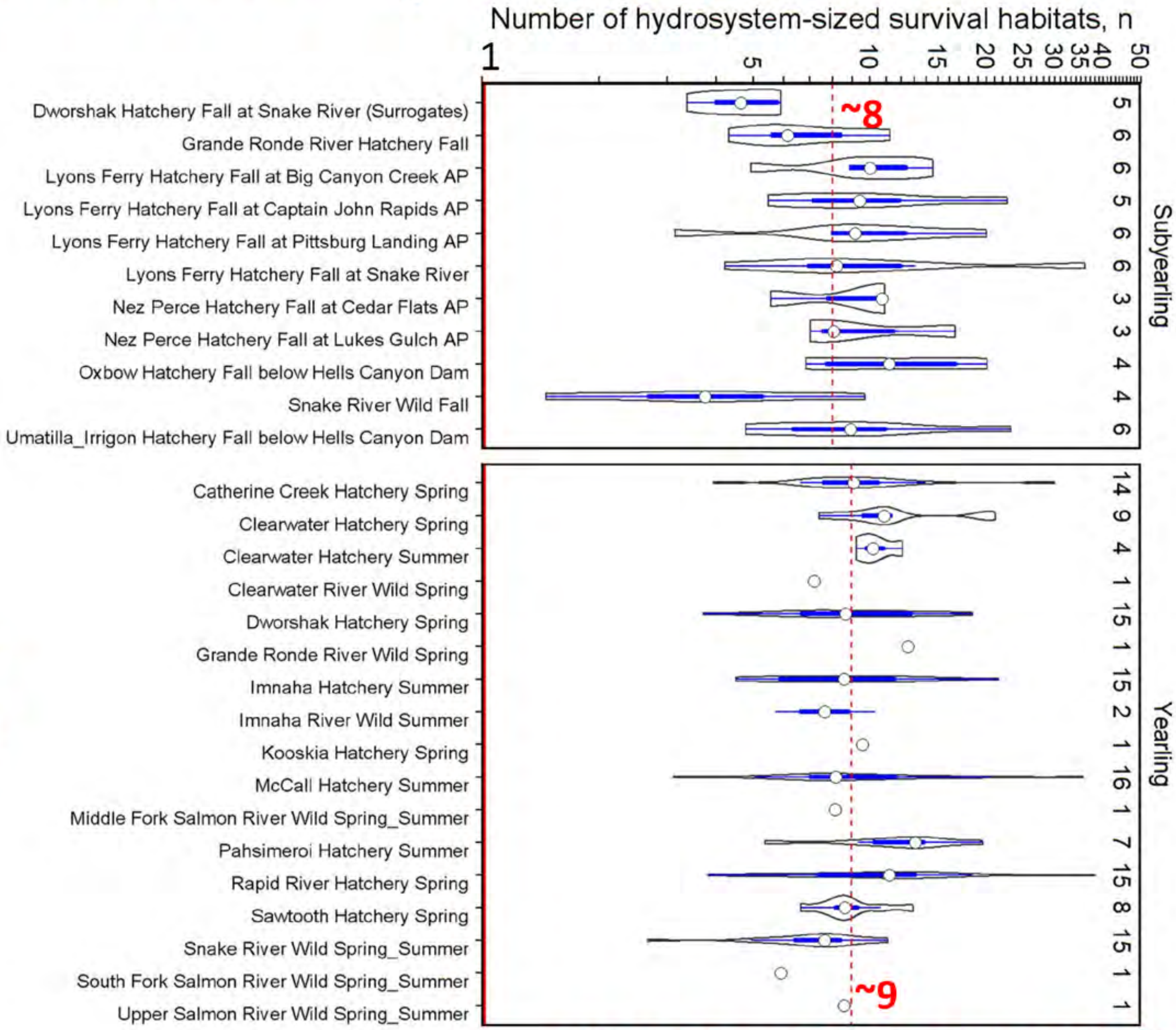
$$SAR = Adults/N_0 = S_1 \times S_2 \ldots \times S_n$$

- The number dying in any one habitat depends on the starting number, N_0, *and the losses* that happened in prior habitats.
- Adult returns depend on the SAR x the number of out-migrating smolts, but the SAR does not depend on numbers.
- (Ignoring density-dependence… more on that later)
- What is needed is to consider the survival in each migration segment

- In Welch et al (2011), we suggested a calculation that suggested the ocean was essentially 25x more important than the hydrosystem. $\{\frac{1/2}{1/50} = 25x\}$
- This is actually an overestimate.
- The correct measurement of information content goes back to a famous paper on information & communication systems by Claude Shannon (1948).
- The correct (fair) estimate of the contribution of the hydrosystem is 1/*n*, where *n*=log(SAR)/log($S_{hydrosystem}$)

Shannon, C. E. (1948). "A Mathematical Theory of Communication." **Bell System Technical Journal 27(3): 379-423.**
Welch *et al* (2011). "*In situ Measurement of Coastal Ocean Movements and Survival of BC Juvenile Pacific Salmon.*" **Proc. Nat. Acad. Sci. USA 108(21): 8708-8713**

Here are the values of *n* calculated using the CSS annual values of S_t & SAR_{t+2} for Chinook



Typically,

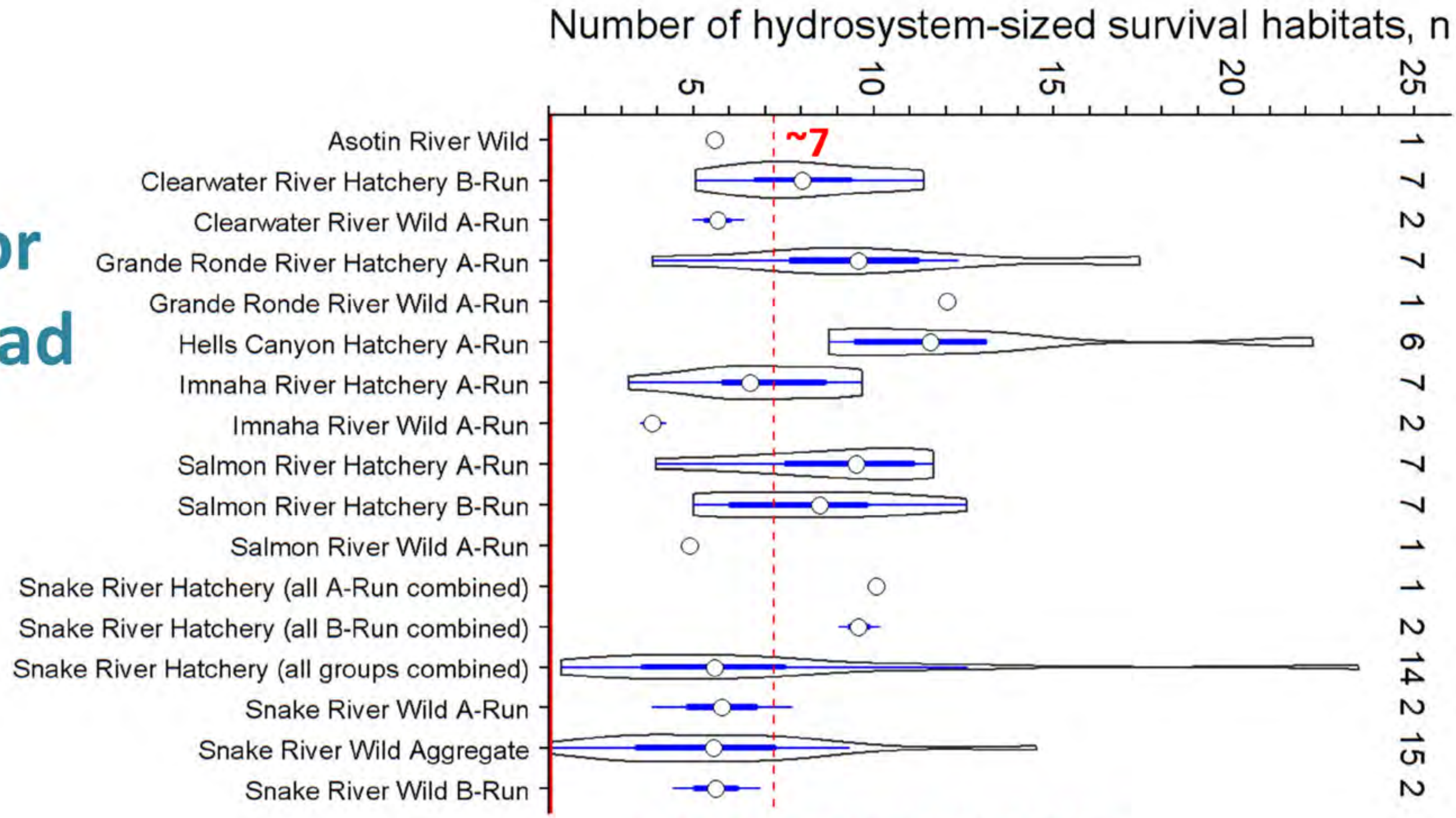
$n_{subyearling} \approx 8$

$n_{yearling} \approx 9$

1/8~1/9 is only 11%~12% of the SAR!

...and for Steelhead

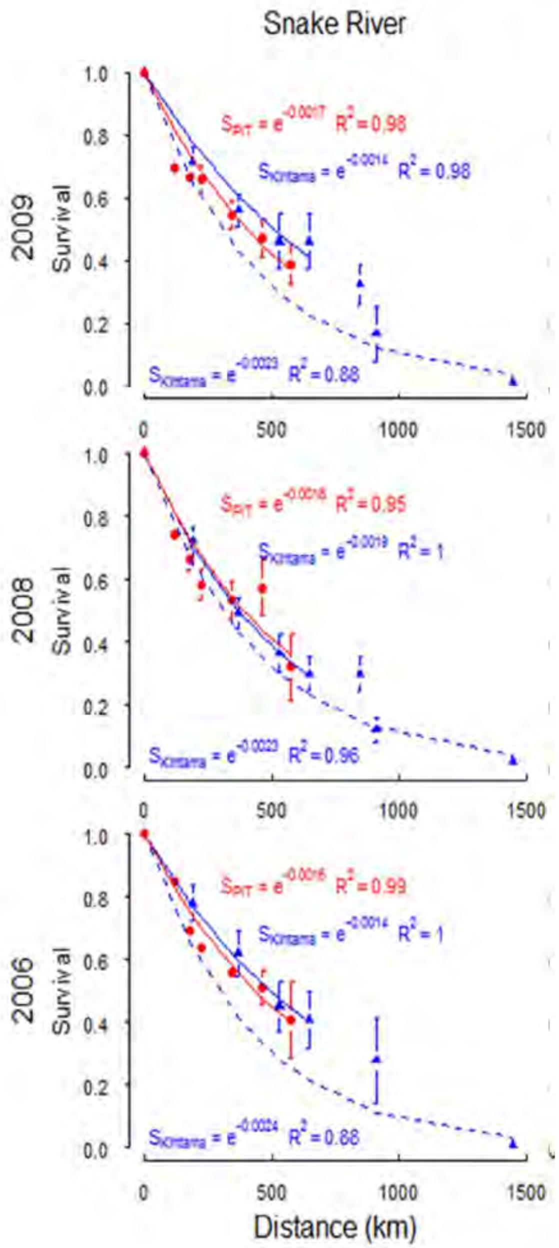
n≈7



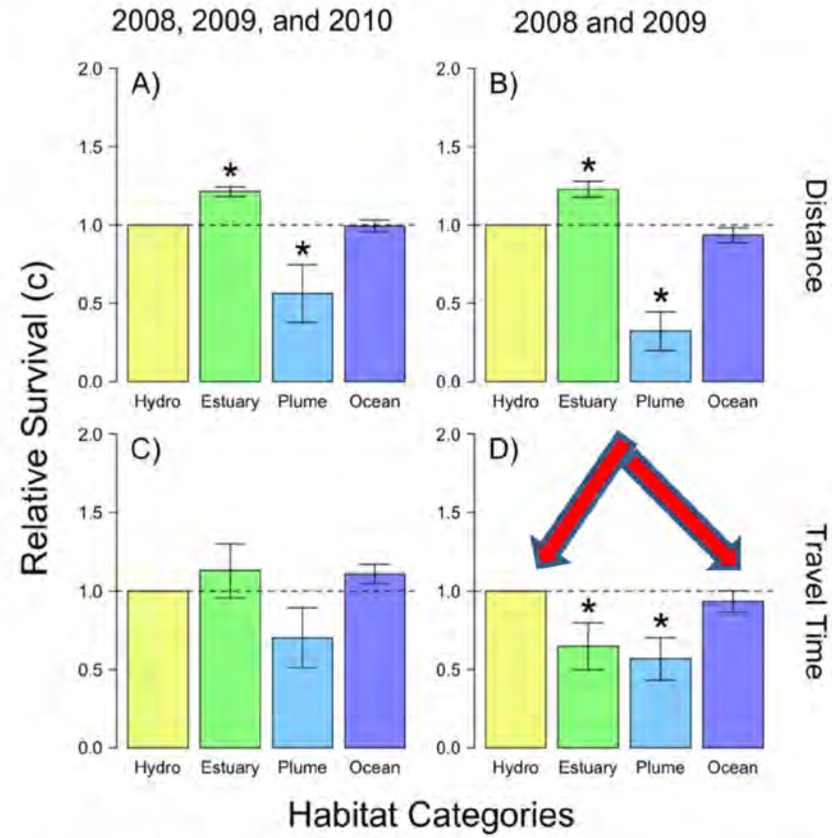
1/7 is just 14% of the SAR!

- Even for steelhead (*n*≈7), the contribution of the hydrosystem to determining the SAR is only 14%
- For subyearling Chinook (*n*≈8) & yearling Chinook (*n*≈9), the hydrosystem's role is even lower (12% & 11%, respectively).
- This may seem abstruse, but it sets the analysis of the SAR on a firm theoretical footing, fairly identifying how big (or small) the contribution of survival in the FCRPS is to determining poor SARs.
- Implications for statistical power of analyses of TDG/hydrosystem operations on SAR underway

Update on the current paper



(Left). Comparison of NOAA's PIT-tag based estimates of hydrosystem survival & Kintama's acoustic tag-based survival estimates.



(Above). Habitat-specific survival rate constants for (top row) smolt survival per 100 km and (bottom) per week of travel for Snake River spring Chinook. The left column includes the three years 2008-10, while the right column excludes 2010. Error bars are ±1 SE and * indicates rates significantly different from the hydrosystem ($p<0.05$). Hydrosystem and ocean survival rates are approximately the same.

Upcoming Contracting?

- We would ask BPA to financially support two efforts (plus outreach travel)

1) "*21st Century Salmon Management*" paper
   - Target AFS journal Fisheries
   - Get wide readership in Columbia River basin on problems with current salmon strategy
   - Start a broader debate on whether current salmon strategy is actually working

2) Design a dual purpose TDG/salmon survival rate study using acoustic telemetry
   1) Determine "*how much TDG is too much*"
   2) Design & cost out a telemetry study to establish hydrosystem & coastal ocean survival rates

1) "*21st Century Salmon Management*" paper targeting Fisheries (to get wide readership in Columbia River basin)

- Will put the case bluntly that past salmon management collected much data, but did not recognize the data did not really match their preconceptions (i.e., SAR paper)
- Will show that it is ***only*** the presence of density-dependence (SRR) that has prevented complete collapse
- Will show that ignoring ***timing*** of density-dependence will negate much current freshwater habitat work ("*feel good*" work as opposed to "*effective*" work).
- The latter point about the nature of the stock-recruitment relationship appears to be a genuinely new idea.

2) Design a Dual Purpose TDG/Salmon Survival Rate Study

a) Will identify a design for a highly cost-effective array that can do both

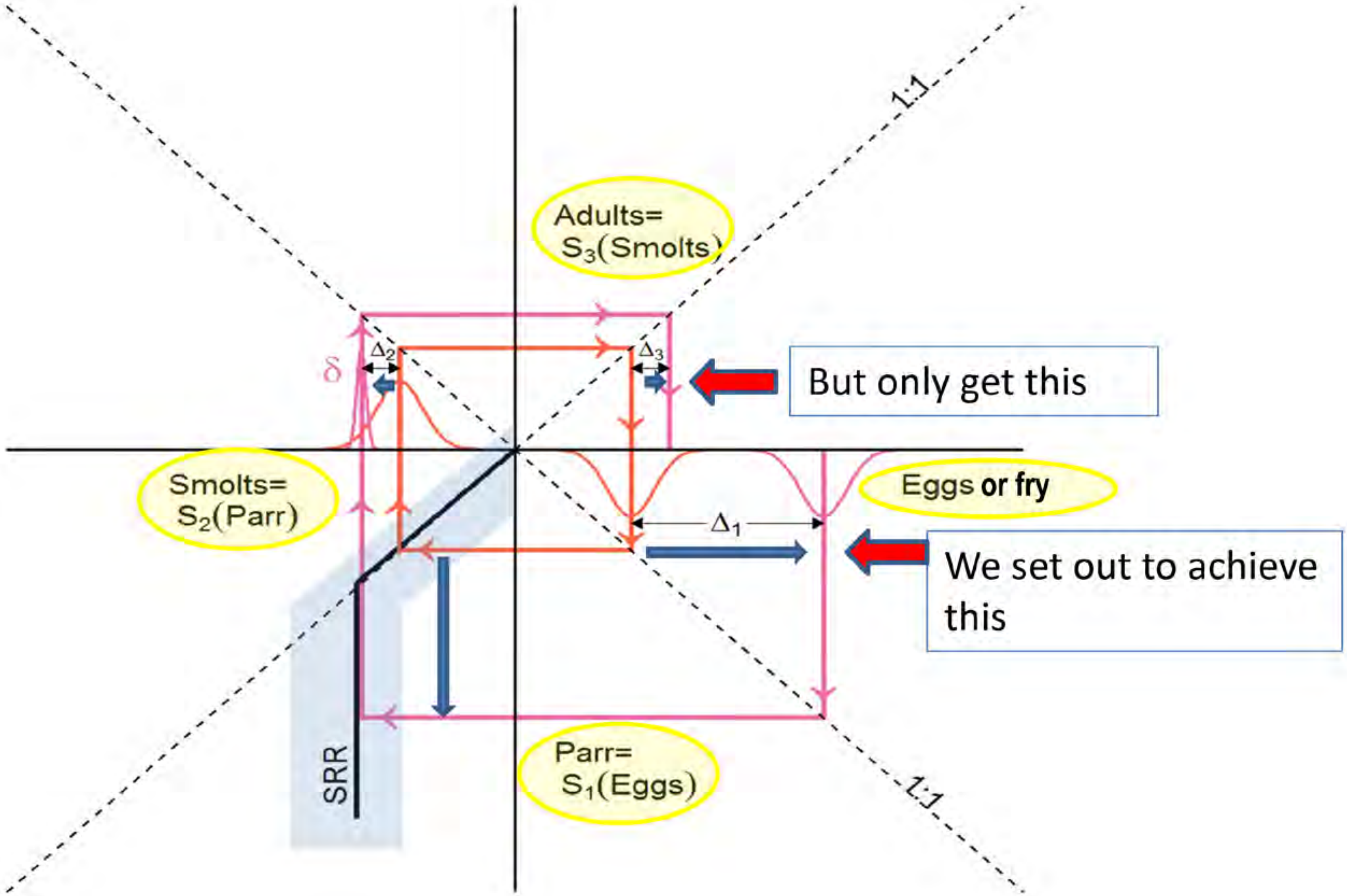
- TDG Study will use current best scientific practices (double blinding, statistical power analysis, treatment & control groups, pre-publication of study design)
- Will unambiguously determine relative survival of smolt cohorts exposed to different TDG levels.
- Use of acoustic telemetry solves problem of poor PIT tag detection due to high spill & extends survival measurements out into the ocean (➔"crippled" smolts)
- Can evaluate costs of Vemco & JSATS technologies

b) Will allow region to directly compare coastal ocean survival rates with hydrosystem survival rates and understand cost trade-offs

Where Does Density-Dependence Occur?

- Most stock-recruitment relationships for salmon show that recruitment is flat (asymptotic, or B-H dynamics)
- ***Where/When*** this occurs in the life history is not well understood, but critical to success of current freshwater habitat efforts
- Density-dependence probably happens while the parr hold territories & transform into smolts
- This means freshwater habitat interventions earlier in the life history **could be wasted** (improving spawning beds, increasing egg or fry numbers filtered out by density-dependence)
- We critically need to better understand ***when*** the density-dependent processes occur (returning adults?)

The Role of Density-Dependence in Freshwater Habitat Restoration



From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Jan 11 16:18:30 2019

To: Erin Rechisky; David Welch

Subject: FW: flexible spill

Importance: Normal

Attachments: Proposed_FlexSpillOps_01072019.pptx; Flex spill and power Agreement_Executed Signature Pages.pdf

Hi,

Thank you for your presentation.

Here is Leah's interpretation of the flexible spill operation, and I will also attach the legal agreement. There is an advanced level of understanding in that at the end of each year, there are three areas of potential complaint which could end or change the agreement. There are monitoring details, but it is claimed that costs cannot increase. I do not know what will happen at the end of 2019 but it is implied that biological patterns will be evaluated. I have heard that alternative 2b is far more likely than 2a. But the key point is that we are going up from 120% in 2019 to 125% TDG as the higher spill daily block in 2020. We are trying to figure out whether we could look at within day adult ladder patterns or whether the four hour low spill block would just be too hard to interpret. I cannot figure out if University of Idaho will have any financing for radiotags like they have in the past.

Christine

From: Sullivan,Leah S (BPA) - EWP-4
Sent: Wednesday, January 09, 2019 12:51 PM
To: Petersen,Christine H (BPA) - EWP-4; Connor,Joseph W (BPA) - EWU-4
Subject: RE: flexible spill

Here is the quick PPT we used in our EWP* meeting this week. Do not distribute – we are working on slides 5 and 7 and the validity of what proportion of flow would be resulting in discharge at the powerhouse vs. spillway during 120% and 125% TDG spill as well as performance based spill levels.

Joe, I'm happy to sit down with you (or by phone) and discuss the details and nuisances.

Leah

Leah Sullivan

Fish & Wildlife Administrator – Environment, Fish and Wildlife, Policy and Planning (EWP-4)

Bonneville Power Administration
bpa.gov | P 503-230-5208 | C (b) (6) [redacted] lssullivan@bpa.gov

Please consider the environment before printing this email.

2019-2021 Flexible Spill Operation Agreement

- **Spring spill**
  - Spring spill operations (LSR Apr 3 – Jun 20: LCR Apr 10 – Jun 15)
  - Daily outflow does not change, fish passage spill operations only affect the proportion of water flowing through the various outlets at the dams
- **Objectives**
  - Biological benefit (2019 ≥ 2018, 2020-2021 ≥ 2019)
  - Power system benefits ≥ 2018
  - Corps implementation and maintain operation
- **Summer spill**
  - 2019, same as 2018
  - 2020-2021, reduced spill August 15

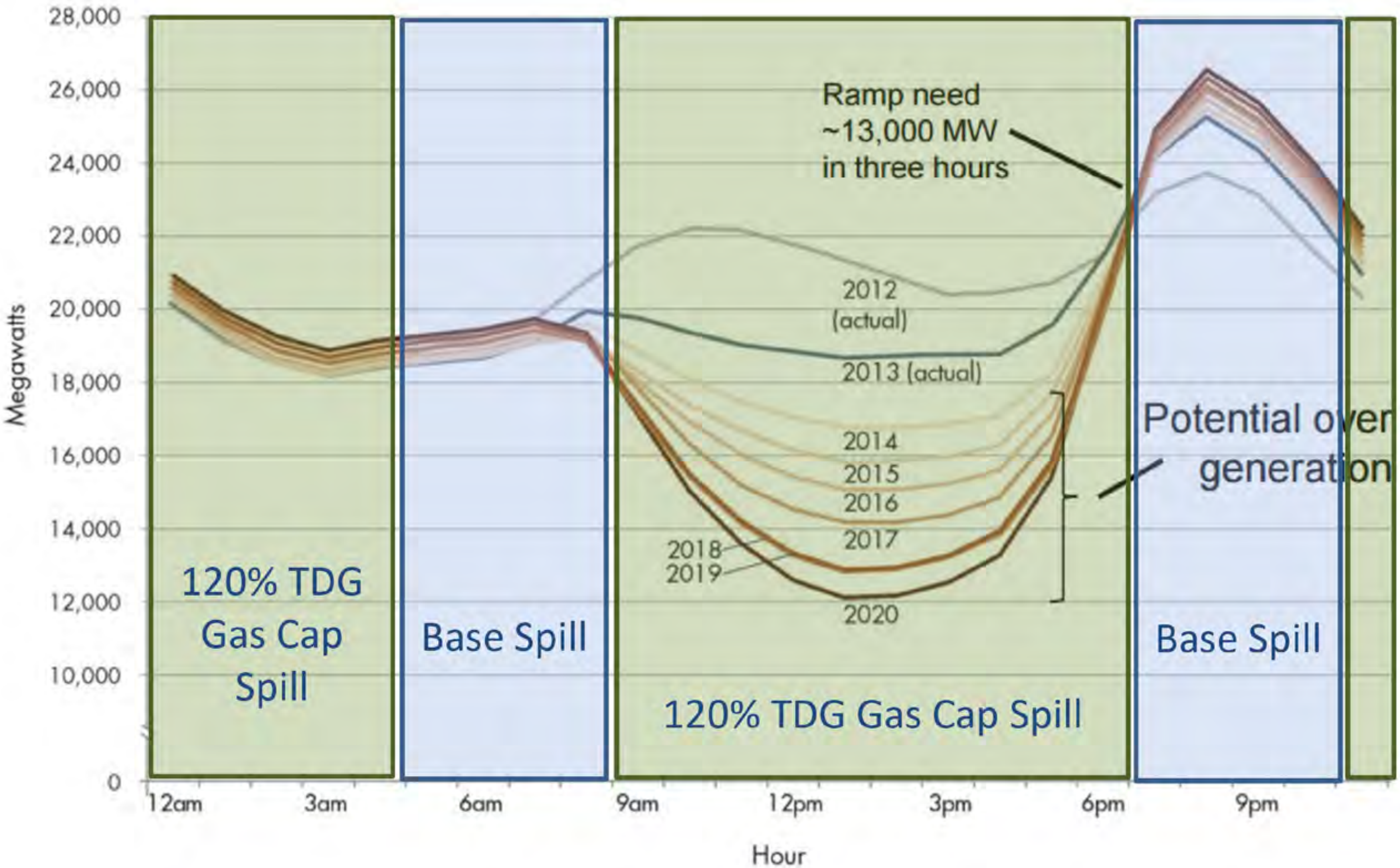
2019 Flexible Spring Spill Operations

Table 1.1.
Planned 2019 spring spill operation, applying estimated 120% mean total dissolved gas spill caps and performance standard spill[4] flex operations.

Location	COE Estimated Mean 120% Total Dissolved Gas Spill Cap (16 hours)	Performance Standard Spill (8 hours)
Lower Granite	45 kcfs	20 kcfs
Little Goose	52 kcfs	30%
Lower Monumental	44 kcfs	30 kcfs (bulk spill pattern)
Ice Harbor	87 kcfs	30%
McNary	180 kcfs	48%
John Day	146 kcfs	32%
The Dalles	135 kcfs	40%
Bonneville	122 kcfs	100 kcfs

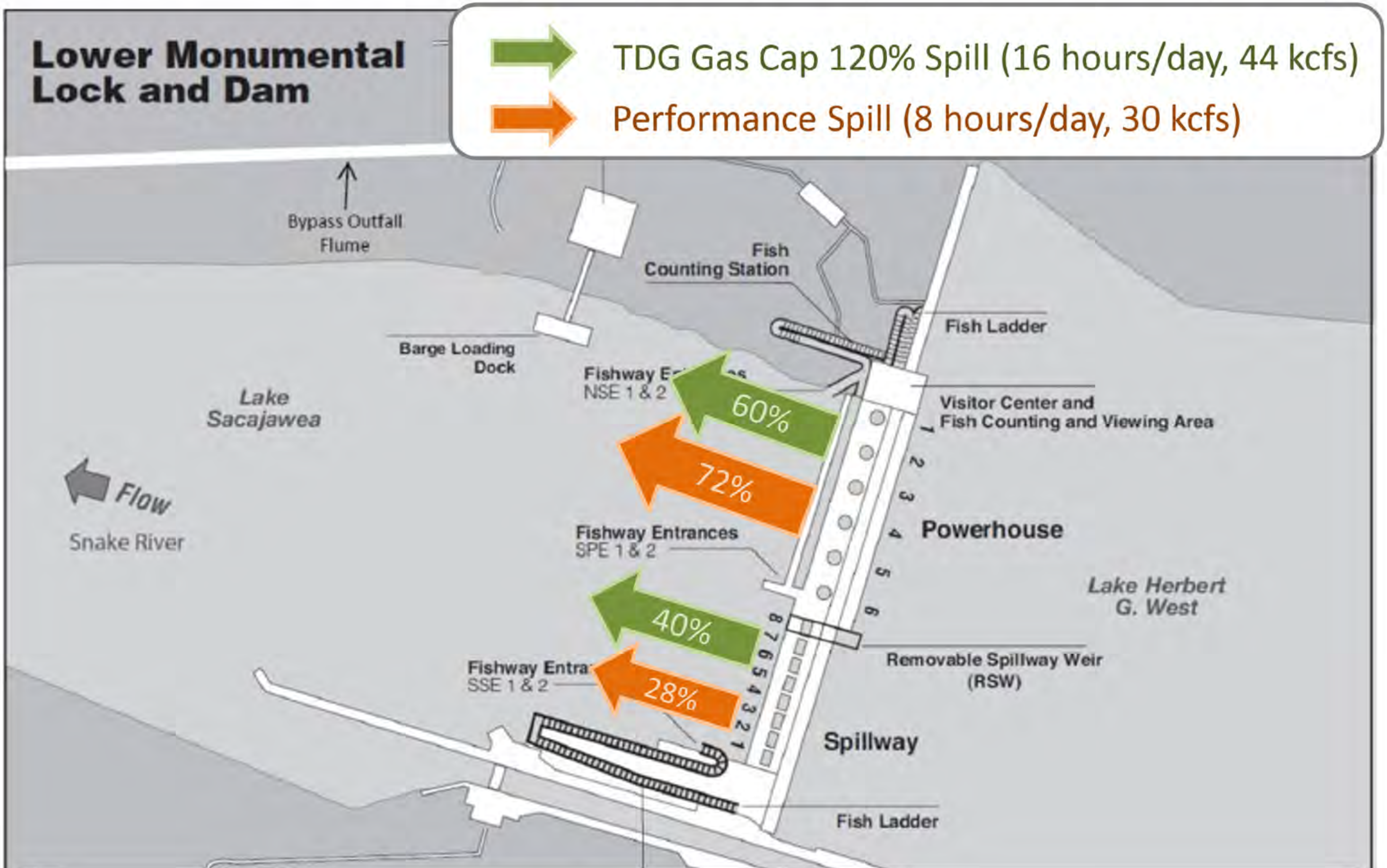
Conceptual Flexible Spill Operations

- ‘Gas Cap’ spill ~16 h/d, ‘Performance’ base spill 8 h/d



Key points:

- Spring spill operations would be initiated April 3 and April 10th and transition to summer spill operations on June 21 and June 16 at Lower Snake River projects and at Lower Columbia River projects, respectively.
- The 8 hours of performance standard spill would occur with some flexibility. Only Little Goose would be set to at least 4 hours in the a.m. (beginning near dawn and not to exceed 5 hours in the a.m.) and no more than 4 hours in the p.m. (generally near dusk) to help with adult passage issues. All other projects could spill either 3 or 4 hours for the performance standard spill a.m. time period and then up to a max of 5 hours in the performance standard spill p.m. period (not to exceed 8 hours in the day).
- No ponding above current MOP assumptions: Snake River - MOP+1.5 ft (to provide 1 ft. of useable space); John Day - MIP+2 ft (to provide 1.5 ft. of useable space).
- Controlled spill at Bonneville Dam capped at 150 kcfs due to erosion concerns.
- Controlled spill at The Dalles contained between the walls (Bays 1-8) unless river flows were over 350 kcfs then spill outside the walls would be permitted.
- Existing adaptive management processes will be employed to help address any unintended consequences that may arise in-season as a result of implementing these proposed spill operations.
- Spill may be temporarily reduced at any project if necessary to ensure navigation safety or transmission reliability.



AVERAGE flow year = 2009

(average daily flow at LMN, 3 Apr – 20 Jun, 109 kcfs; minimum generation flow required 11.5 kcfs)

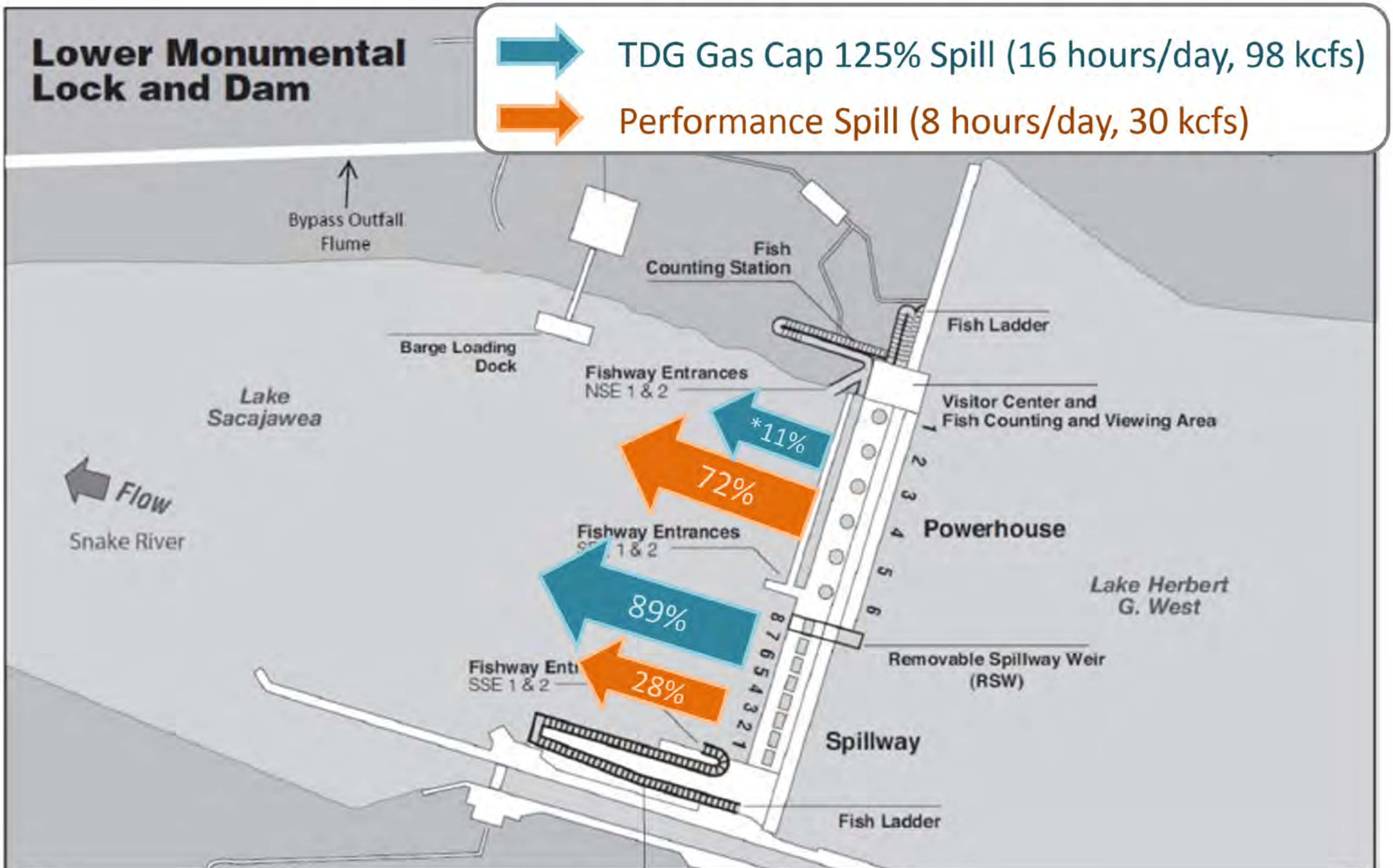
Data source DART (http://www.cbr.washington.edu/dart)

2020-2021 Flexible Spring Spill Operations

Table 1.3.b.

Representative spring spill alternative two, for implementation in 2020 and 2021. Six projects using 125% TDG flexible spill with JDD and TDA using 24-hour performance standard spill. Table 1.1 key points apply.

Location	COE Estimated mean 125% Total Dissolved Gas Spill Cap (16 hours), with alternative operation at JDD and TDA.	Performance Standard Spill (8 hours)
Lower Granite (125 flex)	72 kcfs	20 kcfs
Little Goose (125 flex)	79 kcfs	30%
Lower Monumental (125 flex)	98 kcfs	30 kcfs (bulk spill pattern)
Ice Harbor (125 flex)	119 kcfs	30%
McNary (125 flex)	265 kcfs	48%
John Day (Performance Standard)	32%	32%
The Dalles (Performance Standard)	40%	40%
Bonneville (125 flex)	150 kcfs	100 kcfs



AVERAGE flow year = 2009

(average daily flow at LMN, 3 Apr – 20 Jun, 109 kcfs; minimum generation flow required 11.5 kcfs)

Data source DART (http://www.cbr.washington.edu/dart)

2020-2021 Flexible Summer Spill Operations

Table 1.4.

Planned summer spill operations for 2020 and 2021. Cessation of juvenile transportation June 21 through August 14 with allowance for Technical Management Team adaptive management adjustments.

Location	Initial Summer Spill Operation: Volume/Percent of Total Flow Routed to Spillway (June 21/16 – August 14)	Late Summer Transitional Spill Operation: Volume/Percent of Total Flow Routed to Spillway (August 15 – August 31)
Lower Granite	18 kcfs	RSW or 7 kcfs
Little Goose	30%	ASW or 7 kcfs
Lower Monumental	17 kcfs	RSW or 7 kcfs
Ice Harbor	30%	RSW or 8.5 kcfs
McNary	57%	20 kcfs
John Day	35%	20 kcfs
The Dalles	40%	30%
Bonneville	95 kcfs	55 kcfs - includes 5k corner collector

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Jan 11 16:34:25 2019

To: Erin Rechisky; David Welch

Subject: Muir and Williams

Importance: Normal

Attachments: MuirWilliams_freshmarine.pdf

Hi,

This underreported paper has some level of connection to what you were talking about with regard to lifecycle stages. Hydrosystem survival increased but adult returns lagged. The travel time figure is wrong for four and eight dams – Agnes wanted to use it but that then Steve Smith said it was wrong.

Christine

Ecological Engineering xxx (2011) xxx–xxx

Contents lists available at ScienceDirect

Ecological Engineering

journal homepage: www.elsevier.com/locate/ecoleng

Improving connectivity between freshwater and marine environments for salmon migrating through the lower Snake and Columbia River hydropower system

William D. Muir*, John G. Williams

National Marine Fisheries Service, 2725 Montlake Blvd. East, Seattle, WA 98112, USA

ARTICLE INFO

Article history:
Received 15 November 2010
Received in revised form 31 May 2011
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Keywords:
Chinook salmon
Hydropower system
Smolt survival
Travel time
Columbia River plume

ABSTRACT

Snake River stream-type Chinook salmon smolts migrate >1000 km from rearing habitats to the Pacific Ocean and return 1–3 years later for their upstream spawning migration. Construction of 8 mainstem dams on the Snake/Columbia River that fish must pass has greatly altered the connectivity between their freshwater spawning and rearing habitats and the ocean. In addition to direct mortality to smolts passing through turbines, these dams along with over 200 additional dams and storage reservoirs above them affect the volume, timing and turbidity of river flows and the size of the plume entering the ocean. At mainstem dams, improvements to fish ladders have largely eliminated problems for upstream migrants, while construction of screened bypass systems, a spill program, and transport of smolts by barge have greatly improved direct survival of juveniles. However, smolt-to-adult returns have not shown the same improvement and have been highly variable in recent years. While direct survival for juveniles passing 8 dams is now as high or higher than historically when they passed only 4, survival downstream of the last dam has changed in part due to altered timing and condition of smolts upon ocean entry. Recent additions of surface passage structures at dams have reduced travel time through the system to more closely approach historical rates prior to dam construction. However, substantial additional improvement in direct survival of smolts through the hydropower system does not appear achievable with existing knowledge and technology. Restoring conditions in the plume might improve survival but would require increased flow volume.

1. Introduction

The Columbia River, U.S.A., once had the largest runs of Chinook salmon *Oncorhynchus tshawytscha* in the world (Netboy, 1980). Large percentages of the runs were lost when Grand Coulee Dam (1941) on the upper Columbia River and Brownlee Dam (1959) on the Snake River blocked upstream migration of major summer and fall runs. Access, however, to the majority of habitat for stream-type Chinook salmon in the Snake River Basin, the largest tributary system to the Columbia River, still remains (Fig. 1). Snake River stream-type Chinook salmon evolved to spawn and rear in high-elevation streams up to 2000 m above sea level and as far as 1500 km inland from the ocean. Historically, juveniles left rearing areas during the spring of their second year and migrated rapidly downstream to and through the lower Snake and Columbia Rivers, then passed through the large turbid Columbia River plume before reaching the ocean. They entered the ocean during the spring transition when the near-shore ocean switches from winter downwelling conditions characterized by low nutrients levels and low turbidity to spring upwelling conditions characterized by high nutrient levels and greater turbidity (Pearcy, 1992; Bottom et al., 2005). Once in the ocean they migrated rapidly northward along the continental shelf into the north Pacific to feed and grow for 1–3 years before returning to spawn (Healey, 1991; Matthews and Waples, 1991). The juvenile migration occurs in conjunction with a parr–smolt transformation (Folmar and Dickhoff, 1980) and coincides with increasing water temperature and spring snowmelt. Successful completion of their life cycle depends on migrating through these connected habitats as juveniles and adults, synchronized with changing environmental conditions favorable to their survival.

Construction of eight mainstem dams and reservoirs on the lower Snake and Columbia Rivers between the 1930s and 1970s disrupted the connectivity between spawning and rearing

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E-mail address: bill.muir@noaa.gov (W.D. Muir).

0925-8574/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.ecoleng.2011.06.034

Please cite this article in press as: Muir, W.D., Williams, J.G., Improving connectivity between freshwater and marine environments for salmon migrating through the lower Snake and Columbia River hydropower system. Ecol. Eng. (2011), doi:10.1016/j.ecoleng.2011.06.034

Fig. 1. Snake and Columbia River basin showing locations of major dams.

habitats and the ocean, resulting in delayed ocean entry for juveniles (Scheuerell et al., 2009). Further, construction and operation of additional dams and reservoirs have greatly altered the volume and timing of flows throughout the basin and the shape and size of the Columbia River plume (National Research Council, 1996; Bottom et al., 2005; Williams et al., 2005). Several large storage reservoirs were added to the system in the 1970s, including Mica, Libby, and Dworshak dams, adding about 26.3 km^3 of storage. In addition to these large reservoirs, about 70 hydroelectric dams and another 128 smaller storage dams on basin tributaries resulted in a combined storage capacity for the Columbia River basin of approximately 68.2 km^3. This volume represents one quarter of the total annual discharge of the basin (Williams et al., 2005). Dams, along with overfishing, grazing, mining, and other perturbations have reduced these runs to historically low levels (Nehlsen et al., 1991; National Research Council, 1996). Coincident with development of the hydropower system, ocean conditions, which exhibit decadal scale oscillations, shifted to a state that negatively affected salmon survival (Francis et al., 1998; Francis and Mantua, 2003; Mantua et al., 1997; Petrosky and Schaller, 2010). In the 1990s, declines in returning salmon resulted in multiple listings of stream-type Chinook salmon as threatened under the U.S. Endangered Species Act (NMFS, 1992). Ambitious and expensive restoration programs to recover these and other salmonid stocks have continued for many years. The primary focus of these efforts has been to improve dam passage survival for smolts and adults (National Research Council, 1996). In addition to improvements at the dams for smolt passage, barges are used to transport some juveniles through the hydropower system to a release point below the last dam (Muir et al., 2006). Although the diverse habitats that Chinook salmon use during their life cycle remain physically connected, construction and operation of the hydropower system have altered conditions within the mainstem, estuary, plume, and nearshore ocean. In this paper, we summarize recent juvenile and adult passage travel time and survival through the hydropower system, smolt-to-adult (SAR) return rates, and discuss other factors that may continue to suppress SARs.

2. Methods

2.1. River conditions

To determine how current river conditions compare with those prior to full development of the hydropower system, the average discharge, turbidity, and water temperature measured at Bonneville Dam from 1959 through 1970 (prior to the addition of large storage reservoirs) were compared to average discharge from 2000 to 2009 during the juvenile migration period (April 15th through June 15th) using data from the University of Washington Dart website (http://www.cbr.washington.edu/dart/).

2.2. Juvenile migrant travel time and survival

Since the early 1990s, estimation of migrant travel time and survival has been based on PIT-tagged smolts (Prentice et al., 1990b; Muir et al., 2001a; Williams et al., 2001; Smith et al., 2002). Seven of the eight mainstem dams that Snake River smolts pass during their downstream migration have PIT-tag detection systems within their juvenile fish bypass systems (Prentice et al., 1990a; Muir et al., 2001b). Additionally, in the Lower Columbia River, NOAA Fisheries operates a 2-boat trawl with a PIT-tag detector in the cod end (Ledgerwood et al., 2004). Using the detection history of each individually tagged migrant (detected and not detected at each dam) and detections from the trawl, we used Cormack–Jolly–Seber methods to estimate survival of PIT-tagged juveniles through individual reaches (one reservoir and dam combination) and combined reaches from the head of Lower Granite Reservoir (RKm 747) to the tailrace of Bonneville Dam (RKm 234) (Cormack, 1964; Jolly, 1965; Seber, 1965; Skalski et al., 1998; Muir et al., 2001a). The estimates presented are for a combination of hatchery and wild smolts (>90% hatchery) as there were insufficient numbers of PIT-tagged wild smolts available to reliably estimate their survival. Survival of wild smolts through the hydropower system have been shown on average to be about 16% lower than for hatchery smolts (with wide confidence intervals for wild only), but wild adult return rates

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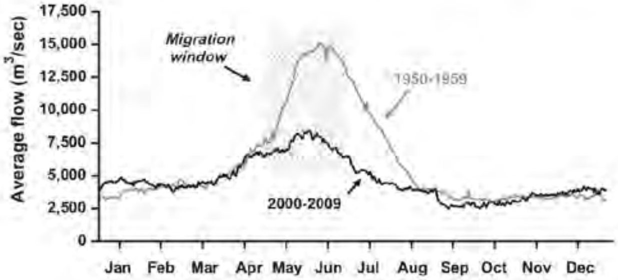

Fig. 2. Ten-year average flow ($m^3 s^{-1}$) measured at Bonneville Dam before (1950–1959) and after full hydropower system development. The downstream migration period for stream-type Chinook salmon is also shown.

are often higher (Buchanan et al., 2010). We compared hydropower system survival estimates from these recent studies with estimates made during the 1960s and 1970s, which were based on nitrogen freeze-brand studies conducted during hydropower system development using mostly wild smolts (Raymond, 1979; Williams et al., 2001, 2005). Median travel time was measured (in days) from Lower Granite Dam to Bonneville Dam for PIT-tagged fish detected in bypass systems at both dams. Estimates of travel time from earlier years were adapted from Raymond (1979).

2.3. Relationship between hydropower system survival and smolt-to-adult return

We used linear regression to explore the relationship between hydropower system survival (head of Lower Granite Reservoir to the tailrace of Bonneville Dam) and SAR (Lower Granite to Lower Granite Dam) for PIT-tagged hatchery and wild yearling Chinook salmon migrating through the hydropower system from 1993 to 2007. In some years (1993–1998), juvenile survival data were not available for the lower portion of the hydropower system, so system survival was calculated by expanding the survival data from the upper reaches to the lower reaches using a per-project (reservoir and dam) expansion (Williams et al., 2001).

3. Results and discussion

3.1. River conditions

Compared to historic conditions before the majority of storage reservoirs were constructed in the Columbia River, flows are greatly reduced during the juvenile spring migration period (Fig. 2). Overall, annual discharge has been reduced by about 15% due to irrigation and climate change (ISAB, 2011); however, the shape of the hydrograph has been highly altered with spring flows now stored for use during summer and winter months.

Although we lack consistent historic measures of turbidity in the Columbia River plume, based on turbidity measured at Bonneville Dam, water clarity in the spring when yearling Chinook salmon smolts pass Bonneville Dam has more than doubled since major storage reservoirs were added. Reservoirs have trapped much of the sedimentation that historically was entrained in high spring flows. Average turbidity (secchi disk) between 15 April and 15 June from 1950 to 1959 was 0.45 m compared to 1.24 m from 2000 to 2009 (Fig. 3). Water temperature during the juvenile migration period has changed little over the same time periods with a 10-year average of 12.1 °C measured at Bonneville Dam from 1950 to 1959 and 12.7 °C from 2000 to 2009 during the smolt migration (Fig. 3).

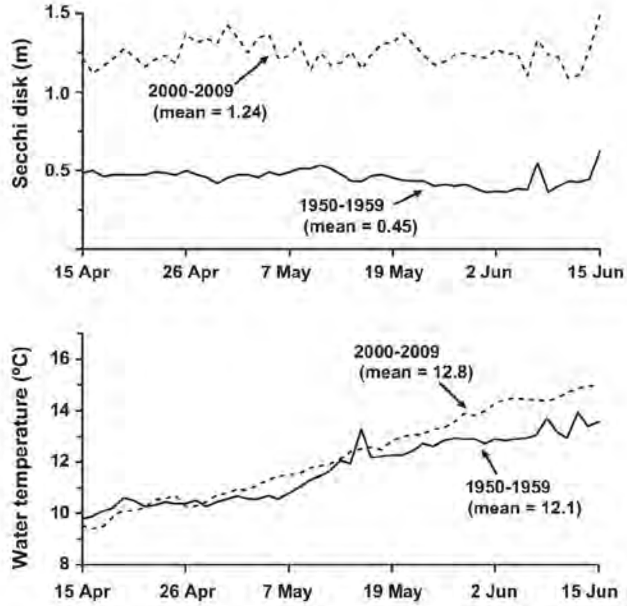

Fig. 3. Ten-year average turbidity (secchi disk in meters) and water temperature (°C) measured at Bonneville Dam before (1950–1959) and after full hydropower system development during the downstream migration period of stream-type Chinook salmon.

3.2. Downstream passage survival and travel time

After initial construction of the Columbia River hydropower system, Raymond (1979) found that survival of Chinook salmon smolts passing through it was quite low, averaging about 22% from 1966 to 1980, with extremely poor survival during the drought years of 1973 and 1977 (Fig. 4). This led to major efforts to improve passage conditions at dams (Williams and Matthews, 1995). Installation of screened bypass systems at most mainstem dams, a spill program (Williams et al., 2005), and more recently, surface-passage structures (Johnson and Dauble, 2006) have greatly improved direct survival of juveniles through the hydropower system compared to estimates of survival in earlier years with survival averaging

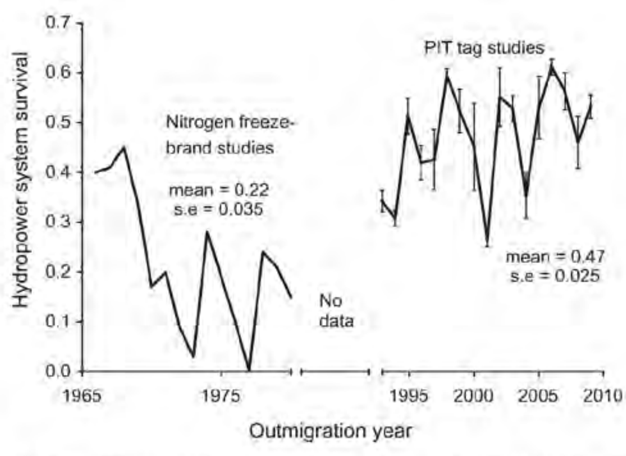

Fig. 4. Hydropower system Chinook salmon smolt (wild and hatchery combined) survival (from the uppermost dam to Bonneville Dam) estimated from nitrogen freeze-brand studies in the 1960s and 1970s prior to complete hydropower system development and from PIT tags studies (Snake River trap above Lower Granite Dam to the tailrace of Bonneville Dam) since 1993. Standard errors are shown for the PIT tag estimates.

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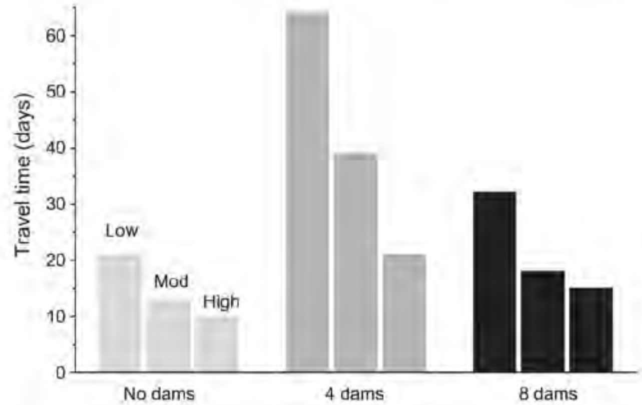

Fig. 5. Hydropower system Chinook salmon travel time (days) from Lower Granite (RKm 695) to Bonneville Dam (RKm 234) under low (Snake 995–1505, Columbia 4005–5028 $m^3 s^{-1}$), moderate (Snake 2017–3010, Columbia 6022–9034 $m^3 s^{-1}$), and high (Snake 4010–5028, Columbia 10,028–14,034 $m^3 s^{-1}$) flow conditions with no dams, 4 dams, and 8 dams.

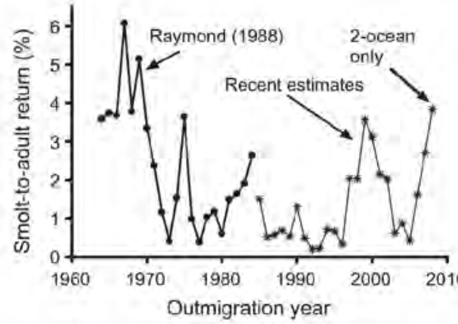

Fig. 6. Estimated Snake River wild stream-type Chinook salmon smolt-to-adult return (SAR) (escapement to upper Snake River dam plus catch).

about 47% from 1993 to 2009 (Fig. 4). While Smith et al. (2002) and Williams et al. (2005) found only a weak and inconsistent relationship between flow and juvenile survival for PIT-tagged Chinook salmon migrating through the Snake/Columbia River hydropower system, they found a strong and consistent correlation between flow and travel time.

While structural and operation changes at dams have led to current juvenile survival that is higher than that estimated after the first four dams were operational, and travel time has decreased considerably since then, the average smolt travel time through the hydropower system over the last 5 years is still longer than it was historically (Fig. 5). As a result, fish now enter the ocean later than they did historically (Muir et al., 2006; Scheuerell et al., 2009). Congleton et al. (2004) found that Chinook salmon smolts migrating under current conditions were in a negative energy balance (lipid and protein) which was related to their travel time through the hydropower system. Smolts arriving to the ocean late and in poor condition could result in latent or delayed mortality that is not captured in short-term estimates of smolt survival within the hydropower system (Budy et al., 2002; Schaller and Petrosky, 2007).

Because we have no estimates of survival in the undammed Snake and Columbia Rivers for comparison, it is difficult to determine a reasonable goal for smolt survival through the system. However, in a study comparing acoustically tagged survival of Chinook salmon and steelhead *Oncorhynchus mykiss* from the dammed Snake and Columbia Rivers to those migrating from the undammed Fraser River in British Columbia, Welch et al. (2008) found survival was similar. This finding suggests we may have restored direct migrant survival to near historic levels.

3.3. Upstream passage survival

The eight mainstem dams on the Columbia and Snake Rivers that adult Chinook salmon must pass were all designed and built with adult fish ladders. Research on adult upstream passage behavior using radio telemetry has led to further modifications within the ladders and adjustments to spill patterns to improve upstream passage success (Caudill et al., 2007; Ferguson et al., 2005; Keefer et al., 2004). Fish ladders at several mainstem dams, including Bonneville and Lower Granite Dams, are now equipped with PIT tag detectors that detect nearly 100% of the adults migrating upstream (Ferguson et al., 2005). Survival for PIT-tagged adult Chinook salmon migrating from Bonneville, the first dam, to Lower Granite, the last dam (through 6 dams) averaged 84% from 2001 to 2004, for a per-project survival rate of about 97% (Schaller and Petrosky, 2007). Further, adults migrate through the current hydropower system in a time that is now similar or shorter than it was when the system had few dams (Ferguson et al., 2005), likely due to reduced velocities in reservoirs.

3.4. Smolt-to-adult return rates

Despite the improved travel time and survival for Chinook smolts passing downstream through the hydropower system in recent years compared to those in the 1970s and early 1980s, and high survival for adults migrating upstream, SARs have not shown consistent improvement (Fig. 6). Further, Chinook SARs show little relationship to the direct survival of juveniles through the hydropower system (Fig. 7). Excluding the SARs from 1999 and 2000 from Fig. 7, years of very high ocean productivity and Chinook salmon ocean survival, results in a significant relationship ($R^2 = 0.485$, $P = 0.008$) between hydropower system survival and SAR, but SARs in those years are all <1%.

Petrosky and Schaller (2010) found that lower SARs for Snake/Columbia Rivers Chinook salmon were associated with warmer ocean conditions, reduced upwelling, and lower river velocity. Decadal (or longer) regime shifts in ocean conditions that affect salmon survival that occurred during this time period (Beamish et al., 1997; Francis et al., 1998; Francis and Mantua, 2003; Mantua et al., 1997) complicates determining the relative influence of hydropower development on SARs (Petrosky and Schaller, 2010). Further complicating comparison of historical and present day SAR estimates is the limited time series of reliable estimates of SAR, which only go back to the 1960s. Another potential

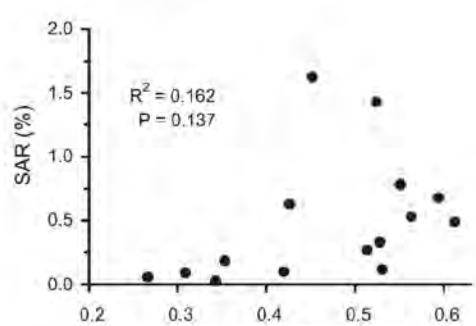

Fig. 7. Relationship between stream-type Chinook salmon hydropower system survival and smolt-to-adult return (SAR), 1993–2007.

contributing factor that may continue to suppress wild Chinook salmon SARs is the negative effect of large hatchery releases in the Snake and Columbia River basins which also increased coincident with hydropower system development (National Research Council, 1996; Levin et al., 2001; Levin and Williams, 2002). Annually, more than 13 million hatchery spring/summer Chinook salmon have been released in the Snake River Basin in recent years, with similar numbers of other hatchery salmonids released (ISAB, 2011).

Spring migrating smolts now enter the Pacific Ocean in a plume greatly reduced in size and turbidity that might affect survival (ISAB, 2011). The association between Snake/Columbia River Chinook salmon SARs and river velocity (higher flows) reported by Petrosky and Schaller (2010) could be due to reduced travel time through the hydropower system and earlier ocean entry (Scheuerell et al., 2009), a larger plume, or both. While Burla et al. (2010) did not find any correlation between plume size and Chinook SARs, over a period of 4 recent outmigration years for Chinook salmon (but did for steelhead), we hypothesize that historically a larger and more turbid Columbia River plume provided a greater buffer between the fresh and saltwater environments, giving smolts time to acclimate and grow. Reduced buffering capacity of the plume could lead to greater variability in early marine survival as ocean conditions change. Under ocean conditions characterized by less food for growth, more predators, and increased hatchery production, a large turbid plume could buffer the negative effects of these conditions by providing protective cover from visual predators (Gregory and Levings, 1998; DeRobertis et al., 2003). Increased flow volume would speed smolts away from the estuary and coastline, where predation is high (Pearcy, 1992). Under good ocean conditions, this buffering effect would be of lesser importance. Further, nutrient rich Columbia River plume waters increase productivity along the continental shelf where Chinook salmon smolts migrate (Hickey and Banas, 2008). Hickey and Banas (2008) hypothesized that nutrients provided by the Columbia River plume act as a buffer during years with poor ocean conditions, or years when the spring transition is late, and that reduced flows would result in less buffering capacity.

Structural and operational improvements at mainstem dams in the Snake and Columbia River hydropower system have improved the connectivity between the relatively pristine high elevation spawning and rearing areas in Idaho and eastern Oregon and the Pacific Ocean by restoring travel time and ocean entry timing closer to what it was prior to hydropower development. In our view, additional substantial improvements in hydropower system travel time and survival for smolts are unlikely to occur with existing knowledge and technology. Further, although limited amounts of flow volume from storage reservoirs are allocated to fish managers as a "water budget" to improve smolt travel time (NRC, 1996), these reservoirs have a dual purpose for not only power production, but flood control. Presently, flood control constraints have a large effect on limiting spring flows. The ability to increase spring flows and restore the size and turbidity of the Columbia River plume closer to historic levels cannot occur without further modifying operation or removing some of the large storage reservoirs. However, substantial changes are unlikely to happen due to concerns about flood control and the need for summer/winter power generation.

4. Conclusions

1. Structural and operational improvements to mainstem Snake and Columbia River hydropower dams in recent years have substantially improved Chinook salmon smolt survival, reduced travel time, and increased connectivity between rearing areas and the Pacific Ocean by restoring entry timing closer to that prior to hydropower development.
2. Despite substantial gains in direct downstream smolt survival and improved upstream passage success through the hydropower system, SARs have not shown the same improvement in most years. However, variable ocean conditions and increased hatchery production confound comparisons with historical SARs.
3. Factors that may contribute to depressed and variable SARs include changes in ocean productivity, increased hatchery production, and the reduction in volume and turbidity of the Columbia River plume due to increased water storage in the basin.

Acknowledgements

We would like to thank Steve Smith, Jim Faulkner, Ben Sandford, Rich Zabel, and Doug Marsh from NOAA Fisheries for their efforts in the conduct and analysis of travel time and survival data used in this study and the Bonneville Power Administration for providing funding to conduct this research.

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From: David Welch

Sent: Tue Jan 15 16:15:56 2019

To: Petersen,Christine H (BPA) - EWP-4

Cc: Aswea Porter; Erin Rechisky

Subject: [EXTERNAL] RE: Possible response to Michelle deHart's memo

Importance: Normal

Thanks, Christine. If memory serves, there were three different requests to the FPC. I don't want it to be a huge deal for you to find, but it would be useful to just state the different dates that we (well, you) asked them for SAR data including the above dam component. "Proving" that we did so in the past probably won't be such an issue to the editor at PLoS ONE (we just say that we asked x times, but never got the data), but in our BPA-requested response it would be good to document the number of times and the dates it was asked for.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, January 15, 2019 4:01 PM
To: David Welch
Cc: Aswea Porter; Erin Rechisky
Subject: RE: Possible response to Michelle deHart's memo

Yes, I meant “do not do”.

I put in a request for funding for this review document, and travel to conferences to our finance team. I thought they would be meeting today, but it will actually be on Thursday.

Two weeks would be great but I think it would be fine to receive it by mid February. I will also see what their recommendation is for potential conferences.

Let me look back in my email for the request for SAR data from FPC. It was over a year ago.

BPA actually has a different relationship with the three states- Idaho, Washington and Oregon, and is most wary of ODFW because Oregon always participates in lawsuits (this goes back at least 20 years). Washington has standing policies to emphasize climate change and hydropower- I don’t remember what the Washington state law was but it encouraged creation of Public utility districts – hence the PUDs on the upper Columbia. And Washington holds stronger water quality standards than the other states. The state of Idaho traditionally is most concerned about the fate of returning adults, and least concerned about estuary habitat. The Nez Perce tribe does not sign accords agreements and has cooperated with lawsuits, except making their own set of arguments.

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Thx, David

From: CBFish on behalf of support@cbfish.org

Sent: Wed Jan 16 14:00:08 2019

To: chpetersen@bpa.gov; erin.rechisky@kintama.com

Subject: [EXTERNAL] Status Report Submitted

Importance: Normal

To: Christine Petersen;Erin Rechisky
Cc:

The "Oct-Dec 2018 (10/1/2018 - 12/31/2018)" report for contract #75025 under project #1996-017-00 ("Technical and Analytical Support for ESA Activities/Issues") has recently been submitted by erin.rechisky@kintama.com. You may view the submitted report in Pisces.

If you feel this email has reached you in error, please contact the assigned COTR for this contract, Christine Petersen (chpetersen@bpa.gov).

Thank you,

Environment Fish and Wildlife
Bonneville Power Administration

From: David Welch

Sent: Fri Jan 18 15:39:30 2019

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] FW: Media inquiry re your study and your recommendations to the Power Council

Importance: Normal

Whoops… forgot to BCC you on my response before I hit send!

From: David Welch
Sent: Friday, January 18, 2019 3:39 PM
To: 'K.C. Mehaffey'
Subject: RE: Media inquiry re your study and your recommendations to the Power Council

Hi KC—

Sure, happy to take your call, & thanks for your interest.

I will probably be in the office until 4:30 or so today, and in all next week. My cell is probably the better number to try first.

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

755 Terminal Ave N, Nanaimo BC V9S 4K1 Canada

Office: (250) 729-2600 Mobile [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: K.C. Mehaffey [mailto:kcmehaffey@newsdata.com]
Sent: Friday, January 18, 2019 3:16 PM
To: David Welch
Subject: Media inquiry re your study and your recommendations to the Power Council

Hi David,

My name is K.C. Mehaffey and I'm the "fish" reporter for Clearing Up, a trade journal covering the power industry in the Pacific Northwest, and reporter and editor of the online monthly publication Northwest Fishletter, which is basically a compilation of my relevant stories in Clearing Up.

A fish biologist sent me your recommendation to the Northwest Power and Conservation Council, and your study, "The coast-wide collapse in marine survival of west coast Chinook and steelhead: slow-moving catastrophe or deeper failure?"

I was hoping you might be able to chat with me sometime next week (or this afternoon if I'm not too late). Mondays and Tuesdays are best for me. If you want to set a time and day, I'd be happy to call you at either the office or mobile number on your recommendation letter.

Thank you!

K.C. Mehaffey
Reporter, Clearing Up / NW Fishletter
NewsData, LLC
kcmehaffey@newsdata.com
509-997-2512

From: David Welch

Sent: Fri Jan 18 15:55:56 2019

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky

Cc: Aswea Porter

Subject: [EXTERNAL] RE: Pending contract

Importance: Normal

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Being a bit less flippant, I can get the rebuttal points I drew up in reasonable form for internal use by BPA in 1.5 days (probably)… maybe a little less. But I think we should talk about what is needed here… I sense an opportunity to do outreach to Columbia basin biologists by making one or more presentations that include as a first part an explicit response to Michelle's memo, and then use that to frame the urgency and gravity of the current situation, where current "*approaches to recovery*" are potentially seriously mis-aligned due to density-dependence in the freshwater life history and ocean survival rates being as low as they seem to be.

It may also be time for Kintama to do a science blog… or a Twitter Storm? But my sense is that is a lot of work for possibly little real movement. (to discuss).

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, January 11, 2019 12:46 PM
To: David Welch
Cc: Aswea Porter; Erin Rechisky
Subject: RE: Kintama Update to BPA (11 Jan 2019).pptx

Hi,

Thank you. This looks good

Our conference room is reserved until 2 but hopefully I can get in earlier just because the computer takes 2-3 minutes to boot up. Nobody is there after 3, so hopefully we could safely go a little late, however some participants might have to leave.

One additional thing – I just spoke to Jody. She asked for an estimate of time for you to write a line by line 'rebuttal' (but only to be given to BPA) of the FPC memo, for our greater understanding. We would add it to the contract because it would be new work. I brought up outreach and travel and mentioned that the ocean ecology conference.

FYI – there was one sentence in that memo that was like reverse projection or 'gaslighting' in that they were seeming to accuse your group of developing the 2-6% SAR goal.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, January 11, 2019 12:34 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Aswea Porter; Erin Rechisky
Subject: [EXTERNAL] Kintama Update to BPA (11 Jan 2019).pptx

Hi Christine—

I am attaching a copy of the update for you, in case the WebEx link does not work. If you want to go through the presentation prior to the meeting, please press F5 to view the slides and use the space bar to step through it… there are a few slides (esp. the final one) where we have animated the steps so that we can work through the concepts with your group (I hope!).

Erin and I will log on a few minutes before 2, as I am unsure whether the audio will work or I will have to call your mobile and use your speakerphone.

Thx, David

From: David Welch

Sent: Mon Jan 21 10:06:32 2019

To: Aswea Porter

Cc: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky

Subject: [EXTERNAL] RE: BPA-- Hydrosystem equivalencies draft 2

Importance: Normal

Thanks, Aswea. (c.c. Christine & Erin)

Taking your data below, I get the following comparisons, using n=log(SAR)/log(FW):

	N	1/n (%)
subyearling:	**7.5**	**13.4%**
yearling:	**8.9**	**11.2%**

Your comments are quite useful, because I will use them to round out the Discussion, I think, and they buttress what I was saying. Two points come up:

a) Even though yearling smolts go to sea at larger average size, have (much) lower harvest rates, and are

at sea for only about half the length of time that subyearling smolts spend in the ocean, their median SAR values are *__in absolute terms__*, smaller (0.9% vs 1.23%). From what our general expectation is of the biology, this is unexpected (and, so far as I am aware of the literature), no one has previously commented on this anomaly.

a. Larger smolts should have better survival; yearling smolts should have higher SARS, not lower as observed.

b. Spring (yearling) Chinook have harvest rates in the 10% range while Fall Chinook historically had harvest rates up to 60%; the FPC data does not correct for harvest, so yearling smolts should have higher SARS, not lower as observed..

c. Spring Chinook smolts go out in May, return in April two years later when they are censused at Bonneville Dam. Fall Chinook smolts go out in July(?), return in October, *__three years later.__* So this means yearling Chinook are in the ocean for ~22 months instead of ~39 months, as I currently ball park it. Again, yearling smolts should have higher SARS.

b) Christine, the values in the table I calculated above show how many times measured smolt survival in the hydrosystem has to be repeated for the SAR to fall to the observed return level; essentially $(S_h)^n$=SAR. So, for subyearling smolts, the smolts experience n=7.5 sequential migration segments each of equal survival magnitude to the hydrosystem before they return as adults and are censused at Bonneville Dam. For yearling Chinook, n=8.9 sequential migration segments.

c) The key point here is that yearling Chinook experience more "things" that reduce survival in the ocean than do the Fall Chinook, and this applies in either absolute terms (a) or when contrasted with hydrosystem survival (b)

Christine, do you know if anyone has ever commented on this important anomaly? It fits in nicely with what we are working up for the paper.

Aswea, can you please provide some context for these numbers: what stocks, what years? I'm not sure I can work this into the current manuscript, but I might be able to include a fuller description of this issue in

either the “21 Century Salmon Management” paper when we get to it, or a different paper—it is an important point that so far as I can see has been overlooked by the community and adds further evidence that the ocean is hugely controlling SARs. (Christine, not sure I have yet mentioned this t you, but the 1/n calculation in the table above is a quantitative measure of how much the hydrosystem contributes to determining SARs. For subyearlings it is only 13%, and for yearlings it is even less—11% of the total). These numbers square well with those we are using in the current manuscript that are the median information ratio: 12.5% and 10.9%.

Thanks, David

From: Aswea Porter
Sent: Monday, January 21, 2019 8:36 AM
To: David Welch
Subject: RE: BPA-- Hydrosystem equivalencies draft 2

Hi D,

Was finally thinking a bit about the observation you made on the phone the other day that the hydrosystem is a larger percentage of the subyearling SARS than it is for the yearlings even though the subyearlings spend an extra year in the ocean. So that was because either 1) ocean survival is ~equivalent across ocean years and the subyearlings somehow have better survival than do the yearlings (maybe go someplace where survival is higher), or 2) ocean survival is extremely high for the 3rd year (ie maybe most ocean mortality is in the first year). Am I understanding correctly? The evidence is for the later is it not?

I wanted to note that despite the ~difference of a full hydrosystem mortality value between the yearlings and subyearlings, the median SAR and FW survivals are fairly equivalent.

From: David Welch
Sent: January-16-19 16:11
To: Aswea Porter
Subject: RE: BPA-- Hydrosystem equivalencies draft 2

These are perfect, Aswea—great job!!

A few things (no rush).

1) We should update the data to using the CSS report that has just come out.

2) Please put together for me the summary table showing short/long name equivalencies, what year range the n-values are calculated for, and anything else that you think should go in that table (including the citation for which data tables you used in the CSS report to put this together.

3) I changed my mind again on the bottom x-axis labeling (sorry!!). Let's just make it read "# Hydrosystem-Sized Segments (n)". That better matches the upper x-axis label.

I (almost) promise not to ask for any further changes. J I can certainly use the current versions with no problem until you get back to me with updated versions… its just that we will need to be completely up to date for publication.

A heads up. A follow-on paper (not yet funded) with the working title of "21st Century Salmon Management" will likely need to use this graph, but extending it to all Columbia River basin stocks, much like the approach we used in the PLoS ONE paper. (& we may well need to extend it to those other areas of the west coast where we can match up freshwater smolt survival and subsequent adult SARs). No rush on this, but I am very likely to call on you to put that together.

Thx, d

From: Aswea Porter
Sent: Wednesday, January 16, 2019 7:15 AM
To: David Welch
Subject: RE: BPA-- Hydrosystem equivalencies draft 2

Hi D,

Here are those plots. Anything else? We can always make changes later as necessary.

These are also on the server here:

"K:\3. DATA_ANALYSIS\Critical_Periods_paper\AP_sync\Hydro_S_equivalencies"

~A

From: David Welch
Sent: January-14-19 16:15
To: Aswea Porter
Subject: RE: BPA-- Hydrosystem equivalencies draft 2

Thanks, Aswea—

Sorry about th e 4 emails… I was writing them from my iPad, and it doesn't allow me to switch between different email windows, so each time I sent and closed an email I then had some other ideas when I looked at the graphs again!

I think I still prefer the semi-log plots because they compress the higher n-values which represent very similar % hydrosystem contributions, but I will keep an open mind about this until we actually write it up.

Other comments below.

From: Aswea Porter
Sent: Monday, January 14, 2019 8:00 AM
To: David Welch
Subject: RE: BPA-- Hydrosystem equivalencies draft 2

Hi D,

I hope you had a nice weekend! Mine was so quiet that I've already forgotten what happened.

I've gone through your 4 (lol) emails of suggestions. Here are a few more versions for CH and some questions:

1) With plots stacked vertically, it could be interpreted that the top x-axis applies to the top plot (Subyearlings) and the bottom x-axis applies to the bottom plot (Yearlings). Do you agree? If so, I can separate these plots (now created as one facetted plot) into 2 separate plots (in one image) so that both have axis numbering, but axis titles as they are now (top title on top plot only and bottom title on bottom plot only). This is a rearrangement of code so wanted to check before proceeding. ***[DW>]*** **Yes, please separate into two plots.. or two clearly defined panels, anyway. We need the space between for both axis tic marks and to move the median values for each plot (in red) out of the body of the plot and onto the appropriate axis (please also rotate counterclockwise 90 °). See below**

2) Do you want to add STHD to this figure as its own facet/plot-panel or have a separate figure for STHD? 17 stocks for STHD so adds equivalent height as the Yearling CH (ie would be a tall plot for sure).***[DW>]*** **Separate.**

3) X-axis goes from 1 on both plots. Since it is not possible for the hydrosystem survival to be smaller than the SAR, I thought your initial suggestion to limit to 1 was good. Why would we change it to 0?***[DW>]*** **Changed my**

mind again… 1 is fine as the lower limit (& essential for semi-log plotting, unless we go to an arbitrary negative number)

4) Stocks are sorted by reverse alphabetical. I can rearrange so are alphabetical from top to bottom. Do want sorting by H/W designations too? ***[DW>]*** **Alphabetical would be good. I think it would be good to have hatchery data in the top part of each graph and then wild stocks in the bottom, and then presented alphabetically.**

5) Do you like the short names? These match the SARS paper, but in this context there is a bit of repetition with the H W designations. See SnakeWFa, ClearHSu, ClearHSp, ImnahaW, and ImnahaH. Would you rather have the definitions match the SARS paper or be free of repetition? ***[DW>]*** **Be free of repetition. In general, if a stock is released as a yearling it is a Spring or Summer, while subyearlings are Fall (a few exceptions exist… but I am not sure if there are any exceptions for this analysis).** Also, just wanted to mention that the shortened titles will be a bit more difficult for people to understand. Possibly folks in the Columbia are more used to seeing the format as it outputs from the FPC (ie the full names). Only benefit to shortened names is that it makes the plots narrower—depends on purpose I suppose. For presentations, the long version might be better.***[DW>]*** **We will certainly need a table giving the equivalences. (Also, I note that ImnahaW & ImnahaH can be simplified to just the hatchery name because you also have the H or W designator). So the SpSu, Su, and Sp disgnator can be removed from the short names because it is almost always clear from context (Y/subyearling) what is represented. I suggest a clear (short) hatchery name, space, and H/W designation. In the accompanying table we can list full name, short name and some other details tbd (lat/long, run timing, …?).**

6) The labels on the median lines are squished in. Any thoughts there?***[DW>]*** **Not exactly sure what you mean. If you mean the red numbers indicating the median across all data, these definitely need to be moved out of the cntral graph and out onto the axis (as bold-faced) red font to distinguish from the regular axis numbers. Even I found it very confusing to have the dashed red line labeled with two numbers (one on each end) until I realized what was going on—a more naïve reader would struggle further. To make this clear, extend the red dashed line out of the graph's body so that it terminates just above the regular black numbers for both sets of axis labeling, and then put the bold-faced red median value above that. Although it will take up more space, it also highlights & makes a very important overall result clear, I think.**

7) I still don't see the point of the log axis since logs make it harder to understand and just transfer the white

space from the top to the bottom of the plot. Am I misunderstanding?***[DW>]*** **Yes, I think so. The reciprocal axis values (1/n) are better spaced out on the log2 axis, and this is what is really important, not n. (n is the df that the SAR includes, while 1/n is the proportion of the variability total SAR that the hydrosystem is expected to determine).**

[DW>] **A couple of other points. On the upper axis, the labeling is fine, but please append a percent sign (%) to each of the numbers. I recognize that you will need to lose some of the numeric avlues to do so, but that is ok. I suggest just using (100%, 50%, 33%, 20%, 10%, 5%, 3%, & 2%). You can drop some of that series if it is still too crowded.**

"Probably" it makes sense to shorten the lower x-axis label to "# of Survival Segments (n)"... Should be better for a print publication while the longer label is better for verbal presentations as part of a Powerpoint.

Best,

A

From: David Welch
Sent: January-12-19 12:47
To: Aswea Porter
Subject: Re: BPA-- Hydrosystem equivalencies draft 2

...and append H or W after the shortened y axis name (where the map code is

David Welch, Kintama Research

Tel: +1 (250) 729-2600 x223

Cell: [redacted]

Sent from my iPad

On Jan 12, 2019, at 07:51, Aswea Porter <Aswea.Porter@kintama.com> wrote:

Hi D,

The attached plot from the SARs paper is approximately what you are describing with the rotated axes except with differing data and the facet labels moved to inside the plot. Can you confirm this is what you want before I proceed because it is a rewrite of the code to make 2 plots rather than a single plot with facets. The problem with the facetted vers when rotated is that it has only one set of axis labels so all the populations will be listed on the y-axis creating gaps in each plot (yearlings vers subyearlings). Made a quick vers to illustrate—see attached. Not that time-consuming but wanted to check.

Needs to have shortened names when making 2 plots or gets too wide. I can use the ones from the SARS paper minus the numbers that link to the map. For SNAK at least, they seem fine.

~A

From: David Welch
Sent: January-10-19 15:48
To: Aswea Porter
Subject: RE: BPA-- Hydrosystem equivalencies draft 2

Sorry, hit send too soon!

A few more points (none urgent):

1) **I am currently rotating the figures 90 ° clockwise, which makes reading them easier. I think we should plan to do this for the final figures you produce.**

2) **Put the "number of hydrosystem-sized survival habitats," on the bottom x-axis on the re-oriented figure. Relabel as "# of survival habitats, n". On the top put the alternate axis labeling "Hydrosystem Contribution (%)".**

3) **Move the subyearling & yearling labels to the upper left corner of each panel(log-axis) or upper right hand corner (arithmetic axis).**

4) **We will need to work on shorter labels for the populations, as we did for the SARs paper. TBD**

From: Aswea Porter

Sent: Wednesday, January 09, 2019 1:01 PM
To: David Welch
Subject: FW: BPA-- Hydrosystem equivalencies draft 2

Ignore last version-- the counts were off.

From: Aswea Porter
Sent: January-09-19 16:28
To: David Welch
Subject: RE: BPA-- Hydrosystem equivalencies draft 1

Hi D,

Here are some more versions. B&W is very hard to see the boxplot inside the violin. Log axis leaves a lot of white space at bottom of plot...

Would like to check this over one more time, but am out of time because I promised C I'd watch part of her first gymnastics class.

And some stats:

SpeciesCode

SmoltAge

Count

Mean

SE

SD

0%

10%

25%

50%

75%

90%

100%

CH

Subyearling

54

9.54

0.83

6.09

1.46

4.26

5.57

8.01

11.25

16.34

35.94

CH

Yearling

126

10.20

0.48

5.39

2.67

5.50

7.11

8.94

11.44

14.75

38.24

ST

NA

84

7.72

0.44

4.02

1.00

3.47

4.96

7.24

9.76

12.27

23.46

~A

From: David Welch
Sent: January-09-19 12:56
To: Aswea Porter
Subject: RE: BPA-- Hydrosystem equivalencies draft 1

I'm back… just refreshed my mind on the violin plots again.

a) **I think we should go with violin plots, though I would like to see the B&W version.**

b) **Make the y axis minimum 1, not zero, and draw a solid red horizontal line across the panels, as you have done with the dashed red line.**

c) **We will also need to look at QQ-plots to assess how close to normality the data are after log transformation… to discuss when I am in the office.**

From: Aswea Porter

Sent: Wednesday, January 09, 2019 8:12 AM
To: David Welch
Subject: BPA-- Hydrosystem equivalencies draft 1

Hi D,

Here's the first vers of the plot showing the number of hydrosystem survival events required to equal the SARs. This is for CH, I'll start organizing the STHD data now.

SmoltAge

Count

Mean

SE

SD

0%

10%

25%

50%

75%

90%

100%

Subyearling

54

9.54

0.83

6.09

1.46

4.26

5.57

8.01

11.25

16.34

35.94

Yearling

126

10.20

0.48

5.39

2.67

5.50

7.11

8.94

11.44

14.75

38.24

This plot is a violin because I'm into them right now, but might be better to do boxplots or histograms to match the other plots in the SARs paper?

For the SARS, the reach is from LGR and back to BON and estimates include jacks. For the smolts, the reach is LGR to arrival at BON. By using the LGR to BON reach for SARs, we lost a bit of data: 4 stocks lost years 1997-1999, and 1 stock lost years 1994-1999.

We also lost most of the SARS data for 6 stocks (all wild) because there were limited matching FW estimates

(most only had matchers for 2014 which is the last year of complete SARS data)

The 2018 CSS report should be coming out soon which would mean updates here.

~A

Aswea Dawn Porter

Senior Research Analyst

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Skype: aswea.porter
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<SARS_by_stock_Chinook_29Oct.tif>

<FLIPPEDDistribution_hydrosystem_equivalencies_CH.png>

From: Petersen,Christine H (BPA) - EWP-4

Sent: Tue Jan 22 15:36:34 2019

To: Erin Rechisky; David Welch

Cc: Aswea Porter

Subject: RE: Pending contract

Importance: Normal

Hi,

Sorry, I had to circle around with a couple people to get the decision on this.

Let's see – we have a primary 2019 contract to cover your second daily survival rates paper, peer review for the SARs paper of $70,000. In addition, we would like you to write a response to this FPC memo. Please just spend ~ 2 days on it, and keep it relatively straightforward and focused at an internal audience at BPA, rather than an expanded audience who potentially could have seen the memo. (I realize that you might wish to mentally compose something like this to more of a regional group of scientists).

For travel, Jody and Kristen think the Salmon Recovery Conference in Tacoma is the top preference for us, and we would like to fund that. Jody plans to attend. Could you provide expected costs for the conference and expected cost for flight, and I will try to look up the GSA rate for the hotel for you.

The WA-BC AGM sounds like a good conference, but we didn't initially prioritize it. It would be fine with us if you were able to attend on your own. However, I speculate that if it made sense to cut one conference short and just do day passes, perhaps it would be equal cost? If you could provide the costs for reference, that could be helpful.

So, please put your budget together with these additional two small items. I will have to be at an off site meeting on Wednesday afternoon/Thursday and our remote access email has been having troubles lately, but I should be able to log into cbfish.org and help make progress. You could reach me at my phone (b) (6) [redacted] or cc an alternate email (b) (6) [redacted] If you would like to go over the contract over the phone, I might be able to set aside at least half an hour for that in the next couple days, so please let me know.

Best,

Christine Petersen

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Friday, January 18, 2019 4:40 PM
To: Petersen,Christine H (BPA) - EWP-4; David Welch
Cc: Aswea Porter
Subject: [EXTERNAL] RE: Pending contract

Hi Christine,

We might get the most bang for our buck if one or both of us attends the Salmon Recovery Conference and the WA-BC AGM. They are in WA and overlap by a day so could be done in one trip to WA. It would depend on how the talks are scheduled. (We could request a certain day to accommodate our schedule). This is also likely the best audience, I think.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: January 18, 2019 3:39 PM
To: Erin Rechisky; David Welch
Cc: Aswea Porter
Subject: RE: Pending contract

Thanks for contacting me. Somehow, this request fell off the end of their finance meeting yesterday. I did not get a final answer regarding one or two meetings and which ones?

Can you suggest one meeting that you would most like to go to? I saw that one of them already just had a Jan 15th deadline. This would at least let us price location and how many days, and we could write that in.

For the rebuttal to this FPC memo, they'd like to keep it relatively simple. Just spend two days or so on writing a response and don't worry about making it completely polished.

Again – I'm sorry because I hoped to get this answer for the funding by the end of this week, and I will prompt them for an answer again and maybe we could respond by end of today.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Friday, January 18, 2019 11:40 AM
To: Petersen,Christine H (BPA) - EWP-4; David Welch
Cc: Aswea Porter
Subject: [EXTERNAL] Pending contract

Hi Christine,

Was there a decision made on funding the review document (response to the FPC memo) and travel? I'd like to add those funds to the pending contract that we are working on instead of having to do a contract modification later. We'd like to get the contract in place as soon as possible since our current contract ends on Jan 31st and abstracts are due for some meetings:

Salmon Recovery Conference: Jan 31st

WA-BC AFS: Feb 15th

Thanks,

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: January 15, 2019 4:01 PM
To: David Welch
Cc: Aswea Porter; Erin Rechisky
Subject: RE: Possible response to Michelle deHart's memo

Yes, I meant "do not do".

I put in a request for funding for this review document, and travel to conferences to our finance team. I thought they would be meeting today, but it will actually be on Thursday.

Two weeks would be great but I think it would be fine to receive it by mid February. I will also see what their recommendation is for potential conferences.

Let me look back in my email for the request for SAR data from FPC. It was over a year ago.

BPA actually has a different relationship with the three states- Idaho, Washington and Oregon, and is most wary of ODFW because Oregon always participates in lawsuits (this goes back at least 20 years). Washington has standing policies to emphasize climate change and hydropower- I don't remember what the Washington state law was but it encouraged creation of Public utility districts – hence the PUDs on the upper Columbia. And Washington holds stronger water quality standards than the other states. The state of Idaho traditionally is most concerned about the fate of returning adults, and least concerned about estuary habitat. The Nez Perce tribe does not sign accords agreements and has cooperated with lawsuits, except making their own set of arguments.

With those memos, keep in mind that we suspect that the person making the analysis request might have been asked to make that request. So I wouldn't read that much into the fact that the request originated with Jones at ODFW. I would think that a local meeting would be a great forum to potentially present, and even send a message encouraging them to go. It is more than you need to know based in Canada – but Jason Sweet clued me in to the FPAC meetings. It is often a way to learn about what other agencies will talk about soon at policy meetings. These occur with states, tribes, and NOAA with FPC as the official data keeper and statistical analyst. There isn't enough time in the week to listen to these regularly but that reminds me that I ought to go through their recording and see if this came up in recent weeks.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Monday, January 14, 2019 3:45 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Aswea Porter; Erin Rechisky
Subject: [EXTERNAL] RE: Possible response to Michelle deHart's memo

Thanks, Christine—

You said below "*they responded that they do off-the-record discussions***". Did you leave off the word "not"?**

Aswea contacted me today chomping at the bit to get started on the response. If possible, I suggest that you budget 4 days at my rate ($1K/d) as we will need to allocate some tasks and everyone will need to give

it a careful final read. I had some thoughts about how best to respond to the review, but I need to draft the response accordingly and then share with Erin & Aswea. Do you need a tight turnaround on this (i.e., within 2 weeks from today)?

Also, can you please pull out and send to me copies of your formal requests to the FPC for the survival data with the above LGR survival included? One (brief) part of our response should be that we asked for this several times through you, but it was never forthcoming. Having the emails will be good because we may get the same criticism if they are a reviewer for PLoS ONE.

Finally, from the guidance below I would take it that we shouldn't reach out to Tucker Jones of ODFW, who apparently asked the FPC for a review? The way I was thinking of of doing so was to ask if there was a scientific venue where we could present our results (an invited talk at ODFW or some regional meeting) and present our views. But if you think that is inadvisable, I will drop it.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, January 14, 2019 3:33 PM
To: David Welch
Cc: Aswea Porter; Erin Rechisky
Subject: RE: Possible response to Michelle deHart's memo

Hi,

Let's see – I just asked Jody about conferences that are coming up, and I am hoping we can make a decision about that and make a lot of progress on the contract in cbfish.org during the current week.

For the review of debated issues, this would primarily be for us. Should I ask for 3-4 days of time? We cannot tell you how to interact with staff from other agencies, media and so forth. However I think many of us here would not recommend reaching out to staff at agencies involved in litigation outside of the context of a scientific meeting or similar. The example that comes to mind first is my coworker Julie's story from last week that she offered to do lunch with FPC staff to be available to answer any questions regarding the participation of the CSS model in the Environmental Impact Statement process – and they responded that they do off-the-record discussions. You have shared a few similar stories. I think you shouldn't hesitate to participate in meetings such as the Upper Columbia science conference or carrying on any discussion about your work with people in your collegial networks.

By the way, with regards to density – I was just looking at this announcement in Clearing Up of increased hatchery releases targeted at improving the status of southern resident killer whales. I speculate there will be some interesting debates over wild versus hatchery competition, carrying capacity of the ocean, and limiting factors.

Click this link for this week's issue of Clearing Up:

http://www.newsdata.com/cgi-bin/viewpdf.cgi?iss=cup1884&cid=IFJrjXxjxeiQ

Click this link for this week's Clearing Up news clips:

http://www.newsdata.com/cgi-bin/viewpdf.cgi?iss=cuclips1884&cid=IFJrjXxjxeiQ

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, January 11, 2019 1:27 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Aswea Porter; Erin Rechisky
Subject: [EXTERNAL] Possible response to Michelle deHart's memo

Well, I spent last night reading Ms deHart's memo carefully, highlighting the key points that would need to be responded to, and jotting down key points for the rebuttal. That took about 4 hours total and in the process (b) (6) (b) (6) [redacted] but I would guesstimate 3 full days for a polished rebuttal.

Being a bit less flippant, I can get the rebuttal points I drew up in reasonable form for internal use by BPA in 1.5 days (probably)… maybe a little less. But I think we should talk about what is needed here… I sense an opportunity to do outreach to Columbia basin biologists by making one or more presentations that include as a first part an explicit response to Michelle's memo, and then use that to frame the urgency and gravity of the current situation, where current "*approaches to recovery*" are potentially seriously mis-aligned due to density-dependence in the freshwater life history and ocean survival rates being as low as they seem to be.

It may also be time for Kintama to do a science blog… or a Twitter Storm? But my sense is that is a lot of work for possibly little real movement. (to discuss).

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, January 11, 2019 12:46 PM
To: David Welch
Cc: Aswea Porter; Erin Rechisky
Subject: RE: Kintama Update to BPA (11 Jan 2019).pptx

Hi,

Thank you. This looks good

Our conference room is reserved until 2 but hopefully I can get in earlier just because the computer takes 2-3 minutes to boot up. Nobody is there after 3, so hopefully we could safely go a little late, however some participants might have to leave.

One additional thing – I just spoke to Jody. She asked for an estimate of time for you to write a line by line 'rebuttal' (but only to be given to BPA) of the FPC memo, for our greater understanding. We would add it to the contract because it would be new work. I brought up outreach and travel and mentioned that the ocean ecology conference.

FYI – there was one sentence in that memo that was like reverse projection or 'gaslighting' in that they were seeming to accuse your group of developing the 2-6% SAR goal.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, January 11, 2019 12:34 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Aswea Porter; Erin Rechisky
Subject: [EXTERNAL] Kintama Update to BPA (11 Jan 2019).pptx

Hi Christine—

I am attaching a copy of the update for you, in case the WebEx link does not work. If you want to go through the presentation prior to the meeting, please press F5 to view the slides and use the space bar to step through it… there are a few slides (esp. the final one) where we have animated the steps so that we can work through the concepts with your group (I hope!).

Erin and I will log on a few minutes before 2, as I am unsure whether the audio will work or I will have to call your mobile and use your speakerphone.

Thx, David

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Feb 01 10:49:57 2019

To: Erin Rechisky; David Welch

Subject: RE: contract

Importance: Normal

Hi,

Rachel says we should move the start date up because she cannot write a 'pre-award' letter to a technical services contractor promising that we will cover invoices over the period before the contract is signed (they can do this with some state agencies). It is best to try to put it together soon. I need to ask how quickly she thinks she could possibly get the contract out. I also need to get a stamp of approval from Kristen Jule.

Christine

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Friday, February 01, 2019 10:31 AM
To: Petersen,Christine H (BPA) - EWP-4; David Welch
Subject: [EXTERNAL] RE: contract

I prefer Feb 1, if possible. For 3 reasons: I've just written in the last status report (in many fields) that the project is continuing under a new contract ending Feb 1, 2019. I plan to finish the budget and SOW this morning, and we will continue to work on the contract during the next 10 days.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: February 1, 2019 10:24 AM
To: David Welch
Cc: Erin Rechisky
Subject: RE: contract

I think we also have to move the start date up from Feb 1. Rachel Kulak prefers this to post-dating a contract. I am hoping she can get it out very quickly though. Should we set Feb 10?

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, February 01, 2019 10:21 AM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] Re: contract

Should be able to. I am going to be in at 10:30 and will discuss with Erin then

David Welch

M: [redacted]

Kintama Research Services

Sent from my iPhone

On Feb 1, 2019, at 9:53 AM, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

Do you have time this morning to make progress with the contract?

One change I made was to add a blank for the suggested or preliminary title for the second paper, and a superficial description of contents of the expected draft. I also copied over the paragraph declaring independence of your staff as scientists.

Christine

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Feb 01 15:33:33 2019

To: Erin Rechisky; Scranton,Russell W (BPA) - EWP-4; David Welch

Subject: Coordinated assessments

Importance: Normal

Hi Russ,

Could you briefly describe the issue with the SARs data from CSS tagged fish not ending up in the Coordinated Assessments? You referred to this earlier this week. The Kintama staff were asked to expand on points raised by FPC and anyone else in initial public discussions of the paper. I had a hard time getting SARs (with me interfacing with the database manager, rather than Erin or David), because they said that it would amount to hundreds of separate species x year queries. We had offered to simplify the request for it has been on the back burner for over a year now.

Part of the critique of the study is which hatchery data sources are used, comparing CWT and PIT based SAR estimates so they would like to talk about what data they had access to and the choice they made

Also – I wanted to share the two Seattle Times climate change articles from this week [hopefully this doesn't end up behind a pay wall for you]

https://www.seattletimes.com/seattle-news/environment/washington-state-to-regulate-federal-dams-on-columbia-snake-to-cool-hot-water-check-pollution/ (Ritchie Graves is always reasonable at NOAA regulatory branch) https://www.seattletimes.com/seattle-news/environment/starfish-slaughter-along-west-coast-imperils-biggest-starfish-of-all-as-oceans-warm/

Christine

From: David Welch

Sent: Fri Mar 08 16:30:45 2019

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] Re: Energy news

Importance: Normal

Thanks... I can see it now (had to wait for the ferry to move past a dead zone on the crossing to access the link).

I think it is very well worded and quite balanced. (Didn't know that ODFW had apparently issued a critique of our recommendations as well...I will try to track that down).

I think our next few papers will fill in the gap people are mentioning about (a) how the ocean impacts can be formally brought into the management mix for BPA and (b) why the density-dependent processes are neutralizing much of the FW habitat interventions that are currently underway.

Have a good weekend and enjoy the cross country skiing if you can!

d

David Welch
M: [redacted]
Kintama Research Services
Sent from my iPhone

On Mar 8, 2019, at 3:11 PM, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

Can you access this link for Clearing up?

Greg Ruggerone is on the council. They changed the focus towards advocating for more ocean research funding, which Greg would certainly support. With his density dependence work, I suspect he wouldn't doubt your results.

http://www.newsdata.com/cgi-bin/viewpdf.cgi?iss=cup1889&cid=IFJrjXxjxeiQ

Christine

From: Kulak,Rachel A (BPA) - NSSP-4

Sent: Tue Mar 19 14:41:04 2019

To: 'David Welch'

Cc: Petersen,Christine H (BPA) - EWP-4; F&W Support Group; Erin Rechisky; Saway,Wesley J (BPA) - NSSF-4

Subject: Bonneville Contract No. 81498

Importance: Normal

David,

Good afternoon. This e-mail is to notify you that Stephanie Green is replacing me as the Contracting Officer assigned to this award. All future correspondence regarding this contract should be directed to Stephanie. She can be reached by phone 360-418-2710, or by email at sagreen@bpa.gov.

Thanks,

Rachel Kulak

Contracting Officer | NSSP-4

Bonneville Power Administration
bpa.gov | P 503-230-5091 | C(b) (6) [redacted]

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From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, February 14, 2019 10:14 AM
To: Sheidler,Tybee A (CONTR) - NSSP-4; Erin Rechisky
Cc: Kulak,Rachel A (BPA) - NSSP-4; Petersen,Christine H (BPA) - EWP-4; F&W Support Group
Subject: [EXTERNAL] RE: Bonneville Contract No. 81498 - 1996-017-00 EXP SURVIVAL IN LARGE WESTERN RIVERS

Please find attached our signed contract page.

Kind regards,

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

755 Terminal Ave N, Nanaimo BC V9S 4K1 Canada

Office: (250) 729-2600 Mobile: [redacted]

Skype: david.welch.kintama

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: **http://kintama.com/media/videos/**

P Please consider the environment before printing this e-mail

From: Sheidler,Tybee A (CONTR) - NSSP-4 [mailto:tasheidler@bpa.gov]
Sent: Monday, February 11, 2019 2:20 PM
To: Erin Rechisky
Cc: Kulak,Rachel A (BPA) - NSSP-4; Petersen,Christine H (BPA) - EWP-4; F&W Support Group; David Welch
Subject: Bonneville Contract No. 81498 - 1996-017-00 EXP SURVIVAL IN LARGE WESTERN RIVERS

Hello,

Enclosed for your review and acceptance are the subject Contract documents. Please review the documents and if acceptable, sign and promptly return one fully executed copy of the signature page to me via E-mail.

Christine Petersen is the Contracting Officer's Representative (COR) for this contract. You may contact her at (503) 230-4965, email: chpetersen@bpa.gov .The attached appointment letter designates her as COR and describes her delegated authority in detail.

Should you have any questions, please do not hesitate to contact me or the Contracting Officer, Rachel Kulak at rakulak@bpa.gov or (503) 230-5091.

Regards,

Tybee Sheidler
(ContR) Aerotek

Contract Acquisition Specialist/Administrator 2 | NSSP

Bonneville Power Administration
tasheidler@bpa.gov | P 503-230-3820

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From: Erin Rechisky

Sent: Wed Mar 20 09:23:59 2019

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] Automatic reply: Your abstract has been accepted!

Importance: Normal

Hello-

I will be out of the office until March 22nd.

For urgent matters, please contact David Welch (david.welch@kintama.com).

Kind regards,

Erin

From: David Welch

Sent: Wed Mar 20 09:24:56 2019

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Your abstract has been accepted!

Importance: Normal

Hi Christine—

I am just back in the office as well. Is this a good time to call? (I have meetings from 10-2), but open outside of that.

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, March 20, 2019 9:24 AM
To: David Welch
Cc: Erin Rechisky
Subject: RE: Your abstract has been accepted!

Hi,

I am back in the office.

Will you be able to give us what you have for the FPC memo review or response this week or fairly soon? Greg said he is trying to put materials together for someone else to start drafting an outline of studies available for the next biological Opinion. Primarily, we are giving them your paper in-review.

How is everything going with the conferences coming up soon?

Thanks

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, March 07, 2019 6:48 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] RE: Your abstract has been accepted!

Thanks, Erin and Aswea sent me back comments on the FPC response today, so I will work to incorporate those tomorrow.

Perhaps we could set up a time for a call (preferable in the morning , after 9 am)? I'm not sure what you mean by talking points.

d

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, March 07, 2019 2:55 PM
To: David Welch
Cc: Erin Rechisky
Subject: RE: Your abstract has been accepted!

Hi David and Erin,

Jody was able to inquire what was going on at Salmon Recovery. Apparently they really cut the number of panels, going from 3 days to 2, and 4 rather than 8 sessions. At least 50 speakers were turned down.

We definitely recommend going to the AFS in Bremerton. I'm glad you submitted your presentation there.

Jody was pondering the national AFS, but it is in Saint Louis (?). It would only be worth going to the national meeting if it is in a west coast location, when you tend to get a lot of salmon focus.

Let's see, how is everything else going lately? Will you have the talking points or response to the FPC critique?

Talk to you soon

Christine Petersen

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, March 07, 2019 1:09 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: FW: Your abstract has been accepted!

Hi Christine—

Just circling around on this. My paper has been accepted for an oral presentation at the AFS (WA-BC) AGM in Bremerton in April. I do think it would be good to shift the BPA funding support to my attendance at this meeting rather than having a poster presentation at the salmonid recovery symposium (they will likely put my poster in a dark corner in the basement, given the contrarian message that I am sending!)

However, that is a call for you and your colleagues to make.

Best, David

From: WA-BC Chapter of the AFS [mailto:no-reply@wa-bc.fisheries.org]
Sent: Thursday, March 07, 2019 8:25 AM
To: David Welch
Subject: Your abstract has been accepted!

Dear David,

On behalf of the 2019 WABC Chapter of the AFS Meeting Program Committee, I am pleased to inform you that your abstract submission has been accepted.

Oral presentations should be brought to the room you will present in (see program) to be uploaded each morning between **7:30 and 8:00 AM**. Poster presentations can be set up beginning **Tuesday, April 9 at 7:00 AM.**

The program committee is working to build the meeting program and the full schedule will be posted to the website soon. You can find more info and register at https://wa-bc.fisheries.org/2019-meeting/.

Early bird registration closes March 8, 2019 and can be accessed at the following link: https://wa-bc.fisheries.org/2019-meeting/registration/

We have included guidelines for presenters on our AGM website for both oral and poster presentations. Please visit https://wa-bc.fisheries.org/2019-meeting/program/guidelines-for-presenters/ for more information.

A block of rooms have been reserved at the Fairfield Inn & Suites and the Hampton Inn & Suites in Bremerton, WA at a special rate of $114.00 - $144.00 per night on a first come, first served basis. The room blocks close **March 11**. Accommodation information is available at: https://wa-bc.fisheries.org/2019-meeting/venue-accommodations/

Please contact us at afs.wabc@gmail.com if you have further questions.

We look forward to seeing you at the conference!

From: Petersen,Christine H (BPA) - EWP-4

Sent: Wed Mar 20 09:59:11 2019

To: David Welch

Importance: Normal

There are three previous papers (Hostetter, Paulsen/Fisher, Zabel 2005) that demonstrated evidence for size selectivity... but it is easy for policy people to have amnesia and only focus on the parties who speak the loudest – with more unbelievable claims. The comments on the Washington proposals for altering TDG rules and for holding hydrosystem responsible for maintaining temps under 68F frequently showed a claim from the same source that SAR would be 2-3X higher. That is straight from a set of talking points. But what if we do not see 2-3 X SARs, or the neutral or negative PDO emerging gets credited to spill?

https://www.biorxiv.org/content/biorxiv/early/2019/03/08/572594.full.pdf

From: David Welch

Sent: Sat Mar 30 19:11:16 2019

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE:] RE: revisions

Importance: Normal

Attachments: Reviewer #5 Comments (14 Jan 2019).pdf; PLoS ONE Decision Letter (14 January 2019).pdf; Response to FPC (29 March 2019).pdf

Hi Christine-

(b) (6) [redacted]

(b) (6) [redacted] **I am attaching the review comments, as well as my comments in response to the FPC memo. {Note—I completed this on the plane while on my flight back to Toronto Friday night—I intended to send it after my arrival, but am sending it Saturday afternoon instead!)**

As I noted last week when I first told you, despite the date on the decision letter, I never received notification that the PLOS ONE reviews were completed until I checked on the status last week. I think that the manuscript can be saved and re-submitted to a different journal, but I need to do two things: (a) Adopt a softer and more conciliatory tone, and not state or imply that there is a fisheries management crisis under way (that got the reviewers' backs up... note the lack of any comment on the cognitive dissonance issue nor the case studies on precisely this issue); (b) focus on reporting the data and making

the point that this is the official government SARs data collected at great cost. If almost all the time series show the same decline and to the same level, then it will require an amazing coincidence for the differences between the various SAR estimation techniques to yield the same result in recent years, which is essentially what the Fish Passage Center is claiming (without showing any proof in support of this thesis, I might add).

(b) (6) [redacted] **I will be back in the office by Wednesday noon, but call me anytime on my cell if you want to talk, including the weekend if need be. I should also have email access.**

David Welch

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, March 21, 2019 3:04 PM
To: David Welch
Subject:] RE: revisions

Hu, Jody Lando will be out next week, although possibly in tomorrow. She suggested something the week after where you could tell us what you are thinking about next steps, if that will influence your work on the second paper and the contract etc. I relayed some of what you said, where a reviewer suggested rhere should be a null hypothesis and statistical testing, while you were describing established patterns and moving into management implications. Jody said she would be both interested in the reviews if you're willing to share and the response to FPC point because it does help us talk about the data and main results. Our next Biological Assessment legal document starts very soon (only a one year gap). I gave Greg Smith a list of referencea including Neala Kendall's study that describe a productivity decline in various locations for different species.

Christine

Sent from Workspace ONE Boxer

On Mar 20, 2019 4:23 PM, David Welch <David.Welch@kintama.com> wrote:

Hi Christine—

Yes, absolutely. We should also discuss further about some next steps. I am tied up all o f tomorrow at UBC, but Friday is pretty open.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, March 20, 2019 3:38 PM
To: David Welch
Subject: revisions

Hi David,

Sorry, running out of time today. Would you like to talk to Jody Lando? She will be at the Salmon recovery conference and I think she might be helpful for thinking about or at least hearing about your potential next steps.

Christine Petersen

From: David Welch

Sent: Sun Mar 31 19:26:12 2019

To: Erin Rechisky

Cc: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] Re: ocean survival

Importance: Normal

Hi Christine-

I am back as of Wednesday noon. The rest of the week is pretty open for me. Given what you outlined from your schedule, it sounds like Friday might be the first time that will work for you.

Please advise what time might work for you.

David Welch
M: [redacted]
Kintama Research Services
Sent from my iPhone

On Mar 29, 2019, at 8:04 PM, Erin Rechisky <Erin.Rechisky@kintama.com> wrote:

> Hi Christine,
>
> They put a link to an article referring to our 2008 PLOS paper of which Carl was a co-author.

Unfortunately, the recent paper we submitted to PLOS was rejected. So we have to revise the paper for another journal and take into account the reviewers comments. This may extend the timeline for the SAR paper, and likely the survival rate paper. David can update you. He's en route to Toronto at the moment.

The commentary to the FPS was largely complete but I advised David to change the tone a bit, which is a challenge given the harshness of Michelle Dehart's review. We had also received the reviewers comments from the journal at that time so I think David wanted to re-think parts of the commentary.

Also, we've been incredibly busy over the past couple of weeks with proposals and meetings regarding Chinook and southern residence killer whales studies.

Let's touch base next week if we need to talk about timelines.

Have a good weekend,

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: March 29, 2019 4:23 PM
To: David Welch; Erin Rechisky
Subject: ocean survival

Hi,

Here is an interesting Seattle Times article. They refer directly to your study but somehow Carl Schreck is being highlighted as a coauthor. I don't know what to make of that, because either they found this press release, or they decided that OSU and USGS are reputable organizations?

https://www.seattletimes.com/opinion/salmon-and-dams-can-coexist/

Anyway, I wish you good luck at the conferences next week. Jody Lando will be at Salmon Recovery. Next week (b) (6) [redacted] she wanted to touch bases about next steps for the paper, progress on what you're doing right now (could doing a revision change your timeline?). Also, for our Biological Assessment process for 2020 which starts right away as the 2018 Biological Opinion is released, we would like to see your commentary on the FPC review. Jody was interested in what the major sticking points in the review at PloS.

I am out next Wednesday looking at NOAA's flexible PIT detection cable, and Thursday has an EIS meeting in the early part of the day. Would there be a good time to suggest for a check in?

Christine Petersen

From: Petersen,Christine H (BPA) - EWP-4

Sent: Tue Apr 02 14:40:09 2019

To: David Welch

Subject: RE: revisions

Importance: Normal

Sorry for the delayed response. My family has an element of the same thing- [redacted]

Thank you for the materials. Jody is catching up from being out last week. You undoubtedly will cross paths at Salmon recovery conference but maybe if we grabbed some time friday, we could have a better discussion. Late Thursday might work too but I have to check. I will forward these and see if Jody has a preference. Kristen Jule, Anne or Katie Mcdonald could also be optional.

Christine

Sent from Workspace ONE Boxer

On Mar 30, 2019 7:11 PM, David Welch <David.Welch@kintama.com> wrote:

Hi Christine-

I am sorry, I lost track of this—(b) (6) [redacted] (b) (6) [redacted] (b) (6) [redacted] am attaching the review comments, as well as my comments in response to the FPC memo. (Note—I completed this on the plane while on my flight back to Toronto Friday night—I intended to send it after my arrival, but am sending it Saturday afternoon instead!)

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David Welch

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Sent: Thursday, March 21, 2019 3:04 PM

To: David Welch
Subject:] RE: revisions

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David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, March 20, 2019 3:38 PM
To: David Welch
Subject: revisions

Hi David,

Sorry, running out of time today. Would you like to talk to Jody Lando? She will be at the Salmon recovery conference and I think she might be helpful for thinking about or at least hearing about your potential next steps.

Christine Petersen

From: David Welch

Sent: Mon Apr 15 11:26:06 2019

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Clearing Up, Issue 1897

Importance: Normal

Hi Christine—

Thanks for this. I am going to try calling in a minute, on the chance that you are free to take a call—it is probably easier to discuss than email on how to get the required data out of the FPC. The big issue for me is (in the very near term) is to get the full survival estimates so that we can revise the manuscript and remove this possible criticism from the point that we are comparing "apples and oranges" . However, it is also clear that the FPC will always argue this because the data doesn't support their beliefs, so the other part of this is to actually have written, documentary proof that we tried to get this and they have failed to pony up the data needed to do so. (At this point I would probably prefer to just take the latter path, get the key data out& published, and then revise and refine in future publications—we obviously aren't going to convert everyone overnight with one paper.

I couldn't find a quote about evaluating the undammed question. Can you give me a quote from the webpage so that I know what to search for? (undam, un-dam, and Inslee turned up nothing).

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, April 15, 2019 8:10 AM
To: David Welch
Subject: Clearing Up, Issue 1897

Hi David

Sorry for the delayed response.

I am glad everything went well at the meetings. I have to go through abstracts for both of those.

Last time I went over the SAR request with Fish Passage Center, they seemed ro be saying that it involved gundreds or thousands of individual estimates and would take them months.

Are you able to point to a set of species and locations that are of highest importance, or should we ask for all of it? I could ask dor it eight now, and then next week they have their annual presentations. I could reinforce the request during the break.

I am forwarding this link in order ro highlight the Washington state politics in the fish column. Jay Inslee is running for president. He has less baggage than many other candidates but his climate change policies are still a little vague, and they tend to be stalling or indecisive about lower Snake dams. See the quotes about how no one has evaluated the undammed survival question before, and they already plan to set the environmental impact statement aside.

Christine

Sent from Workspace ONE Boxer

---------- Forwarded message ----------
From: NewsData LLC <dispatch@newsdata.com>
Date: Apr 12, 2019 6:31 PM
Subject: [EXTERNAL] Clearing Up, Issue 1897
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Cc:

Click this link for this week's issue of Clearing Up:

http://www.newsdata.com/cgi-bin/viewpdf.cgi?iss=cup1897&cid=IFJrjXxjxeiQ

PUBLISHER'S NOTE: We encourage you to check out NewsData Meter Readings, a new curated collection of high-quality relevant energy coverage from other reliable sources (regionally and nationally) delivered via email to all Clearing Up subscribers every Wednesday morning. It replaces the former Clips section.

You can also paste the link into your browser's address box and press Enter (or Return). The issue should appear after a moment.

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From: Petersen,Christine H (BPA) - EWP-4

Sent: Wed Apr 24 15:14:19 2019

To: David Welch

Subject: Report - Survival estimates for the passage of spring-migrating juvenile salmonids through Snake and Columbia River dams and reservoirs, 2018

Importance: Normal

Attachments: Widener.et.al.2019 Spring Survival 2018 Report.pdf

Thank you. I'm attaching the NOAA survival report, which has some hatchery-to-LGR tables at the end.

We were at the Comparative Survival study presentations today. The most melodramatic portion was Ed Bowles, the head of ODFW giving an ebullient statement about how the science is now settled and CSS is now uncontested? (Julie had a remark about them always playing on their turf and no away games). There wasn't that much new but they are adding some upper Columbia stuff using the same spill formulation for those PUD dams, even though they are structurally quite different, without the same type of spillway vs bypass.

From: Andrianna Jutt - NOAA Federal [mailto:Andrianna.Jutt@noaa.gov]
Sent: Monday, April 22, 2019 2:30 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Daniel Widener; Jim (James) Faulkner; Tiffani Marsh (NOAA Federal); Steven G. Smith
Subject: [EXTERNAL] Report - Survival estimates for the passage of spring-migrating juvenile salmonids through Snake and Columbia River dams and reservoirs, 2018

Hello,

I am sending the attached cover letter and report on behalf of Dr. Richard W. Zabel, Director of the Northwest Fisheries Science Center's Fish Ecology Division.

Thank you,

Andrianna Jutt

Administrative Support

NOAA NWFSC Fish Ecology Division

206-860-3270 (phone) ~ 206-860-3267 (fax)

"The contents of this message are my personal opinions and do not necessarily reflect any position of NOAA or the U.S. Government."

From: David Welch

Sent: Wed Apr 24 15:54:20 2019

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] RE: Report - Survival estimates for the passage of spring-migrating juvenile salmonids through Snake and Columbia River dams and reservoirs, 2018

Importance: Normal

Thanks. My Ed Bowles study was from years ago when he was head(?) of fisheries at IDFG. I was asked to give a presentation on my DFO work on how the ocean could differentially affect different salmon stocks; this was back in 1998 when the "delayed mortality" issue was settled too (Ed had apparently given a speech at the Idaho AFS saying that science was settled a year earlier). DFO management balked at me giving the report to the State Senate Committee as "too political", but then backed off when the request was made to do the presentation at IDFG HQ in Boise.

Curiously, it seemed that most of the state senators showed up for my presentation there! I methodically laid out the evidence for differential ocean conditions along the west coast, and then showed the evidence that at least some stocks of salmon were occupying different parts of the coastal ocean. I vividly recall Ed sitting off to the side during my talk and then just burying his face in his hands when I got to about the 40% mark in the presentation… what he thought of as "uncontrovertible evidence" for delayed mortality in Snake River salmon stocks could quite easily also fit with the idea that different populations went to different locations in the ocean and then encountered different survival conditions there. We couldn't prove that of course (it wasn't technically possible at that time), but we could make a very plausible case for how the ocean could be causing the problems that people were blaming on the dams.

I then headed off to the Idaho Chapter of the AFS a few weeks later, and gave essentially the same talk. A few weeks later I found out they had awarded me the "best paper presented at the AFS chapter meeting" that year—just one year after the Idaho Chapter had voted ~90% in favour of taking out the Snake River dams!

I guess my point in relating this is that it is now 20 years on and Ed still seems very much enamored with the idea that only the dams can cause these problems!

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, April 24, 2019 3:14 PM
To: David Welch
Subject: Report - Survival estimates for the passage of spring-migrating juvenile salmonids through Snake and Columbia River dams and reservoirs, 2018

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Andrianna Jutt

Administrative Support

NOAA NWFSC Fish Ecology Division

206-860-3270 (phone) ~ 206-860-3267 (fax)

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From: David Welch

Sent: Mon Jun 03 13:15:53 2019

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Resubmittal

Importance: Normal

Hi Christine-

I drafted a response to you, but asked Erin to go over it before sending it to you. (b) (6) [redacted] (b) (6) [redacted] **so I probably won't get that response to you before tomorrow.**

However, here is the P.S. from that emailed response, since it doesn't involve science or budgets!

David

(b) (6) [redacted]

(b) (6)

[redacted]

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, June 03, 2019 11:53 AM
To: Erin Rechisky; David Welch
Subject: Resubmittal

Hi Erin and David

I trust you are both back… although it seems like this would be the height of the field season if you are doing anything around Vancouver Island with smolts this year.

Sorry, I was unable to attend the Ocean conference in Portland a couple of weeks ago. I saw that you had two presentations. Jody Lando said that she was able to talk with you there, and also at the Salmon Ecology meeting.

How are things going generally, and with the redrafting of the Coastwide SARs manuscript? I would not prompt us to have a check in meeting unless it were really warranted. It seems like the redraft could become quite elaborate, with a host of considerations to deal with.

Jody has expressed that in light of the upcoming Biological Assessment and Biological Opinions (the process starting over again for 2020, just a year after the last one was finished), she would strongly prefer that you focus all of your energies on trying to publish the SARs paper.

Does this make sense to you? From our viewpoint, you have to remember that we are thinking of your billable hours, although I understand that in reality, you might be slowly piecing things together amidst your other work and cannot exactly speed up one task by slowing your mental effort and data collection for the second time indexed survival paper.

Christine Petersen

From: David Welch

Sent: Tue Jun 04 12:08:54 2019

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] Re: Resubmittal

Importance: Normal

Attachments: Fig 2 FW_survivals.tif

Hi Christine—

Thanks for checking in.

Erin attended the Portland meeting and gave both our talks, as I was off on my long-planned dive trip. We have had more of our time occupied with getting logistics ready for this years' field work than I would like, but I am currently now back working full time on the SAR revision.

Perhaps after you read through this we can call you to discuss your thoughts:

1) On the BPA-funded work, I have switched to exclusively working on the SAR manuscript. I will not go back survival rate analysis & write-up until this is accomplished and back out to a reputable journal. (We will also need to identify a budget for that work, of course).

2) The revision to cut down the SARs paper by removing the management implications is the most straightforward issue…. Cutting is always faster than adding. This will still take a few weeks because two major criticisms of the reviewers were that (a) we were not sufficiently quantitative and (b) that we did not test a hypothesis. So we need to revise to address these criticisms—at this point I am not sure how much additional work this will be.

3) What is not clear-cut is whether we remove the literature review section containing the downstream freshwater (only) smolt survival data based on all published data (the original Fig. 2, attached). This received a torrent of criticism by a couple of reviewers. The part of the criticism that I think is valid is that we did not compare survival rates with time, only distance. However, the reason for that decision was because most other authors whose work we collated did not report travel time in their papers. I asked Erin to look into how much work it might be to go back and get the original data from the authors and extract travel times and she tells me that this will be "major". (She points out that there are about 129 survival estimates in the summary table we collated. For the majority, which lack published travel time information, we would need to get the original data from the authors, identify river mouth arrival time for each fish, subtract the release time, and then calculate the arrival time statistics.)

4) So it might be that it is best to exclude the freshwater survival comparison from this current paper to (a) keep within budget and (b) because to do it full justice we may need to expand the section quite a bit-- the analysis gets complex because of the different tag types. In addition, adding the California (Sacramento river) would give us an additional long river to compare with the Fraser & Columbia River basin data and also remove the criticism that we exclude California with its very poor freshwater survival

from the comparison. There are methods of addressing this, but let's discuss what is most important to address from your view—give me a time to call and we can discuss this. There is certainly a major published paper here, but it is going to be a battle to get it out over the (probably) heated objections of the FPC… see this Figure from my response to the FPC review that I sent BPA 6-8 weeks ago for my thinking and to frame a major paper around this—I am thinking we could add in all the other data sets we used in the current manuscript to flesh out this initial version.

California vs Columbia Survival Comparison.png

Text Box: Figure 4. Comparison of freshwater and marine survival estimates reported by Michel (2018) with the Columbia River survival estimates. The Columbia's SAR values are much more strongly determined by poor marine survival and much better freshwater survival than the California case reported by Michel (2018).

5) You mentioned "? From our viewpoint, you have to remember that we are thinking of your billable hours,"**. I'm not sure of the meaning here. Do you just mean to say that you are concerned that we stay within budget? Or are you concerned about us getting things published and the timeline to do so? Please advise.**

Thanks, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, June 03, 2019 11:53 AM
To: Erin Rechisky; David Welch
Subject: Resubmittal

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Christine Petersen

From: David Welch

Sent: Wed Jun 12 16:45:57 2019

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] FW: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble

Importance: Normal

Attachments: ICUA Annual Meeting Registration Packet (revised 061219).pdf

Christine—

This is the meeting that I have been asked to speak at in Idaho… they are blocking off 1 hr & 15 minutes for me and putting me in the speaking slot just prior to the Chief of Staff for Congressman Simpson as a result of learning about the SARs paper. (Kurt Miller, the new Exec. Director of NW RiverPartners, heard Erin speak at the Portland meeting in May, and this is what generated the sudden interest).

I had not realized that BPA is playing as prominent a role in this meeting as they are portrayed below (Elliot Mainzer is speaking just before lunch). It might be a good idea to run the prominence of my presentation up the chain of command at BPA so that no one is blindsided; it is pretty clear that if they think our views have credibility this group will want to be pushing for answers to the issues I will raise. People may therefore turn to BPA senior managers at the meeting and publically ask whether they think our views are

credible and, if so, how BPA is going to deal with the questions we raise.

I am happy to give BPA the presentation when done, but that won't be until July, because I am juggling that, the SARs paper revision, and a number of other unrelated tasks. A good chunk of what I will outline in Idaho will concern why the region may have chosen the fundamentally wrong conservation approach 5 decades ago, and never really recognized this. As a result, I have to prepare this material in a way that it has never been presented before and it is going to take some time; I can't just steal from some of our past presentations for a good chunk of what I will discuss. I can, of course, send versions of the outline along as we refine the presentation.

David

From: Will Hart [mailto:icuaregister@gmail.com]
Sent: Wednesday, June 12, 2019 3:09 PM
Subject: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble

An updated Annual Meeting agenda is attached.

Reminders...

- Please be sure to complete registrations and golf sponsorships
- Hotel reservation deadline is ***Monday, June 17***
- Note Golf Scramble Time Change – 10:00a.m. Shotgun Start

Registration Information at: https://icuaregistrationadmin.wufoo.com/forms/icua-bpa-registration-july-1012-2019/

We are very excited to invite you to attend the *combined* 2019 Idaho Consumer-Owned Utilities Association Annual Meeting/Conference and 2019 BPA Annual Customers' Meeting. ICUA and BPA are coming together again July 10-12, 2019 in beautiful Boise, Idaho, to provide a meeting you do not want to miss!

Our agenda is packed with top BPA executives and staff, state political leaders, and representatives from the Idaho congressional delegation – all gearing up to provide you with insightful, useful, and important tools and information to benefit your utilities and the consumers/members you serve. In addition, many utility industry vendors and regional public power industry leaders will be on hand with whom you will be able to meet, network, and socialize.

Located in the heart of downtown Boise, this year's conference is being held at The Riverside Hotel - just steps away from the Boise River, dining, culture, and nightlife. You will find all of the conference registration materials attached to this email along with the hotel contact information. Please note that you will need to secure your hotel reservations by calling the hotel directly.

Last, but certainly not least, please do not miss out on the fun and comradery of the ICUA Annual Golf Scramble (*event held day before conference -not affiliated with BPA meeting*). We will be playing again this year right along the Boise River at the picturesque Warm Springs Golf Club located just minutes from our conference hotel.

We look forward to having you join us in July. Please register for this valuable conference soon.

Sincerely,

Will Hart

Executive Director, ICUA

https://icuaregistrationadmin.wufoo.com/forms/icua-bpa-registration-july-1012-2019/

ICUA ANNUAL MEETING

IDAHO CONSUMER-OWNED UTILITIES ASSOCIATION

July 10, 2019 *Wednesday*	
10:00am - 3:30pm	15th Annual PAC Fund Golf Scramble Warm Springs Golf Course - Boise, Idaho (additional information attached) 8:00am - 9:30am - Registration 10:00am - Shotgun Start

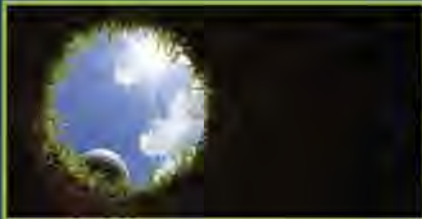
ICUA Annual Meeting & BPA Customers' Annual Meeting
Agenda *(Tentative)*
July 11-12, 2019
The Riverside Hotel - Boise, Idaho

July 10, 2019 *Wednesday* - The Riverside Hotel	
2:00pm - 7:00pm	Associate/Exhibitor Setup (Fireplace Foyer)
6:00pm - 8:00pm	Opening Reception: *Sponsored by - Idaho Falls Power* (River's Edge Terrace)
July 11, 2019 *Thursday* - The Riverside Hotel	
7:00am - 11:00am	Member and Affiliate Registration (Convention Center Lobby)
7:00am - 7:00pm	Exhibit Area Open to all Members (Fireplace Foyer)
7:15am - 8:00am	Breakfast: *Sponsored by CFC* (Laurel) *Russell Green, Regional Vice President - CFC* *Bob Boren, NCSC Board of Directors*
8:10am - 8:20am	Welcome and Introductions (Juniper) *Will Hart, Executive Director, Idaho Consumer-Owned Utilities Association*
8:20am - 9:00am	Succession Planning (Juniper) *Leigh Taylor, MBA, CCXP, Executive Search/NRECA*
9:00am - 9:15am	NRTC Update (Juniper) *Chris Bradley, Regional Business Manager, NRTC*
9:15am - 10:00am	State ESA and Salmon Recovery Panel (Juniper) *Scott Pugrud, Director, Idaho Office of Species Conservation* *Jeff Allen, Council Member, NWPCC*
10:00am - 10:15am	**Break**
10:15am - 11:00am	Federal Energy Update (Juniper) *Mitch Silvers, State Natural Resource Director- US Senator Mike Crapo* *Mike Mathews, State Director - US Senator Jim Risch* *Dirk Mendive, Regional Director - US Representative Russ Fulcher* *Nikki Wallace, District/Communications Director - US Representative Mike Simpson*

(cont'd...)

July 11, 2019 *Thursday (...cont'd)* – The Riverside Hotel	
11:00 – 11:25	Ruralite Update (Juniper) *Mike Shepard, CEO, Pioneer Utility Resources*
11:25 – 12:00	BPA: State of the Agency (Juniper) *Elliot Mainzer, Administrator BPA*
12:00–1:00pm	**Lunch**: Scott Corwin – What NWPPA does for Public Power *Sponsored by CoBank – John Donner, Vice President* (Laurel)
1:00pm–2:00pm	BPA: Regional Issues including; Joining an EIM, "What it Means to BPA and its Customers," Value of Lower Snake Projects to the FCRPS and Spill Test Outcomes (Juniper) *Elliot Mainzer, Administrator, BPA and Michelle Manary, CFO, BPA*
2:00pm – 3:15pm	Coast-Wide Survival of Salmon and Steelhead, Problems are Primarily Ocean-Related, Yet We Continue to Focus on the Wrong Problems *Introduction by: Kurt Miller, Northwest River Partners* *Presentation: Dr. David Welch, CEO, Kintama*
3:15pm–3:30pm	**Break**
3:30pm–4:30pm	"Rewriting the Northwest Power Act" (Juniper) *Lindsay Slater, Chief of Staff, Congressman Mike Simpson*
5:00pm–6:00pm	*Optional* "Small Modular Reactor participation – A customers' perspective (Quiet Bar) *Bear Prairie, GM Idaho Falls Power (casual Q&A session with refreshments provided)*
6:30pm – 7:00pm	**Reception**: *Sponsored by Federated Rural Electric Insurance* (Fireplace Foyer and Terrace)
7:00pm – 9:00pm	**Banquet and Live & Silent Auctions**: *Sponsored by Federated Rural Electric Insurance* (Laurel) Banquet Speakers: *Bear Prairie, President, Idaho Consumer-Owned Utilities Association* *"State of the Association"* *Will Hart, Executive Director, Idaho Consumer-Owned Utilities Association* *"In Appreciation of Our Sponsors"*

July 12, 2019 *Friday* – The Riverside Hotel	
7:30am–8:30am	**Breakfast** (Laurel)
8:30am–11:00am	ICUA Business Meeting (separate agenda) (Juniper)
11:00am–11:30am	Co-op Association Business Meeting (separate agenda) (Juniper)
11:30am–12pm	Snake River Power Business Meeting (Juniper)
12pm	Adjourn



ICUA PAC Fund
GOLF SCRAMBLE

IDAHO CONSUMER-OWNED UTILITIES ASSOCIATION

The 15th Annual PAC Fund Golf Scramble is an excellent opportunity to enjoy a round of golf while networking with vendors, elected officials, and utility representatives. In the coming months and year, many important issues will be before Congress and the Idaho legislature that directly affect our members/consumers. The funds we raise during this Golf Scramble help ICUA actively engage in the political process at the state and federal levels to promote our mission of safe, reliable, and affordable power for our members/consumers. Your support in the 15th Annual PAC Fund Golf Scramble helps make all of this possible!

Teams of 4 - Registration fees include 18 holes, cart, boxed lunch & 2 drink tickets, 2 mulligans, 2 throw-its, 2 magic putts. Contact golf course directly for club rentals. Proceeds go toward ICUA Political Action Committee (PAC) fund.

15th Annual PAC Fund Golf Scramble - Wednesday, July 10, 2019

Warm Springs Golf Course
2495 W Warm Springs Ave, Boise ID 83712
208-343-5661
warmspringsgolfcourse.com

8:00am - 9:30am	Registration
10:00am	Shotgun Start
10:00am - 5:30pm	Golf Scramble

Sponsorships

A $500 golf hole, lunch, or drink sponsorship includes:

- Signage with your company's name and/or logo displayed at the tee box of the hole you sponsor or, in the case of a lunch or drink sponsorship, at the registration table.
- Recognition in the Annual Meeting Program and during the Annual Meeting Banquet and Auction.

Auction - Thursday, July 11, 2019

The Riverside Hotel
2900 W Chinden Blvd, Boise ID 83714
208-343-1871
riversideboise.com

We encourage you to bring an item for our exciting live and silent auction during the banquet.

2019 Registration

ICUA Annual Meeting

July 10-12, 2019 - The Riverside Hotel, Boise, Idaho

15th Annual PAC Golf Scramble

July 10, 2019 - Warm Springs Golf Course, Boise, Idaho

Registration Information * (Required Fields) ***Separate registration for each attendee***

First* ______ Last* ______ Company ______

Title ______ Email * ______

Company Contact Information*

Phone ______

Address ______

Address Line 2 ______

City, State, Zip ______

Meeting Registration (July 10-12, 2019) * *See agenda for details*

☐ ICUA Annual Meeting ($200)

☐ Vendor ($200) ***Reserve an Exhibit Table?*** ☐ Yes ☐ No

☐ Spouse/Guest Banquet Only ($70) **Meeting Registration Amount*** **$** ______

ICUA PAC Golf Scramble Registration (July 10, 2019)

Proceeds go to ICUA Political Action Committee (PAC) fund

☐ $65 per golfer X ______ golfers = **Golf Registration Amount*** **$** ______

Golfer's Home Address *(required for PAC reporting)*

Home Address ______

City, State, Zip ______

Preferred Teammates/ ______

Additional Information: ______

ICUA PAC Golf Sponsorships (Check all that apply)

☐ Golf Hole ($500) ☐ Drink ($500) - *only 2 available* ☐ Lunch ($500) - *only 2 available*

Sponsorship Amount* **$** ______

(Enter total due from above: meeting registration, golf registration, sponsorship amounts) **Total Due*** **$** ______

Payment Methods:

Make Checks Payable to: ***ICUA***

Mail check along with registration to:

Clearwater Power Company

Attn: ICUA Registrations

PO Box 997, Lewiston ID 83501

OR

Register Online and Pay by Credit Card at:

https://icuaregistrationadmin.wufoo.com/forms/icua-bpa-registration-july-1012-2019/

HOTEL

The Riverside Hotel
2900 W Chinden Blvd
Boise Idaho 83714
Tel: (208) 343-1871
riversideboise.com

Hotel Reservation Deadline: June 17, 2019
Rate: $93 Single Occupancy and $108 Double Occupancy

Complimentary ground transportation is available from the airport. Please use the shuttle phone located by the baggage claim area in the airport terminal. Please allow for 15-30 minutes travel time once your call is received.

GOLF TOURNAMENT

Warm Springs Golf Course
2495 W Warm Springs Ave, Boise ID 83712
208-343-5661
warmspringsgolfcourse.com

PAYMENT METHODS

Make Checks Payable to: ***ICUA***
Mail check along with registration to:
Clearwater Power Company
Attn: ICUA Registrations
PO Box 997
Lewiston, ID 83501

OR

Register Online and Pay by Credit Card at:
https://icuaregistrationadmin.wufoo.com/forms/icua-bpa-registration-july-1012-2019/

CONTACTS

Will Hart, ICUA Executive Director
whart@icua.coop
Idaho Consumer-Owned Utilities Association
PO Box 1898 Boise, ID 83701
Phone: 208-344-3873

Registration Information:
icuaregister@gmail.com

From: David Welch

Sent: Wed Jun 12 19:50:59 2019

To: Ben Zelinsky

Subject: [EXTERNAL] Fwd: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble

Importance: Normal

Attachments: image001.png; ATT00001.htm; ICUA Annual Meeting Registration Packet (revised 061219).pdf; ATT00002.htm

Hey Ben—

Ordinarily I would let this percolate up from Christine's side, but given the nature of the meeting I am attending (and BPA's role being much more prominent than I had originally thought when I had accepted the speaking invitation), I am passing this on to you privately to ensure that Elliot Mainzer and other senior folk don't get blind sided by what I will be saying.

In essence, what I will be outlining on the salmon conservation issues is what I would have said to Elliot and you if we had ever gotten together as discussed this spring. I am just preparing this now, so as I note below it is not ready for prime time sharing as yet. I am, however, happy to keep you (and others) in the loop on this as we develop the presentation. Basically, I am going to be completely diplomatic and uncontroversial, and simply say that the region diagnosed the salmon problem wrong half a Century ago and has been going down the wrong path ever since. □. I will take the sting out of those words by saying salmon biologists everywhere else are wrong too.

As I say, happy to provide as much of this material as I develop it as needed. Just handle this email carefully because I don't want to put my COTR's nose out of joint and have her think I went behind her back because I didn't trust her. (I've just that I have ended up in exactly that situation too many times in the past to want to trust to The Fates!).

[redacted]

d

David Welch, Kintama Research
Tel: +1 (250) 729-2600 x223
Cell: [redacted]
Sent from my iPad

Begin forwarded message:

From: David Welch <David.Welch@kintama.com>
Date: June 12, 2019 at 16:45:57 PDT
To: "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
Cc: Erin Rechisky <Erin.Rechisky@kintama.com>
Subject: FW: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble

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David

From: Will Hart [mailto:icuaregister@gmail.com]
Sent: Wednesday, June 12, 2019 3:09 PM
Subject: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble

An updated Annual Meeting agenda is attached.

Reminders...

- Please be sure to complete registrations and golf sponsorships
- Hotel reservation deadline is ***Monday, June 17***
- Note Golf Scramble Time Change – 10:00a.m. Shotgun Start

Registration Information at: https://icuaregistrationadmin.wufoo.com/forms/icua-bpa-registration-july-1012-2019/

We are very excited to invite you to attend the *combined* 2019 Idaho Consumer-Owned Utilities Association Annual Meeting/Conference and 2019 BPA Annual Customers' Meeting. ICUA and BPA are coming together again July 10-12, 2019 in beautiful Boise, Idaho, to provide a meeting you do not want to miss!

Our agenda is packed with top BPA executives and staff, state political leaders, and representatives from the Idaho congressional delegation – all gearing up to provide you with insightful, useful, and important tools and information to benefit your utilities and the consumers/members you serve. In addition, many utility industry vendors and regional public power industry leaders will be on hand with whom you will be able to meet, network, and socialize.

Located in the heart of downtown Boise, this year's conference is being held at The Riverside Hotel - just steps away from the Boise River, dining, culture, and nightlife. You will find all of the conference registration materials attached to this email along with the hotel contact information. Please note that you will need to secure your hotel reservations by calling the hotel directly.

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We look forward to having you join us in July. Please register for this valuable conference soon.

Sincerely,

Will Hart

Executive Director, ICUA

https://icuaregistrationadmin.wufoo.com/forms/icua-bpa-registration-july-1012-2019/

From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Jun 13 09:01:41 2019

To: Jule,Kristen R (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4; David Welch

Subject: check in call

Importance: Normal

Attachments: ICUA Annual Meeting Registration Packet (revised 061219).pdf

- (b) (2) [redacted] (internal)
- (b) (2) [redacted] (external)
- (b) (2) [redacted]oll free)

Call ID: (b) (2) [redacted]

I am updating to give us more time to talk, and also attaching the ICUA agenda that David received. This meeting will have major BPA participation.

Anyone else to invite?

From: David Welch

Sent: Thu Jun 13 09:06:34 2019

To: Petersen,Christine H (BPA) - EWP-4

Subject: Accepted: check in call

Importance: Normal

You might ask Ben Zelinsky.

Tell him that the talk I will be preparing for Idaho will be essentially the same one that I would have given to Elliot Mainzer if Ben's earlier plans this spring had gone forward to have a few different people give Elliot their perspectives on where salmon conservation needs to go.

From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Jun 13 09:10:09 2019

To: David Welch

Cc: Erin Rechisky

Subject: RE: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble

Importance: Normal

Hi

Yes – they will definitely want to know. I hadn't heard of the ICUA but the BPA customers' meeting is prominent (and totally not my area. I have no idea what they talk about there). You are independent so I am not sure if it will come across like a 'BPA' presentation that Elliot Mainzer should already be familiar with. I will need to have Peter Lofy, Kristen Jule, or Jody Lando run that up the chain, so to speak, and see what people are saying. After all, you have already had some press and several public presentations at scientific meetings. And the staff of that meeting are clearly indicating something by inviting you. I wonder if it would come across as though BPA had been the ones to put you on the agenda. Anyway, more later.

Christine

From: David Welch [mailto:David.Welch@kintama.com]

Sent: Wednesday, June 12, 2019 4:46 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] FW: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble

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https://icuaregistrationadmin.wufoo.com/forms/icua-bpa-registration-july-1012-2019/

From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Jun 13 13:07:50 2019

To: David Welch

Cc: Erin Rechisky; Aswea Porter

Subject: RE: Accepted: check in call

Importance: Normal

Hi,

Okay – earlier this morning I was working from my cell phone while in the monthly operations meeting where they spent about an hour on the topic of tribes being permitted to sample steelhead at the Bonneville ladder for adding PIT tags when temperatures exceed 21C (NOAA says no).

I was just able to talk to Ben Zelinsky, who didn't initially think there would be a big issue for you being on the same agenda, but luckily he will be able to talk to Peter Cogswell (our previous Fish and Wildlife leader who works with Elliot Mainzer), I suspect that they might want to brief him on background and main points. And we also have our call scheduled tomorrow.

We have previously discussed extensively how we regard you as independent scientists; my only recommendation would be to let your data speak for itself. If people understand the time trends occurring at all of these hatcheries and traps, the main points will easily come across. Also, set the context that other studies have been finding similar results.

A month or two ago, the announcement by Rep Simpson was being circulated. It reflects a lot of the same thinking and debates that government in Washington and Oregon has been going through with deciding to endorse the spill tests that require suspending the EPA limit on TDG. They are hearing very vocal advocacy and thousands of public comments that reflect two very different versions of science. How can you decide who to trust. The policy and management areas are quite a minefield. With your work, you have always (rather appropriately) held back from concluding ***why*** SARs are tending downwards, and I wonder if you will be asked "okay, if the decline is in the ocean, what can we do about it). Also, mention that you are Canadian (you have a light Canadian accept that is a bit different from Seattle area. Actually, my cousins in Las Vegas just pointed out that I have an accent, that I cannot hear myself).

https://www.columbiariverkeeper.org/news/2019/5/idaho-congressman-questions-snake-river-dams

https://www.spokesman.com/stories/2019/apr/25/congressman-mike-simpson-says-hes-determined-to-se/

I perceive that there are very different camps in Idaho and eastern Washington and Oregon. This writer for the Seattle Times who typically does thoughtful work was stereotyping a western vs eastern Washington mindset, or democrats vs republicans. This is either not true or barely true. Judd is also not questioning that the Snake Dams have a very large deleterious effect, but just saying that it could be populist to consider the positions of farmers. There are major contingents in Idaho who consider themselves on the short end of the stick and are frustrated that they don't know what will help, so this organized campaign seems to promise the best results??

https://www.seattletimes.com/pacific-nw-magazine/breaching-snake-river-dams-could-save-salmon-and-orcas-but-destroy-livelihoods/?wb48617274
=Q0hQMTc2ODtCVUQuQlBBLkdPVjsxMC4xNC42LjUzOzE1NjA0Njk0NTQ7pKHTq+YSsh+dHTTL4rqEuVJ/zxhcNMa7RDtWuJaUjflOu62wOiLKzv0ki/4Aqga8joYHUGe+sFdgQYa/y15lFsUofh1Gftzt5LW2wl7NlhF5grfJpSstab/xKh6

Z5RaKXCWjymaRjalEr0GmLfMZDXIq8LaJ6Wm+NUV6gvrYT70=

talk to you soon

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, June 13, 2019 12:20 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky; Aswea Porter
Subject: [EXTERNAL] RE: Accepted: check in call

No I wasn't aware of that specific recommendation from the Congressman to "take dramatic action". If you can give me any pointers here I would appreciate it.

From my perspective, where we currently are represents coming full circle. Twenty one years ago I ended up in the fight in Idaho over taking drastic action to "fix" the delayed mortality issue by taking out the dams. I stepped into that debate even though I was Canadian (and working for the Cdn federal government!) because I just didn't see the arguments as being based on good science because the arguments basically ignored what the ocean was doing and came up with an interesting (if convoluted) theory that "explained" how extra mortality due to stress from Snake River dam passage caused the fish to die at higher rates in the ocean.

I ended up leaving the federal government partly over those type of issues…. DFO didn't really want staff saying there might be a better way because that is seen as implicitly undermining and criticizing the status quo even in Canada… and doing things in the States was even more indelicate. So, partly for these reasons, I left. As you know, we tested the delayed mortality theory with BPA support and came up with some impressive technical and scientific results which we published in PNAS and a number of other top specialist journals. Then the funding was cut just when I thought we finally had enough new insight and had enough technical skills to really answer the bigger questions. I understand that decision because in 2010 in the wake of the financial collapse everyone was scared for their jobs because the Tea Party was running rampant then and there was widespread fear that everyone had to toe the line or be forced out. And, of course, advocating for something that wasn't already the consensus view in the basin (and being Canadian) made it easier to cut us.

Unfortunately, we are now back in the crisis mentality of 20 years ago. This time it is enhanced spill because this is believed to have rather mystical properties that will somehow "*save the salmon*" even if it will demonstrably kill more of them! This obviously is a great opportunity for my company to show (yet again) that there are credible alternative interpretations for the existing data people use. These interpretations of the data do not indicate that the current apparent near consensus on enhanced spill (or dam breach) is correct.

So, what I will do my utmost at during my presentation in Idaho is to show that there are sober alternative explanations that fit the same data the FPC uses and therefore should be seen as credible and deserving of support. That is great for Kintama, of course, if we can be sufficiently persuasive. However, it is also a potential minefield given the background politics at play. One particularly big bomb that I don't want to step on is having senior BPA staff present at that meeting and have some members of the audience call them out and say, in effect: "*Come on, BPA, this is highly credible and suggests that salmon biologists have made fundamental errors in logic for decades… why haven't you done more to resolve these issues than you have? Why is this the first time that we are hearing this?*". If they ask me, I can defuse this (somewhat) by saying that it is partly work that is even now under development. However, if they call out

Elliot Mainzer (or other BPA staff) to answer that question and they are not prepared, it could be embarrassing.

Partly this depends on how well-behaved and polite this group will be. I hope that everything will go smoothly and professionally, but I am just trying to lay some groundwork here so that if it doesn't go smoothly and people get upset that current conservation plans <u>may</u> be fundamentally flawed that your folks aren't blind-sided and are prepared! As I say, I am happy to lay out the arguments for BPA ahead of time, its just that having not yet pulled all of this together, I won't be able to do so very far in advance of the meeting.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, June 13, 2019 11:32 AM
To: David Welch
Subject: Accepted: check in call

Excellent idea. He is now our 'senior policy advisor' and I sent him the background but he wasn't vat his desk. Perhaps he could give Mainzer the briefing of main points. The fact that you are in Canada and were invited by River Partners sort of makes you an out of basin researcher that they found important.

Are you aware of the congressman from Idaho recently saying we should take dramatic action to recover Idaho steelhead and salmon?

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From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Jun 13 14:27:25 2019

To: David Welch

Cc: Erin Rechisky; Aswea Porter

Subject: RE: Accepted: check in call

Importance: Normal

Quick additional rumor – someone said that Scott Armentrout rather than Elliot Mainzer may be presenting at the meeting. I need to ask what topic he will have. I need to talk to Kristen

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, June 13, 2019 12:20 PM
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From: David Welch

Sent: Thu Jun 13 17:12:16 2019

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] RE: Accepted: check in call

Importance: Normal

(b) (6) [redacted]

Anytime next week will work for me, apart from 11-2 on Wednesday, 19 June.

Some of the messaging between BPA & Kintama could be contradictory—because I think that ramping up spill to lethal levels on the basis of a correlation with adult returns is poor science.

However, that is easily dealt with because if specifically asked my opinion I can simply make that exact point!

I would then go on to say that this agreement on spill is but one more example of what I am concerned

about:

(a) Moving to more and more extreme measures as other things tried in the past are recognized as having *__not__* worked, rather than questioning the basic issue of whether the region really is on the right track, and

(b) Moving into doing spill "experiments" using adult returns from the ocean rather than directly measuring the survival of spilled smolts *__into the ocean__*. As I have said before, the region should do an explicit test of this by exposing smolts to different levels of TDG and then measuring their survival out into the ocean, because smolt survival is what can be potentially improved. Measuring survival of adults back into the river without explicit controls is poor science because (i) It lacks controls and (ii) it adds on all the variability in ocean survival to what is being measured. If ocean variability is large (yes) then measuring adults back in has poor statistical power, so real effects will be hard to identify. It could take many years, if ever, to identify an effect in this case. Since the proponents of spill are basically proposing to kill some smolts in hopes of improving the survival of the others, it should be in everyone's interest to do these measurements quickly and clearly because both economic losses and conservation losses will ramp up the longer the experiment runs if it is not likely to be successful.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, June 13, 2019 3:14 PM
To: David Welch
Cc: Erin Rechisky; Aswea Porter

Subject: RE: Accepted: check in call

Hi,

Okay – I met with Kristen. She said that Ben Zelinsky and Peter Cogswell can work to prep Scott Armentrout on your paper. Scott is our new director, coming over from the Forest Service. He knows large government natural resources programs very well, and has had a crash course of dam management and fish issues. He would be presenting on the flexible spill agreement, and they are concerned that some of the messages could be contradictory – because this is being touted as a wonderful example of multiple interest groups coming together to agree on a hydrosystem operation for fish, and you might be saying that the ocean is where we should look. Is that a contradiction?

Anyhow, I just learned we will need to reschedule the meeting tomorrow (b) (6) [redacted] (b) (6) [redacted] She was able to call on the phone. She suggested next week, such as Tuesday? What days will you be in?

Thanks

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Thursday, June 13, 2019 2:49 PM
To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter
Subject: [EXTERNAL] RE: Accepted: check in call

Thanks—I had forgotten about that paper on food webs, although I have it in my library.

I will try to remember to cite it when/if we get to do the "21st Century Salmon Management" perspectives paper, because it is a useful citation for the point that habitat structure remediation hasn't been working well. (Although I think that the actual issue may be that density-dependence underlying the stock-recruitment relationship comes later in the freshwater life history and wipes out gains from habitat intervention occurring earlier on).

I'm going to probably take the high ground and not directly accuse people of promoting higher TDG levels to improve adult returns, but will likely use it as part of a discussion of how these ever-more extreme solutions are probably occurring because the fundamental premises are wrong. Hpwever, rather than concluding that, the proponents tend to double down and conclude that their interventions just haven't been extreme enough "yet"

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, June 13, 2019 2:24 PM
To: David Welch
Cc: Erin Rechisky; Aswea Porter
Subject: RE: Accepted: check in call

By the way, another point that you made is about how the higher TDG spill test could be damaging. To me, it seems like we might have a 'calling one's bluff' moment, because after a couple of years, people will want to see more fish. Although, there is still potential for the debate to be diverted to something else than the original test. Indeed, in the recent model results for the environmental impact statement, the CSS group was showing for the baseline, 'no-action' alternative was showing that SARs for Chinook and steelhead should be about 2.5-3% currently. We know they are lower, currently closer to 1%. The model showed this because the beginning of the 40 year time series of observations was higher than recent years. Yet, shouldn't higher spill in recent years have resulted in a higher recent SAR, unless you argue you aren't capturing something in your model such as nonconstant ocean survival.

By the way, this paper that I came across while finding food web references for the EIS had some interesting observations about the high number of hatchery fish released each spring.

https://www.pnas.org/content/109/52/21201.abstract

On another topic – the whole energy industry has had declining prices (hypothetically good for the consumer) due to competition particularly with natural gas and oil. I was talking with one of our folks who went from Fish and Wildlife to the transmission department, where there is a huge task of keeping power lines free of fallen trees and other risks. In California, PG&E is a regulated for profit company, that is often accused of cutting corners. John Tyler said we do a more thorough job. After a couple huge fires last year traced to power lines, they are now doing rotating outages during dry wind conditions. Most areas have storms in the winter that result in outages, which feels temporarily, but I am wondering if this will seep into people's consciousness in a different way. It might make people feel like they need to buy generators and prepare for regular outages – because it is not something that has happened in prior decades. Most people feel like the large fires are a new normal.

https://www.redding.com/story/news/local/2019/06/13/what-pge-customers-need-know-proactive-power-shutoffs-california-wildfire-pacific-gas-electric-safe/1426465001/

https://www.abc10.com/video/news/local/wildfire/we-avoided-a-wildland-fire-pge-says-power-shutoffs-worked/103-fdcbf77b-33b6-4996-815c-b3c159d4de85

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No I wasn't aware of that specific recommendation from the Congressman to "take dramatic action". If you can give me any pointers here I would appreciate it.

From my perspective, where we currently are represents coming full circle. Twenty one years ago I ended up in the fight in Idaho over taking drastic action to "fix" the delayed mortality issue by taking out the dams. I stepped into that debate even though I was Canadian (and working for the Cdn federal government!) because I just didn't see the arguments as being based on good science because the arguments basically ignored what the ocean was doing and came up with an interesting (if convoluted) theory that "explained" how extra mortality due to stress from Snake River dam passage caused the fish to die at higher rates in the ocean.

I ended up leaving the federal government partly over those type of issues…. DFO didn't really want staff saying there might be a better way because that is seen as implicitly undermining and criticizing the status quo even in Canada… and doing things in the States was even more indelicate. So, partly for these reasons, I left. As you know, we tested the delayed mortality theory with BPA support and came up with some impressive technical and scientific results which we published in PNAS and a number of other top specialist journals. Then the funding was cut just when I thought we finally had enough new insight and had enough technical skills to really answer the bigger questions. I understand that decision because in 2010 in the wake of the financial collapse everyone was scared for their jobs because the Tea Party was running rampant then and there was widespread fear that everyone had to toe the line or be forced out. And, of course, advocating for something that wasn't already the consensus view in the basin (and being Canadian) made it easier to cut us.

Unfortunately, we are now back in the crisis mentality of 20 years ago. This time it is enhanced spill because this is believed to have rather mystical properties that will somehow "*save the salmon*" even if it will demonstrably kill more of them! This obviously is a great opportunity for my company to show (yet again) that there are credible alternative interpretations for the existing data people use. These interpretations of the data do not indicate that the current apparent near consensus on enhanced spill (or dam breach) is correct.

So, what I will do my utmost at during my presentation in Idaho is to show that there are sober alternative explanations that fit the same data the FPC uses and therefore should be seen as credible and deserving of support. That is great for Kintama, of course, if we can be sufficiently persuasive. However, it is also a potential minefield given the background politics at play. One particularly big bomb that I don't want to step on is having senior BPA staff present at that meeting and have some members of the audience call them out and say, in effect: "*Come on, BPA, this is highly credible and suggests that salmon biologists have made fundamental errors in logic for decades… why haven't you done more to resolve these issues than you have? Why is this the first time that we are hearing this?*". If they ask me, I can defuse this

(somewhat) by saying that it is partly work that is even now under development. However, if they call out Elliot Mainzer (or other BPA staff) to answer that question and they are not prepared, it could be embarrassing.

Partly this depends on how well-behaved and polite this group will be. I hope that everything will go smoothly and professionally, but I am just trying to lay some groundwork here so that if it doesn't go smoothly and people get upset that current conservation plans <u>may</u> be fundamentally flawed that your folks aren't blind-sided and are prepared! As I say, I am happy to lay out the arguments for BPA ahead of time, its just that having not yet pulled all of this together, I won't be able to do so very far in advance of the meeting.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Thursday, June 13, 2019 11:32 AM
To: David Welch
Subject: Accepted: check in call

Excellent idea. He is now our 'senior policy advisor' and I sent him the background but he wasn't vat his desk. Perhaps he could give Mainzer the briefing of main points. The fact that you are in Canada and were invited by River Partners sort of makes you an out of basin researcher that they found important.

Are you aware of the congressman from Idaho recently saying we should take dramatic action to recover Idaho steelhead and salmon?

Christine

Sent from Workspace ONE Boxer

On Jun 13, 2019 9:06 AM, David Welch <David.Welch@kintama.com> wrote:

You might ask Ben Zelinsky.

Tell him that the talk I will be preparing for Idaho will be essentially the same one that I would have given to Elliot Mainzer if Ben's earlier plans this spring had gone forward to have a few different people give Elliot their perspectives on where salmon conservation needs to go.

From: Zelinsky,Benjamin D (BPA) - E-4

Sent: Fri Jun 14 13:33:32 2019

To: 'David Welch'

Subject: RE: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble

Importance: Normal

Thank you David. I appreciate the heads up and the sensitivity. (b) (6) [redacted] (b) (6) [redacted]

Let me look through the slides and get a better sense of what Scott Armentrout (filling in for Elliot) is planning to say to see if there is any need to coordinate. As always I respect your scientific autonomy but appreciate the communication and transparency.

I hope your family is doing well too and that summer in BC is off to a glorious start.

Ben

From: David Welch <David.Welch@kintama.com>
Sent: Wednesday, June 12, 2019 7:51 PM

To: Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>
Subject: [EXTERNAL] Fwd: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble

Hey Ben—

Ordinarily I would let this percolate up from Christine's side, but given the nature of the meeting I am attending (and BPA's role being much more prominent than I had originally thought when I had accepted the speaking invitation), I am passing this on to you privately to ensure that Elliot Mainzer and other senior folk don't get blind sided by what I will be saying.

In essence, what I will be outlining on the salmon conservation issues is what I would have said to Elliot and you if we had ever gotten together as discussed this spring. I am just preparing this now, so as I note below it is not ready for prime time sharing as yet. I am, however, happy to keep you (and others) in the loop on this as we develop the presentation. Basically, I am going to be completely diplomatic and uncontroversial, and simply say that the region diagnosed the salmon problem wrong half a Century ago and has been going down the wrong path ever since. □. I will take the sting out of those words by saying salmon biologists everywhere else are wrong too.

As I say, happy to provide as much of this material as I develop it as needed. Just handle this email carefully because I don't want to put my COTR's nose out of joint and have her think I went behind her back because I didn't trust her. (I've just that I have ended up in exactly that situation too many times in the past to want to trust to The Fates!).

[redacted]

d

David Welch, Kintama Research

Tel: +1 (250) 729-2600 x223

Cell: [redacted]

Sent from my iPad

Begin forwarded message:

> **From:** David Welch <David.Welch@kintama.com>
> **Date:** June 12, 2019 at 16:45:57 PDT
> **To:** "Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>
> **Cc:** Erin Rechisky <Erin.Rechisky@kintama.com>
> **Subject: FW: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble**
>
> **Christine—**
>
> **This is the meeting that I have been asked to speak at in Idaho… they are blocking off 1 hr & 15 minutes for me and putting me in the speaking slot just prior to the Chief of Staff for Congressman Simpson as a result of learning about the SARs paper. (Kurt Miller, the new Exec. Director of NW RiverPartners, heard Erin speak at the Portland meeting in May, and this is what generated the sudden interest).**

I had not realized that BPA is playing as prominent a role in this meeting as they are portrayed below (Elliot Mainzer is speaking just before lunch). It might be a good idea to run the prominence of my presentation up the chain of command at BPA so that no one is blindsided; it is pretty clear that if they think our views have credibility this group will want to be pushing for answers to the issues I will raise. People may therefore turn to BPA senior managers at the meeting and publically ask whether they think our views are credible and, if so, how BPA is going to deal with the questions we raise.

I am happy to give BPA the presentation when done, but that won't be until July, because I am juggling that, the SARs paper revision, and a number of other unrelated tasks. A good chunk of what I will outline in Idaho will concern why the region may have chosen the fundamentally wrong conservation approach 5 decades ago, and never really recognized this. As a result, I have to prepare this material in a way that it has never been presented before and it is going to take some time; I can't just steal from some of our past presentations for a good chunk of what I will discuss. I can, of course, send versions of the outline along as we refine the presentation.

David

From: Will Hart [mailto:icuaregister@gmail.com]
Sent: Wednesday, June 12, 2019 3:09 PM
Subject: REMINDERS & UPDATED AGENDA 2019 ICUA Annual Meeting | BPA Annual Customers' Meeting | 15th Annual ICUA PAC Golf Scramble

An updated Annual Meeting agenda is attached.

Reminders...

- Please be sure to complete registrations and golf sponsorships
- Hotel reservation deadline is ***Monday, June 17***
- Note Golf Scramble Time Change – 10:00a.m. Shotgun Start

Registration Information at: https://icuaregistrationadmin.wufoo.com/forms/icua-bpa-registration-july-1012-2019/

From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Jun 20 18:49:25 2019

To: David Welch

Subject:] FW: Notes_on_which_reaches_to_use_PITData.docx

Importance: Normal

Hi David
Sorry, I wasn't able to call in the last teo days (have been in Seattle). I forwarded your idea of using Josh Murauskas as a collaborator to several people. It is actually a pretty good idea for several reasons. Several years ago before he had his current company, Josh proposed doing a SAR stidy mostly using the RMIS hatchery database. He has definitely been thinking of the topic.

I need to hear back from Jody either tomorrow morning, or our 11am call. I left a note for Ben Zelinsky to remember to relay whatever discussion he had with Scott Armentrout.

Talk to tou soon
Christine Petersen

Sent from Workspace ONE Boxer

On Jun 19, 2019 10:55 AM, David Welch <David.Welch@kintama.com> wrote:

Hi Christine—

Just a heads up prior to our phone call on Friday. (This may be easier to discuss by phone to explain

some of the nuances; if you have time my schedule is open except for today 11:30-2 & Thursday 2-2:30).

We have been chasing our tail a lot (and being inefficient in the process) by trying to clearly delineate some of the caveats in comparing the coast-wide SARs data in our manuscript. The sort of issues we face are that not only are their different geographic regions to compare, but different mixes of hatchery and wild stocks (SE Alaska is all wild for example, the Columbia River basin is mostly hatchery stocks), and the CWT tag vs PIT tag differences (the first includes harvest, the second does not), and the geographic extent of the migration life history included in the measurement of SARs.

One big difference is the last one, the differences in what geographic stretch are included in the survival analysis. We have asked the FPC 3 or 4 times now for the SARs data incorporating the smolt survival above the uppermost dam as this would make the comparisons clearer without ever making any progress. However, it is clear that they will criticize the analysis if we don't use the data including the above dam segment.

Erin had the very bright idea yesterday of asking Josh Murauskas if he would be willing to do re-do the SAR analysis that the FPC reports on, but including the above dam smolt survival. Josh has a detailed understanding of the PITAGIS data and the extraction methods that need to be used to independently extract the populations the FPC reports on in their CSS report.

I asked Josh about this and he said he would be interested to do so, and also said that their existing general services contract with BPA is only about half spent this year. So, if this is agreeable with your group, we would work with Josh to get him to do this and then re-run our analyses using the new

Columbia River PIT tag dataset. We would of course add Josh as a co-author.

Ideally, if you can consult internally prior to our phone call on Friday we can start in on this with Josh.

Please call to discuss if you need further clarification… I am not sure how much time Josh would need to actually do this, but he certainly was interested and willing to try.

David

From: David Welch
Sent: Wednesday, June 19, 2019 9:27 AM
To: Aswea Porter
Cc: Erin Rechisky
Subject: RE: Notes_on_which_reaches_to_use_PITData.docx

Possibly… but I am very concerned about "mission creep" at this late date… it has already proven to be far more work than we had anticipated to get the data summarized and described (beyond Aswea's work in doing the actual analysis!).

I am also wary of introducing new populations into the mix because we want to minimize the ability of

the FPC to just dismiss the results because it doesn't match "their" list of chosen populations. Having Josh just extract the data for the populations used in the CSS study makes it much easier for people to evaluate this paper. As and when we get this paper published we can look at working with Josh to expand the list of populations to everything as part of an expanded study in future, assuming money can be found.

As I said above I am sobered both by how much work this paper has been, how strident the reviewer's opposition to the message was, and my (personal) failure to recognize this… one of the big criticisms of our paper was I moved beyond just reporting the data to laying out the big picture implications. This is not what scientific papers generally do, so we got added criticisms for implicitly criticizing the way salmon science & management has been done here (pointing out the repeated pattern of agencies ignoring the ocean when it became evident that was where the major problem lay and going back to finding new things to do in freshwater, for example… as I recall, not one reviewer commented on that whole section at all, but instead argued over discrepancies in the data, which we will always have).

So, rant (or *mea culpa*) over. My thoughts is let's keep this just to having Josh redo the CSS populations for use in the SAR analysis if BPA agrees.

From: Aswea Porter
Sent: Wednesday, June 19, 2019 9:07 AM
To: David Welch
Cc: Erin Rechisky
Subject: RE: Notes_on_which_reaches_to_use_PITData.docx

The availability of other data suggests that including populations beyond those used by the FPC, should be discussed. We do need some populations that overlap with the FPC in order to QA Josh's estimates, but the FPC data is rather heavily weighted towards SNAK—other regions could use improved representation.

~A

From: David Welch
Sent: June-19-19 13:18
To: Aswea Porter
Cc: Erin Rechisky
Subject: RE: Notes_on_which_reaches_to_use_PITData.docx

In red.

From: Aswea Porter
Sent: Wednesday, June 19, 2019 8:06 AM
To: David Welch
Cc: Erin Rechisky
Subject: RE: Notes_on_which_reaches_to_use_PITData.docx

What?! Josh is redoing the PIT SARs!? If he can do it, that's terrific! If we use the CWT SARS that are NOT compensated for harvest along with the PIT SARS from release, then we've got 2 mostly comparable datasets! (Thereby allowing reviewers to focus on more nuanced issues lol)

I'm nervous though because it seems likely that recalcing the SARS is a job that seems surficially easy, but which may in fact be the opposite.

I'm going to have to redo almost all my scripts! As usual...

I don't think we need a list for Josh; he can just use Appendix B in the CSS Annual Reports can't he? If he can only do the SARS for a subset of the populations in Appendix B, then we should discuss because there are already SARS from release available from the FPC for SNAK yearling hatchery populations and for some MCOL pops—so these would be the ones to drop from his list. Yes, we will do a QA check to compare his values against those from the FPC.

DWW: Good point about just using Appendix B of the CSS, but it will be even easier for him if we give him the list, along with an explanation of where it comes from. Josh made the point to me a number of years ago that the CSS uses only 5% of the PIT tag data generated in the Columbia River basin each year; we had mused about whether the CSS' delayed mortality argument would really hold up if the full dataset was used. We "sort of" answered that ourselves because three of the CSS's five Mid-Columbia River populations don't support the delayed mortality argument that they advance for the other two (Yakima & John Day) for Spring Chinook, and *none* of the Fall Chinook support the delayed mortality argument! So, although steelhead and two Spring populations do support it, there seems to be a good deal of conscious or unconscious exclusion of data that doesn't fit their hunches.

I'll send another email with the Effect of Jacks and Reach info (although maybe Effect of Reach is now moot).

~A

From: David Welch
Sent: June-18-19 21:24
To: Aswea Porter
Cc: Erin Rechisky
Subject: Notes_on_which_reaches_to_use_PITData.docx

Please read my comments in red … to discuss.

d

From: David Welch

Sent: Mon Jul 01 20:14:42 2019

To: Lando,Jody B (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4; Erin Rechisky

Subject: [EXTERNAL] RE: West Coast SARs check in

Importance: Normal

Hi Jody-

Happy Canada Day! (The Canadian equivalent of your July 4th. (b) (6) [redacted] (b) (6) [redacted]

All of what you indicate is fine with me. The title was not really ours—the title was actually suggested to us on a tight turnaround (I think it was already in the draft agenda before I saw it, and we had them change a couple of words, but didn't try a major exercise in wordsmithing). It wasn't until we actually saw the agenda and realized the number and caliber of people in the audience that we realized how much attention this presentation might get. So "their" title probably indicates significant interest in getting alternative viewpoints on the table for discussion.

We will certainly be sticking to the science; however, I will be framing the science based on my opinion that the region went down the wrong path in the early 1970s was based on a flawed understanding of salmon ecology. I will be giving examples. I don't think that this will be too objectionable in itself, but I

will be arguing that many scientists missed the key point in how salmon ecology is actually structured and that there is a strong chance that as a result much current work has important flaws, and that the alternative path not taken might lead to very different management strategies. Because these alternative strategies would very likely yield much higher economic value, this is obviously going to be a receptive audience for this message. That is good for Kintama. My concern is that I need to steer this so that the current BPA administration doesn't take the heat for what I think are major flaws from the past which continue to direct how salmon recovery efforts are done in the Columbia River basin.... i.e., it is not a BPA-problem but rather a much broader problem with our current science and management.

Be aware that although I will almost certainly try to avoid making much (any) criticism of freshwater habitat restoration, I have come to a pretty clear understanding that density-dependent processes are probably negating much of the intended good works in freshwater habitat work. I may have mentioned this to you when we met, but if not Christine has some understanding of the main points in my thinking here. I can certainly take the time to outline them to you too, but we have set aside further work on this until the SARs paper is re-submitted. At some point we should discuss if I didn't detail my thinking here in the spring—I believe it is important and potentially ground breaking, and applies equally well in Canada and the US

(b) (6) [redacted]

(b) (6) [redacted] **I won't have my final presentation ready until the night I arrive, but I can certainly share an earlier version with you. Would Friday afternoon be enough time?**

David

David Welch

kintamav_RGB

Office: (250) 729-2600

Mobile: (b) (6) [redacted]

From: Lando,Jody B (BPA) - EWP-4 [mailto:jblando@bpa.gov]
Sent: Monday, July 01, 2019 3:06 PM
To: David Welch; Petersen,Christine H (BPA) - EWP-4; Erin Rechisky
Subject: RE: West Coast SARs check in

David et al.–

For the sake of clarity and efficiency, please consider the following points as you develop your presentation for the ICUA/Customers:

· Focus on the scientific findings of your research and resulting questions that we should be considering as we seek to effectively manage the hydrosystem. BPA is concerned that the title of your presentation reflects opinion rather than a focus on science.

· Tributary habitat freshwater mitigation actions will continue to provide benefits to the NPCC Program. Investigating the limitations of freshwater habitat benefits can help inform how BPA and NPCC strategically implement habitat mitigation work that is both biologically beneficial and cost-effective to mitigate for the effects of hydrosystem operations.

- We would like to review your presentation prior to submitting it to ICUA.

I am confident you will be a compelling presenter. As I believe you already know, Scott Armentrout, Executive VP for F&W, will be discussing our flexible spill strategy following your presentation.

In the future, and in full recognition of Kintama's explicit scientific independence, please know that BPA appreciates early notification of any requests to present BPA-funded research. While we do not intend to shape your research, early communication does enable us to effectively coordinate.

As for hiring Josh Murauskas to assist with revising the 1st manuscript – I support the concept on technical merits and with no increase in funding. Christine would need to help on the contracting side of things. Although I am not a BPA contracting expert, I believe a subcontract to Josh under Kintama would be the most streamline.

I hope this is helpful.

Jody

Jody B. Lando, Ph.D.
Research, Monitoring and Evaluation Lead | EWP-4

Bonneville Power Administration
jblando@bpa.gov | P 503-230-5809 | C [redacted]

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-

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, June 21, 2019 10:22 AM
To: Petersen,Christine H (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4; Erin Rechisky
Subject: [EXTERNAL] RE: West Coast SARs check in

[redacted] **(In the office next Friday, however, the 28th of June).**

Perhaps you & I can talk today about a potential contract to bring Josh in, and I can give you some background info?

I think it will expedite our work because it solves several issues that have been criticized by the FPC in comparing CWT & PIT tag based survival estimates. It would be nice if the FPC played nice and was helpful, but lacking that we need a path forward to address the issues.

I am here all day except 12-1:30

d

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, June 21, 2019 10:17 AM
To: David Welch; Lando,Jody B (BPA) - EWP-4; Erin Rechisky
Subject: Re: West Coast SARs check in

Hi

I am sorry but we need to cancel and reschedyle again, because the coordination hasn't occurred to make it productive. Look for early next week.

Sent from Workspace ONE Boxer

From: Pisces

Sent: Thu Aug 08 13:54:13 2019

To: Pisces

Subject: New Pisces Web Tips and Tricks Training!

Importance: Normal

Good Afternoon Pisces Users!

We will be offering another tips and tricks training with all new tips and tricks! The training will be offered via WebEx on **Tuesday, September 17 at 10:00 – 11:00 AM PDT** for all external users.

Examples of topics that will be covered include:

- Who can update a Work Element Budget after the contract's end
- What you might want to know about the Subcontractor's role within Pisces Web
- Where to find the Study Design information for your contract all in one place
- When you might have problems entering metrics for Metric sets
- Why doesn't your Dashboard tell you that your Status Report is due soon
- How can you find a contract with only the Contract Change Request (CCR) number

And where else you might find out some of this information if you forget!

If you're interested in attending, please **RSVP by replying to this email** so we can hold a spot for you!

As always…

- For system access or bugs in Pisces Web – email support@cbfish.org
- For feedback on new functionality in Pisces Web – email pisces@bpa.gov

Regards,

The Pisces Team

Bonneville Power Administration

This email was sent to all Pisces Web users.

From: David Welch

Sent: Wed Aug 21 12:25:18 2019

To: Ben Zelinsky

Subject: [EXTERNAL] The FCRPS as a battery?

Importance: Normal

Attachments: Mills (The New Energy Economy-An Exercise in Magical Thinking 2019).pdf; Sepulveda et al (The Role of Firm Low-Carbon Electricity in Deep Decarbonization-Joule 2018).pdf; Poff (Beyond the natural flow regime- Freshwater Biol 2018).pdf

Ben–

I just read this analysis by Mills outlining just how hard it will be to move away from fossil fuel dependency even over multiple decades. (It is from a somewhat right wing but very well respected think tank back east—they were one of the earliest champions of the "Broken Windows" theory of policing, which has turned out to work well and has been widely adopted). It dovetails well with a MIT thesis by Sepulveda who concluded that trying to build a fully decarbonized electric power system without firm baseline power supplies would probably double the costs. (Also attached).

The reason I am writing is that though the FCRPS has considerable current economic value as a source of hydroelectric power, the true value may be many multiples of what it is currently valued at if the power can primarily be used as the "rapid response" power needed to support the electric power grid at night or when the wind isn't blowing (i.e., using the water supply essentially as a giant reliable battery or capacitor). As the Mills report demonstrates, there is no chance that battery technology is going to get there to replace fossil fuels, but hydropower can in the Pacific northwest).

I assume that your folks at BPA actually recognize this point I have been harping on for years, but if ocean survival rates really are the same as survival rates in the hydrosystem then the present day arguments to mimic that natural, undammed, river go away and thus potentially the constraints on when and how power can be produced. Also, (although you would never know it from current thinking in the Columbia basin!!), some of the early proponents of mimicking the natural flow regime are now changing their views… see the third paper by Poff (**"Reliance on the assumption of restoration to reference conditions for either hydrologic or ecological conditions is no longer tenable"**).

David

Mills, M. P. (2019). "THE "NEW ENERGY ECONOMY": AN EXERCISE IN MAGICAL THINKING." Manhattan Institute Report: 23 pp.

Sepulveda, N. A., J. D. Jenkins, F. J. de Sisternes and R. K. Lester (2018). "The role of firm low-carbon electricity resources in deep decarbonization of power generation." Joule **2**(11): 2403-2420.

Poff, N. L. (2018). "Beyond the natural flow regime? Broadening the hydro-ecological foundation to meet environmental flows challenges in a non-stationary world." Freshwater Biology **63**(8): 1011-1021.

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

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Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: Zelinsky,Benjamin D (BPA) - E-4

Sent: Thu Aug 22 08:31:39 2019

To: 'David Welch'

Subject: RE: The FCRPS as a battery?

Importance: Normal

Thank you David – looking forward to reading these. I'll pass them around to others who may be interested too.

Hope all is well with you!

From: David Welch <David.Welch@kintama.com>
Sent: Wednesday, August 21, 2019 12:25 PM
To: Zelinsky,Benjamin D (BPA) – E-4 <bdzelinsky@bpa.gov>
Subject: [EXTERNAL] The FCRPS as a battery?

Ben–

I just read this analysis by Mills outlining just how hard it will be to move away from fossil fuel dependency even over multiple decades. (It is from a somewhat right wing but very well respected think tank back east—they were one of the earliest champions of the "Broken Windows" theory of policing, which has turned out to work well and has been widely adopted). It dovetails well with a MIT thesis by Sepulveda who concluded that trying to build a fully decarbonized electric power system without firm baseline power supplies would probably double the costs. (Also attached).

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David

Mills, M. P. (2019). "THE "NEW ENERGY ECONOMY": AN EXERCISE IN MAGICAL THINKING." Manhattan Institute Report: 23 pp.

Sepulveda, N. A., J. D. Jenkins, F. J. de Sisternes and R. K. Lester (2018). "The role of firm low-carbon electricity resources in deep decarbonization of power generation." Joule 2(11): 2403-2420.

Poff, N. L. (2018). "Beyond the natural flow regime? Broadening the hydro-ecological foundation to meet environmental flows challenges in a non-stationary world." Freshwater Biology **63**(8): 1011-1021.

David Welch, Ph.D.

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Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Sep 13 15:04:18 2019

To: David Welch

Cc: Erin Rechisky

Subject: RE: Checking in

Importance: Normal

Hi

Sorry for the slow response. (b) (6) [redacted]

(b) (6) [redacted]

I forwarded this around, and the element of harvest might be something we discuss over here. John Skidmore and Jody Lando are trying to appoint someone to slowly become involve in harvest forums and start to develop agency policy positions related to predation and harvest – which are two areas we have pretty much stayed out of for years. This might be mostly a social role as far as trying to build up contacts for information and data, and seeing how we could assert any influence.

Anyway, it is good that it sounds like you have completed some blackboard sessions with the major challenges with the revision. We are going to be having some annual check-ins with John Skalski and Jim Anderson's groups on DART, and various things they have underway. The database page in DART where they store hatchery SARs etc often seems like a site where they provided space for this data to be recorded, but it wasn't their responsibility to QA/QC or pursue the new data point for each year etc. My coworker was thinking of asking them to build database space for wild trap PIT tag information so that it would be accessible, and Streamnet and other sites doesn't have easy query tools. Please let us know if you have any conclusions that we should point out to them as far as how RMIS, FPC and other sources are not in agreement.

Talk to you soon,

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, September 10, 2019 3:06 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] Re: Checking in

Hi Christine—

Good timing... I was going to contact you soon just to give you a brief update from our end.

I am back working on the SARs paper with Aswea. I think we have now mostly emerged from the complexities of diving into RMIS and trying to sort out the conflicting data (some of which are misleading or just unusable because of the lack of complete data… but potential problems are certainly not well-signposted in these databases). I'm not entirely sure how well this will go until we finish re-working the SARs paper, but one of the big findings (for me at least) is how badly downwards biased the PIT tag-based SAR estimates are owing to the lack of any way to incorporate harvest data into the PIT tag survival estimates.

There is no information on harvest included in the PIT tag-based SAR estimates from the FPC. Basically, because the PIT tag based survival estimates cannot include fish harvested in the sport or commercial fisheries, the PIT tag system detects 100% of surviving adults returning to the dams. What it misses though, is the magnitude of the harvest of Chinook, which surprised me when we dug it out of the PSC data system, particularly for subyearling (Fall) Chinook.

Call the harvest rate in year of adult return t+τ, $h_{t+\tau}$. Then the fraction of PIT tagged adults returning to be enumerated at the fish ladders is ($1-h_{t+\tau}$). The SAR calculated by the CSS is the Adult escapement to the dams in year t+τ divided by the number of smolts migrating past a dam several years earlier in ocean entry year t. Here τ (tau) is the time from smolt entry to adult return τ years later (basically τ is 2 because most Chinook return τ=2 years after ocean entry as adults).

So, using PIT tags, $SAR_t = Escapement_{t+\tau}/(Smolts_t)$. But escapement back to the river does not include adults caught in the fisheries. Failure to include adults that would have returned but were caught by commercial or sport fisheries will necessarily bias the PIT tag-based SARs downwards. I had thought that

this bias was reasonably small, but we were very surprised when we looked into this to realize just how large and variable the harvest rate actually was.

We have data from the PSC on how harvest rates vary over time for 5 Columbia River basin subyearling (Fall) Chinook stocks which were coded wire tagged, one of which is Lyons Ferry (a Snake River basin stock). In the attached graph we have calculated the correction factor $(1-h_t)^{-1}$, which is the multiplier that the CSS's published SAR estimates should be multiplied by to correct for the lack of information on what the catch was. (For example, if the harvest rate was 50%, then the SAR estimate based on escapement back to the river should be multiplied by a factor of two to correct for the lack of data on harvest).

I find these values surprisingly large, but even more important is the fact that (a) the multipliers show large variations over time (they aren't stable) and (b) do not show the same pattern over time between populations. So fishery managers have been able to substantively modify harvest rates over time and to target higher or lower harvest rates on certain Fall Chinook stocks.

Most of the FPC's PIT tag based SAR estimates start in 1998. From the graph, the Lyon's Ferry stock had a harvest rate multiplier of about 1.5X in the early years, but after 2008 harvest has gone up a lot so that by the end of the available time series the downward bias in SAR estimates was almost a factor of 3X… i.e., whatever the CSS report said was the SAR for Brood year 2012 should actually be multiplied by 3X because a very large fraction (2/3) of the adults that should have returned were caught in fisheries. (And this catch does not apparently include harvest by tribes or sport fishermen above Bonneville Dam in the mainstem or tributaries).

Most Columbia River basin stocks do not seem to have sufficient CWT data to do a similar analysis of the

effect of variation in harvest rates over time, but are in the CSS PIT tag-based survival study. These therefore appear to be large downward-bias in the published CSS SAR estimates.

Are people in the Columbia River aware of the magnitude of these impacts on the CSS estimates from excluding harvest?

Perhaps easier to discuss this further by phone.

David

P.S. I hope things aren't too bad with your family (dad?). We are just in the process of selling my mother's house because at 91 yrs old it is clear she is not going home from the nursing home. She just signed (on her own!) a provisional offer to purchase her house yesterday. It has been a challenge getting her to this point and the family was (privately) prepared to step in and sell it over her wishes if she had balked at the last minute, but to our relief she went through with the sale yesterday. I hope things are going as well as possible with your family as well?

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Tuesday, September 10, 2019 10:47 AM
To: Erin Rechisky; David Welch
Subject: Checking in

Hi,

(b) (6) [redacted]ow are things going? Do you foresee any changes involving [redacted]ntract?

Have you been seeing anything interesting with salmon returns in the Fraser this year?

Christine Petersen

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Oct 04 09:27:46 2019

To: David Welch

Subject: RE: Kintama Letter

Importance: Normal

Hi David,

Yes – Scott Bettin has observed the long running pattern with that group that they get worked up when they are worried about something.

Charlie Paulsen presented a data analysis two years ago where he had analyzed dam route passage based on the size of smolts at time of PIT tagging. He looked at Snake dam routes. Faulkner/Bellerud/Widener/Zabel just published a more comprehensive and easy to understand paper that looked at passage through Columbia and Snake dams using the fish from their 20 year study. Anyway, both analyses found that most of the dams (Bonneville and lower Granite least so) show size bias where larger fish go through the spillway and surface weirs. This effect would account for apparent delayed mortality. When Charlie presented, there was an overreaction from FPC and one IDFG rep. One of the things he had to deal with was the variable amount of time that smolts tagged at hatcheries and traps from upstream take to get to Lower Granite. Not knowing how large the juveniles were precisely when they reached Lower Granite (because they were measured days or weeks ago upstream) was considered a flaw when using CSS fish. (next, I will forward a response from Tim Copeland to that email from two days ago – some of what he is pointing out reinforces this point, and also the original justification you had for wanting hatchery-to-hatchery rather than LGR-to-LGR SARs).

One thing that Charlie talked to us about was the potential for bias in the C0 and C1 groups at Lower Granite as a function of size. Their study design has to assume that groups randomly enter C0 and C1 because the C0 group is estimated. What if really, the C0 group are larger and arrived several days earlier than the smaller C1 fish detected at the bypass. However, there are many issues with messy data from the various traps so it is hard to evaluate this hypothesis.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Wednesday, October 02, 2019 10:16 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: Kintama Letter

Thanks, Christine—

Let's talk when you get back and settled in [redacted] (b) (6)

I think that this response from the FPC is sufficient for what we need in dealing with the editor, eventually. We should talk soon though, because in addition to the published SARs not including the survival in the segment upstream of the dams, we have been able to establish that there are huge biases in the PIT tag-based SAR estimates.

The upshot is that the CSS' SAR estimates are highly precise estimates because all PIT tagged animals passing through the dams are detected but seriously *__and badly__* wrong… in other words there are tight confidence intervals on the SAR estimates that are way off from the true survival values.

We will put together a summary graph on why this is so today and we can talk tomorrow. Once we have outlined the issue it will probably be time for you to solicit advice/opinion from some of your BPA colleagues as to whether they (a) agree and (b) think that this is as big an issue as I do. We may want to add this to our revised paper or just produce a memo for you & your colleagues to use internally. I do think what we have found out is very important, though.

More soon.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, October 02, 2019 9:12 AM
To: David Welch
Subject: FW: Kintama Letter

Hi David

I am heading back from Seattle this morning. I actually got an incoming call from FPC (b) (6) [redacted]
(b) (6) [redacted]

This letter may warrant no response, and may be the documentation needed to show we don't have access to hatchery to hatchery PIT based SARs. A little weird to CC all the agencies. I will talk with Jody Lando or maybe Ben Z tomorrow.

Christine

Sent from Workspace ONE Boxer

---------- Forwarded message ----------
From: Michele Dehart <mdehart@fpc.org>
Date: Oct 1, 2019 3:50 PM
Subject: [EXTERNAL] FW: Kintama Letter
To:
adam.j.storch@state.or.us,Erick.S.VanDyke@coho2.dfw.state.or.us,tucker.a.jones@state.or.us,lort@critfc.org,lotr@critfc.org,LESR@critfc.org,'Christine Golightly' <GOLC@critfc.org>,ED.Bowles@state.or.us,lance Hebdon <lance.hebdon@idfg.idaho.gov>,tim.copeland@idfg.idaho.gov,Daniel.Rawding@dfw.wa.gov,tweitwmt@dfw.wa.gov,Michael.Garrity@dfw.wa.gov,Steve_Haeseker@fws.gov,David Swank <david_swank@fws.gov>,ritche.graves@noaa.gov,jayh@nezperce.org,zpenney@critfc.org
Cc: Jerry McCann <jmccann@fpc.org>,Brandon Chockley <bchockley@fpc.org>,Erin Cooper <ecooper@fpc.org>,Gabriel Scheer <gscheer@fpc.org>,Bobby Hsu <bobbyhsu@fpc.org>,"Petersen,Christine H (BPA) - EWP-4" <chpetersen@bpa.gov>

Hello:

This is just a heads up, to pass along a recent certified letter received by the Fish Passage Center from David Welch, Kintama Research Services. This letter is related an article by Welch et al, developed under contract with BPA, submitted for publication in the online journal PLOS. The article titled, “The coast-wide collapse in marine survival of west coast Chinook and steelhead: slow moving catastrophe or deeper failure?”. The article was posted on a biological sciences archive page, for non-peer reviewed articles, called bioRxiv. The analyses developed under BPA contract was attached to recommendations by Welch to the NW Power Planning Council amendment process.

The BPA COTR on this contract is Christine Petersen and Welch has copied her on this letter. Some of the statements by Welch in this letter, do not comport with the documentation of emails from Christine Petersen, BPA, to the Fish Passage Center in 2017, in which Ms. Petersen states that BPA is interested in SARs from release to uppermost dam for the 2017 Biological Assessment. SARs from point of release to upper most dam, are not a component of CSS analyses or study design. The FPC does not generate these SARs and Ms. Petersen was advised accordingly in 2017 and advised that this request would represent a significant amount of new work. When the FPC was asked to review the Welch analyses, 2019, the BPA contract, including deliverables and work elements was requested, to understand the hypotheses that BPA contracted Kintama to pursue. The Kintama contract, work elements, deliverables, was not provided.

The FPC provides all data and analyses completed in FPC, CSS and SMP projects to the public. SARs from point of release, traps, etc…are not generated as part of these projects. The FPC will respond to the Welch letter and will once again request the BPA/Kintama contract work elements and deliverables.

Michele

From: David Welch

Sent: Tue Oct 15 12:14:00 2019

To: Petersen,Christine H (BPA) - EWP-4; Jody Lando (BPA)

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] FW: SARS-- harvest multiplier figure

Importance: Normal

Attachments: Harvest_Multiplier_150Oct19-No RHS Axis Label.tif

Good morning, Christine & Jody—

We are still working through the revision of the paper to first compare only coast-wide CWT-based SAR estimates and then bring in the FPC's PIT tag based SAR estimates after that. (We are trying to defuse the criticism that our SAR comparison is meaningless because the two tagging technologies (PIT & CWT) are so different that they can't be compared).

Unfortunately, we are not quite done with the CWT only exercise because of the complexities with trying to sort through the data quality issues in the potential data sources (DART AND RMIS). Many data sources are missing either harvest (catch) or escapement, and the adult return (recruitment) requires credible data on both components unless harvest rate is negligible and escapement to the river can be considered in isolation.

This does raise the primary point I want to raise in the phone check-in: I was stunned to realize just how large harvest rates of Columbia River basin Chinook stocks still are and:

(a) how variable they are over time for a given population and

(b) how strikingly different the harvest rates are on different Columbia River basin populations in the same year.

Although not the primary purpose of our funded work, I think this point is extremely important to BPA and its broader needs. Many of the major conservation claims about how to modify hydrosystem operations are based on PIT tag SAR analysis and, indeed, the entire 600+ page CSS analysis is based on PIT tag SARs. I need your perspective on this.

PIT tags do not reflect losses to sport or commercial harvest because there is no operational way to identify the presence of PIT tags in the catch, unlike CWTs. The CSS acknowledges this in their analysis, but does not seem to recognize how important this bias is. Essentially, if the harvest rate in year t is h_t, then PIT tag-based SARs are biased low by the harvest. To take a specific numerical value, if the harvest rate was 50% one needs to multiply the PIT tag-based SAR by two to correct for the missing fish that were caught at sea or in the river. If the harvest rate is 75%, then the multiplier is *four*. (The general formula to correct the PIT tag based SARs is $(1-h_t)^{-1}$).

Aswea has found harvest rate data for a number of CWT tagged Columbia River basin populations. The attached figure shows the harvest rate multiplier that is needed to correct PIT tag based SAR estimates for these populations. The top two panels show the multipliers needed to correct PIT tag based SAR estimates for FALL Chinook based on reported harvest rates in (top) the ocean and (middle) in-river fisheries; one would need to multiply the two values together to get the full correction for harvest losses.

The bottom figure shows the same result for in-river harvest rate of Spring (yearling) stocks. (We exclude ocean harvest of Spring stocks because it is very low).

The key points I want to make are that there are (1) huge biases in the PIT tag-based SARs and (2) there is no simple way to correct for these biases. As a result, variation in PIT-based SARs due to changes in harvest rates will bias the true survival values in unexpected ways. The graph shows the available time series of harvest rate data we have collected so far from official sources. The FPC's SAR estimates start around 1998 and go to 2012, so is the time interval most relevant to what I will show.

Fall Chinook stocks are shelf resident and subject to many ocean fisheries, so failing to include harvest in the SAR estimates means that PIT tag based estimates are way low compared to the actual SARs. For example, take Lyons Ferry (Snake River) Fall Chinook. Around 2004 harvest rates were low, so the CSS SAR estimates "only" need to be multiplied by ~1.4 to get the actual SAR (too low by 40%... still a big number). However, fisheries managers changed something so harvest rates went up dramatically over time, so by 2012 the harvest rate multiplier was between 3~4 (note log scale). In other words, somewhere between 2/3rds and 3/4s of the adults were harvested at sea and failed to come back—Managers had doubled the at sea harvest rate! Even if there was no change in natural mortality at sea the CSS SAR estimates would then drop to half its former value, which would seriously compromise any ability to discern the effect of spill or TDG levels on adult returns.

The middle panel shows the in-river (freshwater) harvest rates for Fall Chinook and the same story of variable large harvest rates holds here. (Note that we switched to an arithmetic y-axis because the variability isn't so extreme). To get the full impact on PIT Tag SARs we need to multiply the top and middle panel values together for Fall Chinook. These are extremely large numbers compared to the much smaller

variability that the CSS tries to interpret as the effect of hydrosystem manipulation on survival.

Things are somewhat better for Spring Chinook, but really only in comparison. There is negligible harvest at sea (perhaps ~2%), so no substantial effect on PIT tag based SAR estimates. But even Snake River Spring/Summer Chinook, where harvest rates are lowest and most stable there is a great deal of variation in in-river (freshwater) harvest rates (bottom panel)—if we take the annual point estimates at face value there could be 10-20% variation in SARs just because of in-river harvest rate variation between years.

My question: To what degree has the Columbia River community recognized the magnitude of the potential errors from interpreting PIT tag based SARs as reflective of hydrosystem manipulations several years earlier (spill, TDG…)? These effects seem shockingly large to me and strongly suggests that the use of PIT tags should be restricted to measuring smolt survival to Bonneville Dam and *not* the adult return. I am looking for practical guidance as to whether the broader Columbia River community just dismisses the CSS claims (I think not) and how much we should emphasize this finding in our revised manuscript.

From: David Welch
Sent: Monday, October 14, 2019 6:49 PM
To: Aswea Porter
Subject: RE: SARS-- harvest multiplier figure

Thanks, Aswea. It makes most sense to have the x-axis the same for all 3 panels. To me (an "ocean guy"!) it makes most sense to lag all of them back to ocean entry year, but no one would object to lagging the data back to brood year or even year of (primary) adult return (Return Year).

You said in your email this morning “x axis is Brood Year for plot A the subyearling total harvest, and is Return Year for the other 2 plots”**. I would normally expect that the top two panels (Fall Chinook) would have a common reference year, but you are saying that Fall inriver harvest and Spring in-river harvest are both Return year, which perhaps makes the greatest sense for most readers—the year of major adult harvest. So for consistency Panel A should be lagged forward by 4 years to capture the primary age of adult return for Fall Chinook: The adults spawn in year t, the eggs hatch and go to sea in (roughly) June of year t+1, and the adults come back 3 yrs (& 4 yrs) later at age t+4. So if brood year is year t, Return Year for Fall Chinook will be t+4.**

Can you oblige?

From: Aswea Porter
Sent: Monday, October 14, 2019 5:47 AM
To: David Welch
Subject: RE: SARS-- harvest multiplier figure

Right now, the x axis is Brood Year for plot A the subyearling total harvest, and is Return Year for the other 2 plots.

You asked me to convert plot A to Ocean Entry Year awhile ago, but this version is still Brood Year. You also suggested a few days ago that we lag the adult returns back by 2 calendar years for springs and 3 years for falls which is the main age of return; however, I understood that to apply to how we’d actually correct the SARs rather than to the plots.

Convert Plot A to Ocean Entry? Assuming yes.

Lag the adult returns for Plots B and C?

From: David Welch
Sent: October-14-19 01:44
To: Aswea Porter
Subject: RE: SARS-- harvest multiplier figure

Thanks, Aswea—One quick question: What is the appropriate x-axis label? Brood Year? ocean entry year?

From: Aswea Porter
Sent: Sunday, October 13, 2019 12:27 PM
To: David Welch
Subject: RE: SARS-- harvest multiplier figure

Next version!

From: David Welch
Sent: October-10-19 14:06
To: Aswea Porter

Subject: RE: SARS-- harvest multiplier figure

Please put this data together. Let's make your existing harvest rate multiplier figure 3 panels: (A) Subyearling (Ocean Harvest); (B) Subyearling (In-River Harvest); (C) yearling (In-River Harvest).

Just label the 3 panels with A, B, & C.. there isn't enough space to do more while putting the labeling in a consistent position for all three panels.

Although Ocean-freshwater pairings for the same stock would be nice, the main purpose here is to show whether there have been large changes in harvest rates that would affect the PIT tag-based SAR estimates, so the goal here is to show credible time series of data, not necessarily just the same stocks. (That may come in a final step).

From: Aswea Porter
Sent: Thursday, October 10, 2019 2:56 AM
To: David Welch
Subject: RE: SARS-- harvest multiplier figure

Yes, there are some data for fall stocks, but not easy pairings.

-PFMC Table B15 has harvest for Spring Ck fall CH which you'd think is a match with the CTC Spring Creek population.

-PFMC Table B18 is for upriver bright fall Chinook destined for areas above McNary Dam and the Deschutes River. This might roughly match the CTC Upriver Bright stock (which is actually from Priest Rapids Hatchery) and maybe the Lyons Ferry stock.

PFMC Table B19 is for mid Columbia bright fall CH destined for areas below McNary Dam. This might roughly match the CTC mid-Columbia Summers because both groups outmigrate as subyearlings...but maybe freshwater harvest differs too much between fall and summer adult returns??

The JointStaff report has a table for Snake Wild Fall CH. Also data for other fall CH stocks, but is either for only one year or requires a magical matching of tables in order to obtain the full harvest.

From: David Welch
Sent: October-09-19 17:28
To: Aswea Porter
Subject: RE: SARS-- harvest multiplier figure

Thanks Aswea.

A question—this figure shows ocean harvest rates for subyearlings, and in-river harvest rates for yearlings. In pulling this together, did you come across data on what in-river harvest rates would be for subyearling stocks in the Columbia River (ideally, of course) the same stocks as are in the existing harvest rate plot!

d

From: Aswea Porter
Sent: Wednesday, October 09, 2019 11:52 AM
To: David Welch
Subject: RE: SARS-- harvest multiplier figure

Hi D,

Here's an update on the harvest rate multiplier figure. See below

~A

From: David Welch
Sent: October-07-19 20:14
To: Aswea Porter
Cc: Erin Rechisky
Subject: RE: SARS-- harvest multiplier figure

As below.

From: Aswea Porter
Sent: Saturday, October 05, 2019 2:24 PM
To: David Welch
Cc: Erin Rechisky
Subject: SARS-- harvest multiplier figure

Hi D,

Here are the harvest adjustment factors for subyearlings (same as previous) and yearlings. The yearling plot is not straightforward:

1) The CTC harvest data is by ocean entry year. The JointStaff and PFMC are by return year. For the later, it's not clear how we would apply a harvest multiplier directly. It will be fine as a general adjustment (as harvest ranged between x-y).***[DW>]*** **For springs, we lad adult returns back by 2 calendar years. For Falls, we lag back by 3 yrs. This is the main age of return after entering the ocean as smolts. ADP: ok**

2) The Upriver Spring stock includes all spring Chinook originating above BON and the Snake River summers because their run timing overlaps.

3) The Upriver Summer stock includes all summer Ch originating above BON minus the Snake River summers.

4) Between 1980 and 1994, the WA/OR Joint numbers are reported as 5-yr averages for the Upriver Spring and UCOL Summer stocks. I needed a value for each year so I just used the average value for each of the years that contributed. This means the CIs are incorrect (too tight).***[DW>]*** **We should just put a single dot in at the midpoint of each 5 yr average… or delete. Not sure what makes more sense (maybe the former) . ADP: I**

went back to an older report (2010) and found the original estimates back to 1990 for Upriver Springs and back to the start (1980) for Upriver summers. Helps. For the remaining averages, I still retained the average for each year because using only 1 dot per 5 years will artificially inflate the CIs. Can remove if you'd prefer to be conservative.

5) The data for Upper Columbia Wild Spring are completely obscured by Snake Wild Spring/Summer.***[DW>]*** **.I'm not clear what you mean here by "obscure"… the values are identical, so one overplots the other?.** ADP: Yes, 100% overplotting.The Run Size and counts harvested differ, but their ratio is the same suggesting some formula must have been used. Possibly the main point of these tables was to estimate other values such as Passage Loss? In future, I would need to remove data for one group and label the other so that it is for both.

6) The plot combines 2 data sources. One is the PFMC Review of Ocean Salmon Fisheries (PFMC), and the other is the WA/OR Joint Staff Report: Stock Status and Fisheries (WA/OR Joint).

7) The specific harvests included in the harvest rate calculation are unclear. Do we need a firm understanding here (i.e. I ask Jeromy) or should we instead write the report in a way that doesn't rely on clearly knowing what's included***[DW>]*** **TRhe latter.**? ADP: Sure! Hope it works.The harvest rate multipliers are substantially smaller for the Yearlings and won't shift a SAR of 1% very far regardless if trib harvest is included or not.***[DW>]*** **Perhaps not in absolute magnitude, but it is still extremely important. I frequently heard speakers speculate about what caused SARs to increase from 1% to 1.2% or 1.3% and then further speculation about how if they can identify what in the hydrosystem is causing the change they can then manage the system to drive that change to higher values. If this is just due to harvest rate fluctuations then those efforts will be still-borne. ADP: Right.**

a. Upriver Spring: This is the only stock with 2 estimates—one from each source. The PFMC harvest rates include tributaries while WA/OR Joint Staff rates for the same stock do not. It is unclear which tributaries are included—which is what I asked Jeromy last week.***[DW>]*** **Oh… I think I finally figured out your plot. Solid line means PFMC, dashed WA/OR? (The blue colour for that pair threw me off). ADP: Was a default legend. For simplicity, I removed the linetype legend (ie JointStaff vers PFMC) with the idea that you could explain in the legend ("Dotted lines indicate data from the WA/OR Joint Staff Reports (2018); solid lines are data from the PFMC (2018)". Otherwise, I'll have to concatenate the stock and data source in the legend for every group and then manually set the colours and linetypes. Not sure the data source is that important to**

have it repeated for each stock.

b. Upriver Summers: includes tributaries but not clear exactly which ones.

c. Upper Columbia Wild Spring and Snake Wild Spring/Summer. Labelling on tables (and magnitude of the harvest rate multiplier) suggest that these are only for mainstem to the end of Zone 6 (McNary Dam or the WA/OR border ~ 20kms further on). But unclear.

d. Upper Columbia Summers: includes harvest beyond Zone 6 up to Grand Coulee Dam plus harvest from the Colville Tribe which is probably a bit beyond the GC Dam because that's where the town of Colville is.***[DW>]*** **There are no salmon above Grand Coulee dam—I believe that the dam cut off all salmon stocks from farther upstream? In any event, I think we just report some of these estimates as illustrative of the level that inclusion of harvest will compromise SAR estimates if it is not included. ADP: Ok. Must just be the town up there then. The trival harvest must be nearby. Also, I discovered that the tributary harvest is only included for years 2000 and beyond for this stock. Previous values stop at end of Zone 6.**

To take up less room in the manuscript, I could use axis labels only on the bottom plot with axis title=Year which we would have to explain in the legend. Then move the Yearling and Subyearling labels into the plot body or on the right like a facetted plot. I am thinking the log 2 axis is not necessary for the Yearling plot. Any other requests? ***[DW>]*** **Sure. I agree with all of this. However, if I am having trouble understanding the current legend others will have a much more difficult time.**

~A

Aswea Dawn Porter

Senior Research Analyst

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From: David Welch

Sent: Mon Oct 21 14:48:22 2019

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] FW: SARS-- harvest multiplier figure

Importance: Normal

Hi Christine—

Just a reminder that we would like the OK to reduce the scope of the first article to focus only on Chinook (i.e., drop steelhead). As below, the article will be too long for CJFAS if we have to add in all the graphs for steelhead, as it will definitely exceed journal limits on the number of figures, as well as take additional time (we have to dig out steelhead harvest rates from the various agency reports for the Columbia River basin).

Regards, David

From: Erin Rechisky
Sent: Friday, October 18, 2019 12:18 PM
To: David Welch; Aswea Porter
Subject: RE: SARS-- harvest multiplier figure

I think the journal decision party depends on Jody's answer as to whether we drop steelhead out of the analysis. (otherwise it may be too long). The other part is content.

From CJFAS:

Scope

The *Canadian Journal of Fisheries and Aquatic Sciences* (publishing since 1901 under various titles) is the primary publishing vehicle for the multidisciplinary field of aquatic sciences. It publishes perspectives (syntheses, critiques, and re-evaluations), discussions (comments and replies), articles, and rapid communications, relating to current research on -omics, cells, organisms, populations, ecosystems, or processes that affect aquatic systems. The journal seeks to amplify, modify, question, or redirect accumulated knowledge in the field of fisheries and aquatic science. For primary biodiversity data authors are strongly encouraged to place all species distribution records in a publicly accessible database such as the national Global Biodiversity Information Facility (GBIF) nodes (www.gbif.org) or data centres endorsed by GBIF, including BioFresh (www.freshwaterbiodiversity.eu) for freshwater data and the Ocean Biogeographic Information System (OBIS, http://www.iobis.org/) for marine biodiversity data, which also holds supporting measurements taken alongside the species occurrence data.

From Fish and Fisheries:

Fish and Fisheries adopts a broad, interdisciplinary approach to the subject of fish biology and fisheries. It draws contributions in the form of major synoptic papers and syntheses or meta-analyses that lay out new approaches, re-examine existing findings, methods or theory, and discuss papers and commentaries from diverse areas. Focal areas include fish palaeontology, molecular biology and ecology, genetics, biochemistry, physiology, ecology, behaviour, evolutionary studies, conservation, assessment, population dynamics, mathematical modelling, ecosystem analysis and the social, economic and policy aspects of fisheries where they are grounded in a scientific approach.

From: David Welch
Sent: October 18, 2019 12:01 PM
To: Aswea Porter
Cc: Erin Rechisky
Subject: RE: SARS-- harvest multiplier figure

Let's discuss with Erin as well… now may be a good time to discuss—Erin, comments on the below?

From: Aswea Porter
Sent: Friday, October 18, 2019 12:00 PM
To: David Welch
Subject: FW: SARS-- harvest multiplier figure

Hi D,

Did you choose a journal? If so, I could update the harvest rate plot while I wait for some clarity on the RMIS data.
[DW>] I'm inclined to go with CJFAS. Jody Lando of BPA liked it as well.

Did you like the secondary y-axis with the actual harvest rate labels?***[DW>]*** Yes!!

I'm having a slow work day because I don't know where to go with the SARS work...only just over an hour so far.

~A

From: Aswea Porter
Sent: October-15-19 14:32
To: David Welch
Cc: Erin Rechisky
Subject: RE: SARS-- harvest multiplier figure

I don't see anything too restrictive at cjfas:

https://www.nrcresearchpress.com/page/cjfas/authors#illustrations

No definition on what is "essential labelling"

"Only essential labelling should be used, with detailed

information given in the caption"

“**Color illustrations** will be at the author’s expense.”

Requires CYMK colour modes so I’d have to figure that out again.

From: David Welch
Sent: October-15-19 12:22
To: Aswea Porter
Subject: Re: SARS-- harvest multiplier figure

Labelling the lines looks great, Aswea... I was going to suggest this for exactly the reason that you mention. If you can do that for the other two panels, please do so.

1). We do need to decide on a target journal because of some of the minutiae about how graphs need to be constructed. I was thinking about maybe submitting to CJFAS, but they used to have very picky and unreasonable strictures on how graphs were to be done. One point for me that would rule it out would be if they still prohibit labelling lines in graphs with full names. (They wanted single letter labels and the explanation in the legend, which was daft). Can you have a look at current guidelines?

If the guidelines have been eaed we can have a discussion with Erin about whether we go with Fish and Fisheries or CJFAS

Thx, d

David Welch, Kintama Research

Tel: +1 (250) 729-2600 x223

Cell: +[redacted]

Sent from my iPad

On Oct 15, 2019, at 07:39, Aswea Porter <Aswea.Porter@kintama.com> wrote:

Good morning David,

It's easy enough to lag the years; however, this figure is presenting a Harvest Rate Multiplier rather than Harvest Rates. As such, I'm thinking it implies that the values in each year can be multiplied by the SARs in that same year—which in our case is ocean entry year. If it was a Harvest Rate plot, then I'd agree that using the year of most ocean harvest would be best.

I guess I'm also a bit hesitant to lag the Panel A estimates because these are the only ones that CAN be multiplied directly by the SAR without inaccuracies around lagging (i.e. the CTC went to the work to pair the harvest to the brood year).

later...Writing this stimulated me to see if I could add a secondary axis to the harvest rate multiplier plot to show the actual harvest rate. Draft attached. Everything is a little wonky but I don't want to take more time until you've reviewed. In particular, I got hung up trying to get the Panel A secondary axis to start at 0...no luck there...the secondary axis is a transformation of the primary axis which is on a log scale in this case which I suspect is causing the trouble.

Other main change is to remove the legends and instead label the lines. The legends take up a lot of room. I've made room for the labels, but only carried through for Panel A using the CTC abbreviations. For the other panels, I've have to either make up labels, or we could switch to lower case letters or something. Unfortunately, the harvest rate stocks don't all correspond to the stocks with SARS which already have an abbreviation corresponding with their mapcode.

~A

~A

From: David Welch
Sent: October-14-19 23:19
To: Aswea Porter
Subject: RE: SARS-- harvest multiplier figure

Thanks, Aswea. It makes most sense to have the x-axis the same for all 3 panels. To me (an "ocean guy"!) it makes most sense to lag all of them back to ocean entry year, but no one would object to lagging the data back to brood year or even year of (primary) adult return (Return Year).

You said in your email this morning "x axis is Brood Year for plot A the subyearling total harvest, and is Return Year for the other 2 plots"**. I would normally expect that the top two panels (Fall Chinook) would have a common reference year, but you are saying that Fall inriver harvest and Spring in-river harvest are both Return year, which perhaps makes the greatest sense for most readers—the year of major adult harvest. So for consistency Panel A should be lagged forward by 4 years to capture the primary age of adult return for Fall Chinook: The adults spawn in year t, the eggs hatch and go to sea in (roughly) June of year t+1, and the adults come back 3 yrs (& 4 yrs) later at age t+4. So if brood year is year t, Return Year for Fall Chinook will be t+4.**

Can you oblige?

From: Aswea Porter
Sent: Monday, October 14, 2019 5:47 AM
To: David Welch
Subject: RE: SARS-- harvest multiplier figure

Right now, the x axis is Brood Year for plot A the subyearling total harvest, and is Return Year for the other 2 plots.

You asked me to convert plot A to Ocean Entry Year awhile ago, but this version is still Brood Year. You also suggested a few days ago that we lag the adult returns back by 2 calendar years for springs and 3 years for falls which is the main age of return; however, I understood that to apply to how we'd actually correct the SARs rather than to the plots.

Convert Plot A to Ocean Entry? Assuming yes.

Lag the adult returns for Plots B and C?

From: David Welch
Sent: October-14-19 01:44
To: Aswea Porter
Subject: RE: SARS-- harvest multiplier figure

Thanks, Aswea—One quick question: What is the appropriate x-axis label? Brood Year? ocean entry year?

From: Aswea Porter
Sent: Sunday, October 13, 2019 12:27 PM
To: David Welch
Subject: RE: SARS-- harvest multiplier figure

Next version!

From: David Welch
Sent: October-10-19 14:06
To: Aswea Porter
Subject: RE: SARS-- harvest multiplier figure

Please put this data together. Let's make your existing harvest rate multiplier figure 3 panels: (A) Subyearling (Ocean Harvest); (B) Subyearling (In-River Harvest); (C) yearling (In-River Harvest).

Just label the 3 panels with A, B, & C.. there isn't enough space to do more while putting the labeling in a consistent position for all three panels.

Although Ocean-freshwater pairings for the same stock would be nice, the main purpose here is to show whether there have been large changes in harvest rates that would affect the PIT tag-based SAR estimates, so the goal here is to show credible time series of data, not necessarily just the same stocks. (That may come in a final step).

From: Aswea Porter
Sent: Thursday, October 10, 2019 2:56 AM
To: David Welch
Subject: RE: SARS-- harvest multiplier figure

Yes, there are some data for fall stocks, but not easy pairings.

-PFMC Table B15 has harvest for Spring Ck fall CH which you'd think is a match with the CTC Spring Creek population.

-PFMC Table B18 is for upriver bright fall Chinook destined for areas above McNary Dam and the Deschutes River. This might roughly match the CTC Upriver Bright stock (which is actually from Priest Rapids Hatchery) and maybe the Lyons Ferry stock.

PFMC Table B19 is for mid Columbia bright fall CH destined for areas below McNary Dam. This might roughly match the CTC mid-Columbia Summers because both groups outmigrate as subyearlings...but maybe freshwater harvest differs too much between fall and summer adult returns??

The JointStaff report has a table for Snake Wild Fall CH. Also data for other fall CH stocks, but is either for only one year or requires a magical matching of tables in order to obtain the full harvest.

From: David Welch
Sent: October-09-19 17:28
To: Aswea Porter
Subject: RE: SARS-- harvest multiplier figure

Thanks Aswea.

A question—this figure shows ocean harvest rates for subyearlings, and in-river harvest rates for yearlings. In pulling this together, did you come across data on what in-river harvest rates would be for subyearling stocks in the Columbia River (ideally, of course) the same stocks as are in the existing harvest rate plot!

d

From: Aswea Porter
Sent: Wednesday, October 09, 2019 11:52 AM
To: David Welch
Subject: RE: SARS-- harvest multiplier figure

Hi D,

Here's an update on the harvest rate multiplier figure. See below

~A

From: David Welch
Sent: October-07-19 20:14

To: Aswea Porter
Cc: Erin Rechisky
Subject: RE: SARS-- harvest multiplier figure

As below.

From: Aswea Porter
Sent: Saturday, October 05, 2019 2:24 PM
To: David Welch
Cc: Erin Rechisky
Subject: SARS-- harvest multiplier figure

Hi D,

Here are the harvest adjustment factors for subyearlings (same as previous) and yearlings. The yearling plot is not straightforward:

1) The CTC harvest data is by ocean entry year. The JointStaff and PFMC are by return year. For the later, it's not clear how we would apply a harvest multiplier directly. It will be fine as a general adjustment (as harvest ranged between x-y).***[DW>]*** **For springs, we lad adult returns back by 2 calendar years. For Falls, we lag back by 3 yrs. This is the main age of return after entering the ocean as smolts. ADP: ok**

2) The Upriver Spring stock includes all spring Chinook originating above BON and the Snake River

summers because their run timing overlaps.

3) The Upriver Summer stock includes all summer Ch originating above BON minus the Snake River summers.

4) Between 1980 and 1994, the WA/OR Joint numbers are reported as 5-yr averages for the Upriver Spring and UCOL Summer stocks. I needed a value for each year so I just used the average value for each of the years that contributed. This means the CIs are incorrect (too tight).***[DW>]*** **We should just put a single dot in at the midpoint of each 5 yr average… or delete. Not sure what makes more sense (maybe the former) . ADP: I went back to an older report (2010) and found the original estimates back to 1990 for Upriver Springs and back to the start (1980) for Upriver summers. Helps. For the remaining averages, I still retained the average for each year because using only 1 dot per 5 years will artificially inflate the CIs. Can remove if you'd prefer to be conservative.**

5) The data for Upper Columbia Wild Spring are completely obscured by Snake Wild Spring/Summer.***[DW>]*** **.I'm not clear what you mean here by "obscure"… the values are identical, so one overplots the other?.** ADP: Yes, 100% overplotting.The Run Size and counts harvested differ, but their ratio is the same suggesting some formula must have been used. Possibly the main point of these tables was to estimate other values such as Passage Loss? In future, I would need to remove data for one group and label the other so that it is for both.

6) The plot combines 2 data sources. One is the PFMC Review of Ocean Salmon Fisheries (PFMC), and the other is the WA/OR Joint Staff Report: Stock Status and Fisheries (WA/OR Joint).

7) The specific harvests included in the harvest rate calculation are unclear. Do we need a firm understanding here (i.e. I ask Jeromy) or should we instead write the report in a way that doesn't rely on clearly knowing what's included***[DW>]*** **TRhe latter.**? ADP: Sure! Hope it works.The harvest rate multipliers are substantially smaller for the Yearlings and won't shift a SAR of 1% very far regardless if trib harvest is included or not.***[DW>]*** **Perhaps not in absolute magnitude, but it is still extremely important. I frequently heard speakers speculate about what caused SARs to increase from 1% to 1.2% or 1.3% and then further speculation about how if they can identify what in the hydrosystem is causing the change they can then manage the system to drive that change to higher values. If this is just due to harvest rate fluctuations then those efforts will be still-borne. ADP: Right.**

a. Upriver Spring: This is the only stock with 2 estimates—one from each source. The PFMC harvest rates include tributaries while WA/OR Joint Staff rates for the same stock do not. It is unclear which tributaries are included—which is what I asked Jeromy last week.***[DW>]*** **Oh… I think I finally figured out your plot. Solid line means PFMC, dashed WA/OR? (The blue colour for that pair threw me off). ADP: Was a default legend. For simplicity, I removed the linetype legend (ie JointStaff vers PFMC) with the idea that you could explain in the legend ("Dotted lines indicate data from the WA/OR Joint Staff Reports (2018); solid lines are data from the PFMC (2018)". Otherwise, I'll have to concatenate the stock and data source in the legend for every group and then manually set the colours and linetypes. Not sure the data source is that important to have it repeated for each stock.**

b. Upriver Summers: includes tributaries but not clear exactly which ones.

c. Upper Columbia Wild Spring and Snake Wild Spring/Summer. Labelling on tables (and magnitude of the harvest rate multiplier) suggest that these are only for mainstem to the end of Zone 6 (McNary Dam or the WA/OR border ~ 20kms further on). But unclear.

d. Upper Columbia Summers: includes harvest beyond Zone 6 up to Grand Coulee Dam plus harvest from the Colville Tribe which is probably a bit beyond the GC Dam because that's where the town of Colville is.***[DW>]*** **There are no salmon above Grand Coulee dam—I believe that the dam cut off all salmon stocks from farther upstream? In any event, I think we just report some of these estimates as illustrative of the level that inclusion of harvest will compromise SAR estimates if it is not included. ADP: Ok. Must just be the town up there then. The trival harvest must be nearby. Also, I discovered that the tributary harvest is only included for years 2000 and beyond for this stock. Previous values stop at end of Zone 6.**

To take up less room in the manuscript, I could use axis labels only on the bottom plot with axis title=Year which we would have to explain in the legend. Then move the Yearling and Subyearling labels into the plot body or on the right like a facetted plot. I am thinking the log 2 axis is not necessary for the Yearling plot. Any other requests?***[DW>]*** **Sure. I agree with all of this. However, if I am having trouble understanding the current legend others will have a much more difficult time.**

~A

Aswea Dawn Porter

Senior Research Analyst

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<Harvest_Multiplier_150Oct19temp.tif>

From: David Welch

Sent: Wed Oct 23 12:55:03 2019

To: Petersen,Christine H (BPA) - EWP-4; Jody Lando (BPA)

Subject: [EXTERNAL] FW: Follow up on Dworshak Hatchery SARs...

Importance: Normal

FYI, see Aswea's questions about the SAR estimates the Dworshak staff have published in their (IDFG) report series. As you will see, lots of questions even though this seems to be a very well buttoned-down product in comparison with most!

This email trail is separate from the issues we raised with you last week about the problems with the CSS' PIT-tag based SAR estimates, which definitely fail to include harvest and are therefore biased very low by a highly variable amount. I am passing this on to you as an example of how challenging it is to nail down what is actually going on in even the best documented time series, and that BPA staff should be cognizant of the need to get these groups to really carefully (and fully) document how they derive their SAR estimates.

Short version: **if Dworshak is deficient, other groups will likely be even more so. This applies to both PIT & CWT based SAR estimates. But because the SAR is the "gold standard" for demonstrating that hydrosystem modifications will be effective in improving conservation, it is very important for BPA to get this right. Over time, this will involve identifying *which* time series are actually credible and documenting how credible they are.**

The former has three components: at the very least include annual estimates of all important processes forming the SAR: Catch (Harvest—all fisheries), Escapement (to spawning grounds), and Hatchery rack removals.

David Welch, Ph.D.

kintamav_RGB

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Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

2

P Please consider the environment before printing this e-mail

David

From: Aswea Porter
Sent: Wednesday, October 23, 2019 12:21 PM
To: David Welch
Subject: FW:

Hi D,

I called the FWS to ask about the Dworshak SARS. Not a good call. The authors have all moved away and the replacement doesn't know the methods. They are using PBT for SARS now. I emailed my questions—apparently forgetting to add a subject line (sigh). He said that he would reply next week.

~A

From: Aswea Porter
Sent: October-23-19 16:49
To: 'christopher_griffith@fws.gov'
Cc: David Welch
Subject:

Hi Christopher,

Thanks for talking just now. As I mentioned, my company is writing a paper that collates survival to adult return data (SAR) along the west coast of North America. As part of this, I am trying to understand the differences between SARs calculated by differing groups. In particular, we are using the SARs calculated by the Pacific Salmon Commission using coded wire tags, by the Fish Passage Center's Comparative Survival Study using PIT tags, and those available through the Regional Mark Processing Center's RMIS database of coded wire tags. Recently, we have come across the SARS by the Idaho Fishery Resource Office in Table 3 of the attached file (HistoricAdultData_Dworshak) and I need to know how these compare.

Here are my questions regarding the SARS estimates in Table 3 of the Historic Data report attached here. I'm hoping we can chase this email with a phone call when you are ready, because there are a lot of details here!

1) Why are you calculating your own SARS rather than using the CWT returns available from the RMIS database, or the estimates from the CSS? I'm wondering if there are some flaws in those other methods or other reasons that they might not suite your purposes. You told me on the phone that you have switched to genetic methods to estimate SAR, but the question is still applicable to past years.

2) Do you know why the SARS for Dworshak available through the RMIS system are so low? I've attached a scatterplot where your SARS are plotted against those from RMIS (color coding separates the years where your SARS included escapement from the earlier years that did not as per Table 1 in the HistoricAdultData document). For example, is there a known lack of effort for CWT recovery at the hatchery or on the spawning grounds? Or inaccuracies in the expansion of CWT recoveries? The RMIS estimates are from hatchery release until adult return to the hatchery and spawning grounds, and are theoretically compensated for sport, tribal and commercial harvest

in the mainstem and tributaries.

3) What are the start and end points for the SARs estimates? Using Tables 11 and 12 in the SCSAnnualReport, it appears to me that the start is hatchery release, and the end is adult return to Lower Granite Dam.

4) Are these SARS compensated for harvest (ie was the harvest added back in)? From the descriptions, the estimates of sport and tribal harvest appear to be limited to the Clearwater and Clear Ck (ie not mainstem Columbia commercial, sport, or tribal harvests). If the SARS end with adult return to Lower Granite Dam, then these harvests occur upstream of the end point.

5) Table 9 provides the conversation rates. For the rate between Lower Granite Dam and Dworshak, the conversion rate is 0.22. This means that 78% of the fish detected at Lower Granite did not survive to reach Dworshak correct? If so, that's a lot! Is it possible to identify how much of this mortality is due to harvest versus natural processes? In the previous report (for 2014), the conversion rates are in Table 10...I'm just curious if you know why the conversion rate between Bonneville and Lower Granite plummeted from 0.72 in the 2014 report to 0.197 in 2015?

Thank you!

Aswea

Aswea Dawn Porter

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From: David Welch

Sent: Fri Nov 01 06:23:09 2019

To: Petersen,Christine H (BPA) - EWP-4; Jody Lando (BPA)

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] BPA-Kintama Check in (1 Nov 2019).pptx

Importance: Normal

Attachments: BPA-Kintama Check in (1 Nov 2019).pptx

Hi Christine & Jody—

I wanted to keep our check in later this morning simple and focused on the problems we have found in sorting through how SARs are calculated, and whether the comparison between CWT & PIT tag based SARs is reasonable to do.

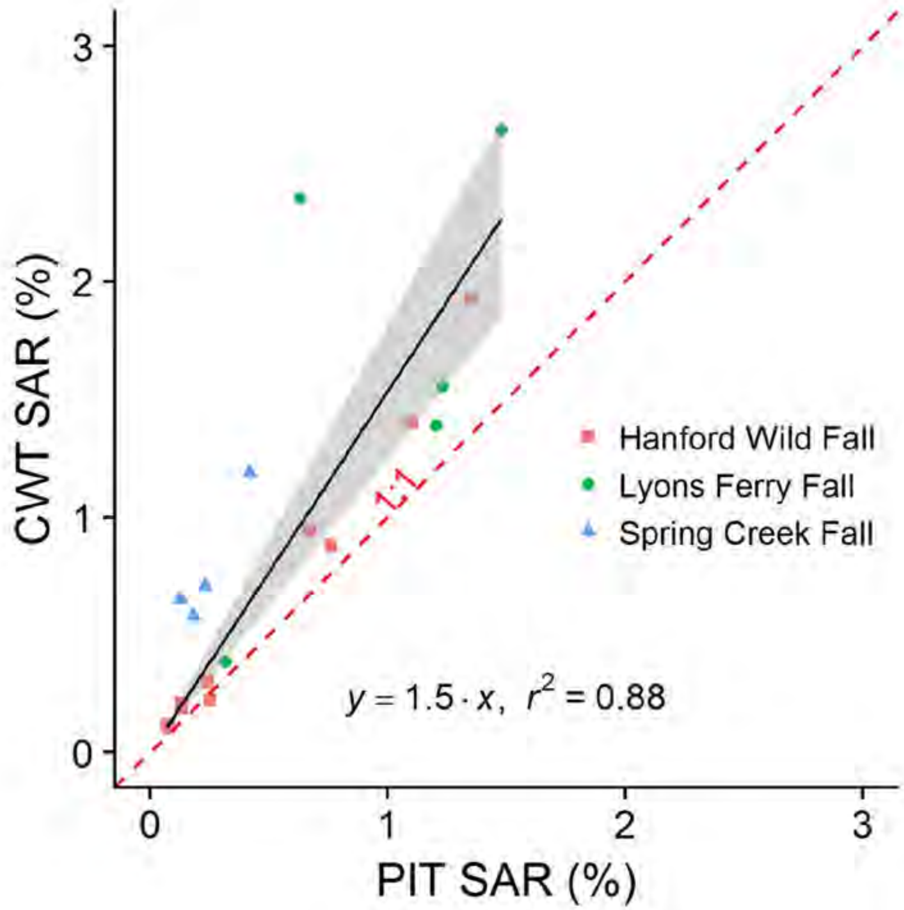
We would also value a reality check as to whether the problems we have found with the CSS/FPC's PIT tag based SARs are as significant as I think they are. The attached PowerPoint is only 4 slides long, but has no corporate identifier on it, as we need to be very sure of our ground here. I hope we can have a wide ranging and open discussion after I step you through the slides.

Could I ask you to have this presentation open on a laptop while we go through it?

David

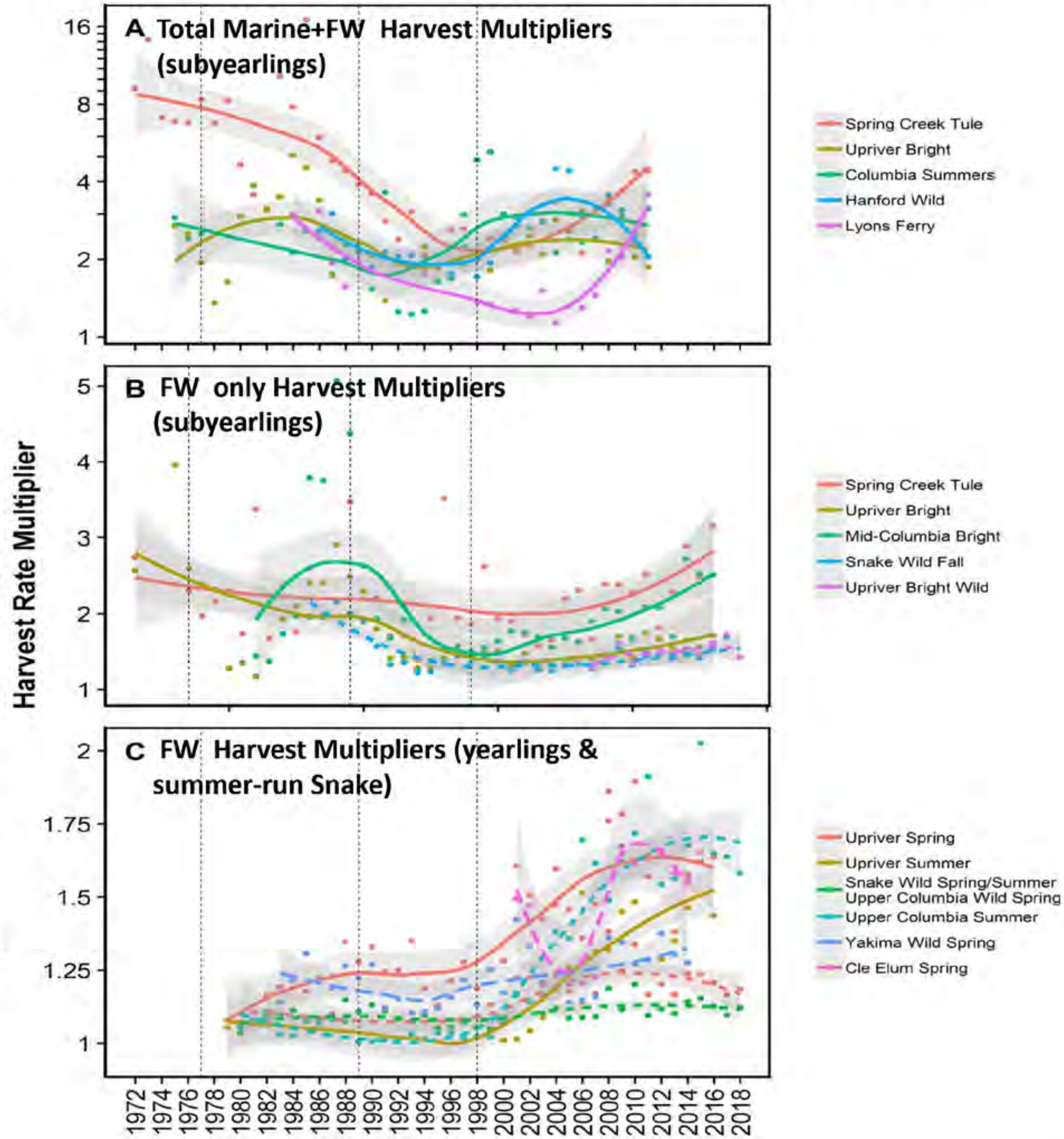
Why PIT Tag-Based SARs are Misleading

- We can compare 3 Columbia River basin subyearling (Fall) Chinook stocks that have both CWT & PIT Tag SARs generated for the same set of years.
- Not surprisingly, CWT-based SARs are 50% higher on average, because the PIT tags exclude catch (harvest) from consideration, as well as survival in the migration segment upstream of the dams.
- PIT tag SARs are seriously biased low because they do not include harvest and biased high because they exclude smolt & adult survival above the dams.
- There is also a lot of interannual variability around the regression line—possibly because of interannual variability in harvest rates. Without knowledge of what harvest levels actually were for each stock, this is hard to correct for
- The impact is less for Spring (yearling) Chinook stocks, because significant harvest occurs only in the river.



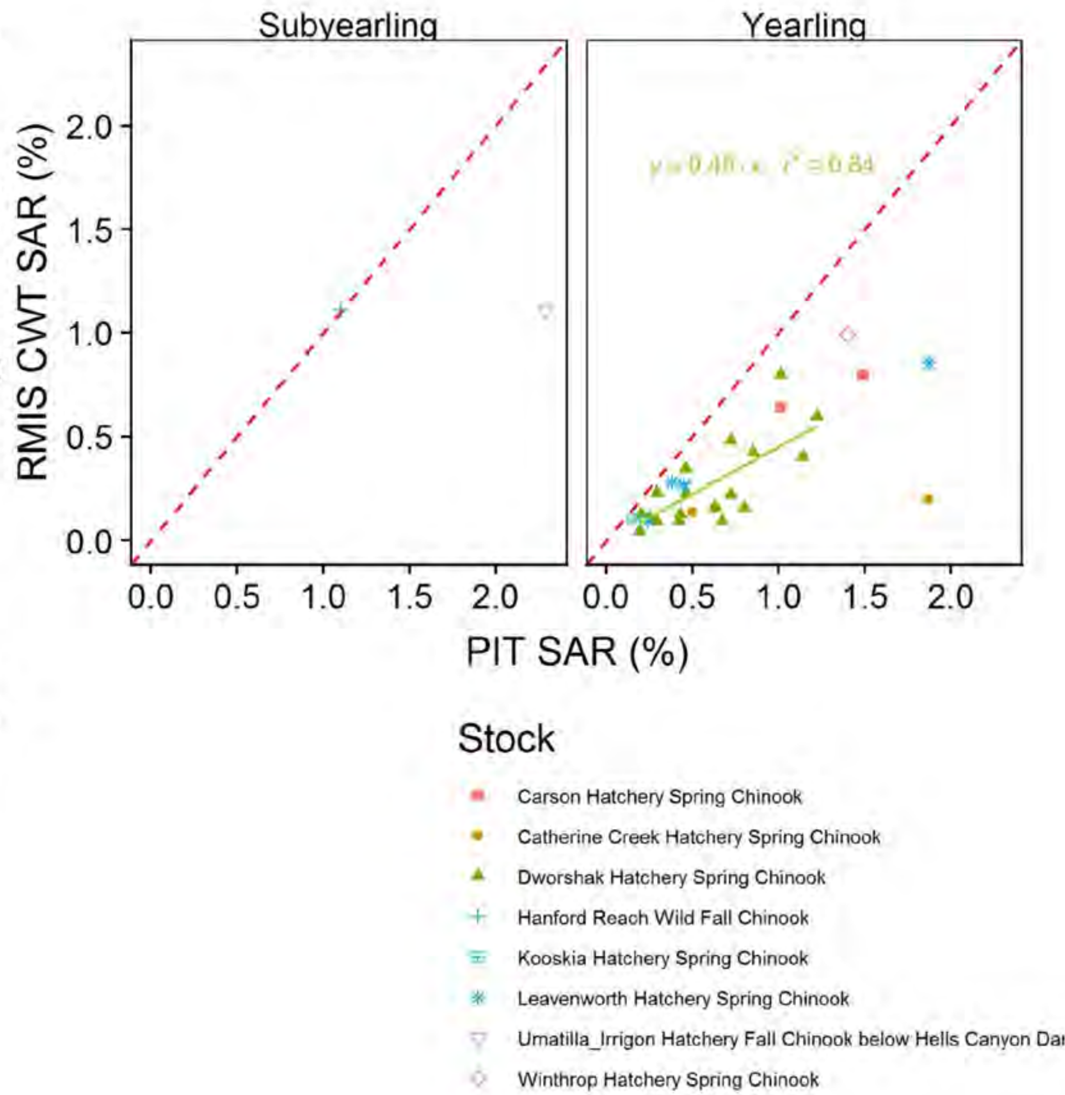
Effect of Excluding Harvest on PIT SARs

- The influence of fisheries interceptions on the return of adult Chinook to the Columbia River is highly variable by year and between stocks!!
- Y-axis shows multiplier needed in a given year to convert PIT tag based SARs to actual survival. (PIT SARs only available from 1998 to present).
- For example, if the harvest rate is 50%, the CSS' SAR must be doubled to account for adults intercepted in fisheries
- The upshot is excluding harvest when calculating PIT Tag SARs will have large & unpredictable impacts on survival estimates
- **Solid lines** are data from the Review of 2018 Ocean Salmon Fisheries by the Pacific Fishery Management Council
- **Short-dashed lines** are from the 2019 WA/OR Joint Staff Report
- **Long-dashed lines** are from the Yakima Klickitat Fisheries Project 2016 Annual Report



RMIS ☹

- Most SAR data in RMIS seems to be deficient
- Not all components of the catch (harvest) & escapement are enumerated & included.
- Hard to determine what to do here apart from going door-to-door with hatchery staff and trying to figure out what data is actually missing! (We will not… too time consuming)
- There needs to be a coast-wide workshop designed to set SAR standards and align best practices
- In correspondence with Dworshak NFH, Aswea encountered a new term we had never heard before: SAS (Smolt to Adult Survivals), as opposed to SARs (Returns).
- To quote verbatim: "**All harvest, including below LGR, is used to calculate SAS (smolt-to-adult survival). Though not presented in this report it will be in future reports".**



BPA Has a Big Problem with the Use of PIT tag SARs

- Even though people in the Columbia River basin know that catches are *not* routinely included in SARs (but should be) when using PIT tags, they still think of SARs as a useful measure of survival!
- **This should be viewed as a major problem for BPA: It means anyimprovements in SARs achieved at great cost (spill, bypasses) can be simply absorbed by fisheries managers operating fisheries at a higher rate and nothing will get credited to hydrosystem improvements… SARs won't change because the fisheries absorb the benefits**
- **Second, variation in harvest rates will have large impacts on SARs. Statistical analyses looking at how spill, TDG, etc. affect adult returns using PIT tags will very likely be misleading. Even in the best case of Snake River Spring Chinook, annual harvest rate variations of 10~20% are as big as any expected improvements anticipated from hydrosystem modifications.**
- **We will work these findings up "lightly" in our revised manuscript.**

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Nov 01 09:05:41 2019

To: David Welch; Lando,Jody B (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: RE: BPA-Kintama Check in (1 Nov 2019).pptx

Importance: Normal

Okay –sounds good. I did not set up a webex – I have been having some troubles recently signing in to the computer network from the conference rooms we have here, so I will have a paper backup. That will be interesting to hear if you were able to engage the US Fish and Wildlife folks at the Idaho hatchery on this topic.

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, November 01, 2019 6:23 AM
To: Petersen,Christine H (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4
Cc: Erin Rechisky; Aswea Porter
Subject: [EXTERNAL] BPA-Kintama Check in (1 Nov 2019).pptx

Hi Christine & Jody—

I wanted to keep our check in later this morning simple and focused on the problems we have found in sorting through how SARs are calculated, and whether the comparison between CWT & PIT tag based SARs is reasonable to do.

We would also value a reality check as to whether the problems we have found with the CSS/FPC's PIT tag based SARs are as significant as I think they are. The attached PowerPoint is only 4 slides long, but has no corporate identifier on it, as we need to be very sure of our ground here. I hope we can have a wide ranging and open discussion after I step you through the slides.

Could I ask you to have this presentation open on a laptop while we go through it?

David

Title:
B: 183 - The coast-wide collapse in marine survival of Chinook salmon

Description:
Under contract 75025, we submitted a manuscript to PLoS ONE entitled "The coast-wide collapse in marine survival of west coast Chinook and steelhead: slow-moving catastrophe or a deeper failure?". This paper included smolt-to-adult returns (SAR) for Columbia Basin salmonids (Chinook salmon and steelhead) compared to Chinook and steelhead originating from areas outside of the basin, and included an update to our paper "Survival of migrating salmon smolts in large rivers with and without dams" published in PLoS Biology in 2008 with additional data on relative fresh water survival of smolts in the Fraser and Columbia rivers, and other west coast rivers where data were available.
The "coast-wide collapse" paper was reviewed by four reviewers but was not accepted for publication. A common theme of the four reviewers was that PIT-tags based SARs and coded wire tag (CWT) based SARs are not directly comparable, that the manuscript was too long, and the discussion was very opinionated. We agree, and for the next iteration of the paper we will do the following:

1) Remove the steelhead analysis from the paper (this could potentially be submitted a s a stand-alone paper)
2) Remove the comparative analysis of the freshwater smolt survival of Chinook & steelhead smolts on west coast rivers (this could potentially be submitted a s a stand-alone paper)
3) Use CWT-based SAR estimates for the Columbia R, where possible
4) Formally compare CWT to PIT tag based SAR estimates
5) Include in the SAR analysis the California (Sacramento R only) SAR data set recently published in the Canadian Journal of Fisheries and Aquatic Sciences (November 2018)
6) Reformat the paper and submit to another journal

From: David Welch

Sent: Wed Dec 18 12:39:38 2019

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: contract mod

Importance: Normal

Hi Christine—

(b) (6) [redacted] **I'm not clear what you mean by "**Also, at BPA we were not able to talk about possibly reviving the second paper where you completed the initial data analysis but we cancelled the work element for submitting the manuscript.**".**

Is there a time I can call you to discuss your email?

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, December 18, 2019 12:37 PM
To: Erin Rechisky; David Welch

Subject: RE: contract mod

Okay, for the time being I went in and set it as a 6 month extension in cbfish. Be aware that we do not typically have overlapping contracts at BPA. Also, at BPA we were not able to talk about possibly reviving the second paper where you completed the initial data analysis but we cancelled the work element for submitting the manuscript.

We should critically look at the language for 'accepted' vs submitted etc.

Christine

Sent from Workspace ONE Boxer

On Dec 18, 2019 11:13 AM, Erin Rechisky <Erin.Rechisky@kintama.com> wrote:

Hi Christine,

We've decided to submit our manuscript to Fish and Fisheries. We've e-mailed the managing editor to ask the time to a decision and to acceptance so we can get a better idea of the time require for the contract extension.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: December 17, 2019 2:00 PM
To: Erin Rechisky; David Welch
Subject: RE: contract mod

Hi,

Yes – we were hoping this period would cover the review and response to the journal. Jay Chong said he would like to minimize the number of future modifications. Is it reasonable to try to address the remaining discussions with agencies regarding PIT tag SAR protocols, and to wrap up the new harvest related section soon?

This is a very timely paper. Besides the Environmental Impact Statement and BiOp this year, there are a lot of public debates over status of various runs, and future directions for restoration (we tend to think the council is trying to regain a greater role, because he isn't that clear here about a new vision for recovery). https://www.oregonlive.com/opinion/2019/12/opinion-40-years-after-creation-northwest-power-and-conservation-council-at-a-crossroads.html

https://news.streetroots.org/2019/12/13/tragedy-ahead-if-we-do-not-act-snake-river-dams-steven-hawley-warns (this new film came out. Joe Norton at some others at the Corps in Walla Walla went to their showing, and Hawley was not very friendly towards discussion at all. Joe is a fly fisherman, and Hawley tends to have a bias towards guides and anglers so they should have had more in common. Their second film is here – the Deschutes had been a big cold water refuge due to the PGE dam at Lake Billy Chinook. When they changed back to a normal hydrograph, I have no doubt that the swallows and steelhead left as they report. There also seem to be some issues with water quality and fertilizer runoff? https://vimeo.com/203075790

From: Erin Rechisky [mailto:Erin.Rechisky@kintama.com]
Sent: Tuesday, December 17, 2019 11:30 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] RE: [EXTERNAL] RE:] RE: contract mod

Hi Christine,

David and I just discussed the deliverable date. We expect that a 4 month extension on the contract will allow us ample time to submit the manuscript. Is that acceptable, or would you like to allow for review and a decision from the journal?

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: December 17, 2019 11:08 AM
To: Erin Rechisky
Subject: [EXTERNAL] RE:] RE: contract mod

actually, this is one of the things we were looking at in the text. We used the term 'accepted' or published in various places, where it is unclear because we also discussed the contingency that the paper were not accepted. the time and amount of work for a revision is a big variable.

Christine

Sent from Workspace ONE Boxer

On Dec 17, 2019 10:23 AM, Erin Rechisky <Erin.Rechisky@kintama.com> wrote:

Hi Christine,

What is the deliverable? Submitting, first decision or acceptance?

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: December 17, 2019 9:46 AM
To: Erin Rechisky
Subject:] RE: contract mod

Hi Erin,

Do you think 5-6 months is a reasonable time to add as an extension?

I will try to supply more details later.

Christine

Sent from Workspace ONE Boxer

On Dec 13, 2019 4:43 PM, Erin Rechisky <Erin.Rechisky@kintama.com> wrote:

Hi Christine,

Thanks for the update. We can certainly include more details in the contract SOW to clarify our deliverables and dates.

We are still debating on which journal to submit our paper. We are considering CJFAS or Fish and Fisheries. The time to the first decision is about 41 days on average for CJFAS; I can't seem to find the time for Fish and Fisheries. CJFAs is a very quantitative-focused journal so we need to ensure that the paper fits the journal's scope. Fish and Fisheries hosts review papers so may be a better option given the collated data we are presenting. We will need to make a final call after the paper is more solid.

Have a good weekend,

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: December 13, 2019 3:50 PM
To: Erin Rechisky; David Welch; Aswea Porter
Subject: contract mod

Hi all,

Let's see – our discussion of the time extension dragged on a bit because we had to cancel meetings twice, and then I opened up the copy of the contract this afternoon with the proposed changes. Various people had minor edits they wanted to do with the text, because they felt we were being a bit unclear regarding the contingencies for a paper being accepted, being accepted with revisions, and whether we should specify where you are submitting the paper to. I will follow up later with some more details.

In short though, we want to extend the end date for the contract. I need to talk to Jay Chong next Monday to discover what length of period he would prefer. Naturally, it is out of your control how long a journal might take with a review. Do you still plan to submit to Canadian Journal? Do you have any anecdotal information about how long it might normally take to go through the process there?

Talk to you soon,

Christine Petersen

From: David Welch

Sent: Fri Feb 21 22:42:46 2020

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky

Cc: Aswea Porter

Subject: [EXTERNAL] RE: Clearing Up, Issue 1940

Importance: Normal

Attachments: Delayed Mortality-2006-09 Rechisky et al (PNAS 2013).tif

Thanks for this-- very interesting.

I must confess that I find it very frustrating to have people still go around saying that there is latent mortality(=delayed mortality) after we spent all that effort to design a study with Bonneville funding, fight through all the hurdles, and find that survival was identical for the Yakima & Dworshak smolts all the way to the northern tip of Vancouver Island, over 1,000 kms & 1 month away from the mouth of the Columbia River!

Here is the quote from Ed Bowles in Clearing Up:

"He told me one way to understand why latent mortality
makes sense, even if the precise cause is not understood, is
to compare adult fish returns (known as smolt-to-adult return
ratios, or SARs) to Lower Granite Dam (the fourth dam on
the Snake River) with adult returns to the John Day system
in Oregon (the third dam up the Columbia River main stem).
Spring Chinook from both watersheds experience the
same estuary and the same ocean conditions, he noted. ".

And attached is the key figure from Erin's PNAS paper; all the survival segments line up on the 1:1 line, not the 1:3.4 line (which was the relative Yakima:Dworshak SAR by the time adults from those years came back). We just didn't find any evidence in support of the theory.

I would certainly agree with Scott Levy's quote:

"Millions of juvenile salmon are perishing in the lower
Snake River and we should not be going into this next
spill season unnecessarily blind," he said".

A couple of questions:

(1) Does NOAA's COMPASS model also depend on PIT tag-based SARs for calibration, or CWTs? (I assume PIT tags, but don't really know).

(2) Can you send us the prior week's column, "(CU No. 1938 [8])"? I am just about to send the completely revised draft SAR comparison to Aswea for review (then Erin), but it piqued my interest that K.C. Mehaffey says that she did a "deep dive" into methods of measuring juvenile survival in the prior week's newsletter.

Have a great weekend, David
-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: Friday, February 21, 2020 4:23 PM
To: David Welch <David.Welch@Kintama.com>; Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: Clearing Up, Issue 1940

Hi,

There was a sort of interesting interview on various perspectives on juvenile survival around the region in the Energy newsletter this week. The most surprising might have been Scott Levy, a long term critic, seeming to take gas bubble trauma seriously - although he is mostly advocating for removing dams.

Use the pdf link and go to page 4.

Have a nice weekend

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From: NewsData LLC <dispatch@newsdata.com>
Sent: Friday, February 14, 2020 6:09 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] Clearing Up, Issue 1940

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From: David Welch

Sent: Mon Feb 24 17:14:30 2020

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky

Cc: Aswea Porter

Subject: [EXTERNAL] RE: Clearing Up, Issue 1940

Importance: Normal

Thank you!

We should touch base toward the middle of next week, once Aswea & Erin have had a chance to do a read through on the revised draft manuscript. A bit of a warning-- it is a very different manuscript from the earlier one because I (reluctantly) pruned out a lot of the material on the psychology of cognitive dissonance (which also explains the "selective ignorance" issue that you mention below). I did a lot of the cutting to make the paper more likely to pass through peer review, but I still shake my head at the obstinance of people refusing to change their minds and really ask whether "more of the same" is really going to work any better as a strategy. (As a friend of mine, who is a biomedical researcher quipped the other day when I described my frustration, that's the "more of the same strategy"... Couldn't possibly have been wrong with my original guess, so obviously we just need to do more of what hasn't been working to make things work the way we know they should!

The important new section is the part that outlines just how badly awry the PIT tag-based SARs appear to be because of the absence of data on harvest rates. The impact of not including hrvest (catch) is really large for almost all populations, and even for Snake River Spring/Summer Chinook, where harvest rates are lowest, they are still as large or larger than the signal that the FPC is trying to pull out of the SARs to predict how increased spill will benefit Snake River Spring Chinook. So we should have a conversation on that part soon with you and your colleagues.

David

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: Monday, February 24, 2020 3:41 PM
To: David Welch <David.Welch@Kintama.com>; Erin Rechisky <Erin.Rechisky@Kintama.com>
Cc: Aswea Porter <Aswea.Porter@Kintama.com>

Subject: RE: Clearing Up, Issue 1940

Hi,
Here is the earlier part of the juvenile survival essay on page 4 For the PDF version, click this link for this week's issue of Clearing Up:
https://grok.newsdata.com/cgi-bin/viewpdf.cgi?iss=cup1939&cid=IFJrjXxjxeiQ

some of the policy makers have only been paying attention to some information. The NOAA model does have some functions which allow differential survival due to arrival timing or carryover effects of transportation. Bowles et al. are selectively ignoring NOAA and other studies.

Yes, there will be no 'new' monitoring this year, (and the Corps budget from DC looks even smaller), but this week we are trying to get organized to deliver gas bubble trauma and smolt injury monitoring data from the existing monitoring at the bypasses to the hydro operators who are supposed to respond as quickly as possible. The 2020 Flexible Spill Agreement has some rules, that they would drop down from 125% TDG to 120/115% TDG once a sample of anadromous or reservoir fish exceeded a certain level (Leah knows the limit better than I do). But there are some details to be worked out about how quickly they would return back to 125%, or delay time for getting the data. I guess everyone has their hypothesis for what will happen. In 2017 and 2018, flows were periodically very high due to snowmelt and precipitation but it was not constant for days at a time. Adult monitoring is only observational.

Christine

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From: David Welch <David.Welch@Kintama.com>
Sent: Friday, February 21, 2020 10:43 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>; Erin Rechisky <Erin.Rechisky@Kintama.com>
Cc: Aswea Porter <Aswea.Porter@Kintama.com>
Subject: [EXTERNAL] RE: Clearing Up, Issue 1940

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FISH and FISHERIES

Review of the Coast-wide Decline in Survival of West Coast Chinook Salmon (Oncorhynchus tshawytscha)

Journal:	*Fish and Fisheries*
Manuscript ID	Draft
Wiley - Manuscript type:	Original Article
Date Submitted by the Author:	n/a
Complete List of Authors:	Welch, David; Kintama Research Services Ltd, Porter, Aswea; Kintama Research Services Ltd Rechisky, Erin; Kintama Research Services Ltd
Key terms:	Aquaculture, Columbia River, dams, delayed mortality, smolt-to-adults returns, Snake River
Abstract:	We collated data for Chinook salmon from all available regions of the Pacific coast of North America to examine the large-scale patterns of salmon survival. Survival, defined as smolt-to-adult return rates (SARs), collapsed over the past half century by roughly a factor of four to ca. 1% for many regions. Within the Columbia River the SARs of Snake River populations, often singled out as exemplars of poor survival, are unexceptional and in fact higher than estimates reported from other regions of the west coast lacking dams. Columbia River rebuilding targets may be unachievable because other regions with nearly pristine freshwater conditions, such as SE Alaska and northern BC, also largely fail to reach these SAR targets. For consistency, our analyses primarily use coded wire tag-based SAR estimates. Passive integrated transponder (PIT) tag-based SAR estimates also available for Columbia River basin populations are generally consistent with these findings; however, PIT tag-based SARs contain important shortfalls whose importance has gone unrecognized that compromise their intended use. More attention is needed on how SARs should be defined and documented and in the definition of rebuilding targets. We call for a systematic review by funding agencies to assess consistency and comparability of the SAR data generated and to further assess the implications of survival falling to similar levels in most regions of the west coast.

Review of the Coast-wide Decline in Survival of West Coast Chinook Salmon (*Oncorhynchus tshawytscha*)

Short title: Coast-wide survival of Chinook

David W. Welch[*,1], Aswea D. Porter[2], Erin L. Rechisky[3]

Kintama Research Services, 4737 Vista View Cr., Nanaimo, B.C. Canada V9V 1N8

* Corresponding Author E-Mail: david.welch@kintama.com

1: ORCID ID 0000-0001-8851-5436

2: ORCID ID 000-0002-1258-8265

3: ORCID ID 0000-0002-2811-8399

Key words:

aquaculture, Columbia River, dams, delayed mortality, smolt-to-adult returns, Snake River

Abbreviations

BC- British Columbia, Canada

CSS- Comparative Survival Study

CWT-Coded Wire Tag

PSC- Pacific Salmon Commission

SAR-Smolt to Adult Return (Survival)

PIT- Passive Integrated Transponder

Conflict of Interest Statement

DWW is President and owner of Kintama Research Services Ltd., an environmental consultancy primarily focused on the development of innovative applications of telemetry to improve fisheries management. ADP and ELR are employed at Kintama. All authors received a financial benefit while conducting this study and their future salaries depend on their continued technical and scientific performance, which includes publication of this study.

Funding

This study was initially internally funded by Kintama Research Services as part of a separate research effort to assess the credibility of the critical period concept in Pacific salmon. In the course of assembling Strait of Georgia SAR data, we discovered that Chinook survival in many rivers of the Strait of Georgia region had fallen to levels well below those reported for Snake River Chinook. We developed a proposal and obtained funding from the US Dept. of Energy, Bonneville Power Administration, to cover staff time for coast-wide data collation, analysis, and writing of this paper (Contract # 75025). The funder (BPA) played no role in the design of the study nor the conclusions reached and was not made privy to the contents of this manuscript prior to submission.

Abstract

We collated data for Chinook salmon from all available regions of the Pacific coast of North America to examine the large-scale patterns of salmon survival. Survival, defined as smolt-to-adult return rates (SARs), collapsed over the past half century by roughly a factor of four to ca. 1% for many regions. Within the Columbia River the SARs of Snake River populations, often singled out as exemplars of poor survival, are unexceptional and in fact higher than estimates reported from other regions of the west coast lacking dams. Columbia River rebuilding targets may be unachievable because other regions with nearly pristine freshwater conditions, such as SE Alaska and northern BC, also largely fail to reach these SAR targets. For consistency, our analyses primarily use coded wire tag-based SAR estimates. Passive integrated transponder (PIT) tag-based SAR estimates also available for Columbia River basin populations are generally consistent with these findings; however, PIT tag-based SARs contain important shortfalls whose importance has gone unrecognized that compromise their intended use. More attention is needed on how SARs should be defined and documented and in the definition of rebuilding targets. We call for a systematic review by funding agencies to assess consistency and comparability of the SAR data generated and to further assess the implications of survival falling to similar levels in most regions of the west coast. *(221/250 words)*

Table of Contents

References

Introduction

The abundance of salmon in the North Pacific has reached record levels (Irvine et al., 2009; Ruggerone & Irvine, 2018; Schoen et al., 2017); however, most of the increase is in the two lowest valued species (pink, *Oncorhynchus gorbuscha,* and chum, *O. keta,* salmon) in far northern regions, at least in part due to ocean ranching (Ruggerone & Irvine, 2018). In contrast, essentially all west-coast North American Chinook (*O. tshawytscha*) populations (including Alaska) are now performing poorly with dramatically reduced productivity (Dorner, Catalano, & Peterman, 2017). The situation is similar for most southern populations of steelhead (*O. mykiss*) (Kendall, Marston, & Klungle, 2017), coho (*O. kisutch*) (Logerwell, Mantua, Lawson, Francis, & Agostini, 2003; Zimmerman et al., 2015), and sockeye (*O. nerka*) (Cohen, 2012; COSEWIC, 2017; Peterman & Dorner, 2012; Rand et al., 2012). These poorly performing species are of higher economic value and the focus of indigenous, sport, and commercial fisheries.

The historical pattern of declines in salmon abundance (steeper in the south, less so in the north) were originally assumed to reflect a freshwater anthropogenic cause because of the greater degree of freshwater habitat modification in the more populous southern regions (Allendorf et al., 1997; Nehlsen, Williams, & Lichatowich, 1991). The growing appreciation of ocean climate change (Hare, Mantua, & Francis, 1999; Mantua, Hare, Zhang, Wallace, & Francis, 1997; Mantua & Hare, 2002) has brought an awareness of the role of the ocean in influencing salmon survival. As Ryding and Skalski (Ryding & Skalski, 1999, p. 2374) noted two decades ago, "*It is becoming increasingly clear that understanding the relationship between the marine environment and salmon survival is central to better management of our salmonid resources*".

Unfortunately, our understanding of survival during the marine phase remains extremely limited, so there has been little change in management strategy beyond the essential first step of reducing harvest rates in the face of falling marine survival. The recent recognition of the decline in Chinook returns across essentially all of Alaska (ADF&G Chinook Salmon Research Team, 2013; Cunningham, Westley, & Adkison, 2018; Schindler et al., 2013) and the Canadian portion of the Yukon River (Bradford, von Finster, &

Milligan, 2009), where anthropogenic freshwater habitat impacts are negligible, is another example of how simple explanations are potentially flawed. If survival across this vast swathe of relatively pristine territory is severe enough to seriously impact salmon productivity, then there is little hope that modifying freshwater habitat in more southern regions will support a newly productive environment for salmon.

Formal SAR recovery targets have not been specified for any region of the west coast of North America outside the Columbia River basin. Within the extensively dammed Columbia River basin, the Northwest Power and Conservation Council's Fish and Wildlife Program (NPCC) set rebuilding targets for SARs at 2%-6% (McCann et al., 2018, p. 4), roughly the survival observed in the 1960s prior to the completion of the 8-dam Federal Columbia River Power System (FCRPS) (Raymond, 1968, 1979). The NPCC SAR objectives did not specify the points in the life cycle where Chinook smolt and adult numbers should be determined. However, one extensive analysis for Snake River spring/summer Chinook was based on SARs calculated as adult and jack returns to the uppermost dam encountered in the migration path (D. R. Marmorek, Peters, & Parnell, 1998): "*Median SARs must exceed 4% to achieve complete certainty of meeting the 48-year recovery standard, while ... A median of greater than 6% is needed to meet the 24-year survival standard with certainty*" (p. 41).

In this paper, we collate Chinook survival time series for the west coast of North America to document broad patterns in survival, here defined as the smolt-to-adult return rate (SAR). The SAR is the three-fold product of freshwater smolt survival during downstream migration multiplied by the marine survival experienced over 2-3 years in the ocean and multiplied by adult freshwater survival during the upstream migration to the final census point. (Depending upon the specific dataset, adult abundance may be enumerated prior to actual arrival at the spawning grounds; see Methods). Given the widely recognized poor survival of Snake River Chinook salmon resulting in their listing under the Endangered Species Act (NMFS, 2017a, 2017b), many of our analyses compare regional survival to that of the Snake River region.

Methods

Data Sources

Most survival rates of Pacific salmon are based on mark-recapture efforts, where juveniles are "marked"— implanted with either coded wire tags (CWT) or passive integrated transponder (PIT) tags—and recaptured in the fishery or detected upon return to the river. CWT technology dates back to the 1960s. A review is provided by (Johnson, 1990); the application of the methodology to coastal marine migrations of coho and Chinook is described by (L. Weitkamp & Neely, 2002; L. A. Weitkamp, 2009) and to measuring harvest and survival by (ADF&G Chinook Salmon Research Team, 2013; Bernard & Clark, 1996; Chinook Technical Committee, 2014). The tag is implanted in the nose cartilage of smolts, and the fish must be dissected to recover the tag. In contrast, PIT tags first came into widespread use in the Columbia River Basin in 1997. They are long-lived but short-distance radio-frequency tags that can successfully transmit their unique ID code when within <0.5 m of a detector (Prentice, Flagg, McCutcheon, & Brastow, 1990b; Prentice, Flagg, McCutcheon, Brastow, & Cross, 1990c; Prentice, Flagg, & McCutcheon., 1990a; Skalski, Smith, Iwamoto, Williams, & Hoffmann, 1998). The short detection range essentially limits the use of PIT tags to the Columbia River dams, which channel sufficient tagged individuals close to the detectors to generate useful results.

We collated SAR time series for Chinook from several sources (Supplementary Table S1). For CWT-based estimates, the primary data are the survival estimates for the indicator stocks used by the Pacific Salmon Commission (PSC) under the terms of the US-Canada Salmon Treaty. These datasets are formally submitted to the PSC by a wide variety of management agencies under the terms of the bilateral US-Canada Pacific Salmon Treaty. We supplemented these with CWT-based SAR time series published in the primary or secondary literature or calculated directly from the Pacific States Marine Fisheries Commission's CWT database. Together, these data sets represent California, Oregon, Washington, British Columbia, and Alaska. Estimates for the Upper Columbia and Snake Rivers reported by (Raymond, 1988) are based on freeze-branding, but were included because they are the only estimates available for the time period when SARs collapsed in those regions. Finally, because of their historical

importance to monitoring in the Columbia River we compiled and separately analyzed the PIT tag-based SAR estimates reported by the Comparative Survival Study (McCann et al., 2018).

Because SAR data are typically log-normally distributed, we primarily report the median, as this is equivalent to the geometric mean some authors use. (A simple proof of this statement is to note that that after log-transformation the mean of log-normal data will have 50% of the data above and below it). We therefore use the simpler terminology both for clarity and because Furthermore, the median is invariant under log-transformation, which is not true for the mean.

Pacific Salmon Commission (CWT)

The PSC is a bilateral treaty organization between the US and Canada coordinating coastwide management of Pacific salmon. The data are contributed to the Chinook Technical Committee of the PSC by the various government agencies responsible for conducting the individual monitoring programs. This database was the source of CWT-based Chinook survival estimates for all regions outside the Columbia River basin and for a few stocks located in the Columbia River basin.

The PSC database provides several measures of SAR. We used their estimates calculated as the sum of adults returning at all ages or caught in the fisheries, uninflated for losses to natural mortality for Chinook remaining at sea for longer than two years:

$$SAR_{i,j} = \frac{\sum_{k=2 or 3}^{\max age} \left(\sum_{l=1}^{n} (F_{i,j,k,l} + IM_{i,j,k,l}) + Esc_{i,j,k}\right)}{\mathrm{Rel}_{i,j}}$$

where $F_{i,j,k,l}$ = the tags recovered in fishery l, for age k, from brood year j, of stock i that are expanded for the fraction of the catch sampled; $IM_{i,j,k,l}$= the incidental mortalities; and $Esc_{i,j}$ = the number of tags recovered in the escapement including hatchery and spawning ground recoveries that are expanded for the fraction sampled. Columbia River stocks also have an inter-dam loss (IDL) calculation, so fish (or tags) returning to the river are adjusted upward to account for in-river mortality. IDLs are explained in (Chinook Technical Committee, 2018).

CWT-based SAR estimates for hatchery-origin fish generally cover the period from hatchery release until adult return to the hatchery and/or spawning grounds and are compensated for harvest (i.e., mortalities due to harvest are included as survivors). However, some of the CWT-based survival estimates for wild stocks are biased high because they can exclude survival losses occurring in the initial phase of the migration upstream of the census point (see (McPherson, III, Fleischman, & Boyce, 2010)). In contrast, all five Alaskan hatcheries are located at sea level and smolts are released directly into the ocean after several weeks of seawater acclimation in holding pens, eliminating losses in freshwater (see later). Other miscellaneous notes about this dataset are recorded as footnotes at the bottom of Supplementary Table S1.

Agency Estimates (CWT)

The PSC does not include indicator stocks for California or for yearling Chinook from the Columbia River, presumably because these stocks are not relevant to international management. We therefore included published estimates for fall, late-fall, and winter Chinook runs from the Sacramento River in California (Michel, 2018). We also collated some annual reports produced by individual hatcheries in the Columbia River basin and/or contacted the hatcheries directly to build up a partial inventory of CWT-based SAR estimates for Chinook.

These supplemental estimates were calculated similarly to those done by the PSC but are unexpanded for incidental mortality (or inter-dam loss in the Columbia River). Hatcheries that do not tag 100% of smolts released may expand their estimates for the proportion tagged while others are estimated using only tagged fish. See the specific paper/reports for details (Supplementary Table S1).

Pacific States Marine Fisheries Commission

All CWT release and recovery data are submitted to the Regional Mark Processing Center hosted by the Pacific State Marine Fisheries Commission, which maintains the online Regional Mark Information System (RMIS) to facilitate exchange of CWT data. We investigated this source; however, we could not verify that adult return numbers from all possible significant components were correctly incorporated and expanded for sampling effort. Ideally, adult returns should include hatchery rack returns, adult escapement to spawning grounds, adults captured for use as brood stock, and immature or maturing individuals caught in all fisheries (sport, commercial, tribal) and locations (at sea, in-river). For this reason, we focused on the PSC and Agency estimates described above. We used RMIS only for Entiat Spring Chinook (UCOL) after consulting with Entiat Hatchery biologists (G. Fraser, *pers. comm.* USFWS, Leavenworth, WA. gregory_fraser@fws.gov).

Raymond (1988)

Data on survival in the 1960s to early 1980s period for the Snake and Upper Columbia Rivers was based on mark-recapture estimates of the abundance of a mixture of freeze-branded hatchery and wild smolts passing the first dam encountered each year (Raymond 1988). An essentially complete enumeration of adult returns was possible at upstream dams several years later because the adults must ascend fish ladders. Estimates were compensated for harvest as per (Raymond, 1988). These SAR estimates are inflated relative to the CWT-based estimates described above because they do not include migration losses from the time downstream migration is initiated until the smolts are censused at the dams and also exclude adult upstream losses between the dam and the spawning grounds. Nevertheless, this dataset is important because it incorporates the period of relatively high survival in the 1960s and early 1970s and the period when survival collapsed, which was attributed primarily to dam construction. We used these estimates in conjunction with the CWT estimates for a more complete time series.

Comparative Survival Study (PIT tags)

PIT tags have largely supplanted CWTs in the Columbia River basin because of the ability to measure smolt survival between dams and to estimate SARs. We used the estimates of overall SAR from Chapter 4 of the Fish Passage Center's Comparative Survival Study (McCann et al., 2018) which are essentially the number of adults returning to the uppermost FCRPS dam with detection capability (Lower Granite, McNary, John Day and/or Bonneville dams depending on the origin of the population) divided by the estimated number of PIT-tagged smolts surviving to their uppermost dam during downstream migration. For example, for most Chinook salmon originating from the Snake River basin, the SAR is estimated from Lower Granite Dam back to Lower Granite Dam.

When estimates were available for multiple segments, we selected the SARs covering the greatest extent of the migratory life-history (i.e., smolt releases and adult returns to the uppermost dam available in the Columbia River basin), and we used SAR estimates that included jacks when available. In the mid-Columbia region, SAR estimates with jacks were sometimes available only for a shorter migration segment; in these cases we selected the SAR data sets representing the longer migration segment but excluding jacks because this was most similar to the CWT survival estimates. PIT tag-based SARs do not incorporate losses due to harvest (McCann et al., 2018, p. 95) because the commercial and sport catch is not monitored for PIT tags.

Because published PIT tag-based SAR estimates contain several limitations that are problematic to the interpretation of survival (particularly lack of harvest information), we use these estimates only as a secondary validation of the major conclusions.

Division by Life History

Chinook salmon display two major life history types (subyearling and yearling) that correspond with adult run-timing (Fall or Spring respectively). These life history types are examined separately in our analysis because there are important ecological differences between them (see reviews by (Riddell et al., 2018); Sharma and Quinn (2012)) which likely influence survival. We review the general characteristics below but note that this simple picture is more complicated due to hatchery rearing practices and natural variability.

Subyearling/Fall populations are widely distributed in low gradient coastal streams or the lower mainstem of major rivers but are absent from Alaska. They migrate to the ocean within a few months of hatching and almost certainly remain as long-term residents of the continental shelf off the west coast of North America where they are exposed to commercial and sport harvest in coastal marine waters over multiple years (Sharma & Quinn, 2012). Survival of shelf-resident subyearling Chinook populations can therefore be significantly reduced by coastal fisheries that can harvest these animals over several years of marine life.

Yearling/Spring populations are found in headwater tributaries of large river systems penetrating well into the interior of the continent, such as the Columbia and Fraser rivers. They migrate to sea after completing one or more full years of life in freshwater and are thus significantly larger at ocean entry. Yearlings are thought to move offshore and become purely open ocean residents for much of the marine phase, and thus are essentially immune to harvest by fisheries until their return to freshwater, where variable levels of harvest may occur. Yearlings also (generally) spend one less year in the ocean than subyearlings.

Comparisons between Regions

To develop a formal statistical test of the similarity in SARs between regions in the most recent years of the record, we first grouped the CWT-based SAR data separately by smolt age (Yearling/Subyearling), region, and rearing type (hatchery/wild). For each of these groupings, we pooled all data in the 2010-2014 period across all populations in a region, and then resampled the pooled data with replacement N=10,000 times, each time drawing a sample of the same size as the original pooled data. Limiting the samples to this timespan ensured the data were current and removed the variability due to differing lengths of the time series. For each group, we calculated the N median SARs, and then calculated the ratio of those N medians with those from each of the other regions in turn. The empirical distribution of the N ratios allows for a formal statistical test of the proposition that median SARs in the two regions are equal (i.e. that the ratios are not different from one). The normalized SAR ratio for region i in sample j=1,.., N was then $SAR_{i,j}/SAR_{SNAK,j}$. Because of the generally recognized poor survival of Snake River Chinook salmon, we present the results of the comparison to this region in the main text but also provide the comparison using all possible regions in the denominator in Supplementary Figure S1.

Comparison between CWT and PIT tag-based SARs

There are some fundamental differences between PIT and CWT tag-based SAR estimates. PIT tag-based SARs exclude smolt and adult survival above the topmost dam where they are censused and do not account for harvest in ocean or mainstem river fisheries. CWT-based estimates incorporate these factors. Therefore, an aggregate correction factor $\widehat{c_{i,j}}$ for the PIT-based SAR estimates to make them consistent with the CWT-based SAR estimates is:

$$\widehat{c_{i,j}} = \frac{S_{i,j}^{smolt} * S_{i,j}^{adult}}{(1 - h_{i,j})}$$

where $S_{i,j}^{smolt}$ = the estimated survival of stock i between the hatchery or pre-smolt rearing grounds and the uppermost dam for smolts from brood year j; $S_{i,j}^{adult}$ = the estimated survival of stock i between the uppermost dam and return to the hatchery/spawning grounds; and $h_{i,j}$ = the estimated harvest of stock i in year j. For notational simplicity, we neglect harvest in years prior to adult return. Here the numerator corrects for upwards bias in PIT-based SAR estimates caused by excluding survival above the topmost dam while the denominator corrects for the downward bias caused by excluding harvest.

We were interested in estimating $c_{i,j}$ to assess if it was reasonable to use it to combine these data into a single term that could provide a reliable metric for converting between PIT and CWT-based SAR estimates. To do this, we first attempted to collate the three components ($S_{i,j}^{smolt}$, $S_{i,j}^{adult}$, and $h_{i,j}$) for the populations with PIT tag SAR estimates, but we encountered difficulty obtaining sufficient data, particularly for the adult stage. However, combined ocean plus mainstem harvest rates were readily available for the PSC's indicator stocks. For yearling populations, marine harvest rates are thought to be very low (Waples, Teel, Myers, & Marshall, 2004) and are not included in the CTC database. We therefore collated mainstem harvest data from other sources for yearlings (Supplementary Table S2).

Our second approach to estimating $c_{i,j}$ was to identify populations with both CWT- and PIT-based SAR estimates generated in the same years and then use simple linear regression to

identify the relationship. If there was no difference between estimation methodologies, then the regression of CWT SAR estimates on PIT tag-based SAR estimates should have a regression slope of $\hat{c} = 1$.

Results

We collated 123 eastern North Pacific Ocean Chinook salmon SAR time series totaling 2,279 years of monitoring (Fig. 1). SAR estimates included in our analysis were from populations extending from central California to south east Alaska and include 94 hatchery populations, 26 wild, and 3 hatchery-wild (mixed) populations.

SARs obtained from Coded Wire Tags

Most regions of west coast North America with CWT time series extending back prior to the 1978 regime shift (Beamish, 1993; Beamish & Bouillon, 1993; Ebbesmeyer et al., 1990; Francis & Hare, 1994; Mantua et al., 1997) show an approximate four-fold decrease in SARs for hatchery populations (Fig. 2). This applies to subyearling Chinook from west coast Vancouver Island, the Strait of Georgia, Puget Sound, and the mid-Columbia River; and to yearling Chinook from SE Alaska, the lower and upper Columbia River, and the Snake River (upper Columbia and Snake rivers are relative to the historical freeze brand data from Raymond (1988)). Except for coastal Oregon subyearlings, average CWT-based SARs for all regions are now approximately 1% or less.

All time series outside the Columbia River watershed are based on CWTs. Within the Columbia, several methods of estimating SARs have been employed with recent estimates based on both PIT and CWT tags. These tag types show different SAR trends over time and substantial offsets (Fig. 2), with PIT tag-based SAR estimates lower than CWT-based estimates for subyearlings and higher for yearlings, which we discuss later.

With the exception of lower Columbia yearlings, Chinook from all regions of the Columbia show some increase in CWT-based SARs since the 1980s and early 1990s, the period when SARs reached their lowest values, but none of these time series recovered to the survival levels measured by Raymond (1988) in the 1960s.

Median population specific SARs show that wild populations generally have higher survival than hatchery populations; however, there are limitations: CWT data are limited for wild populations and there are no data available for a direct hatchery vs wild comparison for the same population (Fig. 3). The wild yearling Chinook populations in SE Alaska tend to have lower survival than the hatchery-reared population; however, the Alaskan hatchery SAR estimate provided to the PSC is based on combined data for five hatcheries that all release smolts directly into the ocean after acclimation to seawater for several weeks, eliminating losses from freshwater migration (Bill Gass, Production Manager, Southern Southeast Regional Aquaculture Association, & John Eiler, NOAA; pers. comms.).

Median SARs for hatchery or wild populations within a given region tend to cluster together, but a few populations (University of Washington experimental hatchery releases in Puget Sound and the Chilliwack production hatchery in the Strait of Georgia) have unusually high SARs relative to other stocks in their regions. These are also the only populations whose medians substantively attain the 2-6% SAR recovery level adopted in the Columbia River basin. Apart from SE Alaska, north-central BC yearlings, and Oregon Coast subyearlings, which have higher regional survivals, populations from other regions have only rarely reached this level of production.

To compare the current status of regional CWT-based SARs we included the five most recent years of available SAR data (2010-2014) in a resampling procedure to statistically quantify relative SARs and control for differences in interannual timing. We used Snake River population SARs as a baseline in which to compare all other regions; five-year data using other regions as the basis for comparison are presented in Supplementary Information SI-3. A striking result emerges for hatchery-reared subyearling Chinook in the 2010-14 period: median SARs in all regions except the Oregon Coast are lower than median Snake River SARs (Fig. 4). Only in three of nine regions with numerically lower SARs does the upper 5th percentile of the empirical distribution include the possibility of equal SARs with the Snake River region (North-Central

BC, Mid, and Upper Columbia). For all other regions, subyearling SARs are statistically lower than the Snake River survivals. There are no CWT-based SAR estimates for wild subyearling Chinook.

Applying the same procedure to hatchery-reared yearling Chinook, current regional SARs were statistically indistinguishable from Snake River SARs for the Salish Sea (Strait of Georgia, Puget Sound) and all other regions of the Columbia River basin (Lower, Mid, and Upper; Fig. 4). California, northern BC, and SE Alaska yearling SARs were significantly higher than Snake River yearling populations. The SARs of SE Alaska wild yearling Chinook (four river systems) were significantly lower than the SARs of the one wild stock of Snake River yearling Chinook available for comparison (Tucannon River; Fig 3).

SARs obtained with PIT Tags

PIT tag-based SAR estimates are available for Chinook salmon originating from the Columbia River Basin and are published annually by the Fish Passage Center (McCann et al., 2018). Comparing PIT tag-based SARs across regions of the Columbia River basin (Fig. 5) yields similar results to the CWT analysis: wild fish generally have higher survival and different regions have similar or lower median SARs to the Snake River. The exceptions are two mid-Columbia populations of wild yearling Chinook salmon which have consistently high SARs that fall within the 2-6% rebuilding target set for Columbia River Basin yearling Chinook. However, both wild and hatchery subyearling SARs from the mid-Columbia fall well below the Snake River medians, and all other populations (including three hatchery-reared mid-Columbia yearling populations) have SARs which rarely or never exceed 2%; from this perspective only the two wild yearling populations (John Day and Yakima) have substantively higher SARs.

Comparison of CWT and PIT tag-based SARs

We attempted to develop a direct comparison of PIT- and CWT-based SAR estimates so that we could incorporate PIT tag-based SAR datasets into our analysis. PIT-based estimates differ in two major ways from CWT estimates: (1) they exclude sport, commercial, and indigenous harvest and (2) they exclude smolt and adult losses in the region lying between the uppermost dam and the hatchery or spawning site.

We attempted to develop a direct comparison of PIT and CWT-based SAR estimates but encountered difficulty finding comparable data. Where paired populations were available, regression relationships were population-specific for both life history types (Fig. 6). Subyearling CWT-based SAR regression estimates were consistently higher than PIT-based estimates (Fig. 6), presumably because the high subyearling harvest rates not captured in PIT-based estimates (currently between ~45-80%; Fig. 7) outweigh the influence of excluding upstream losses. In contrast, CWT-based SARs for yearling populations were consistently lower than PIT-based estimates indicating that mortality above the uppermost dam outweighs the influence of the generally lower harvest rates on yearling populations. Although fitted linear relationships had high R^2, the substantial differences in regression slopes among populations (ranging, from 1.3 to 3 times for subyearling populations), suggests that population-specific factors strongly influence the relationship. A simple correction factor between PIT and CWT-based SAR estimates appears infeasible.

Discussion

Governments primarily attempt to increase salmon populations by using hatcheries and restoring degraded habitats. A major assumption is that regional factors such as freshwater habitat degradation or salmon aquaculture make important contributions to the decreasing survival of salmon observed coastwide. Consequently, evidence that Chinook salmon survival (SARs) has decreased to roughly the same amount everywhere along the west coast of North America is both surprising and important. Most populations in many regions of the west coast of North America have declined to reach approximately the same low numerical level, ~1%, with a few important exceptions which we discuss below. Direct measurements of SARs are lacking for stocks located west of SE Alaska, but the decrease in the number of adult Chinook returning to the rest of Alaska (ADF&G Chinook Salmon Research Team, 2013; Schindler et al., 2013) further demonstrates that survival has fallen over a very large geographic range. Given the potentially profound conclusions, we consider two questions: (a) How close are numerical estimates of SARs generated by agencies along the west coast of North America? (b) How well can we trust the data?

SAR Comparison

Comparing the entire coastwide data set of CWT-based SAR estimates plus the earlier Raymond (1988) estimates (Fig 1), the aggregate data reveal that essentially all time series extending back to the 1970s show survival of both yearling and subyearling Chinook dropping by roughly a factor of four, to ~1% (all regions of southern BC, Puget Sound, and the Columbia River basin). The similar timing of the decline in the Salish Sea and west coast Vancouver Island to that in the Columbia River basin is striking, suggesting the strong influence of a broad driver (Beamish, 1993; Beamish & Bouillon, 1993; Mantua et al., 1997).

Despite the relative shortness of coastal streams in most regions of the west coast, aggregate subyearling SARs from these regions are lower than those reported for Snake River populations in the five most recent years of the dataset (2010-2014; Fig. 4). Oregon coast populations are clear exceptions. The SARs of yearling populations from Puget Sound, the Strait of Georgia, and the lower, mid, and upper Columbia River are statistically indistinguishable from the Snake River (Fig. 4). Only yearling hatchery populations from California, north-central BC, and SE Alaska have SARs exceeding the Snake River populations. When comparing all available years of data (Fig. 3), the conclusion is generally the same; thus, the numerical similarity in SARs is not an artifact of some recent event but something that has persisted for many years. When the value of these SARs is considered over the entire record available for individual populations (Fig. 3), median SARs are similarly poor everywhere, and generally ~1% except in the earliest years of the time series. (Supplementary Tables S3 and S4 provide a summary of the actual numeric values.)

The few wild yearling CWT-based Chinook SAR time series available for comparison with wild Snake River SARs are not consistently better, as might be expected. One population of yearling Chinook from the Upper Columbia River had survival slightly higher than the Snake River wild population, but all four wild Alaskan stocks have lower SARs than the one Snake River wild stock available for comparison (CWT Tucannon; Fig. 4). These results also indicate that not only are wild Snake River SARs are poor, but that survival is poor almost everywhere along the west coast of North America.

A few populations with anomalously high SARs relative to other populations in the same region exist, and provide intriguing evidence that some populations have an intrinsic ability to support higher SARs meeting the Columbia River basin's current 2-6% recovery targets (subyearlings from the Chilliwack hatchery in the lower Fraser River (SOG) and a ten year release record of experimental hatchery releases from the University of Washington (PS)). It is unclear why these two populations are so much more productive. If the underlying reasons for higher survival can be identified it might be possible to improve the productivity of other hatchery populations.

Intriguingly, the higher SARs of the two coastal Oregon subyearling populations and yearling Chinook from California (Figs. 3, 4) all involve populations that apparently do not migrate far north. The SARs of California Chinook are particularly noteworthy because freshwater survival is exceedingly low (Michel, 2018); for overall SARS to be higher than Snake River stocks suggests much higher survival during the marine phase. (Riddell et al., 2018, p. 580) note the unique marine distributions of southern Oregon Chinook stocks, which restricts them for their entire ocean phase to life in the California Current, similar to the assumed ocean distribution of California stocks. It thus seems plausible that specific salmon populations home to distinct feeding grounds, some of which may confer better survival.

Credibility of SAR estimates

CWT-based estimates

We restricted most SAR comparisons to CWT-based data, as these are available for the entire west coast to as far north as SE Alaska. Most estimates are for hatchery-reared indicator stocks published by the Pacific Salmon Commission; few estimates are available for wild populations. For upper Columbia and Snake yearling populations we used estimates published by individual fishery agencies. The PSC cites several challenges with CWT-based estimates including representativeness of the indicator populations, limitations on sampling the fishery and spawning grounds, and distortions introduced by mark-selective fisheries (Hankin et al., 2005). Agencies presumably generate these data using internally consistent methodologies over time to avoid biasing parts of the time series, thus, the large concurrent downward trend in survival of individual populations is most likely to be credible.

PIT tag- based estimates

PIT tag detectors in dam bypasses and fish ladders census both the downstream and upstream movements of PIT-tagged salmon within the Columbia River basin. Originally developed to study smolt survival in the hydrosystem, PIT tag-based studies subsequently evolved to measure adult returns, presumably because of the unique ability to completely enumerate returning adults as they ascend fish ladders. SAR data sets are now generated for many yearling and subyearling Chinook (McCann et al., 2018) and as a result PIT tags have largely supplanted CWT tags for estimating SARs in the Columbia River basin. Dividing estimated smolt counts at the dams in the ocean entry year by the returning adult counts in subsequent years provides the SAR.

PIT tag-based SAR estimates show that recent SARs are now generally low compared to historical levels (Fig. 2) and track reasonably well with CWT-based estimates for individual populations (Fig. 6); however, our results indicate that PIT tag-based estimates are not comparable to CWT-based estimates and are not inter-convertible. There are two reasons for this. First, for dam-to-dam estimates (e.g., Lower Granite Dam smolts to Lower Granite Dam adults) the survival losses incurred upstream of the dam can vary substantially between populations (Faulkner, Widener, Smith, Marsh, & Zabel, 2017). Unless census points are located at the start and end of the migration period, the amount of excluded upstream survival acts as a random variable influenced by the excluded distance. This is true for essentially all published PIT-based SAR data (McCann et al., 2018) and for some CWT-based SAR estimates for wild populations, where smolt abundance is usually censused after migration has started (e.g., (McPherson et al., 2010)). For Columbia River basin Chinook, the result is that PIT-based SAR estimates are overestimated relative to CWT-based estimates (Fig. 6).

The second reason is that Chinook harvested in fisheries prior to return are not accounted for in PIT tag-based estimates. Authors have previously noted that PIT tag-based SAR estimates do not include harvest (D. Marmorek & Peters, 2001; McCann et al., 2018) and recommendations have recently been made to incorporate harvest (ISRP, 2019, p. 22), but to our knowledge neither the magnitude of the harvest nor the variability over time has not been recognized. The result is that PIT tag-based SARs represent the surviving adults left over from the operation of multiple fisheries operating over several years. The influence of commercial, sport, and tribal fisheries on adult returns, and thus survival, is large.

Harvest and PIT Tag-based SAR

Unfortunately, the power of the PIT tag system to identify all returning adults is compromised by the inability to identify PIT-tagged fish in the harvest. Ocean harvest rates on Columbia River basin yearling (Spring) Chinook stocks are ≤2% (H. A. Schaller, C. E. Petrosky, & O. P. Langness, 1999; Waples et al., 2004), presumably because maturing Spring Chinook cross the continental shelf only near their natal river mouth on return and are not exposed to the many coastal fisheries operating along the shelf; however, yearling Chinook harvests in freshwater are still substantial (Fig 7). Harvest rates for Upriver Spring Chinook increased from 10% to 25% of the number arriving at the river mouth over the 1998-2012 period (PFMC, 2019). Not accounting for this harvest results in underestimating the true SAR by ca. 10% in 1999 (near the beginning of the PIT tag record) and increasing to 33% in the most recent years of the record. For other yearling stocks the correction is larger.

For subyearling Chinook, which are much more heavily harvested, PIT-based SAR estimates likely underestimate the true SAR by 300-400% in recent years. For example, Lyons Ferry (Snake River) subyearling Chinook harvest rates rose from a low of ~20% in 2004 to >70% in 2012. These values imply correction factors increasing from 1.25 to >3 over eight years.

The varying patterns of increase in harvest rates towards the most recent years of the record is particularly important because PIT-based SAR estimates will not reflect the higher harvest rates of recent years and will therefore understate the improvements in adult survival that actually occurred (Fig 7). Further, given the variability in harvest rates over time and between populations, a reliable correction factor to account for harvest will be difficult to achieve for PIT tag-based SAR estimates, while leaving these estimates uncorrected for harvest results in a substantial downwards bias in survival estimates (Fig 6).

Another unrecognized problem with using PIT tag-based SAR estimates to set quantitative recovery targets for Columbia River basin Chinook (e.g., 2-6% SAR) is that the strategy dictating management of the fisheries is divorced from these goals. Under the terms of the renegotiated Pacific Salmon Treaty, beginning in 1999 coastwide management of ocean fisheries for Chinook is explicitly abundance-based (Miller, 2003). As a consequence of the treaty revision, fisheries are intensified when Chinook abundance is high and restricted when low. Consequently, PIT-based SAR estimates will inaccurately reflect true survival if managers simply identify and harvest any increase in abundance—which is precisely what the treaty dictates they should do. In fact, if managers had perfect control of ocean fisheries survival changes would not be reflected in PIT tag-based SAR estimates at all because any change in abundance would simply be compensated for by altering harvests prior to adult return. In practice, over or under-harvesting is likely, so PIT-based SAR fluctuations will partially reflect the inability to manage ocean fisheries perfectly. Even for Snake River Spring Chinook, where harvest rates are lowest and the inter-annual fluctuations in harvest are on the order of 10-20% (Fig. 6), SAR increases of this size would generally be considered significant. That they may simply be reflecting limitations inherent to the management system is of concern and appears to have gone unrecognized. Equally important, expensive changes to the operation of the Columbia River hydropower system intended to improve survival may benefit the ocean fisheries without credit accruing to those bearing the costs.

Delayed mortality

Delayed mortality, the theory that greater dam passage results in poorer survival of Snake River Spring Chinook after smolts migrate out of the hydrosystem (Budy, Thiede, Bouwes, Petrosky, & Schaller, 2002; Independent Scientific Advisory Board (ISAB), 2007; Schaller & Petrosky, 2007; Howard A Schaller, Charles E Petrosky, & Olaf P Langness, 1999), still plays an important role in Columbia River salmon management (McCann et al., 2019, pp. 116-119). The theory has been questioned because it is based primarily on the view that the higher PIT-based survival of two wild mid-Columbia yearling populations (Yakima and John Day) than wild Snake River populations must be due to the difference in the number of dams these populations migrate past (ISAB, 2019). However, neither the broader PIT nor CWT-based SAR estimates assembled here support the theory. Apart from the two mid-Columbia PIT-tagged wild yearling populations cited above, all other SAR estimates are similar to Snake River values despite differences in the number of dams in the migration path. Hatchery-reared yearlings from three PIT tagged mid-Columbia populations have similar SARs to Snake River populations (Fig. 5) and CWT-based SAR estimates for Lower-, Mid- and Upper-Columbia yearling populations have survival consistent with Snake River populations (Fig. 4), as do Salish Sea (Strait of Georgia and Puget Sound) populations where no dams lie in the migration path. Also of note, both PIT- and CWT-based SAR estimates for Mid-Columbia populations of wild and hatchery subyearling Chinook are generally lower than Snake River values. Thus, none of these comparisons support the claim that greater dam passage—and Snake River dam passage in particular—results in subsequently reduced survival.

Conclusions

The policy implications of Chinook salmon SARs converging to similar levels nearly everywhere along the west coast of North America are profound. Current efforts to conserve salmon populations assume that restoring habitats modified by anthropogenic factors (dams, dykes, forestry, road culverts or salmon farms in coastal regions) will improve salmon returns and at least partially compensate for worsening ocean conditions. However, if survival also falls by the same amount in regions with nearly pristine freshwater habitats (SE Alaska, north-central British Columbia), it is difficult to argue for a major role of these regional factors in causing the decline.

It is a long-standing assumption that the construction of the four Snake River dams has prevented the recovery of listed Chinook stocks by either directly reducing smolt survival during downstream migration or reducing survival after smolts leave the hydrosystem as a result of delayed mortality (Budy et al., 2002; ISAB, 2018; McCann et al., 2018; Howard A Schaller et al., 1999). However, the evidence that many other Chinook populations outside the Columbia River basin show large declines at about the same time make this belief questionable. Our point here is not to question that dams cause mortality, but rather that their overall contribution to reduced SARs is likely much smaller than originally believed.

Presumably in response to worsening SARs, a large increase in monitoring effort is evident both inside and outside the Columbia basin (Fig. 8). In assembling the SAR data used in this report we encountered substantial challenges in fully understanding what components of adult returns were included in many SAR estimates, and what parts of the migratory life cycle were excluded. As a result, many datasets were excluded from our analysis. We were particularly surprised to discover that some important basic elements of survival were excluded from PIT tag-based SAR estimates.

For example, exactly where abundance is estimated during migration should be more carefully considered. In practice, survival time series exclude variable proportions of upstream survival for both smolts and adults. Unless smolt counts are taken at the hatchery and adult counts occur on the spawning grounds, variability is introduced because different amounts of the migratory life history are incorporated into the SAR estimates for different populations.

The same point can be made for more carefully considering the role of harvest. Harvest levels for some yearling populations are a considerable fraction of adult returns to the river, while for subyearling populations they are substantially larger than adult escapement. A major change in the Pacific Salmon Treaty occurred in 1999 when a shift to an abundance-based management system was negotiated (Caldwell, 1999; Miller, 2003; Noakes, Fang, Hipel, & Kilgour, 2005). A key part of this renegotiation was securing coastwide agreement that managers would modify harvest in response to abundance. What appears to have gone unrecognized was the effect on scientific studies based on PIT tags.

A direct consequence of modifying harvest relative to abundance is that improvements in survival caused by modifying the operation of the Columbia River hydropower system may be obscured. If fisheries managers are perfect at implementing the treaty's mandate, then each year the same number of adults will return—precisely because managers identify changes in abundance at sea and then adjust harvest in response. Attempts to evaluate improvements in hydrosystem operations by studying how PIT-based SARs vary will be frustrated because there will be no change—managers will harvest any increases and conceal any decreases by varying catches. Improvements in freshwater conditions that increase adult returns (perhaps achieved at great cost) will not be credited appropriately because the treaty mechanism allocates the increased abundance to the fisheries.

Given the geographically widespread collapse in survival to numerically similar levels, the fisheries community need to re-assess several core conservation assumptions. Of primary importance is the actual effectiveness of freshwater habitat restoration initiatives when northern populations have similar SARs. The resulting policy implications range from the prospects for successfully feeding killer whales to the real role of dams in the demise of Snake River salmon stocks. Finally, the large changes in PIT tag-based SARs caused by managers modifying harvest in response to changes in Chinook abundance are problematic for attempts to rebuild populations unless harvest management is better coordinated with freshwater conservation efforts. Given the steadily increasing effort devoted to survival monitoring for salmonids (Fig. 8), further work is needed to document the source data and to better understand the implications. A logical next step would be to convene a coast-wide review of the quality and consistency of the various data sources used for measuring survival and to define rigorous technical standards for measuring SARs. In addition, identifying the factors leading to substantially higher SARs for a few populations (e.g., University of Washington and Chilliwack hatchery subyearlings) might lead to greater conservation success in future.

Acknowledgements

We particularly thank Dr Gayle Brown (DFO) for providing access to the Chinook Technical Committee's SAR database and for many discussions clarifying the interpretation and use of the data. We also received significant assistance in understanding critical details of many SAR and harvest datasets from scientists from the USFWS (Haley Muir, Greg Fraser, Michael Humling, Christopher Griffith, and David Hand), the Nez Perce Tribe (Billy Arnsberg), CRITFC (Tommy Garrison), WDFW (Kristen Ryding), ODFW (Michelle Varney), and NOAA (Jeromy Jording, Larry LaVoy and Robert Kope).

Data Availability

All data are available without limitation from Dryad. (The datasets will be finalized and submitted at the time the revised manuscript is re-submitted, as the most recent years of data available for inclusion in this paper may change).

Figures

Fig. 1. Map of Chinook salmon survival time series used in the analyses. Numbers inside symbols are keyed to the populations in Table S1. SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; WAC=Washington Coastal; ORC=Oregon Coastal; SOG=Strait of Georgia; PS=Puget Sound; CA=California.

Fig. 2. Time series of smolt-to-adult return (SAR) estimates for Chinook salmon plotted by source. Annual SAR estimates for Hatchery (H), Wild (W), and mixed hatchery-wild data sources (B) are shown, but regional loess curves of survival and associated 95% confidence interval use hatchery data only, colour coded by data source. In order to focus on the trends, a few SAR estimates have been clipped by restricting the y-axis maximum to near the loess curve maxima. Blank panels indicate regions where the life history type does not occur. The SAR 2-6% recovery target adopted for Snake River Spring Chinook is shown as a grey band. The major regime shifts of 1977, 1989, and 1998 are indicated by vertical dotted lines. The horizontal dotted line indicates 1% SAR. Note logarithmic y-axis. Sources correspond to Table S1 as follows: PSC CWT= PSC 2019; CSS PIT=McCann et al. 2018; Agency CWT=all other sources exclusive of Raymond 1998 and Michel 2019. CWT=coded wire tag; CSS=Comparative Survival Study, PIT= Passive-Integrated-Transponder; SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.

(Reviewers: We have found that conversion of the high definition .tif figure format during incorporation into Word or PDF documents can cause substantial degradation of the fine detail actually present. If this is so, please request the native file format, which will support high resolution zoomed views of the individual panels. We can also provide this in a vertical orientation if the journal prefers).

Fig. 3. Box plots of Chinook survival (SAR) based on coded wire tags, disaggregated by population and region; all years combined. Central lines show medians, boxes show the inter-quartile range (central 50% of data points), whiskers bracket 1.5 times the interquartile range, and open circles identify outliers. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates for each population is shown to the right. See Table S1 for definitions of population acronyms and Fig. 2

for region acronyms. H=hatchery; W=wild; HW=mixture. *Indicates data sets ending prior to 1998 (all data from Raymond (1998) and three Puget Sound data series from PSC (2019)).

Fig. 4. Regional CWT-based SAR estimates for Chinook salmon normalized relative to Snake River SARs for the 2010-2014 period. Estimates above the horizontal black dotted line indicate higher survival than Snake River populations. Horizontal red lines show the empirical 5% and 95% percentiles on the sampling distribution of the normalized ratio. See Fig. S1 for SAR estimates normalized to all other regions. H=hatchery; W=wild.

Fig. 5. Box plots of Chinook PIT tag-based SAR estimates in the Columbia River basin, disaggregated by population and region; all years combined. These SAR estimates exclude harvest and smolt and adult losses above the top-most dam. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates is shown on the right. H=hatchery; W=wild; HW=mixture. All data from McCann et al (2018).

Fig. 6. Comparison of smolt-to-adult survival (SAR) estimates made using coded wire tags (CWT) and passive integrated transponder (PIT) tags for Chinook salmon populations where both tagging methodologies were employed in the same year. Linear regressions were fit with the intercept constrained to zero.

Fig. 7. Annual Columbia River Chinook harvest rate estimates, fitted loess trend lines, and associated 95% confidence intervals. The right-hand axis shows reported aggregate harvest before Chinook reach McNary Dam. The left-hand axis shows the corresponding value that PIT tag-based SAR estimates should be multiplied by to correct for exclusion of harvest; note log scale. Tributary harvests (i.e., above McNary Dam) are excluded. Substantial variation over time and between populations is evident after 1998 (vertical dashed line), when PIT tag-based survival estimation began. Data sources that present harvest estimates by brood year were converted to return year using the dominant year of return. See Table S2 for population names and references.

Fig. 8. Increase in the number of annual SAR estimates used in this paper. The drop in monitoring evident in the most recent years probably reflects lags in data processing rather than a decrease in effort. See Table S1 for specific populations included.

Supplementary Information

Figure S1. Normalized regional SAR estimates for Chinook salmon based on coded wire tags (CWT) in the 2010-2014 period. Each panel uses a different geographic region as the basis for comparing normalized SARs; the figure in the main text (Fig. 4) uses the Snake River as the basis for comparison. The central points on the plot indicate the median of the normalized ratios, and the whiskers extend to the empirical 5% and 95% percentiles on the sampling distribution. Estimates above the horizontal black dotted line indicate higher survival than the region to which the data are normalized (i.e., the region in each panel's title). Most data summaries are for hatchery-origin stocks; wild stocks are indicated by a star (*). SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.

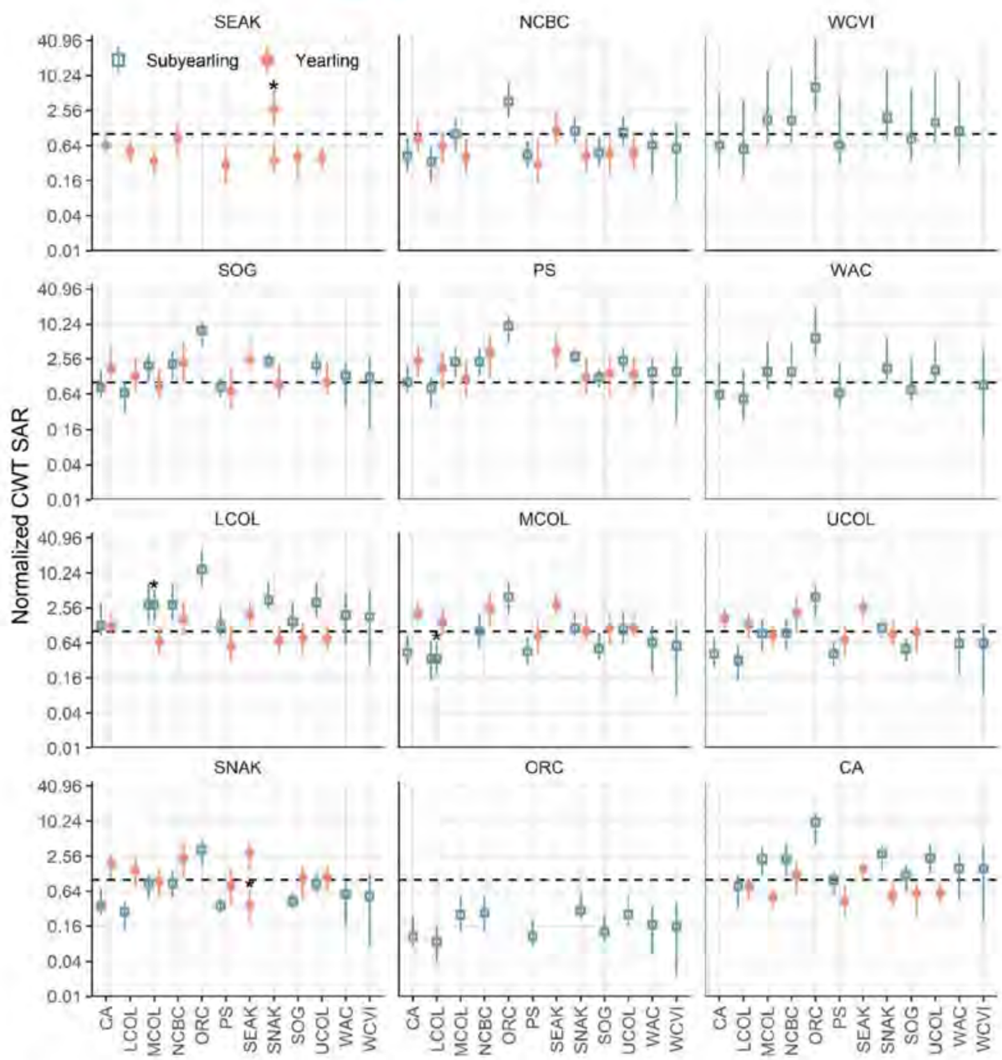

Table S1. Datasets of smolt-to-adult return (SAR) estimates for Chinook salmon (*Oncorhynchus tshawytscha*) used in this study. The Map field corresponds to the numbering displayed in Figure 1. Race refers to adult run-timing. Rear is either hatchery (H) or wild (W). Age indicates the year of smolt outmigration as either yearlings (1) or subyearlings (0). Jacks indicates whether precocious male returns are included in survival estimates. Reach is specific to passive integrated transponder SAR estimates in the Columbia River; it refers to the migration segment over which SARs were estimated. N is the sample size (years of data). From and To describe the first and last years of outmigration. AK=Alaska, NCBC=North Central British Columbia, WCVI=West Coast Vancouver Island, SOG=Strait of Georgia, PS=Puget Sound, WAC=Washington State Coast, LCOL=Lower Columbia River (below Bonneville Dam), MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River, ORC=Oregon Coast, CA=California, Rel=Release, BON=Bonneville Dam, MCN=McNary Dam, JDA=John Day Dam, RRE=Rocky Reach Dam, PRD=Priest Rapids Dam, LGR=Lower Granite Dam, LGS=Little Goose Dam, IHR=Ice Harbor Dam, LMN=Lower Monumental Dam.

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
AK	Alaska	Alaska	5	Spr	H	1	Y		37	1978	2014	PSC 2019
	Chilkat	Chilkat	1	Spr	W	1	Y		14	2001	2014	PSC 2019
	Stikine	Stikine	3	Spr	W	1	Y		16	2000	2015	PSC 2019
	Taku	Taku	2	Spr	W	1	Y		30	1977	2015	PSC 2019
	Unuk	Unuk	4	Spr	W	1	Y		26	1984	2014	PSC 2019
NCBC	Atnarko	Atnarko	8	Sum	H	0	Y		26	1987	2014	PSC 2019
	Kitsumkalum	Kitsumk	6	Sum	H	1	Y		14	2001	2015	PSC 2019
WCVI	Robertson	Roberts	16	Fall	H	0	Y		42	1974	2015	PSC 2019
SOG	Big Qualicum	Big Qua	15	Fall	H	0	Y		42	1974	2015	PSC 2019
	Chilliwack	Chilliw	18	Fall	H	0	Y		34	1982	2015	PSC 2019
	Cowichan	Cowicha	21	Fall	H	0	Y		28	1986	2015	PSC 2019
	Dome	Dome	7	Spr	H	1	Y		16	1988	2004	PSC 2019
	Elwha	Elwha	28	Sum/Fall	H	0	Y		13	1983	2013	PSC 2019
	Harrison	Harriso	17	Fall	H	0	Y		33	1982	2015	PSC 2019
	Hoko	Hoko	27	Fall	H	0	Y		26	1986	2012	PSC 2019
	Lower Shuswap	LowShus	10	Sum	H	0	Y		31	1985	2015	PSC 2019
	Middle Shuswap	MidShus	11	Sum	H	0	Y		7	2009	2015	PSC 2019
	Nanaimo	Nanaimo	19	Fall	H	0	Y		19	1980	2005	PSC 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Nicola	Nicola	12	Spr	H	1	Y		29	1987	2015	PSC 2019
	Phillips	Phillip	9	Fall	H	0	Y		6	2010	2015	PSC 2019
	Puntledge	Puntled	14	Sum	H	0	Y		39	1976	2015	PSC 2019
	Quinsam	Quinsam	13	Fall	H	0	Y		40	1975	2014	PSC 2019
PS	George Adams	George	38	Sum/Fall	H	0	Y		35	1973	2013	PSC 2019
	Nisqually	Nisqual	42	Sum/Fall	H	0	Y		34	1980	2013	PSC 2019
	Nooksack	Nooksac	20	Spr	H	0	Y		23	1990	2014	PSC 2019
	Nooksack	Nooksac	20	Spr	H	1	Y		13	1983	1998	PSC 2019
	Samish	Samish	22	Sum/Fall	H	0	Y		31	1975	2013	PSC 2019
	Skagit	Skagit	23	Spr	H	0	Y		21	1987	2014	PSC 2019
	Skagit	SkagSpr	23	Spr	H	1	Y		26	1983	2012	PSC 2019
	Skagit	SkagSm	23	Sum	H	0	Y		19	1995	2013	PSC 2019
	Skykomish	Skykomi	30	Sum/Fall	H	0	Y		13	2001	2013	PSC 2019
	South Puget Sound	SthPug	43	Sum/Fall	H	0	Y		40	1972	2013	PSC 2019
	Squaxin Pens	Squaxin	39	Fall	H	1	Y		10	1987	1998	PSC 2019
	Stillaguamish	Stillag	26	Sum/Fall	H	0	Y		28	1981	2013	PSC 2019
	University of Washington	UWAccel	33	Fall	H	0	Y		10	1976	1985	PSC 2019
	White	White	41	Spr	H	1	Y		13	1976	2014	PSC 2019
WAC	Queets	Queets	35	Fall	H	0	Y		34	1978	2012	PSC 2019
	Sooes	Sooes	25	Fall	H	0	Y		26	1986	2012	PSC 2019
LCOL	Columbia Lower	LowCol	54	Fall	H	0	Y		37	1977	2013	PSC 2019
	Cowlitz	Cowlitz	55	Fall	H	0	Y		36	1978	2013	PSC 2019
	Lewis	Lewis	63	Fall	W	0	Y		33	1978	2013	PSC 2019
	Willamette	Willame	84	Spr	H	1	Y		37	1977	2013	PSC 2019
MCOL	Carson	Carson	62	Spr	H	1	Y		29	1985	2015	Silver et al. 2019
	Carson	Carson	62	Spr	H	1	N	Rel to BON	14	2000	2013	McCann et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Carson	Carson	62	Spr	H	1	Y	Rel to BON	2	2014	2015	McCann et al. 2018
	Cle Elum	CleElum	40	Spr	H	1	Y	MCN to MCN	14	2002	2015	McCann et al. 2018
	Deschutes	Deschut	72	Fall	W	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	N	Rel to BON	9	2000	2010	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	Y		27	1987	2013	PSC 2019
	John Day	JohnDay	71	Spr	W	1	Y	JDA to BON	16	2000	2015	McCann et al. 2018
	Little White Salmon	LtlWhSa	67	Spr	H	1	Y		29	1984	2015	Silver et al. 2019
	Little White Salmon	LtlWhSa	67	Fall	H	0	N	Rel to BON	3	2008	2010	McCann et al. 2018
	Little White Salmon	LtlWhSa	67	Fall	H	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Spring Creek	SprgCrk	66	Fall	H	0	Y		41	1973	2013	PSC 2019
	Spring Creek (April Release)	SprgApr	66	Fall	H	0	N	Rel to BON	5	2008	2012	McCann et al. 2018
	Spring Creek (April Release)	SprgApr	66	Fall	H	0	Y	Rel to BON	1	2013	2013	McCann et al. 2018
	Spring Creek (May Release)	SprgMay	66	Fall	H	0	N	Rel to BON	5	2008	2012	McCann et al. 2018
	Spring Creek (May Release)	SprgMay	66	Fall	H	0	Y	Rel to BON	1	2013	2013	McCann et al. 2018
	Umatilla	Umatill	60	Fall	H	0	Y		24	1992	2015	Cameron et al. 2018
	Umatilla	Umatill	60	Spr	H	1	Y		29	1988	2016	Cameron et al. 2018
	Upriver Bright	UpCol	45	Fall	H	0	Y		38	1976	2013	PSC 2019
	Warm Springs	Warm	79	Spr	H	1	Y		28	1980	2014	Silver et al. 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Warm Springs	Warm	79	Spr	H	1	N	Rel to BON	7	2007	2013	McCann et al. 2018
	Warm Springs	Warm	79	Spr	H	1	Y	Rel to BON	2	2014	2015	McCann et al. 2018
	Yakima	Yakima	53	Spr	W	1	Y	MCN to MCN	12	2002	2015	McCann et al. 2018
UCOL	Columbia	ColSm	29	Sum	H	0	Y		33	1976	2013	PSC 2019
	Entiat	Entiat	32	Spr	H	1	Y		20	1977	2007	Fraser 2019
	Entiat	Entiat	32	Sum	H	0	Y	RRE to BON	5	2011	2015	McCann et al. 2018
	Entiat and Methow	Entiat	31	Spr	W	1	Y	RRE to BON	8	2008	2015	McCann et al. 2018
	Leavenworth	Leavenw	34	Spr	H	1	Y		33	1982	2014	Muir et al. 2019
	Leavenworth	Leavenw	34	Spr	H	1	Y	MCN to BON	16	2000	2015	McCann et al. 2018
	Mid-Columbia	ColSprH	29	Spr	H	1	Y	First to PRD	13	1972	1984	Raymond 1988
	Mid-Columbia	ColSmHW	29	Sum	HW	0	Y	First to PRD	16	1968	1983	Raymond 1988
	Mid-Columbia	ColSprW	29	Spr	W	1	Y	First to PRD	23	1962	1984	Raymond 1988
	Mid-Columbia	ColSmW	29	Sum	W	0	Y	First to PRD	7	1962	1968	Raymond 1988
	Tagged at Rock Island Dam	RockISpr	37	Spr	HW	1	Y	Rel to BON	15	2000	2015	McCann et al. 2018
	Tagged at Rock Island Dam	RockISm	37	Sum	HW	0	Y	Rel to BON	16	2000	2015	McCann et al. 2018
	Upper Columbia above Wells Dam	UpCol	29	Sum	W	0	Y	RRE to BON	4	2011	2014	McCann et al. 2018
	Wenatchee	Wenatch	36	Spr	W	1	Y	MCN to BON	9	2007	2015	McCann et al. 2018
	Winthrop	Winthro	24	Spr	H	1	Y		13	2002	2014	Humling et al. 2018
	Winthrop	Winthro	24	Spr	H	1	Y	RRE to BON	7	2009	2015	McCann et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
SNAK	Catherine	Catheri	74	Spr	H	1	Y		11	2003	2013	Feldhaus et al. 2018
	Catherine	Catheri	74	Spr	H	1	Y	LGR to LGR	15	2001	2015	McCann et al. 2018
	Clearwater	ClearSpr	48	Spr	H	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Clearwater	ClearSm	48	Sum	H	1	Y	LGR to LGR	5	2011	2015	McCann et al. 2018
	Clearwater	Clear	50	Spr	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Dworshak	Dworsha	48	Spr	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Dworshak at Snake	Dworsha	48	Fall	H	0	Y	LGR to LGR	5	2006	2011	McCann et al. 2018
	Grande Ronde	Grande	65	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Grande Ronde	Grande	65	Spr	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Imnaha	Imnaha	64	Spr	H	1	Y		29	1984	2013	Feldhaus et al. 2018
	Imnaha	Imnaha	64	Sum	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Imnaha	ImnahaW	64	Sum	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Kooskia	Kooskia	57	Spr	H	1	Y	LGR to LGR	2	2014	2015	McCann et al. 2018
	Lookingglass	Looking	65	Spr	H	1	Y		5	2006	2013	Feldhaus et al. 2018
	Lostine	Lostine	69	Spr	H	1	Y		13	1999	2013	Feldhaus et al. 2018
	Lyons Ferry at Big Canyon	BigCany	49	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Big Canyon	BigCany	49	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Lyons Ferry at Captain John	CaptJoh	56	Fall	H	0	Y	LGR to LGR	5	2008	2012	McCann et al. 2018
	Lyons Ferry at Captain John	CaptJoh	56	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Pittsburg Landing	Pittsbu	68	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Lyons Ferry at Pittsburg Landing	Pittsbu	68	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Snake	LyonsFe	46	Fall	H	0	Y		20	1985	2013	PSC 2019
	Lyons Ferry at Snake	LyonsFe	46	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	McCall	McCall	78	Sum	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Middle Fork Salmon	MidSalm	82	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Nez Perce at Cedar Flats	CedFlat	58	Fall	H	0	Y	LGR to LGR	3	2010	2012	McCann et al. 2018
	Nez Perce at Lukes Gulch	LukeGul	59	Fall	H	0	Y	LGR to LGR	3	2010	2012	McCann et al. 2018
	Oxbow below Hells Canyon Dam	Oxbow	77	Fall	H	0	Y	LGR to LGR	4	2008	2012	McCann et al. 2018
	Pahsimeroi	Pahsime	80	Sum	H	1	Y	LGR to LGR	8	2008	2015	McCann et al. 2018
	Rapid	Rapid	70	Spr	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Sawtooth	Sawtoot	83	Spr	H	1	Y	LGR to LGR	9	2007	2015	McCann et al. 2018
	Snake	Snake	44	SpSu	W	1	Y	LGR to LGR	22	1994	2015	McCann et al. 2018
	Snake	Snake	44	Spr	H	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	Snake	44	Spr	H	1	Y	IHR to IHR	3	1966	1968	Raymond 1988

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Snake	Snake	44	Spr	H	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	Snake	44	Spr	H	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	Snake	Snake	44	Fall	W	0	Y	LGR to LGR	4	2006	2011	McCann et al. 2018
	Snake	SnakSpr	44	Spr	W	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	IHR to IHR	5	1964	1968	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	IHR to IHR	5	1964	1968	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	South Fork Salmon	SthSalm	81	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Tucannon	TucanH	52	Spr	H	1	Y		28	1987	2014	Gallinat & Ross 2018
	Tucannon	TucanW	52	Spr	W	1	Y		28	1987	2014	Gallinat & Ross 2018
	Umatilla Irrigon below Hells Canyon Dam	Umatill	61	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Upper Grande Ronde	UpGrand	75	Spr	H	1	Y		11	2003	2013	Feldhaus et al. 2018
	Upper Salmon	UpSalm	73	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
ORC	Elk	Elk	85	Fall	H	0	Y		34	1980	2013	PSC 2019
	Salmon	Salmon	76	Fall	H	0	Y		36	1977	2013	PSC 2019
CA	Colman	ColFa	87	Fall	H	0	Y		14	1999	2012	Michel 2019
	Colman	ColLtFa	87	Fall	H	1	Y		20	1993	2012	Michel 2019
	Livingston Stone	Livings	86	Win	H	0	Y		14	1999	2012	Michel 2019

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Notes on Data PSC 2019

Atnarko River Summer Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as ATN and ATY by the PSC respectively. We retained ATN but excluded ATY because Atnarko is primarily a subyearling stock and the yearling releases are a hatchery management practise (Velez-Espino et al. 2011).

Kitsumkalum River Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as KLM and KLY by the PSC respectively. We excluded KLM but retained KLY because Kitsumkalum is primarily a yearling stock. The subyearlings are released by the hatchery as fry and remain in the river an extra year until they migrate to sea at the same time as their sibling KLM fish (David Willis personal communication May 2018. Section Head, Coastal Operations, Fisheries and Oceans Canada. David.Willis@dfo-mpo.gc.ca).

Lyons Ferry Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as LYF and LYY by the PSC respectively. We retained LYF but excluded LYY because Lyons Ferry is primarily a subyearling stock and the yearling releases are a hatchery management practise (Tommy Garrison personal communication Jan 2018. Biometrician. Fisheries Management Department. Columbia River Inter-Tribal Fish Commission. gart@critfc.org).

Nooksack Spring Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as NKF and NKS by the PSC respectively. We retained both because the Nooksack stock is naturally a mix of both life-history strategies (Larrie LaVoy personal communication Jan 2018).

Skagit Spring Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as SSF and SKS by the PSC respectively. We retained both because the Skagit stock is naturally a mix of both life-history strategies (Larrie LaVoy personal communication Jan 2018. National Marine Fisheries Service, National Oceanic and Atmospheric Administration. Larrie.Lavoy@noaa.gov).

South Puget Sound Fall Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as SPS and SPY by the PSC respectively. We retained SPS but excluded SPY because South Puget is primarily a subyearling stock and the yearling releases are a hatchery management practise (Larrie LaVoy personal communication Jan 2018).

Yearling/subyearling designations were taken from PSC (2015; Table 2.1) with the following exceptions: 1) Squaxin Pens Fall Chinook and University of Washington Accelerated Chinook were designated using PSC (2005; Table 2.1); and 2) we assumed Stikine Spring Chinook outmigrate as yearlings, and Phillips Fall Chinook outmigrate as subyearlings based on the typical behaviour for their adult run timing (neither stock was listed in PSC (2015)).

We excluded SAR estimates for ocean entry years with incomplete adult returns.

Notes on Data McCann et al. 2018

For most stocks, SAR estimates are provided with and without jack returns, and with differing start and end points to fish enumeration. When available, we used the estimates that included jacks and that covered the largest portion of the migration. For some MCOL populations, the estimates that included jack returns were available only for the shorter migration segment. In these cases, we used the estimates for the longer migration segment excluding jacks. Includes Spring Creek Hatchery Fall Chinook (5 of 5 years), Little White Salmon Hatchery Fall Chinook (3 of 5 years), Carson Hatchery Spring Chinook (14 of 15 years), Warm Springs Hatchery Spring Chinook (7 of 8 years), and Hanford Reach Wild Fall Chinook (9 of 11 years).

We excluded SAR estimates for ocean entry years with incomplete adult returns.

SAR estimates are referenced to McCann et al. (2017), Appendix B, but were actually downloaded from the Fish Passage Center: http://www.fpc.org/survival/smolttoadult_queries.php.

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Notes on Data Fishery Agencies

Entiat Spring Chinook- SAR estimates were calculated using data downloaded from the Regional Mark Processing Center's RMIS database. Estimates are referenced to Fraser 2019 as a personal communication to support that the estimates are the best available (i.e. no known shortfalls in the RMIS database for the years presented). The estimates were calculated as the proportion of recoveries expanded for sampling effort of all coded wire tagged smolts released from the hatchery in each year.

Lyons Ferry at Big Canyon, Captain John, and Pittsburg Landing acclimation sites- Nez Perce hatchery releases groups of coded wire-tagged smolts with and without adipose fin clips. They report that the tag returns for unclipped fish are biased low relative to those for clipped fish; we used the SAR estimates only for clipped fish.

Tucannon Wild Spring Chinook- SARS are not compensated for harvest; however, we included the wild stock because harvest for the hatchery stock is reported as minor (average of <6% of the adult hatchery fish recovered for 1985-1996 brood years; Gallinat & Ross 2018).

We used the SARS from the Conventional Hatchery Program rather than from the Captive Broodstock Program for stocks referenced to Felhaus et al. 2018.

Notes on Data Raymond 1988

Raymond 1988 provides SAR estimates for Chinook returning to the Snake River and to the Columbia River above Priest Rapids Dam. The author assigns the Columbia River estimates to the "Mid Columbia" region; however, we have classed them as "Upper Columbia" following the definition used in McCann et al. 2018 where the Upper Columbia is defined as the area between Priest Rapids Dam and Chief Joseph Dam.

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Table S2. Datasets used in this study providing harvest rate estimates for Columbia River basin Chinook salmon (*Oncorhynchus tshawytscha*). The Nickname and Map fields are populated for those stocks that also have smolt-to-adult return (SAR) estimates. The Map field corresponds to the numbering used in Figure 1. Stocks with harvest estimates from JCRMS 2019 are not displayed in Figure 1; these are defined as follows: Upper Columbia= summer Chinook destined for production areas and hatcheries upstream of Priest Rapids Dam; Upriver Spring=all spring Chinook passing Bonneville Dam from March through May including the Snake River summer Chinook (since 2005); Upriver Wild=as for Upriver Spring but for wild stocks. Race refers to adult run-timing. Rear is either hatchery (H) or wild (W). N is the sample size (years of data). From and To describe the first and last years of return. MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River.

Region	Stock	Nickname	Map	Race	Rear	N	From	To	Source
MCOL	Hanford	Hanford	47	Fall	W	26	1990	2015	PSC 2019
	Spring Creek	SprgCrk	66	Fall	H	40	1976	2015	PSC 2019
	Upriver Bright	UpCol	45	Fall	H	37	1979	2015	PSC 2019
	Yakima	Yakima	53	Spr	W	32	1983	2014	Sampson et al. 2016 Table 21
UCOL	Columbia Summers	ColSm	29	Sum	H	37	1979	2015	PSC 2019
	Leavenworth	Leavenw	34	Spr	H	10	2007	2016	Muir et al. 2019 Table 18
	Upper Columbia			Sum	HW	39	1980	2018	JCRMS 2019 Table 8
	Upriver Spring			Spr	HW	31	1982	2018	JCRMS 2019 Table 5
	Upriver Wild			Spr/Sum	W	39	1980	2018	JCRMS 2019 Tables 6 & 7
	Winthrop	Winthro	24	Spr	H	14	2003	2016	Humling et al. 2018 Table 25
SNAK	Lyons Ferry at Snake	LyonsFe	46	Fall	H	28	1988	2015	PSC 2019

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Region	Stock	Nickname	Map	Race	Rear	N	From	To	Source

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Supplementary Information

Figure S1. Normalized regional SAR estimates for Chinook salmon based on coded wire tags (CWT) in the 2010-2014 period. Each panel uses a different geographic region as the basis for comparing normalized SARs; the figure in the main text (Fig. 4) uses the Snake River as the basis for comparison. The central points on the plot indicate the median of the normalized ratios, and the whiskers extend to the empirical 5% and 95% percentiles on the sampling distribution. Estimates above the horizontal black dotted line indicate higher survival than the region to which the data are normalized (i.e., the region in each panel's title). Most data summaries are for hatchery-origin stocks; wild stocks are indicated by a star (*). SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.

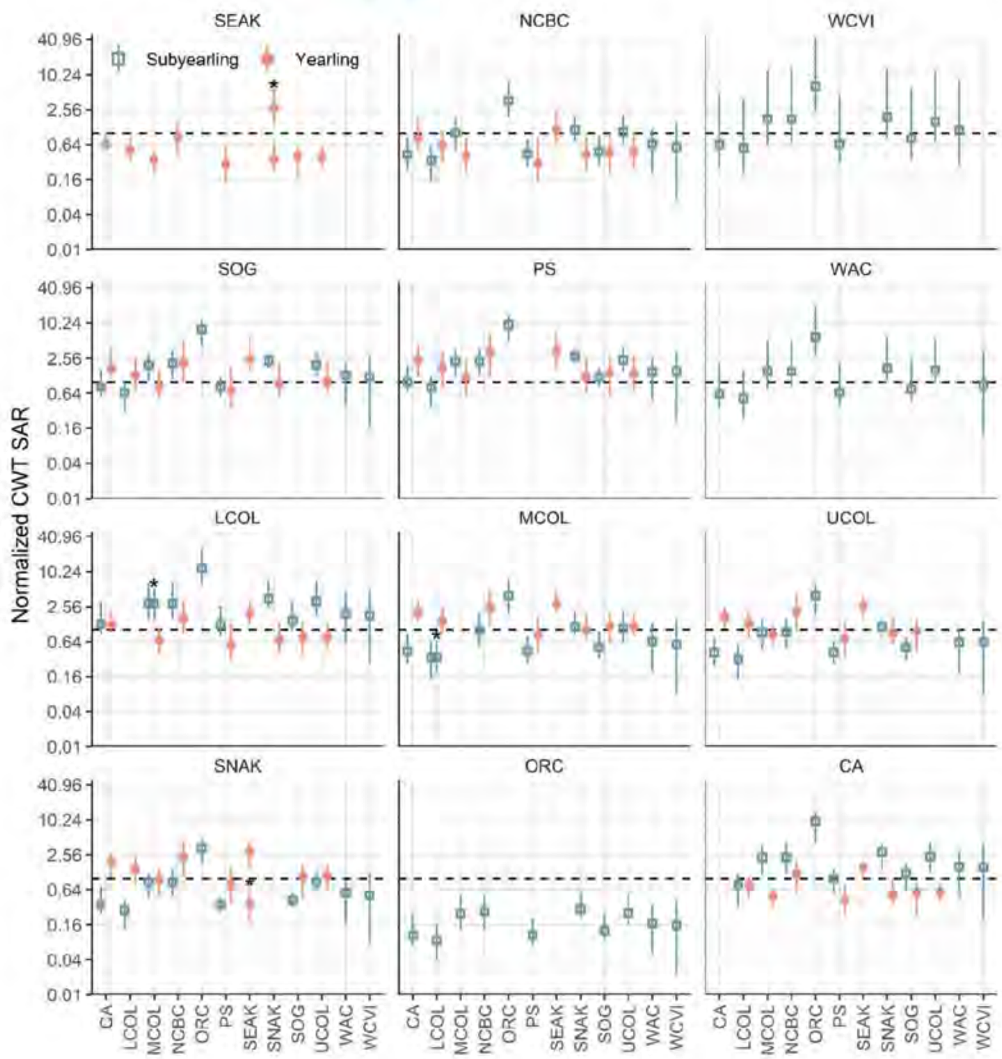

Table S1. Datasets of smolt-to-adult return (SAR) estimates for Chinook salmon (*Oncorhynchus tshawytscha*) used in this study. The Map field corresponds to the numbering displayed in Figure 1. Race refers to adult run-timing. Rear is either hatchery (H) or wild (W). Age indicates the year of smolt outmigration as either yearlings (1) or subyearlings (0). Jacks indicates whether precocious male returns are included in survival estimates. Reach is specific to passive integrated transponder SAR estimates in the Columbia River; it refers to the migration segment over which SARs were estimated. N is the sample size (years of data). From and To describe the first and last years of outmigration. AK=Alaska, NCBC=North Central British Columbia, WCVI=West Coast Vancouver Island, SOG=Strait of Georgia, PS=Puget Sound, WAC=Washington State Coast, LCOL=Lower Columbia River (below Bonneville Dam), MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River, ORC=Oregon Coast, CA=California, Rel=Release, BON=Bonneville Dam, MCN=McNary Dam, JDA=John Day Dam, RRE=Rocky Reach Dam, PRD=Priest Rapids Dam, LGR=Lower Granite Dam, LGS=Little Goose Dam, IHR=Ice Harbor Dam, LMN=Lower Monumental Dam.

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
AK	Alaska	Alaska	5	Spr	H	1	Y		37	1978	2014	PSC 2019
	Chilkat	Chilkat	1	Spr	W	1	Y		14	2001	2014	PSC 2019
	Stikine	Stikine	3	Spr	W	1	Y		16	2000	2015	PSC 2019
	Taku	Taku	2	Spr	W	1	Y		30	1977	2015	PSC 2019
	Unuk	Unuk	4	Spr	W	1	Y		26	1984	2014	PSC 2019
NCBC	Atnarko	Atnarko	8	Sum	H	0	Y		26	1987	2014	PSC 2019
	Kitsumkalum	Kitsumk	6	Sum	H	1	Y		14	2001	2015	PSC 2019
WCVI	Robertson	Roberts	16	Fall	H	0	Y		42	1974	2015	PSC 2019
SOG	Big Qualicum	Big Qua	15	Fall	H	0	Y		42	1974	2015	PSC 2019
	Chilliwack	Chilliw	18	Fall	H	0	Y		34	1982	2015	PSC 2019
	Cowichan	Cowicha	21	Fall	H	0	Y		28	1986	2015	PSC 2019
	Dome	Dome	7	Spr	H	1	Y		16	1988	2004	PSC 2019
	Elwha	Elwha	28	Sum/Fall	H	0	Y		13	1983	2013	PSC 2019
	Harrison	Harriso	17	Fall	H	0	Y		33	1982	2015	PSC 2019
	Hoko	Hoko	27	Fall	H	0	Y		26	1986	2012	PSC 2019
	Lower Shuswap	LowShus	10	Sum	H	0	Y		31	1985	2015	PSC 2019
	Middle Shuswap	MidShus	11	Sum	H	0	Y		7	2009	2015	PSC 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Nanaimo	Nanaimo	19	Fall	H	0	Y		19	1980	2005	PSC 2019
	Nicola	Nicola	12	Spr	H	1	Y		29	1987	2015	PSC 2019
	Phillips	Phillip	9	Fall	H	0	Y		6	2010	2015	PSC 2019
	Puntledge	Puntled	14	Sum	H	0	Y		39	1976	2015	PSC 2019
	Quinsam	Quinsam	13	Fall	H	0	Y		40	1975	2014	PSC 2019
PS	George Adams	George	38	Sum/Fall	H	0	Y		35	1973	2013	PSC 2019
	Nisqually	Nisqual	42	Sum/Fall	H	0	Y		34	1980	2013	PSC 2019
	Nooksack	Nooksac	20	Spr	H	0	Y		23	1990	2014	PSC 2019
	Nooksack	Nooksac	20	Spr	H	1	Y		13	1983	1998	PSC 2019
	Samish	Samish	22	Sum/Fall	H	0	Y		31	1975	2013	PSC 2019
	Skagit	Skagit	23	Spr	H	0	Y		21	1987	2014	PSC 2019
	Skagit	SkagSpr	23	Spr	H	1	Y		26	1983	2012	PSC 2019
	Skagit	SkagSm	23	Sum	H	0	Y		19	1995	2013	PSC 2019
	Skykomish	Skykomi	30	Sum/Fall	H	0	Y		13	2001	2013	PSC 2019
	South Puget Sound	SthPug	43	Sum/Fall	H	0	Y		40	1972	2013	PSC 2019
	Squaxin Pens	Squaxin	39	Fall	H	1	Y		10	1987	1998	PSC 2019
	Stillaguamish	Stillag	26	Sum/Fall	H	0	Y		28	1981	2013	PSC 2019
	University of Washington	UWAccel	33	Fall	H	0	Y		10	1976	1985	PSC 2019
	White	White	41	Spr	H	1	Y		13	1976	2014	PSC 2019
WAC	Queets	Queets	35	Fall	H	0	Y		34	1978	2012	PSC 2019
	Sooes	Sooes	25	Fall	H	0	Y		26	1986	2012	PSC 2019
LCOL	Columbia Lower	LowCol	54	Fall	H	0	Y		37	1977	2013	PSC 2019
	Cowlitz	Cowlitz	55	Fall	H	0	Y		36	1978	2013	PSC 2019
	Lewis	Lewis	63	Fall	W	0	Y		33	1978	2013	PSC 2019
	Willamette	Willame	84	Spr	H	1	Y		37	1977	2013	PSC 2019
MCOL	Carson	Carson	62	Spr	H	1	Y		29	1985	2015	Silver et al. 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Carson	Carson	62	Spr	H	1	N	Rel to BON	14	2000	2013	McCann et al. 2018
	Carson	Carson	62	Spr	H	1	Y	Rel to BON	2	2014	2015	McCann et al. 2018
	Cle Elum	CleElum	40	Spr	H	1	Y	MCN to MCN	14	2002	2015	McCann et al. 2018
	Deschutes	Deschut	72	Fall	W	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	N	Rel to BON	9	2000	2010	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	Y		27	1987	2013	PSC 2019
	John Day	JohnDay	71	Spr	W	1	Y	JDA to BON	16	2000	2015	McCann et al. 2018
	Little White Salmon	LtlWhSa	67	Spr	H	1	Y		29	1984	2015	Silver et al. 2019
	Little White Salmon	LtlWhSa	67	Fall	H	0	N	Rel to BON	3	2008	2010	McCann et al. 2018
	Little White Salmon	LtlWhSa	67	Fall	H	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Spring Creek	SprgCrk	66	Fall	H	0	Y		41	1973	2013	PSC 2019
	Spring Creek (April Release)	SprgApr	66	Fall	H	0	N	Rel to BON	5	2008	2012	McCann et al. 2018
	Spring Creek (April Release)	SprgApr	66	Fall	H	0	Y	Rel to BON	1	2013	2013	McCann et al. 2018
	Spring Creek (May Release)	SprgMay	66	Fall	H	0	N	Rel to BON	5	2008	2012	McCann et al. 2018
	Spring Creek (May Release)	SprgMay	66	Fall	H	0	Y	Rel to BON	1	2013	2013	McCann et al. 2018
	Umatilla	Umatill	60	Fall	H	0	Y		24	1992	2015	Cameron et al. 2018
	Umatilla	Umatill	60	Spr	H	1	Y		29	1988	2016	Cameron et al. 2018
	Upriver Bright	UpCol	45	Fall	H	0	Y		38	1976	2013	PSC 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Warm Springs	Warm	79	Spr	H	1	Y		28	1980	2014	Silver et al. 2019
	Warm Springs	Warm	79	Spr	H	1	N	Rel to BON	7	2007	2013	McCann et al. 2018
	Warm Springs	Warm	79	Spr	H	1	Y	Rel to BON	2	2014	2015	McCann et al. 2018
	Yakima	Yakima	53	Spr	W	1	Y	MCN to MCN	12	2002	2015	McCann et al. 2018
UCOL	Columbia	ColSm	29	Sum	H	0	Y		33	1976	2013	PSC 2019
	Entiat	Entiat	32	Spr	H	1	Y		20	1977	2007	Fraser 2019
	Entiat	Entiat	32	Sum	H	0	Y	RRE to BON	5	2011	2015	McCann et al. 2018
	Entiat and Methow	Entiat	31	Spr	W	1	Y	RRE to BON	8	2008	2015	McCann et al. 2018
	Leavenworth	Leavenw	34	Spr	H	1	Y		33	1982	2014	Muir et al. 2019
	Leavenworth	Leavenw	34	Spr	H	1	Y	MCN to BON	16	2000	2015	McCann et al. 2018
	Mid-Columbia	ColSprH	29	Spr	H	1	Y	First to PRD	13	1972	1984	Raymond 1988
	Mid-Columbia	ColSmHW	29	Sum	HW	0	Y	First to PRD	16	1968	1983	Raymond 1988
	Mid-Columbia	ColSprW	29	Spr	W	1	Y	First to PRD	23	1962	1984	Raymond 1988
	Mid-Columbia	ColSmW	29	Sum	W	0	Y	First to PRD	7	1962	1968	Raymond 1988
	Tagged at Rock Island Dam	RockISpr	37	Spr	HW	1	Y	Rel to BON	15	2000	2015	McCann et al. 2018
	Tagged at Rock Island Dam	RockISm	37	Sum	HW	0	Y	Rel to BON	16	2000	2015	McCann et al. 2018
	Upper Columbia above Wells Dam	UpCol	29	Sum	W	0	Y	RRE to BON	4	2011	2014	McCann et al. 2018
	Wenatchee	Wenatch	36	Spr	W	1	Y	MCN to BON	9	2007	2015	McCann et al. 2018
	Winthrop	Winthro	24	Spr	H	1	Y		13	2002	2014	Humling et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Winthrop	Winthro	24	Spr	H	1	Y	RRE to BON	7	2009	2015	McCann et al. 2018
SNAK	Catherine	Catheri	74	Spr	H	1	Y		11	2003	2013	Feldhaus et al. 2018
	Catherine	Catheri	74	Spr	H	1	Y	LGR to LGR	15	2001	2015	McCann et al. 2018
	Clearwater	ClearSpr	48	Spr	H	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Clearwater	ClearSm	48	Sum	H	1	Y	LGR to LGR	5	2011	2015	McCann et al. 2018
	Clearwater	Clear	50	Spr	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Dworshak	Dworsha	48	Spr	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Dworshak at Snake	Dworsha	48	Fall	H	0	Y	LGR to LGR	5	2006	2011	McCann et al. 2018
	Grande Ronde	Grande	65	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Grande Ronde	Grande	65	Spr	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Imnaha	Imnaha	64	Spr	H	1	Y		29	1984	2013	Feldhaus et al. 2018
	Imnaha	Imnaha	64	Sum	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Imnaha	ImnahaW	64	Sum	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Kooskia	Kooskia	57	Spr	H	1	Y	LGR to LGR	2	2014	2015	McCann et al. 2018
	Lookingglass	Looking	65	Spr	H	1	Y		5	2006	2013	Feldhaus et al. 2018
	Lostine	Lostine	69	Spr	H	1	Y		13	1999	2013	Feldhaus et al. 2018
	Lyons Ferry at Big Canyon	BigCany	49	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Lyons Ferry at Big Canyon	BigCany	49	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Lyons Ferry at Captain John	CaptJoh	56	Fall	H	0	Y	LGR to LGR	5	2008	2012	McCann et al. 2018
	Lyons Ferry at Captain John	CaptJoh	56	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Pittsburg Landing	Pittsbu	68	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Lyons Ferry at Pittsburg Landing	Pittsbu	68	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Snake	LyonsFe	46	Fall	H	0	Y		20	1985	2013	PSC 2019
	Lyons Ferry at Snake	LyonsFe	46	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	McCall	McCall	78	Sum	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Middle Fork Salmon	MidSalm	82	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Nez Perce at Cedar Flats	CedFlat	58	Fall	H	0	Y	LGR to LGR	3	2010	2012	McCann et al. 2018
	Nez Perce at Lukes Gulch	LukeGul	59	Fall	H	0	Y	LGR to LGR	3	2010	2012	McCann et al. 2018
	Oxbow below Hells Canyon Dam	Oxbow	77	Fall	H	0	Y	LGR to LGR	4	2008	2012	McCann et al. 2018
	Pahsimeroi	Pahsime	80	Sum	H	1	Y	LGR to LGR	8	2008	2015	McCann et al. 2018
	Rapid	Rapid	70	Spr	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Sawtooth	Sawtoot	83	Spr	H	1	Y	LGR to LGR	9	2007	2015	McCann et al. 2018
	Snake	Snake	44	SpSu	W	1	Y	LGR to LGR	22	1994	2015	McCann et al. 2018
	Snake	Snake	44	Spr	H	1	Y	LGS to IHR	5	1970	1974	Raymond 1988

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Snake	Snake	44	Spr	H	1	Y	IHR to IHR	3	1966	1968	Raymond 1988
	Snake	Snake	44	Spr	H	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	Snake	44	Spr	H	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	Snake	Snake	44	Fall	W	0	Y	LGR to LGR	4	2006	2011	McCann et al. 2018
	Snake	SnakSpr	44	Spr	W	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	IHR to IHR	5	1964	1968	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	IHR to IHR	5	1964	1968	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	South Fork Salmon	SthSalm	81	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Tucannon	TucanH	52	Spr	H	1	Y		28	1987	2014	Gallinat & Ross 2018
	Tucannon	TucanW	52	Spr	W	1	Y		28	1987	2014	Gallinat & Ross 2018
	Umatilla Irrigon below Hells Canyon Dam	Umatill	61	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Upper Grande Ronde	UpGrand	75	Spr	H	1	Y		11	2003	2013	Feldhaus et al. 2018
	Upper Salmon	UpSalm	73	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
ORC	Elk	Elk	85	Fall	H	0	Y		34	1980	2013	PSC 2019
	Salmon	Salmon	76	Fall	H	0	Y		36	1977	2013	PSC 2019
CA	Colman	ColFa	87	Fall	H	0	Y		14	1999	2012	Michel 2019
	Colman	ColLtFa	87	Fall	H	1	Y		20	1993	2012	Michel 2019
	Livingston Stone	Livings	86	Win	H	0	Y		14	1999	2012	Michel 2019

Notes on Data PSC 2019

Atnarko River Summer Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as ATN and ATY by the PSC respectively. We retained ATN but excluded ATY because Atnarko is primarily a subyearling stock and the yearling releases are a hatchery management practise (Velez-Espino et al. 2011).

Kitsumkalum River Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as KLM and KLY by the PSC respectively. We excluded KLM but retained KLY because Kitsumkalum is primarily a yearling stock. The subyearlings are released by the hatchery as fry and remain in the river an extra year until they migrate to sea at the same time as their sibling KLM fish (David Willis personal communication May 2018. Section Head, Coastal Operations, Fisheries and Oceans Canada. David.Willis@dfo-mpo.gc.ca).

Lyons Ferry Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as LYF and LYY by the PSC respectively. We retained LYF but excluded LYY because Lyons Ferry is primarily a subyearling stock and the yearling releases are a hatchery management practise (Tommy Garrison personal communication Jan 2018. Biometrician, Fisheries Management Department, Columbia River Inter-Tribal Fish Commission. gart@critfc.org).

Nooksack Spring Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as NKF and NKS by the PSC respectively. We retained both because the Nooksack stock is naturally a mix of both life-history strategies (Larrie LaVoy personal communication Jan 2018).

Skagit Spring Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as SSF and SKS by the PSC respectively. We retained both because the Skagit stock is naturally a mix of both life-history strategies (Larrie LaVoy personal communication Jan 2018. National Marine Fisheries Service, National Oceanic and Atmospheric Administration. Larrie.Lavoy@noaa.gov).

South Puget Sound Fall Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as SPS and SPY by the PSC respectively. We retained SPS but excluded SPY because South Puget is primarily a subyearling stock and the yearling releases are a hatchery management practise (Larrie LaVoy personal communication Jan 2018).

Yearling/subyearling designations were taken from PSC (2015; Table 2.1) with the following exceptions: 1) Squaxin Pens Fall Chinook and University of Washington Accelerated Chinook were designated using PSC (2005; Table 2.1); and 2) we assumed Stikine Spring Chinook outmigrate as yearlings, and Phillips Fall Chinook outmigrate as subyearlings based on the typical behaviour for their adult run timing (neither stock was listed in PSC (2015)).

We excluded SAR estimates for ocean entry years with incomplete adult returns.

Notes on Data McCann et al. 2018

For most stocks, SAR estimates are provided with and without jack returns, and with differing start and end points to fish enumeration. When available, we used the estimates that included jacks and that covered the largest portion of the migration. For some MCOL populations, the estimates that included jack returns were available only for the shorter migration segment. In these cases, we used the estimates for the longer migration segment excluding jacks. Includes Spring Creek Hatchery Fall Chinook (5 of 5 years), Little White Salmon Hatchery Fall Chinook (3 of 5 years), Carson Hatchery Spring Chinook (14 of 15 years), Warm Springs Hatchery Spring Chinook (7 of 8 years), and Hanford Reach Wild Fall Chinook (9 of 11 years).

We excluded SAR estimates for ocean entry years with incomplete adult returns.

SAR estimates are referenced to McCann et al. (2017), Appendix B, but were actually downloaded from the Fish Passage Center: http://www.fpc.org/survival/smolttoadult_queries.php.

Notes on Data Fishery Agencies

Entiat Spring Chinook- SAR estimates were calculated using data downloaded from the Regional Mark Processing Center's RMIS database. Estimates are referenced to Fraser 2019 as a personal communication to support that the estimates are the best available (i.e. no known shortfalls in the RMIS database for the years presented). The estimates were calculated as the proportion of recoveries expanded for sampling effort of all coded wire tagged smolts released from the hatchery in each year.

Lyons Ferry at Big Canyon, Captain John, and Pittsburg Landing acclimation sites- Nez Perce hatchery releases groups of coded wire-tagged smolts with and without adipose fin clips. They report that the tag returns for unclipped fish are biased low relative to those for clipped fish; we used the SAR estimates only for clipped fish.

Tucannon Wild Spring Chinook- SARS are not compensated for harvest; however, we included the wild stock because harvest for the hatchery stock is reported as minor (average of <6% of the adult hatchery fish recovered for 1985-1996 brood years; Gallinat & Ross 2018).

We used the SARS from the Conventional Hatchery Program rather than from the Captive Broodstock Program for stocks referenced to Felhaus et al. 2018.

Notes on Data Raymond 1988

Raymond 1988 provides SAR estimates for Chinook returning to the Snake River and to the Columbia River above Priest Rapids Dam. The author assigns the Columbia River estimates to the "Mid Columbia" region; however, we have classed them as "Upper Columbia" following the definition used in McCann et al. 2018 where the Upper Columbia is defined as the area between Priest Rapids Dam and Chief Joseph Dam.

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Government of Canada. Gayle.Brown@dfo-mpo.gc.ca

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Table S2. Datasets used in this study providing harvest rate estimates for Columbia River basin Chinook salmon (*Oncorhynchus tshawytscha*). The Nickname and Map fields are populated for those stocks that also have smolt-to-adult return (SAR) estimates. The Map field corresponds to the numbering used in Figure 1. Stocks with harvest estimates from JCRMS 2019 are not displayed in Figure 1; these are defined as follows: Upper Columbia= summer Chinook destined for production areas and hatcheries upstream of Priest Rapids Dam; Upriver Spring=all spring Chinook passing Bonneville Dam from March through May including the Snake River summer Chinook (since 2005); Upriver Wild=as for Upriver Spring but for wild stocks. Race refers to adult run-timing. Rear is either hatchery (H) or wild (W). N is the sample size (years of data). From and To describe the first and last years of return. MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River.

Region	Stock	Nickname	Map	Race	Rear	N	From	To	Source
MCOL	Hanford	Hanford	47	Fall	W	26	1990	2015	PSC 2019
	Spring Creek	SprgCrk	66	Fall	H	40	1976	2015	PSC 2019
	Upriver Bright	UpCol	45	Fall	H	37	1979	2015	PSC 2019
	Yakima	Yakima	53	Spr	W	32	1983	2014	Sampson et al. 2016 Table 21
UCOL	Columbia Summers	ColSm	29	Sum	H	37	1979	2015	PSC 2019
	Leavenworth	Leavenw	34	Spr	H	10	2007	2016	Muir et al. 2019 Table 18
	Upper Columbia			Sum	HW	39	1980	2018	JCRMS 2019 Table 8
	Upriver Spring			Spr	HW	31	1982	2018	JCRMS 2019 Table 5
	Upriver Wild			Spr/Sum	W	39	1980	2018	JCRMS 2019 Tables 6 & 7
	Winthrop	Winthro	24	Spr	H	14	2003	2016	Humling et al. 2018 Table 25
SNAK	Lyons Ferry at Snake	LyonsFe	46	Fall	H	28	1988	2015	PSC 2019

References

Humling, M., Pasley, C., Reese, S., Becker, T. & Cooper, M. (2018). *Winthrop National Fish Hatchery spring Chinook Salmon annual report – 2017*. U.S. Fish & Wildlife Service, Mid-Columbia Fish & Wildlife Conservation Office, Winthrop, WA.

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Muir, H., Maxey, M., Thomas, C., Becker, T., & Cooper, M. (2019). *Monitoring and Evaluation of the Leavenworth National Fish Hatchery Spring Chinook Salmon Program, 2018*. U.S. Fish and Wildlife Service, Leavenworth WA.

PSC 2019. Pacific Salmon Commission harvest rates database provided by G. Brown, Personal Communication. Department of Fisheries and Oceans, Government of Canada. Gayle.Brown@dfo-mpo.gc.ca

Region	Stock	Nickname	Map	Race	Rear	N	From	To	Source

Sampson, M.R., Fast, D.E., & Bosch, W.J. (2016). *Yakima-Klickitat Fisheries Project Monitoring and Evaluation – Yakima Subbasin*, Final Report for the performance period May/2015-April/2016, Project number 1995-063-25, 265 electronic pages.

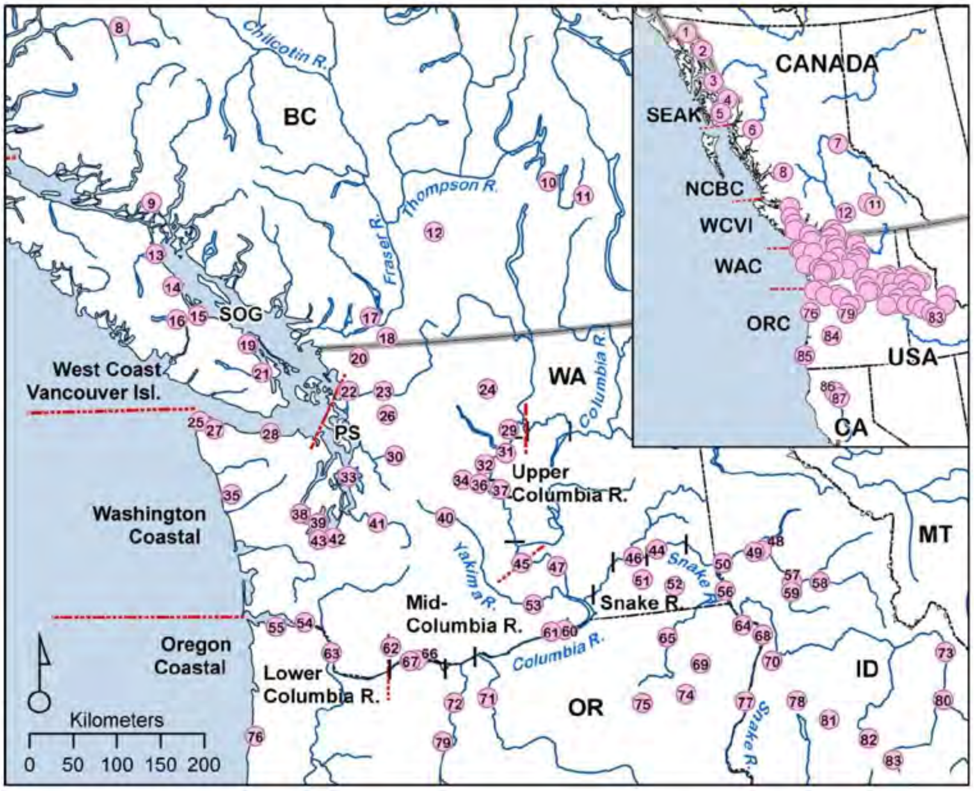

Fig. 1. Map of Chinook salmon survival time series used in the analyses. Numbers inside symbols are keyed to the populations in Table S1. SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; WAC=Washington Coastal; ORC=Oregon Coastal; SOG=Strait of Georgia; PS=Puget Sound; CA=California.

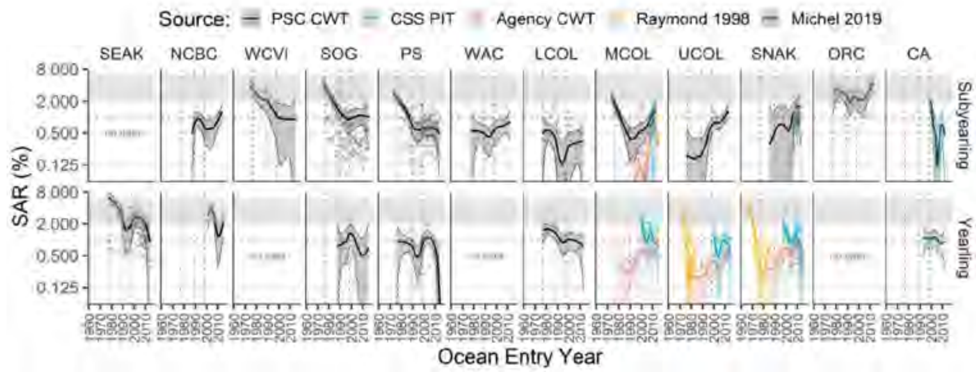

Fig. 2. Time series of smolt-to-adult return (SAR) estimates for Chinook salmon plotted by source. Annual SAR estimates for Hatchery (H), Wild (W), and mixed hatchery-wild data sources (B) are shown, but regional loess curves of survival and associated 95% confidence interval use hatchery data only, colour coded by data source. In order to focus on the trends, a few SAR estimates have been clipped by restricting the y-axis maximum to near the loess curve maxima. Blank panels indicate regions where the life history type does not occur. The SAR 2-6% recovery target adopted for Snake River Spring Chinook is shown as a grey band. The major regime shifts of 1977, 1989, and 1998 are indicated by vertical dotted lines. The horizontal dotted line indicates 1% SAR. Note logarithmic y-axis. Sources correspond to Table S1 as follows: PSC CWT= PSC 2019; CSS PIT=McCann et al. 2018; Agency CWT=all other sources exclusive of Raymond 1998 and Michel 2019. CWT=coded wire tag; CSS=Comparative Survival Study, PIT= Passive-Integrated-Transponder; SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.
(Reviewers: We have found that conversion of the high definition .tif figure format during incorporation into Word or PDF documents can cause substantial degradation of the fine detail actually present. If this is so, please request the native file format, which will support high resolution zoomed views of the individual panels. We can also provide this in a vertical orientation if the journal prefers).

179x69mm (600 x 600 DPI)

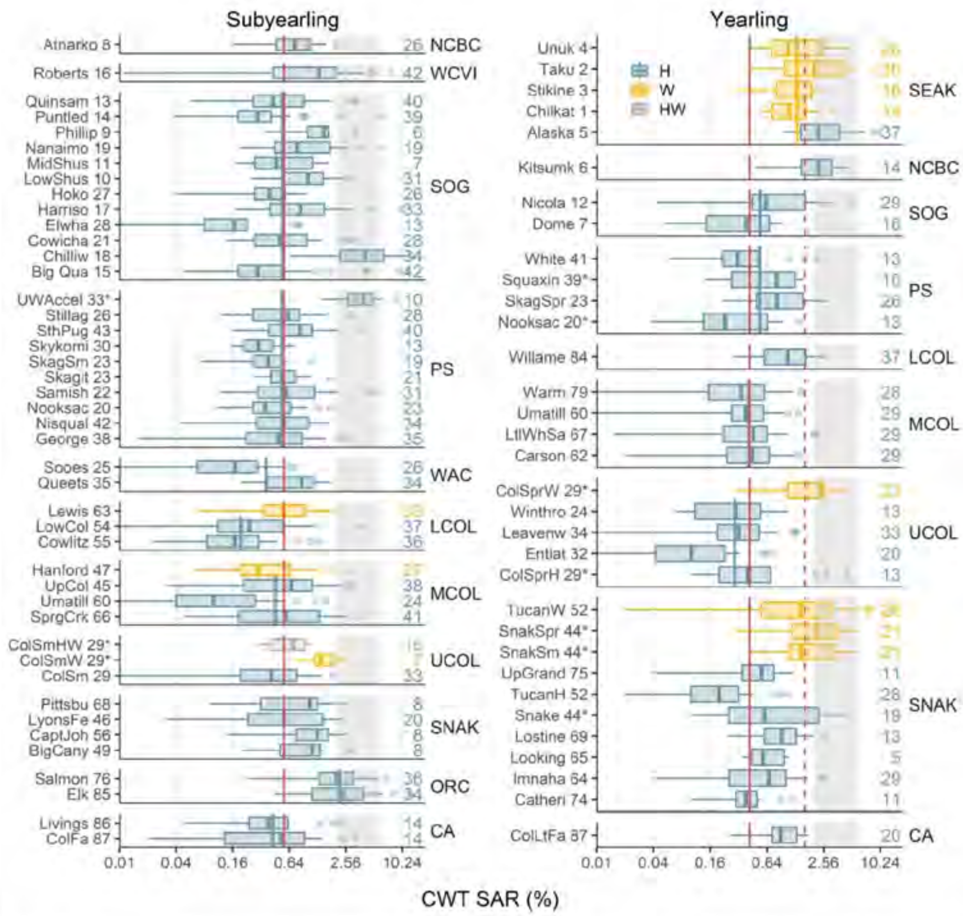

Fig. 3. Box plots of Chinook survival (SAR) based on coded wire tags, disaggregated by population and region; all years combined. Central lines show medians, boxes show the inter-quartile range (central 50% of data points), whiskers bracket 1.5 times the interquartile range, and open circles identify outliers. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates for each population is shown to the right. See Table S1 for definitions of population acronyms and Fig. 2 for region acronyms. H=hatchery; W=wild; HW=mixture. *Indicates data sets ending prior to 1998 (all data from Raymond (1998) and three Puget Sound data series from PSC (2019)).

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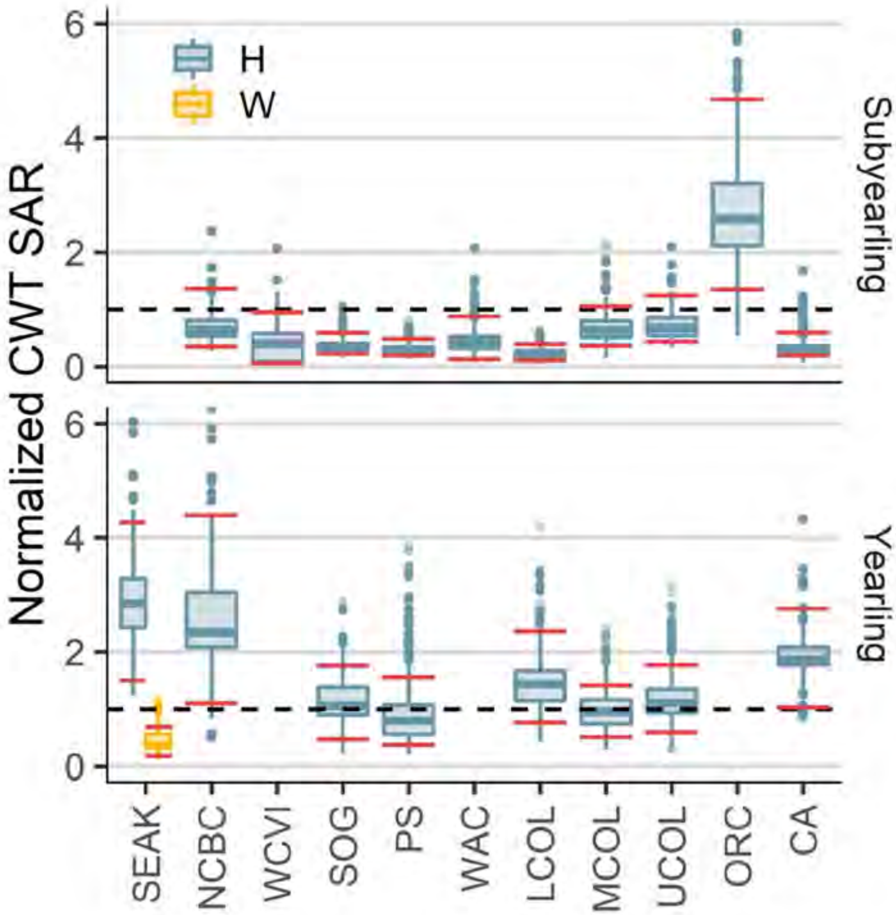

Fig. 4. Regional CWT-based SAR estimates for Chinook salmon normalized relative to Snake River SARs for the 2010-2014 period. Estimates above the horizontal black dotted line indicate higher survival than Snake River populations. Horizontal red lines show the empirical 5% and 95% percentiles on the sampling distribution of the normalized ratio. See Fig. S1 for SAR estimates normalized to all other regions. H=hatchery; W=wild.

79x79mm (600 x 600 DPI)

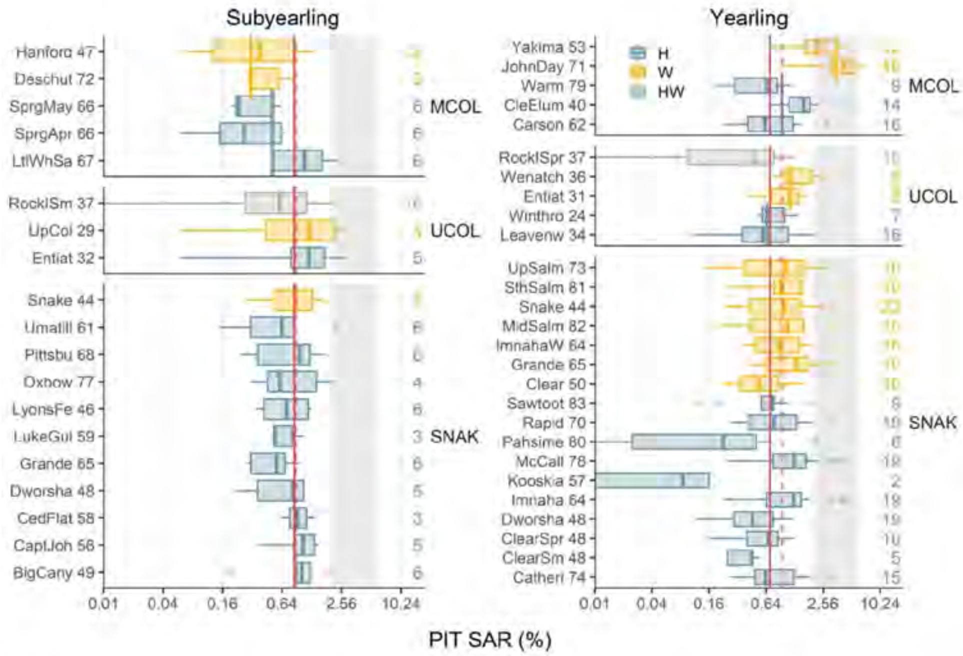

Fig. 5. Box plots of Chinook PIT tag-based SAR estimates in the Columbia River basin, disaggregated by population and region; all years combined. These SAR estimates exclude harvest and smolt and adult losses above the top-most dam. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates is shown on the right. H=hatchery; W=wild; HW=mixture. All data from McCann et al (2018).

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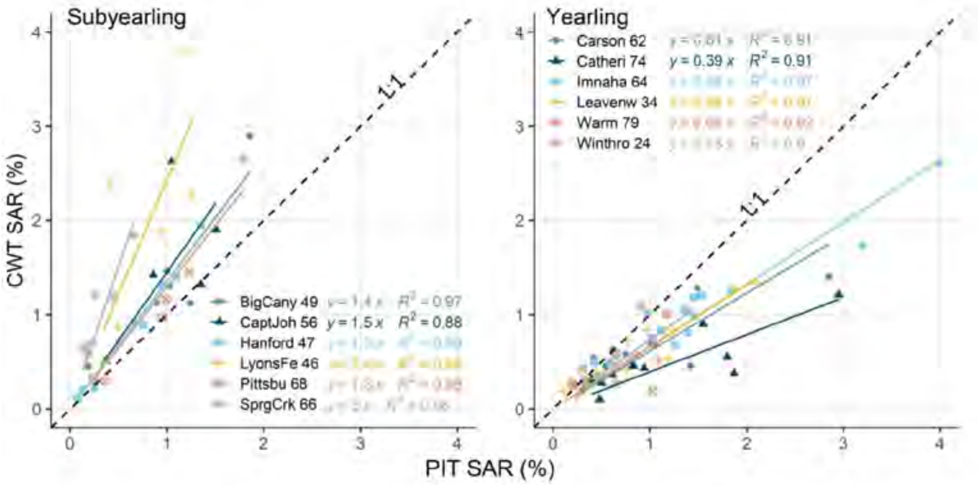

Fig. 6. Comparison of smolt-to-adult survival (SAR) estimates made using coded wire tags (CWT) and passive integrated transponder (PIT) tags for Chinook salmon populations where both tagging methodologies were employed in the same year. Linear regressions were fit with the intercept constrained to zero.

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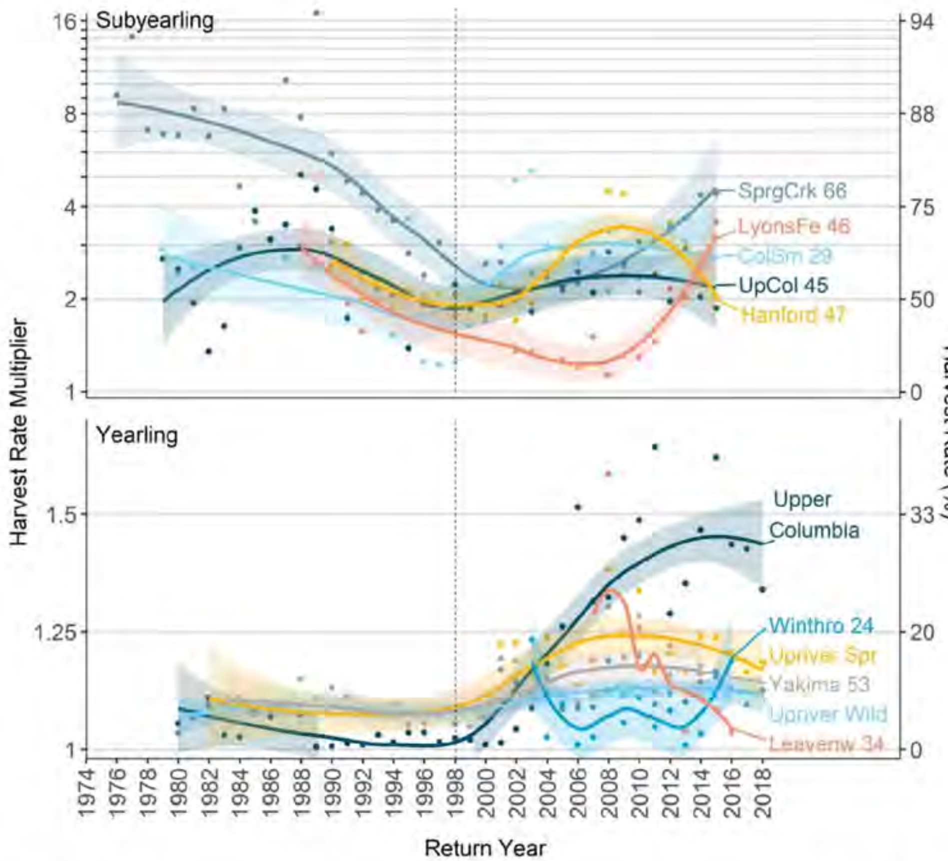

Fig. 7. Annual Columbia River Chinook harvest rate estimates, fitted loess trend lines, and associated 95% confidence intervals. The right-hand axis shows reported aggregate harvest before Chinook reach McNary Dam. The left-hand axis shows the corresponding value that PIT tag-based SAR estimates should be multiplied by to correct for exclusion of harvest; note log scale. Tributary harvests (i.e., above McNary Dam) are excluded. Substantial variation over time and between populations is evident after 1998 (vertical dashed line), when PIT tag-based survival estimation began. Data sources that present harvest estimates by brood year were converted to return year using the dominant year of return. See Table S2 for population names and references.

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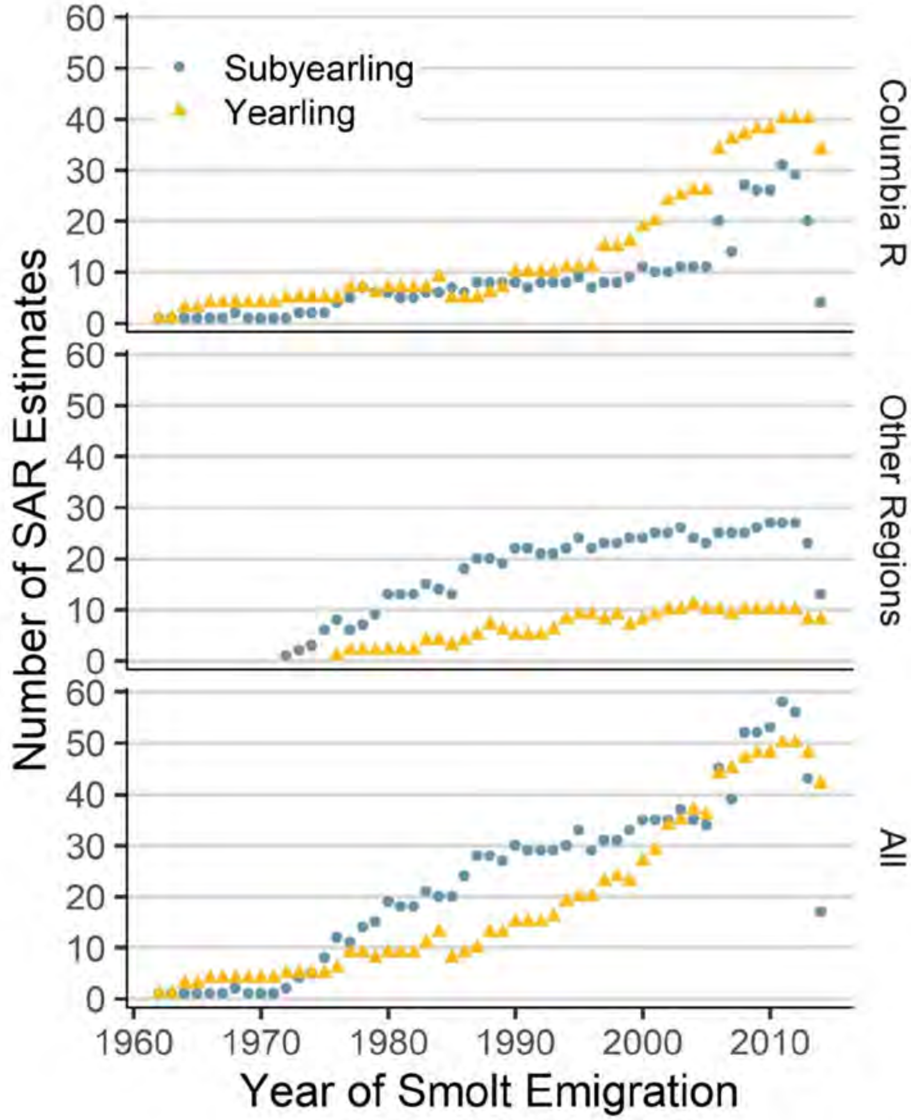

Fig. 8. Increase in the number of annual SAR estimates used in this paper. The drop in monitoring evident in the most recent years probably reflects lags in data processing rather than a decrease in effort. See Table S1 for specific populations included.

79x99mm (600 x 600 DPI)

From: Erin Rechisky

Sent: Wed Apr 01 11:59:37 2020

To: chpetersen@bpa.gov

Subject: [EXTERNAL] RE: Status Report Submitted

Importance: Normal

Hi Christine,
I meant to add a comment to the status report. Can you add this:
Final Jan-Mar 2020 (1/1/2020 - 3/31/2020) Submitter Comments

Our manuscript of the Review of the Coast-wide Decline in Survival of West Coast Chinook Salmon (Oncorhynchus tshawytscha) was submitted to Fish and Fisheries on March 30, 2020.
Abstract
We collated data for Chinook salmon from all available regions of the Pacific coast of North America to examine the large-scale patterns of salmon survival. Survival, defined as smolt-to-adult return rates (SARs), collapsed over the past half century by roughly a factor of four to ca. 1%
for many regions. Within the Columbia River the SARs of Snake River populations, often singled out as exemplars of poor survival, are unexceptional and in fact higher than estimates reported from other regions of the west coast lacking dams. Columbia River rebuilding targets may be unachievable because other regions with nearly pristine freshwater conditions, such as SE Alaska and northern BC, also largely
fail to reach these SAR targets. For consistency, our analyses primarily use coded wire tag-based SAR estimates. Passive integrated transponder (PIT) tag-based SAR estimates also available for Columbia River basin populations are generally consistent with these findings;
however, PIT tag-based SARs contain important shortfalls whose importance has gone unrecognized that compromise their intended use. More attention is needed on how SARs should be defined and documented and in the definition of rebuilding targets. We call for a systematic review by funding agencies to assess consistency and comparability of the SAR data generated and to further assess the implications of survival falling to similar levels in most regions of the west coast.

Erin
-----Original Message-----
From: CBFish on behalf of support@cbfish.org <donotreply@cbfish.org>
Sent: April 1, 2020 11:55 AM
To: chpetersen@bpa.gov; Erin Rechisky <Erin.Rechisky@Kintama.com>

Subject: Status Report Submitted

To: Christine Petersen;Erin Rechisky
Cc:

The "Final Jan-Mar 2020 (1/1/2020 - 3/31/2020)" report for contract #81498 under project #1996-017-00 ("Technical and Analytical Support for ESA Activities/Issues") has recently been submitted by erin.rechisky@kintama.com. You may view the submitted report in Pisces.

If you feel this email has reached you in error, please contact the assigned COTR for this contract, Christine Petersen (chpetersen@bpa.gov).

Thank you,

Environment Fish and Wildlife
Bonneville Power Administration

From: David Welch

Sent: Wed Apr 01 12:27:45 2020

To: Erin Rechisky; Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Deliverable Marked Complete

Importance: Normal

Hi Christine--

I think getting wide distribution of the manuscript makes great sense. I have no problem with sending the paper out for information or comment.

David

-----Original Message-----
From: Erin Rechisky <Erin.Rechisky@Kintama.com>
Sent: Wednesday, April 01, 2020 11:49 AM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Cc: David Welch <David.Welch@Kintama.com>
Subject: RE: Deliverable Marked Complete

Hi Christine,
Yes, you may share the paper. I've cc'd David in case he feels otherwise.
I've gone back in and selected "Pisces users" for access to the manuscript file.
I've marked travel complete and added that we did not travel.
I've marked contract admin complete and added a comment.
Looks like the final status report needs to be submitted before the invoice can be processed. I just have a couple more things to do in Pisces. Hopefully I can get them completed today but my workday is coming to a close since I am home schooling.
Erin

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: April 1, 2020 11:27 AM

To: Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: RE: Deliverable Marked Complete

Hi Erin,

Thank you very much for the paper. I spoke with David yesterday, and the figures really have a lot of implications if you understand and let it sink in. I need to read the full paper later this week.
I was actually about to write you and ask if it is okay to distribute the paper to people outside of BPA? Greg Smith is working on the BiOp with NOAA.

In Pisces - you might select 'pisces users', but I am not sure what level would make the paper accessible via a web crawler such as google. My best understanding is that only the annual reports that Suzie Frye 'publishes' on the website end up being findable. Another element is that I believe the tech services project number for Bioanalyst might be accessible to contacts only, because this is the case for UW (Jim Anderson) so it wouldn't make a difference what option you pick.

You could check green for travel, and then add a note or comment.

For timely administration of contracting, you can also mark this complete.
I spoke with David briefly about next steps, but I need to talk to Jody and Kristen about setting up a time for you guys to possibly present or respond to questions. We can let several of them read the paper and I anticipate they will like to participate. I will raise the second data analysis that you halted with Jody, and David also spoke of a couple new ideas yesterday.

Christine

-----Original Message-----
From: Erin Rechisky <Erin.Rechisky@Kintama.com>
Sent: Wednesday, April 1, 2020 11:03 AM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] RE: Deliverable Marked Complete

Hi Christine,
I've uploaded the SAR paper to Pisces. I was not sure who should have access? I selected "Contacts" from the drop down menu. Let me know if I should change that.
For the final status report of our contract, how do we handle "optional travel to conference"?
Also, can I mark the Deliverable for E:119 "Effective implementation management and timely contract administration" complete as of yesterday?

Thanks,
Erin

-----Original Message-----
From: CBFish on behalf of support@cbfish.org <donotreply@cbfish.org>
Sent: April 1, 2020 10:56 AM
To: chpetersen@bpa.gov; Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: Deliverable Marked Complete

To: Christine Petersen;Erin Rechisky
Cc:

The milestone "Deliverable: Produce Journal Article" for work element "B: 183. The coast-wide collapse in marine survival of North American Chinook salmon" on contract #81498 under project #1996-017-00 ("Technical and Analytical Support for ESA Activities/Issues") has recently been marked complete on status report "Final Jan-Mar 2020 (1/1/2020 - 3/31/2020)".

If you feel this email has reached you in error, please contact the assigned COTR for this contract, Christine Petersen (chpetersen@bpa.gov).

Thank you,

Environment Fish and Wildlife
Bonneville Power Administration

From: Erin Rechisky

Sent: Thu Apr 02 16:28:09 2020

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Deliverable Marked Complete

Importance: Normal

Managing....barely!

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: April 2, 2020 4:24 PM
To: Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: RE: Deliverable Marked Complete

Thank you very much, Erin,

I brought up the manuscript again today when Russell Scranton was describing his proposed monitoring plan for the agency, and SARs were one of the metrics that BPA would commit to funding. When we endorse smolt productivity, run timing, survival or SARs, should we also be prescribing the method of estimation, given that we know there are key differences.

There are various time consuming challenges in the next week, but I should think we would be prepared by 2-3 weeks from now. There have been some wild discussions of monitoring, and dramatic changes in the planned operation at the dams this spring. Exciting times!

(b) (6) [redacted]

Talk to you soon,
Christine

-----Original Message-----
From: Erin Rechisky <Erin.Rechisky@Kintama.com>
Sent: Thursday, April 2, 2020 4:05 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] RE: Deliverable Marked Complete

Done.
Just let us know when you are ready to discuss the SARs manuscript.

Erin

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: April 1, 2020 3:05 PM
To: Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: RE: Deliverable Marked Complete

Hi Erin,

I am able to return the status report, but it won't let me copy in your comment. Just enter it and return it to me.

Kristen suggests a discussion in 2-3 weeks when several of us have had a chance to read the manuscript?

Christine

-----Original Message-----
From: Erin Rechisky <Erin.Rechisky@Kintama.com>
Sent: Wednesday, April 1, 2020 11:49 AM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Cc: David Welch <David.Welch@Kintama.com>
Subject: [EXTERNAL] RE: Deliverable Marked Complete

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I've marked contract admin complete and added a comment.
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Erin

-----Original Message-----
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To: Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: RE: Deliverable Marked Complete

Hi Erin,

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You could check green for travel, and then add a note or comment.

For timely administration of contracting, you can also mark this complete.
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Christine

-----Original Message-----
From: Erin Rechisky <Erin.Rechisky@Kintama.com>
Sent: Wednesday, April 1, 2020 11:03 AM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] RE: Deliverable Marked Complete

Hi Christine,
I've uploaded the SAR paper to Pisces. I was not sure who should have access? I selected "Contacts" from the drop down menu. Let me know if I should change that.
For the final status report of our contract, how do we handle "optional travel to conference"?
Also, can I mark the Deliverable for E:119 "Effective implementation management and timely contract administration" complete as of yesterday?

Thanks,
Erin

-----Original Message-----
From: CBFish on behalf of support@cbfish.org <donotreply@cbfish.org>
Sent: April 1, 2020 10:56 AM
To: chpetersen@bpa.gov; Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: Deliverable Marked Complete

To: Christine Petersen;Erin Rechisky
Cc:

The milestone "Deliverable: Produce Journal Article" for work element "B: 183. The coast-wide collapse in marine survival of North American Chinook salmon" on contract #81498 under project #1996-017-00 ("Technical and Analytical Support for ESA Activities/Issues") has recently been marked complete on status report "Final Jan-Mar 2020 (1/1/2020 - 3/31/2020)".

If you feel this email has reached you in error, please contact the assigned COTR for this contract, Christine Petersen (chpetersen@bpa.gov).

Thank you,

Environment Fish and Wildlife
Bonneville Power Administration

From: David Welch

Sent: Mon Apr 20 10:36:45 2020

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] FW: Next steps?

Importance: Normal

Attachments: Distributions_early_survivals_v2.png

Hi Christine—

Erin corrected me on something I had written to you previously (see below for the email trail).

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Sent: Wed Apr 22 16:49:46 2020

To: 'David Welch'

Cc: Erin Rechisky; Aswea Porter

Subject: RE: Next steps?

Importance: Normal

Attachments: Schaller2020CompSRI.pdf

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Sent: Thu Apr 23 14:29:10 2020

To: David Welch; Petersen,Christine H (BPA) - EWP-4

Cc: Aswea Porter

Subject: [EXTERNAL] RE: Next steps?

Importance: Normal

I believe they cited our paper as an example of early arrival to the estuary as a mechanism for delayed mortality.

Christine, can you send an example of a handout?

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Thanks. I had heard that Charlie's paper was going to come out soon, but I hadn't seen it. I did have a good laugh in quickly skimming it just now—for perhaps the first time ever they have cited one of our delayed mortality papers! However, here is the (only) citation: "*The outmigration experience results in an accumulation of injuries, multiple stress events, and alteration of estuary arrival timing: mechanisms that may* *explain delayed mortality (Budy et al. 2002; Muir et al. 2006; Scheuerell et al. 2009; Rechisky et al. 2012).***".**

So, it is nice to be cited (I suppose), but they have apparently felt compelled to cite us in a way that suggests we support that claim. Of course, we don't. The explicit test we did refuted the claim that there would be lower survival, which they don't say… and the paper they cite (deliberately?) was one comparing survival of transported and in-river migrants, not the one assessing the effect of multiple dams on survival. I don't think anyone from the Columbia cites our PNAS paper that found no difference in below Bonneville survival or the subsequent MEPS paper that expanded that result to smaller smolts (and more groups).

May 18th works. With luck we will have emerged from most of our social distancing by then, if only for a few months.

You mentioned Jody suggested handouts to present new ideas. We can certainly do this (and have lots of ideas), but a discussion about what would be most helpful to BPA staff would be useful… some of the work we were proceeding with until the contract was re-focused on the relative SAR comparison? The re-analysis of the spill vs SAR (TDG) projections?

Also, it would be good to discuss whether "unofficially" it is safe to proceed with the time vs distance survival analysis—I know the official answer (don't), but I have a good time window now that would accelerate publication.

My calendar is open the rest of this week apart from two Friday calls at 12-1 and 4-5 pm.

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Cell: [redacted]

Sent from my iPad

On Apr 16, 2020, at 17:22, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

I was just prompting some coworkers to suggest a good time for this. Basically, they are forecasting being extremely busy in the first two weeks of May when they receive the NOAA draft BiOp and need to respond to it. So we would need to choose either before this, or later in May. I could think of several elements in the paper that would be useful to bring up when responding to the draft BiOp. But we might also want to wait a bit longer.

Managers here wanted your paper to successfully get through review, and we might be at that stage in May and better able to talk about planning additional work at that point. (b) (6) [redacted]
(b) (6) [redacted]

Let me see if I can get in touch with Jody Lando and see if she can see a time in late April that she would suggest.

Were you able to talk with Ben Zelinsky?

Christine

From: David Welch <David.Welch@Kintama.com>
Sent: Thursday, April 16, 2020 3:21 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Cc: Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: [EXTERNAL] Next steps?

Hi Christine-

I wonder if we could organize a video conference to go over the key points of our paper with your colleagues, and talk about next steps?

As mentioned, from my perspective I would be keen to get back on the comparative survival of smolts in the ocean and in the hydrosystem and wrap that up. However, if BPA was supportive we could also do an additional small contract (ca. $40K?) that would re-assess whether Steve Haeseker's original TDG analysis projecting much higher adult returns if spill was increased would hold up once currently unaccounted for harvest was added back in. I have a couple of ideas about how to do this that we could discuss. I think that this could be turned into a very short and sharply focused paper with a couple of months work, which certainly seems timely.

Stay safe,

David

David Welch, Ph.D.

<image001.jpg>

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fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Apr 30 11:58:05 2020

To: Sullivan,Leah S (BPA) - EWP-4; Jule,Kristen R (BPA) - EWP-4; 'David Welch'; Erin Rechisky; Aswea Porter; Skidmore,John T (BPA) - EWL-4; Bettin,Scott W (BPA) - EWP-4; Smith,Gregory M (BPA) - EWP-4

Subject: Revised West coast SARs paper, Kintama

Importance: Normal

Attachments: Submitted Manuscript Proof-Welch et al--Fish & Fisheries (30 March 2020).pdf

[redacted] (internal)

[redacted] (external)

[redacted] (toll free)

ID: [redacted]

We would like to invite David, Aswea and Erin to present on their revised and submitted manuscript. While they maintain their focus on patterns of West Coast SARs for yearling and subyearling Chinook, they have developed some new material on CWT and PIT based SARs, and the significance of the harvest component.

We should try to shoot for an hour presentation, but I am setting aside 90 minutes for optional discussion etc. Will provide a Webex link later.

It was challenging to find a good time when we're all available this month. Please alert me if this is just not going to work because of the BiOp review or any other reason. We can add a few more participants later

FISH and FISHERIES

Review of the Coast-wide Decline in Survival of West Coast Chinook Salmon (Oncorhynchus tshawytscha)

Journal:	*Fish and Fisheries*
Manuscript ID	Draft
Wiley - Manuscript type:	Original Article
Date Submitted by the Author:	n/a
Complete List of Authors:	Welch, David; Kintama Research Services Ltd, Porter, Aswea; Kintama Research Services Ltd Rechisky, Erin; Kintama Research Services Ltd
Key terms:	Aquaculture, Columbia River, dams, delayed mortality, smolt-to-adults returns, Snake River
Abstract:	We collated data for Chinook salmon from all available regions of the Pacific coast of North America to examine the large-scale patterns of salmon survival. Survival, defined as smolt-to-adult return rates (SARs), collapsed over the past half century by roughly a factor of four to ca. 1% for many regions. Within the Columbia River the SARs of Snake River populations, often singled out as exemplars of poor survival, are unexceptional and in fact higher than estimates reported from other regions of the west coast lacking dams. Columbia River rebuilding targets may be unachievable because other regions with nearly pristine freshwater conditions, such as SE Alaska and northern BC, also largely fail to reach these SAR targets. For consistency, our analyses primarily use coded wire tag-based SAR estimates. Passive integrated transponder (PIT) tag-based SAR estimates also available for Columbia River basin populations are generally consistent with these findings; however, PIT tag-based SARs contain important shortfalls whose importance has gone unrecognized that compromise their intended use. More attention is needed on how SARs should be defined and documented and in the definition of rebuilding targets. We call for a systematic review by funding agencies to assess consistency and comparability of the SAR data generated and to further assess the implications of survival falling to similar levels in most regions of the west coast.

Review of the Coast-wide Decline in Survival of West Coast Chinook Salmon (*Oncorhynchus tshawytscha*)

Short title: Coast-wide survival of Chinook

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Key words:

aquaculture, Columbia River, dams, delayed mortality, smolt-to-adult returns, Snake River

Abbreviations

BC- British Columbia, Canada

CSS- Comparative Survival Study

CWT-Coded Wire Tag

PSC- Pacific Salmon Commission

SAR-Smolt to Adult Return (Survival)

PIT- Passive Integrated Transponder

Conflict of Interest Statement

DWW is President and owner of Kintama Research Services Ltd., an environmental consultancy primarily focused on the development of innovative applications of telemetry to improve fisheries management. ADP and ELR are employed at Kintama. All authors received a financial benefit while conducting this study and their future salaries depend on their continued technical and scientific performance, which includes publication of this study.

Funding

This study was initially internally funded by Kintama Research Services as part of a separate research effort to assess the credibility of the critical period concept in Pacific salmon. In the course of assembling Strait of Georgia SAR data, we discovered that Chinook survival in many rivers of the Strait of Georgia region had fallen to levels well below those reported for Snake River Chinook. We developed a proposal and obtained funding from the US Dept. of Energy, Bonneville Power Administration, to cover staff time for coast-wide data collation, analysis, and writing of this paper (Contract # 75025). The funder (BPA) played no role in the design of the study nor the conclusions reached and was not made privy to the contents of this manuscript prior to submission.

Abstract

We collated data for Chinook salmon from all available regions of the Pacific coast of North America to examine the large-scale patterns of salmon survival. Survival, defined as smolt-to-adult return rates (SARs), collapsed over the past half century by roughly a factor of four to ca. 1% for many regions. Within the Columbia River the SARs of Snake River populations, often singled out as exemplars of poor survival, are unexceptional and in fact higher than estimates reported from other regions of the west coast lacking dams. Columbia River rebuilding targets may be unachievable because other regions with nearly pristine freshwater conditions, such as SE Alaska and northern BC, also largely fail to reach these SAR targets. For consistency, our analyses primarily use coded wire tag-based SAR estimates. Passive integrated transponder (PIT) tag-based SAR estimates also available for Columbia River basin populations are generally consistent with these findings; however, PIT tag-based SARs contain important shortfalls whose importance has gone unrecognized that compromise their intended use. More attention is needed on how SARs should be defined and documented and in the definition of rebuilding targets. We call for a systematic review by funding agencies to assess consistency and comparability of the SAR data generated and to further assess the implications of survival falling to similar levels in most regions of the west coast. *(221/250 words)*

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References

Introduction

The abundance of salmon in the North Pacific has reached record levels (Irvine et al., 2009; Ruggerone & Irvine, 2018; Schoen et al., 2017); however, most of the increase is in the two lowest valued species (pink, *Oncorhynchus gorbuscha,* and chum, *O. keta,* salmon) in far northern regions, at least in part due to ocean ranching (Ruggerone & Irvine, 2018). In contrast, essentially all west-coast North American Chinook (*O. tshawytscha*) populations (including Alaska) are now performing poorly with dramatically reduced productivity (Dorner, Catalano, & Peterman, 2017). The situation is similar for most southern populations of steelhead (*O. mykiss*) (Kendall, Marston, & Klungle, 2017), coho (*O. kisutch*) (Logerwell, Mantua, Lawson, Francis, & Agostini, 2003; Zimmerman et al., 2015), and sockeye (*O. nerka*) (Cohen, 2012; COSEWIC, 2017; Peterman & Dorner, 2012; Rand et al., 2012). These poorly performing species are of higher economic value and the focus of indigenous, sport, and commercial fisheries.

The historical pattern of declines in salmon abundance (steeper in the south, less so in the north) were originally assumed to reflect a freshwater anthropogenic cause because of the greater degree of freshwater habitat modification in the more populous southern regions (Allendorf et al., 1997; Nehlsen, Williams, & Lichatowich, 1991). The growing appreciation of ocean climate change (Hare, Mantua, & Francis, 1999; Mantua, Hare, Zhang, Wallace, & Francis, 1997; Mantua & Hare, 2002) has brought an awareness of the role of the ocean in influencing salmon survival. As Ryding and Skalski (Ryding & Skalski, 1999, p. 2374) noted two decades ago, "*It is becoming increasingly clear that understanding the relationship between the marine environment and salmon survival is central to better management of our salmonid resources*".

Unfortunately, our understanding of survival during the marine phase remains extremely limited, so there has been little change in management strategy beyond the essential first step of reducing harvest rates in the face of falling marine survival. The recent recognition of the decline in Chinook returns across essentially all of Alaska (ADF&G Chinook Salmon Research Team, 2013; Cunningham, Westley, & Adkison, 2018; Schindler et al., 2013) and the Canadian portion of the Yukon River (Bradford, von Finster, &

Milligan, 2009), where anthropogenic freshwater habitat impacts are negligible, is another example of how simple explanations are potentially flawed. If survival across this vast swathe of relatively pristine territory is severe enough to seriously impact salmon productivity, then there is little hope that modifying freshwater habitat in more southern regions will support a newly productive environment for salmon.

Formal SAR recovery targets have not been specified for any region of the west coast of North America outside the Columbia River basin. Within the extensively dammed Columbia River basin, the Northwest Power and Conservation Council's Fish and Wildlife Program (NPCC) set rebuilding targets for SARs at 2%-6% (McCann et al., 2018, p. 4), roughly the survival observed in the 1960s prior to the completion of the 8-dam Federal Columbia River Power System (FCRPS) (Raymond, 1968, 1979). The NPCC SAR objectives did not specify the points in the life cycle where Chinook smolt and adult numbers should be determined. However, one extensive analysis for Snake River spring/summer Chinook was based on SARs calculated as adult and jack returns to the uppermost dam encountered in the migration path (D. R. Marmorek, Peters, & Parnell, 1998): "*Median SARs must exceed 4% to achieve complete certainty of meeting the 48-year recovery standard, while ... A median of greater than 6% is needed to meet the 24-year survival standard with certainty*" (p. 41).

In this paper, we collate Chinook survival time series for the west coast of North America to document broad patterns in survival, here defined as the smolt-to-adult return rate (SAR). The SAR is the three-fold product of freshwater smolt survival during downstream migration multiplied by the marine survival experienced over 2-3 years in the ocean and multiplied by adult freshwater survival during the upstream migration to the final census point. (Depending upon the specific dataset, adult abundance may be enumerated prior to actual arrival at the spawning grounds; see Methods). Given the widely recognized poor survival of Snake River Chinook salmon resulting in their listing under the Endangered Species Act (NMFS, 2017a, 2017b), many of our analyses compare regional survival to that of the Snake River region.

Methods

Data Sources

Most survival rates of Pacific salmon are based on mark-recapture efforts, where juveniles are "marked"— implanted with either coded wire tags (CWT) or passive integrated transponder (PIT) tags—and recaptured in the fishery or detected upon return to the river. CWT technology dates back to the 1960s. A review is provided by (Johnson, 1990); the application of the methodology to coastal marine migrations of coho and Chinook is described by (L. Weitkamp & Neely, 2002; L. A. Weitkamp, 2009) and to measuring harvest and survival by (ADF&G Chinook Salmon Research Team, 2013; Bernard & Clark, 1996; Chinook Technical Committee, 2014). The tag is implanted in the nose cartilage of smolts, and the fish must be dissected to recover the tag. In contrast, PIT tags first came into widespread use in the Columbia River Basin in 1997. They are long-lived but short-distance radio-frequency tags that can successfully transmit their unique ID code when within <0.5 m of a detector (Prentice, Flagg, McCutcheon, & Brastow, 1990b; Prentice, Flagg, McCutcheon, Brastow, & Cross, 1990c; Prentice, Flagg, & McCutcheon., 1990a; Skalski, Smith, Iwamoto, Williams, & Hoffmann, 1998). The short detection range essentially limits the use of PIT tags to the Columbia River dams, which channel sufficient tagged individuals close to the detectors to generate useful results.

We collated SAR time series for Chinook from several sources (Supplementary Table S1). For CWT-based estimates, the primary data are the survival estimates for the indicator stocks used by the Pacific Salmon Commission (PSC) under the terms of the US-Canada Salmon Treaty. These datasets are formally submitted to the PSC by a wide variety of management agencies under the terms of the bilateral US-Canada Pacific Salmon Treaty. We supplemented these with CWT-based SAR time series published in the primary or secondary literature or calculated directly from the Pacific States Marine Fisheries Commission's CWT database. Together, these data sets represent California, Oregon, Washington, British Columbia, and Alaska. Estimates for the Upper Columbia and Snake Rivers reported by (Raymond, 1988) are based on freeze-branding, but were included because they are the only estimates available for the time period when SARs collapsed in those regions. Finally, because of their historical

importance to monitoring in the Columbia River we compiled and separately analyzed the PIT tag-based SAR estimates reported by the Comparative Survival Study (McCann et al., 2018).

Because SAR data are typically log-normally distributed, we primarily report the median, as this is equivalent to the geometric mean some authors use. (A simple proof of this statement is to note that that after log-transformation the mean of log-normal data will have 50% of the data above and below it). We therefore use the simpler terminology both for clarity and because Furthermore, the median is invariant under log-transformation, which is not true for the mean.

Pacific Salmon Commission (CWT)

The PSC is a bilateral treaty organization between the US and Canada coordinating coastwide management of Pacific salmon. The data are contributed to the Chinook Technical Committee of the PSC by the various government agencies responsible for conducting the individual monitoring programs. This database was the source of CWT-based Chinook survival estimates for all regions outside the Columbia River basin and for a few stocks located in the Columbia River basin.

The PSC database provides several measures of SAR. We used their estimates calculated as the sum of adults returning at all ages or caught in the fisheries, uninflated for losses to natural mortality for Chinook remaining at sea for longer than two years:

$$SAR_{i,j} = \frac{\sum_{k=2or3}^{\max age}\left(\sum_{l=1}^{n}(F_{i,j,k,l}+IM_{i,j,k,l})+Esc_{i,j,k}\right)}{\mathrm{Rel}_{i,j}}$$

where $F_{i,j,k,l}$ = the tags recovered in fishery *l*, for age *k*, from brood year *j*, of stock *i* that are expanded for the fraction of the catch sampled; $IM_{i,j,k,l}$= the incidental mortalities; and $Esc_{i,j}$ = the number of tags recovered in the escapement including hatchery and spawning ground recoveries that are expanded for the fraction sampled. Columbia River stocks also have an inter-dam loss (IDL) calculation, so fish (or tags) returning to the river are adjusted upward to account for in-river mortality. IDLs are explained in (Chinook Technical Committee, 2018).

CWT-based SAR estimates for hatchery-origin fish generally cover the period from hatchery release until adult return to the hatchery and/or spawning grounds and are compensated for harvest (i.e., mortalities due to harvest are included as survivors). However, some of the CWT-based survival estimates for wild stocks are biased high because they can exclude survival losses occurring in the initial phase of the migration upstream of the census point (see (McPherson, III, Fleischman, & Boyce, 2010)). In contrast, all five Alaskan hatcheries are located at sea level and smolts are released directly into the ocean after several weeks of seawater acclimation in holding pens, eliminating losses in freshwater (see later). Other miscellaneous notes about this dataset are recorded as footnotes at the bottom of Supplementary Table S1.

Agency Estimates (CWT)

The PSC does not include indicator stocks for California or for yearling Chinook from the Columbia River, presumably because these stocks are not relevant to international management. We therefore included published estimates for fall, late-fall, and winter Chinook runs from the Sacramento River in California (Michel, 2018). We also collated some annual reports produced by individual hatcheries in the Columbia River basin and/or contacted the hatcheries directly to build up a partial inventory of CWT-based SAR estimates for Chinook.

These supplemental estimates were calculated similarly to those done by the PSC but are unexpanded for incidental mortality (or inter-dam loss in the Columbia River). Hatcheries that do not tag 100% of smolts released may expand their estimates for the proportion tagged while others are estimated using only tagged fish. See the specific paper/reports for details (Supplementary Table S1).

Pacific States Marine Fisheries Commission

All CWT release and recovery data are submitted to the Regional Mark Processing Center hosted by the Pacific State Marine Fisheries Commission, which maintains the online Regional Mark Information System (RMIS) to facilitate exchange of CWT data. We investigated this source; however, we could not verify that adult return numbers from all possible significant components were correctly incorporated and expanded for sampling effort. Ideally, adult returns should include hatchery rack returns, adult escapement to spawning grounds, adults captured for use as brood stock, and immature or maturing individuals caught in all fisheries (sport, commercial, tribal) and locations (at sea, in-river). For this reason, we focused on the PSC and Agency estimates described above. We used RMIS only for Entiat Spring Chinook (UCOL) after consulting with Entiat Hatchery biologists (G. Fraser, *pers. comm.* USFWS, Leavenworth, WA. gregory_fraser@fws.gov).

Raymond (1988)

Data on survival in the 1960s to early 1980s period for the Snake and Upper Columbia Rivers was based on mark-recapture estimates of the abundance of a mixture of freeze-branded hatchery and wild smolts passing the first dam encountered each year (Raymond 1988). An essentially complete enumeration of adult returns was possible at upstream dams several years later because the adults must ascend fish ladders. Estimates were compensated for harvest as per (Raymond, 1988). These SAR estimates are inflated relative to the CWT-based estimates described above because they do not include migration losses from the time downstream migration is initiated until the smolts are censused at the dams and also exclude adult upstream losses between the dam and the spawning grounds. Nevertheless, this dataset is important because it incorporates the period of relatively high survival in the 1960s and early 1970s and the period when survival collapsed, which was attributed primarily to dam construction. We used these estimates in conjunction with the CWT estimates for a more complete time series.

Comparative Survival Study (PIT tags)

PIT tags have largely supplanted CWTs in the Columbia River basin because of the ability to measure smolt survival between dams and to estimate SARs. We used the estimates of overall SAR from Chapter 4 of the Fish Passage Center's Comparative Survival Study (McCann et al., 2018) which are essentially the number of adults returning to the uppermost FCRPS dam with detection capability (Lower Granite, McNary, John Day and/or Bonneville dams depending on the origin of the population) divided by the estimated number of PIT-tagged smolts surviving to their uppermost dam during downstream migration. For example, for most Chinook salmon originating from the Snake River basin, the SAR is estimated from Lower Granite Dam back to Lower Granite Dam.

When estimates were available for multiple segments, we selected the SARs covering the greatest extent of the migratory life-history (i.e., smolt releases and adult returns to the uppermost dam available in the Columbia River basin), and we used SAR estimates that included jacks when available. In the mid-Columbia region, SAR estimates with jacks were sometimes available only for a shorter migration segment; in these cases we selected the SAR data sets representing the longer migration segment but excluding jacks because this was most similar to the CWT survival estimates. PIT tag-based SARs do not incorporate losses due to harvest (McCann et al., 2018, p. 95) because the commercial and sport catch is not monitored for PIT tags.

Because published PIT tag-based SAR estimates contain several limitations that are problematic to the interpretation of survival (particularly lack of harvest information), we use these estimates only as a secondary validation of the major conclusions.

Division by Life History

Chinook salmon display two major life history types (subyearling and yearling) that correspond with adult run-timing (Fall or Spring respectively). These life history types are examined separately in our analysis because there are important ecological differences between them (see reviews by (Riddell et al., 2018); Sharma and Quinn (2012)) which likely influence survival. We review the general characteristics below but note that this simple picture is more complicated due to hatchery rearing practices and natural variability.

Subyearling/Fall populations are widely distributed in low gradient coastal streams or the lower mainstem of major rivers but are absent from Alaska. They migrate to the ocean within a few months of hatching and almost certainly remain as long-term residents of the continental shelf off the west coast of North America where they are exposed to commercial and sport harvest in coastal marine waters over multiple years (Sharma & Quinn, 2012). Survival of shelf-resident subyearling Chinook populations can therefore be significantly reduced by coastal fisheries that can harvest these animals over several years of marine life.

Yearling/Spring populations are found in headwater tributaries of large river systems penetrating well into the interior of the continent, such as the Columbia and Fraser rivers. They migrate to sea after completing one or more full years of life in freshwater and are thus significantly larger at ocean entry. Yearlings are thought to move offshore and become purely open ocean residents for much of the marine phase, and thus are essentially immune to harvest by fisheries until their return to freshwater, where variable levels of harvest may occur. Yearlings also (generally) spend one less year in the ocean than subyearlings.

Comparisons between Regions

To develop a formal statistical test of the similarity in SARs between regions in the most recent years of the record, we first grouped the CWT-based SAR data separately by smolt age (Yearling/Subyearling), region, and rearing type (hatchery/wild). For each of these groupings, we pooled all data in the 2010-2014 period across all populations in a region, and then resampled the pooled data with replacement N=10,000 times, each time drawing a sample of the same size as the original pooled data. Limiting the samples to this timespan ensured the data were current and removed the variability due to differing lengths of the time series. For each group, we calculated the N median SARs, and then calculated the ratio of those N medians with those from each of the other regions in turn. The empirical distribution of the N ratios allows for a formal statistical test of the proposition that median SARs in the two regions are equal (i.e. that the ratios are not different from one). The normalized SAR ratio for region i in sample j=1,.., N was then $SAR_{i,j}/SAR_{SNAK,j}$. Because of the generally recognized poor survival of Snake River Chinook salmon, we present the results of the comparison to this region in the main text but also provide the comparison using all possible regions in the denominator in Supplementary Figure S1.

Comparison between CWT and PIT tag-based SARs

There are some fundamental differences between PIT and CWT tag-based SAR estimates. PIT tag-based SARs exclude smolt and adult survival above the topmost dam where they are censused and do not account for harvest in ocean or mainstem river fisheries. CWT-based estimates incorporate these factors. Therefore, an aggregate correction factor $\widehat{c_{i,j}}$ for the PIT-based SAR estimates to make them consistent with the CWT-based SAR estimates is:

$$\widehat{c_{i,j}} = \frac{S_{i,j}^{smolt} * S_{i,j}^{adult}}{(1 - h_{i,j})}$$

where $S_{i,j}^{smolt}$ = the estimated survival of stock i between the hatchery or pre-smolt rearing grounds and the uppermost dam for smolts from brood year j; $S_{i,j}^{adult}$ = the estimated survival of stock i between the uppermost dam and return to the hatchery/spawning grounds; and $h_{i,j}$ = the estimated harvest of stock i in year j. For notational simplicity, we neglect harvest in years prior to adult return. Here the numerator corrects for upwards bias in PIT-based SAR estimates caused by excluding survival above the topmost dam while the denominator corrects for the downward bias caused by excluding harvest.

We were interested in estimating $c_{i,j}$ to assess if it was reasonable to use it to combine these data into a single term that could provide a reliable metric for converting between PIT and CWT-based SAR estimates. To do this, we first attempted to collate the three components ($S_{i,j}^{smolt}$, $S_{i,j}^{adult}$, and $h_{i,j}$) for the populations with PIT tag SAR estimates, but we encountered difficulty obtaining sufficient data, particularly for the adult stage. However, combined ocean plus mainstem harvest rates were readily available for the PSC's indicator stocks. For yearling populations, marine harvest rates are thought to be very low (Waples, Teel, Myers, & Marshall, 2004) and are not included in the CTC database. We therefore collated mainstem harvest data from other sources for yearlings (Supplementary Table S2).

Our second approach to estimating $c_{i,j}$ was to identify populations with both CWT- and PIT-based SAR estimates generated in the same years and then use simple linear regression to

identify the relationship. If there was no difference between estimation methodologies, then the regression of CWT SAR estimates on PIT tag-based SAR estimates should have a regression slope of $\hat{c} = 1$.

Results

We collated 123 eastern North Pacific Ocean Chinook salmon SAR time series totaling 2,279 years of monitoring (Fig. 1). SAR estimates included in our analysis were from populations extending from central California to south east Alaska and include 94 hatchery populations, 26 wild, and 3 hatchery-wild (mixed) populations.

SARs obtained from Coded Wire Tags

Most regions of west coast North America with CWT time series extending back prior to the 1978 regime shift (Beamish, 1993; Beamish & Bouillon, 1993; Ebbesmeyer et al., 1990; Francis & Hare, 1994; Mantua et al., 1997) show an approximate four-fold decrease in SARs for hatchery populations (Fig. 2). This applies to subyearling Chinook from west coast Vancouver Island, the Strait of Georgia, Puget Sound, and the mid-Columbia River; and to yearling Chinook from SE Alaska, the lower and upper Columbia River, and the Snake River (upper Columbia and Snake rivers are relative to the historical freeze brand data from Raymond (1988)). Except for coastal Oregon subyearlings, average CWT-based SARs for all regions are now approximately 1% or less.

All time series outside the Columbia River watershed are based on CWTs. Within the Columbia, several methods of estimating SARs have been employed with recent estimates based on both PIT and CWT tags. These tag types show different SAR trends over time and substantial offsets (Fig. 2), with PIT tag-based SAR estimates lower than CWT-based estimates for subyearlings and higher for yearlings, which we discuss later.

With the exception of lower Columbia yearlings, Chinook from all regions of the Columbia show some increase in CWT-based SARs since the 1980s and early 1990s, the period when SARs reached their lowest values, but none of these time series recovered to the survival levels measured by Raymond (1988) in the 1960s.

Median population specific SARs show that wild populations generally have higher survival than hatchery populations; however, there are limitations: CWT data are limited for wild populations and there are no data available for a direct hatchery vs wild comparison for the same population (Fig. 3). The wild yearling Chinook populations in SE Alaska tend to have lower survival than the hatchery-reared population; however, the Alaskan hatchery SAR estimate provided to the PSC is based on combined data for five hatcheries that all release smolts directly into the ocean after acclimation to seawater for several weeks, eliminating losses from freshwater migration (Bill Gass, Production Manager, Southern Southeast Regional Aquaculture Association, & John Eiler, NOAA; pers. comms.).

Median SARs for hatchery or wild populations within a given region tend to cluster together, but a few populations (University of Washington experimental hatchery releases in Puget Sound and the Chilliwack production hatchery in the Strait of Georgia) have unusually high SARs relative to other stocks in their regions. These are also the only populations whose medians substantively attain the 2-6% SAR recovery level adopted in the Columbia River basin. Apart from SE Alaska, north-central BC yearlings, and Oregon Coast subyearlings, which have higher regional survivals, populations from other regions have only rarely reached this level of production.

To compare the current status of regional CWT-based SARs we included the five most recent years of available SAR data (2010-2014) in a resampling procedure to statistically quantify relative SARs and control for differences in interannual timing. We used Snake River population SARs as a baseline in which to compare all other regions; five-year data using other regions as the basis for comparison are presented in Supplementary Information SI-3. A striking result emerges for hatchery-reared subyearling Chinook in the 2010-14 period: median SARs in all regions except the Oregon Coast are lower than median Snake River SARs (Fig. 4). Only in three of nine regions with numerically lower SARs does the upper 5th percentile of the empirical distribution include the possibility of equal SARs with the Snake River region (North-Central

BC, Mid, and Upper Columbia). For all other regions, subyearling SARs are statistically lower than the Snake River survivals. There are no CWT-based SAR estimates for wild subyearling Chinook.

Applying the same procedure to hatchery-reared yearling Chinook, current regional SARs were statistically indistinguishable from Snake River SARs for the Salish Sea (Strait of Georgia, Puget Sound) and all other regions of the Columbia River basin (Lower, Mid, and Upper; Fig. 4). California, northern BC, and SE Alaska yearling SARs were significantly higher than Snake River yearling populations. The SARs of SE Alaska wild yearling Chinook (four river systems) were significantly lower than the SARs of the one wild stock of Snake River yearling Chinook available for comparison (Tucannon River; Fig 3).

SARs obtained with PIT Tags

PIT tag-based SAR estimates are available for Chinook salmon originating from the Columbia River Basin and are published annually by the Fish Passage Center (McCann et al., 2018). Comparing PIT tag-based SARs across regions of the Columbia River basin (Fig. 5) yields similar results to the CWT analysis: wild fish generally have higher survival and different regions have similar or lower median SARs to the Snake River. The exceptions are two mid-Columbia populations of wild yearling Chinook salmon which have consistently high SARs that fall within the 2-6% rebuilding target set for Columbia River Basin yearling Chinook. However, both wild and hatchery subyearling SARs from the mid-Columbia fall well below the Snake River medians, and all other populations (including three hatchery-reared mid-Columbia yearling populations) have SARs which rarely or never exceed 2%; from this perspective only the two wild yearling populations (John Day and Yakima) have substantively higher SARs.

Comparison of CWT and PIT tag-based SARs

We attempted to develop a direct comparison of PIT- and CWT-based SAR estimates so that we could incorporate PIT tag-based SAR datasets into our analysis. PIT-based estimates differ in two major ways from CWT estimates: (1) they exclude sport, commercial, and indigenous harvest and (2) they exclude smolt and adult losses in the region lying between the uppermost dam and the hatchery or spawning site.

We attempted to develop a direct comparison of PIT and CWT-based SAR estimates but encountered difficulty finding comparable data. Where paired populations were available, regression relationships were population-specific for both life history types (Fig. 6). Subyearling CWT-based SAR regression estimates were consistently higher than PIT-based estimates (Fig. 6), presumably because the high subyearling harvest rates not captured in PIT-based estimates (currently between ~45-80%; Fig. 7) outweigh the influence of excluding upstream losses. In contrast, CWT-based SARs for yearling populations were consistently lower than PIT-based estimates indicating that mortality above the uppermost dam outweighs the influence of the generally lower harvest rates on yearling populations. Although fitted linear relationships had high R^2, the substantial differences in regression slopes among populations (ranging, from 1.3 to 3 times for subyearling populations), suggests that population-specific factors strongly influence the relationship. A simple correction factor between PIT and CWT-based SAR estimates appears infeasible.

Discussion

Governments primarily attempt to increase salmon populations by using hatcheries and restoring degraded habitats. A major assumption is that regional factors such as freshwater habitat degradation or salmon aquaculture make important contributions to the decreasing survival of salmon observed coastwide. Consequently, evidence that Chinook salmon survival (SARs) has decreased to roughly the same amount everywhere along the west coast of North America is both surprising and important. Most populations in many regions of the west coast of North America have declined to reach approximately the same low numerical level, ~1%, with a few important exceptions which we discuss below. Direct measurements of SARs are lacking for stocks located west of SE Alaska, but the decrease in the number of adult Chinook returning to the rest of Alaska (ADF&G Chinook Salmon Research Team, 2013; Schindler et al., 2013) further demonstrates that survival has fallen over a very large geographic range. Given the potentially profound conclusions, we consider two questions: (a) How close are numerical estimates of SARs generated by agencies along the west coast of North America? (b) How well can we trust the data?

SAR Comparison

Comparing the entire coastwide data set of CWT-based SAR estimates plus the earlier Raymond (1988) estimates (Fig 1), the aggregate data reveal that essentially all time series extending back to the 1970s show survival of both yearling and subyearling Chinook dropping by roughly a factor of four, to ~1% (all regions of southern BC, Puget Sound, and the Columbia River basin). The similar timing of the decline in the Salish Sea and west coast Vancouver Island to that in the Columbia River basin is striking, suggesting the strong influence of a broad driver (Beamish, 1993; Beamish & Bouillon, 1993; Mantua et al., 1997).

Despite the relative shortness of coastal streams in most regions of the west coast, aggregate subyearling SARs from these regions are lower than those reported for Snake River populations in the five most recent years of the dataset (2010-2014; Fig. 4). Oregon coast populations are clear exceptions. The SARs of yearling populations from Puget Sound, the Strait of Georgia, and the lower, mid, and upper Columbia River are statistically indistinguishable from the Snake River (Fig. 4). Only yearling hatchery populations from California, north-central BC, and SE Alaska have SARs exceeding the Snake River populations. When comparing all available years of data (Fig. 3), the conclusion is generally the same; thus, the numerical similarity in SARs is not an artifact of some recent event but something that has persisted for many years. When the value of these SARs is considered over the entire record available for individual populations (Fig. 3), median SARs are similarly poor everywhere, and generally ~1% except in the earliest years of the time series. (Supplementary Tables S3 and S4 provide a summary of the actual numeric values.)

The few wild yearling CWT-based Chinook SAR time series available for comparison with wild Snake River SARs are not consistently better, as might be expected. One population of yearling Chinook from the Upper Columbia River had survival slightly higher than the Snake River wild population, but all four wild Alaskan stocks have lower SARs than the one Snake River wild stock available for comparison (CWT Tucannon; Fig. 4). These results also indicate that not only are wild Snake River SARs are poor, but that survival is poor almost everywhere along the west coast of North America.

A few populations with anomalously high SARs relative to other populations in the same region exist, and provide intriguing evidence that some populations have an intrinsic ability to support higher SARs meeting the Columbia River basin's current 2-6% recovery targets (subyearlings from the Chilliwack hatchery in the lower Fraser River (SOG) and a ten year release record of experimental hatchery releases from the University of Washington (PS)). It is unclear why these two populations are so much more productive. If the underlying reasons for higher survival can be identified it might be possible to improve the productivity of other hatchery populations.

Intriguingly, the higher SARs of the two coastal Oregon subyearling populations and yearling Chinook from California (Figs. 3, 4) all involve populations that apparently do not migrate far north. The SARs of California Chinook are particularly noteworthy because freshwater survival is exceedingly low (Michel, 2018); for overall SARS to be higher than Snake River stocks suggests much higher survival during the marine phase. (Riddell et al., 2018, p. 580) note the unique marine distributions of southern Oregon Chinook stocks, which restricts them for their entire ocean phase to life in the California Current, similar to the assumed ocean distribution of California stocks. It thus seems plausible that specific salmon populations home to distinct feeding grounds, some of which may confer better survival.

Credibility of SAR estimates

CWT-based estimates

We restricted most SAR comparisons to CWT-based data, as these are available for the entire west coast to as far north as SE Alaska. Most estimates are for hatchery-reared indicator stocks published by the Pacific Salmon Commission; few estimates are available for wild populations. For upper Columbia and Snake yearling populations we used estimates published by individual fishery agencies. The PSC cites several challenges with CWT-based estimates including representativeness of the indicator populations, limitations on sampling the fishery and spawning grounds, and distortions introduced by mark-selective fisheries (Hankin et al., 2005). Agencies presumably generate these data using internally consistent methodologies over time to avoid biasing parts of the time series, thus, the large concurrent downward trend in survival of individual populations is most likely to be credible.

PIT tag- based estimates

PIT tag detectors in dam bypasses and fish ladders census both the downstream and upstream movements of PIT-tagged salmon within the Columbia River basin. Originally developed to study smolt survival in the hydrosystem, PIT tag-based studies subsequently evolved to measure adult returns, presumably because of the unique ability to completely enumerate returning adults as they ascend fish ladders. SAR data sets are now generated for many yearling and subyearling Chinook (McCann et al., 2018) and as a result PIT tags have largely supplanted CWT tags for estimating SARs in the Columbia River basin. Dividing estimated smolt counts at the dams in the ocean entry year by the returning adult counts in subsequent years provides the SAR.

PIT tag-based SAR estimates show that recent SARs are now generally low compared to historical levels (Fig. 2) and track reasonably well with CWT-based estimates for individual populations (Fig. 6); however, our results indicate that PIT tag-based estimates are not comparable to CWT-based estimates and are not inter-convertible. There are two reasons for this. First, for dam-to-dam estimates (e.g., Lower Granite Dam smolts to Lower Granite Dam adults) the survival losses incurred upstream of the dam can vary substantially between populations (Faulkner, Widener, Smith, Marsh, & Zabel, 2017). Unless census points are located at the start and end of the migration period, the amount of excluded upstream survival acts as a random variable influenced by the excluded distance. This is true for essentially all published PIT-based SAR data (McCann et al., 2018) and for some CWT-based SAR estimates for wild populations, where smolt abundance is usually censused after migration has started (e.g., (McPherson et al., 2010)). For Columbia River basin Chinook, the result is that PIT-based SAR estimates are overestimated relative to CWT-based estimates (Fig. 6).

The second reason is that Chinook harvested in fisheries prior to return are not accounted for in PIT tag-based estimates. Authors have previously noted that PIT tag-based SAR estimates do not include harvest (D. Marmorek & Peters, 2001; McCann et al., 2018) and recommendations have recently been made to incorporate harvest (ISRP, 2019, p. 22), but to our knowledge neither the magnitude of the harvest nor the variability over time has not been recognized. The result is that PIT tag-based SARs represent the surviving adults left over from the operation of multiple fisheries operating over several years. The influence of commercial, sport, and tribal fisheries on adult returns, and thus survival, is large.

Harvest and PIT Tag-based SAR

Unfortunately, the power of the PIT tag system to identify all returning adults is compromised by the inability to identify PIT-tagged fish in the harvest. Ocean harvest rates on Columbia River basin yearling (Spring) Chinook stocks are ≤2% (H. A. Schaller, C. E. Petrosky, & O. P. Langness, 1999; Waples et al., 2004), presumably because maturing Spring Chinook cross the continental shelf only near their natal river mouth on return and are not exposed to the many coastal fisheries operating along the shelf; however, yearling Chinook harvests in freshwater are still substantial (Fig 7). Harvest rates for Upriver Spring Chinook increased from 10% to 25% of the number arriving at the river mouth over the 1998-2012 period (PFMC, 2019). Not accounting for this harvest results in underestimating the true SAR by ca. 10% in 1999 (near the beginning of the PIT tag record) and increasing to 33% in the most recent years of the record. For other yearling stocks the correction is larger.

For subyearling Chinook, which are much more heavily harvested, PIT-based SAR estimates likely underestimate the true SAR by 300-400% in recent years. For example, Lyons Ferry (Snake River) subyearling Chinook harvest rates rose from a low of ~20% in 2004 to >70% in 2012. These values imply correction factors increasing from 1.25 to >3 over eight years.

The varying patterns of increase in harvest rates towards the most recent years of the record is particularly important because PIT-based SAR estimates will not reflect the higher harvest rates of recent years and will therefore understate the improvements in adult survival that actually occurred (Fig 7). Further, given the variability in harvest rates over time and between populations, a reliable correction factor to account for harvest will be difficult to achieve for PIT tag-based SAR estimates, while leaving these estimates uncorrected for harvest results in a substantial downwards bias in survival estimates (Fig 6).

Another unrecognized problem with using PIT tag-based SAR estimates to set quantitative recovery targets for Columbia River basin Chinook (e.g., 2-6% SAR) is that the strategy dictating management of the fisheries is divorced from these goals. Under the terms of the renegotiated Pacific Salmon Treaty, beginning in 1999 coastwide management of ocean fisheries for Chinook is explicitly abundance-based (Miller, 2003). As a consequence of the treaty revision, fisheries are intensified when Chinook abundance is high and restricted when low. Consequently, PIT-based SAR estimates will inaccurately reflect true survival if managers simply identify and harvest any increase in abundance—which is precisely what the treaty dictates they should do. In fact, if managers had perfect control of ocean fisheries survival changes would not be reflected in PIT tag-based SAR estimates at all because any change in abundance would simply be compensated for by altering harvests prior to adult return. In practice, over or under-harvesting is likely, so PIT-based SAR fluctuations will partially reflect the inability to manage ocean fisheries perfectly. Even for Snake River Spring Chinook, where harvest rates are lowest and the inter-annual fluctuations in harvest are on the order of 10-20% (Fig. 6), SAR increases of this size would generally be considered significant. That they may simply be reflecting limitations inherent to the management system is of concern and appears to have gone unrecognized. Equally important, expensive changes to the operation of the Columbia River hydropower system intended to improve survival may benefit the ocean fisheries without credit accruing to those bearing the costs.

Delayed mortality

Delayed mortality, the theory that greater dam passage results in poorer survival of Snake River Spring Chinook after smolts migrate out of the hydrosystem (Budy, Thiede, Bouwes, Petrosky, & Schaller, 2002; Independent Scientific Advisory Board (ISAB), 2007; Schaller & Petrosky, 2007; Howard A Schaller, Charles E Petrosky, & Olaf P Langness, 1999), still plays an important role in Columbia River salmon management (McCann et al., 2019, pp. 116-119). The theory has been questioned because it is based primarily on the view that the higher PIT-based survival of two wild mid-Columbia yearling populations (Yakima and John Day) than wild Snake River populations must be due to the difference in the number of dams these populations migrate past (ISAB, 2019). However, neither the broader PIT nor CWT-based SAR estimates assembled here support the theory. Apart from the two mid-Columbia PIT-tagged wild yearling populations cited above, all other SAR estimates are similar to Snake River values despite differences in the number of dams in the migration path. Hatchery-reared yearlings from three PIT tagged mid-Columbia populations have similar SARs to Snake River populations (Fig. 5) and CWT-based SAR estimates for Lower-, Mid- and Upper-Columbia yearling populations have survival consistent with Snake River populations (Fig. 4), as do Salish Sea (Strait of Georgia and Puget Sound) populations where no dams lie in the migration path. Also of note, both PIT- and CWT-based SAR estimates for Mid-Columbia populations of wild and hatchery subyearling Chinook are generally lower than Snake River values. Thus, none of these comparisons support the claim that greater dam passage—and Snake River dam passage in particular—results in subsequently reduced survival.

Conclusions

The policy implications of Chinook salmon SARs converging to similar levels nearly everywhere along the west coast of North America are profound. Current efforts to conserve salmon populations assume that restoring habitats modified by anthropogenic factors (dams, dykes, forestry, road culverts or salmon farms in coastal regions) will improve salmon returns and at least partially compensate for worsening ocean conditions. However, if survival also falls by the same amount in regions with nearly pristine freshwater habitats (SE Alaska, north-central British Columbia), it is difficult to argue for a major role of these regional factors in causing the decline.

It is a long-standing assumption that the construction of the four Snake River dams has prevented the recovery of listed Chinook stocks by either directly reducing smolt survival during downstream migration or reducing survival after smolts leave the hydrosystem as a result of delayed mortality (Budy et al., 2002; ISAB, 2018; McCann et al., 2018; Howard A Schaller et al., 1999). However, the evidence that many other Chinook populations outside the Columbia River basin show large declines at about the same time make this belief questionable. Our point here is not to question that dams cause mortality, but rather that their overall contribution to reduced SARs is likely much smaller than originally believed.

Presumably in response to worsening SARs, a large increase in monitoring effort is evident both inside and outside the Columbia basin (Fig. 8). In assembling the SAR data used in this report we encountered substantial challenges in fully understanding what components of adult returns were included in many SAR estimates, and what parts of the migratory life cycle were excluded. As a result, many datasets were excluded from our analysis. We were particularly surprised to discover that some important basic elements of survival were excluded from PIT tag-based SAR estimates.

For example, exactly where abundance is estimated during migration should be more carefully considered. In practice, survival time series exclude variable proportions of upstream survival for both smolts and adults. Unless smolt counts are taken at the hatchery and adult counts occur on the spawning grounds, variability is introduced because different amounts of the migratory life history are incorporated into the SAR estimates for different populations.

The same point can be made for more carefully considering the role of harvest. Harvest levels for some yearling populations are a considerable fraction of adult returns to the river, while for subyearling populations they are substantially larger than adult escapement. A major change in the Pacific Salmon Treaty occurred in 1999 when a shift to an abundance-based management system was negotiated (Caldwell, 1999; Miller, 2003; Noakes, Fang, Hipel, & Kilgour, 2005). A key part of this renegotiation was securing coastwide agreement that managers would modify harvest in response to abundance. What appears to have gone unrecognized was the effect on scientific studies based on PIT tags.

A direct consequence of modifying harvest relative to abundance is that improvements in survival caused by modifying the operation of the Columbia River hydropower system may be obscured. If fisheries managers are perfect at implementing the treaty's mandate, then each year the same number of adults will return—precisely because managers identify changes in abundance at sea and then adjust harvest in response. Attempts to evaluate improvements in hydrosystem operations by studying how PIT-based SARs vary will be frustrated because there will be no change—managers will harvest any increases and conceal any decreases by varying catches. Improvements in freshwater conditions that increase adult returns (perhaps achieved at great cost) will not be credited appropriately because the treaty mechanism allocates the increased abundance to the fisheries.

Given the geographically widespread collapse in survival to numerically similar levels, the fisheries community need to re-assess several core conservation assumptions. Of primary importance is the actual effectiveness of freshwater habitat restoration initiatives when northern populations have similar SARs. The resulting policy implications range from the prospects for successfully feeding killer whales to the real role of dams in the demise of Snake River salmon stocks. Finally, the large changes in PIT tag-based SARs caused by managers modifying harvest in response to changes in Chinook abundance are problematic for attempts to rebuild populations unless harvest management is better coordinated with freshwater conservation efforts. Given the steadily increasing effort devoted to survival monitoring for salmonids (Fig. 8), further work is needed to document the source data and to better understand the implications. A logical next step would be to convene a coast-wide review of the quality and consistency of the various data sources used for measuring survival and to define rigorous technical standards for measuring SARs. In addition, identifying the factors leading to substantially higher SARs for a few populations (e.g., University of Washington and Chilliwack hatchery subyearlings) might lead to greater conservation success in future.

Acknowledgements

We particularly thank Dr Gayle Brown (DFO) for providing access to the Chinook Technical Committee's SAR database and for many discussions clarifying the interpretation and use of the data. We also received significant assistance in understanding critical details of many SAR and harvest datasets from scientists from the USFWS (Haley Muir, Greg Fraser, Michael Humling, Christopher Griffith, and David Hand), the Nez Perce Tribe (Billy Arnsberg), CRITFC (Tommy Garrison), WDFW (Kristen Ryding), ODFW (Michelle Varney), and NOAA (Jeromy Jording, Larry LaVoy and Robert Kope).

Data Availability

All data are available without limitation from Dryad. (The datasets will be finalized and submitted at the time the revised manuscript is re-submitted, as the most recent years of data available for inclusion in this paper may change).

Figures

Fig. 1. Map of Chinook salmon survival time series used in the analyses. Numbers inside symbols are keyed to the populations in Table S1. SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; WAC=Washington Coastal; ORC=Oregon Coastal; SOG=Strait of Georgia; PS=Puget Sound; CA=California.

Fig. 2. Time series of smolt-to-adult return (SAR) estimates for Chinook salmon plotted by source. Annual SAR estimates for Hatchery (H), Wild (W), and mixed hatchery-wild data sources (B) are shown, but regional loess curves of survival and associated 95% confidence interval use hatchery data only, colour coded by data source. In order to focus on the trends, a few SAR estimates have been clipped by restricting the y-axis maximum to near the loess curve maxima. Blank panels indicate regions where the life history type does not occur. The SAR 2-6% recovery target adopted for Snake River Spring Chinook is shown as a grey band. The major regime shifts of 1977, 1989, and 1998 are indicated by vertical dotted lines. The horizontal dotted line indicates 1% SAR. Note logarithmic y-axis. Sources correspond to Table S1 as follows: PSC CWT= PSC 2019; CSS PIT=McCann et al. 2018; Agency CWT=all other sources exclusive of Raymond 1998 and Michel 2019. CWT=coded wire tag; CSS=Comparative Survival Study, PIT= Passive-Integrated-Transponder; SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.

(Reviewers: We have found that conversion of the high definition .tif figure format during incorporation into Word or PDF documents can cause substantial degradation of the fine detail actually present. If this is so, please request the native file format, which will support high resolution zoomed views of the individual panels. We can also provide this in a vertical orientation if the journal prefers).

Fig. 3. Box plots of Chinook survival (SAR) based on coded wire tags, disaggregated by population and region; all years combined. Central lines show medians, boxes show the inter-quartile range (central 50% of data points), whiskers bracket 1.5 times the interquartile range, and open circles identify outliers. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates for each population is shown to the right. See Table S1 for definitions of population acronyms and Fig. 2

for region acronyms. H=hatchery; W=wild; HW=mixture. *Indicates data sets ending prior to 1998 (all data from Raymond (1998) and three Puget Sound data series from PSC (2019)).

Fig. 4. Regional CWT-based SAR estimates for Chinook salmon normalized relative to Snake River SARs for the 2010-2014 period. Estimates above the horizontal black dotted line indicate higher survival than Snake River populations. Horizontal red lines show the empirical 5% and 95% percentiles on the sampling distribution of the normalized ratio. See Fig. S1 for SAR estimates normalized to all other regions. H=hatchery; W=wild.

Fig. 5. Box plots of Chinook PIT tag-based SAR estimates in the Columbia River basin, disaggregated by population and region; all years combined. These SAR estimates exclude harvest and smolt and adult losses above the top-most dam. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates is shown on the right. H=hatchery; W=wild; HW=mixture. All data from McCann et al (2018).

Fig. 6. Comparison of smolt-to-adult survival (SAR) estimates made using coded wire tags (CWT) and passive integrated transponder (PIT) tags for Chinook salmon populations where both tagging methodologies were employed in the same year. Linear regressions were fit with the intercept constrained to zero.

Fig. 7. Annual Columbia River Chinook harvest rate estimates, fitted loess trend lines, and associated 95% confidence intervals. The right-hand axis shows reported aggregate harvest before Chinook reach McNary Dam. The left-hand axis shows the corresponding value that PIT tag-based SAR estimates should be multiplied by to correct for exclusion of harvest; note log scale. Tributary harvests (i.e., above McNary Dam) are excluded. Substantial variation over time and between populations is evident after 1998 (vertical dashed line), when PIT tag-based survival estimation began. Data sources that present harvest estimates by brood year were converted to return year using the dominant year of return. See Table S2 for population names and references.

Fig. 8. Increase in the number of annual SAR estimates used in this paper. The drop in monitoring evident in the most recent years probably reflects lags in data processing rather than a decrease in effort. See Table S1 for specific populations included.

Supplementary Information

Figure S1. Normalized regional SAR estimates for Chinook salmon based on coded wire tags (CWT) in the 2010-2014 period. Each panel uses a different geographic region as the basis for comparing normalized SARs; the figure in the main text (Fig. 4) uses the Snake River as the basis for comparison. The central points on the plot indicate the median of the normalized ratios, and the whiskers extend to the empirical 5% and 95% percentiles on the sampling distribution. Estimates above the horizontal black dotted line indicate higher survival than the region to which the data are normalized (i.e., the region in each panel's title). Most data summaries are for hatchery-origin stocks; wild stocks are indicated by a star (*). SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.

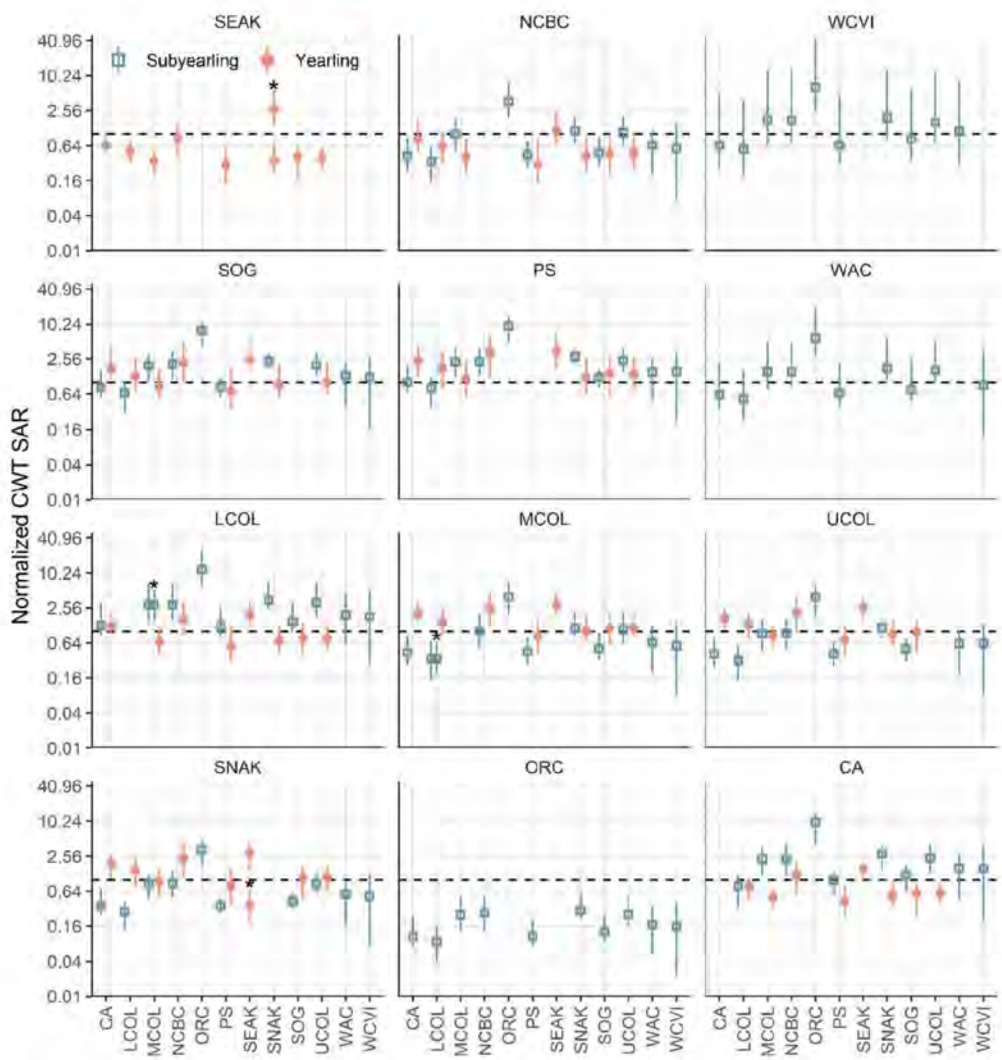

Table S1. Datasets of smolt-to-adult return (SAR) estimates for Chinook salmon (*Oncorhynchus tshawytscha*) used in this study. The Map field corresponds to the numbering displayed in Figure 1. Race refers to adult run-timing. Rear is either hatchery (H) or wild (W). Age indicates the year of smolt outmigration as either yearlings (1) or subyearlings (0). Jacks indicates whether precocious male returns are included in survival estimates. Reach is specific to passive integrated transponder SAR estimates in the Columbia River; it refers to the migration segment over which SARs were estimated. N is the sample size (years of data). From and To describe the first and last years of outmigration. AK=Alaska, NCBC=North Central British Columbia, WCVI=West Coast Vancouver Island, SOG=Strait of Georgia, PS=Puget Sound, WAC=Washington State Coast, LCOL=Lower Columbia River (below Bonneville Dam), MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River, ORC=Oregon Coast, CA=California, Rel=Release, BON=Bonneville Dam, MCN=McNary Dam, JDA=John Day Dam, RRE=Rocky Reach Dam, PRD=Priest Rapids Dam, LGR=Lower Granite Dam, LGS=Little Goose Dam, IHR=Ice Harbor Dam, LMN=Lower Monumental Dam.

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
AK	Alaska	Alaska	5	Spr	H	1	Y		37	1978	2014	PSC 2019
	Chilkat	Chilkat	1	Spr	W	1	Y		14	2001	2014	PSC 2019
	Stikine	Stikine	3	Spr	W	1	Y		16	2000	2015	PSC 2019
	Taku	Taku	2	Spr	W	1	Y		30	1977	2015	PSC 2019
	Unuk	Unuk	4	Spr	W	1	Y		26	1984	2014	PSC 2019
NCBC	Atnarko	Atnarko	8	Sum	H	0	Y		26	1987	2014	PSC 2019
	Kitsumkalum	Kitsumk	6	Sum	H	1	Y		14	2001	2015	PSC 2019
WCVI	Robertson	Roberts	16	Fall	H	0	Y		42	1974	2015	PSC 2019
SOG	Big Qualicum	Big Qua	15	Fall	H	0	Y		42	1974	2015	PSC 2019
	Chilliwack	Chilliw	18	Fall	H	0	Y		34	1982	2015	PSC 2019
	Cowichan	Cowicha	21	Fall	H	0	Y		28	1986	2015	PSC 2019
	Dome	Dome	7	Spr	H	1	Y		16	1988	2004	PSC 2019
	Elwha	Elwha	28	Sum/Fall	H	0	Y		13	1983	2013	PSC 2019
	Harrison	Harriso	17	Fall	H	0	Y		33	1982	2015	PSC 2019
	Hoko	Hoko	27	Fall	H	0	Y		26	1986	2012	PSC 2019
	Lower Shuswap	LowShus	10	Sum	H	0	Y		31	1985	2015	PSC 2019
	Middle Shuswap	MidShus	11	Sum	H	0	Y		7	2009	2015	PSC 2019
	Nanaimo	Nanaimo	19	Fall	H	0	Y		19	1980	2005	PSC 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Nicola	Nicola	12	Spr	H	1	Y		29	1987	2015	PSC 2019
	Phillips	Phillip	9	Fall	H	0	Y		6	2010	2015	PSC 2019
	Puntledge	Puntled	14	Sum	H	0	Y		39	1976	2015	PSC 2019
	Quinsam	Quinsam	13	Fall	H	0	Y		40	1975	2014	PSC 2019
PS	George Adams	George	38	Sum/Fall	H	0	Y		35	1973	2013	PSC 2019
	Nisqually	Nisqual	42	Sum/Fall	H	0	Y		34	1980	2013	PSC 2019
	Nooksack	Nooksac	20	Spr	H	0	Y		23	1990	2014	PSC 2019
	Nooksack	Nooksac	20	Spr	H	1	Y		13	1983	1998	PSC 2019
	Samish	Samish	22	Sum/Fall	H	0	Y		31	1975	2013	PSC 2019
	Skagit	Skagit	23	Spr	H	0	Y		21	1987	2014	PSC 2019
	Skagit	SkagSpr	23	Spr	H	1	Y		26	1983	2012	PSC 2019
	Skagit	SkagSm	23	Sum	H	0	Y		19	1995	2013	PSC 2019
	Skykomish	Skykomi	30	Sum/Fall	H	0	Y		13	2001	2013	PSC 2019
	South Puget Sound	SthPug	43	Sum/Fall	H	0	Y		40	1972	2013	PSC 2019
	Squaxin Pens	Squaxin	39	Fall	H	1	Y		10	1987	1998	PSC 2019
	Stillaguamish	Stillag	26	Sum/Fall	H	0	Y		28	1981	2013	PSC 2019
	University of Washington	UWAccel	33	Fall	H	0	Y		10	1976	1985	PSC 2019
	White	White	41	Spr	H	1	Y		13	1976	2014	PSC 2019
WAC	Queets	Queets	35	Fall	H	0	Y		34	1978	2012	PSC 2019
	Sooes	Sooes	25	Fall	H	0	Y		26	1986	2012	PSC 2019
LCOL	Columbia Lower	LowCol	54	Fall	H	0	Y		37	1977	2013	PSC 2019
	Cowlitz	Cowlitz	55	Fall	H	0	Y		36	1978	2013	PSC 2019
	Lewis	Lewis	63	Fall	W	0	Y		33	1978	2013	PSC 2019
	Willamette	Willame	84	Spr	H	1	Y		37	1977	2013	PSC 2019
MCOL	Carson	Carson	62	Spr	H	1	Y		29	1985	2015	Silver et al. 2019
	Carson	Carson	62	Spr	H	1	N	Rel to BON	14	2000	2013	McCann et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Carson	Carson	62	Spr	H	1	Y	Rel to BON	2	2014	2015	McCann et al. 2018
	Cle Elum	CleElum	40	Spr	H	1	Y	MCN to MCN	14	2002	2015	McCann et al. 2018
	Deschutes	Deschut	72	Fall	W	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	N	Rel to BON	9	2000	2010	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	Y		27	1987	2013	PSC 2019
	John Day	JohnDay	71	Spr	W	1	Y	JDA to BON	16	2000	2015	McCann et al. 2018
	Little White Salmon	LtlWhSa	67	Spr	H	1	Y		29	1984	2015	Silver et al. 2019
	Little White Salmon	LtlWhSa	67	Fall	H	0	N	Rel to BON	3	2008	2010	McCann et al. 2018
	Little White Salmon	LtlWhSa	67	Fall	H	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Spring Creek	SprgCrk	66	Fall	H	0	Y		41	1973	2013	PSC 2019
	Spring Creek (April Release)	SprgApr	66	Fall	H	0	N	Rel to BON	5	2008	2012	McCann et al. 2018
	Spring Creek (April Release)	SprgApr	66	Fall	H	0	Y	Rel to BON	1	2013	2013	McCann et al. 2018
	Spring Creek (May Release)	SprgMay	66	Fall	H	0	N	Rel to BON	5	2008	2012	McCann et al. 2018
	Spring Creek (May Release)	SprgMay	66	Fall	H	0	Y	Rel to BON	1	2013	2013	McCann et al. 2018
	Umatilla	Umatill	60	Fall	H	0	Y		24	1992	2015	Cameron et al. 2018
	Umatilla	Umatill	60	Spr	H	1	Y		29	1988	2016	Cameron et al. 2018
	Upriver Bright	UpCol	45	Fall	H	0	Y		38	1976	2013	PSC 2019
	Warm Springs	Warm	79	Spr	H	1	Y		28	1980	2014	Silver et al. 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Warm Springs	Warm	79	Spr	H	1	N	Rel to BON	7	2007	2013	McCann et al. 2018
	Warm Springs	Warm	79	Spr	H	1	Y	Rel to BON	2	2014	2015	McCann et al. 2018
	Yakima	Yakima	53	Spr	W	1	Y	MCN to MCN	12	2002	2015	McCann et al. 2018
UCOL	Columbia	ColSm	29	Sum	H	0	Y		33	1976	2013	PSC 2019
	Entiat	Entiat	32	Spr	H	1	Y		20	1977	2007	Fraser 2019
	Entiat	Entiat	32	Sum	H	0	Y	RRE to BON	5	2011	2015	McCann et al. 2018
	Entiat and Methow	Entiat	31	Spr	W	1	Y	RRE to BON	8	2008	2015	McCann et al. 2018
	Leavenworth	Leavenw	34	Spr	H	1	Y		33	1982	2014	Muir et al. 2019
	Leavenworth	Leavenw	34	Spr	H	1	Y	MCN to BON	16	2000	2015	McCann et al. 2018
	Mid-Columbia	ColSprH	29	Spr	H	1	Y	First to PRD	13	1972	1984	Raymond 1988
	Mid-Columbia	ColSmHW	29	Sum	HW	0	Y	First to PRD	16	1968	1983	Raymond 1988
	Mid-Columbia	ColSprW	29	Spr	W	1	Y	First to PRD	23	1962	1984	Raymond 1988
	Mid-Columbia	ColSmW	29	Sum	W	0	Y	First to PRD	7	1962	1968	Raymond 1988
	Tagged at Rock Island Dam	RockISpr	37	Spr	HW	1	Y	Rel to BON	15	2000	2015	McCann et al. 2018
	Tagged at Rock Island Dam	RockISm	37	Sum	HW	0	Y	Rel to BON	16	2000	2015	McCann et al. 2018
	Upper Columbia above Wells Dam	UpCol	29	Sum	W	0	Y	RRE to BON	4	2011	2014	McCann et al. 2018
	Wenatchee	Wenatch	36	Spr	W	1	Y	MCN to BON	9	2007	2015	McCann et al. 2018
	Winthrop	Winthro	24	Spr	H	1	Y		13	2002	2014	Humling et al. 2018
	Winthrop	Winthro	24	Spr	H	1	Y	RRE to BON	7	2009	2015	McCann et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
SNAK	Catherine	Catheri	74	Spr	H	1	Y		11	2003	2013	Feldhaus et al. 2018
	Catherine	Catheri	74	Spr	H	1	Y	LGR to LGR	15	2001	2015	McCann et al. 2018
	Clearwater	ClearSpr	48	Spr	H	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Clearwater	ClearSm	48	Sum	H	1	Y	LGR to LGR	5	2011	2015	McCann et al. 2018
	Clearwater	Clear	50	Spr	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Dworshak	Dworsha	48	Spr	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Dworshak at Snake	Dworsha	48	Fall	H	0	Y	LGR to LGR	5	2006	2011	McCann et al. 2018
	Grande Ronde	Grande	65	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Grande Ronde	Grande	65	Spr	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Imnaha	Imnaha	64	Spr	H	1	Y		29	1984	2013	Feldhaus et al. 2018
	Imnaha	Imnaha	64	Sum	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Imnaha	ImnahaW	64	Sum	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Kooskia	Kooskia	57	Spr	H	1	Y	LGR to LGR	2	2014	2015	McCann et al. 2018
	Lookingglass	Looking	65	Spr	H	1	Y		5	2006	2013	Feldhaus et al. 2018
	Lostine	Lostine	69	Spr	H	1	Y		13	1999	2013	Feldhaus et al. 2018
	Lyons Ferry at Big Canyon	BigCany	49	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Big Canyon	BigCany	49	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Lyons Ferry at Captain John	CaptJoh	56	Fall	H	0	Y	LGR to LGR	5	2008	2012	McCann et al. 2018
	Lyons Ferry at Captain John	CaptJoh	56	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Pittsburg Landing	Pittsbu	68	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Lyons Ferry at Pittsburg Landing	Pittsbu	68	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Snake	LyonsFe	46	Fall	H	0	Y		20	1985	2013	PSC 2019
	Lyons Ferry at Snake	LyonsFe	46	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	McCall	McCall	78	Sum	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Middle Fork Salmon	MidSalm	82	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Nez Perce at Cedar Flats	CedFlat	58	Fall	H	0	Y	LGR to LGR	3	2010	2012	McCann et al. 2018
	Nez Perce at Lukes Gulch	LukeGul	59	Fall	H	0	Y	LGR to LGR	3	2010	2012	McCann et al. 2018
	Oxbow below Hells Canyon Dam	Oxbow	77	Fall	H	0	Y	LGR to LGR	4	2008	2012	McCann et al. 2018
	Pahsimeroi	Pahsime	80	Sum	H	1	Y	LGR to LGR	8	2008	2015	McCann et al. 2018
	Rapid	Rapid	70	Spr	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Sawtooth	Sawtoot	83	Spr	H	1	Y	LGR to LGR	9	2007	2015	McCann et al. 2018
	Snake	Snake	44	SpSu	W	1	Y	LGR to LGR	22	1994	2015	McCann et al. 2018
	Snake	Snake	44	Spr	H	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	Snake	44	Spr	H	1	Y	IHR to IHR	3	1966	1968	Raymond 1988

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Snake	Snake	44	Spr	H	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	Snake	44	Spr	H	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	Snake	Snake	44	Fall	W	0	Y	LGR to LGR	4	2006	2011	McCann et al. 2018
	Snake	SnakSpr	44	Spr	W	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	IHR to IHR	5	1964	1968	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	IHR to IHR	5	1964	1968	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	South Fork Salmon	SthSalm	81	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Tucannon	TucanH	52	Spr	H	1	Y		28	1987	2014	Gallinat & Ross 2018
	Tucannon	TucanW	52	Spr	W	1	Y		28	1987	2014	Gallinat & Ross 2018
	Umatilla Irrigon below Hells Canyon Dam	Umatill	61	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Upper Grande Ronde	UpGrand	75	Spr	H	1	Y		11	2003	2013	Feldhaus et al. 2018
	Upper Salmon	UpSalm	73	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
ORC	Elk	Elk	85	Fall	H	0	Y		34	1980	2013	PSC 2019
	Salmon	Salmon	76	Fall	H	0	Y		36	1977	2013	PSC 2019
CA	Colman	ColFa	87	Fall	H	0	Y		14	1999	2012	Michel 2019
	Colman	ColLtFa	87	Fall	H	1	Y		20	1993	2012	Michel 2019
	Livingston Stone	Livings	86	Win	H	0	Y		14	1999	2012	Michel 2019

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Notes on Data PSC 2019

Atnarko River Summer Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as ATN and ATY by the PSC respectively. We retained ATN but excluded ATY because Atnarko is primarily a subyearling stock and the yearling releases are a hatchery management practise (Velez-Espino et al. 2011).

Kitsumkalum River Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as KLM and KLY by the PSC respectively. We excluded KLM but retained KLY because Kitsumkalum is primarily a yearling stock. The subyearlings are released by the hatchery as fry and remain in the river an extra year until they migrate to sea at the same time as their sibling KLM fish (David Willis personal communication May 2018. Section Head, Coastal Operations, Fisheries and Oceans Canada. David.Willis@dfo-mpo.gc.ca).

Lyons Ferry Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as LYF and LYY by the PSC respectively. We retained LYF but excluded LYY because Lyons Ferry is primarily a subyearling stock and the yearling releases are a hatchery management practise (Tommy Garrison personal communication Jan 2018. Biometrician. Fisheries Management Department. Columbia River Inter-Tribal Fish Commission. gart@critfc.org).

Nooksack Spring Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as NKF and NKS by the PSC respectively. We retained both because the Nooksack stock is naturally a mix of both life-history strategies (Larrie LaVoy personal communication Jan 2018).

Skagit Spring Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as SSF and SKS by the PSC respectively. We retained both because the Skagit stock is naturally a mix of both life-history strategies (Larrie LaVoy personal communication Jan 2018. National Marine Fisheries Service, National Oceanic and Atmospheric Administration. Larrie.Lavoy@noaa.gov).

South Puget Sound Fall Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as SPS and SPY by the PSC respectively. We retained SPS but excluded SPY because South Puget is primarily a subyearling stock and the yearling releases are a hatchery management practise (Larrie LaVoy personal communication Jan 2018).

Yearling/subyearling designations were taken from PSC (2015; Table 2.1) with the following exceptions: 1) Squaxin Pens Fall Chinook and University of Washington Accelerated Chinook were designated using PSC (2005; Table 2.1); and 2) we assumed Stikine Spring Chinook outmigrate as yearlings, and Phillips Fall Chinook outmigrate as subyearlings based on the typical behaviour for their adult run timing (neither stock was listed in PSC (2015)).

We excluded SAR estimates for ocean entry years with incomplete adult returns.

Notes on Data McCann et al. 2018

For most stocks, SAR estimates are provided with and without jack returns, and with differing start and end points to fish enumeration. When available, we used the estimates that included jacks and that covered the largest portion of the migration. For some MCOL populations, the estimates that included jack returns were available only for the shorter migration segment. In these cases, we used the estimates for the longer migration segment excluding jacks. Includes Spring Creek Hatchery Fall Chinook (5 of 5 years), Little White Salmon Hatchery Fall Chinook (3 of 5 years), Carson Hatchery Spring Chinook (14 of 15 years), Warm Springs Hatchery Spring Chinook (7 of 8 years), and Hanford Reach Wild Fall Chinook (9 of 11 years).

We excluded SAR estimates for ocean entry years with incomplete adult returns.

SAR estimates are referenced to McCann et al. (2017), Appendix B, but were actually downloaded from the Fish Passage Center: http://www.fpc.org/survival/smolttoadult_queries.php.

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Notes on Data Fishery Agencies

Entiat Spring Chinook- SAR estimates were calculated using data downloaded from the Regional Mark Processing Center's RMIS database. Estimates are referenced to Fraser 2019 as a personal communication to support that the estimates are the best available (i.e. no known shortfalls in the RMIS database for the years presented). The estimates were calculated as the proportion of recoveries expanded for sampling effort of all coded wire tagged smolts released from the hatchery in each year.

Lyons Ferry at Big Canyon, Captain John, and Pittsburg Landing acclimation sites- Nez Perce hatchery releases groups of coded wire-tagged smolts with and without adipose fin clips. They report that the tag returns for unclipped fish are biased low relative to those for clipped fish; we used the SAR estimates only for clipped fish.

Tucannon Wild Spring Chinook- SARS are not compensated for harvest; however, we included the wild stock because harvest for the hatchery stock is reported as minor (average of <6% of the adult hatchery fish recovered for 1985-1996 brood years; Gallinat & Ross 2018).

We used the SARS from the Conventional Hatchery Program rather than from the Captive Broodstock Program for stocks referenced to Felhaus et al. 2018.

Notes on Data Raymond 1988

Raymond 1988 provides SAR estimates for Chinook returning to the Snake River and to the Columbia River above Priest Rapids Dam. The author assigns the Columbia River estimates to the "Mid Columbia" region; however, we have classed them as "Upper Columbia" following the definition used in McCann et al. 2018 where the Upper Columbia is defined as the area between Priest Rapids Dam and Chief Joseph Dam.

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Table S2. Datasets used in this study providing harvest rate estimates for Columbia River basin Chinook salmon (*Oncorhynchus tshawytscha*). The Nickname and Map fields are populated for those stocks that also have smolt-to-adult return (SAR) estimates. The Map field corresponds to the numbering used in Figure 1. Stocks with harvest estimates from JCRMS 2019 are not displayed in Figure 1; these are defined as follows: Upper Columbia= summer Chinook destined for production areas and hatcheries upstream of Priest Rapids Dam; Upriver Spring=all spring Chinook passing Bonneville Dam from March through May including the Snake River summer Chinook (since 2005); Upriver Wild=as for Upriver Spring but for wild stocks. Race refers to adult run-timing. Rear is either hatchery (H) or wild (W). N is the sample size (years of data). From and To describe the first and last years of return. MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River.

Region	Stock	Nickname	Map	Race	Rear	N	From	To	Source
MCOL	Hanford	Hanford	47	Fall	W	26	1990	2015	PSC 2019
	Spring Creek	SprgCrk	66	Fall	H	40	1976	2015	PSC 2019
	Upriver Bright	UpCol	45	Fall	H	37	1979	2015	PSC 2019
	Yakima	Yakima	53	Spr	W	32	1983	2014	Sampson et al. 2016 Table 21
UCOL	Columbia Summers	ColSm	29	Sum	H	37	1979	2015	PSC 2019
	Leavenworth	Leavenw	34	Spr	H	10	2007	2016	Muir et al. 2019 Table 18
	Upper Columbia			Sum	HW	39	1980	2018	JCRMS 2019 Table 8
	Upriver Spring			Spr	HW	31	1982	2018	JCRMS 2019 Table 5
	Upriver Wild			Spr/Sum	W	39	1980	2018	JCRMS 2019 Tables 6 & 7
	Winthrop	Winthro	24	Spr	H	14	2003	2016	Humling et al. 2018 Table 25
SNAK	Lyons Ferry at Snake	LyonsFe	46	Fall	H	28	1988	2015	PSC 2019

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Region	Stock	Nickname	Map	Race	Rear	N	From	To	Source

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Supplementary Information

Figure S1. Normalized regional SAR estimates for Chinook salmon based on coded wire tags (CWT) in the 2010-2014 period. Each panel uses a different geographic region as the basis for comparing normalized SARs; the figure in the main text (Fig. 4) uses the Snake River as the basis for comparison. The central points on the plot indicate the median of the normalized ratios, and the whiskers extend to the empirical 5% and 95% percentiles on the sampling distribution. Estimates above the horizontal black dotted line indicate higher survival than the region to which the data are normalized (i.e., the region in each panel's title). Most data summaries are for hatchery-origin stocks; wild stocks are indicated by a star (*). SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.

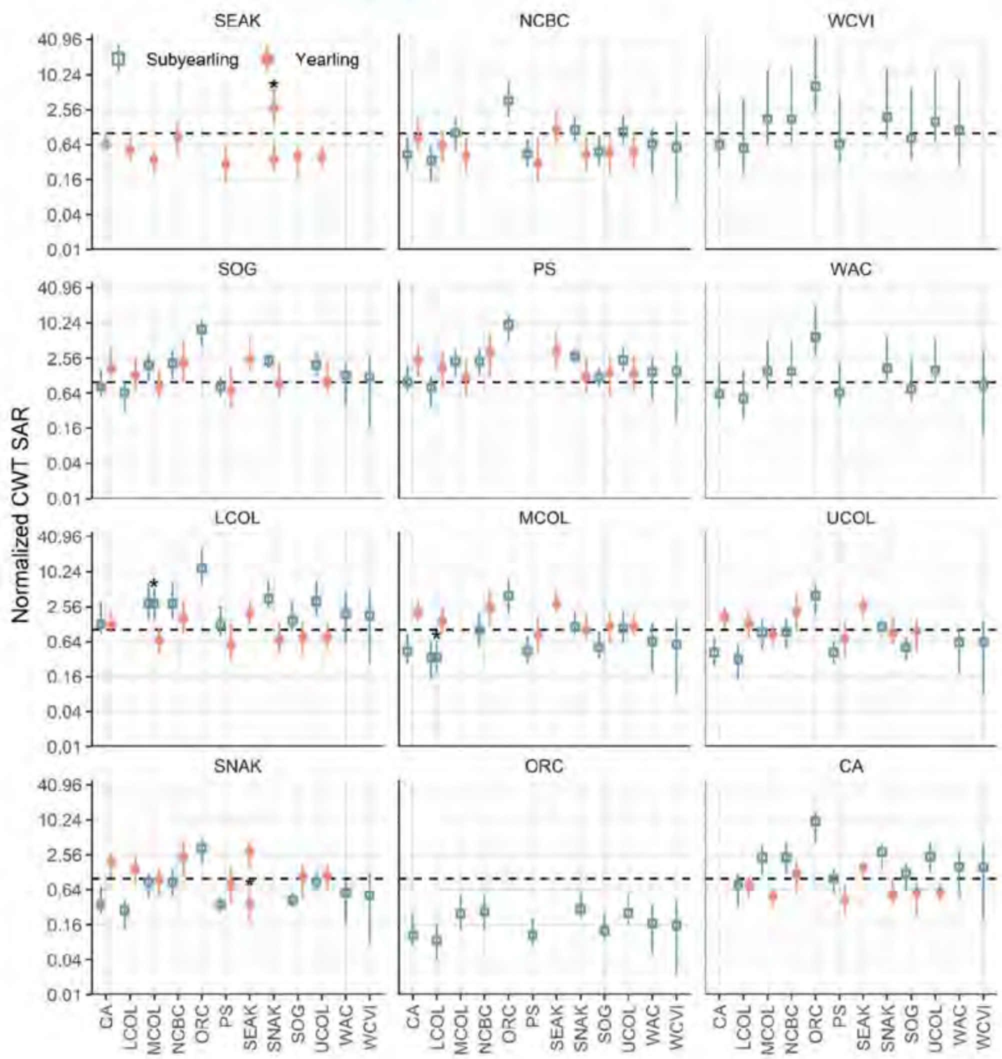

Table S1. Datasets of smolt-to-adult return (SAR) estimates for Chinook salmon (*Oncorhynchus tshawytscha*) used in this study. The Map field corresponds to the numbering displayed in Figure 1. Race refers to adult run-timing. Rear is either hatchery (H) or wild (W). Age indicates the year of smolt outmigration as either yearlings (1) or subyearlings (0). Jacks indicates whether precocious male returns are included in survival estimates. Reach is specific to passive integrated transponder SAR estimates in the Columbia River; it refers to the migration segment over which SARs were estimated. N is the sample size (years of data). From and To describe the first and last years of outmigration. AK=Alaska, NCBC=North Central British Columbia, WCVI=West Coast Vancouver Island, SOG=Strait of Georgia, PS=Puget Sound, WAC=Washington State Coast, LCOL=Lower Columbia River (below Bonneville Dam), MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River, ORC=Oregon Coast, CA=California, Rel=Release, BON=Bonneville Dam, MCN=McNary Dam, JDA=John Day Dam, RRE=Rocky Reach Dam, PRD=Priest Rapids Dam, LGR=Lower Granite Dam, LGS=Little Goose Dam, IHR=Ice Harbor Dam, LMN=Lower Monumental Dam.

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
AK	Alaska	Alaska	5	Spr	H	1	Y		37	1978	2014	PSC 2019
	Chilkat	Chilkat	1	Spr	W	1	Y		14	2001	2014	PSC 2019
	Stikine	Stikine	3	Spr	W	1	Y		16	2000	2015	PSC 2019
	Taku	Taku	2	Spr	W	1	Y		30	1977	2015	PSC 2019
	Unuk	Unuk	4	Spr	W	1	Y		26	1984	2014	PSC 2019
NCBC	Atnarko	Atnarko	8	Sum	H	0	Y		26	1987	2014	PSC 2019
	Kitsumkalum	Kitsumk	6	Sum	H	1	Y		14	2001	2015	PSC 2019
WCVI	Robertson	Roberts	16	Fall	H	0	Y		42	1974	2015	PSC 2019
SOG	Big Qualicum	Big Qua	15	Fall	H	0	Y		42	1974	2015	PSC 2019
	Chilliwack	Chilliw	18	Fall	H	0	Y		34	1982	2015	PSC 2019
	Cowichan	Cowicha	21	Fall	H	0	Y		28	1986	2015	PSC 2019
	Dome	Dome	7	Spr	H	1	Y		16	1988	2004	PSC 2019
	Elwha	Elwha	28	Sum/Fall	H	0	Y		13	1983	2013	PSC 2019
	Harrison	Harriso	17	Fall	H	0	Y		33	1982	2015	PSC 2019
	Hoko	Hoko	27	Fall	H	0	Y		26	1986	2012	PSC 2019
	Lower Shuswap	LowShus	10	Sum	H	0	Y		31	1985	2015	PSC 2019
	Middle Shuswap	MidShus	11	Sum	H	0	Y		7	2009	2015	PSC 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Nanaimo	Nanaimo	19	Fall	H	0	Y		19	1980	2005	PSC 2019
	Nicola	Nicola	12	Spr	H	1	Y		29	1987	2015	PSC 2019
	Phillips	Phillip	9	Fall	H	0	Y		6	2010	2015	PSC 2019
	Puntledge	Puntled	14	Sum	H	0	Y		39	1976	2015	PSC 2019
	Quinsam	Quinsam	13	Fall	H	0	Y		40	1975	2014	PSC 2019
PS	George Adams	George	38	Sum/Fall	H	0	Y		35	1973	2013	PSC 2019
	Nisqually	Nisqual	42	Sum/Fall	H	0	Y		34	1980	2013	PSC 2019
	Nooksack	Nooksac	20	Spr	H	0	Y		23	1990	2014	PSC 2019
	Nooksack	Nooksac	20	Spr	H	1	Y		13	1983	1998	PSC 2019
	Samish	Samish	22	Sum/Fall	H	0	Y		31	1975	2013	PSC 2019
	Skagit	Skagit	23	Spr	H	0	Y		21	1987	2014	PSC 2019
	Skagit	SkagSpr	23	Spr	H	1	Y		26	1983	2012	PSC 2019
	Skagit	SkagSm	23	Sum	H	0	Y		19	1995	2013	PSC 2019
	Skykomish	Skykomi	30	Sum/Fall	H	0	Y		13	2001	2013	PSC 2019
	South Puget Sound	SthPug	43	Sum/Fall	H	0	Y		40	1972	2013	PSC 2019
	Squaxin Pens	Squaxin	39	Fall	H	1	Y		10	1987	1998	PSC 2019
	Stillaguamish	Stillag	26	Sum/Fall	H	0	Y		28	1981	2013	PSC 2019
	University of Washington	UWAccel	33	Fall	H	0	Y		10	1976	1985	PSC 2019
	White	White	41	Spr	H	1	Y		13	1976	2014	PSC 2019
WAC	Queets	Queets	35	Fall	H	0	Y		34	1978	2012	PSC 2019
	Sooes	Sooes	25	Fall	H	0	Y		26	1986	2012	PSC 2019
LCOL	Columbia Lower	LowCol	54	Fall	H	0	Y		37	1977	2013	PSC 2019
	Cowlitz	Cowlitz	55	Fall	H	0	Y		36	1978	2013	PSC 2019
	Lewis	Lewis	63	Fall	W	0	Y		33	1978	2013	PSC 2019
	Willamette	Willame	84	Spr	H	1	Y		37	1977	2013	PSC 2019
MCOL	Carson	Carson	62	Spr	H	1	Y		29	1985	2015	Silver et al. 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Carson	Carson	62	Spr	H	1	N	Rel to BON	14	2000	2013	McCann et al. 2018
	Carson	Carson	62	Spr	H	1	Y	Rel to BON	2	2014	2015	McCann et al. 2018
	Cle Elum	CleElum	40	Spr	H	1	Y	MCN to MCN	14	2002	2015	McCann et al. 2018
	Deschutes	Deschut	72	Fall	W	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	N	Rel to BON	9	2000	2010	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	Y		27	1987	2013	PSC 2019
	John Day	JohnDay	71	Spr	W	1	Y	JDA to BON	16	2000	2015	McCann et al. 2018
	Little White Salmon	LtlWhSa	67	Spr	H	1	Y		29	1984	2015	Silver et al. 2019
	Little White Salmon	LtlWhSa	67	Fall	H	0	N	Rel to BON	3	2008	2010	McCann et al. 2018
	Little White Salmon	LtlWhSa	67	Fall	H	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Spring Creek	SprgCrk	66	Fall	H	0	Y		41	1973	2013	PSC 2019
	Spring Creek (April Release)	SprgApr	66	Fall	H	0	N	Rel to BON	5	2008	2012	McCann et al. 2018
	Spring Creek (April Release)	SprgApr	66	Fall	H	0	Y	Rel to BON	1	2013	2013	McCann et al. 2018
	Spring Creek (May Release)	SprgMay	66	Fall	H	0	N	Rel to BON	5	2008	2012	McCann et al. 2018
	Spring Creek (May Release)	SprgMay	66	Fall	H	0	Y	Rel to BON	1	2013	2013	McCann et al. 2018
	Umatilla	Umatill	60	Fall	H	0	Y		24	1992	2015	Cameron et al. 2018
	Umatilla	Umatill	60	Spr	H	1	Y		29	1988	2016	Cameron et al. 2018
	Upriver Bright	UpCol	45	Fall	H	0	Y		38	1976	2013	PSC 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Warm Springs	Warm	79	Spr	H	1	Y		28	1980	2014	Silver et al. 2019
	Warm Springs	Warm	79	Spr	H	1	N	Rel to BON	7	2007	2013	McCann et al. 2018
	Warm Springs	Warm	79	Spr	H	1	Y	Rel to BON	2	2014	2015	McCann et al. 2018
	Yakima	Yakima	53	Spr	W	1	Y	MCN to MCN	12	2002	2015	McCann et al. 2018
UCOL	Columbia	ColSm	29	Sum	H	0	Y		33	1976	2013	PSC 2019
	Entiat	Entiat	32	Spr	H	1	Y		20	1977	2007	Fraser 2019
	Entiat	Entiat	32	Sum	H	0	Y	RRE to BON	5	2011	2015	McCann et al. 2018
	Entiat and Methow	Entiat	31	Spr	W	1	Y	RRE to BON	8	2008	2015	McCann et al. 2018
	Leavenworth	Leavenw	34	Spr	H	1	Y		33	1982	2014	Muir et al. 2019
	Leavenworth	Leavenw	34	Spr	H	1	Y	MCN to BON	16	2000	2015	McCann et al. 2018
	Mid-Columbia	ColSprH	29	Spr	H	1	Y	First to PRD	13	1972	1984	Raymond 1988
	Mid-Columbia	ColSmHW	29	Sum	HW	0	Y	First to PRD	16	1968	1983	Raymond 1988
	Mid-Columbia	ColSprW	29	Spr	W	1	Y	First to PRD	23	1962	1984	Raymond 1988
	Mid-Columbia	ColSmW	29	Sum	W	0	Y	First to PRD	7	1962	1968	Raymond 1988
	Tagged at Rock Island Dam	RockISpr	37	Spr	HW	1	Y	Rel to BON	15	2000	2015	McCann et al. 2018
	Tagged at Rock Island Dam	RockISm	37	Sum	HW	0	Y	Rel to BON	16	2000	2015	McCann et al. 2018
	Upper Columbia above Wells Dam	UpCol	29	Sum	W	0	Y	RRE to BON	4	2011	2014	McCann et al. 2018
	Wenatchee	Wenatch	36	Spr	W	1	Y	MCN to BON	9	2007	2015	McCann et al. 2018
	Winthrop	Winthro	24	Spr	H	1	Y		13	2002	2014	Humling et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Winthrop	Winthro	24	Spr	H	1	Y	RRE to BON	7	2009	2015	McCann et al. 2018
SNAK	Catherine	Catheri	74	Spr	H	1	Y		11	2003	2013	Feldhaus et al. 2018
	Catherine	Catheri	74	Spr	H	1	Y	LGR to LGR	15	2001	2015	McCann et al. 2018
	Clearwater	ClearSpr	48	Spr	H	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Clearwater	ClearSm	48	Sum	H	1	Y	LGR to LGR	5	2011	2015	McCann et al. 2018
	Clearwater	Clear	50	Spr	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Dworshak	Dworsha	48	Spr	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Dworshak at Snake	Dworsha	48	Fall	H	0	Y	LGR to LGR	5	2006	2011	McCann et al. 2018
	Grande Ronde	Grande	65	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Grande Ronde	Grande	65	Spr	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Imnaha	Imnaha	64	Spr	H	1	Y		29	1984	2013	Feldhaus et al. 2018
	Imnaha	Imnaha	64	Sum	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Imnaha	ImnahaW	64	Sum	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Kooskia	Kooskia	57	Spr	H	1	Y	LGR to LGR	2	2014	2015	McCann et al. 2018
	Lookingglass	Looking	65	Spr	H	1	Y		5	2006	2013	Feldhaus et al. 2018
	Lostine	Lostine	69	Spr	H	1	Y		13	1999	2013	Feldhaus et al. 2018
	Lyons Ferry at Big Canyon	BigCany	49	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Lyons Ferry at Big Canyon	BigCany	49	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Lyons Ferry at Captain John	CaptJoh	56	Fall	H	0	Y	LGR to LGR	5	2008	2012	McCann et al. 2018
	Lyons Ferry at Captain John	CaptJoh	56	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Pittsburg Landing	Pittsbu	68	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Lyons Ferry at Pittsburg Landing	Pittsbu	68	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Snake	LyonsFe	46	Fall	H	0	Y		20	1985	2013	PSC 2019
	Lyons Ferry at Snake	LyonsFe	46	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	McCall	McCall	78	Sum	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Middle Fork Salmon	MidSalm	82	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Nez Perce at Cedar Flats	CedFlat	58	Fall	H	0	Y	LGR to LGR	3	2010	2012	McCann et al. 2018
	Nez Perce at Lukes Gulch	LukeGul	59	Fall	H	0	Y	LGR to LGR	3	2010	2012	McCann et al. 2018
	Oxbow below Hells Canyon Dam	Oxbow	77	Fall	H	0	Y	LGR to LGR	4	2008	2012	McCann et al. 2018
	Pahsimeroi	Pahsime	80	Sum	H	1	Y	LGR to LGR	8	2008	2015	McCann et al. 2018
	Rapid	Rapid	70	Spr	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Sawtooth	Sawtoot	83	Spr	H	1	Y	LGR to LGR	9	2007	2015	McCann et al. 2018
	Snake	Snake	44	SpSu	W	1	Y	LGR to LGR	22	1994	2015	McCann et al. 2018
	Snake	Snake	44	Spr	H	1	Y	LGS to IHR	5	1970	1974	Raymond 1988

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Snake	Snake	44	Spr	H	1	Y	IHR to IHR	3	1966	1968	Raymond 1988
	Snake	Snake	44	Spr	H	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	Snake	44	Spr	H	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	Snake	Snake	44	Fall	W	0	Y	LGR to LGR	4	2006	2011	McCann et al. 2018
	Snake	SnakSpr	44	Spr	W	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	IHR to IHR	5	1964	1968	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	IHR to IHR	5	1964	1968	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	South Fork Salmon	SthSalm	81	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Tucannon	TucanH	52	Spr	H	1	Y		28	1987	2014	Gallinat & Ross 2018
	Tucannon	TucanW	52	Spr	W	1	Y		28	1987	2014	Gallinat & Ross 2018
	Umatilla Irrigon below Hells Canyon Dam	Umatill	61	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Upper Grande Ronde	UpGrand	75	Spr	H	1	Y		11	2003	2013	Feldhaus et al. 2018
	Upper Salmon	UpSalm	73	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
ORC	Elk	Elk	85	Fall	H	0	Y		34	1980	2013	PSC 2019
	Salmon	Salmon	76	Fall	H	0	Y		36	1977	2013	PSC 2019
CA	Colman	ColFa	87	Fall	H	0	Y		14	1999	2012	Michel 2019
	Colman	ColLtFa	87	Fall	H	1	Y		20	1993	2012	Michel 2019
	Livingston Stone	Livings	86	Win	H	0	Y		14	1999	2012	Michel 2019

Notes on Data PSC 2019

Atnarko River Summer Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as ATN and ATY by the PSC respectively. We retained ATN but excluded ATY because Atnarko is primarily a subyearling stock and the yearling releases are a hatchery management practise (Velez-Espino et al. 2011).

Kitsumkalum River Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as KLM and KLY by the PSC respectively. We excluded KLM but retained KLY because Kitsumkalum is primarily a yearling stock. The subyearlings are released by the hatchery as fry and remain in the river an extra year until they migrate to sea at the same time as their sibling KLM fish (David Willis personal communication May 2018. Section Head, Coastal Operations, Fisheries and Oceans Canada. David.Willis@dfo-mpo.gc.ca).

Lyons Ferry Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as LYF and LYY by the PSC respectively. We retained LYF but excluded LYY because Lyons Ferry is primarily a subyearling stock and the yearling releases are a hatchery management practise (Tommy Garrison personal communication Jan 2018. Biometrician, Fisheries Management Department, Columbia River Inter-Tribal Fish Commission. gart@critfc.org).

Nooksack Spring Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as NKF and NKS by the PSC respectively. We retained both because the Nooksack stock is naturally a mix of both life-history strategies (Larrie LaVoy personal communication Jan 2018).

Skagit Spring Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as SSF and SKS by the PSC respectively. We retained both because the Skagit stock is naturally a mix of both life-history strategies (Larrie LaVoy personal communication Jan 2018. National Marine Fisheries Service, National Oceanic and Atmospheric Administration. Larrie.Lavoy@noaa.gov).

South Puget Sound Fall Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as SPS and SPY by the PSC respectively. We retained SPS but excluded SPY because South Puget is primarily a subyearling stock and the yearling releases are a hatchery management practise (Larrie LaVoy personal communication Jan 2018).

Yearling/subyearling designations were taken from PSC (2015; Table 2.1) with the following exceptions: 1) Squaxin Pens Fall Chinook and University of Washington Accelerated Chinook were designated using PSC (2005; Table 2.1); and 2) we assumed Stikine Spring Chinook outmigrate as yearlings, and Phillips Fall Chinook outmigrate as subyearlings based on the typical behaviour for their adult run timing (neither stock was listed in PSC (2015)).

We excluded SAR estimates for ocean entry years with incomplete adult returns.

Notes on Data McCann et al. 2018

For most stocks, SAR estimates are provided with and without jack returns, and with differing start and end points to fish enumeration. When available, we used the estimates that included jacks and that covered the largest portion of the migration. For some MCOL populations, the estimates that included jack returns were available only for the shorter migration segment. In these cases, we used the estimates for the longer migration segment excluding jacks. Includes Spring Creek Hatchery Fall Chinook (5 of 5 years), Little White Salmon Hatchery Fall Chinook (3 of 5 years), Carson Hatchery Spring Chinook (14 of 15 years), Warm Springs Hatchery Spring Chinook (7 of 8 years), and Hanford Reach Wild Fall Chinook (9 of 11 years).

We excluded SAR estimates for ocean entry years with incomplete adult returns.

SAR estimates are referenced to McCann et al. (2017), Appendix B, but were actually downloaded from the Fish Passage Center: http://www.fpc.org/survival/smolttoadult_queries.php.

Notes on Data Fishery Agencies

Entiat Spring Chinook- SAR estimates were calculated using data downloaded from the Regional Mark Processing Center's RMIS database. Estimates are referenced to Fraser 2019 as a personal communication to support that the estimates are the best available (i.e. no known shortfalls in the RMIS database for the years presented). The estimates were calculated as the proportion of recoveries expanded for sampling effort of all coded wire tagged smolts released from the hatchery in each year.

Lyons Ferry at Big Canyon, Captain John, and Pittsburg Landing acclimation sites- Nez Perce hatchery releases groups of coded wire-tagged smolts with and without adipose fin clips. They report that the tag returns for unclipped fish are biased low relative to those for clipped fish; we used the SAR estimates only for clipped fish.

Tucannon Wild Spring Chinook- SARS are not compensated for harvest; however, we included the wild stock because harvest for the hatchery stock is reported as minor (average of <6% of the adult hatchery fish recovered for 1985-1996 brood years; Gallinat & Ross 2018).

We used the SARS from the Conventional Hatchery Program rather than from the Captive Broodstock Program for stocks referenced to Felhaus et al. 2018.

Notes on Data Raymond 1988

Raymond 1988 provides SAR estimates for Chinook returning to the Snake River and to the Columbia River above Priest Rapids Dam. The author assigns the Columbia River estimates to the "Mid Columbia" region; however, we have classed them as "Upper Columbia" following the definition used in McCann et al. 2018 where the Upper Columbia is defined as the area between Priest Rapids Dam and Chief Joseph Dam.

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Table S2. Datasets used in this study providing harvest rate estimates for Columbia River basin Chinook salmon (*Oncorhynchus tshawytscha*). The Nickname and Map fields are populated for those stocks that also have smolt-to-adult return (SAR) estimates. The Map field corresponds to the numbering used in Figure 1. Stocks with harvest estimates from JCRMS 2019 are not displayed in Figure 1; these are defined as follows: Upper Columbia= summer Chinook destined for production areas and hatcheries upstream of Priest Rapids Dam; Upriver Spring=all spring Chinook passing Bonneville Dam from March through May including the Snake River summer Chinook (since 2005); Upriver Wild=as for Upriver Spring but for wild stocks. Race refers to adult run-timing. Rear is either hatchery (H) or wild (W). N is the sample size (years of data). From and To describe the first and last years of return. MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River.

Region	Stock	Nickname	Map	Race	Rear	N	From	To	Source
MCOL	Hanford	Hanford	47	Fall	W	26	1990	2015	PSC 2019
	Spring Creek	SprgCrk	66	Fall	H	40	1976	2015	PSC 2019
	Upriver Bright	UpCol	45	Fall	H	37	1979	2015	PSC 2019
	Yakima	Yakima	53	Spr	W	32	1983	2014	Sampson et al. 2016 Table 21
UCOL	Columbia Summers	ColSm	29	Sum	H	37	1979	2015	PSC 2019
	Leavenworth	Leavenw	34	Spr	H	10	2007	2016	Muir et al. 2019 Table 18
	Upper Columbia			Sum	HW	39	1980	2018	JCRMS 2019 Table 8
	Upriver Spring			Spr	HW	31	1982	2018	JCRMS 2019 Table 5
	Upriver Wild			Spr/Sum	W	39	1980	2018	JCRMS 2019 Tables 6 & 7
	Winthrop	Winthro	24	Spr	H	14	2003	2016	Humling et al. 2018 Table 25
SNAK	Lyons Ferry at Snake	LyonsFe	46	Fall	H	28	1988	2015	PSC 2019

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PSC 2019. Pacific Salmon Commission harvest rates database provided by G. Brown, Personal Communication. Department of Fisheries and Oceans, Government of Canada. Gayle.Brown@dfo-mpo.gc.ca

Region	Stock	Nickname	Map	Race	Rear	N	From	To	Source

Sampson, M.R., Fast, D.E., & Bosch, W.J. (2016). *Yakima-Klickitat Fisheries Project Monitoring and Evaluation – Yakima Subbasin*, Final Report for the performance period May/2015-April/2016, Project number 1995-063-25, 265 electronic pages.

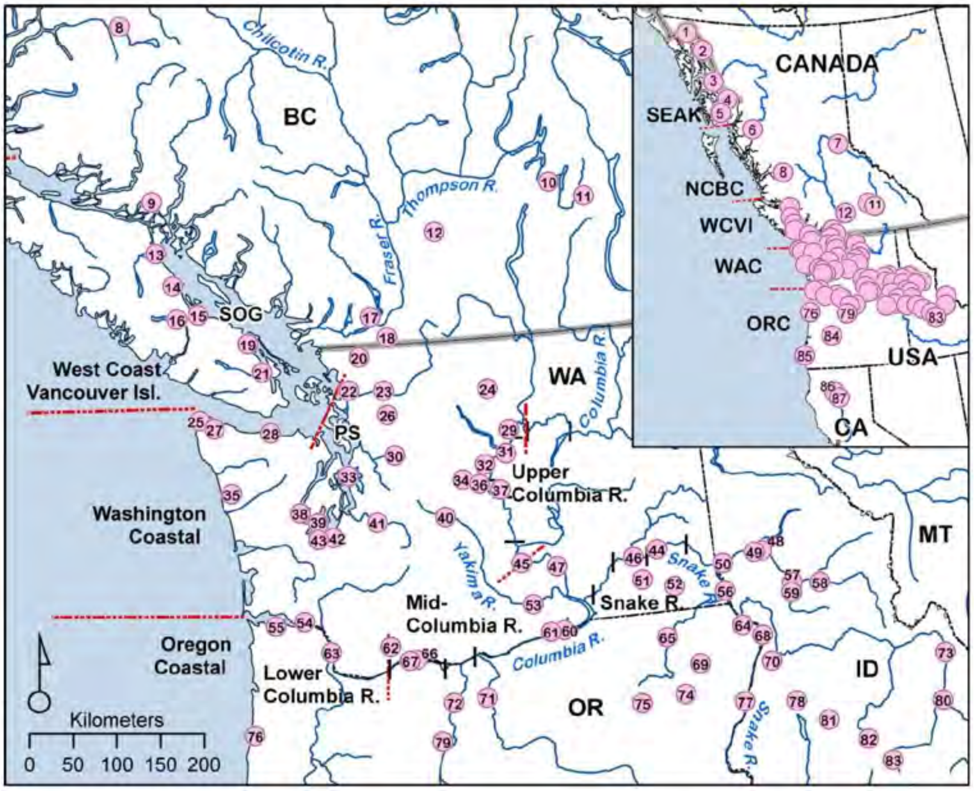

Fig. 1. Map of Chinook salmon survival time series used in the analyses. Numbers inside symbols are keyed to the populations in Table S1. SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; WAC=Washington Coastal; ORC=Oregon Coastal; SOG=Strait of Georgia; PS=Puget Sound; CA=California.

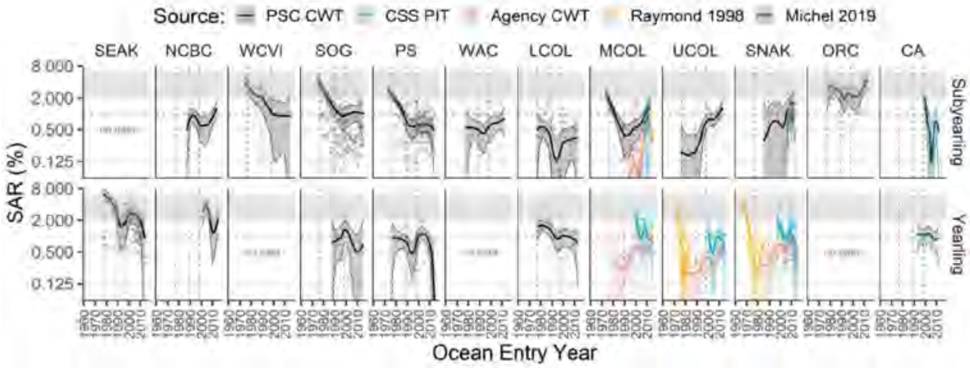

Fig. 2. Time series of smolt-to-adult return (SAR) estimates for Chinook salmon plotted by source. Annual SAR estimates for Hatchery (H), Wild (W), and mixed hatchery-wild data sources (B) are shown, but regional loess curves of survival and associated 95% confidence interval use hatchery data only, colour coded by data source. In order to focus on the trends, a few SAR estimates have been clipped by restricting the y-axis maximum to near the loess curve maxima. Blank panels indicate regions where the life history type does not occur. The SAR 2-6% recovery target adopted for Snake River Spring Chinook is shown as a grey band. The major regime shifts of 1977, 1989, and 1998 are indicated by vertical dotted lines. The horizontal dotted line indicates 1% SAR. Note logarithmic y-axis. Sources correspond to Table S1 as follows: PSC CWT= PSC 2019; CSS PIT=McCann et al. 2018; Agency CWT=all other sources exclusive of Raymond 1998 and Michel 2019. CWT=coded wire tag; CSS=Comparative Survival Study, PIT= Passive-Integrated-Transponder; SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.
(Reviewers: We have found that conversion of the high definition .tif figure format during incorporation into Word or PDF documents can cause substantial degradation of the fine detail actually present. If this is so, please request the native file format, which will support high resolution zoomed views of the individual panels. We can also provide this in a vertical orientation if the journal prefers).

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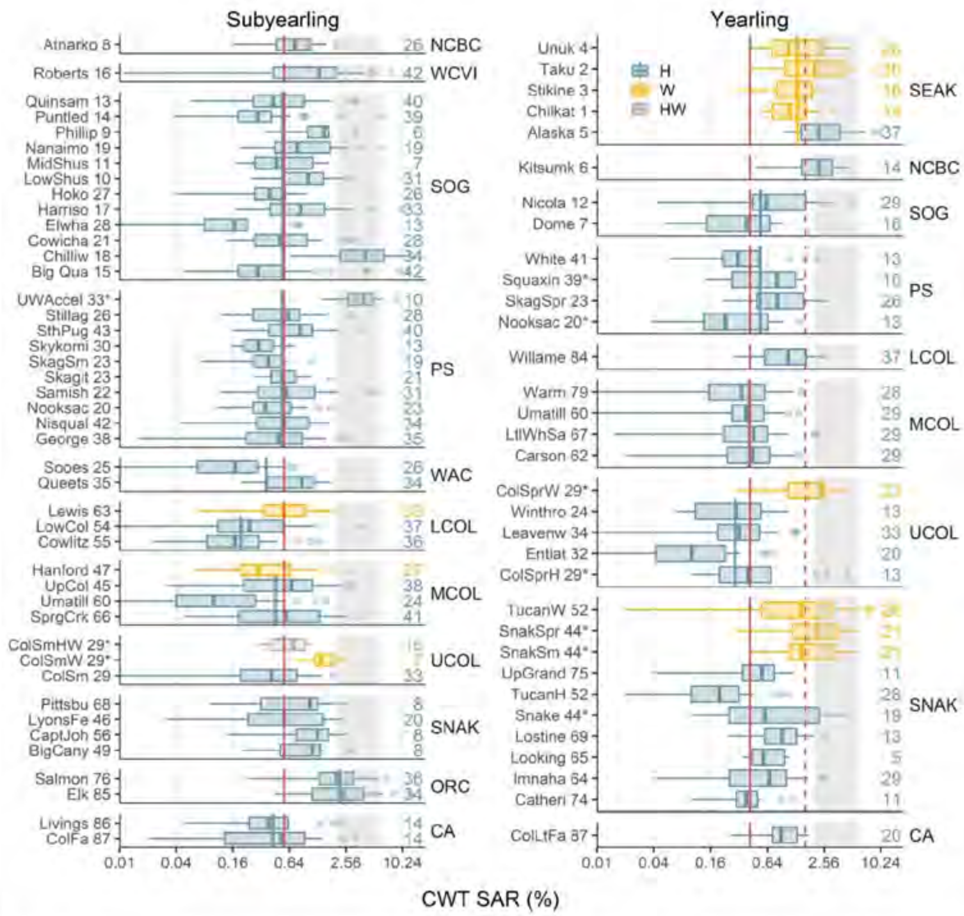

Fig. 3. Box plots of Chinook survival (SAR) based on coded wire tags, disaggregated by population and region; all years combined. Central lines show medians, boxes show the inter-quartile range (central 50% of data points), whiskers bracket 1.5 times the interquartile range, and open circles identify outliers. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates for each population is shown to the right. See Table S1 for definitions of population acronyms and Fig. 2 for region acronyms. H=hatchery; W=wild; HW=mixture. *Indicates data sets ending prior to 1998 (all data from Raymond (1998) and three Puget Sound data series from PSC (2019)).

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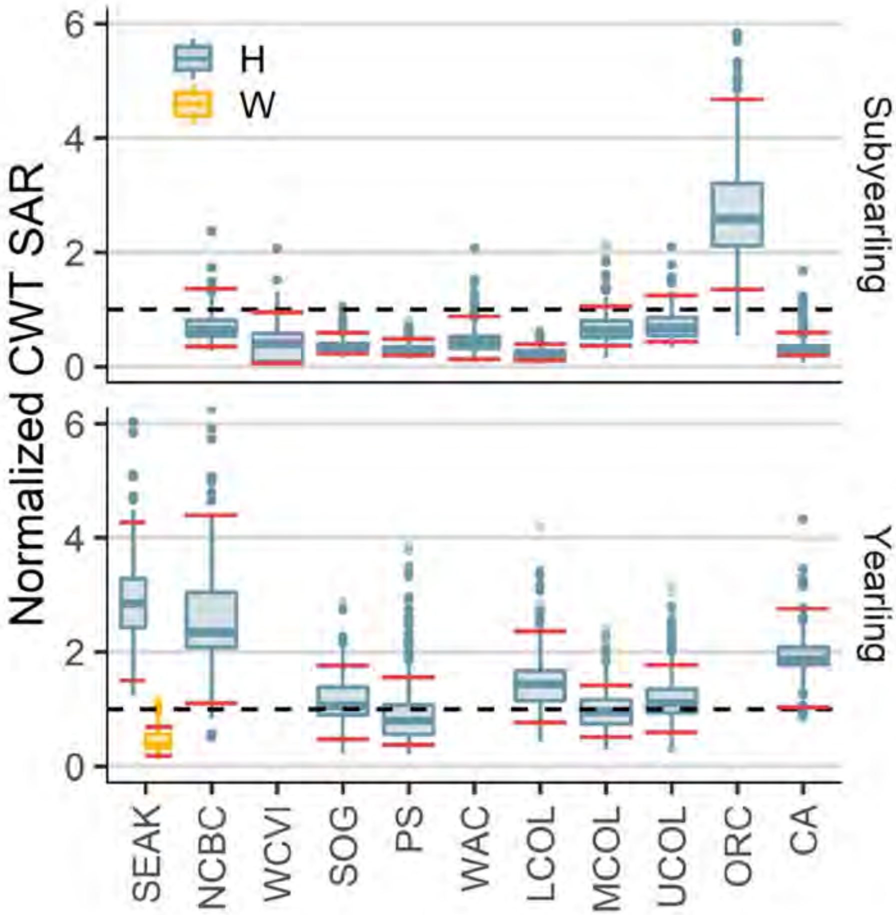

Fig. 4. Regional CWT-based SAR estimates for Chinook salmon normalized relative to Snake River SARs for the 2010-2014 period. Estimates above the horizontal black dotted line indicate higher survival than Snake River populations. Horizontal red lines show the empirical 5% and 95% percentiles on the sampling distribution of the normalized ratio. See Fig. S1 for SAR estimates normalized to all other regions. H=hatchery; W=wild.

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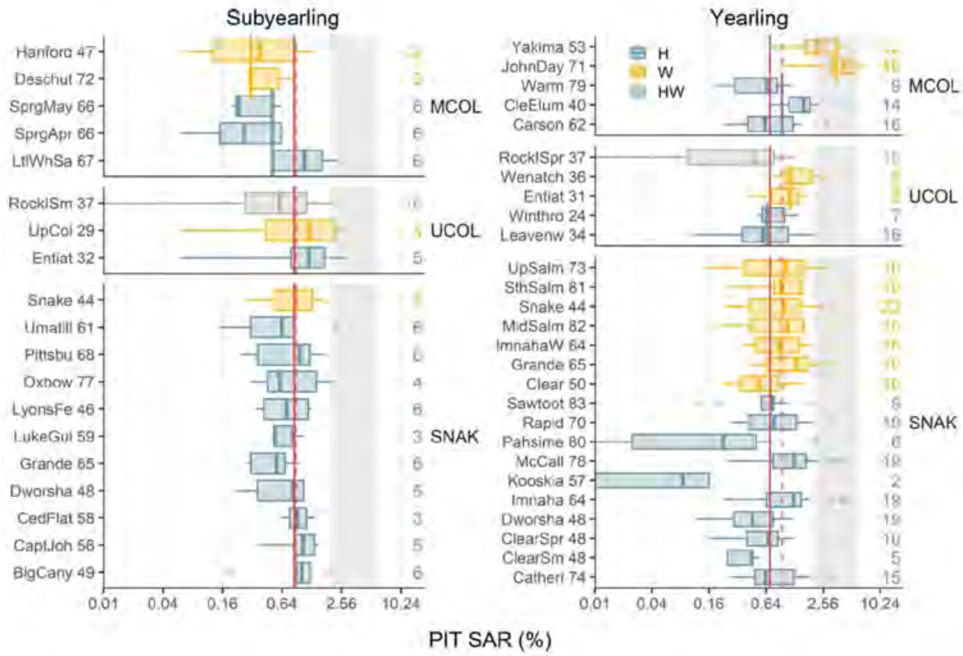

Fig. 5. Box plots of Chinook PIT tag-based SAR estimates in the Columbia River basin, disaggregated by population and region; all years combined. These SAR estimates exclude harvest and smolt and adult losses above the top-most dam. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates is shown on the right. H=hatchery; W=wild; HW=mixture. All data from McCann et al (2018).

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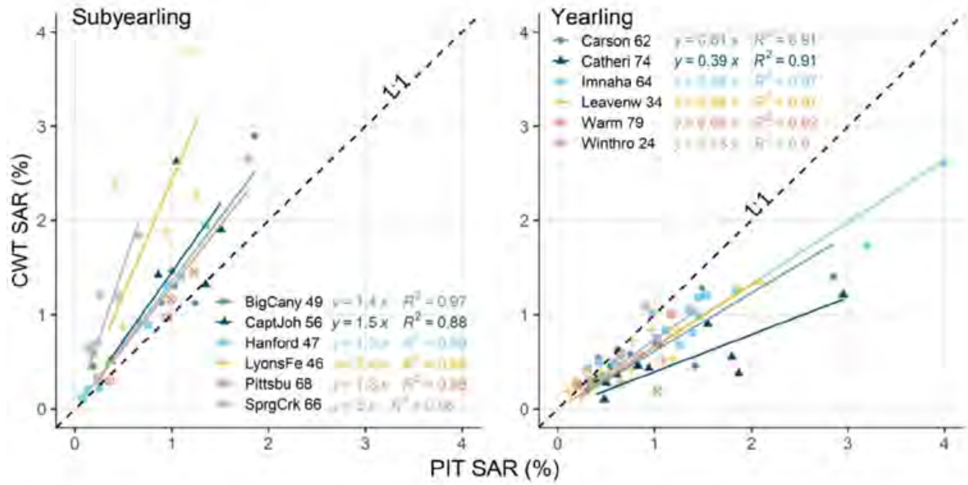

Fig. 6. Comparison of smolt-to-adult survival (SAR) estimates made using coded wire tags (CWT) and passive integrated transponder (PIT) tags for Chinook salmon populations where both tagging methodologies were employed in the same year. Linear regressions were fit with the intercept constrained to zero.

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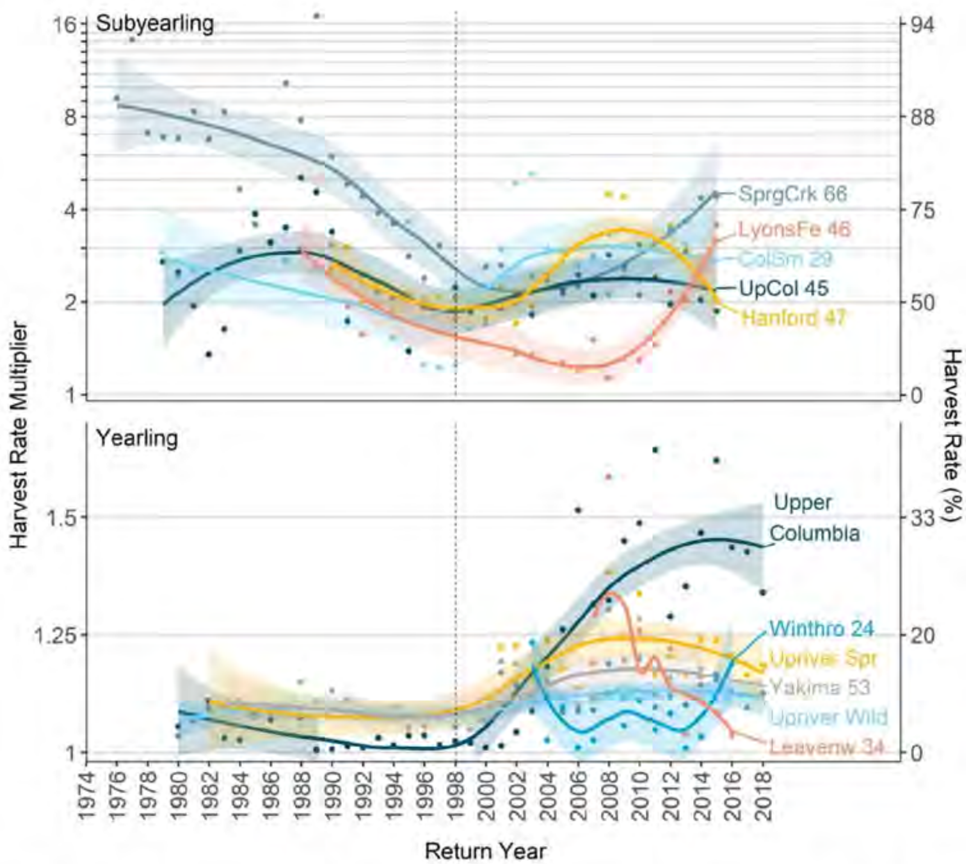

Fig. 7. Annual Columbia River Chinook harvest rate estimates, fitted loess trend lines, and associated 95% confidence intervals. The right-hand axis shows reported aggregate harvest before Chinook reach McNary Dam. The left-hand axis shows the corresponding value that PIT tag-based SAR estimates should be multiplied by to correct for exclusion of harvest; note log scale. Tributary harvests (i.e., above McNary Dam) are excluded. Substantial variation over time and between populations is evident after 1998 (vertical dashed line), when PIT tag-based survival estimation began. Data sources that present harvest estimates by brood year were converted to return year using the dominant year of return. See Table S2 for population names and references.

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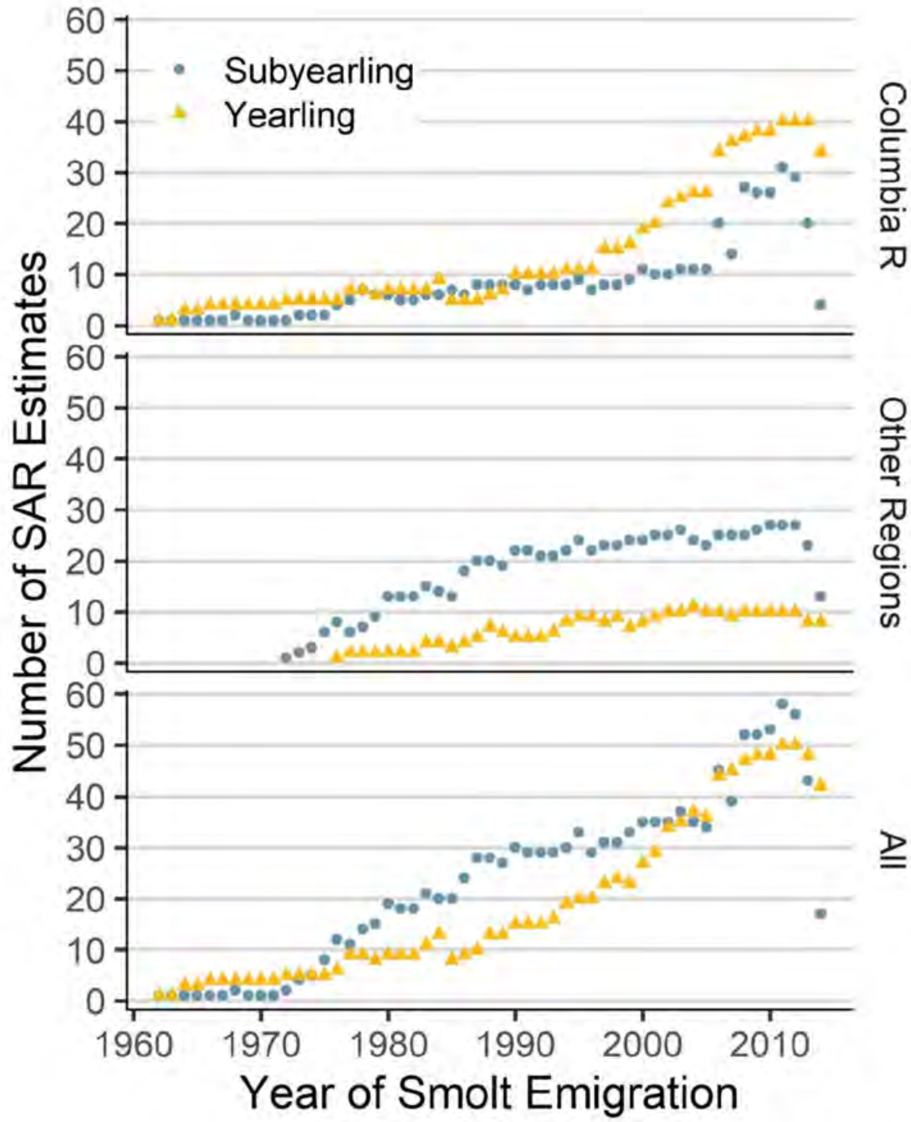

Fig. 8. Increase in the number of annual SAR estimates used in this paper. The drop in monitoring evident in the most recent years probably reflects lags in data processing rather than a decrease in effort. See Table S1 for specific populations included.

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From: David Welch

Sent: Tue May 05 14:39:25 2020

To: Erin Rechisky

Cc: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Important...

Importance: Normal

Attachments: Karier(Perspectives_ Independent Science Needed in Fish-Recovery Strategy _ NW Fishletter 2020).com.pdf

I wonder what BPA will think when they realize that all these survival estimates (both FPC's & NOAA's) are based on badly biased survival estimates because the PIT tag results were never corrected for harvest?

I copy Christine for her comments.

David

P.S. Christine, no doubt you have seen Tom Karier's article, but I attach it here in case you haven't. I pointed this out to Erin & Aswea because I am currently working up precisely that proposal to explicitly test the TDG effects of higher spill. If Tom is calling for "independent science needed", then you can't get much more independent than Kintama! J

From: Erin Rechisky <Erin.Rechisky@Kintama.com>
Sent: Tuesday, May 05, 2020 2:18 PM
To: David Welch <David.Welch@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: RE: Important...

Really good article.

This was surprising:

Rather than choose a different operation, Bonneville chose a different science, one that it found at the Fish Passage Center. According to the FPC, the preferred alternative should increase survival of the same species by 35 percent. In a remarkable reversal, the draft EIS elevates the status of the Fish Passage Center to the level of NMFS science, if not higher.

Erin

From: David Welch <David.Welch@Kintama.com>
Sent: May 5, 2020 2:02 PM
To: Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: RE: Important...

From: Erin Rechisky <Erin.Rechisky@Kintama.com>
Sent: Tuesday, May 05, 2020 1:52 PM
To: David Welch <David.Welch@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: RE: Important...

I can't access the NewsData Fishletters anymore.

Erin

From: David Welch <David.Welch@Kintama.com>
Sent: May 5, 2020 12:35 PM
To: Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: Important...

This is a very interesting read on the politics and the science. If you haven't a;ready read it, take the time in the next few days to do so:

https://www.newsdata.com/nw_fishletter/perspectives-independent-science-needed-in-fish-recovery-strategy/article_0c582fe4-8e30-11ea-be82-d3f89c05343a.html

David Welch, Ph.D.

kintamav_RGB

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755 Terminal Ave N, Nanaimo BC V9S 4K1 Canada

Office Mobile [redacted]

Skype: david.welch_29

david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: David Welch

Sent: Sat May 09 10:27:57 2020

To: Erin Rechisky; Aswea Porter

Cc: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] FW: "Survival of migrating salmon smolts in large rivers ..." - new citations

Importance: Normal

A useful citation for when we can get back to the comparison of acoustic telemetry-based survival along the west coast. I can't access the paper yet off Sci-Hub, and I don't want to pay for purchase of the full article right now. However, the figures are free to view and the abstract is quite interesting.

Note how much lower the Sacramento smolt survival is than the Columbia River hydropower system survival for the same species. I'm not sure right now as I don't have access to the full paper, but I suspect these are independent datapoints from the paper we cited by Cyril Michel for the same area.

I copy Christine for her info—survival in California is 0-9% versus ca. 50% for the Snake River to Astoria.

d

From: Google Scholar Alerts <scholaralerts-noreply@google.com>
Sent: Saturday, May 09, 2020 5:30 AM
To: David Welch <David.Welch@Kintama.com>
Subject: "Survival of migrating salmon smolts in large rivers ..." - new citations

[1. Historic drought influences outmigration dynamics of juvenile fall and spring-run Chinook Salmon]

GP Singer, ED Chapman, NA Fangue, DD Colombano...

Riverine ecosystems around the world have undergone extensive anthropogenic alterations, often to the detriment of native aquatic biodiversity. Migratory fishes are particularly vulnerable to habitat fragmentation and degradation. For example ...

Save

Twitter

Facebook

"Survival of migrating salmon smolts in large rivers with and without dams" - new citations

Cancel alert

From: David Welch

Sent: Mon May 25 11:54:42 2020

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Revised West coast SARs paper, Kintama

Importance: Normal

Hi Christine—

I am currently preparing the PowerPoint for this review. A question: Will I be able to share my screen and step through the Powerpoint from my end, or will you need to control the presentation as the organizer?

I ask because if I don't have full control over the presentation I won't add a lot of little animations to make it easier for the attendees to follow the various points we want to make on individual slides.

We should probably have a brief coordination call to discuss the presentation prior to the actual time. I won't put anything into the presentation on a proposed telemetry study apart from one bullet on the last slide pointing out why it is important, as I think the review should be focusing on what we have found out to date—I think that the harvest rate implications are profound (& disturbing), so there will be much to talk about without getting into new work.

-----Original Appointment-----
From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: Thursday, April 30, 2020 11:58 AM
To: Petersen,Christine H (BPA) - EWP-4; Sullivan,Leah S (BPA) - EWP-4; Jule,Kristen R (BPA) - EWP-4; David Welch; Erin Rechisky; Aswea Porter; Skidmore,John T (BPA) - EWL-4; Bettin,Scott W (BPA) - EWP-4; Smith,Gregory M (BPA) - EWP-4
Cc: Lando,Jody B (BPA) - EWP-4
Subject: Revised West coast SARs paper, Kintama
When: Friday, May 29, 2020 1:30 PM-3:00 PM (UTC-08:00) Pacific Time (US & Canada).
Where: (b) (2) [redacted]

Note: Changing the time to Friday May 29th to allow greater attendance.

(b) (2) [redacted] (internal)

(b) (2) [redacted] (external)

(b) (2) [redacted] (toll free)

ID: (b) (2) [redacted]

We would like to invite David, Aswea and Erin to present on their revised and submitted manuscript. While they maintain their focus on patterns of West Coast SARs for yearling and subyearling Chinook, they have developed some new material on CWT and PIT based SARs, and the significance of the harvest component.

We should try to shoot for an hour presentation, but I am setting aside 90 minutes for optional discussion etc. Will provide a Webex link later.

It was challenging to find a good time when we're all available this month. Please alert me if this is just not going to work because of the BiOp review or any other reason. We can add a few more participants later

From: Petersen,Christine H (BPA) - EWP-4

Sent: Tue Jun 09 13:07:00 2020

To: Bettin,Scott W (BPA) - EWP-4; Smith,Gregory M (BPA) - EWP-4; 'David Welch'; Skidmore,John T (BPA) - EWL-4; Lando,Jody B (BPA) - EWP-4; Zelinsky,Benjamin D (BPA) - E-4; Creason,Anne M (BPA) - EWL-4; Erin Rechisky; Aswea Porter

Subject: West Coast SARs presentation

Importance: Normal

Attachments: Submitted Manuscript Proof-Welch et al--Fish & Fisheries (30 March 2020).pdf

Let's reschedule David/Aswea/Erin's presentation for June 29th. Please respond if this time will work for you.

See the attached manuscript. The revised paper focuses on Chinook (yearling and subyearling) temporal and spatial patterns of SAR, and adds sections comparing CWT and PIT based SARs, and the importance of including/excluding harvest in the SAR.

We should try to shoot for 60 minutes, but I am scheduling 90 minutes for optional extended discussion.

Will update with Webex later

From: Petersen,Christine H (BPA) - EWP-4

Sent: Wed Jun 24 13:47:36 2020

To: Bettin,Scott W (BPA) - EWP-4; Smith,Gregory M (BPA) - EWP-4; 'David Welch'; Skidmore,John T (BPA) - EWL-4; Lando,Jody B (BPA) - EWP-4; Zelinsky,Benjamin D (BPA) - E-4; Creason,Anne M (BPA) - EWL-4; Erin Rechisky; Aswea Porter; Jule,Kristen R (BPA) - EWP-4; Scranton,Russell W (BPA) - EWP-4

Cc: Sullivan,Leah S (BPA) - EWP-4

Subject: West Coast SARs presentation

Importance: Normal

Attachments: Submitted Manuscript Proof-Welch et al--Fish & Fisheries (30 March 2020).pdf

Updating with Webex Link.

David, Aswea and Erin will present their revised and submitted West Coast SARs study.

See the attached manuscript. The revised paper focuses on Chinook (yearling and subyearling) temporal and spatial patterns of SAR, and adds sections comparing CWT and PIT based SARs, and the importance of including/excluding harvest in the SAR.

We should try to shoot for 60 minutes, but I am scheduling 90 minutes for optional extended discussion.

Please call in via the Webex conference call number, or have the program call your home number. We find this works better than using a separate conference line.

Monday, June 29, 2020

1:30 pm | (UTC-07:00) Pacific Time (US & Canada) | 2 hrs 30 mins

[Join meeting]

Join by phone

Tap to call in from a mobile device (attendees only)

(b) (2) [redacted] US Toll

[Global call-in numbers]

Join from a video system or application

(b) (2) [redacted]

Join using Microsoft Lync or Microsoft Skype for Business

(b) (2) [redacted]

From: David Welch

Sent: Wed Jun 24 18:59:56 2020

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] RE: Monday

Importance: Normal

Thanks. It sounds like you have things covered. One minor potential hiccup is that WebEx could balk at calling a Canadian (foreign) number, but given that the two countries share one country code (1) I suspect it will be seamless.

If not, will fall back on using the audio and microphone on my computer.

Thanks you!

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: Wednesday, June 24, 2020 4:03 PM
To: David Welch <David.Welch@Kintama.com>; Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: RE: Monday

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Comparative SAR Analysis- Study Update

- Revised manuscript resubmitted to F&F 3 June.
- We substantially revised the writing of the Discussion & Conclusions.
- Sent out for re-review.
- Of the 3 initial original reviews, two said paper well written, one said poorly written.
- None had substantial technical criticisms—almost all the comments were on presentation & interpretation

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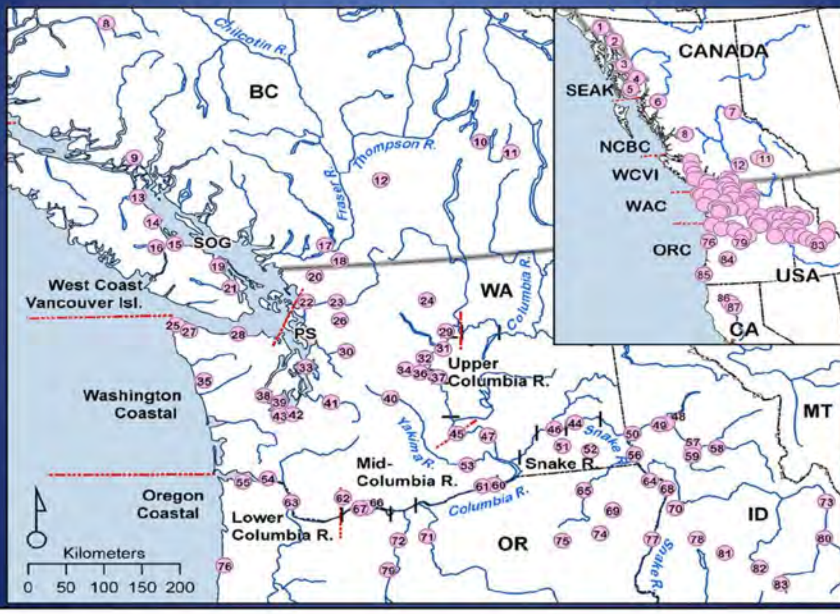
The Study Area



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Differences between Old (PLoS ONE) & New (Fish & Fisheries) Manuscripts

OLD

- Chinook & Steelhead
- Alaska to Oregon
- Combined tagging methods (CWT & PIT)
- Combined H&W
- Conclusions:

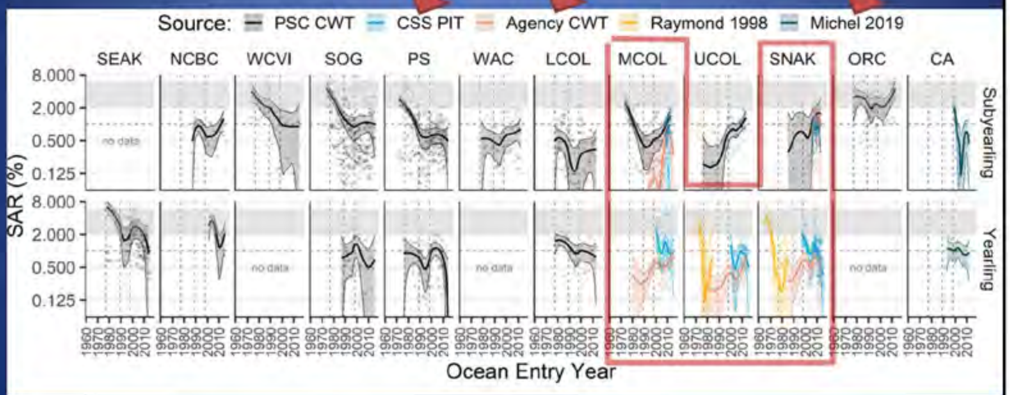
1) SARs have fallen to "about" the same level
2) No delayed mortality

NEW

- Chinook (Only)
- Added California
- Separated tagging methods
- Separated H&W
- Conclusions:

1) *Same*
2) *Same*
3) *PIT-based SARs deeply flawed*

Chinook SAR Data Broken Out by Methodology



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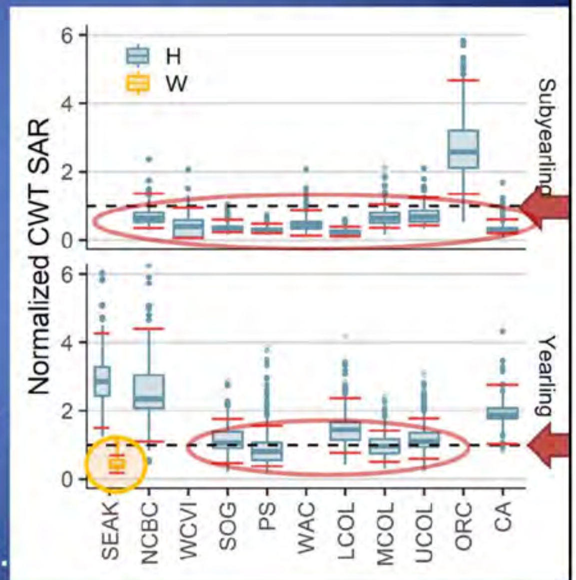
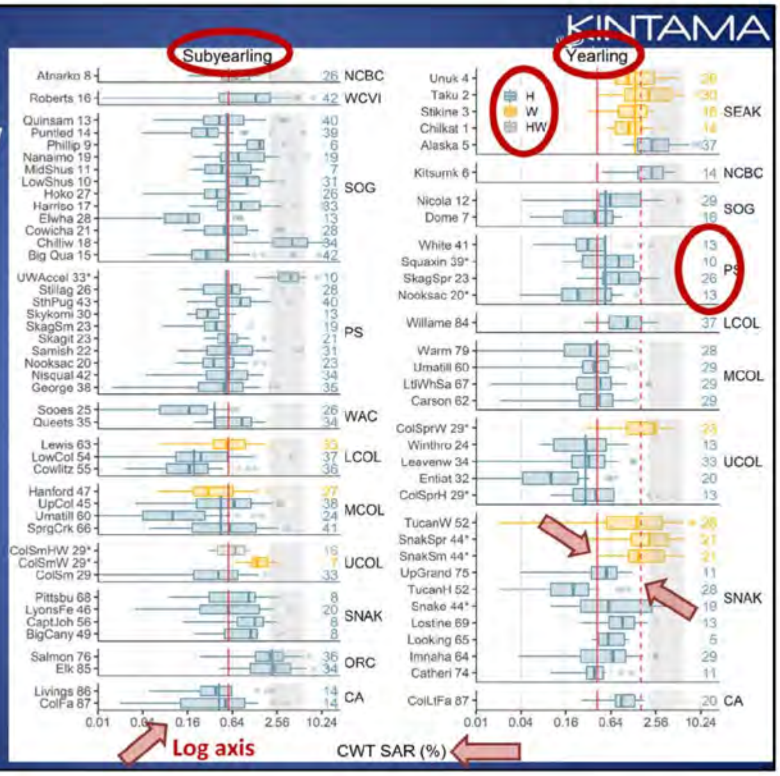
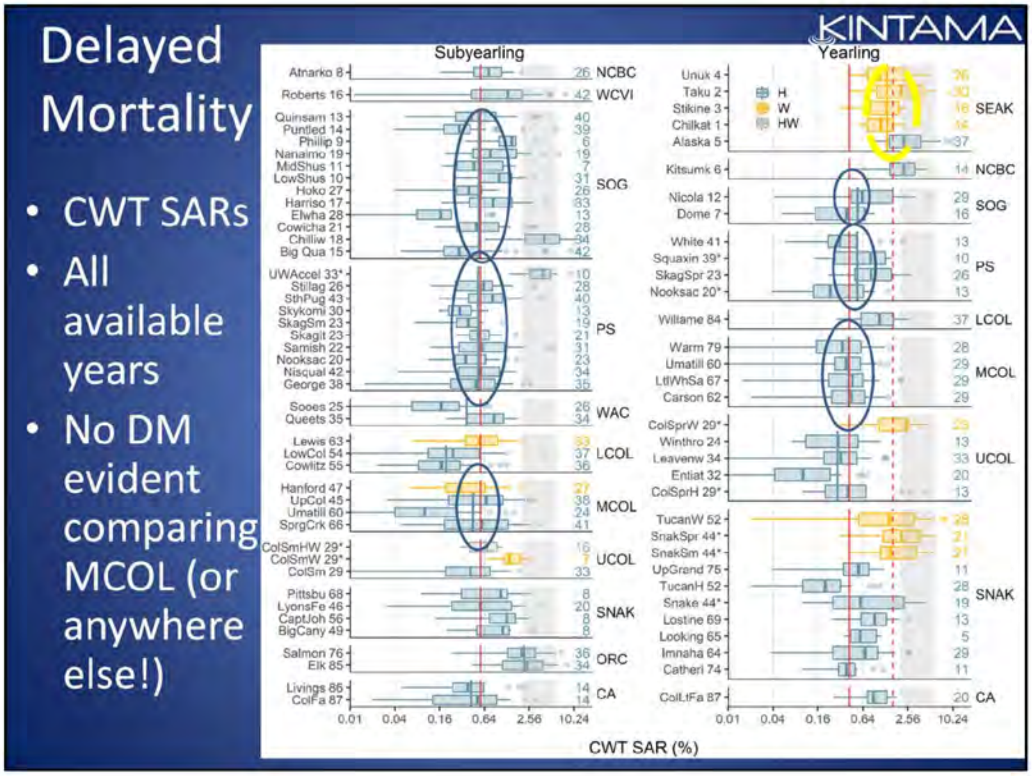
The Bottom Line: SARs 2010-2014

- Used CWT-based SAR estimates ***only***
- Restricted comparison to most recent 5 years
- Used a resampling scheme, normalizing against median Snake River SAR (see MS)
- Most regional SARs are worse (subyearling) or indistinguishable (yearling) from Snake R.



Delayed Mortality -CWTs




KINTAMA
Delayed Mortality
• CWT SARs
• All available years
• No DM evident comparing MCOL (or anywhere else!)
Subyearling
Yearling
H
W
HW
NCBC
WCVI
SOG
PS
WAC
LCOL
MCOL
UCOL
SNAK
ORC
CA
SEAK
0.01
0.04
0.16
0.64
2.56
10.24
CWT SAR (%)

Delayed Mortality -PIT Tags

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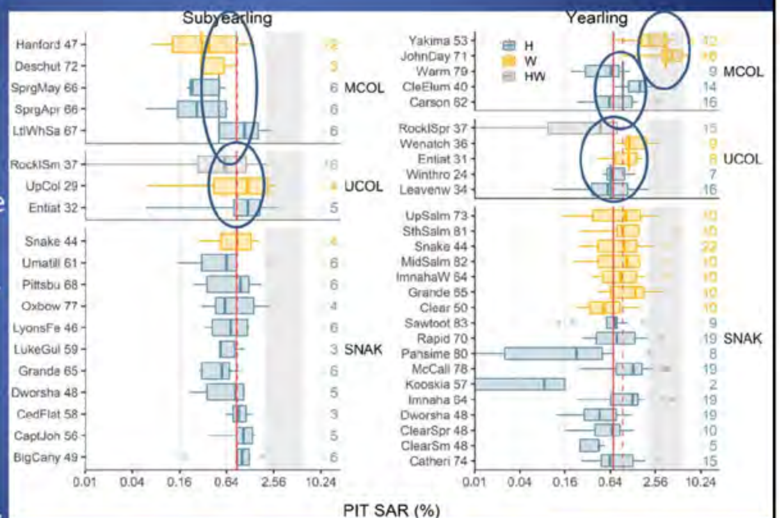
- All available years
- Generally same conclusion– NO DELAYED MORTALITY for most comparisons
- ***Only*** Yakima & John Day wild stocks have higher than expected SARS.



- Claims of delayed mortality underly most conservation arguments for how the FCRPS should be operated. However, only one of multiple possible comparisons actually supports that view—most contradict it.

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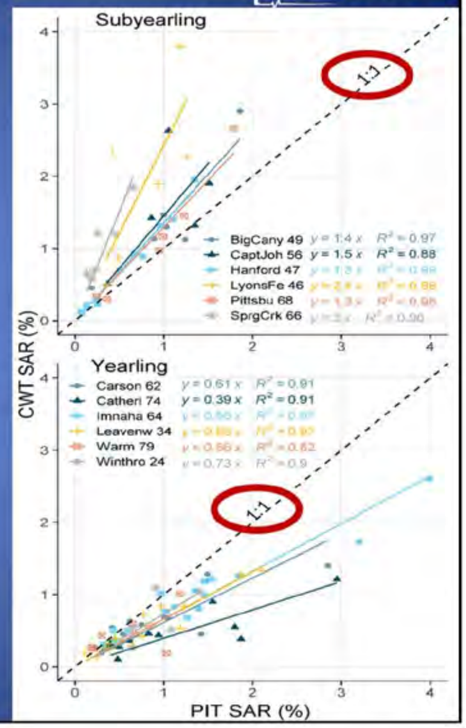
CWT Vs PIT Tag SARs

- Much time spent finding Columbia River basin hatcheries with CWT & PIT data for the same years
- ***Subyearling (Fall) Chinook:*** CWT SAR estimates are consistently ***higher***
- ***Yearling (Spring) Chinook:*** CWT SAR estimates are consistently ***lower***
- Hatchery-specific regression estimates have high R^2
- Regression slopes clearly not transferrable between hatcheries/stocks
- *➔No magic "one size fits all" conversion possible*

- There needs to be a coast-wide workshop designed to set SAR standards and align best practices (we explicitly called for this in paper)
- In correspondence with Dworshak NFH, Aswea encountered a new term we had never heard before: SAS (Smolt to Adult Survivals), as opposed to SARs (Returns).
- To quote verbatim: "**All harvest, including below LGR, is used to calculate SAS (smolt-to-adult survival). Though not presented in this report it will be in future reports".**



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Effect of Excluding Harvest on PIT SARs

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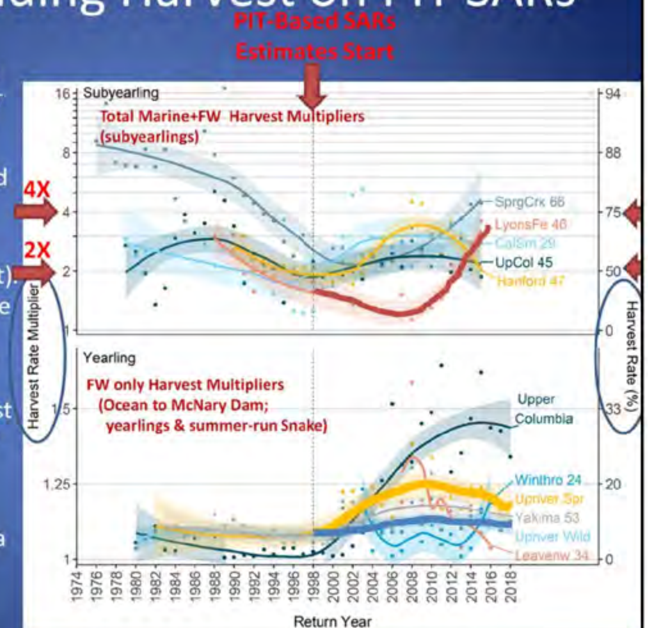
- The influence of fisheries harvest on the return of adult Chinook to the Columbia River is highly variable by year and between stocks!! ☹
- Y-axis shows multiplier needed in a given year to convert PIT tag based SARs to actual survival. (PIT SARs only available from 1998 to present).
- For example, if the harvest rate is 50%, the CSS' SAR must be doubled to account for adults intercepted in fisheries
- The upshot is excluding harvest when calculating PIT Tag SARs seriously distorts survival estimates.
- Different populations have different harvest patterns, so a simple inference of the consequences are unclear.



** data sources are documented in an appendix to the paper*

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The Pacific Salmon Treaty & The FCRPS

- PIT tag SARs came on-line in 1998
- Renegotiated treaty signed in 1999
- Treaty commits managers to abundance-based harvest management for Chinook
  - When abundance is low, harvest rates are reduced
  - When abundance is high, harvest rates are increased
- Because PIT tag SARs measure <u>returns</u>, not <u>survival</u>, they are measuring <u>*escapement from the fisheries*</u>

1) The fisheries get the benefit of improved hydrosystem conditions (increased catch) & Columbia R biologists aren't accounting for it
2) If managers are good at their jobs, escapement will be constant & freshwater improvements to survival will be hidden. Almost all of the Columbia River debate is around the role of the dams on <u>*adult returns*</u>, not smolt #s exiting the river.

The Current Use of PIT tag SARs

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- ***First***, even though people in the Columbia River basin know that catches are ***not*** routinely included in PIT tag SARs, they still think of SARs as measuring survival!
- ***SARs measure escapement from the fisheries-the survivors.***
  - This should be viewed as a major problem
  - Under the terms of the US-Canada Salmon Treaty, SAR improvements achieved at great cost are simply absorbed by fisheries—none of the additional harvest gets credited to hydrosystem changes.
- ***Second***, variation in harvest rates have large impacts on SARs.
  - Statistical analyses (spill, TDG…) using PIT tags are misleading.
  - Annual harvest rate variations of even 10~20% are as big as any expected improvements anticipated from hydropower modifications.
  - Because PIT tag-based SARs are used to calibrate ***all*** Columbia basin model analyses, harvest variability compromises findings.
  - We see no evidence modelers/policy people recognize this.

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For Example: CRSO Ecological Models Independent External Peer Review* (IEPR) Include

- NOAA Fisheries Comprehensive Passage (COMPASS) Model
- NOAA Fisheries Interior Columbia Basin Life-Cycle Models (LCM)
- Fish Passage Center Comparative Survival Study (CSS) Model
- University of Washington (UW) Columbia Basin Research Total Dissolved Gas (TDG) Model

All calibrated using PIT Tags

*Battelle. (2020). *Final Report For The Model Independent External Peer Review Columbia River System Operations (CRSO) Ecological Models. Battelle Memorial Institute, 4 May 2020.*

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Implications

- Battelle (2020):
  - "Both sets of models, COMPASS/LCM and CSS, are sensible and credible, and allow for flexibility over a range of inputs that will be helpful for modeling future conditions.".
- But both models are calibrated using PIT tag-based SARs, *which exclude harvest.*
- So both models are similarly distorted
- It will take multiple years to sort out the impact of harvest on Columbia River models.

Ref: Battelle. (2020). *Final Report For The Model Independent External Peer Review Columbia River System Operations (CRSO) Ecological Models.*

Tom Karier's Editorial (Clearing Up-1 May 2020; NW Newsletter-4 May 2020)

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- "Competing analyses of spill and dam breaching revolve around a single issue—latent mortality" (p. 5).
- "How, after decades of experimenting with higher levels of spill, do we still not know whether spill harms or helps fish?" (p. 3)

Tom Karier's Editorial (Clearing Up-1 May 2020; NW Newsletter 4 May 2020)

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- Our current paper addresses the latent mortality issues
  - Even the FPC's own broader SAR data ***doesn't support*** their own theory—only the original Yakima/John Day comparison does.
  - ***None*** of the Columbia basin CWT data sets support the belief that Snake River dams cause latent mortality
  - So we get to the same conclusions as our earlier telemetry studies delivered: There is no meaningful latent mortality, so events at sea are not substantively influenced by dam passage ("independent").

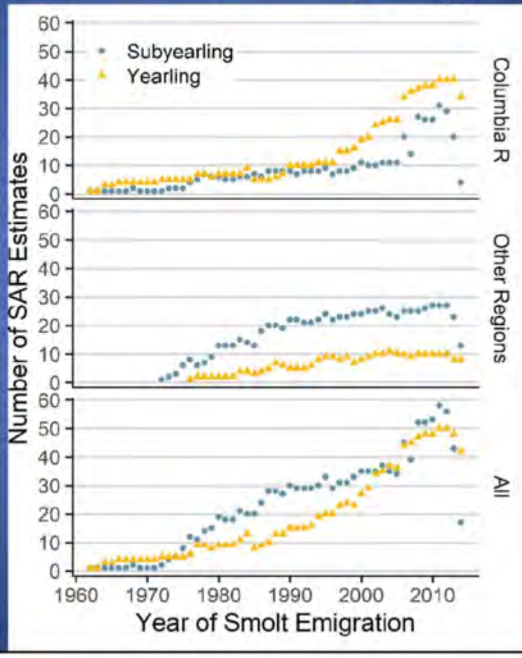
Next Steps?

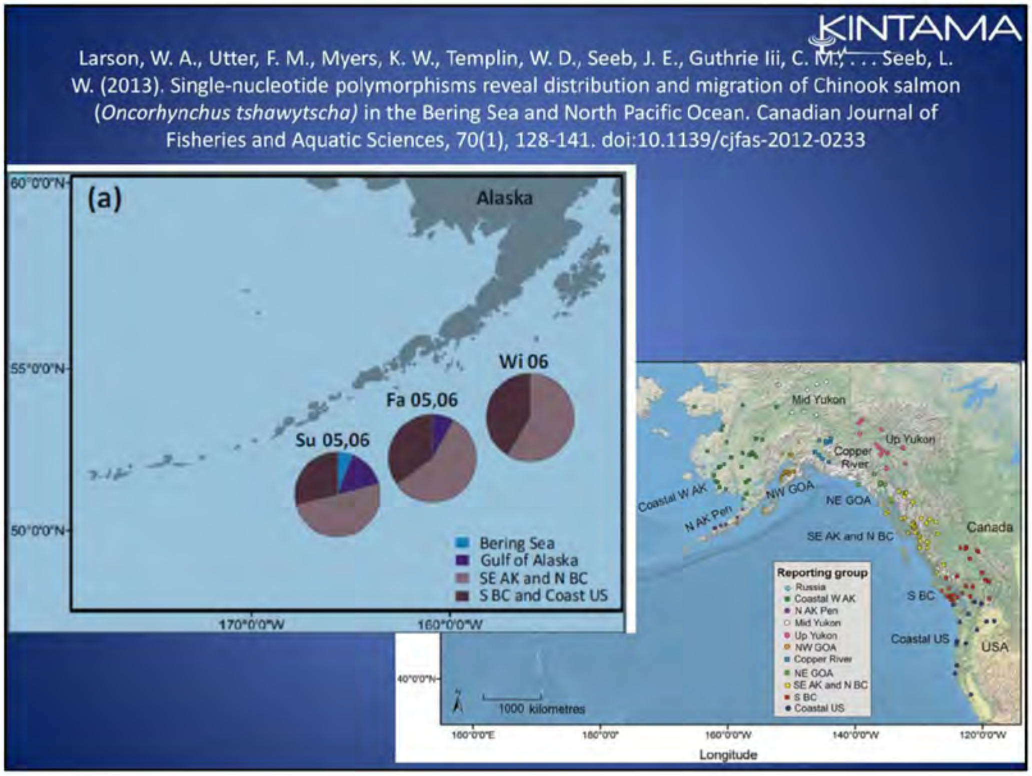
Complete paper on ocean vs freshwater survival rates. (Key point: Transport/Spill isn't effective because survival rates are similar—you don't change survival, just where the salmon die).

(***Additional Proposal***) Do quick paper on Haeseker et al's flow vs SAR projections, adding harvest in to investigate credibility (=consistency) of flow recommendations? (Target journal: N. Amer. J. Fish. Management)

Complete proposal for a large-scale experimental test of TDG effects on survival in the field. Tailor budget to encompass different environments (lower river, plume, coastal ocean, different size smolts →$$$).

Coast-Wide SARs Sampling Effort




KINTAMA
Larson, W. A., Utter, F. M., Myers, K. W., Templin, W. D., Seeb, J. E., Guthrie Iii, C. M., . . . Seeb, L. W. (2013). Single-nucleotide polymorphisms reveal distribution and migration of Chinook salmon (*Oncorhynchus tshawytscha*) in the Bering Sea and North Pacific Ocean. Canadian Journal of Fisheries and Aquatic Sciences, 70(1), 128-141. doi:10.1139/cjfas-2012-0233
(a)
Alaska
60°0'0"N
55°0'0"N
50°0'0"N
170°0'0"W
160°0'0"W
Wi 06
Fa 05,06
Su 05,06
Bering Sea
Gulf of Alaska
SE AK and N BC
S BC and Coast US
Mid Yukon
Up Yukon
Copper River
Coastal W AK
N AK Pen
NW GOA
NE GOA
SE AK and N BC
Canada
S BC
Coastal US
USA
Reporting group
Russia
Coastal W AK
N AK Pen
Mid Yukon
Up Yukon
NW GOA
Copper River
NE GOA
SE AK and N BC
S BC
Coastal US
40°0'0"N
1000 kilometres
160°0'0"E
180°0'0"
160°0'0"W
140°0'0"W
120°0'0"W
Longitude

FISH and FISHERIES

Review of the Coast-wide Decline in Survival of West Coast Chinook Salmon (Oncorhynchus tshawytscha)

Journal:	*Fish and Fisheries*
Manuscript ID	Draft
Wiley - Manuscript type:	Original Article
Date Submitted by the Author:	n/a
Complete List of Authors:	Welch, David; Kintama Research Services Ltd, Porter, Aswea; Kintama Research Services Ltd Rechisky, Erin; Kintama Research Services Ltd
Key terms:	dams, delayed mortality, smolt-to-adult return, Snake River, productivity, survival
Abstract:	We collated smolt-to-adult return rate (SAR) data for Chinook salmon from all available regions of the Pacific coast of North America to examine the large-scale patterns of salmon survival. For consistency, our analyses primarily used coded wire tag-based (CWT) SAR estimates. Survival collapsed over the past half century by roughly a factor of four to ca. 1% for many regions. Within the Columbia River, the SARs of Snake River populations, often singled out as exemplars of poor survival, are unexceptional and in fact higher than estimates reported from many other regions of the west coast lacking dams. Given the seemingly congruent decline in SARs to similar levels, the notion that contemporary survival is driven primarily by broader oceanic factors rather than local factors cannot be dismissed. Ambitious Columbia River rebuilding targets may be unachievable because other regions with nearly pristine freshwater conditions, such as SE Alaska and northern BC, also largely fail to reach these levels. Passive integrated transponder (PIT) tag-based SAR estimates available for Columbia River basin populations are generally consistent with CWT findings; however, PIT tag-based SARs are not adjusted for harvest which compromises their intended use because harvest rates are large. More attention is needed on how SARs should be quantified and how rebuilding targets are defined. We call for a systematic review by funding agencies to assess consistency and comparability of the SAR data generated and to further assess the implications of survival falling to similar levels in most regions of the west coast.

Review of the Coast-wide Decline in Survival of West Coast Chinook Salmon (*Oncorhynchus tshawytscha*)

Short title: Coast-wide survival of Chinook

David W. Welch*[,1], Aswea D. Porter[2], Erin L. Rechisky[3]

Kintama Research Services, 4737 Vista View Cr., Nanaimo, B.C. Canada V9V 1N8

* Corresponding Author E-Mail: david.welch@kintama.com

1: ORCID ID 0000-0001-8851-5436

2: ORCID ID 000-0002-1258-8265

3: ORCID ID 0000-0002-2811-8399

Key words:

Columbia River, dams, delayed mortality, smolt-to-adult return, Snake River, productivity, marine survival, northeast Pacific Ocean

Abbreviations

BC- British Columbia, Canada

CSS- Comparative Survival Study

CWT-Coded Wire Tag

PSC- Pacific Salmon Commission

SAR-Smolt to Adult Return Rate (Survival)

PIT- Passive Integrated Transponder

Conflict of Interest Statement

DWW is President and owner of Kintama Research Services Ltd., an environmental consultancy primarily focused on the development of innovative applications of telemetry to improve fisheries management. ADP and ELR are employed at Kintama. All authors received a financial benefit while conducting this study and their future salaries depend on their continued technical and scientific performance, which includes publication of this study.

Funding

This study was initially internally funded by Kintama Research Services as part of a separate research effort to assess the credibility of the critical period concept in Pacific salmon. In the course of assembling Strait of Georgia SAR data, we discovered that Chinook survival in many rivers of the Strait of Georgia region had fallen to levels well below those reported for Snake River Chinook. We developed a proposal and obtained funding from the US Dept. of Energy, Bonneville Power Administration, to cover staff time for coast-wide data collation, analysis, and writing of this paper (Contract # 75025). The funder (BPA) played no role in the design of the study nor the conclusions reached and was not made privy to the specific contents of this manuscript prior to submission.

Abstract

We collated smolt-to-adult return rate (SAR) data for Chinook salmon from all available regions of the Pacific coast of North America to examine the large-scale patterns of salmon survival. For consistency, our analyses primarily used coded wire tag-based (CWT) SAR estimates. Survival collapsed over the past half century by roughly a factor of four to ca. 1% for many regions. Within the Columbia River, the SARs of Snake River populations, often singled out as exemplars of poor survival, are unexceptional and in fact higher than estimates reported from many other regions of the west coast lacking dams. Given the seemingly congruent decline in SARs to similar levels, the notion that contemporary survival is driven primarily by broader oceanic factors rather than local factors cannot be dismissed. Ambitious Columbia River rebuilding targets may be unachievable because other regions with nearly pristine freshwater conditions, such as SE Alaska and northern BC, also largely fail to reach these levels. Passive integrated transponder (PIT) tag-based SAR estimates available for Columbia River basin populations are generally consistent with CWT findings; however, PIT tag-based SARs are not adjusted for harvest which compromises their intended use because harvest rates are large. More attention is needed on how SARs should be quantified and how rebuilding targets are defined. We call for a systematic review by funding agencies to assess consistency and comparability of

the SAR data generated and to further assess the implications of survival falling to similar levels in most regions of the west coast. *(248/250 words)*

Table of Contents

References

INTRODUCTION

The abundance of salmon in the North Pacific has reached record levels (Irvine et al., 2009; Ruggerone & Irvine, 2018; Schoen et al., 2017); however, most of the increase is in the two lowest valued species (pink, *Oncorhynchus gorbuscha,* and chum, *O. keta,* salmon) in far northern regions, at least in part due to ocean ranching (Ruggerone & Irvine, 2018). In contrast, essentially all west coast North American Chinook (*O. tshawytscha*) populations (including Alaska) are now performing poorly with dramatically reduced productivity (Dorner, Catalano, & Peterman, 2017; Ohlberger, Scheuerell, & Schindler, 2016). The situation is similar for most southern populations of coho (*O. kisutch*) (Logerwell, Mantua, Lawson, Francis, & Agostini, 2003; Zimmerman et al., 2015), sockeye (*O. nerka*) (Cohen, 2012; COSEWIC, 2017; Peterman & Dorner, 2012; Rand et al., 2012), and steelhead (*O. mykiss*) (Kendall, Marston, & Klungle, 2017). These poorly performing species are of higher economic value and the focus of indigenous, sport, and commercial fisheries.

The historical pattern of declines in salmon abundance (steeper in the south, less so in the north) were originally assumed to reflect a freshwater anthropogenic cause because of the greater degree of freshwater habitat modification in the more populous southern regions (Allendorf et al., 1997; Nehlsen, Williams, & Lichatowich, 1991). The growing appreciation of ocean climate change (Hare, Mantua, & Francis, 1999; Mantua, Hare, Zhang, Wallace, & Francis, 1997; Mantua & Hare, 2002) has brought an awareness of the role of the ocean in influencing salmon survival. As Ryding and Skalski (Ryding & Skalski, 1999, p. 2374) noted two decades ago, "*It is becoming increasingly clear that understanding the relationship between the marine environment and salmon survival is central to better management of our salmonid resources*".

Unfortunately, our understanding of survival during the marine phase remains extremely limited, so there has been little change in management strategy beyond the essential first step of reducing harvest rates in the face of falling marine survival. The recent recognition of the decline in Chinook returns across essentially all of Alaska
(ADF&G Chinook Salmon Research Team, 2013; Cunningham, Westley, & Adkison, 2018;

Ohlberger et al., 2016; Schindler et al., 2013) and the Canadian portion of the Yukon River (Bradford, von Finster, & Milligan, 2009), where anthropogenic freshwater habitat impacts are negligible, is another example of how simple explanations are potentially flawed. If survival across this vast swathe of relatively pristine territory is severe enough to seriously impact salmon productivity, then there is little hope that modifying freshwater habitat in more southern regions will support a newly productive environment for salmon.

Formal SAR recovery targets have not been specified for any region of the west coast of North America outside the Columbia River basin. Within the extensively dammed Columbia River basin, the Northwest Power and Conservation Council's Fish and Wildlife Program (NPCC) set rebuilding targets for SARs at 2%-6% (McCann et al., 2018, p. 4), roughly the survival observed in the 1960s prior to the completion of the eight-dam Federal Columbia River Power System (FCRPS) (Raymond, 1968, 1979). The NPCC SAR objectives did not specify the points in the life cycle where Chinook smolt and adult numbers should be determined. However, one extensive analysis for Snake River spring/summer Chinook was based on SARs calculated as the proportion of smolts reaching the uppermost dam in the migration path that survived to return there as adults and jacks (D. R. Marmorek, Peters, & Parnell, 1998): "*Median SARs must exceed 4% to achieve complete certainty of meeting the 48-year recovery standard, while ... A median of greater than 6% is needed to meet the 24-year survival standard with certainty*" (p. 41).Although not explicitly stated, this seems to be the basis for setting the 2-6% rebuilding standard for the Columbia River.

In this paper, we collate Chinook survival time series for the west coast of North America to document broad patterns in survival, here defined as the smolt-to-adult return rate (SAR). The SAR is the three-fold product of freshwater smolt survival during downstream migration multiplied by the marine survival experienced over two to three years in the ocean, and multiplied by adult freshwater survival during the upstream migration to the final census point. There are two major methods of estimating survival on the west coast of North America, one using Coded Wire Tags (CWT) and another using Passive Integrated Transponder tags (PIT). We assessed whether the SAR estimates using these methods could be pooled but concluded that they are not inter-convertible. The CWT program is more geographically extensive, thus our primary analysis uses the CWT-based estimates for coast-wide survival comparison. However, within the Columbia River basin PIT tags have been widely relied upon for over two decades as the primary source of survival data, so we separately analyze the survival patterns reported using the PIT tag methodology. The collated data are presented by region, smolt age at outmigration, stock, and/or year of outmigration. We then test the current similarity of SAR estimates across regions using data from the five most recent years of available data. Given the widely recognized poor survival of Snake River Chinook salmon resulting in their listing under the US Endangered Species Act (NMFS, 2017a, 2017b), many of our analyses compare regional survival to that of the Snake River region. We show that, overall, Chinook salmon survival (SAR) has decreased by roughly the same amount everywhere along the west coast of North America and have now reached similar or lower survival levels to Snake River stocks.

In the process of assessing how well survival estimates from CWT and PIT-based tagging methodologies can be compared, we found that there were large population-specific changes in harvest rates over time which are not incorporated into PIT tag-based survival estimates. This previously unrecognized limitation of PIT tagging methodologies is critical to current conservation efforts in the Columbia River basin because of changes to the terms of the US-Canada Pacific Salmon Treaty, which we outline.

Finally, we examine the CWT and PIT tag SAR datasets to evaluate the broader evidence for "delayed mortality", an important theory that argues that the greater dam passage experienced by Snake River stocks predisposes these populations to lower subsequent survival after migration out of the hydropower system than populations not migrating through the Snake River dams.

At the broadest level, the major implication of our results is that most of the salmon conservation problem is determined in the ocean by common processes. Attempts to improve SARs by addressing region-specific issues such as freshwater habitat degradation or salmon aquaculture in coastal zones are therefore unlikely to be successful. Given the importance of these conclusions, we call for a systematic review by funding agencies to further assess the broader consistency and comparability of SAR data with our findings.

METHODS

Data sources

Most survival rates of Pacific salmon are based on mark-recapture efforts, where juveniles are "marked"— implanted with either coded wire tags (CWT) or passive integrated transponder (PIT) tags—and recaptured in the fishery or detected upon return to the river. CWT technology dates back to the 1960s. A review is provided by (Johnson, 1990); the application of the methodology to coastal marine migrations of coho and Chinook is described by (L. Weitkamp & Neely, 2002; L. A. Weitkamp, 2009) and to measuring harvest and survival by (ADF&G Chinook Salmon Research Team, 2013; Bernard & Clark, 1996; Chinook Technical Committee, 2014). The tag is implanted in the nose cartilage of smolts, and the fish must be dissected to recover the tag. In contrast, PIT tags first came into widespread use in the Columbia River Basin in 1997. They are long-lived but short-distance radio-frequency tags that can successfully transmit their unique ID code when within <0.5 m of a detector (Prentice, Flagg, McCutcheon, & Brastow, 1990b; Prentice, Flagg, McCutcheon, Brastow, & Cross, 1990c; Prentice, Flagg, & McCutcheon., 1990a; Skalski, Smith, Iwamoto, Williams, & Hoffmann, 1998). The short detection range essentially limits the use of PIT tags to the Columbia River dams, which channel sufficient tagged individuals close to the detectors to generate useful results.

We collated SAR time series for Chinook from several sources (Supplementary Table S1). For CWT-based estimates, the primary data are the survival estimates for the indicator stocks used by the Pacific Salmon Commission (PSC) under the terms of the US-Canada Salmon Treaty. These datasets are formally submitted to the PSC by a wide variety of management agencies under the terms of the bilateral US-Canada Pacific Salmon Treaty. We supplemented these with CWT-based SAR time series published in the primary or secondary literature or calculated directly from the Pacific States Marine Fisheries Commission's CWT database. Together, these data sets represent California, Oregon, Washington, British Columbia, and Alaska. Estimates for the Upper Columbia and Snake Rivers reported by (Raymond, 1988) are based on freeze-branding, but were included because they are the only estimates available for the time period when SARs collapsed in those regions. Finally, because of their historical

importance to monitoring in the Columbia River we compiled and separately analyzed the PIT tag-based SAR estimates reported by the Comparative Survival Study (McCann et al., 2018).

Because SAR data are typically log-normally distributed, we primarily report the median, as this is equivalent to the geometric mean some authors use. (A simple proof of this statement is to note that that after log-transformation the mean of log-normal data will have 50% of the data above and below it). We therefore use the simpler terminology both for clarity and because Furthermore, the median is invariant under log-transformation, which is not true for the mean.

Pacific Salmon Commission (CWT)

The PSC is a bilateral treaty organization between the US and Canada coordinating coastwide management of Pacific salmon. The data are contributed to the Chinook Technical Committee of the PSC by the various government agencies responsible for conducting the individual monitoring programs. This database was the source of CWT-based Chinook survival estimates for all regions outside the Columbia River basin and for a few stocks located in the Columbia River basin.

The PSC database provides several measures of SAR. We used their estimates calculated as the sum of adults returning at all ages or caught in the fisheries, uninflated for losses to natural mortality for Chinook remaining at sea for longer than two years:

$$SAR_{i,j} = \frac{\sum_{k=2\,or\,3}^{\max age} \left(\sum_{l=1}^{n} (F_{i,j,k,l} + IM_{i,j,k,l}) + Esc_{i,j,k} \right)}{\mathrm{Rel}_{i,j}}$$

where $F_{i,j,k,l}$ = the tags recovered in fishery l, for age k, from brood year j, of stock i that are expanded for the fraction of the catch sampled; $IM_{i,j,k,l}$ = the incidental mortalities; and $Esc_{i,j}$ = the number of tags recovered in the escapement including hatchery and spawning ground recoveries that are expanded for the fraction sampled. Columbia River stocks also have an inter-dam loss (IDL) calculation, so fish (or tags) returning to the river are adjusted upward to account for in-river mortality. IDLs are explained in (Chinook Technical Committee, 2018).

CWT-based SAR estimates for hatchery-origin fish generally cover the period from hatchery release until adult return to the hatchery and/or spawning grounds and are compensated for harvest (i.e., mortalities due to harvest are included as survivors). However, some of the CWT-based survival estimates for wild stocks are biased high because they can exclude survival losses occurring in the initial phase of the migration upstream of the census point (see (McPherson, III, Fleischman, & Boyce, 2010)). In contrast, all five Alaskan hatcheries are located at sea level and smolts are released directly into the ocean after several weeks of seawater acclimation in holding pens, eliminating losses in freshwater (see later). Other miscellaneous notes about this dataset are recorded as footnotes at the bottom of Supplementary Table S1.

Agency estimates (CWT)

The PSC does not include indicator stocks for California or for yearling Chinook from the Columbia River, presumably because these stocks are not relevant to international management. We therefore included published estimates for fall, late-fall, and winter Chinook runs from the Sacramento River in California (Michel, 2018). We also collated some annual reports produced by individual hatcheries in the Columbia River basin and/or contacted the hatcheries directly to build up a partial inventory of CWT-based SAR estimates for Chinook.

These supplemental estimates were calculated similarly to those done by the PSC but are unexpanded for incidental mortality (or inter-dam loss in the Columbia River). Hatcheries that do not tag 100% of smolts released may expand their estimates for the proportion tagged while others are estimated using only tagged fish. See Supplementary Table S1 for details.

Pacific States Marine Fisheries Commission

All CWT release and recovery data are submitted to the Regional Mark Processing Center hosted by the Pacific State Marine Fisheries Commission, which maintains the online Regional Mark Information System (RMIS) to facilitate exchange of CWT data. We investigated this source; however, we could not verify that adult return numbers from all possible significant components were correctly incorporated and expanded for sampling effort. Ideally, adult returns should include hatchery rack returns, adult escapement to spawning grounds, adults captured for use as brood stock, and immature or maturing individuals caught in all fisheries (sport, commercial, tribal) and locations (at sea, in-river). For this reason, we focused on the PSC and Agency estimates described above. We used RMIS only for Entiat Spring Chinook (UCOL) after consulting with Entiat Hatchery biologists on the integrity of the data set (G. Fraser, *pers. comm.* USFWS, Leavenworth, WA. gregory_fraser@fws.gov).

Raymond (1988)

Data on survival in the 1960s to early 1980s period for the Snake and Upper Columbia Rivers was based on mark-recapture estimates of the abundance of a mixture of freeze-branded hatchery and wild smolts passing the first dam encountered each year (Raymond 1988). An essentially complete enumeration of adult returns was possible at upstream dams several years later because the adults must ascend fish ladders. Estimates were compensated for harvest as per (Raymond, 1988). These SAR estimates are inflated relative to the CWT-based estimates described above because they do not include migration losses from the time downstream migration is initiated until the smolts are censused at the dams and also exclude adult upstream losses between the dam and the spawning grounds. Nevertheless, this dataset is important because it incorporates the period of relatively high survival in the 1960s and early 1970s and the period when survival collapsed, which was attributed primarily to dam construction. We used these estimates in conjunction with the CWT estimates for a more complete time series.

Comparative Survival Study (PIT tags)

PIT tags have largely supplanted CWTs in the Columbia River basin because of the ability to measure smolt survival between dams and to estimate SARs. We used the estimates of overall SAR from Chapter 4 of the Fish Passage Center's Comparative Survival Study (McCann et al., 2018) which are essentially the number of adults returning to the uppermost FCRPS dam with detection capability (Lower Granite, McNary, John Day and/or Bonneville dams depending on the population) divided by the estimated number of PIT-tagged smolts surviving to their uppermost dam during downstream migration. For example, for most Chinook salmon originating from the Snake River basin, the SAR is estimated from Lower Granite Dam back to Lower Granite Dam.

When estimates were available for multiple segments, we selected the SARs covering the greatest extent of the migratory life-history (i.e., smolt releases and adult returns to the uppermost dam available in the Columbia River basin), and we used SAR estimates that included jacks when available. In the mid-Columbia region, SAR estimates with jacks were sometimes available only for a shorter migration segment; in these cases we selected the SAR data sets representing the longer migration segment but excluding jacks because this was most similar to the CWT survival estimates. PIT tag-based SARs do not incorporate losses due to harvest (McCann et al., 2018, p. 95) because the commercial and sport catch is not monitored for PIT tags.

Because published PIT tag-based SAR estimates contain several limitations that are problematic to the interpretation of survival (particularly lack of harvest information), we use these estimates only as a secondary validation of the major conclusions.

Division by life history

Chinook salmon display two major juvenile life history types (subyearling and yearling) that correspond with adult run-timing (Fall or Spring respectively). These life history types are examined separately in our analysis because there are important ecological differences between them (see reviews by (Riddell et al., 2018; Sharma & Quinn, 2012)) which likely influence survival. We review the general characteristics below but note that this simple picture is more complicated due to hatchery rearing practices and natural variability.

Subyearling/Fall populations are widely distributed in low gradient coastal streams or the lower mainstem of major rivers but are absent from Alaska. They migrate to the ocean within a few months of hatching and almost certainly remain as long-term residents of the continental shelf off the west coast of North America where they are exposed to commercial and sport harvest in coastal marine waters over multiple years (Sharma & Quinn, 2012). Survival of shelf-resident subyearling Chinook populations can therefore be significantly reduced by coastal fisheries that can harvest these animals over several years of marine life.

Yearling/Spring populations are found in headwater tributaries of large river systems penetrating well into the interior of the continent, such as the Columbia and Fraser rivers. They migrate to sea after completing one or more full years of life in freshwater and are thus significantly larger at ocean entry. Yearlings are thought to migrate along the continental shelf as juveniles and then move offshore and become purely open ocean residents for much of the marine phase, and thus are essentially immune to harvest by fisheries until their return to freshwater, where variable levels of harvest may occur. Yearlings also (generally) spend one less year in the ocean than subyearlings. Only the yearling life history type is found in Alaska (Healey, 1983).

Comparisons between regions

To develop a formal statistical test of the similarity in SARs between regions in the most recent years of the record, we first grouped the CWT-based SAR data separately by smolt age (Yearling/Subyearling), region, and rearing type (hatchery/wild). For each of these groupings, we pooled all data in the 2010-2014 period across all populations in a region, and then resampled the pooled data with replacement N=10,000 times, each time drawing a sample of the same size as the original pooled data. We chose this time period because there were consistent number of populations contributing to each regional grouping used in the comparison period and it avoided including 2008, a year of unusually cold conditions (Arguez et al., 2020) . Limiting the samples to this period ensured the data were current and removed the potential variability due to differing lengths of the time series. For each group, we calculated the N median SARs, and then calculated the ratio of those N medians with those from each of the other regions in turn. The empirical distribution of the N ratios allows for a formal statistical test of the proposition that median SARs in the two regions are equal (i.e. that the ratios are not different from one). The normalized SAR ratio for region i in sample j=1,.., N was then $\mathrm{SAR}_{i,j}/\mathrm{SAR}_{SNAK,j}$. Because of the generally recognized poor survival of Snake River Chinook salmon, we present the results of the comparison to this region in the main text but also provide the comparison using all possible regions in the denominator in Supplementary Figure S1.

Comparison between CWT and PIT tag-based SARs

There are some fundamental differences between PIT and CWT tag-based SAR estimates. PIT tag-based SARs exclude smolt and adult survival above the topmost dam where they are censused and do not account for harvest in ocean or mainstem river fisheries. CWT-based estimates incorporate these factors. Therefore, an aggregate correction factor $\widehat{c_{i,j}}$ for the PIT-based SAR estimates to make them consistent with the CWT-based SAR estimates is:

$$\widehat{c_{i,j}} = \frac{S_{i,j}^{smolt} * S_{i,j}^{adult}}{(1 - h_{i,j})}$$

where $S_{i,j}^{smolt}$ = the estimated survival of stock i between the hatchery or pre-smolt rearing grounds and the uppermost dam for smolts from brood year j; $S_{i,j}^{adult}$ = the estimated survival of stock i between the uppermost dam and return to the hatchery/spawning grounds; and $h_{i,j}$ = the estimated harvest of stock i in year j. For notational simplicity, we neglect harvest in years prior to adult return. Here the numerator corrects for upwards bias in PIT-based SAR estimates caused by excluding survival above the topmost dam while the denominator corrects for the downward bias caused by excluding harvest.

We were interested in estimating $c_{i,j}$ to assess if it was reasonable to use it to combine these data into a single term that could provide a reliable metric for converting between PIT and CWT-based SAR estimates. To do this, we first attempted to collate the three components ($S_{i,j}^{smolt}$, $S_{i,j}^{adult}$, and $h_{i,j}$) for the populations with PIT tag SAR estimates, but we encountered difficulty obtaining sufficient data, particularly for the adult stage. However, combined ocean plus mainstem harvest rates were readily available for the PSC's indicator stocks. For yearling populations, marine harvest rates are thought to be very low (Waples, Teel, Myers, & Marshall, 2004) and are not included in the CTC database. We therefore collated mainstem harvest data from other sources for yearlings (Supplementary Table S2).

Our second approach to estimating $c_{i,j}$ was to identify populations with both CWT- and PIT-based SAR estimates generated in the same years and then use simple linear regression to

identify the relationship. If there was no difference between estimation methodologies, then the regression of CWT SAR estimates on PIT tag-based SAR estimates should have a regression slope of $\hat{c} = 1$.

RESULTS

We collated 123 eastern North Pacific Ocean Chinook salmon SAR time series totaling 2,279 years of monitoring (Fig. 1). SAR estimates included in our analysis were from populations extending from central California to south east Alaska and include 94 hatchery populations, 26 wild, and 3 hatchery-wild (mixed) populations. These populations were then aggregated by geographic area to compare regional SARs. All time series outside the Columbia River watershed are based on CWTs. Within the Columbia, both PIT and CWT-based SARs are available.

SARs obtained from coded wire tags

Most regions of west coast North America with CWT time series extending back prior to the 1978 regime shift (Beamish, 1993; Beamish & Bouillon, 1993; Ebbesmeyer et al., 1990; Francis & Hare, 1994; Mantua et al., 1997) show an approximate four-fold decrease in SARs for hatchery populations (Fig. 2). This applies to subyearling Chinook from west coast Vancouver Island, the Strait of Georgia, Puget Sound, and the mid-Columbia River; and to yearling Chinook from SE Alaska, the lower and upper Columbia River, and the Snake River (upper Columbia and Snake rivers are relative to the historical freeze brand data from Raymond (1988)). Except for coastal Oregon subyearlings, average CWT-based SARs for all regions are now approximately 1% or less.

Within the Columbia River basin, Chinook from all regions except for lower Columbia yearlings show some increase in CWT-based SARs since the 1980s and early 1990s, the period when SARs reached their lowest values in the basin. None of these time series recovered to the survival levels measured by Raymond (1988) in the 1960s.

Median population specific SARs show that wild populations generally have higher survival than hatchery populations; however, there are limitations: CWT data are limited for wild populations and there are no data available for a direct hatchery vs wild comparison for the same population (Fig. 3). The wild yearling Chinook populations in SE Alaska tend to have lower survival than the hatchery-reared population; however, the Alaskan hatchery SAR estimate provided to the PSC is based on combined data for five hatcheries that all release smolts directly into the ocean after acclimation to seawater for several weeks, eliminating losses from freshwater migration (Bill Gass, Production Manager, Southern Southeast Regional Aquaculture Association, & John Eiler, NOAA; pers. comms.).

Median SARs for hatchery or wild populations within a given region tend to cluster together, but a few populations (University of Washington experimental hatchery releases in Puget Sound and the Chilliwack hatchery in the Strait of Georgia) have unusually high SARs relative to other stocks in their respective region. These are also the only populations whose medians substantively attain the 2-6% SAR recovery level adopted in the Columbia River basin. Apart from SE Alaska, north-central BC yearlings, and Oregon Coast subyearlings, which have higher regional survivals, populations from other regions have only rarely reached this level of production.

Comparison between regions

To compare the current status of regional CWT-based SARs, we included the five most recent years of consistently available SAR data (2010-2014) in a resampling procedure to statistically quantify relative SARs. We used Snake River population SARs as the baseline region to compare all other regions with because of the perceived status of the Snake River as having particularly poor survival; the same analysis using other regions as the basis for comparison are presented in Supplementary Information SI-3. A striking result emerges for hatchery-reared subyearling Chinook: median SARs in all regions except the Oregon Coast are lower than median Snake River SARs (Fig. 4). Only in three of nine regions with numerically lower SARs does the upper 5th percentile of the empirical distribution include the possibility of equal SARs with the Snake River region (North-Central BC, Mid, and Upper Columbia). For all other regions, subyearling SARs are statistically lower than the Snake River survivals. There are no CWT-based SAR estimates for wild subyearling Chinook.

Applying the same procedure to hatchery-reared yearling Chinook, current regional SARs were statistically indistinguishable from Snake River SARs for the Salish Sea (Strait of Georgia, Puget Sound) and all other regions of the Columbia River basin (Lower, Mid, and Upper; Fig. 4). California, northern BC, and SE Alaska yearling SARs were significantly higher than Snake River yearling populations. The SARs of SE Alaska wild yearling Chinook (four river systems) were significantly lower than the SARs of the one wild stock of Snake River yearling Chinook available for comparison (Tucannon River; Fig 3).

SARs obtained with PIT tags

PIT tag-based SAR estimates are available for Chinook salmon originating from the Columbia River Basin and published annually by the Fish Passage Center (McCann et al., 2018). Comparing PIT tag-based SARs across regions of the Columbia River basin (Fig. 5) yields similar results to the CWT analysis: wild fish generally have higher survival and different regions have similar or lower median SARs to the Snake River. The exceptions are two mid-Columbia populations of wild yearling Chinook salmon (John Day River and Yakima River) which have consistently high SARs that fall within the 2-6% rebuilding target set for Columbia River Basin yearling Chinook. However, both wild and hatchery subyearling SARs from the mid-Columbia fall well below the Snake River medians, and all other populations (including three hatchery-reared mid-Columbia yearling populations) have SARs which rarely or never exceed 2%; from this perspective only the two wild yearling populations have substantively higher SARs.

Comparison of CWT and PIT tag-based SARs

We attempted to develop a direct comparison of PIT- and CWT-based SAR estimates so that we could incorporate PIT tag-based SAR datasets into our analysis. PIT-based estimates differ in two major ways from CWT estimates: (1) they exclude sport, commercial, and indigenous harvest and (2) they exclude smolt and adult losses in the region lying between the uppermost dam and the hatchery or spawning site. Unfortunately, it was difficult to find sufficient comparable data. Where paired populations were available, regression relationships were population-specific for both life history types (Fig. 6). Subyearling CWT-based SAR regression estimates were consistently higher than PIT-based estimates, presumably because the high subyearling harvest rates not captured in PIT-based estimates (currently between ~45-80%; Fig. 7) outweigh the influence of excluding upstream losses. In contrast, CWT-based SARs for yearling populations were consistently lower than PIT-based estimates, indicating that mortality above the uppermost dam outweighs the influence of the generally lower (but not insignificant) harvest rates on yearling populations. Although fitted linear relationships had high R^2, the substantial differences in regression slopes among populations (ranging, from 1.3 to 3 times for subyearling populations), suggests that population-specific factors strongly influence the relationship. A simple correction factor between PIT and CWT-based SAR estimates appears infeasible.

DISCUSSION

SAR comparison

Evidence that Chinook salmon survival (SARs) has decreased to roughly 1% in many regions along the west coast of North America is both surprising and important. Direct measurements of SARs are lacking for stocks located west of SE Alaska, but the decrease in the number of adult Chinook returning to the rest of Alaska (ADF&G Chinook Salmon Research Team, 2013; Ohlberger et al., 2016; Schindler et al., 2013) demonstrates that survival has fallen over a very large geographic range.

These decreases in survival have occurred despite governments' best attempts to increase salmon populations through harvest regulation, hatchery enhancement, and habitat restoration. A major assumption underlying these efforts is that regional factors such as freshwater habitat degradation or salmon aquaculture make important contributions to the decreasing survival of salmon observed coastwide; however, the similar timing of the decline in the Salish Sea, west coast of Vancouver Island, and Columbia River basin suggests the primary influence of a broad ocean driver (Beamish, 1993; Beamish & Bouillon, 1993; Mantua et al., 1997).

In the Snake River basin, where ESA-listed Chinook salmon migrate through eight major dams, subyearling survival of hatchery Chinook is higher than aggregate subyearling SARs from most regions of the west coast of North America despite the shortness of streams in these other regions and the general absence of dams (Fig. 4; Oregon coast is the clear exception). For hatchery-origin yearling populations, SARs for the Snake River are lower than three regions (California, north-central BC, and SE Alaska) but are statistically indistinguishable from all others (Puget Sound, Strait of Georgia, and lower, mid, and upper Columbia River).

When comparing wild populations, the few Chinook SAR time series outside of the Columbia River basin are also not consistently better than wild Snake River SARs as conventional thinking would assume. The median SAR of four wild Alaskan stocks is lower than the median SAR of three Snake River wild stocks when all years of data are considered (Fig. 3) and also when the comparison is restricted to the 2010-2014 time period (Tucannon River is the only population available for the Snake River region; Fig. 4). The conclusion is similar when comparing all available years of CWT and PIT tag data for most populations (Figs. 3 and 5): median SARs are poor everywhere, and generally ~1% except in the earliest years of the time series. Thus, the numerical similarity in SARs is not an artifact of some recent event but something that has persisted for many years. (Supplementary Tables S3 and S4 provide a summary of the actual numeric values.)

A few populations with anomalously high SARs relative to other populations in the same region exist, and provide intriguing evidence that some populations have an intrinsic ability to support higher SARs meeting the Columbia River basin's current 2-6% recovery targets (subyearlings from the Chilliwack hatchery in the lower Fraser River (SOG) and a ten year record of experimental hatchery releases from the University of Washington (PS)). It is unclear why these two populations are more productive. Similarly, a few populations with anomalously low SARs relative to regional medians also are evident (Fig. 3). If the underlying reasons for higher or lower survival can be identified it might be possible to improve hatchery productivity more broadly.

Intriguingly, the higher SARs of the two coastal Oregon subyearling populations and yearling Chinook from California (Figs. 3, 4) all involve populations that apparently do not migrate far north. The SARs of California Chinook are particularly noteworthy because freshwater survival is exceedingly low (Michel, 2018); for overall SARS to be higher than Snake River stocks suggests much higher survival during the marine phase. (Riddell et al., 2018, p.

580) note the unique marine distributions of southern Oregon Chinook stocks, which restricts them for their entire ocean phase to life in the California Current, similar to the assumed ocean distribution of California stocks. It thus seems plausible that specific salmon populations home to distinct feeding grounds, some of which may confer better survival (Quinn, Chamberlain, & Banks, 2011; Tucker et al., 2011; Welch, Boehlert, & Ward, 2002).

The reasons for poor marine survival of Chinook are likely multiple, with mechanisms proposed just in the last decade alone including: growth (Claiborne, Fisher, Hayes, & Emmett, 2011; Duffy & Beauchamp, 2011; Graham, Sutton, Adkison, McPhee, & Richards, 2019; Lewis, Grant, Brenner, & Hamazaki, 2015; Losee, Miller, Peterson, Teel, & Jacobson, 2014; MacFarlane, 2010; J. A. Miller, Teel, Peterson, & Baptista, 2014; Orsi, 2013; Schindler et al., 2013; L. Tomaro, Teel, Peterson, & Miller, 2012); hatchery practices (Chamberlin, Essington, Ferguson, & Quinn, 2011; B.W. Nelson, Shelton, Anderson, Ford, & Ward, 2019; Sabal et al., 2016; L. M. Tomaro, 2010); predation (Chasco et al., 2017; Friedman et al., 2019; J. A. Miller, Teel, Baptista, & Morgan, 2013; Benjamin W. Nelson, Walters, Trites, & McAllister, 2019); competition (Cunningham et al., 2018; J. A. Miller et al., 2013); bycatch mortality in fisheries (Cunningham et al., 2018); and ocean conditions (Dorner et al., 2017; Ruff et al., 2017; Sharma, Vélez-Espino, Wertheimer, Mantua, & Francis, 2013).

Delayed mortality, the theory that greater dam passage results in poorer survival of Snake River Spring Chinook relative to mid-Columbia Chinook populations after smolts migrate past the dams (Budy, Thiede, Bouwes, Petrosky, & Schaller, 2002; Independent Scientific Advisory Board (ISAB), 2007; Schaller & Petrosky, 2007; Howard A Schaller, Charles E Petrosky, & Olaf P Langness, 1999), still plays an important role in Columbia River salmon management (McCann et al., 2019, pp. 116-119). However, direct tests of the theory have not found evidence to support it (ISAB, 2019; E.L. Rechisky, Welch, Porter, Hess, & Narum, 2014; Erin L. Rechisky, Welch, Porter, Jacobs-Scott, & Winchell, 2013; E.L. Rechisky, Welch, Porter, Jacobs, & Ladouceur, 2009). The PIT and CWT-based SAR estimates assembled here also fail to support the theory because the SARs of Snake River populations are not reduced on average when compared to other regions. Apart from two mid-Columbia PIT-tagged wild yearling populations (Yakima River and John Day River), all other SAR estimates are similar to Snake River values regardless of differences in the number of dams lying in the migration path. Three PIT-tagged hatchery-reared mid-Columbia yearling populations and two Upper Columbia populations have similar SARs to Snake River populations (Fig. 5), and CWT-based SAR estimates for Lower-, Mid- and Upper-Columbia yearling populations have survival consistent with Snake River populations (Fig. 4). Also of note, both PIT- and CWT-based SAR estimates for Mid-Columbia populations of wild and hatchery subyearling Chinook are generally lower than Snake River values. Thus, none of these comparisons support the claim that greater dam passage—and Snake River dam passage in particular—results in subsequently reduced survival. Our point is not to question that dams cause mortality, but rather to note that their current contribution to reduced survival is likely much smaller than originally believed. We urge biologists to consider all available data when evaluating the delated mortality theory, not just select comparisons that fit the proposed theory.

Credibility of SAR estimates

CWT-based estimates

We restricted most SAR comparisons to CWT-based data, as these are available for the entire west coast to as far north as SE Alaska. Most estimates are for hatchery-reared indicator stocks collated by the Pacific Salmon Commission; few estimates are available for wild populations. For upper Columbia and Snake yearling populations we used estimates generated by individual fishery agencies. The PSC cites several challenges with CWT-based estimates including representativeness of the indicator populations, limitations on sampling the fishery and spawning grounds, and distortions introduced by mark-selective fisheries (Hankin et al., 2005). Agencies presumably generate these data using internally consistent methodologies over time to avoid biasing parts of the time series, thus, the large concurrent downward trend in survival of individual populations is likely to be credible.

PIT tag-based estimates

PIT tag detectors in dam bypasses and fish ladders census both the downstream and upstream movements of PIT-tagged salmon within the Columbia River basin. Originally developed to study smolt survival, PIT tag-based studies subsequently expanded to measure adult returns, presumably because of the unique ability to completely enumerate returning adults as they ascend fish ladders. SAR data sets are now generated for many yearling and subyearling Chinook populations (McCann et al., 2018) and as a result PIT tags have largely supplanted

CWT tags for estimating SARs in the Columbia River basin. Dividing estimated smolt counts at the dams in the ocean entry year by the returning adult counts in subsequent years provides the SAR.

PIT tag-based SAR estimates show that recent SARs are now generally low compared to historical levels (Fig. 2) and track well with CWT-based estimates for individual populations (Fig. 6); however, our results indicate that PIT tag-based estimates for Columbia River basin Chinook are overestimated relative to CWT-based estimates for yearling Chinook and underestimated for subyearling Chinook (Fig. 6). Despite being consistent for individual populations, the two methods are therefore not inter-convertible. There are two reasons for this. First, for dam-to-dam estimates (e.g., Lower Granite Dam exiting smolts to Lower Granite Dam returning adults) the survival losses incurred upstream of the dam can vary substantially between populations (Faulkner, Widener, Smith, Marsh, & Zabel, 2017). Unless census points are located at the start and end of the migration period, the amount of excluded upstream survival acts as a population-specific random variable influenced by the excluded distance. This is true for essentially all published PIT-based SAR data (McCann et al., 2018) and for some CWT-based SAR estimates for wild populations, where smolt abundance is censused after migration has started (e.g., (McPherson et al., 2010)).

The second reason is that Chinook harvested in fisheries prior to return are not accounted for in PIT tag-based estimates. Authors have previously noted that PIT tag-based SAR estimates do not include harvest (D. Marmorek & Peters, 2001; McCann et al., 2018) and recommendations have recently been made to incorporate harvest (ISRP, 2019, p. 22), but neither the magnitude of the harvest nor the variability over time has been recognized. The result is that PIT tag-based SARs represent the surviving adults left over from the operation of multiple fisheries operating over several years. So although PIT tag-based estimates of juvenile survival in the hydrosystem appear reliable, the influence of commercial, sport, and tribal fisheries on adult returns is large, and therefore PIT-based SARs likely do not provide a credible measure of smolt-to-adult survival but rather estimates of escapement from the fisheries to the river.

Harvest and PIT-based SARs

The potential of PIT tags to identify all returning adults to the Columbia River is compromised by the inability to identify PIT-tagged fish in the harvest. Ocean harvest rates on Columbia River basin yearling (Spring) Chinook stocks are ≤2% (H. A. Schaller, C. E. Petrosky, & O. P. Langness, 1999; Waples et al., 2004), presumably because maturing Spring Chinook cross the continental shelf only near their natal river mouth on return and are not exposed to the many coastal fisheries operating along the shelf; however, yearling Chinook harvests in freshwater are still substantial (Fig 7). Harvest rates for Upriver Spring Chinook increased from 10% to 20% of the number arriving at the river mouth over the 1998-2010 period (PFMC, 2019). Not accounting for this river harvest results in underestimating the true SAR by ca. 10% in 1999 (near the beginning of the PIT tag record) and 25% in the more recent years of the record. For other yearling stocks the correction is larger.

For subyearling Chinook, which are much more heavily harvested, PIT-based SAR estimates likely understate survival by 300-400% in recent years. For example, Lyons Ferry (Snake River) subyearling Chinook harvest rates rose from a low of ~20% in 2004 to >70% in 2012. These values imply correction factors increasing from 1.25X to >3X over eight years.

The varying patterns of increase in harvest rates towards the most recent years of the record are particularly important because PIT tag-based SAR estimates do not reflect the higher harvests of recent years and therefore understate the improvements in adult survival that actually occurred. Given the variability in harvest rates over time and between populations, a reliable correction factor to account for harvest will be difficult to achieve for PIT tag-based SAR estimates, while leaving these estimates uncorrected for harvest results in a substantial downwards bias in survival estimates (Fig 6).

Another challenge with using PIT tag-based SAR estimates to set quantitative recovery targets for Columbia River basin Chinook (e.g., 2-6% SAR) is that the fisheries management strategy is currently divorced from these goals. Under the terms of the renegotiated Pacific Salmon Treaty, beginning in 1999 coastwide management of ocean fisheries for Chinook is explicitly abundance-based (Caldwell, 1999; K. Miller, 2003): fisheries are intensified when abundance is high and restricted when low. Consequently, PIT-based SAR estimates will inaccurately reflect survival if managers identify increases in abundance and increase harvest rates—which is precisely what the treaty dictates they should do. In fact, if managers had perfect control of ocean fisheries survival changes would never be reflected in PIT tag-based SAR estimates because any change in abundance would simply be compensated for by altering harvests. In practice, over or under-harvesting is likely, so PIT-based SAR fluctuations will also reflect the inability to perfectly manage fisheries. Even for Snake River Spring Chinook, where harvest rates are lowest and the inter-annual fluctuations in harvest are on the order of 10-20% (Fig. 6), survival fluctuations of this size would generally be considered significant. That PIT tag-based SAR fluctuations may simply reflect limitations inherent to the treaty is of concern and appears to be unrecognized. Equally important, expensive changes to the operation of the Federal Columbia River Power System intended to improve survival may benefit the fisheries without credit accruing to those bearing the costs. In future, closer coordination is advisable between the managers implementing abundance-based harvest in the various fisheries and the biologists assessing the impact of Columbia River basin hydropower operations on survival.

CONCLUSIONS

The policy implications of Chinook salmon SARs converging to similar levels nearly everywhere along the west coast of North America are profound. Current efforts to conserve salmon populations assume that restoring habitats modified by anthropogenic factors (e.g., dams, dykes, forestry, road culverts, salmon farms in the coastal ocean) will improve salmon returns and at least partially compensate for worsening ocean conditions (Roni, 2019). However, if survival also falls by roughly the same amount in regions with nearly pristine freshwater habitats (SE Alaska, north-central British Columbia), it is difficult to argue for a major role of regional factors in causing the decline.

Given the geographically widespread collapse in survival to numerically similar levels and the steadily increasing effort devoted to survival monitoring for salmonids (Fig. 8), the fisheries community need to re-assess several core conservation assumptions. Of primary importance is the actual effectiveness of freshwater habitat restoration initiatives when northern populations with nearly pristine freshwater conditions have similar SARs. The resulting policy implications range from the prospects for successfully feeding killer whales with increased hatchery Chinook production, the effect of salmon aquaculture on wild stocks, to the real role of dams in the demise of Snake River salmon stocks.

As declining survival has reduced adult return rates, there has been mounting effort to increase monitoring. However, we encountered substantial challenges in fully understanding whether all components of adult returns were adequately included in many SAR time series. In addition, some survival time series exclude variable proportions of upstream survival for both smolts and adults. Unless smolt counts are taken at the hatchery (or at the initiation of migration for wild smolts) and adult counts occur on the spawning grounds, variability is introduced into survival estimates because different amounts of the migratory life history are incorporated for different populations. Exactly where abundance is estimated during migration and what components of adult returns are included should be more carefully documented. We recommend that a coast-wide review of the quality and consistency of smolt-to-adult survival methodologies is needed to ensure that the many initiatives now monitoring survival are achieving sufficient accuracy to be useful.

Because of poor survival, the costs of hatchery supplementation are now extremely high. In Puget Sound, where the reported survival of subyearling (Fall) Chinook has fallen to significantly lower survival levels than the Snake River, the cost of hatchery operations to yield one sport-caught adult Chinook has increased from ~$55 (USD) per fish caught in the 1970s to $768 per (yearlings) Chinook and $392 per (subyearlings) Chinook in the 1990s (Table 5 of (Anonymous, 2010); costs unadjusted for inflation). High costs of production are also noted in British Columbia, particularly for Upper Fraser River Chinook, where costs were estimated at $380 (CDN) per returning adult in the 1980s (Winton & Hilborn, 1994). Given the similarity of the decline in survival, the economics of hatchery Chinook production are likely similar in other regions. Understanding the real drivers of poor survival might substantially improve the economics of hatchery production. The few regional hatchery programs with anomalously high SARs should be investigated to determine when in the post-release life history period survival is high as a first step to understanding why it is low elsewhere.

It is also important to more carefully consider the role of harvest. Harvest levels for some yearling populations are a considerable fraction of adult returns to the river, while for subyearling populations they are substantially larger than adult escapement. A key part of the renegotiation of the terms of the bilateral US-Canada Pacific Salmon Treaty in 1999 was securing coastwide agreement that managers would modify harvest in response to abundance. Unfortunately, what appears to have gone unrecognized was the effect on the many Columbia River studies based on PIT tags. It is unclear whether the quality of reported harvest rate estimates are good enough for PIT-based SAR estimates to be reliably converted into useful survival estimates. This is an important point because the basic ecological models used to inform the Environmental Impact Statements (EIS) for many ESA-listed Columbia River salmon stocks are calibrated using PIT tag-based SAR estimates (McCann et al., 2018; Zabel et al., 2008). The use of modern parentage-based genetic stock ID methods (Beacham et al., 2020; Freshwater et al., 2016; Hess, Matala, & Narum, 2011; Matala, Hess, & Narum, 2011; Satterthwaite et al., 2014) may allow apportioning harvest from the various fisheries to source populations with sufficient precision to be useful for survival analysis in the Columbia in future. However, whether these methods can provide sufficient resolution for past harvest rate estimates is unclear.

Acknowledgements

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Data Availability

All data used in the analysis are available without limitation from the Dryad open-access repository (doi:10.5061/dryad.w6m905qmm).

Figures

Fig. 1. Map of Chinook salmon survival time series used in the analyses. Numbers inside symbols are keyed to the populations in Table S1. SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; WAC=Washington Coastal; ORC=Oregon Coastal; SOG=Strait of Georgia; PS=Puget Sound; CA=California.

Fig. 2. Time series of smolt-to-adult return (SAR) estimates for Chinook salmon plotted by source. Annual SAR estimates for Hatchery (H), Wild (W), and mixed hatchery-wild data sources (B) are shown, but regional loess curves of survival and associated 95% confidence interval use hatchery data only, colour coded by data source. In order to focus on the trends, a few SAR estimates have been clipped by restricting the y-axis maximum to near the loess curve maxima. Blank panels indicate regions where the life history type does not occur. The SAR 2-6% recovery target adopted for Snake River Spring Chinook is shown as a grey band. The timing of the major regime shifts starting in 1977, 1989, and 1998 are indicated by vertical dotted lines. The horizontal dotted line indicates 1% SAR. Note logarithmic y-axis. Sources correspond to Table S1 as follows: PSC CWT= PSC 2019; CSS PIT=McCann et al. 2018; Agency CWT=all other sources exclusive of Raymond 1998 and Michel 2019. CWT=coded wire tag; CSS=Comparative Survival Study, PIT= Passive-Integrated-Transponder; SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.

Fig. 3. Box plots of Chinook survival (SAR) based on coded wire tags, disaggregated by population and region; all years combined. Central lines show medians, boxes show the inter-quartile range (central 50% of data points), whiskers bracket 1.5 times the interquartile range, and open circles identify outliers. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates for each population is shown to the right. See Table S1 for definitions of population acronyms and Fig. 2 for region acronyms. H=hatchery; W=wild; HW=mixture. *Indicates data sets ending prior to 1998 (all data from Raymond (1998) and three Puget Sound data series from PSC (2019)).

Fig. 4. Regional CWT-based SAR estimates for Chinook salmon normalized relative to Snake River SARs for the 2010-2014 period. Estimates above the horizontal black dotted line indicate higher survival than Snake River populations. Horizontal red lines show the empirical 5% and 95% percentiles on the sampling distribution of the normalized ratio. See Fig. S1 for SAR estimates normalized to all other regions. H=hatchery; W=wild.

Fig. 5. Box plots of Chinook PIT tag-based SAR estimates in the Columbia River basin, disaggregated by population and region; all years combined. These SAR estimates exclude harvest and smolt and adult losses above the top-most dam. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates is shown on the right. H=hatchery; W=wild; HW=mixture. All data from (McCann et al., 2018).

Fig. 6. Comparison of smolt-to-adult survival (SAR) estimates made using coded wire tags (CWT) and passive integrated transponder (PIT) tags for Chinook salmon populations where both tagging methodologies were employed in the same year. Linear regressions were fit with the intercept constrained to zero.

Fig. 7. Annual Columbia River Chinook harvest rate estimates, fitted loess trend lines, and associated 95% confidence intervals. The right-hand axis shows reported aggregate harvest before Chinook reach McNary Dam. The left-hand axis shows the corresponding value that PIT tag-based SAR estimates should be multiplied by to correct for exclusion of harvest; note log scale. Tributary harvests (i.e., above McNary Dam) are excluded. Substantial variation over time and between populations is evident after 1998 (vertical dashed line), when PIT tag-based survival estimation began. Data sources that present harvest estimates by brood year were converted to return year using the dominant year of return. See Table S2 for population names and references.

Fig. 8. Increase in the number of annual SAR estimates used in this paper. The drop in monitoring evident in the most recent years probably reflects lags in data processing rather than a decrease in effort. See Table S1 for specific populations included.

Supplementary Information

Figure S1. Normalized regional SAR estimates for Chinook salmon based on coded wire tags (CWT) in the 2010-2014 period. Each panel uses a different geographic region as the basis for comparing normalized SARs; the figure in the main text (Fig. 4) uses the Snake River as the basis for comparison. The central points on the plot indicate the median of the normalized ratios, and the whiskers extend to the empirical 5% and 95% percentiles on the sampling distribution. Estimates above the horizontal black dotted line indicate higher survival than the region to which the data are normalized (i.e., the region in each panel's title). Most data summaries are for hatchery-origin stocks; wild stocks are indicated by a star (*). SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.

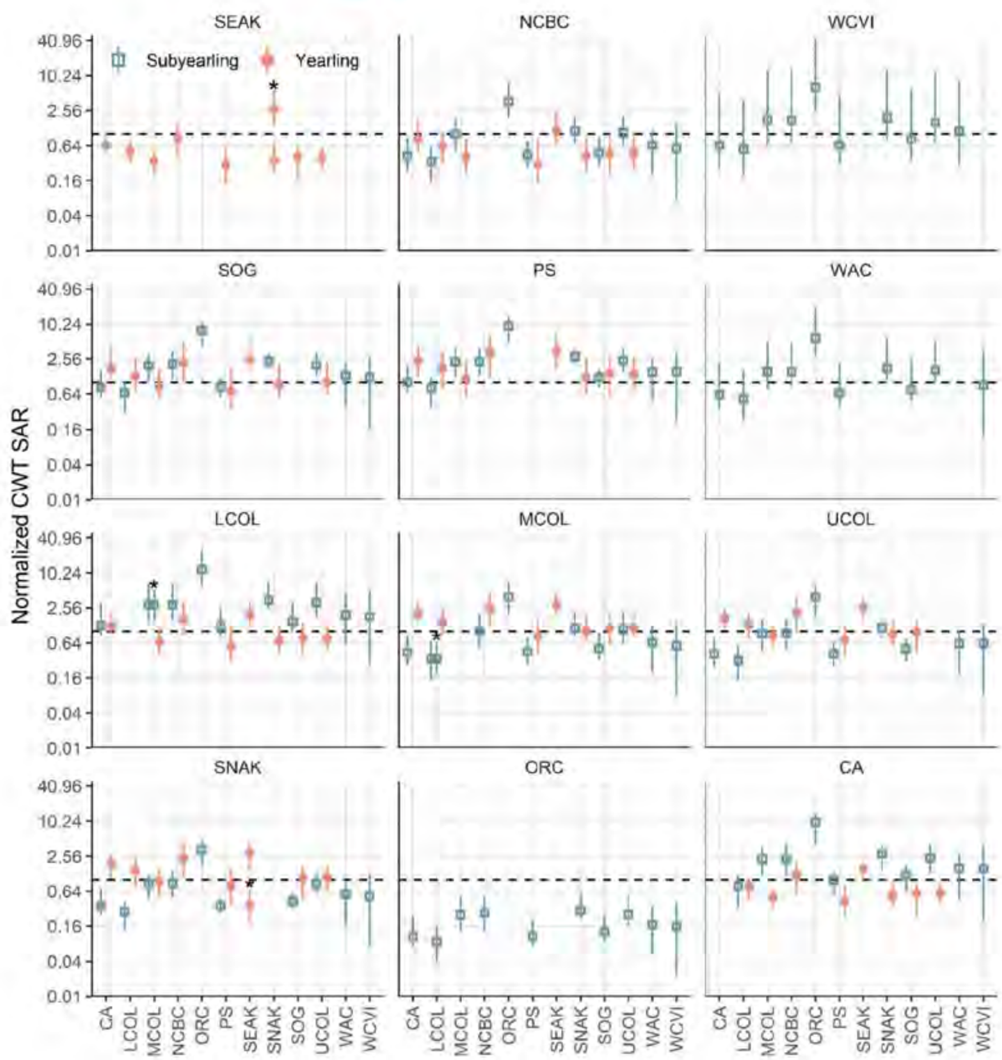

Table S1. Datasets of smolt-to-adult return (SAR) estimates for Chinook salmon (*Oncorhynchus tshawytscha*) used in this study. The Map field corresponds to the numbering displayed in Figure 1. Race refers to adult run-timing. Rear is either hatchery (H) or wild (W). Age indicates the year of smolt outmigration as either yearlings (1) or subyearlings (0). Jacks indicates whether precocious male returns are included in survival estimates. Reach is specific to passive integrated transponder SAR estimates in the Columbia River; it refers to the migration segment over which SARs were estimated. N is the sample size (years of data). From and To describe the first and last years of outmigration. AK=Alaska, NCBC=North Central British Columbia, WCVI=West Coast Vancouver Island, SOG=Strait of Georgia, PS=Puget Sound, WAC=Washington State Coast, LCOL=Lower Columbia River (below Bonneville Dam), MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River, ORC=Oregon Coast, CA=California, Rel=Release, BON=Bonneville Dam, MCN=McNary Dam, JDA=John Day Dam, RRE=Rocky Reach Dam, PRD=Priest Rapids Dam, LGR=Lower Granite Dam, LGS=Little Goose Dam, IHR=Ice Harbor Dam, LMN=Lower Monumental Dam.

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
AK	Alaska	Alaska	5	Spr	H	1	Y		37	1978	2014	PSC 2019
	Chilkat	Chilkat	1	Spr	W	1	Y		14	2001	2014	PSC 2019
	Stikine	Stikine	3	Spr	W	1	Y		16	2000	2015	PSC 2019
	Taku	Taku	2	Spr	W	1	Y		30	1977	2015	PSC 2019
	Unuk	Unuk	4	Spr	W	1	Y		26	1984	2014	PSC 2019
NCBC	Atnarko	Atnarko	8	Sum	H	0	Y		26	1987	2014	PSC 2019
	Kitsumkalum	Kitsumk	6	Sum	H	1	Y		14	2001	2015	PSC 2019
WCVI	Robertson	Roberts	16	Fall	H	0	Y		42	1974	2015	PSC 2019
SOG	Big Qualicum	Big Qua	15	Fall	H	0	Y		42	1974	2015	PSC 2019
	Chilliwack	Chilliw	18	Fall	H	0	Y		34	1982	2015	PSC 2019
	Cowichan	Cowicha	21	Fall	H	0	Y		28	1986	2015	PSC 2019
	Dome	Dome	7	Spr	H	1	Y		16	1988	2004	PSC 2019
	Elwha	Elwha	28	Sum/Fall	H	0	Y		13	1983	2013	PSC 2019
	Harrison	Harriso	17	Fall	H	0	Y		33	1982	2015	PSC 2019
	Hoko	Hoko	27	Fall	H	0	Y		26	1986	2012	PSC 2019
	Lower Shuswap	LowShus	10	Sum	H	0	Y		31	1985	2015	PSC 2019
	Middle Shuswap	MidShus	11	Sum	H	0	Y		7	2009	2015	PSC 2019
	Nanaimo	Nanaimo	19	Fall	H	0	Y		19	1980	2005	PSC 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Nicola	Nicola	12	Spr	H	1	Y		29	1987	2015	PSC 2019
	Phillips	Phillip	9	Fall	H	0	Y		6	2010	2015	PSC 2019
	Puntledge	Puntled	14	Sum	H	0	Y		39	1976	2015	PSC 2019
	Quinsam	Quinsam	13	Fall	H	0	Y		40	1975	2014	PSC 2019
PS	George Adams	George	38	Sum/Fall	H	0	Y		35	1973	2013	PSC 2019
	Nisqually	Nisqual	42	Sum/Fall	H	0	Y		34	1980	2013	PSC 2019
	Nooksack	Nooksac	20	Spr	H	0	Y		23	1990	2014	PSC 2019
	Nooksack	Nooksac	20	Spr	H	1	Y		13	1983	1998	PSC 2019
	Samish	Samish	22	Sum/Fall	H	0	Y		31	1975	2013	PSC 2019
	Skagit	Skagit	23	Spr	H	0	Y		21	1987	2014	PSC 2019
	Skagit	SkagSpr	23	Spr	H	1	Y		26	1983	2012	PSC 2019
	Skagit	SkagSm	23	Sum	H	0	Y		19	1995	2013	PSC 2019
	Skykomish	Skykomi	30	Sum/Fall	H	0	Y		13	2001	2013	PSC 2019
	South Puget Sound	SthPug	43	Sum/Fall	H	0	Y		40	1972	2013	PSC 2019
	Squaxin Pens	Squaxin	39	Fall	H	1	Y		10	1987	1998	PSC 2019
	Stillaguamish	Stillag	26	Sum/Fall	H	0	Y		28	1981	2013	PSC 2019
	University of Washington	UWAccel	33	Fall	H	0	Y		10	1976	1985	PSC 2019
	White	White	41	Spr	H	1	Y		13	1976	2014	PSC 2019
WAC	Queets	Queets	35	Fall	H	0	Y		34	1978	2012	PSC 2019
	Sooes	Sooes	25	Fall	H	0	Y		26	1986	2012	PSC 2019
LCOL	Columbia Lower	LowCol	54	Fall	H	0	Y		37	1977	2013	PSC 2019
	Cowlitz	Cowlitz	55	Fall	H	0	Y		36	1978	2013	PSC 2019
	Lewis	Lewis	63	Fall	W	0	Y		33	1978	2013	PSC 2019
	Willamette	Willame	84	Spr	H	1	Y		37	1977	2013	PSC 2019
MCOL	Carson	Carson	62	Spr	H	1	Y		29	1985	2015	Silver et al. 2019
	Carson	Carson	62	Spr	H	1	N	Rel to BON	14	2000	2013	McCann et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Carson	Carson	62	Spr	H	1	Y	Rel to BON	2	2014	2015	McCann et al. 2018
	Cle Elum	CleElum	40	Spr	H	1	Y	MCN to MCN	14	2002	2015	McCann et al. 2018
	Deschutes	Deschut	72	Fall	W	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	N	Rel to BON	9	2000	2010	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Hanford	Hanford	47	Fall	W	0	Y		27	1987	2013	PSC 2019
	John Day	JohnDay	71	Spr	W	1	Y	JDA to BON	16	2000	2015	McCann et al. 2018
	Little White Salmon	LtlWhSa	67	Spr	H	1	Y		29	1984	2015	Silver et al. 2019
	Little White Salmon	LtlWhSa	67	Fall	H	0	N	Rel to BON	3	2008	2010	McCann et al. 2018
	Little White Salmon	LtlWhSa	67	Fall	H	0	Y	Rel to BON	3	2011	2013	McCann et al. 2018
	Spring Creek	SprgCrk	66	Fall	H	0	Y		41	1973	2013	PSC 2019
	Spring Creek (April Release)	SprgApr	66	Fall	H	0	N	Rel to BON	5	2008	2012	McCann et al. 2018
	Spring Creek (April Release)	SprgApr	66	Fall	H	0	Y	Rel to BON	1	2013	2013	McCann et al. 2018
	Spring Creek (May Release)	SprgMay	66	Fall	H	0	N	Rel to BON	5	2008	2012	McCann et al. 2018
	Spring Creek (May Release)	SprgMay	66	Fall	H	0	Y	Rel to BON	1	2013	2013	McCann et al. 2018
	Umatilla	Umatill	60	Fall	H	0	Y		24	1992	2015	Cameron et al. 2018
	Umatilla	Umatill	60	Spr	H	1	Y		29	1988	2016	Cameron et al. 2018
	Upriver Bright	UpCol	45	Fall	H	0	Y		38	1976	2013	PSC 2019
	Warm Springs	Warm	79	Spr	H	1	Y		28	1980	2014	Silver et al. 2019

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Warm Springs	Warm	79	Spr	H	1	N	Rel to BON	7	2007	2013	McCann et al. 2018
	Warm Springs	Warm	79	Spr	H	1	Y	Rel to BON	2	2014	2015	McCann et al. 2018
	Yakima	Yakima	53	Spr	W	1	Y	MCN to MCN	12	2002	2015	McCann et al. 2018
UCOL	Columbia	ColSm	29	Sum	H	0	Y		33	1976	2013	PSC 2019
	Entiat	Entiat	32	Spr	H	1	Y		20	1977	2007	Fraser 2019
	Entiat	Entiat	32	Sum	H	0	Y	RRE to BON	5	2011	2015	McCann et al. 2018
	Entiat and Methow	Entiat	31	Spr	W	1	Y	RRE to BON	8	2008	2015	McCann et al. 2018
	Leavenworth	Leavenw	34	Spr	H	1	Y		33	1982	2014	Muir et al. 2019
	Leavenworth	Leavenw	34	Spr	H	1	Y	MCN to BON	16	2000	2015	McCann et al. 2018
	Mid-Columbia	ColSprH	29	Spr	H	1	Y	First to PRD	13	1972	1984	Raymond 1988
	Mid-Columbia	ColSmHW	29	Sum	HW	0	Y	First to PRD	16	1968	1983	Raymond 1988
	Mid-Columbia	ColSprW	29	Spr	W	1	Y	First to PRD	23	1962	1984	Raymond 1988
	Mid-Columbia	ColSmW	29	Sum	W	0	Y	First to PRD	7	1962	1968	Raymond 1988
	Tagged at Rock Island Dam	RockISpr	37	Spr	HW	1	Y	Rel to BON	15	2000	2015	McCann et al. 2018
	Tagged at Rock Island Dam	RockISm	37	Sum	HW	0	Y	Rel to BON	16	2000	2015	McCann et al. 2018
	Upper Columbia above Wells Dam	UpCol	29	Sum	W	0	Y	RRE to BON	4	2011	2014	McCann et al. 2018
	Wenatchee	Wenatch	36	Spr	W	1	Y	MCN to BON	9	2007	2015	McCann et al. 2018
	Winthrop	Winthro	24	Spr	H	1	Y		13	2002	2014	Humling et al. 2018
	Winthrop	Winthro	24	Spr	H	1	Y	RRE to BON	7	2009	2015	McCann et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
SNAK	Catherine	Catheri	74	Spr	H	1	Y		11	2003	2013	Feldhaus et al. 2018
	Catherine	Catheri	74	Spr	H	1	Y	LGR to LGR	15	2001	2015	McCann et al. 2018
	Clearwater	ClearSpr	48	Spr	H	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Clearwater	ClearSm	48	Sum	H	1	Y	LGR to LGR	5	2011	2015	McCann et al. 2018
	Clearwater	Clear	50	Spr	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Dworshak	Dworsha	48	Spr	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Dworshak at Snake	Dworsha	48	Fall	H	0	Y	LGR to LGR	5	2006	2011	McCann et al. 2018
	Grande Ronde	Grande	65	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Grande Ronde	Grande	65	Spr	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Imnaha	Imnaha	64	Spr	H	1	Y		29	1984	2013	Feldhaus et al. 2018
	Imnaha	Imnaha	64	Sum	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Imnaha	ImnahaW	64	Sum	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Kooskia	Kooskia	57	Spr	H	1	Y	LGR to LGR	2	2014	2015	McCann et al. 2018
	Lookingglass	Looking	65	Spr	H	1	Y		5	2006	2013	Feldhaus et al. 2018
	Lostine	Lostine	69	Spr	H	1	Y		13	1999	2013	Feldhaus et al. 2018
	Lyons Ferry at Big Canyon	BigCany	49	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Big Canyon	BigCany	49	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Lyons Ferry at Captain John	CaptJoh	56	Fall	H	0	Y	LGR to LGR	5	2008	2012	McCann et al. 2018
	Lyons Ferry at Captain John	CaptJoh	56	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Pittsburg Landing	Pittsbu	68	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Lyons Ferry at Pittsburg Landing	Pittsbu	68	Fall	H	0	Y		8	2006	2013	Arnsberg et al. 2017, 2018; Arnsberg & Kellar 2017
	Lyons Ferry at Snake	LyonsFe	46	Fall	H	0	Y		20	1985	2013	PSC 2019
	Lyons Ferry at Snake	LyonsFe	46	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	McCall	McCall	78	Sum	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Middle Fork Salmon	MidSalm	82	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Nez Perce at Cedar Flats	CedFlat	58	Fall	H	0	Y	LGR to LGR	3	2010	2012	McCann et al. 2018
	Nez Perce at Lukes Gulch	LukeGul	59	Fall	H	0	Y	LGR to LGR	3	2010	2012	McCann et al. 2018
	Oxbow below Hells Canyon Dam	Oxbow	77	Fall	H	0	Y	LGR to LGR	4	2008	2012	McCann et al. 2018
	Pahsimeroi	Pahsime	80	Sum	H	1	Y	LGR to LGR	8	2008	2015	McCann et al. 2018
	Rapid	Rapid	70	Spr	H	1	Y	LGR to LGR	19	1997	2015	McCann et al. 2018
	Sawtooth	Sawtoot	83	Spr	H	1	Y	LGR to LGR	9	2007	2015	McCann et al. 2018
	Snake	Snake	44	SpSu	W	1	Y	LGR to LGR	22	1994	2015	McCann et al. 2018
	Snake	Snake	44	Spr	H	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	Snake	44	Spr	H	1	Y	IHR to IHR	3	1966	1968	Raymond 1988

Region	Stock	Nickname	Map	Race	Rear	Age	Jacks	Reach	N	From	To	Source
	Snake	Snake	44	Spr	H	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	Snake	44	Spr	H	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	Snake	Snake	44	Fall	W	0	Y	LGR to LGR	4	2006	2011	McCann et al. 2018
	Snake	SnakSpr	44	Spr	W	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	IHR to IHR	5	1964	1968	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	SnakSpr	44	Spr	W	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LGS to IHR	5	1970	1974	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	IHR to IHR	5	1964	1968	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LGR to IHR	10	1975	1984	Raymond 1988
	Snake	SnakSm	44	Sum	W	1	Y	LMN to IHR	1	1969	1969	Raymond 1988
	South Fork Salmon	SthSalm	81	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
	Tucannon	TucanH	52	Spr	H	1	Y		28	1987	2014	Gallinat & Ross 2018
	Tucannon	TucanW	52	Spr	W	1	Y		28	1987	2014	Gallinat & Ross 2018
	Umatilla Irrigon below Hells Canyon Dam	Umatill	61	Fall	H	0	Y	LGR to LGR	6	2006	2012	McCann et al. 2018
	Upper Grande Ronde	UpGrand	75	Spr	H	1	Y		11	2003	2013	Feldhaus et al. 2018
	Upper Salmon	UpSalm	73	SpSu	W	1	Y	LGR to LGR	10	2006	2015	McCann et al. 2018
ORC	Elk	Elk	85	Fall	H	0	Y		34	1980	2013	PSC 2019
	Salmon	Salmon	76	Fall	H	0	Y		36	1977	2013	PSC 2019
CA	Colman	ColFa	87	Fall	H	0	Y		14	1999	2012	Michel 2019
	Colman	ColLtFa	87	Fall	H	1	Y		20	1993	2012	Michel 2019
	Livingston Stone	Livings	86	Win	H	0	Y		14	1999	2012	Michel 2019

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Notes on Data PSC 2019

Atnarko River Summer Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as ATN and ATY by the PSC respectively. We retained ATN but excluded ATY because Atnarko is primarily a subyearling stock and the yearling releases are a hatchery management practise (Velez-Espino et al. 2011).

Kitsumkalum River Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as KLM and KLY by the PSC respectively. We excluded KLM but retained KLY because Kitsumkalum is primarily a yearling stock. The subyearlings are released by the hatchery as fry and remain in the river an extra year until they migrate to sea at the same time as their sibling KLM fish (David Willis personal communication May 2018. Section Head, Coastal Operations, Fisheries and Oceans Canada. David.Willis@dfo-mpo.gc.ca).

Lyons Ferry Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as LYF and LYY by the PSC respectively. We retained LYF but excluded LYY because Lyons Ferry is primarily a subyearling stock and the yearling releases are a hatchery management practise (Tommy Garrison personal communication Jan 2018. Biometrician. Fisheries Management Department. Columbia River Inter-Tribal Fish Commission. gart@critfc.org).

Nooksack Spring Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as NKF and NKS by the PSC respectively. We retained both because the Nooksack stock is naturally a mix of both life-history strategies (Larrie LaVoy personal communication Jan 2018).

Skagit Spring Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as SSF and SKS by the PSC respectively. We retained both because the Skagit stock is naturally a mix of both life-history strategies (Larrie LaVoy personal communication Jan 2018. National Marine Fisheries Service, National Oceanic and Atmospheric Administration. Larrie.Lavoy@noaa.gov).

South Puget Sound Fall Chinook- SAR estimates were available for subyearling and yearling stocks which are abbreviated as SPS and SPY by the PSC respectively. We retained SPS but excluded SPY because South Puget is primarily a subyearling stock and the yearling releases are a hatchery management practise (Larrie LaVoy personal communication Jan 2018).

Yearling/subyearling designations were taken from PSC (2015; Table 2.1) with the following exceptions: 1) Squaxin Pens Fall Chinook and University of Washington Accelerated Chinook were designated using PSC (2005; Table 2.1); and 2) we assumed Stikine Spring Chinook outmigrate as yearlings, and Phillips Fall Chinook outmigrate as subyearlings based on the typical behaviour for their adult run timing (neither stock was listed in PSC (2015)).

We excluded SAR estimates for ocean entry years with incomplete adult returns.

Notes on Data McCann et al. 2018

For most stocks, SAR estimates are provided with and without jack returns, and with differing start and end points to fish enumeration. When available, we used the estimates that included jacks and that covered the largest portion of the migration. For some MCOL populations, the estimates that included jack returns were available only for the shorter migration segment. In these cases, we used the estimates for the longer migration segment excluding jacks. Includes Spring Creek Hatchery Fall Chinook (5 of 5 years), Little White Salmon Hatchery Fall Chinook (3 of 5 years), Carson Hatchery Spring Chinook (14 of 15 years), Warm Springs Hatchery Spring Chinook (7 of 8 years), and Hanford Reach Wild Fall Chinook (9 of 11 years).

We excluded SAR estimates for ocean entry years with incomplete adult returns.

SAR estimates are referenced to McCann et al. (2017), Appendix B, but were actually downloaded from the Fish Passage Center: http://www.fpc.org/survival/smolttoadult_queries.php.

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Notes on Data Fishery Agencies

Entiat Spring Chinook- SAR estimates were calculated using data downloaded from the Regional Mark Processing Center's RMIS database. Estimates are referenced to Fraser 2019 as a personal communication to support that the estimates are the best available (i.e. no known shortfalls in the RMIS database for the years presented). The estimates were calculated as the proportion of recoveries expanded for sampling effort of all coded wire tagged smolts released from the hatchery in each year.

Lyons Ferry at Big Canyon, Captain John, and Pittsburg Landing acclimation sites- Nez Perce hatchery releases groups of coded wire-tagged smolts with and without adipose fin clips. They report that the tag returns for unclipped fish are biased low relative to those for clipped fish; we used the SAR estimates only for clipped fish.

Tucannon Wild Spring Chinook- SARS are not compensated for harvest; however, we included the wild stock because harvest for the hatchery stock is reported as minor (average of <6% of the adult hatchery fish recovered for 1985-1996 brood years; Gallinat & Ross 2018).

We used the SARS from the Conventional Hatchery Program rather than from the Captive Broodstock Program for stocks referenced to Felhaus et al. 2018.

Notes on Data Raymond 1988

Raymond 1988 provides SAR estimates for Chinook returning to the Snake River and to the Columbia River above Priest Rapids Dam. The author assigns the Columbia River estimates to the "Mid Columbia" region; however, we have classed them as "Upper Columbia" following the definition used in McCann et al. 2018 where the Upper Columbia is defined as the area between Priest Rapids Dam and Chief Joseph Dam.

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Table S2. Datasets used in this study providing harvest rate estimates for Columbia River basin Chinook salmon (*Oncorhynchus tshawytscha*). The Nickname and Map fields are populated for those stocks that also have smolt-to-adult return (SAR) estimates. The Map field corresponds to the numbering used in Figure 1. Stocks with harvest estimates from JCRMS 2019 are not displayed in Figure 1; these are defined as follows: Upper Columbia= summer Chinook destined for production areas and hatcheries upstream of Priest Rapids Dam; Upriver Spring=all spring Chinook passing Bonneville Dam from March through May including the Snake River summer Chinook (since 2005); Upriver Wild=as for Upriver Spring but for wild stocks. Race refers to adult run-timing. Rear is either hatchery (H) or wild (W). N is the sample size (years of data). From and To describe the first and last years of return. MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River.

Region	Stock	Nickname	Map	Race	Rear	N	From	To	Source
MCOL	Hanford	Hanford	47	Fall	W	26	1990	2015	PSC 2019
	Spring Creek	SprgCrk	66	Fall	H	40	1976	2015	PSC 2019
	Upriver Bright	UpCol	45	Fall	H	37	1979	2015	PSC 2019
	Yakima	Yakima	53	Spr	W	32	1983	2014	Sampson et al. 2016 Table 21
UCOL	Columbia Summers	ColSm	29	Sum	H	37	1979	2015	PSC 2019
	Leavenworth	Leavenw	34	Spr	H	10	2007	2016	Muir et al. 2019 Table 18
	Upper Columbia			Sum	HW	39	1980	2018	JCRMS 2019 Table 8
	Upriver Spring			Spr	HW	31	1982	2018	JCRMS 2019 Table 5
	Upriver Wild			Spr/Sum	W	39	1980	2018	JCRMS 2019 Tables 6 & 7
	Winthrop	Winthro	24	Spr	H	14	2003	2016	Humling et al. 2018 Table 25
SNAK	Lyons Ferry at Snake	LyonsFe	46	Fall	H	28	1988	2015	PSC 2019

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Region	Stock	Nickname	Map	Race	Rear	N	From	To	Source

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From: Paul Hart <onbehalfof@manuscriptcentral.com>
Sent: Monday, May 11, 2020 6:43 AM
To: David Welch <David.Welch@Kintama.com>
Subject: Fish and Fisheries - Decision on Manuscript ID FaF-20-Mar-OA-084 [email ref: DL-SW-4-a]

11-May-2020

Dear Dr. Welch

I write to you regarding manuscript # FaF-20-Mar-OA-084 entitled "Review of the Coast-wide Decline in Survival of West Coast Chinook Salmon (Oncorhynchus tshawytscha)" which you submitted to Fish and Fisheries.

In view of the comments of the reviewers (copied at the bottom of this letter), I have decided to reject this version of your manuscript for publication in Fish and Fisheries. However, if you are able to make major revisions that address the comments effectively, I will send a re-submission out for re-refereeing. If you do decide to resubmit a revised manuscript, please include a letter setting out how you have tackled each of the points raised.

Thank you for considering Fish and Fisheries for the publication of your research.

Sincerely

Paul Hart

Editor, Fish and Fisheries (2016 IF 9.0, 2017 IF 7.0, 2018 IF 6.7) pbh@le.ac.uk

Editor Comments to Author:

The three reviewers give a mixed assessment of your paper with one having only minor suggestions for change but the other two recommending major revision and resubmission. I have gone for the latter because it would be good to have expert opinion as to how you have coped with the reviewer comments. As a resubmission I will send your new version out to be reviewed again.

Although it has not caused me any trouble I would like to point out that both the websites you mention in your Cover Letter that include names of people you didn't want as reviewers, were closed to me. I was denied access to both sites.
Response: I must apologize for the trouble. It seems that these websites have been revamped and are now locked down—I no longer had access either.

If you choose to send the revised manuscript out for review once again, we can provide the list of people we would like to avoid as reviewers, but so long as the reviewers you select are from outside the Columbia River basin region we have no concerns. We are also happy with any of the reviewers we suggested from the original submission that were members of the ISAB/ISRP Columbia River review groups as they are charged with scientific oversight in the Columbia River basin but do not conduct primary research there, so we feel they can provide appropriate perspective and balance on some of our findings.

Reviewers' Comments to Author:

Reviewer: 1

Comments to the Author
This paper combines coastwide data on chinook ocean survival to present a comprehensive story of the historical changes that have been seen, and the result that will surprise many, that survival of Snake River fish is better or equivalent to most west coast chinook stocks.

The paper is clearly written and illustrations are well done and appropriate.

The authors have avoided discussing any causes of the decline in ocean survival which is probably a good idea as it is a totally different paper, but I think it would be worth mentioning the range of explanations that have been put forward.
Response: We added one paragraph in the Discussion, summarizing the potential causes of poor marine survival and listing the authors that identified these factors over the past decade. However, we do not want to get drawn into a debate about why survival is dropping in the ocean, because no one really knows—there is much speculation and some correlation-based analyses, but nothing definitive.

At this point we want to keep the primary focus on the fact that survival (SARs) has fallen everywhere and that this has not been recognized by the fisheries management and research communities, despite the fact that they have been generating more and more of these data sets over the past half-century. This is new information and we feel the community should focus on these results.

My only detailed comment is that lines 100-102 should mention the good performance of Alaskan sockeye fisheries, which are the most valuable salmon fisheries on the west coast
Response: We emphasized the major decline in *southern* populations of commercially important salmon species in our original manuscript because we want to focus on the broader issues and not get drawn into some of the exceptions. As we mention in the Introduction, the lower-valued species of Pacific salmon are doing well. (And, apart from crediting "climate change/global warming" right now I don't think anyone has any actual idea why Bristol Bay sockeye in the Bering Sea are doing so well).

Reviewer: 2

Comments to the Author
Review of Faf-20-Mar-OA-084

Welch et al. examine broad scale patterns in Chinook salmon survival (smolt-to-adult return rates: SARs) by collating data from multiple sources and regions along the Pacific coast of North America. The analysis synthesizes data from most regions where Chinook are monitored (excluding populations further west of SE Alaska), parses data into relevant life history strategies (sub-yearling vs. yearling) and hatchery vs. wild stocks (data more rare for these), and is transparent with sources of data.

With some exceptions, authors found similar and relatively poor SARs based on CWTs for hatchery stocks (both sub-yearling and yearlings) across regions, including those with relatively pristine freshwater conditions. For regions where the time-series of SARs combined across populations were long enough (extended back to 1970's), there was evidence for a synchronous 3-4 fold decline in SAR to approximately the same contemporary level (~1%).

Next, median regional SARs from 2010-2014 were referenced to the Snake River within the Columbia River basin since survival there is generally considered poor (although data suggest currently on the rise?) and SAR recovery targets are in place (2-6%). In general, standardized SARs were not statistically distinguishable from the Snake River (typical case for yearlings) or were lower than the Snake River (typical case for subyearlings).

Patterns in PIT-based estimates of SAR within the Columbia River basin generally aligned with CWT-based estimates, but were not directly transferable, and relationships between the two were population-specific and different between yearlings and subyearlings indicating that a general conversion was not possible. Authors point out that unlike CWT-based estimates, PIT-based estimates may not adequately account for harvest or other components of migration sequence which likely contribute to the lack of transferability.

Primary conclusions included (1) given similarity in regional SARs and seemingly congruent decline in SARs to similar contemporary levels, the notion that survival could be driven more by broader oceanic factors rather than local freshwater factors cannot be dismissed (I feel like relaxing language to something along these lines would help reduce knee jerk reactions and help stimulate conversation and advancement of knowledge)—in other words, actions (presumably small scale??) that try to alleviate ecological bottlenecks during freshwater life may not compensate for ocean conditions as they are generally perceived (or hoped) to do (Snake River dams are highlighted as key example), (2) more careful consideration of the role of harvest and migratory life-history in influencing SAR estimates (particularly PIT-based estimates) is needed to reduce potential bias and increase clarity in patterns of survival for conservation efforts, and (3) more rigorous technical standards are needed for measuring SARs.

Overall, I thought the paper was well written and that the authors effectively distill a large amount of information and present the key elements and patterns. I also do not find myself disagreeing with their conclusions. Given the scale of this assessment, perceptions that it challenges, and new actions that it calls for with the data to support, I feel it is suitable for Fish and Fisheries. However, I do have some suggestions that may help improve the manuscript and that authors and editors should consider:

First, the Abstract seems a little vague to me and primary conclusion (1) above is never explicitly stated and probably should.
Response: We extensively revised the abstract to better clarify the summary points that Reviewer #2 have outlined, and in fact incorporated Reviewer #2's phrasing: "*given similarity in regional SARs and seemingly congruent decline in SARs to similar contemporary levels, the notion that survival could be driven more by broader oceanic factors rather than local freshwater factors cannot be dismissed*" (slightly modified to limit the word count).

Next, I feel like authors could provide a bit better road map for readers by expanding the Introduction and better linking to the Discussion. Essentially including an additional paragraph at the end of the Introduction that makes it clear what is coming down the pipe. As written, all the reader knows is that authors are examining broad scale patterns in SAR, but don't really know what that entails and how it

helps us evaluate the importance of ocean conditions vs. freshwater conditions (main conclusion is related to this)—something we don't know much about but is current focus of Introduction.
Response: This is an excellent point. We added a paragraph to the end of the Introduction to outline the methods, explain how our analyses provide evidence of the relative importance of oceanic versus freshwater conditions, and to clarify the segue from the SARs compilation to the evaluation of the importance of harvest .

Another example is that the transition to PIT-based estimates of survival in the Columbia are never mentioned in the Introduction, but end up seemingly dominating the Results and Discussion. There needs to be a stronger link between what was explicitly examined in the analysis and how different Results regarding SAR methods/patterns would lead to one profound conclusion vs. another to better prime readers for why this assessment is needed and what it all means. If the Introduction could be modified to be a bit more hypothesis driven, maybe that would help?
Response: We have added this material into the Introduction, in order to frame the issues better.

Similarly, the Discussion reads much like repeated Results and most every Figure was cited again. I'm wondering if authors could rework some material that is currently in the Discussion and incorporate into the Results section. I happen to like Results sections that include more context/consistently remind readers as to the how and why, and feel that would be appropriate for a paper like this. The Discussion could then dive a bit deeper into the different profound conclusions. For example, what might be the "broader factors" driving survival? Do we need to ramp up monitoring of wild stocks? Maybe the real answers could be found in those stocks?
Response: We felt the need in the Discussion to reference back to the specific figures as we develop our observations and conclusions—there is a great deal of data boiled down into these figures and we feared losing the readers if they were unsure which data sets/analyses we were gauging our specific statements on.

We added a paragraph providing a literature review of the past decade of Chinook salmon studies (2010 to present) examining aspects of the survival conundrum, categorizing the papers by the mechanisms they propose. However, we don't want to go any further—all of these papers are either conjectural or, at best, correlational. Bluntly put, we don't want to stray into that particular morass when we don't have real data to allow us to discriminate what is going on...we feel it is important to keep the focus on the key points we have identified, not speculate on what is causing poor marine survival when we have no data to contribute.

(And as for the reviewer's point that maybe the "real answers" could be found by ramping up monitoring of wild stocks, this senior author is deeply cynical... he has watched the community start more and more monitoring programs without ever really looking at their data and asking why the survival estimates were so similar everywhere? It should not have taken my group, divorced from the monitoring programs, to point this out.... But it did. Starting more wild salmon monitoring programs will simply be a displacement activity that absolves major governmental organizations from responsibility for going out to sea and finding out what is really causing poor survival. But that is for a different paper).

The other major comment I have pertains to the selection of data. Authors mention excluding a large amount of data in this analysis in their conclusions. Given the call for a broad evaluation of SAR methods and development of more standardized methods for estimation, I feel presenting the rejected data is just as important as presenting the accepted data. The criteria for each is not very clear to me. Do the

rejected data tell a different story, meaning that more digging and Discussion with folks on the ground is needed? Do the accepted data represent and true random sample? Or is there some systematic bias involved? Maybe including rejected data on the map and in supplemental material would help improve transparency and allow us to gauge how representative selected data are?
Response: Including rejected data on the map is simply infeasible. We found in our efforts to find CWT-based SAR data for the Columbia River basin specifically that there are a number of regional databases, but in a number of cases the "SARs" that were calculated in those databases only included some components of adult returns (for example, only hatchery rack returns (the adults used to start the next generation of fish in the hatchery). In a number of cases we variously found that reported SARs did not include hatchery-origin adults spawning on the spawning grounds, counts were not expanded for sampling portions, data were coded as experimental or above dam numbers were not counted. In short, there seem to be very lax standards as to what was being collected & reported. However, we don't want to get into a battle over this—the major focus of the paper is on much more important scientific issues—so we have called for a major inter-agency review of the issues without getting too critical of specific groups. That review will presumably also want to expand our current analysis and make sure that other datasets of acceptable standards are consistent with our own findings. However, we have already done a huge amount of unanticipated work here assessing the quality of the data, and we simply need to publish now and move to the next stage.

Lastly, the standardization procedure authors used could be sensitive to the time-frame examined and I would like to see more rationale for the selection of 2010-2014. Regime shifts are mentioned, with the last one stated to occur in 1998. So, why not consider all data from that point, particularly if the major conclusion from this analysis is that broad scale drivers are more important than local drivers? Doesn't quite line up logically to me.
Response: We have modified the text to provide more rationale for the selection of the 2010-2014 period. We looked closely at Reviewer #2's suggestion but found that extending back over the entire post 1998 period included calendar years where some populations were just not available. We wanted to choose a time frame including the same populations and relatively constant environmental conditions. Unless the populations contributing to the analysis are stable over time, the resampling procedure can potentially include populations which might have different productivity characteristics, distorting the analysis in subtle ways. In addition, 2008 was recognized as a year of major global environmental change (see Arguez et al. (2020)) that was atypical and may have been a regime shift on the west coast of North America (we are still debating that as a community, because there are pros and cons). After 2014 the delays in getting data into the various government information systems meant that few populations were available—so we chose 2010-2014, a 5-year period. This rationale (and the reference to Arguez et al) is now presented.

LINE-BY-LINE COMMENTS:

Lines 360-361: Remind readers that time-series were then combined regionally to better set the stage for the following sections. **Response: We added the sentence "These populations were then aggregated by geographic area to compare regional SARs.".**

Lines 376-380: I would provide this general reminder at the start of the Results section. **Response: Moved.**

Lines 382-383: Two paragraphs above, the mid-Columbia is listed as showing declines in SAR?
Response: We think it is clear from the text and Figure 2 that the major 4-fold decline is referencing those time series that extend back prior to 1978 but that there was some modest increase in numbers since the early 80s & 90s. The two paragraphs up statement said (in part): "*Most regions of west coast North America with CWT time series extending back prior to the 1978 regime shift show an approximate four-fold decrease in SARs for hatchery populations (Fig. 2). This applies to subyearling Chinook from … and the mid-Columbia River… average CWT-based SARs for all regions are now approximately 1% or less*". Lines 382-383 that the reviewer is questioning says "*…Chinook from all regions of the Columbia show some increase in CWT-based SARs since the 1980s and early 1990s*".

Lines 384-385: At least not yet. And, it was mentioned in Methods that SARs from Raymond are probably inflated when compared to those estimated more recently. Why doesn't that matter here? I think more explanation would be useful to improve transparency.
Response: We harbour some concerns that the original downstream smolt abundance estimates from Raymond's time may be distorted because of the technology of the day (possibly high doses of the anesthetic MS-222 and use of freeze branding to mark the fish, which could reduce smolt survival and thus *understate* the resulting SAR estimates). We had debated including this comment in the manuscript but decided against it because there appears to be no way to quantify these impacts (the original data sets that Raymond generated are apparently lost). In addition, the Raymond SARs data (even if underestimates), are the official recovery targets so, if anything, understate the true level of decline in survival.

We don't want to have this issue become a distraction from the main messages of the paper—and, in any event, we can't quantify our concerns—so would prefer to not get drawn into an unproductive side debate that cannot be resolved.

The other aspect which Reviewer #2 may actually be commenting on is from Line 252 of the original manuscript "*…(Raymond, 1988). These SAR estimates are inflated relative to the CWT-based estimates*". However, we think that the manuscript actually makes clear that the PIT tag-based SARs are generated in essentially the same way as the Raymond estimates were (i.e., from dam to dam, not spawning ground to spawning ground). As we go to considerable lengths later in the manuscript to describe our attempts to achieve a consistent conversion factor between PIT & CWT-based SAR estimates (and fail for the reasons described), getting further into this rather murky issue here again seems unlikely to be productive.

Lines 397-404: I assume we should still be looking at Figure 3 here? Might be worth also highlighting any populations that fall well below where others cluster regionally if applicable. Also, on the log scale, some of the differences among medians observed could be quite large. Seems small changes in survival could result in much larger or much fewer adults returning. So, instead of saying that they simply cluster, give us more information by saying that they are variable but fall with XX-XX orders of magnitude of each other etc… Then highlight clear outliers.
Response: The reviewer raises a good point about several populations with unusually low SARs that fall well below the regional clusters. We originally opted not to belabor this point in the manuscript simply because the management response on the west coast of North America is all about trying to

recover the SARs that were achieved 4-5 decades ago. The few populations we could identify that do achieve these recovery targets point to where to look if future research is to focus on this question. However, we did add a short sentence to the Discussion section pointing out that a number of populations with clearly lower SARs than typical for their geographic region could also be worthy targets for investigation: *"Similarly, a few populations with anomalously low SARs relative to regional medians also are evident (Fig. 3). If the underlying reasons for higher or lower survival can be identified it might be possible to improve hatchery productivity more broadly"*.

Line 406: Provide new section heading related to normalization and regional comparisons prior to this paragraph.

Response: Added the subheading "Comparison between regions".

Line 408: Not clear to me what is meant by "Interannual timing" here.
Response: Rephrased the paragraph to read: *"To compare the current status of regional CWT-based SARs we included the five most recent years of consistently available SAR data (2010-2014) in a resampling procedure to statistically quantify relative SARs. We chose this time period because there were a consistent number of populations contributing to each regional grouping used in the comparison period and it avoided including 2008, a year of unusually cold* conditions) Arguez et al. (2020))".

Lines 408-409: Briefly remind us why Snake River was chosen as baseline.
Response: Done.

Line 469-470: What are the profound conclusions here? Seems these should be outlined more explicitly in the first paragraph of Discussion to provide a better road map.
Response: We extensively re-wrote both the Discussion and Conclusions to better outline the major findings and the conclusions that stem from them.

Line 470-471: Rephrase to "How comparable are estimates of SAR's among agencies…"?
Response: Done.

Line 475: Shouldn't Figure 2 be referenced here? Overall, the extensive re-referencing of figures (aside from Figure 8) in the Discussion is odd and I don't think should be needed.
Response: The reviewer is correct, the reference should be to Fig. 2, not Fig. 1 (now corrected). We included the extensive referencing to figures to ensure that the readers do not get lost in what aspects of the analysis we were referring to. We can remove/reduce this if it doesn't fit with journal policy, but are inclined to keep the referencing to the figures as it currently is to minimize confusion.

Line 479: Be more explicit about what these "broad drivers" could be? What kind of spatial or temporal scale are we talking here? Rather than relying on citing other papers, give us the key elements in a review like this.
Response: Unfortunately, apart from likely occurring in the ocean, these "broad drivers" remain opaque. One objective for publishing this paper is to try to get governments to start taking the marine issues more seriously, rather than repeatedly falling back on doing more work on freshwater habitat issues (the current default). Straying into conjecture here about why marine survival is so poor might be interesting but may shift the needed debate from whether our paper is correct in our

current findings to squabbles over a side-issue—whether we have correctly identified the drivers of poor marine survival.

We did adopt a compromise here for the Discussion. We added one paragraph listing the possible mechanisms of poor Chinook marine survival, citing all of the papers we are aware of that touch on each proposed mechanism—a one paragraph mini-review of the literature, if you will. However, it is important to recognize that the cited papers are ALL either conjectural or correlational. There are no scientific papers that are actually testing mechanisms, which is what is really needed to move the field forward. (We are saving that topic for an entirely different paper!).

Line 482: Relative "shortness"? I'd rephrase.
Response: We delated "relative".

Line 684: Consider different word choice than "frustrated".
Response: Changed to "ineffective or misleading".

Line 703: I believe University of WA hatchery ended their Chinook program.
Response: Yes, but this is not relevant to our paper.

Figure 2: I don't see where hatchery vs. wild vs. mixed is being shown as indicated in the caption. I'm assuming that the individual data points on the different panels are coded with the different letters? Also, three regimes shifts are highlighted (1977, 1989, 1998) – what do these signify? Initial decline, low point, and some rebound, respectively? Don't recall these being defined in main body of text, but would be nice to describe these more explicitly to help with interpretation of results.
Response: The reviewer needs to zoom in to the individual panels under high magnification to see this—the data points are shown as H, W, & B (=both). We have re-phrased "*The major regime shifts of 1977, 1989, and 1998 are indicated by vertical dotted lines*" to read "*The* <u>timing of the</u> *major regime shifts* <u>starting in</u> *1977, 1989, and 1998 are indicated by vertical dotted lines*".

Reviewer: 3

Comments to the Author
This manuscript has a lot of potential but it is extremely rough. The paper compiles existing tagging data needed to estimate changes in smolt survival to adulthood for Chinook salmon along the North American west coast. This topic will be interesting to lots of people but the manuscript is very poorly written. There is little coherence in the manuscript and the results are presented as a long list of specific examples, all of which seem to be exceptions to the general trend. This is only interesting to people who are intimately knowledgeable about these data. More effort is needed to improve the writing and provide a more accessible message with the data.
Response: This was a complex paper to write because it condenses a lot of data, has several related but disparate messages, and touches on controversial topics. Given that the first two reviewers thought that the paper was well-written and that Reviewer #3 hasn't provided much detail as to what might be improved, we would welcome the editor's input. We do note that we have extensively re-worked parts of the paper to respond to the specific comments from Reviewer #2 and we think that the new discussion and conclusions provide a readily understood summary of the major findings (and the exceptions, where they occur).

The core message that SAR has declined in most places along the west coast, in both heavily impacted and intact watersheds, across a broad swath of latitude, is an extremely important message. The current paper highlights this in the Abstract, but the paper then buries the result in a long list of exceptions to the rule.
Response: Although we have re-worked the discussion to better highlight the findings, we do wish to disagree with the reviewer here. If our results are to have credibility, we also need to demonstrate that we have carefully analyzed the data in a number of ways to see how robust this conclusion is. The delayed mortality theory (that passage through many dams subsequently reduces survival at sea) is a prominent theory that is very persistent. Despite making this aspect of the paper rather Columbia River-centric, we have taken the opportunity to review this theory in depth because the proponents missed the datasets (including their own!!) that did not support this theory. We are setting that shortcoming to rest.

The paper needs to be rewritten in a more streamlined and coherent fashion. It is currently a hodgepodge of results and observations and is difficult to follow. Those very familiar with the data might have a better time with it but this reads like a management technical report more than it does a coherent paper for the peer-reviewed literature.
Response: The Discussion & Conclusions have been extensively re-worked, and we think it now reads quite well. Suggestions from the editor would be most welcome, of course.

Technically, the paper seems to be reasonable, though I would have liked to see more effort put into statistically describing how the trends in SAR are shared among stocks and locations. The Dorner et al. paper shows one example of how to do this. A chronological clustering approach might as well. Again, statistically quantifying this shared trend would improve the quantitative nature of this paper.
Response: We considered a "chronological clustering approach" early on, but the reality is that the starting time of various populations' survival time series varies. Aggregating the data in the way that Reviewer #3 is suggesting risks introducing artifacts into the analysis where time series of regional SARs suddenly jump up or down as data for additional populations with unusually high or low productivity becomes available. It was for this reason that we chose the statistical approaches that we did. We would also like to point out that wherever possible we show the statistical confidence bounds on the data sets (Figs. 2, 4, 7) or use box & whisker plots (Figs. 3 & 5) to quantify the uncertainty for the readers.

Finally, it is important to point out that our statistical comparison of survival relative to the key Snake River stocks (variously listed as endangered or threatened under the US ESA) used the most rigorous modern statistical re-sampling methods we can identify... they are free from requiring us to make assumptions about the form of the underlying statistical distribution and let the data speak for themselves in the most relevant time frame—the most recent (Fig. 4), and in the supplementary information (Fig. S1) we have shown the results using all possible regions as the basis for comparison (to address the potential question about whether there is something unusual about the Snake River region—there is not).

One relevant paper that is worth looking at that provides an earlier analysis of recent changes in Chinook productivity is:
Ohlberger et al. Ecosphere 2016. Population coherence and environmental impacts across spatial scales: a case study of Chinook salmon.

Response: We missed this reference. We have added citations to this paper as well as a another by the same author to the revision.

Table S3. Numerical values defining the box and whisker plots for CWT SAR estimates reported in Fig. 3 of the main text. AK=Alaska, NCBC=North Central British Columbia, WCVI=West Coast Vancouver Island, SOG=Strait of Georgia, PS=Puget Sound, WAC=Washington State Coast, LCOL=Lower Columbia River (below Bonneville Dam), MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River, ORC=Oregon Coast, CA=California.

					Interquartile Range		Whiskers	
Region	**Stock**	**Label**	**Rear**	**Median**	**Lower**	**Upper**	**Lower**	**Upper**
		Subyearlings						
NCBC	Atnarko	Atnarko 8	H	0.73	0.46	1.08	0.16	1.61
WCVI	Robertson	Roberts 16	H	1.32	0.43	2.06	0.01	3.96
SOG	Quinsam	Quinsam 13	H	0.43	0.27	0.92	0.06	1.81
	Puntledge	Puntled 14	H	0.30	0.18	0.41	0.04	0.66
	Phillips	Phillip 9	H	1.50	1.01	1.69	0.35	1.69
	Nanaimo	Nanaimo 19	H	0.78	0.45	1.73	0.19	2.77
	Middle Shuswap	MidShus 11	H	0.47	0.28	1.14	0.17	1.66
	Lower Shuswap	LowShus 10	H	1.02	0.53	1.48	0.26	2.41
	Hoko	Hoko 27	H	0.40	0.27	0.58	0.04	1.00
	Harrison	Harriso 17	H	0.85	0.40	1.52	0.17	3.00
	Elwha	Elwha 28	H	0.17	0.08	0.23	0.01	0.23
	Cowichan	Cowicha 21	H	0.50	0.27	0.99	0.14	1.43
	Chilliwack	Chilliw 18	H	4.11	2.24	6.49	0.66	11.80
	Big Qualicum	Big Qua 15	H	0.29	0.18	0.56	0.05	1.11
PS	University of Washington	UWAccel 33	H	3.96	2.66	4.95	1.39	6.21
	Stillaguamish	Stillag 26	H	0.62	0.26	0.83	0.12	1.56
	South Puget Sound	SthPug 43	H	0.83	0.39	1.11	0.16	2.17
	Skykomish	Skykomi 30	H	0.30	0.21	0.43	0.16	0.73
	Skagit	Skagit 23	H	0.53	0.41	0.75	0.27	1.09
	Skagit	SkagSm 23	H	0.39	0.27	0.53	0.07	0.62
	Samish	Samish 22	H	0.60	0.29	1.18	0.12	2.25
	Nooksack	Nooksac 20	H	0.36	0.26	0.66	0.11	1.03
	Nisqually	Nisqual 42	H	0.57	0.29	1.03	0.04	1.71
	George Adams	George 38	H	0.49	0.22	0.89	0.02	1.57
WAC	Sooes	Sooes 25	H	0.17	0.07	0.29	0.00	0.59
	Queets	Queets 35	H	0.87	0.37	1.16	0.20	1.81
LCOL	Lewis	Lewis 63	W	0.54	0.35	0.96	0.07	1.85
	Cowlitz	Cowlitz 55	H	0.17	0.08	0.30	0.02	0.48
	Columbia Lower	LowCol 54	H	0.24	0.11	0.55	0.01	1.19
MCOL	Hanford	Hanford 47	W	0.30	0.19	0.66	0.06	1.31
	Upriver Bright	UpCol 45	H	0.68	0.21	1.13	0.03	2.27
	Umatilla	Umatill 60	H	0.10	0.04	0.28	0.00	0.60
	Spring Creek	SprgCrk 66	H	0.59	0.19	1.34	0.05	2.66
UCOL	Mid-Columbia	ColSmHW 29	HW	0.70	0.40	0.95	0.30	1.10
	Mid-Columbia	ColSmW 29	W	1.40	1.20	1.90	0.70	2.70
	Columbia	ColSm 29	H	0.42	0.19	0.77	0.00	1.42
SNAK	Lyons Ferry at Snake	LyonsFe 46	H	0.57	0.23	1.48	0.03	2.35
	Lyons Ferry at Pittsburg Landing	Pittsbu 68	H	1.06	0.32	1.31	0.09	2.66

				Interquartile Range			Whiskers	
Region	Stock	Label	Rear	Median	Lower	Upper	Lower	Upper
	Lyons Ferry at Captain John	CaptJoh 56	H	1.28	0.75	1.66	0.14	2.63
	Lyons Ferry at Big Canyon	BigCany 49	H	1.13	0.51	1.38	0.20	1.46
ORC	Salmon	Salmon 76	H	2.02	1.32	3.12	0.23	5.77
	Elk	Elk 85	H	2.41	1.12	3.92	0.44	6.31
CA	Livingston Stone	Livings 86	H	0.38	0.24	0.62	0.05	0.62
	Colman	ColFa 87	H	0.52	0.13	0.94	0.02	1.46
			Yearlings					
SEAK	Unuk	Unuk 4	W	1.07	0.73	2.50	0.39	5.11
	Taku	Taku 2	W	2.05	0.98	4.17	0.41	6.04
	Stikine	Stikine 3	W	1.34	0.82	1.92	0.31	2.38
	Chilkat	Chilkat 1	W	1.11	0.73	1.64	0.55	2.44
	Alaska	Alaska 5	H	2.25	1.47	3.78	0.93	7.11
NCBC	Kitsumkalum	Kitsumk 6	H	2.25	1.48	3.15	0.48	4.74
SOG	Nicola	Nicola 12	H	0.63	0.44	1.62	0.04	3.22
	Dome	Dome 7	H	0.39	0.15	0.68	0.05	0.92
PS	White	White 41	H	0.31	0.22	0.53	0.06	0.53
	Squaxin Pens	Squaxin 39	H	0.82	0.27	1.27	0.14	1.56
	Skagit	SkagSpr 23	H	0.82	0.50	1.54	0.22	2.89
	Nooksack	Nooksac 20	H	0.23	0.14	0.65	0.04	0.94
LCOL	Willamette	Willame 84	H	1.06	0.60	1.64	0.28	2.75
MCOL	Warm Springs	Warm 79	H	0.34	0.15	0.60	0.00	1.24
	Umatilla	Umatill 60	H	0.38	0.27	0.59	0.00	0.98
	Little White Salmon	LtlWhSa 67	H	0.46	0.22	0.64	0.02	1.05
	Carson	Carson 62	H	0.45	0.24	0.68	0.02	1.28
UCOL	Mid-Columbia	ColSprW 29	W	2.40	1.05	2.60	0.30	4.90
	Winthrop	Winthro 24	H	0.30	0.11	0.55	0.07	1.09
	Mid-Columbia	ColSprH 29	H	0.40	0.20	0.70	0.10	0.70
	Leavenworth	Leavenw 34	H	0.32	0.19	0.53	0.01	0.84
	Entiat	Entiat 32	H	0.10	0.04	0.23	0.00	0.33
SNAK	Tucannon	TucanW 52	W	1.46	0.56	3.11	0.02	5.98
	Snake	SnakSm 44	W	1.50	1.10	3.30	0.40	6.00
	Snake	SnakSpr 44	W	2.10	1.20	3.70	0.30	6.10
	Upper Grande Ronde	UpGrand 75	H	0.56	0.35	0.76	0.04	1.22
	Tucannon	TucanH 52	H	0.20	0.10	0.32	0.02	0.46
	Snake	Snake 44	H	0.60	0.25	2.25	0.10	4.40
	Lostine	Lostine 69	H	0.92	0.60	1.31	0.24	1.97
	Lookingglass	Looking 65	H	0.58	0.44	0.97	0.35	1.12
	Imnaha	Imnaha 64	H	0.68	0.25	1.01	0.04	1.73
	Catherine	Catheri 74	H	0.38	0.30	0.50	0.10	0.55
CA	Colman	ColLtFa 87	H	0.90	0.73	1.33	0.26	1.80

Table S4. Numerical values defining the box and whisker plots for PIT SAR estimates reported in Fig. 5 of the main text. MCOL=Middle Columbia River (Bonneville Dam to Priest Rapids Dam excluding the Snake River), UCOL=Upper Columbia River (Priest Rapids Dam to Chief Joseph Dam), SNAK=Snake River.

				Interquartile Range			Whiskers	
Region	**Stock**	**Label**	**Rear**	**Median**	**Lower**	**Upper**	**Lower**	**Upper**
		Subyearlings						
MCOL	Hanford	Hanford 47	W	0.38	0.13	0.86	0.07	1.35
	Deschutes	Deschut 72	W	0.31	0.30	0.59	0.29	0.87
	Spring Creek (May Release)	SprgMay 66	H	0.23	0.22	0.52	0.20	0.62
	Spring Creek (April Release)	SprgApr 66	H	0.27	0.15	0.63	0.06	0.68
	Little White Salmon	LtlWhSa 67	H	1.09	0.52	1.63	0.50	2.44
UCOL	Tagged at Rock Island Dam	RockISm 37	HW	0.61	0.27	1.14	0.00	2.14
	Upper Columbia above Wells Dam	UpCol 29	W	1.19	0.44	2.19	0.06	2.81
	Entiat	Entiat 32	H	1.19	0.79	1.71	0.06	2.96
SNAK	Snake	Snake 44	W	0.88	0.54	1.31	0.28	1.66
	Umatilla Irrigon below Hells Canyon Dam	Umatill 61	H	0.64	0.31	0.86	0.15	0.86
	Lyons Ferry at Pittsburg Landing	Pittsbu 68	H	0.97	0.36	1.23	0.24	1.79
	Oxbow below Hells Canyon Dam	Oxbow 77	H	0.61	0.46	1.42	0.31	2.22
	Lyons Ferry at Snake	LyonsFe 46	H	0.72	0.42	1.18	0.35	1.26
	Nez Perce at Lukes Gulch	LukeGul 59	H	0.54	0.53	0.81	0.52	1.08
	Grande Ronde	Grande 65	H	0.56	0.31	0.69	0.28	0.95
	Dworshak at Snake	Dworsha 48	H	0.83	0.36	1.06	0.22	1.09
	Nez Perce at Cedar Flats	CedFlat 58	H	0.91	0.77	1.14	0.63	1.36
	Lyons Ferry at Captain John	CaptJoh 56	H	1.05	0.86	1.35	0.37	1.51
	Lyons Ferry at Big Canyon	BigCany 49	H	1.02	0.89	1.24	0.89	1.24
		Yearlings						
MCOL	Yakima	Yakima 53	W	2.16	1.65	3.45	0.73	4.65
	John Day	JohnDay 71	W	4.20	3.12	5.67	0.93	7.11
	Warm Springs	Warm 79	H	0.65	0.30	0.84	0.19	1.18
	Cle Elum	CleElum 40	H	1.59	1.12	1.87	0.73	2.31
	Carson	Carson 62	H	0.62	0.41	1.24	0.23	1.49
UCOL	Tagged at Rock Island Dam	RockISpr 37	HW	0.47	0.10	0.78	0.00	1.32
	Wenatchee	Wenatch 36	W	1.14	1.02	1.93	0.76	2.89
	Entiat and Methow	Entiat 31	W	1.13	0.74	1.44	0.41	1.72
	Winthrop	Winthro 24	H	0.65	0.58	1.00	0.51	1.40
	Leavenworth	Leavenw 34	H	0.59	0.36	1.08	0.11	2.11
SNAK	Upper Salmon	UpSalm 73	W	1.03	0.37	1.62	0.14	2.83
	South Fork Salmon	SthSalm 81	W	0.94	0.78	1.53	0.25	1.61
	Snake	Snake 44	W	0.99	0.43	1.45	0.24	2.55
	Middle Fork Salmon	MidSalm 82	W	1.07	0.44	1.59	0.21	1.59
	Imnaha	ImnahaW 64	W	0.89	0.50	1.44	0.37	1.90
	Grande Ronde	Grande 65	W	1.37	0.64	1.76	0.43	3.32
	Clearwater	Clear 50	W	0.53	0.34	0.87	0.22	1.56
	Sawtooth	Sawtoot 83	H	0.73	0.57	0.78	0.57	1.08
	Rapid	Rapid 70	H	0.78	0.42	1.36	0.27	1.98

Region	Stock	Label	Rear	Interquartile Range Median	Interquartile Range Lower	Interquartile Range Upper	Whiskers Lower	Whiskers Upper
	Pahsimeroi	Pahsime 80	H	0.23	0.03	0.51	0.01	0.73
	McCall	McCall 78	H	1.27	0.77	1.68	0.25	2.37
	Kooskia	Kooskia 57	H	0.08	0.00	0.16	0.00	0.16
	Imnaha	Imnaha 64	H	1.26	0.65	1.50	0.23	1.84
	Dworshak at Snake	Dworsha 48	H	0.46	0.29	0.76	0.12	1.22
	Clearwater	ClearSpr 48	H	0.68	0.40	0.86	0.16	1.31
	Clearwater	ClearSm 48	H	0.45	0.25	0.45	0.25	0.55
	Catherine	Catheri 74	H	0.63	0.49	1.28	0.26	1.87

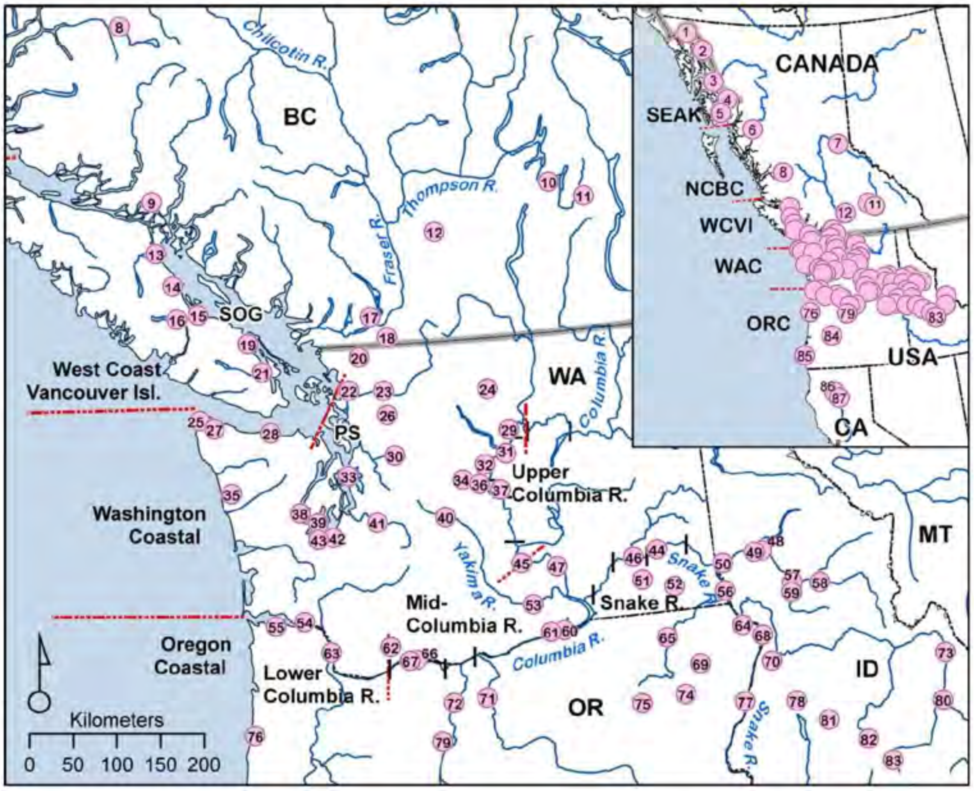

Fig. 1. Map of Chinook salmon survival time series used in the analyses. Numbers inside symbols are keyed to the populations in Table S1. SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; WAC=Washington Coastal; ORC=Oregon Coastal; SOG=Strait of Georgia; PS=Puget Sound; CA=California.

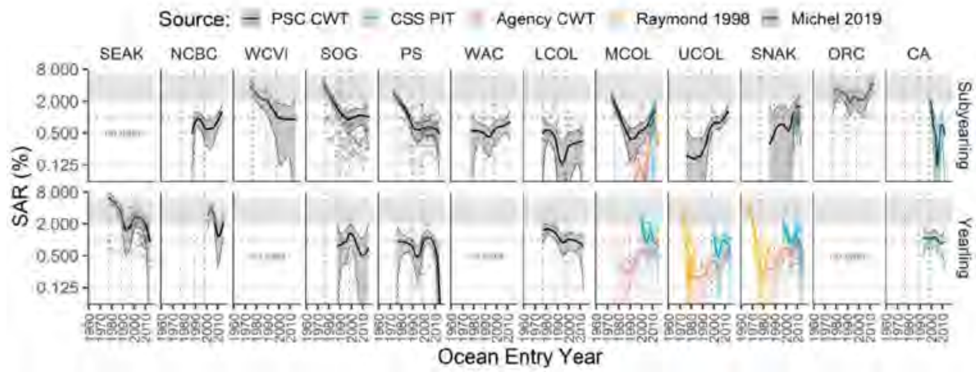

Fig. 2. Time series of smolt-to-adult return (SAR) estimates for Chinook salmon plotted by source. Annual SAR estimates for Hatchery (H), Wild (W), and mixed hatchery-wild data sources (B) are shown, but regional loess curves of survival and associated 95% confidence interval use hatchery data only, colour coded by data source. In order to focus on the trends, a few SAR estimates have been clipped by restricting the y-axis maximum to near the loess curve maxima. Blank panels indicate regions where the life history type does not occur. The SAR 2-6% recovery target adopted for Snake River Spring Chinook is shown as a grey band. The timing of the major regime shifts starting in 1977, 1989, and 1998 are indicated by vertical dotted lines. The horizontal dotted line indicates 1% SAR. Note logarithmic y-axis. Sources correspond to Table S1 as follows: PSC CWT= PSC 2019; CSS PIT=McCann et al. 2018; Agency CWT=all other sources exclusive of Raymond 1998 and Michel 2019. CWT=coded wire tag; CSS=Comparative Survival Study, PIT= Passive-Integrated-Transponder; SEAK=SE Alaska/Northern British Columbia Transboundary Rivers; NCBC=North-Central British Columbia; WCVI=West Coast Vancouver Island; SOG=Strait of Georgia; PS=Puget Sound; WAC=Washington Coastal; LCOL=Lower Columbia River; MCOL=Mid-Columbia River; UCOL=Upper Columbia River, SNAK=Snake River; ORC=Oregon Coastal; CA=California.

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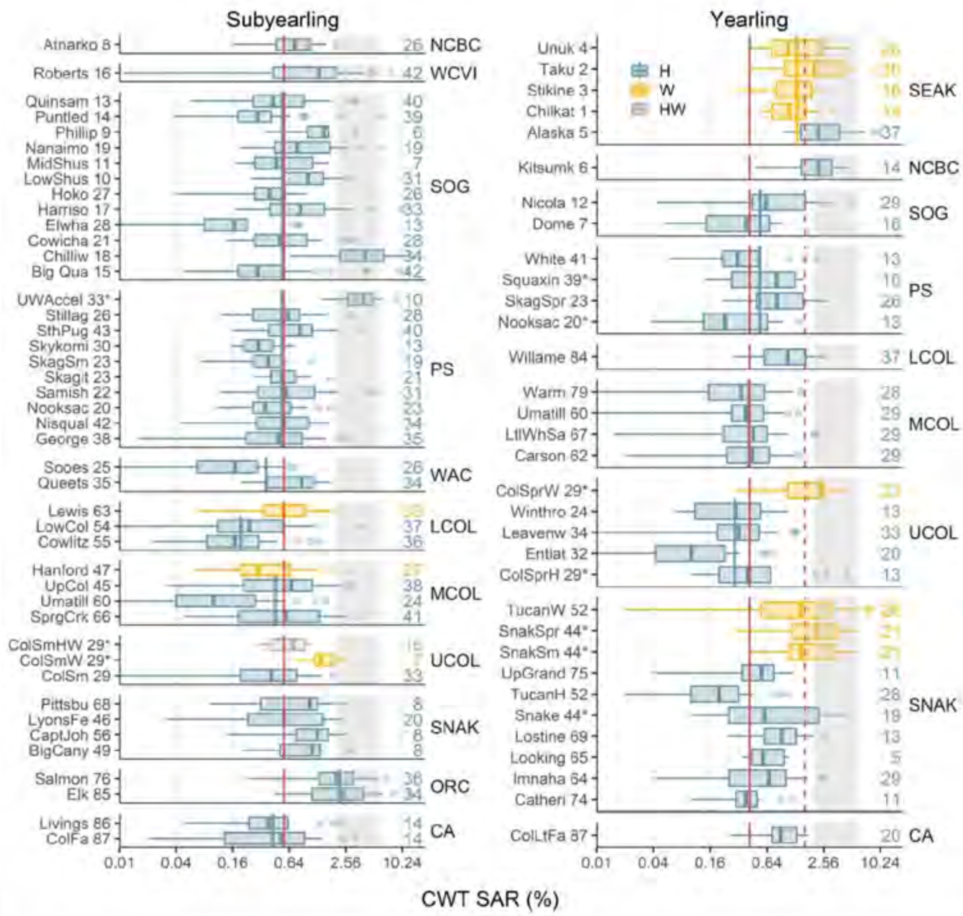

Fig. 3. Box plots of Chinook survival (SAR) based on coded wire tags, disaggregated by population and region; all years combined. Central lines show medians, boxes show the inter-quartile range (central 50% of data points), whiskers bracket 1.5 times the interquartile range, and open circles identify outliers. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates for each population is shown to the right. See Table S1 for definitions of population acronyms and Fig. 2 for region acronyms. H=hatchery; W=wild; HW=mixture. *Indicates data sets ending prior to 1998 (all data from Raymond (1998) and three Puget Sound data series from PSC (2019)).

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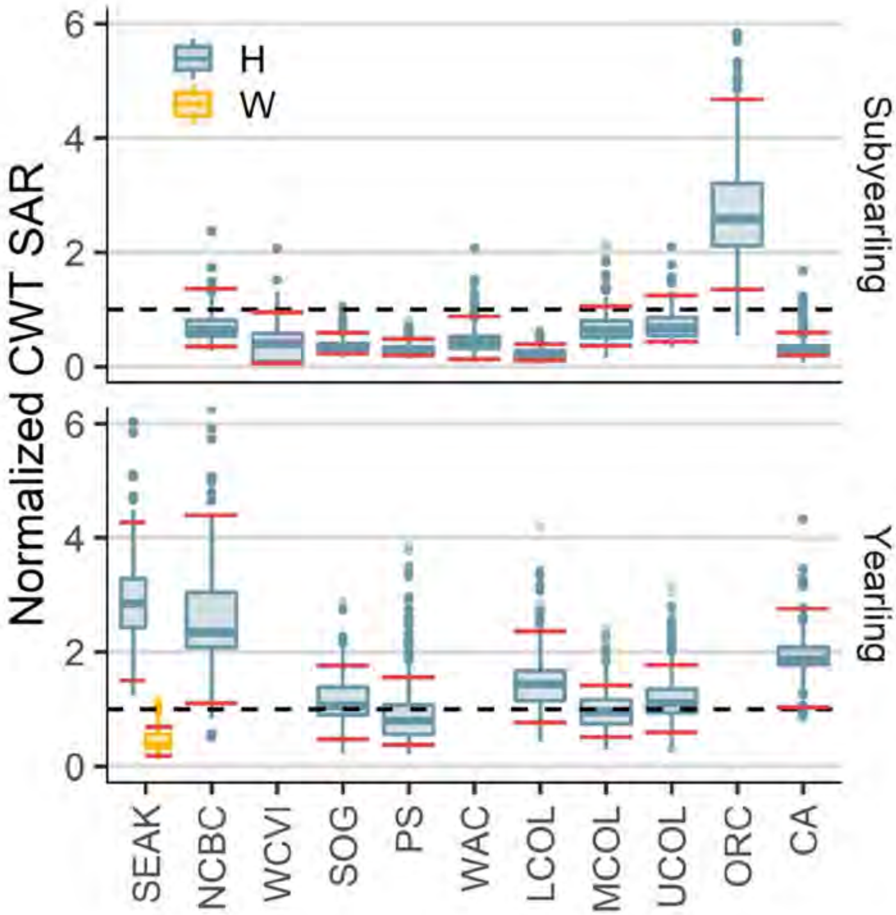

Fig. 4. Regional CWT-based SAR estimates for Chinook salmon normalized relative to Snake River SARs for the 2010-2014 period. Estimates above the horizontal black dotted line indicate higher survival than Snake River populations. Horizontal red lines show the empirical 5% and 95% percentiles on the sampling distribution of the normalized ratio. See Fig. S1 for SAR estimates normalized to all other regions. H=hatchery; W=wild.

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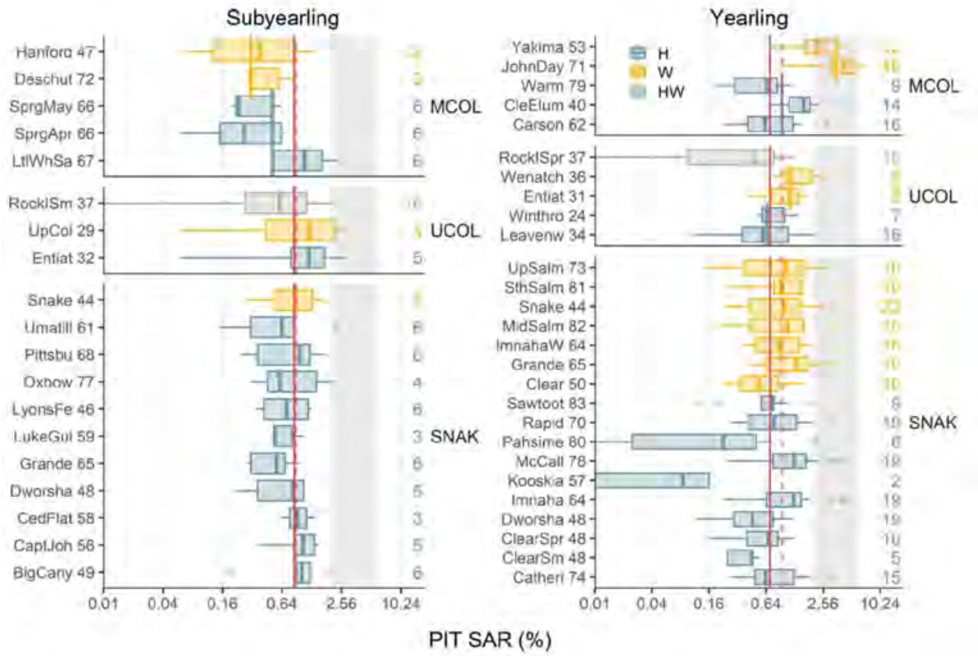

Fig. 5. Box plots of Chinook PIT tag-based SAR estimates in the Columbia River basin, disaggregated by population and region; all years combined. These SAR estimates exclude harvest and smolt and adult losses above the top-most dam. Regional medians are computed using all populations and shown as vertical blue (H) or gold (W) lines, with Snake River medians overplotted as vertical red lines on all panels for comparison (H=solid and W=dashed). The 2-6% target recovery range for Snake River SARs is shown as a shaded band. The number of SAR estimates is shown on the right. H=hatchery; W=wild; HW=mixture. All data from (McCann et al., 2018).

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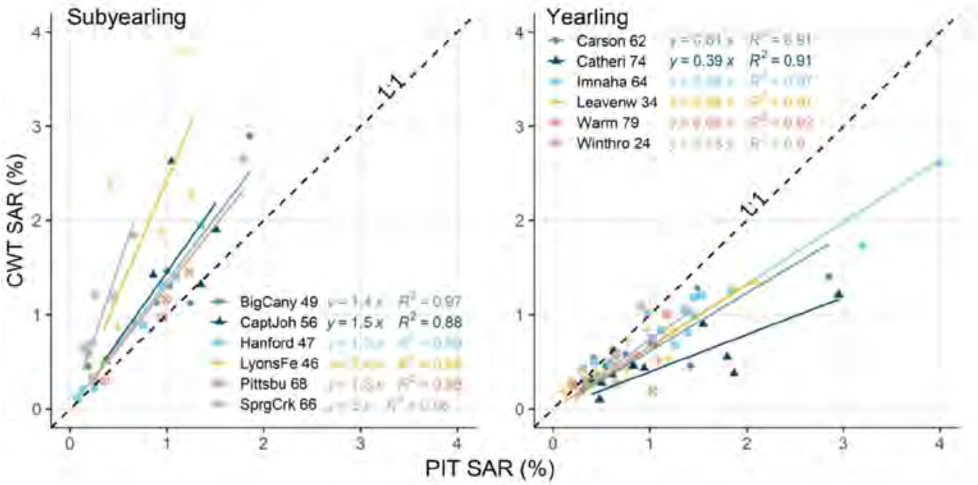

Fig. 6. Comparison of smolt-to-adult survival (SAR) estimates made using coded wire tags (CWT) and passive integrated transponder (PIT) tags for Chinook salmon populations where both tagging methodologies were employed in the same year. Linear regressions were fit with the intercept constrained to zero.

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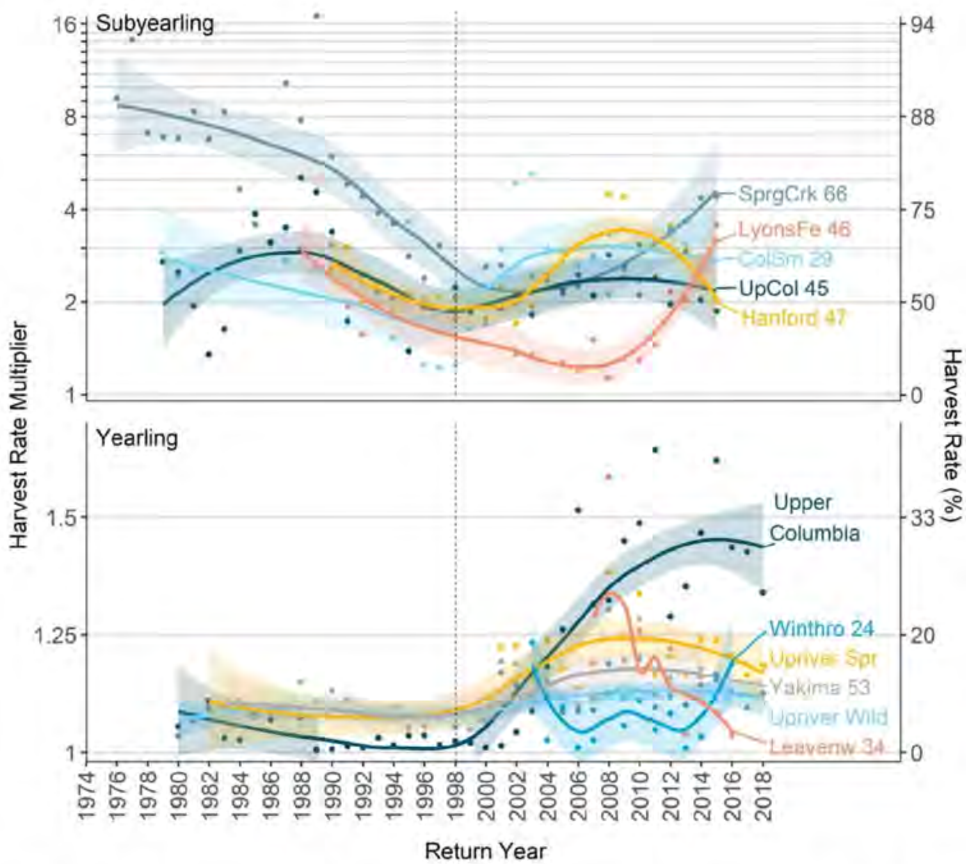

Fig. 7. Annual Columbia River Chinook harvest rate estimates, fitted loess trend lines, and associated 95% confidence intervals. The right-hand axis shows reported aggregate harvest before Chinook reach McNary Dam. The left-hand axis shows the corresponding value that PIT tag-based SAR estimates should be multiplied by to correct for exclusion of harvest; note log scale. Tributary harvests (i.e., above McNary Dam) are excluded. Substantial variation over time and between populations is evident after 1998 (vertical dashed line), when PIT tag-based survival estimation began. Data sources that present harvest estimates by brood year were converted to return year using the dominant year of return. See Table S2 for population names and references.

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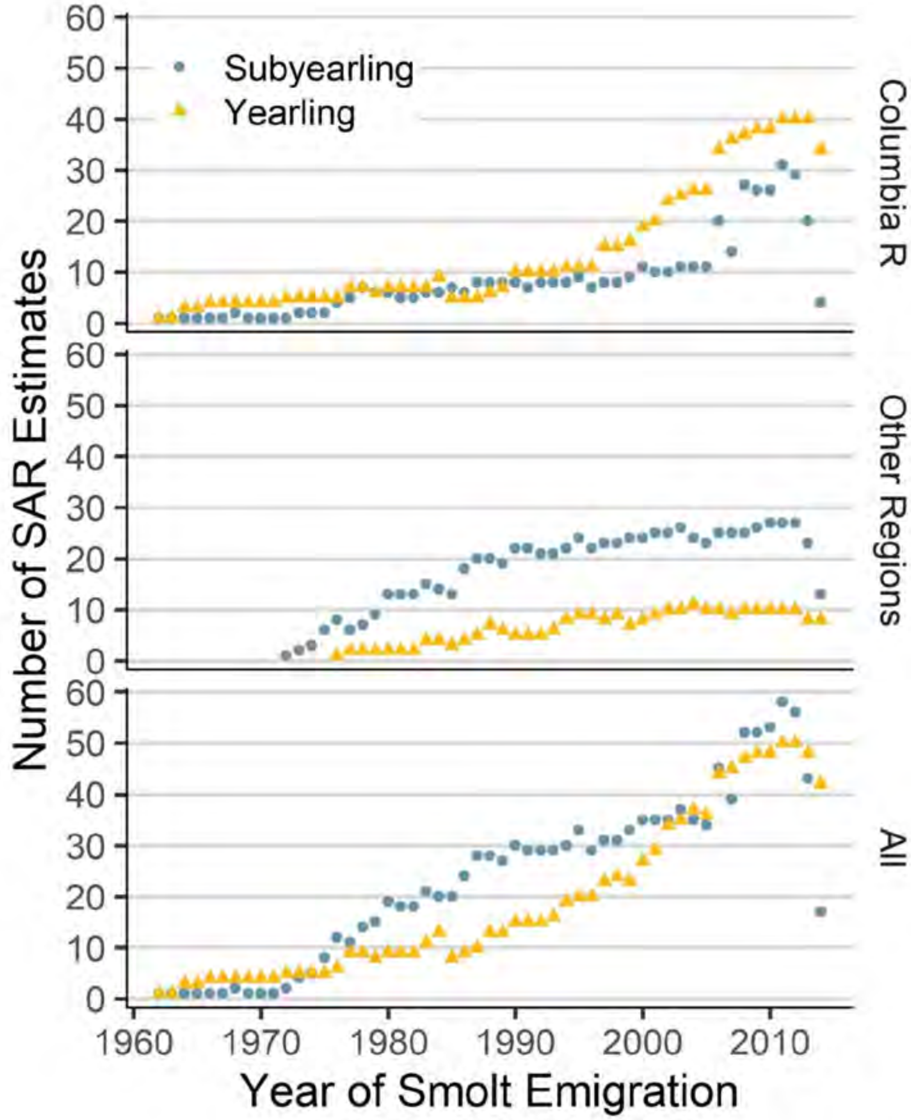

Fig. 8. Increase in the number of annual SAR estimates used in this paper. The drop in monitoring evident in the most recent years probably reflects lags in data processing rather than a decrease in effort. See Table S1 for specific populations included.

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From: Petersen,Christine H (BPA) - EWP-4

Sent: Tue Aug 04 17:29:24 2020

To: 'David Welch'

Subject: RE: Fish and Fisheries - Decision on Manuscript ID FaF-20-Jun-OA-162 [email ref: DL-SW-2-a]

Importance: Normal

Hi David,

Sorry for the slow response. (b) (6) [redacted] The group was very pleased with the presentation on your in press paper, and we still are preparing to brief upper management.

In the future we might be at a better point to discuss potential project ideas, including continuing the time indexed survival data analysis that was in the prior contract. A few other technical contractors who we work with have also voiced that things appear to be very slow, with few or no assignments this summer. It is not just Covid19 related but more of an issue of where we are in the planning process. It will be a good idea to stay in touch regarding your proposals as we go into fall.

You can see some of the response in press and social media to the Biological Opinions and EIS officially released on July 31. It is a near certainty that we will have renewed debates over water quality (TDG effect on fish, true benefits of avoiding bypass route, and also the ability to moderate temperatures via dam and reservoir operations). The Action Agencies will soon be organizing our plan to address the new requirements in the terms and conditions of the Biological Opinions.

https://www.nrdc.org/experts/giulia-cs-good-stefani/our-rivers-increasingly-too-dam-hot-salmon

Christine Petersen

From: David Welch <David.Welch@Kintama.com>
Sent: Tuesday, July 21, 2020 10:05 AM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Cc: Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: [EXTERNAL] RE: Fish and Fisheries - Decision on Manuscript ID FaF-20-Jun-OA-162 [email ref: DL-SW-2-a]

Thanks, Christine.

One point I would like to make (& see reflected in the briefing to senior management) is that for almost a quarter century now I have held the view that the negative impact of the Columbia River hydropower system on salmon is being grossly overstated because it is confounded with large scale climate change effects occurring in the ocean.

This point is important far beyond what the current paper is saying. It offers the prospect that there may be another path forward that can lead to much more economically beneficial hydropower production without harming salmon conservation and, in the best case scenario, could both increase salmon survival AND power production.

Happy to expand on this when appropriate. This point is not in the current paper, but the current paper does demonstrate that the current and past generations of salmon biologists have been capable of making some glaring mistakes. The logical next step is to establish if they were fundamentally wrong about the really big picture as well.

David

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: Tuesday, July 21, 2020 9:49 AM
To: David Welch <David.Welch@Kintama.com>
Cc: Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: RE: Fish and Fisheries - Decision on Manuscript ID FaF-20-Jun-OA-162 [email ref: DL-SW-2-a]

This is great news. We are very glad it is being published. It looks like they selected some reviewers from different geographic locations who put some thought into this.

Your presentation a couple weeks ago was very positively received. We held a follow up discussion and Kristen Jule, Ben Zelinsky, Jody Lando will be briefing some of our higher level management at Bonneville about the content and some of the implications of your paper. That it is as good as accepted is very good as far as being able to promote and distribute the study potentially outside of the agency or to media.

Congratulations,

Christine P.

From: David Welch <David.Welch@Kintama.com>
Sent: Monday, July 20, 2020 9:56 AM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Cc: Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: [EXTERNAL] FW: Fish and Fisheries - Decision on Manuscript ID FaF-20-Jun-OA-162 [email ref: DL-SW-2-a]

Hi Christine--

Good news on our manuscript. We still have some additional minor work done based on the two new reviewers' comments below, but the paper is essentially guaranteed to be accepted for publication once we do so. (As always, I suppose that there could be surprises, but at this point I really don't think so).

Below are all of the comments on the manuscript. I have only deleted the log-in information that I need to submit the revision.

We will get started on the revision. I have read through the comments and don't see any big issues to address. Reviewer #3 is clearly very knowledgeable about the PST and Alaskan fisheries and a few minor tweaks will be required. Otherwise, I don't see any dealbreakers.

The comment about better documenting where the 2% "minimum SAR" recommendation came from was amusing to me… I spent days trying to map out the actual scientific basis for this recommendation (eventually drawing diagrams of which FPC paper referenced which other (mostly) FPC paper to cite the support for this). What I eventually concluded was that the FPC was citing itself as the scientific basis for this value but all of these FPC documents led back to the 2008 PATH analysis paper… which didn't really define an objective basis for the values chosen. After several days of frustrating work I deleted my efforts to roadmap the scientific basis for the recommendation because (a) I couldn't and (b) it would probably look like I was criticizing the FPCs' reports rather than focus on the actual science. In short, I did a lot of work here trying to find the real scientific basis for the FPC's "2-6% minimum SAR" recommendation and ended up just chasing my tail. I will explain that (gently) to the editor.

David

P.S. Nice to see the comments from two of the reviewers about how much work we did to put the paper together… I doubt anyone really can grasp just how much effort went into both the collation and the analysis phases!

-----Original Message-----
From: Paul Hart <onbehalfof@manuscriptcentral.com>
Sent: Monday, July 20, 2020 2:35 AM
To: David Welch <David.Welch@Kintama.com>
Subject: Fish and Fisheries - Decision on Manuscript ID FaF-20-Jun-OA-162 [email ref: DL-SW-2-a]

20-Jul-2020

Dear Dr. Welch

Manuscript ID FaF-20-Jun-OA-162 entitled "Review of the Coast-wide Decline in Survival of West Coast Chinook Salmon (Oncorhynchus tshawytscha)" which you submitted to Fish and Fisheries, has been reviewed. The comments of the reviewers are included at the bottom of this letter.

The reviewers have recommended some minor revisions to your manuscript. Therefore, I invite you to respond to the reviewers' comments and revise your manuscript.

You will be unable to make your revisions on the originally submitted version of the manuscript. Instead, revise your manuscript using a word processing program and save it on your computer.

Once the revised manuscript is prepared, you can upload it and submit it through your Author Center. Please include a letter in the space provided to let me know how you have responded to each of the comments made by the reviewers; please be as specific as possible.

There are two ways to submit your revised manuscript. You may use the link below to submit your revision online with no need to enter log in details:

*** PLEASE NOTE: This is a two-step process. After clicking on the link, you will be directed to a webpage to confirm. ***

*[DW>] ***DELETED****

Alternatively log into https://mc.manuscriptcentral.com/faf and enter your Author Center. You can use the revision link or you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision. Please DO NOT upload your revised manuscripts as a new submission.

IMPORTANT:

- Your original files are available to you when you upload your revised manuscript. Please delete any redundant files before completing the submission.

- Please remember to edit the 'Manuscript Data – Metadata' under 'Manuscript Information' to accurately reflect the number of words, pages etc. in your revision.

Because we are trying to facilitate timely publication of manuscripts submitted to Fish and Fisheries, your revised manuscript should be uploaded as soon as possible. If you feel that you will be unable to submit your revision within two months please contact me to discuss the possibility of extending the revision time.

Once again, thank you for submitting your manuscript to Fish and Fisheries and I look forward to receiving your revision.

Sincerely

Paul Hart

Editor, Fish and Fisheries (2016 IF 9.0, 2017 IF 7.0, 2018 IF 6.7) pbh@le.ac.uk

Editor Comments to Author:

The first reviewer also saw your original submission. The other two are new and have a fresh take on your paper but both agree that minor revisions are appropriate.

The second reviewer makes a very important point relating to the geographical scope of the paper. As it states in our Aims and Objectives "A paper in Fish and Fisheries must draw upon all key elements of the existing literature on a topic, normally have a broad geographic and/or taxonomic scope, and provide points of generic value, which make it compelling to a wide range of readers whatever their geographical location". To fulfil this objective it would be valuable if you could makes some comment about the SAR status in other parts of the chinook's distribution. Has any work in Japan been done on this? I don't expect a comprehensive survey of what's happening on the western side of the Pacific but it would be useful to readers who are not salmon specialists to be able to put your results into a wider context.

Please also pay attention to the Instructions to Authors which gives details as to how the manuscript is laid out. At present it does not follow the instructions. If the paper is accepted you will have to make the necessary changes anyway so you might as well do it now.

Reviewers' Comments to Author:

Reviewer: 1

Comments to the Author

I've carefully reviewed the re-submitted manuscript and response letter. The paper has really improved structurally in my opinion and I appreciate the authors willingness to incorporate numerous recommendations brought up during the first round of review. I also appreciated their thorough and detailed responses to my original comments. Between the substantive revisions that I see and thorough response letter, I have no additional concerns and satisfied with the paper as is.

Reviewer: 2

Comments to the Author

Within the world of "salmonology", this paper will have considerable impact. Its key finding – that there have been fairly consistent region-wide reductions in ocean survival of Chinook salmon – has important policy implications as people consider where to invest in recovery. The authors specifically take aim at attempts to improve freshwater spawning and production, arguing that this may be fruitless if the major cause of declines is reduced ocean survival, including in areas where habitat remains relatively pristine. It is very valuable to have all of the data from such disparate sources assembled in one place. I give credit to the authors for the enormous amount of work that was required to assemble the data and analyze them, while dealing with numerous limitations of the methods that generate survival.

A key issue for this journal is whether this paper will be sufficiently understandable and interesting to a wide audience. It spends a lot of time in the weeds with the details of analyses, specifics of populations, etc. It has to do this, because these details really matter (and it would be good to ensure that the paper is reviewed by people with more experience than I have at analyses of datasets like this, to ensure that issues of comparability of data among sources and across time is adequate to support the authors' conclusions). But the editor should read the paper with an eye as to whether it aims broadly enough with its Intro, Discussion, and Conclusions to serve Fish and Fisheries' objectives.

Line 126. "If survival across this vast swathe of relatively pristine territory is severe enough to seriously impact salmon productivity, then there is little hope that modifying freshwater habitat in more southern regions will support a newly productive environment for salmon." This seems logical, but I don't think most people involved in stream restoration are aiming for a "newly productive environment". They are aiming to increase the number of smolts that migrate to the sea, in the hopes that this will lead to stronger adult returns. If ocean survival is cut in half, then if twice as many smolts leave, that MIGHT mitigate the reduced ocean survival, though this depends crucially on the fitness of the smolts when they leave (e.g. reduced survival from hatcheries) and on negative density dependence, which could be severe if the ocean's carrying capacity is lower. All of this is just to say that the wording should be chosen carefully, in terms of objectives and caveats.

Line 142. "Although not explicitly stated, this seems to be the basis for setting the 2-6% rebuilding standard for the Columbia River." It's interesting that it's not obvious where this target came from, and the explanation doesn't mention 2%. It would be good if the authors could pin down the derivation of the targets, perhaps by contacting the authors of the report.

Line 146. "The SAR is the three-fold product of freshwater smolt survival during downstream migration multiplied by the marine survival experienced over two to three years in the ocean, and multiplied by adult freshwater survival during the upstream migration to the final census point." It would be good to state explicitly how fishing mortality fits in here. When I think of "returns" I usually take this to mean not including fishing mortality, i.e. returns are the num number of fish that return to the coast, and then may or may not be caught. This seems to be the correct interpretation based on Line 244, but readers shouldn't have to wait that long to find out.

Line 179. "Attempts to improve SARs by addressing region-specific issues such as freshwater habitat degradation or salmon aquaculture in coastal zones are therefore unlikely to be successful." Don't you mean "hatcheries", not "aquaculture"? Aquaculture is fish farming; no intentional releases and nothing to do with attempts to improve fish survival. And again, smolt-to-adult returns may not be improved by addressing habitat degradation, but the total number of smolts that leave may be improved.

Line 220. Typo. "is to note that that after log-transformation the mean…"

Line 221. Something missing here "We therefore use the simpler terminology both for clarity and because. Furthermore, the median is invariant under log-transformation, which is not true for the mean. Pacific Salmon Commission (CWT)".

Line 274. "should include hatchery rack returns," What is a hatchery rack return?

Fig. 2 is difficult to read. Consider splitting it in half and present 2 panels one below the other. There is no logical reason to run them all out in a single horizontal row. The caption says "Annual SAR estimates for Hatchery (H), Wild (W), and mixed hatchery-wild data sources (B) are shown…". I don't see those symbols / distinctions among data sources in this figure.

Fig. 3. At first I missed the legend to distinguish whether populations are wild, hatchery or mixture. Why do some population names include additional symbols for these distinctions, but others not?

Reviewer: 3

Comments to the Author

Title: Review of the Coast-wide Decline in Survival of West Coast Chinook Salmon (Oncorhynchus tshawytscha)

Authors: DW Welch, AD Porter, EL Rechisky Manuscript ID: FaF-20-Jun-OA-162

Summary: In this manuscript the authors present an analysis and review of patterns and trends in the survival of Chinook salmon stocks from southeastern Alaska to California. To accomplish this, they collected the historical smolt and return data for 123 stocks that are tagged as juveniles or smolt using either coded-wire (CWT) or passive integrated transponder tags (PIT). Survival was estimated as the smolt-to-adult return (SAR) rate, where return included both harvest and escapement information. While there is are comprehensive programs to sample harvest for CWT across this stretch of coast, no such program exists for PIT leading to SAR estimates that are concordant but biased compared with CWT-based estimates. The authors find that survivals have generally declined across stocks and almost all are below the rebuilding targets (2-6%) set for Columbia River stocks. Based on the observation that declines are consistent across a geographical scale where freshwater habitats range from highly compromised to almost pristine, the authors propose that the main causes are to be found in the marine environment.

Assessment: This manuscript will be interesting to a variety of audiences and will contribute to the ongoing conversation around the current demographic patterns and trends in this species in specific and all Pacific salmon species in general. The concept that one or more critical periods exist in the marine portion of the Chinook salmon life history has been discussed for decades, but the collation of data and presentation of a widespread pattern across this species adds to the discussion. Likewise, the discussion and demonstration that there are significant differences in data depending on the technology and design of application. Sometimes a great technology can't make up for lack of information. I appreciate the time and attention paid to the style and grammar used, which helped with reading and comprehension.

Recommendation: Publish with minor edits

Comments:

1. Line 130 – This is the first use of SAR and a definition is not supplied until Line 145

2. Line 170 – From the text (e.g. Line 734) the changes referred to at this point happened two decades ago, in 1999. The treaty has been renegotiated twice in that period. This needs clarification.

3. Line 182 – Why is the call to funding agencies and not management agencies or trans-jurisdictional management organizations?

4. Line 221 – The end of this sentence is missing.

5. Line 225 – “coastwide” is not and appropriate descriptor. The Treaty only covers fisheries from Cape Suckling, Alaska to Cape Falcon, Oregon.

6. Line 312 – This statemen is true, but could be better worded since the point being made concerns the measurement of the “return”, a term that is hidden in the acronym, SAR. The finer point here may not be clear to a reader that is not familiar with salmon management. See Line 635.

7. Line 341 – “essentially immune” may be too strong as there can be fishery removals at remote marine locations in the Gulf of Alaska and southern Bering Sea and many yearling stocks are subject to a period of harvest in nearshore fisheries.

8. Lines 350 to 354 – Limiting the years to 2010-2014 is explained, but the rationale is not clear. Not including through 2008 because it was unusually cold while not acknowledging the unusual warmth that these boodyears experienced in the marine environment during 2014 and 2015 seems inconsistent.

9. Line 360 – It would help to incorporate the description of this analysis in Lines 444-446 into the description here. The inclusion of SAR_SNAK,j in the equation was confusing until I was reminded that every region was normalized to the Snake River.

10. Line 551 ff – Consider including Howard et al. 2016 and/or Murphy et al. 2017 to the lists for growth and

ocean conditions to extend the range of observations

11. Line 558 – Consider including Seitz et al., 2019 for marine predation

12. Line 607 – This statement is backwards according to the equation at Line 235

13. The style and format of the intext citations varies widely and was actually quite distracting. For example in the paragraph beginning at Line 551.

14. Citation at line 1135 is missing information and difficult to locate. Suggest adding the following information: "Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative retrieved from http://www.aykssi.org/aykssi-chinook-salmon-research-action-plan-2013/"

15. Figure 2 was too small to be informative.

Suggested Citations:

Howard, K. G., Murphy, J. M., Wilson, L. I., Moss, J. H., & Farley Jr, E. V. (2016). Size-selective mortality of Chinook salmon in relation to body energy after the first summer in nearshore marine habitats. N Pac Anad Fish Comm Bull, 6, 1-11.

Murphy, J. M., Howard, K. G., Gann, J. C., Cieciel, K. C., Templin, W. D., & Guthrie III, C. M. (2017). Juvenile Chinook salmon abundance in the northern Bering Sea: Implications for future returns and fisheries in the Yukon River. Deep Sea Research Part II: Topical Studies in Oceanography, 135, 156-167.

Seitz, A. C., Courtney, M. B., Evans, M. D., & Manishin, K. (2019). Pop-up satellite archival tags reveal evidence of intense predation on large immature Chinook salmon (Oncorhynchus tshawytscha) in the North Pacific Ocean.

Canadian Journal of Fisheries and Aquatic Sciences, 76(9), 1608-1615.

Reviewer: 1

Reviewer Identity:

Reviewer: 2

Reviewer Identity:

Reviewer: 3

Reviewer Identity:

From: David Welch

Sent: Fri Aug 21 11:05:43 2020

To: Ben Zelinsky

Subject: [EXTERNAL] A potential Opportunity to expand West Coast telemetry arrays....

Importance: Normal

Hi Ben-

I wonder if we could have a catch up call? Communications with Christine and colleagues seems to have fallen way off, presumably because of exhaustion from getting the EIS published and trying to fit in summer holidays.

A possible opportunity has come up that might address some issues that Scott Armentrout's predecessor, Bryan Mercier, had said to me in a conversation 3(?) years ago.

Specifically, Bryan Mercier had said that "it would be huge" for BPA if Kintama was not a for profit because that would improve the optics of what we were saying. I was surprised that he was that emphatic in what he said, but a potential opportunity to entrain potential BPA financial support for a newly re-energized POST telemetry array with Canadian government support has arisen.

I know that the timing is poor from BPA's perspective with Elliot Mainzer just announcing he is stepping down, but I think it would be worth outlining the opportunity from BPA (& the region's) perspective.

Just about anytime works for me other than today. [redacted]

Hope you are well,

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

755 Terminal Ave N, Nanaimo BC V9S 4K1 Canada

Office Mobile: [redacted]

Home Tel: [redacted] (For the duration of the pandemic!)

david.welch@kintama.com

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fisheries work on-line: http://kintama.com/media/videos/

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From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Aug 27 14:59:08 2020

To: 'David Welch'

Subject: RE: Fraser sockeye returns

Importance: Normal

Hi David,

I was able to speak with Jody Lando. I suppose our answer might sound similar to what we were saying before. Basically, we highly value your work, but are not in a position to pursue additional work at this time. I am not sure what to say regarding a future schedule of potentially initiating (or reinitiating) new technical services work. Our regional process relating to monitoring outcomes under the new 'flexible spill' rules, and tracking progress towards recovery under the Endangered species act will be ongoing and I think you are pretty familiar with how things have unfolded in the past under the 2008 and 2000 BiOp (we tend to keep retreading the same questions and debates over and over). But I do not know when BPA will be able to start new things. Your current publication will be very valuable to distribute and share amongst regional parties.

Christine

-----Original Message-----
From: David Welch <David.Welch@Kintama.com>
Sent: Wednesday, August 26, 2020 12:07 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] RE: Fraser sockeye returns

I strongly suspect that the marine mammal issue is a big one all along the coast-- seals & sea lion populations are now 5X what they were in earlier decades. I also have a hunch that although some seals eat smolts on their way out to sea, the much bigger impact may be on the returning adults. I think the case for that is when we look at the return timing of the adult runs-- it is all over the map, starting with the Spring runs of Chinook (& a very few chum runs) to the late fall.

From an evolutionary perspective, giving up that last summer of growth shouldn't happen unless there are strong counteracting forces to staying out at sea until it is time to migrate upriver--body size would increase by about 50%, so that is giving up a 50% increase in egg numbers for females and the ability of males to fight & compete much more capably for females. So I suspect that there is much stronger and more directed predation at sea shaping these behavioural decisions than we currently perceive.

On a different note, I wonder if you could update me on whether BPA is interested in pursuing the other work that we had discussed (and some started) several years ago. I am sure it is challenging to get people together due to the EIS just wrapping up, summer holidays, and COVID challenges, but it would be helpful to get an idea as to whether BPA still has an interest and a budget to support that work.

David

-----Original Message-----
From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: Tuesday, August 25, 2020 2:03 PM
To: David Welch <David.Welch@Kintama.com>
Subject: RE: Fraser sockeye returns

Hi David,

That is interesting. The upper Columbia sockeye are having an average year as far as abundance (although I don't know if they could get a SAR yet - it would probably be either Jeff Fryer or the Okanagan Nation to do it). That is notable because the Fraser isn't doing so well, and the spring Chinook were doing poorly. It was also interesting that the upper Columbia summer run was doing fairly well - which is a subyearling run. Fall run are doing well in the first week. You could imagine that subyearlings are doing well either due to ocean conditions this past year (or being able to avoid the really high spill) but those sockeye go out earlier than the other yearlings two years ago. It could be that this run is just doing really well after they straightened out the habitat - so maybe there are a ton of juveniles in Wenatchee and Osoyoos.

Have you heard that NOAA has announced they will permit culling of about 800 sea lions per year? I don't know if it is very widely known yet - there hasn't been as much protest as several years ago when they did just a few. The tribes were really speaking up for this. The data from the Science Center really supports it as a limiting factor for the early spring run.

We should mostly be all back (but not in the office) in September. I'm going to talk to Jody Lando tomorrow.

Christine

-----Original Message-----
From: David Welch <David.Welch@Kintama.com>
Sent: Tuesday, August 18, 2020 9:49 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] Fraser sockeye returns

Interesting report on just how dire the issues are for Fraser River sockeye.

David

https://thenarwhal.ca/low-fraser-river-sockeye-salmon-bc/

David Welch
M: [redacted]
Kintama Research Services
Sent from my iPhone

From: David Welch

Sent: Tue Sep 01 20:28:00 2020

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: Clearing Up, Issue 1968

Importance: Normal

Thanks!

My sense is that "interpreting" ambiguous survival data in terms of what various groups hope to see is what has driven the Columbia to have the suite of issues it currently does. For example, there is a rather uncritical acceptance of delayed mortality being an important issue (with even NOAA rolling over and accepting this view recently), but the data is actually quite ambiguous—see our draft paper for a demonstration of how the FPC zeroed in on the populations that fit the expected pattern of higher SARS for populations that don't go through the Snake River dams, but missed/ignored the populations that don't fit with their preferred interpretation.

There is now a rich and recent literature in the biomedical literature on just these issues—there has been a belated recognition that there is far too much interpretation of outcomes as opposed to analysis based on well-posed and high statistical power studies. I think that the Columbia River basin salmon issues suffer from this exact same selective bias.

I wonder if we could schedule a call to talk about your thoughts on what might develop next?—I am of two minds as to whether to just abandon the Columbia as being too unwilling to change, despite the potentially huge economic savings from adopting a more critical view of how salmon survival studies are done (& interpreted).

David

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: Tuesday, September 01, 2020 12:11 PM
To: David Welch <David.Welch@Kintama.com>
Subject: Clearing Up, Issue 1968

Take a look at the River Partners proposal here, in the pdf version of Clearing Up. I wonder how they could achieve consensus on how to carry out an experiment. The current 'experiment' is a 10 year+ approach of doing higher spill and then debating what SAR and in-river survival we see.

I have been contemplating this graph this morning. I don't think this matches what we see with SARs for any ESU from the 60s or 70s until present. The PITPH calculation had us at 5-6 dams/8 back in the 1990s, but we are at 1-2 recently? Have SARs tripled?

https://www.fpc.org/documents/memos/30-20.pdf

Subject: [EXTERNAL] Clearing Up, Issue 1968

You can access this week's issue of Clearing Up on the Web or as a PDF...or both!

For the online version of Clearing Up, go to

https://www.newsdata.com/clearing_up/

As a subscriber you have full access to digital content allowed by your subscription, once you've completed a simple registration process. Please visit https://www.newsdata.com/tutorial-create-a-login/video_bbd2af52-d02c-11e9-adfe-3fc4ba234b3c.html for information on how to register.

The Clearing Up website also features archives of past issues and links to other NewsData news and information services.

For the PDF version, click this link for this week's issue of Clearing Up:

https://grok.newsdata.com/cgi-bin/viewpdf.cgi?iss=cup1968&cid=IFJrjXxjxeiQ

You can also paste the link into your browser's address box and press Enter (or Return). The issue should appear after a moment.

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From: Zelinsky,Benjamin D (BPA) - E-4

Sent: Tue Sep 08 11:57:03 2020

To: David Welch

Subject: [EXTERNAL] RE: [EXTERNAL] A potential Opportunity to expand West Coast telemetry arrays....

Importance: Normal

Yes - this is the most national news we have had in awhile - seems to be if greater interest nationally and internationally than locally frankly.

How about Mon at 10?

Glad you are using your old man "strength" to good effect :) It is a go to move of mine too.

Ben

Sent from Workspace ONE Boxer

On Sep 8, 2020 11:18 AM, David Welch <David.Welch@Kintama.com> wrote:

Good to hear all is well with you guys too… I know the out-of-control rioting in "Democrat controlled" Portland is unlikely to affect you & the others I know at BPA, but it is still sobering when it populations up in the news.

Anytime next week is wide open, apart from 4-5 pm on Tuesday, so suggest something that will work for you and I am sure I can accommodate.

David

P.S. (b) (6) [redacted]
(b) (6) [redacted]

From: Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>
Sent: Tuesday, September 08, 2020 10:43 AM
To: David Welch <David.Welch@Kintama.com>
Subject: [EXTERNAL] A potential Opportunity to expand West Coast telemetry arrays....

Hello David

My apologies for the slow response and (b) (6) [redacted]

Glad to hear you are well. We are doing just fine too although the wind has knocked out our power for the day. One upside being I'm limited to working on my phone and catching up on email.

Let's find a time to catch up - I'd like to hear your thoughts. This week is a little crazy wrapping up the EIS Record of Decision but next week could work.

Any times better than others?

Ben

Sent from Workspace ONE Boxer

On Aug 21, 2020 11:05 AM, David Welch <David.Welch@Kintama.com> wrote:

Hi Ben-

I wonder if we could have a catch up call? Communications with Christine and colleagues seems to have fallen way off, presumably because of exhaustion from getting the EIS published and trying to fit in summer holidays.

A possible opportunity has come up that might address some issues that Scott Armentrout's predecessor, Bryan Mercier, had said to me in a conversation 3(?) years ago.

Specifically, Bryan Mercier had said that "it would be huge" for BPA if Kintama was not a for profit because that would improve the optics of what we were saying. I was surprised that he was that emphatic in what he said, but a potential opportunity to entrain potential BPA financial support for a newly re-energized POST telemetry array with Canadian government support has arisen.

I know that the timing is poor from BPA's perspective with Elliot Mainzer just announcing he is stepping down, but I think it would be worth outlining the opportunity from BPA (& the region's) perspective.

Just about anytime works for me other than today. (b) (6) [redacted]
(b) (6) [redacted]

Hope you are well,

David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd

755 Terminal Ave N, Nanaimo BC V9S 4K1 Canada

Office Mobile: (b) (6) [redacted]

Home Tel: (b) (6) [redacted] for the duration of the pandemic!)

david.welch@kintama.com

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fisheries work on-line: http://kintama.com/media/videos/

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From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Sep 25 16:50:47 2020

To: 'David Welch'

Subject: RE: Manuscript Accepted - Updates Approved FaF-20-Jun-OA-162.R1 [email ref: ENR-AW-1-e]

Importance: Normal

Hi David,

Congratulations! We had just been trying to cite your final study for our BA document on Wednesday.

I spoke with Jody, and we would like to follow up with a phone call, but I need her to suggest the time and set it up. She has been briefing our upper management on your paper.

I am in Seattle area this week (b) (6) [redacted] This rain is luckily putting out these fires. A couple years ago, it was BC suffering the worst wildfires. It is amazing how it is so wind driven - one of the fires came from the Warm Springs reservation area where it had been puffing along without serious danger during the previous month. A lot of these areas where the five recent fires spread are by the Willamette river reservoirs, and we have yet to see how intense they were - one of the TV stations showed the Detroit reservoir area, and parts of it made it look like the fire was rather patchy and did spare a lot of trees, however a few small towns suffered major losses of houses.

We will hopefully contact you next week to cover the manuscript and other things - Jody Lando will set it up.

I hope you have a nice weekend - I might try to do the north Cascades highway with family.
Christine Petersen

-----Original Message-----
From: David Welch <David.Welch@Kintama.com>
Sent: Thursday, September 24, 2020 4:27 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] FW: Manuscript Accepted - Updates Approved FaF-20-Jun-OA-162.R1 [email ref: ENR-AW-1-e]

Hi Christine--

After a few trivial requests concerning the processing of the final paper, the paper has now been formally accepted and scheduled for publication. (See the email below; last week they asked us to change the title of the paper from "A Review..." to "A Synthesis..." for example. A few others of similar import had to be done as well, such as including the Latin name for the family of fish we were dealing with (Salmonidae...sigh!).).

Anyway, all that is done & dusted. I would expect from a message I received a month or two ago that the actual publication will occur in 2-3 weeks from now, but at this point with Britain moving into major COVID lockdown anything is possible, I suppose. "Batten down the hatches" is perhaps the best advice I can give!

It would be useful to touch base on a few final issues. Is there a time that would work for a Zoom or Teams call?

David

P.S. Final (now formally accepted) version of the paper is attached for your information. Nothing of substance has changed, as I indicated, apart from the title.

-----Original Message-----
From: Sue Hart <onbehalfof@manuscriptcentral.com>
Sent: September 24, 2020 4:10 PM
To: David Welch <David.Welch@Kintama.com>
Subject: Manuscript Accepted - Updates Approved FaF-20-Jun-OA-162.R1 [email ref: ENR-AW-1-e]

24-Sep-2020

Dear Dr. Welch:

Manuscript id: FaF-20-Jun-OA-162.R1

The final files that you submitted for your manuscript have been checked and have been found to be suitable for publication and so will be forwarded to the publisher shortly.

Publication in the journal is free and colour figures may be published online free of charge. There is, however, a cost for publishing colour figures in the print version.

If you supply colour figures you will be invited to complete a colour charge agreement in RightsLink for Author Services once the paper is published on Early View. You will be given the option of paying immediately with a credit or debit card, or you can request an invoice. If you choose not to purchase colour printing, the figures will be converted to black and white for the print issue of the journal.

Due to a change in the way in which proofs are presented to authors it may currently be the case that not all corrections that you make are transfered correctly to the final print-ready version.

Early View will be the first opportunity for you to see the final print-ready version unlike the former proof system which allowed one to see, read and edit a print-ready version of the paper.

We therefore suggest that you check your Early View paper carefully for any errors at the earliest opportunity and contact Production if there are any problems.

Sincerely,
Fish and Fisheries Editorial Office

From: Petersen,Christine H (BPA) - EWP-4

Sent: Tue Nov 03 10:37:43 2020

To: 'David Welch'; Erin Rechisky

Subject: RE: Fishing, Conservation Groups Take Step to Renew Legal Challenge to Columbia-Snake Hydropower Operations

Importance: Normal

Hi,

Yes, as of today I have heard quite a few people mentioning it (so the press release worked), and someone at the Corps reached out to our management asking about whether there is a plan to promote or distribute it. I still have to hear from more people on this, and I should be able to talk to Jody later today.

Talk to you soon,

Christine

From: David Welch <David.Welch@Kintama.com>
Sent: Monday, November 2, 2020 12:23 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>; Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: [EXTERNAL] RE: Fishing, Conservation Groups Take Step to Renew Legal Challenge to Columbia-Snake Hydropower Operations

Thanks, Christine-- Interesting reading! I am, yet again, struck by how so much of the claims are interpretative rather than grounded in a rigorous quantitative analysis of how much it actually affects survival.

I wonder—was Judy Lando actually still planning to have a meeting with us? I have heard nothing as yet.

Also, has there been any feedback on our publication—particularly as to the credibility of our work? Or is that too soon and are people just keeping their collective heads down waiting to see what the reaction is?

Regards, David

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: November 2, 2020 12:05 PM
To: Erin Rechisky <Erin.Rechisky@Kintama.com>; David Welch <David.Welch@Kintama.com>
Subject: FW: Fishing, Conservation Groups Take Step to Renew Legal Challenge to Columbia-Snake Hydropower Operations

Hi,,

Below is the notice of intent to sue (a regular pattern, as you know). There is a suggestion that water temperatures (e.g. summer of 2015) will be a theme, or part of what reservoir managers will be held liable for mitigating. If you follow the embedded links, I was interested in the Washington Dept Ecology blog post. It has some mistakes in it.

Water temperature physics, hydrology, and reservoir management are specialty topics, and I have been at a meeting with the purpose of writing guidelines for water management for ecosystem benefit, where USGS (specialists in many things) needed to have the Bureau of Reclamation explain the basics of how the far upstream reservoirs are managed. The USGS participants who did sturgeon research essentially called for flow augmentation all year, with the perspective that it is important for spawning (very true, and validated), and that more water also keeps the water cooler. The Bureau of Rec participants had to explain that it is impossible to store tons of water and augment during most of the year. The fall Chinook researcher had concern over food retention time and said normal historical August flows might be important for feeding. The second contention about releasing flows from upstream is a belief many people have because it is intuitive (see the phrases concerning warm, stagnant reservoirs, even though these are high volume run of river reservoirs, in sharp contrast to many tributary reservoirs with low flow), and you can see it implied that both lower flows in summer and the presence of the reservoir heats the water. I would say that the larger surface area of reservoirs has a small-moderate net effect of gathering more heat, but it also delays the peak temperature by several weeks, which could be important for sockeye in July. Also, faster moving water is not necessarily cooler – it comes from the same inland location. Deep reservoirs like Dworshak can provide cooling, but Grand Coulee, Revelstoke, Mica are not stratified due to the large volumes moving through and have limited potential for cooling in summer. (I didn't understand that before I worked here).

There will, of course, be other themes in the lawsuit – last time the depositions had many pages of claims.

Christine

From: Ball,Crystal A (BPA) - EW-4 <caball@bpa.gov>
Sent: Friday, October 23, 2020 10:21 AM
To: ADL_EW_ALL <ADL_EW_ALL@BPASite1.bpa.gov>
Subject: FW: Fishing, Conservation Groups Take Step to Renew Legal Challenge to Columbia-Snake Hydropower Operations

Earthjustice on behalf of a coalition of fishing and conservation groups sent a 60-day notice of their intent to return to court to challenge the latest federal plan for hydropower operations on the Snake and Columbia Rivers.

From: Peacock Williamson,Julie (BPA) - DIR-7 <jxpeacockwilliamson@bpa.gov>
Sent: Friday, October 23, 2020 9:58 AM
To: ADL_DIR_ALL <ADL_DIR_ALL@BPASite1.bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Armentrout,Scott G (BPA) - E-4 <sgarmentrout@bpa.gov>; Welch,Dorothy W (BPA) - E-4 <dwwelch@bpa.gov>; Ball,Crystal A (BPA) - EW-4 <caball@bpa.gov>; Cogswell,Peter (BPA) - DI-7 <ptcogswell@bpa.gov>; Kaseweter,Alisa D (BPA) - DI-7 <alkaseweter@bpa.gov>; James,Daniel M (BPA) - D-7 <dmjames@bpa.gov>; Sweet,Jason C (BPA) - PGB-5 <jcsweet@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: Fishing, Conservation Groups Take Step to Renew Legal Challenge to Columbia-Snake Hydropower Operations

https://www.commondreams.org/sites/default/files/organizations/screen_shot_2020-08-25_at_2.19.42_pm.png

For Immediate Release

Friday, October 23, 2020

Organization Profile:

Earthjustice

Contact:

Maggie Caldwell, mcaldwell@earthjustice.org, (347) 527-6397, Brett VandenHeuvel, bv@columbiariverkeeper.org

Fishing, Conservation Groups Take Step to Renew Legal Challenge to Columbia-Snake Hydropower Operations

The long legal battle continues after latest federal plan fails to restore endangered salmon.

WASHINGTON - Today, Earthjustice on behalf of a coalition of fishing and conservation groups sent a 60-day notice of their intentto return to court to challenge the latest federal plan for hydropower operations on the Snake and Columbia Rivers. This would be the sixth incarnation of a long legal fight focused on restoring endangered salmon and steelhead. The groups sending the notice have won the previous five challenges but theTrump administration continues to pursue essentially the same strategy courts have consistently rejected.

Earthjustice represents American Rivers, Idaho Rivers United, Institute for Fisheries Resources, NW Energy Coalition, Northwest Sportfishing Industry Association, Natural Resources Defense Council, Pacific Coast Federation of Fishermen's Associations, Sierra Club, National Wildlife Federation, Columbia Riverkeeper, and Idaho Conservation League.

In the notice, the fishing and conservation groups will also challenge recent Trump administration rollbacks to the Endangered Species Act regulations, changes that a coalition of states and conservation organizations have also challenged in separate cases. The latest federal plan for dam operations relies on these new weakened regulations to support its conclusions.

The following are statements from the lawyers and plaintiff groups:

"Hundreds of thousands of people in the region—including tribes, scientists, energy experts, and fishing businesses—told the agencies to remove the four dams that are causing the most harm to the fish and to our communities. But the Trump administration did not listen and rubber-stamped a plan that yet again fails to take the legally-required actions necessary to protect salmon and steelhead. So we have no choice but to begin the process of going back to court again. What we need more urgently than ever is for our senators and members of Congress to step forward and develop a comprehensive solution that will secure a future with abundant salmon, clean energy and prosperous communities." —Todd True, Earthjustice attorney representing the groups.

"The oversight of the federal courts has been critical to ensure that our agencies and political leaders commit to salmon recovery in the Columbia Basin. Restoring the magnificent runs of salmon in the Columbia and Snake Rivers remains one of the National Wildlife Federation's highest priorities."—Tom France, Regional Executive Director, National Wildlife Federation

"Covid has proven that people in this region harbor a deep need to get outdoors and feel safe while doing so. We've seen more families out on the rivers sportfishing than ever before. When we go out and fish, we're expressing hope. If we lose the salmon, then we lose that hope. The federal plan is dangerous and does a grave disservice to the people who love to fish these rivers, and we could not let it go unchallenged." —Liz Hamilton, Executive Director, Northwest Sportfishing Industry Association.

"The once great, but now damaged, salmon runs of the Columbia Basin, originally the largest in the world, still support valuable ocean commercial salmon fisheries from central California to Southeast Alaska. Studies have shown that about 25,000 family wage jobs, and more than $500 million/year in economic benefits, could be restored to the west coast economy by recovering the Columbia's damaged salmon runs. In short, restoring salmon means restoring jobs and dollars to our economy. The illegal Trump administration salmon plan, however, blatantly ignores those restoration benefits."—Glen Spain, Northwest Regional Director, Pacific Coast Federation of Fishermen's Associations (PCFFA)

"The latest federal plan for dams on the Snake and Columbia Rivers completely fails Idaho. It isn't good enough for the many guides, outfitters, river businesses, and communities in Idaho that depend on healthy runs of fish. We want to restore wild salmon and steelhead in ecological and economically significant numbers. We want abundant, healthy and harvestable runs, meaningful populations that allow people to harvest wild fish and for wild fish to fulfill their role supporting wildlife and the ecology of Idaho."—Justin Hayes, Executive Director, Idaho Conservation League

"We are returning to court because the Trump administration has failed Northwest salmon, tribes, fishing business, and orcas. Like past plans, this one will not recover abundant salmon runs or comply with the Endangered Species Act. While legal action is necessary to protect our iconic species from extinction, we desperately need Members of Congress from Oregon, Washington, and Idaho to get off the bench and secure an inclusive, regional solution."

—Brett VandenHeuvel, Executive Director, Columbia Riverkeeper

"The failure of this federal plan to adequately address the rapid extirpation of salmon and steelhead in Idaho and the Snake River Basin cannot be overstated. Instead of proposing solutions that get us to an abundance of wild fish, this continues down the decades long path of failed recovery efforts. This plan fails Idaho, the angling and guiding communities, the Tribal treaty rights, and the ecological integrity of this system that depend upon healthy and increasing populations of what was once one of the greatest Chinook fisheries in the world." —Nic Nelson, Executive Director, Idaho Rivers United

Online version of this press release.

BACKGROUND:

The Columbia River Basin was once among the greatest salmon-producing river systems in the world. But all remaining salmon on its largest tributary, the Snake River, are facing extinction. Four aging dams in Washington—Ice Harbor, Little Goose, Lower Monumental, Lower Granite —block passage along the lower Snake River, a major migration corridor linking pristine cold-water streams in central Idaho to the mighty Columbia River and out to the Pacific Ocean. Scientists say restoring the lower Snake River by taking out the dams is the single best thing we can do to save the salmon.

Migrating through the dams is difficult for the fish, but rising water temperatures caused by the slackwater reservoirs make the passage increasingly deadly. In 2015, some of the earliest and hottest weather on record produced warm river temperatures that killed more than 90% of all adult sockeye salmon returning to the Columbia Basin. In years since, state agencies have had to limit or cancel entire fishing seasons to protect the dwindling fish.

The district court in 2016 found the operations of the hydropower systems in violation of the Endangered Species Act and the National Environmental Policy Act and ordered the federal agencies to prepare a new biological opinion and environmental impact statement. The federal action agencies—the Army Corps of Engineers, the Bureau of Reclamation, and the Bonneville Power Administration—issued their Final Environmental Impact Statement for dam operations in July 2020, and the National Oceanic and Atmospheric Administration issued a companion Biological Opinion that found the proposed plan would not jeopardize salmon, steelhead, or orcas.

On September 28, 2020, the action agencies issued a joint Record of Decision, opting to continue a course of action the court has previously found inadequate to comply with the Endangered Species Act.

Independent researchers who have studied the economics of restoring a free-flowing lower Snake River and renewable power replacement options favor dam removal.

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https://www.commondreams.org/newswire/2020/10/23/fishing-conservation-groups-take-step-renew-legal-challenge-columbia-snake?cd-origin=rss

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Julie Peacock

Oregon Liaison | Regional Relations

Bonneville Power Administration
bpa.gov | Desk: 503.230.3100 | Cell: [redacted]

From: David Welch

Sent: Tue Nov 03 12:09:37 2020

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] FW: Scientia - editorial process complete

Importance: Normal

Attachments: Kintama Chinook SARs Comparison-Print Version.pdf; Kintama Chinook SARs Comparison-Low Res Version.pdf

Hi Christine—

Thanks for your email. This wrap-up email (below) came in this morning, the relevant parts of which I am sharing with you—attached are two versions of the same summary article (the 12 MB one is intended for print, the small (2 MB) one for distributing in emails). The article will be included in a soon-to-be released compendium of environmental science stories when other articles are done.

Feel free to pass on either of the two attached versions of the article as appropriate inside or outside of BPA. Everything is in the public domain and freely available including, of course, the animation hosted on YouTube (https://youtu.be/FN7yp3FefB8).

In the paper (& the animation/policy summary) I have treated the fact that two arms of the US government were unwittingly acting in opposition to one another as lightly as I could. However, the reality is that what we identified is a positive feedback loop, where the US-Canada fishery management process under the treaty has, since 1999, operated to largely wipe out any positive signal from improvements the dams might have on the adult returns and ameliorate any negative effects. In all probability, Columbia River SAR analysts were probably, at best, analyzing noise in studying the adult return. At worst, they may have gotten their policy recommendations exactly wrong.

It is probably difficult for the folks in the Columbia to realize that they were this badly wrong in all their adult survival analyses using PIT tags, and that such a fundamentally flawed oversight could exist in such a complex research environment and for so long without ever being identified. (I certainly didn't set out thinking that the PIT tag system was this badly flawed, and really only came to this realization after the FPC stonewalled us in our requests for their data last year—that's what set us digging into the basics!).

However, the big issue is that all of the SAR analyses underlying two decades of Columbia River BiOPs are based on these PIT tags and the built-in flaw in that system that we describe. (Smolt survival analyses will not be impacted—only studies using adult survival). We have explicitly chosen not to identify the true magnitude of the impact on the BiOP(s) from this error. However, others surely will.

It would make sense to get ahead of the curve here and I would suggest that we discuss the contract I had proposed to re-analyse Steve Haeseker's original statistical finding that increased spill leads to improved adult returns (SARs) 2 years later. More generally, the timing is clearly ripe for now asking whether a number of "key beliefs" in salmon restoration efforts within the Columbia are really well-founded. Perhaps we can discuss this when Jody Lando has time for a call—as yet, I haven't heard from her. Here, finishing up our paper showing that early marine survival rates of smolts are at best the same and, in at least some years, worse than smolt survival if the FCRPS makes a timely follow-on to the current publication and may help to fill a now gaping research void.

David

David Welch, Ph.D.

President, Kintama Research Services

755 Terminal Avenue, Nanaimo, BC Canada V9S 4K1

(m) [redacted]

From: nelly@sciencediffusion.com <nelly@sciencediffusion.com>
Sent: November 3, 2020 3:15 AM
To: David Welch <David.Welch@Kintama.com>
Subject: Scientia - editorial process complete

Dear David,

The editorial process for the article is now complete, and your audiobook will follow soon! I'd like to thank you so much for your input – we have enjoyed working with you immensely.

We are currently working with some of the other participants to be featured in this edition; once their articles are complete we can release the full edition. In the meantime, please find attached your finished article in high and low resolution formats.

In addition to the link to the HTML and pdf that I've already sent you (https://www.scientia.global/dr-david-welch-rethinking-strategies-for-increasing-salmon-survival ; https://www.scientia.global/wp-content/uploads/David_Welch/David_Welch.pdf), here is the DOI: https://doi.org/10.33548/SCIENTIA574

We suggest some of the following ways to personally utilise the article:

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We have also started the twitter campaign with your article, we encourage you and your colleagues to get involved and re-tweet, like and share the link:

https://twitter.com/scientia_social/status/1323582683134545922

Kind regards,

Nelly

Dr Nelly Berg

Editor-in-Chief

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W: www.scientia.global

W: www.scipod.global

IMPORTANT INFORMATION

From: Petersen,Christine H (BPA) - EWP-4

Sent: Tue Nov 10 09:50:55 2020

To: 'David Welch'

Subject: RE: Faulkner Rebuttal [by Oregon] & Response to Rebuttal [by Faulkner]

Importance: Normal

Hi David,

Kurt Miller of River Partners sent out a statement to regional governors, calling for more focus on climate change effects, and they cited your study.

Regarding sampling of resident fish, there were some requirements set out as part of the Flexible spill agreement with the states. Anadromous juveniles will be monitored at the bypasses via the Smolt Monitoring Program, and they also called for sampling 50 individuals of any three species of resident fish per week. It wasn't possible to carry this out last year. We have brainstormed using the pikeminnow rewards program to ask them to bring in smallmouth bass, walleye as well as pikeminnow, but we don't actually know the norms for these species – they probably stay somewhat deep and the critique is that as an angler brought it to the surface, they would give the fish added exposure. We have data for a few species that seem to use the ladders (peamouth etc), but other species don't use the ladders. It isn't that easy to catch sturgeon. We have proposed using a mixture of beach seining below the dam tailraces, and trapping near the ladders. Electrofishing was also proposed but requires a permit. This might be sole source justified for USGS to carry out because they have previously done this sort of thing for years, but we aren't sure yet.

FPC just proposed dropping the Rock Island, John Day and Monumental SMP sites in order to use the savings to fund more tagging in certain locations, so we are trying to figure out what our counterproposal is. One challenge is that we have generally talked but never done a quantitative analysis for what level of PIT tagging we endorse for various ESUs, especially given the changing detection rates.

Christine

From: David Welch <David.Welch@Kintama.com>
Sent: Sunday, November 8, 2020 1:43 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] RE: Faulkner Rebuttal [by Oregon] & Response to Rebuttal [by Faulkner]

Just wondered about this final comment of yours: "and we are currently trying to figure out how we would sample the adult species".

Is this based on PIT tags in the returns, or something else? Remember that unless/until the harvest is monitored for PIT tags the use of those tags for measuring survival is deeply compromised. We did not even hint at this in the published paper because of its sensitivity, but if you take survival back to LGR then you really need to get PIT tag monitoring of the Indian catch between Bonneville Dam & LGR in place—our reported harvest rates did not include those impacts. But if the proportion of the return that is harvested is at all variable in the upstream fisheries then it directly impacts the SAR estimates at LGR.

David

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: November 6, 2020 1:33 PM
To: David Welch <David.Welch@Kintama.com>
Subject: RE: Faulkner Rebuttal [by Oregon] & Response to Rebuttal [by Faulkner]

(b) (6) [redacted]

FPC just put out a memo which probably will appear on their site. They want to reduce effort at the Smolt monitoring project sites (which they oversee, but PSMFC staff carry out the work), and reallocate it for more CSS tagging effort and locations. The rationale is that then BPA wouldn't be able to say it costs too much because it would be a net neutral budget between these two projects. They are saying that Rock Island dam and John Day are not very useful for smolt monitoring. This will involve a negotiation. Part of it would weigh value of smolt condition data vs PIT survival statistical power, by ESU. As part of flexible spill, we are required to monitor juveniles and more adult resident species for gas bubble trauma, and we are currently trying to figure out how we would sample the adult species.

Christine

From: David Welch <David.Welch@Kintama.com>
Sent: Friday, November 6, 2020 10:34 AM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] RE: Faulkner Rebuttal [by Oregon] & Response to Rebuttal [by Faulkner]

(b) (6) [redacted]

All this talk of "non-representative samples" by the FPC is (forgive me) a red herring. Most areas of science don't pick data to fit a belief pattern—and they certainly don't base important conclusions on a correlation, as the Columbia is doing by basing operations on a projection of how spill will increase adult SARs. I would argue that in most areas of science where an important question needs to be resolved the correct way to do so should be to set up treatment and control groups using a randomized double blind study.

Just as with drug trials, the results really matter in the Columbia—you are basing the fate of billions of dollars of clean (non CO_2 producing) baseline power production on a very questionable correlation. I really don't understand how the FPC & Steve Haeseker managed to manouver the region into running the FCRPS on the basis of a possibly spurious correlation rather than testing the theory... the latter would be far cheaper and give a more rapid turnaround and clearer (higher statistical power) result.

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: November 4, 2020 3:51 PM
To: David Welch <David.Welch@Kintama.com>; Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: RE: Faulkner Rebuttal [by Oregon] & Response to Rebuttal [by Faulkner]

This is actually a great point, that the criticisms of the size limits of Vemco tags shouldn't should be reversed or dropped when there is now a focus on differential behavior by size. I should mention that to our hydro group. UW and PNNL were really put on the defensive for not being able to tag smolts below a certain size with JSATs Ryan Harnish's group at PNNL did a type of synthesis of the existing JSATs survival studies at all the dams, and I might be able to share this with you.

I was able to talk to Jody this afternoon. There has been some communication from the Corps and probably others as well that has been reaching Ben Zelinsky, Crystal Ball and others, and they would like a week for the dust to settle and see what the feedback is. As you saw with the Faulkner study, which was not strongly policy focused, there probably will be some opinions. It is very nice to have something published because that puts it in a good status for citing in legal arguments or our numerous planning documents.

Jody thinks that maybe the end of next week would work out for setting up a call? I will definitely remind her on Friday or Monday and then reach out to you to see what time might work.

Christine

From: David Welch <David.Welch@Kintama.com>
Sent: Wednesday, November 4, 2020 2:17 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>; Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: [EXTERNAL] RE: Faulkner Rebuttal [by Oregon] & Response to Rebuttal [by Faulkner]

Thanks—interesting reading.

I have only gotten part way through the exchange, but I am struck by—yet again—the FPC group arguing for "non-representative" fish as a big issue. ("*...salmon and steelhead tagged at Lower*

Granite Dam are unrepresentative of the overall population, and thus analyses based on these fish are likely misleading or spurious").

This is very common in how the group deals with analyses (Kintama's or others) that doesn't come up with their expectations... something must be wrong with the groups of fish used because they don't have the mortality pattern we predict.

Oddly, no one in the region seems to say...OK, let's go and see if the differences the FPC claim ***likely*** are be distorting up the results ***really are*** distorting the results. It seems that it is sufficient to claim that "maybe" it is a problem is good enough... no one goes to the effort of seeing whether it really does make a difference. The FPC used that same argument with our study of delayed mortality (Rechisky et al 2013); they argued that our use of smolts in the upper half of the size spectrum was unrepresentative because even though both the Yakima & Snake River smolt groups had equal survival migrating out over the array, the smaller half of the size spectrum ***might*** have given a different result. But they ignored the point that if the upper half of the size class had no difference in survival but by the time the adults came back there was a three-fold difference in adult survival, then if the smaller 50% of the fish had delayed mortality because of the Snake River dams their survival now had to be ***1/6th*** that of the Yakima fish, not 1/3rd!

Oddly, they didn't seem to be in favour of us re-doing the experiment using the smaller tags now available. Nor, unsurprisingly, did they ever cite the Rechisky et al (2014) MEPS paper where by shifting tagging to Bonneville & John Day dam we were able to tag a much greater fraction of the size range of smolts and still found no difference in survival relative to prior dam passage.

An awful lot of money gets wasted in the Columbia because people just argue and rationalize why what they believe to be true rather than actually rolling up their sleeves and actually doing the work to test their beliefs.

dw

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: November 4, 2020 11:53 AM
To: Erin Rechisky <Erin.Rechisky@Kintama.com>; David Welch <David.Welch@Kintama.com>
Subject: FW: Faulkner Rebuttal [by Oregon] & Response to Rebuttal [by Faulkner]

Hi,

I'm watching at Wisconsin and Michigan pull ahead this morning?

Anyway, I am forwarding the FPC review and Faulkner et al. rebuttal to their paper at TAFS. Sort of interesting how involved this was getting. SARs and delayed mortality are at the center of it. I have been interested in the phenomenon of CSS study hatchery fish having higher mean SAR than the NOAA LGR tagged study smolts. They assert that this has to be due to a tremendous effect of going through a single bypass at Lower Granite, however the difference between CO and C1 (no detections at Lower Granite, Goose or Monumental vs one or more) is only 10% for Chinook and steelhead, (and no difference for subyearlings), so that just doesn't add up.

I will hopefully reach Jody later this afternoon

Christine

From: Sullivan,Leah S (BPA) - EWP-4 <lssullivan@bpa.gov>
Sent: Tuesday, October 27, 2020 1:46 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: FW: Faulkner Rebuttal [by Oregon] & Response to Rebuttal [by Faulkner]

Christine, Scott – Have you heard much about this "dance?" See attachments. I'm going to try to review and digest as time permits tomorrow.

Leah

From: Studebaker, Cynthia A CIV (USA) <Cynthia.A.Studebaker@usace.army.mil>
Sent: Tuesday, October 27, 2020 10:26 AM
To: Sullivan,Leah S (BPA) - EWP-4 <lssullivan@bpa.gov>
Subject: [EXTERNAL] FW: Faulkner Rebuttal [by Oregon] & Response to Rebuttal [by Faulkner]

From: David Welch

Sent: Tue Nov 10 18:44:13 2020

To: Petersen,Christine H (BPA) - EWP-4; Erin Rechisky

Subject: [EXTERNAL] RE: NWRP Press Statement: Dozens of Regional Leaders Call for Holistic Approach to Four-State Process

Importance: Normal

Yes, thanks Christine—

I will definitely be interested to hear what the comments are from Jason—I hadn't thought that K.C. Mehaffey would actually lead off her piece with my rather critical responses to her questions (I thought they should wrap the article up with them), but I think the issues do need to be addressed. I am outlining them here in some greater detail for your internal discussions:

1. Why have regional biologists failed to identify that the reported numerical value of SARs are nearly the same almost everywhere? (Surely, if people were doing a good job they should have identified this issue long ago and either factored it into their thinking ***<u>or found out why the reported SAR values were misleading</u>***). Puget Sound SARs are even from the same State. How could people have missed this—or were they just afraid to break ranks and point out the obvious?

2. Failing to incorporate and include harvest in the SAR estimates is really bad news for the regional process. Several generations of BiOPs have now relied heavily on this data. Why the existing gov't data on what harvest levels actually are wasn't identified and factored into these analyses years ago is a mystery to

me. Again, it just cries out to ask "*How much else was missed by people blind to the obvious*"? (Ironically, I have to credit Michelle DeHart with stimulating us to discover this—if she hadn't stonewalled me and instead simply provided the SAR estimates with the above-LGR survival included as we had requested, we probably might not have dug into the details of in our attempt to re-create the estimates). I very much doubt that the last 22+ years of SAR estimates by NOAA and the FPC can actually be used in the BiOPs or other regional processes—it is not at all clear that past harvest data is sufficiently good to allow use without potentially serious distortion of the SAR estimates. (In other words, harvest may be gig and this important, but it isn't clear how reliable the harvest data is). It is also not clear how many key population groups have harvest data available.

3. I deliberately low-balled this next point in the Fish & Fisheries paper because the results were quite bad already, but this point is important. The terms of the US-Canada Pacific Salmon Treaty basically work as a negative feedback system. Say the manipulations of the dams really did substantively influence survival to adulthood (which I still think is questionable). Then managers are (as we pointed out) required to increase harvests when ***perceived*** abundance goes up and reduce them when ***perceived*** abundance goes down. We pointed out in the paper that if they were "perfect managers" then escapement back to the Columbia would be exactly the same every year and no effect of dam manipulations would ever be detected in the adult returns. What we didn't actually say was that to change the treaty will probably take years of negotiations between all the parties (US, PNW, Canada, and Alaska) to change the terms—and what would the terms of the treaty be changed to? It will also require implementing a way to either detect PIT tags in the coastwide Chinook catch in future or implementing a sufficiently robust PBT-genetic analysis of the coastwide catch to allow the harvest of Columbia stocks to be identified. More years…

So my comments quoted in KC Mehaffey's piece are blunt, but the issues are a good deal more serious than we outlined in the journal paper. Feel free to pas this on to Jason and others as you see fit.

David

David Welch, Ph.D.

President, Kintama Research Services

755 Terminal Avenue, Nanaimo, BC Canada V9S 4K1

(m) (b) (6) [redacted]

Our new paper looking at coastwide survival of Chinook salmon has just been published.

Summary for Policy Makers-

Animation: https://youtu.be/FN7yp3FefB8

Text:https://www.scientia.global/wp-content/uploads/David_Welch/David_Welch.pdf

The research paper: **https://onlinelibrary.wiley.com/doi/10.1111/faf.12514**

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>

Sent: November 10, 2020 3:23 PM
To: David Welch <David.Welch@Kintama.com>; Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: FW: NWRP Press Statement: Dozens of Regional Leaders Call for Holistic Approach to Four-State Process

FYI – this letter was widely distributed. A number of people in our hydrology/power generation group here at BPA heard about your paper in Clearing Up and have been inquiring about it. I will ask for feedback next week when Jason Sweet discusses it in his weekly meeting.

Christine

From: Ball,Crystal A (BPA) - EW-4 <caball@bpa.gov>
Sent: Tuesday, November 10, 2020 1:35 PM
To: ADL_EW_ALL <ADL_EW_ALL@BPASite1.bpa.gov>
Cc: Welch,Dorothy W (BPA) - E-4 <dwwelch@bpa.gov>; Armentrout,Scott G (BPA) - E-4 <sgarmentrout@bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Kennedy,David K (BPA) - EC-4 <dkkennedy@bpa.gov>
Subject: FW: NWRP Press Statement: Dozens of Regional Leaders Call for Holistic Approach to Four-State Process

I'm forwarding the attached letter to the four state governors and a press statement from Northwest RiverPartners.

The letter calls for specific guiding principles to effectively guide the four-state process, including a holistic approach, social cost of carbon and scientific rigor.

The state-led effort is still in the early design phase. Intergovernmental Affairs has participated in some informal conversations with the states around this process but there is a lot we need to understand and consider before we know what Bonneville's role in this process might be.

Thanks,

Crystal

Crystal Ball

Executive Manager | Fish & Wildlife Program EW-4

Bonneville Power Administration
bpa.gov | P 503-230-3991 | C (b) (6) [redacted] | E caball@bpa.gov

From: Kurt Miller <kurt@nwriverpartners.org>
Sent: Tuesday, November 10, 2020 8:38 AM
To: Kurt Miller <kurt@nwriverpartners.org>
Subject: [EXTERNAL] NWRP Press Statement: Dozens of Regional Leaders Call for Holistic Approach to Four-State Process

A picture containing text Description automatically generated

PRESS STATEMENT

November 10, 2020

In Joint Letter to Governors, Dozens of Northwest Leaders Urge Holistic Approach to Four-State Salmon Recovery Process

Contents of the letter below and attached:

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Dear Governors Brown, Bullock, Inslee, Little and Governor-Elect Gianforte:

On behalf of over three million of the region's community-owned utility customers and thousands of small businesses, farms, and manufacturers which depend on clean, affordable hydropower, recreation, irrigation, and navigation, we thank you for coming together to actively work on salmon recovery in the Pacific Northwest.

We collectively embrace the critical importance of healthy salmon populations for the Pacific Northwest and its Tribal Nations. The communities and organizations we represent live here and care greatly for the region's natural environment. It is part of our shared Northwest ethic and heritage.

As Northwest states move towards bold clean energy goals, we point out that several of the nation's most respected environmental advocacy groups recently acknowledged hydropower's importance in the nation's fight against climate change.

Regionally, hydropower plays an even bigger role, providing close to half of all our electricity and 90% of our renewable electricity.

As a result, our region has the least carbon-intensive electric service and the most-affordable renewable power in the nation. It is crucial that we retain this leadership position in clean and affordable energy to meet the region's equity, environmental health, and economic recovery objectives.

Our respective organizations have never believed there is any inherent conflict between the region's hydropower, irrigation, recreation, and navigation systems and healthy salmon populations. The data reflect this perspective.

Viewed on a decade-by-decade basis, the numbers of adult salmon returning to the Columbia River Basin have seen significant improvements since the lower Columbia River dams and lower Snake River dams were built, bolstered by successful hatchery programs and significant fish passage improvements.

There is no denying, however, that compared to the number of juvenile smolts produced, the overall percentage of returning adults is on the decline. That trend is not unique to the Columbia River Basin.

A new peer-reviewed study published in *Fish & Fisheries* shows there have been near-uniform declines in Chinook salmon survival across the West Coast of North America over the past 50 years.

This finding includes rivers with dams and those without dams; from pristine rivers in Alaska to more urbanized rivers in the Puget Sound. The study shows these declines have averaged approximately 65% over the 50-year period. Research indicates this general trend applies to steelhead and southern coho populations, as well.

Two other studies released this summer also point to the strong relationship between climate change, warming oceans, and declining salmonid health.

In its recently released Biological Opinion (p 276), NOAA Fisheries showed that climate change appears to have a much larger effect on Chinook salmon survival in the oceans than in rivers. Alarmingly, NOAA indicates Chinook salmon populations may face extinction in 20 to 30 years if the observed relationships between warming ocean temperatures and salmon survival continue.

Pointing to a more hostile ocean environment, due to ocean-warming and competition from pink salmon, scientists at the University of Alaska found the size of Chinook and sockeye salmon in Alaska's rivers has declined significantly since 1960, as salmon are spending fewer years at sea. The researchers purposely chose a region of North America without dams to isolate this oceanic effect.

It is often implied that breaching the lower Snake River dams will solve the problem of salmon recovery because we are told its habitat is pristine. However, decades of development have taken a toll on many areas of the river. Additionally, the *Fish and Fisheries* study demonstrates that even truly pristine rivers have experienced equivalent steep declines in adult salmon survival.

In conclusion, the referenced studies show salmon struggles are not isolated to the Columbia River Basin. Instead, we have an ocean-wide problem, which requires a holistic approach and perspective.

Accordingly, we, the signatories of this letter, call for the following guiding principles to effectively guide the four-state process:

- **Trans-Oceanic Acknowledgement:** Solutions must be grounded in the fact there is strong scientific research demonstrating the declines in key salmon populations are due to warming, acidifying oceans that are shifting the balance between salmon predators and prey. If these trends continue, salmon survival may decline even further. If this reality is not understood as the baseline, then the solutions that come out of the four-state process will inevitably be unsuccessful.
- **Holistic Approach**: Solutions must be holistic in nature, addressing the broad nature of salmon survival declines. As a result, favored solutions should prioritize efforts to address challenges in the shared ocean environment.
- **Social Cost of Carbon:** Solutions must be evaluated for their effect on the social cost of carbon. The recently adopted Record of Decision for Columbia River System Operations includes data-driven estimates for carbon production increases if hydropower generation is diminished.
- **Diversity, Equity, and Inclusion:** Solutions must be examined for their likely socioeconomic and health impacts for under-represented and vulnerable communities that need access to affordable energy, clean air, and agricultural jobs. The recently adopted Record of Decision for Columbia River System Operations includes relevant scenarios for increased customer costs if hydropower generation is diminished.
- **Wildfires & Climate-Driven Disasters:** Solutions must not add to the risk of wildfires and other climate-driven disasters that can affect both salmon and people.
- **Balanced:** Solutions must be balanced in nature when evaluating the hydropower system, recognizing the Congressionally-authorized multiple purposes of the Federal Columbia River Power System. These purposes include flood control, navigation, recreation, irrigation, and electricity production.
- **Scientific Rigor:** Solutions that would diminish significant clean energy resources and/or low carbon

transportation infrastructure must undergo non-partisan and rigorous scientific testing before adoption.

Once again, we thank you for your efforts as you plan to bring diverse stakeholder groups together to help the region recover threatened and endangered salmon populations. This goal is incredibly important. We offer our pledge to assist you in the process as regional stakeholders and to provide subject matter expertise.

Respectfully,

From: David Welch

Sent: Tue Jan 19 11:39:23 2021

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] RE: ISAB Assignment to review Welch et al. 2020

Importance: Normal

Attachments: Schaller et al (Senior Scientists Review of Welch et al. 2020 11.23.20-NWPCC 2021).pdf

Hi Christine—

Of course, we would be glad to share our response with you folks. Unfortunately, it is not quite ready for sharing as yet—Aswea is working on my first draft, and Erin has yet to read my draft or Aswea's edits. And (sigh) we now have the 16(!) page single-spaced memo from Schaller et al that we will need to address as well as the 21 page FPC memo, so lots of work.

Erik Merrill sent me the Schaller memo (attached) last Friday as part of an email advising me of the various times that the ISAB are open for a Zoom meeting to discuss the issues. I have asked Erik the provenance of this memo because it doesn't say, but I am guessing that it is something the authors sent to the NWPCC. I don't think that there is an issue with me sharing it with you folks, but I can't be certain as yet, so please be a bit discreet and ask your colleagues not to share it outside BPA until I understand where it came from and if there is any problem in sharing it.

Overall, my sense of the Schaller et al memo is that it is a useful contribution to the debate—they don't flat out lie and distort what we said as the FPC have done, but they do make a strong claim on the superiority of the PIT tag SARs over CWT-based SARs (more precise and accurate) that is just flat out wrong. I was surprised to see that claim made, so it will be good for folks to have us (Kintama) spell out why the world has changed for them—because harvests are significant and unaccounted for, past PIT tag-based SAR analyses in the Columbia River Basin will be forever compromised and probably can't be fixed. (That doesn't mean they can't be fixed going forwards).

I feel sorry for the individuals that have invested a lot of their career into those analyses, but I guess it just isn't clear yet to people just how consequential the failure to correctly incorporate harvest into all the past SAR analyses are—and the PST modifying harvest rates in response to perceived abundance adds another whole layer of unrecognized complexity to the rather naïve approaches people have used in the past.

David

P.S. BTW, I liked the Lewiston Tribune article you mentioned (Josh Murauskas sent me the link on the weekend). I thought it was a very fair and balanced piece of work. However, I also like it because it shows the fallacy in Michelle's thinking. She is quoted as follows: *"If the ocean conditions are really bad and your objective is to get as many adult fish back to the river as possible, your management strategy is to do everything you can to get the highest possible survival in freshwater, to get as many smolts out to the ocean as possible, to get as many adults back as possible," she said."*. That is not actually true for the reason that I have been banging on about for a decade now—if ocean survival dropped to zero, getting *"as many smolts out to the ocean as possible"* would be a failure—equivalent to flushing them down the toilet.

So the real question then is how bad to ocean conditions have to be before Michelle's strategy of flushing them into the ocean quicker doesn't make sense? That's what I hope to address if we can agree on BPA funding the next contract to contrast daily survival rates I the ocean and in the hydrosystem as an important step towards having that discussion. Do you have time to chat and discuss what the appetite is to fund that work?

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: January 19, 2021 11:06 AM
To: David Welch <David.Welch@Kintama.com>
Subject: RE: ISAB Assignment to review Welch et al. 2020

Hi David,

I was just about to write you. I did not see this yet from Schaller. (this morning we were looking at a critique of the sampling for fish condition in John Day that they issued).

We wanted to ask you if your group was able to share your response to the FPC review. Crystal Ball, Kristen Jule, Jody Lando were interested in it, but they were just discussing the Lewis Tribune opinion piece. Salmon science dispute rages | Outdoors | lmtribune.com . This sounds like a handful to think about and deal with, but your paper was well thought out and you have a good background for many topics that were not in your paper that might come up. I will talk to Jody later this afternoon and will bring this up.

Christine

From: David Welch <David.Welch@Kintama.com>
Sent: Monday, January 18, 2021 2:11 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] FW: ISAB Assignment to review Welch et al. 2020

Hi Christine—

FYI, below. Just keeping you in the loop.

I assume that you have seen the Schaller et al memo that we have to address as well? (If not, I can send you a copy, but it might be more appropriate to get it from Erik Merrill directly; as my email to him below says, I don't really understand where it was submitted to).

I am looking forward to the ISAB review because this will be (finally!) a chance to professionally call out the FPC and demonstrate just how questionable their credibility is—their 21-page critical memo is chock-full of deceptive claims and (in some cases) even deliberate lies. Refuting this in public is going to be a good thing, and the Schaller et al memo demonstrates that those folks still aren't thinking through the key issues.

David

David Welch, Ph.D.

President, Kintama Research Services

755 Terminal Avenue, Nanaimo, BC Canada V9S 4K1

(m) (b) (6) [redacted]

Our new paper looking at coastwide survival of Chinook salmon has just been published.

Summary for Policy Makers-

Animation: https://youtu.be/FN7yp3FefB8

Text:https://www.scientia.global/wp-content/uploads/David_Welch/David_Welch.pdf

The research paper: **https://onlinelibrary.wiley.com/doi/10.1111/faf.12514**

From: David Welch <David.Welch@Kintama.com>

Sent: January 18, 2021 2:01 PM
To: Erik Merrill <emerrill@nwcouncil.org>
Subject: RE: ISAB Assignment to review Welch et al. 2020

Hi Erik-

Thanks for your email last Friday. I asked my co-authors to complete the Doodle poll and be prepared to make themselves available for the virtual review meeting with the ISAB.

I do think that the suggested time line of ~ 90 minutes is unreasonably short—our actual initial meeting could actually run closer to at least half a day and possibly a full(!) day. As things currently stand, we have to present our paper and our response to the FPC memo and (now) the Schaller et al memo. (You can tell the ISAB members that, on the bright side, we will be saving them a lot of work—by addressing the FPC & Schaller memos point by point, they get to sit back a bit and adjudicate on whether in their collective opinions the FPC/Schaller criticisms or our rebuttals are more credible, so we get to do the heavy lifting and then they get to assess whether our rebuttals are on point and hold water).

I wonder if you and I could have an initial call to discuss the issues, and get a sense of direction as to what is most important for the NPCC review? My draft rebuttal of the FPC (21 page) memo is now in the hands of my co-authors and was (at last count) now ~48 pages long (that includes the ~19 pages of text pasted in from the FPC memo so that we can't be accused of avoiding something the FPC wrote). To this we now add the 16 page Schaller et al memo that we also need to address. Fortunately, that memo mostly covers similar ground but with a different emphasis, so will be quicker to deal with.

A couple of questions here:

1. The Schaller et al review doesn't say where it was sent to. How should I reference it… as a memo sent by Schaller et al to the Council? (It doesn't say).
2. What is going to be the most effective format for presenting (and defending our work)? This is the main reason for asking to set up a phone call—it is more of a discussion bouncing back and forth the pros and cons of what is going to work best for the Council/ISAB. I am not looking for unfair advantage here, but if time is short I don't want to put much if any, time on presenting our paper if we have the publicly released FPC memo to deal with—there are a mix of downright lies in it and deliberate misrepresentations that we need to address, so from Kintama's perspective if time is very short we have to devote it to demonstrate that the FPC (& now Schaller) memos are clearly off-base and why.

Like the rest of the planet, I am working from home for the duration of the pandemic. My cell doesn't work well at the house, so try my landline first. (Or specify a time and I can call you).

Regards, David

David Welch,

Kintama Research Services

4737 Vista View Crescent

Nanaimo, BC

Canada V9V 1N8

Home Tel: [redacted]

Mobile: [redacted]

From: Erik Merrill <emerrill@nwcouncil.org>
Sent: January 15, 2021 7:51 PM
To: David Welch <David.Welch@Kintama.com>
Cc: Gregory, Stanley Vincent <stanley.gregory@oregonstate.edu>; Erik Merrill <emerrill@nwcouncil.org>; Leslie Bach <LBach@NWCouncil.org>
Subject: ISAB Assignment to review Welch et al. 2020

Hi David,

The ISAB assignment to review your and your co-authors' article "A Synthesis of the Coast-wide Decline in Survival of West Coast Chinook Salmon" has been approved, and we are gathering review materials and scheduling briefings for that assignment and three others.

We invite you and your co-authors to brief the ISAB on your study. If you'd like to brief us, please fill out this Doodle poll of ISAB online meeting dates and time blocks: February 5, February 18, March 18, April 8, and February 19 if needed. We generally schedule briefings for an hour, about 30 minutes each for presentation and discussion. Do you think that is adequate time to present and discuss your team's article? The briefing should help us answer our assignment questions, below. A few days before the briefing, the ISAB might share some additional specific questions to help guide the briefing and discussion.

Please see the ISAB's assignment description and references below, and please send any other key documents to ISAB Chair Stan Gregory (copied) and me to share with the ISAB and others. From our previous email discussion, I know you have the FPC's response to your article and plan to develop a rebuttal. The ISAB will also consider a review by Howard Schaller, Charles Petrosky, and Margaret Filardo, which is attached.

Thank you for considering our invitation, and please share the message and Doodle poll with your co-authors.

Stay well,

Erik

Evaluate "A Synthesis of the Coast-wide Decline in Survival of West Coast Chinook Salmon" (Welch et. al 2020) and its interpretation of the implications of smolt-to-adult return values as well as the Fish Passage Center's review of the paper (FPC 2020)

The Independent Scientific Advisory Board is asked to review scientific basis for the analysis of regional declines in Chinook salmon abundances and the conclusions and recommendations of "A Synthesis of the Coast-wide Decline in Survival of West Coast Chinook Salmon" (Welch et. al 2020). A review by the ISAB could provide an important context for interpreting the findings and important questions raised by this recent publication and the Fish Passage Center's review of the paper (FPC 2020).

Welch et al. 2020 examined SAR data for Chinook salmon for the Pacific coast to determine whether there are large-scale patterns of salmon survival based on coded wire tag data. Welch et al. report Chinook salmon survival has declined broadly across the Pacific coast and SAR values of 1% or less are widely observed. They highlight the use of the low SAR values to support management actions in the Columbia River Basin and question the validity of the interpretation of those SAR values. They note that similar declines in SAR values have been observed in west coast rivers without major dams and suggest that “contemporary survival is driven primarily by broader oceanic factors rather than local factors.” They identify several methodological issues related to analyzing coded wire tags and PIT tags to calculate SAR values. Based on these interpretations, they indicate that targets for restoring salmon populations in the Columbia River Basin may not be attainable and question whether restoring freshwater habitat or improving dam passage will improve returns of salmon. The authors suggest that salmon recovery efforts should focus on actions in the marine environment rather than freshwater habitats. Welch et al. 2020 called for “a systematic review by funding agencies to assess consistency and comparability of the SAR data generated and to further assess the implications of survival falling to similar levels in most regions of the west coast.” These findings and their interpretations raise critical questions that should be examined more closely.

In response to requests from the Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife, the Fish Passage Center conducted a technical review of the Welch et al. paper and raised issues about the paper’s methods, results, and interpretations (FPC 2020).

A review by the ISAB would provide information for the Council and regional policy makers for interpreting the findings of the Welch et al. paper about SARs, salmon survival, and appropriate management actions and the Fish Passage Center’s criticism of the paper.

Review questions for the ISAB:

1. Was the Welch et al. analysis scientifically sound, and were the data it used appropriate for addressing the question?

2. Were the conclusions drawn by Welch et al. supported by their results?

3. Does the ISAB have recommendations to improve the current analysis and interpretation of SAR values in the future?

4. Are the criticisms raised by the Fish Passage Center supported by the evidence and do any of those criticisms weaken Welch et al.'s results or conclusions?

5. What are the management implications of the ISAB's conclusions and recommendation?

If feasible, we would appreciate a completed review by April 23, 2021.

References

Fish Passage Center (FPC). 2020. Technical review of Welch et al. (2020), titled, *A synthesis of the coast-wide decline in survival of West Coast Chinook Salmon (Oncorhynchus tshawytscha, Salmonidae).* Memorandum from Michele DeHart (FPC) to Bill Tweit (WDFW), Tucker Jones (ODFW), and Margaret Filardo (citizen). December 4, 2020. https://www.fpc.org/documents/memos/53-20.pdf

Welch, D.W, A.D. Porter, and E.L. Rechisky. A synthesis of the coast-wide decline in survival of West Coast Chinook Salmon (*Oncorhynchus tshawytscha*, Salmonidae). *Fish and Fisheries*
2020; 00: 1– 18. https://doi.org/10.1111/faf.12514

Erik Merrill

Independent Science Manager

Northwest Power and Conservation Council

851 SW 6th Avenue, Suite 1100

Portland, Oregon 97204

503-222-5161

800-452-5161 (toll-free)

From: David Welch

Sent: Tue Feb 09 13:55:47 2021

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] Time for a call?

Importance: Normal

Hi Christine—

I think I saw you were logged in for the ISAB review last Friday, but I wasn't sure… I was trying to keep my focus on the presentation. However, I do recall seeing that Jody Lando was logged in, as was Howard Schaller, but I didn't see Michelle Dehart or any of the other people from the FPC, although I am sure they were in attendance. (Perhaps they were anonymously logged in?).

I thought the presentation went well, but I would be interested in hearing the views of you & your colleagues. Also, now that the review is past and (I assume) found no devastating error in what we have done despite the FPC's claims, I would like to have a discussion about whether it would be possible to restart our earlier contracted work comparing survival rates between the ocean and freshwater. Given Representative Simpson's recent trial balloon about spending $35B to compensate for taking out the Snake River dams, it might not be a bad idea to move to finish the additional work needed to compare downstream ***smolt*** survival rates between rivers; it was interesting to me that the ISAB actually raised our 2008 paper during the discussion.

The new information we have on smolt survival rates was in the earlier (BioRχive) version of the paper, but the reviewers didn't like it when we submitted it to PLoS ONE because we couldn't show survival rates corrected for migration time, just distance. (Because the other groups that have published data did not reported migration time in their papers). However, it would be a relatively simple for us to reach out to those groups, offer co-authorship and ask for their raw data.

I can outline more on this when we can talk—my week is fairly open.

Regards, David

David Welch, Ph.D.

President, Kintama Research Services

755 Terminal Avenue, Nanaimo, BC Canada V9S 4K1

(m) (b) (6) [redacted]

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Summary for Policy Makers-

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Text:https://www.scientia.global/wp-content/uploads/David_Welch/David_Welch.pdf

The research paper: **https://onlinelibrary.wiley.com/doi/10.1111/faf.12514**

From: David Welch

Sent: Wed Feb 10 16:55:25 2021

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: NPAFC Newsletter Issue No. 49 is Now Available!

Importance: Normal

Thanks, Christine.

(b) (6) [redacted]

Let's try for 11:30 am tomorrow. I can set up a Teams or Zoom call if you like or we can just do the regular phone call approach.

I haven't heard much of anything about broader coverage. I CCed my original response to Bill Crampton and KC Mehaffey, but the email to Crampton at the Columbia Basin Bulleting bounced back. Perhaps Mehaffey will write something?

As I wrote in the cover letter to the ISAB (and the region), I think that the big issue is that without significant delayed mortality the Columbia could switch to trying to keep smolt survival in freshwater "reasonable" and move away from being blamed for poor adult returns. I know this is bureaucratically hard to imagine because the system is so entrenched in accepting blame for poor ocean conditions, but it seems to me that the potential of the hydropower system to backstop renewable sources of energy is being frittered away without really carefully thinking through the issues.

Much to talk about!

David

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: February 10, 2021 4:39 PM
To: David Welch <David.Welch@Kintama.com>; Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: FW: NPAFC Newsletter Issue No. 49 is Now Available!

Hi,

Those of us who watched your presentation each thought it was very well done. We also greatly appreciated how you took the extra time to thoroughly respond to the FPC and Schaller comments. It was helpful to have both a public presentation that dozens of people called into (although that probably raises the pressure on the presenters a little bit) and the dialog that you were able to have at the end. We look forward to the ISAB response and subsequent discussions.

With respect to restarting the time indexed survival rates analysis, I spoke to Jody Lando and unfortunately we are not in a position to fund it at this time. We are short on financing some monitoring efforts that we opted to add this spring including expanded avian diet analysis and PIT detection (from fish that birds eat) and monitoring of adults from resident species in the tailrace for TDG effects. There is still potential for fitting the analysis in the budget at a future date but I am not certain what timeframe that would be.

If you would like, I could be available for a call tomorrow at 11:30-1, after 3, or 8-9am, or most of Friday, and could discuss what the ISAB brought up, or how this relates to that big proposal by Rep. Simpson of Idaho. I also referred to it as a trial balloon as you did. This seemed to point to one or two of the older SAR related studies as the biological basis for making this major decision and creating a large new program, (and agreeing to stop litigation for 30 years – although I have been wondering whether this is actually possible. Can you just conclude that the facts are all in, and cut NOAA out of the endangered species act analysis and enforcement?)

After the newspaper articles, and also the ISAB presentation and their eventual review on the subject, I hope that you have received additional attention and feedback for your very timely study. In some of the online comments that I have seen, it seems like people have definitely heard and absorbed it (even if they only saw the news release and didn't download the paper) because I have seen references to concerns over declines, and comparable survival rates in Canada.

It strikes me that the subject of two of the articles in the most recent issue of NPAFC that Julie forwarded could be factors that influence the Chinook decline – the 2013-16 N pacific heatwave and pink/chum hatchery output. I didn't realize that so many of the pinks were being released in Alaska and had assumed there were more released from asia.

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Sent: Wednesday, February 10, 2021 12:32 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: FW: [EXTERNAL] NPAFC Newsletter Issue No. 49 is Now Available!

There were some interesting articles in here, I tried to read these for the broader perspective on the other side of the Pacific J the recipe looks good, too!

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From: David Welch

Sent: Wed Feb 10 16:59:21 2021

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: NPAFC Newsletter Issue No. 49 is Now Available!

Importance: Normal

Oh—I forgot to mention this. Our study stopped in smolt ocean entry year 2014, so we missed most of the heatwave impacts. No doubt they are severe. BC is reported to have had the worst salmon returns (across all species) in over a Century of record keeping. For many of the populations the word is that we are looking at near-extinction level spawning numbers this past autumn, even with almost all salmon fisheries shut down. My sense is that DFO is sitting on the escapement data and reluctant to report it for this reason.

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: February 10, 2021 4:39 PM
To: David Welch <David.Welch@Kintama.com>; Erin Rechisky <Erin.Rechisky@Kintama.com>
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From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Feb 11 08:51:49 2021

To: David Welch

Subject: RE: NPAFC Newsletter Issue No. 49 is Now Available!

Importance: Normal

Hi,

Should we do a regular phone call?

My work phone number is (971)266-7553

Christine

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From: David Welch

Sent: Thu Feb 11 10:19:38 2021

To: Petersen,Christine H (BPA) - EWP-4

Subject: [EXTERNAL] RE: NPAFC Newsletter Issue No. 49 is Now Available!

Importance: Normal

Hi Christine—Confirming that I will call your office phone number at 11:30.

David

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To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Subject: [EXTERNAL] RE: NPAFC Newsletter Issue No. 49 is Now Available!

Thanks, Christine.

(b) (6) [redacted]

Let's try for 11:30 am tomorrow. I can set up a Teams or Zoom call if you like or we can just do the regular phone call approach.

I haven't heard much of anything about broader coverage. I CCed my original response to Bill Crampton and KC Mehaffey, but the email to Crampton at the Columbia Basin Bulleting bounced back. Perhaps Mehaffey will write something?

As I wrote in the cover letter to the ISAB (and the region), I think that the big issue is that without significant delayed mortality the Columbia could switch to trying to keep smolt survival in freshwater “reasonable” and move away from being blamed for poor adult returns. I know this is bureaucratically hard to imagine because the system is so entrenched in accepting blame for poor ocean conditions, but it seems to me that the potential of the hydropower system to backstop renewable sources of energy is being frittered away without really carefully thinking through the issues.

Much to talk about!

David

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: February 10, 2021 4:39 PM
To: David Welch <David.Welch@Kintama.com>; Erin Rechisky <Erin.Rechisky@Kintama.com>
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From: David Welch

Sent: Thu Feb 11 11:07:20 2021

To: Ben Zelinsky

Subject: [EXTERNAL] Time for a call?

Importance: Normal

Hi Ben-

No particular rush, but I would value having a call to get your views on where BPA Is going? (see below).

I need to make some decisions about whether it is even worth pursuing future work in the Columbia River. In short, I think I do really good research, can see the underlying scientific issues, and develop strong research results that clearly demonstrate the biological direction taken in the Columbia River Basin over the past half century probably has fundamental flaws.

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From: David Welch

Sent: Thu Feb 11 13:17:50 2021

To: Zelinsky,Benjamin D (BPA) - E-4

Subject: [EXTERNAL] RE: Time for a call?

Importance: Normal

Thanks, Ben—

I appreciate you taking the time. I think you can use Zoom?

I will send you a link for a call next Tuesday at 10:30. If Zoom won't work, Teams or Skype are fine as well—just choose what does work for you. (Sonia tells me that some of the US federal agencies are still not allowed to use Zoom).

Regards, David

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Sent: February 11, 2021 12:07 PM

To: David Welch <David.Welch@Kintama.com>
Subject: RE: Time for a call?

Yes – of course David.

Those are fair questions to ask and I'd be happy to share my perspective.

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Would either of those work?

Looking forward to it.

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From: Zelinsky,Benjamin D (BPA) - E-4

Sent: Thu Feb 11 13:30:25 2021

To: David Welch

Subject: RE: Time for a call?

Importance: Normal

Perfect!

From: David Welch <David.Welch@Kintama.com>
Sent: Thursday, February 11, 2021 1:18 PM
To: Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>
Subject: [EXTERNAL] RE: Time for a call?

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From: David Welch

Sent: Thu Feb 11 14:22:38 2021

To: Ben Zelinsky

Subject: David Welch's Zoom Meeting

Importance: Normal

David Welch is inviting you to a scheduled Zoom meeting.

Join Zoom Meeting

https://us04web.zoom.us/j/78335207597?pwd=djJ5aW5TdnlKWUFuY2lITkcwNmk2Zz09

Meeting ID: 783 3520 7597

Passcode: aRK1UB

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Thanks in advance for your perspective.

From: David Welch

Sent: Tue Feb 16 14:00:19 2021

To: Ben Zelinsky

Subject: [EXTERNAL] CSAS (Integrated Biological Status of S BC Chinook-2016 042).pdf

Importance: Normal

Attachments: CSAS (Integrated Biological Status of S BC Chinook-2016 042).pdf; Neilson & Taylor (EA-Thompson & Chilcotin SteelheadTrout-COSEWIC Feb 2018).pdf

Ben-

Thanks for your time. I mentioned that I would send you the report on the status of Chinook in the Fraser River.

To save some time, I pasted into the bottom of this email the status of southern BC Chinook stocks ***as of 2016***. (See the attached file for the officially accepted report, as well as a separate file petition for an emergency listing of Upper Fraser steelhead from 2018).

The two key take home points are that: (a) salmon & steelhead are in real trouble in southern BC, despite the absence of dams (so how will removing the dams improve salmon conservation in the Columbia if their absence in BC hasn't led to a better status?) and (b) conditions here in BC are in far, far, worse shape in 2020 than was apparent back in 2016. Probably because of the back to back marine heatwaves happening since 2016 BC now has the lowest salmon returns in over a century of record keeping—almost all salmon fisheries were shut down, yet spawning escapement numbers are apparently catastrophic.

When you contemplate how to manage this into the future, with its even worse levels of warming, ask yourself how removing the non-CO2 producing power that the dams generate is a good thing when all these other regions with no dams are faring no better.

David

From: Zelinsky,Benjamin D (BPA) - E-4

Sent: Tue Feb 16 14:33:51 2021

To: David Welch

Subject: RE: CSAS (Integrated Biological Status of S BC Chinook-2016 042).pdf

Importance: Normal

Thanks David

It was good to catch up for a minute. I'll take a look and will consider how incorporate these into our thinking.

All the best.

Ben

From: David Welch <David.Welch@Kintama.com>
Sent: Tuesday, February 16, 2021 2:00 PM
To: Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>
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David

From: David Welch

Sent: Fri Feb 19 15:41:12 2021

To: Ben Zelinsky

Subject: [EXTERNAL] BPA budget for survival rate paper

Importance: Normal

Ben—

I forgot to mention this before we hung up the other day, but we originally had a SOW in BPA's PICES system for looking at the relative survival rate of smolts in the FCRPS vs the coastal ocean. (You may recall we had started this work when BPA senior management then re-directed BPA staff to have us work on the relative coastwide SAR values that resulted in the paper that was published last October 30th).

I still think that publishing this is crucial to making the case that Columbia River salmon conservation may be working off the wrong assumption, namely that survival in the ocean is better than in the FCRPS—all of the current arguments for increasing spill are based on the implicit assumption that smolt survival is better in the ocean than in the FCRPS.

We budgeted this at $115K US. To remind BPA senior staff about what was to be accomplished I have taken a stab at writing a short summary blurb on this based on what was already in our PICES proposal. My hope is that BPA can support this work in the current calendar year both because it gives us an initial resolution to the question outlined, but also because the data can be fed into the costing of a subsequent proposal to directly measure TDG impacts on smolt survival in the lower river and the coastal ocean.

Regards, David

David Welch

(m) [redacted]

Project background: From 2006-2011, the Coastal Ocean Acoustic Salmon Tracking project (COAST; formerly the Pacific Ocean Shelf Tracking project, POST; BPA project 2003-114-00) managed by Kintama Research used a large-scale acoustic telemetry array to track Columbia River basin yearling Chinook salmon smolts during their seaward and early-ocean migration. More than 8000 salmon smolts were tagged with VEMCO acoustic transmitters and tracking arrays extended from the Snake River basin to southeast Alaska. The tracking data were used to estimate estuarine and early marine survival and to perform a series of experiments to test key hypotheses related to the possible delayed effects of the Federal Columbia River Power System (FCRPS) on Chinook smolt survival. Results from project 2003-114-00 were peer-reviewed and successfully published in the scientific literature (e.g., Rechisky et al. 2009, Welch et al. 2011, Rechisky et al. 2012, Rechisky et al. 2013, amongst others).

Contract description: We will conduct a survival rate analysis (survival per unit time) using the data previously collected under project #2003-114-00 to contrast measurements of Snake River spring Chinook smolt survival in four regions: (1) the hydropower system, (2) the undammed lower Columbia River and estuary, (3) the Columbia River plume, and (4) the coastal ocean. We will reanalyze the data, as necessary, and interpret the results.

This analysis will provide important geographic perspective on the role of Snake River salmon survival in freshwater and the ocean in limiting recovery. The current assumption is that flushing salmon smolts out of the hydrosystem faster (by spilling more water, for example), will result in better adult survival. However, our past acoustic tagging work suggests that daily survival rates in the coastal ocean are similar to those experienced by smolts in the hydrosystem, so spill strategies may simply shift where animals die, and not improve overall survival. Because the original POST array was designed to test the delayed mortality theory and did not have as a primary goal the measurement of relative survival rates in the river and coastal ocean, an additional outcome will be to provide the information needed to develop an optimized second generation array. Such an array, appropriately designed, could then provide the resolution to verify or reject the findings from in this project with sufficient precision to support policy decisions.

From: Erin Rechisky
Sent: Wednesday, September 2, 2020 6:34 PM
To: David Welch <David.Welch@Kintama.com>
Subject: RE: BPA budget for survival rate paper

Years ago, it was three papers, but one of those was a comparison of freshwater survival in large rivers which was included in the SAR paper....and then removed, right?

I'll have to go back to 2017 budgets. I'll have to ask Shaun to send more files.

Erin

From: David Welch <David.Welch@Kintama.com>
Sent: September 2, 2020 6:19 PM
To: Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: RE: BPA budget for survival rate paper

Thank you. If you have it , let me know the value of the other piece (can't even recall what that was to be right now!).

From: Erin Rechisky <Erin.Rechisky@Kintama.com>
Sent: Wednesday, September 02, 2020 5:22 PM
To: David Welch <David.Welch@Kintama.com>
Subject: BPA budget for survival rate paper

Hi David,

I had Shaun send me files. I see that we budgeted $115k for the survival rate paper. I think we did use some of this in the past since you, and maybe Aswea, were working on it a year and bit ago.

I think it's safe to stick with $115k for an approximation.

Erin

From: David Welch

Sent: Fri Aug 19 12:13:41 2016

To: Petersen,Christine H (BPA) - EWP-4; Creason,Anne M (BPA) - EWL-4

Cc: Zelinsky,Benjamin D (BPA) - EWP-4

Subject: RE: Draft SOW & Sole Source. Justification..

Importance: Normal

Thanks, Christine. I would appreciate those leads on sources of "estuary" populations with SAR data. The key point from my perspective is that I need to be scrupulously sure to try to assess all possible sources of viable survival data here, rather than just go after the Willamette data, so that I am making sure I can derive a balanced perspective rather than just selecting one population know to have poor SARS despite the lack of dams. (Josh Murauskas and I have had several past conversations about just this stock, in fact).

Anne, when you are ready for a conversation, let me know. I'm in all day, and should be in all next week as well. However, it is probably most productive if you review the two draft files I submitted earlier first.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, August 19, 2016 12:08 PM
To: David Welch; Creason,Anne M (BPA) - EWL-4
Cc: Zelinsky,Benjamin D (BPA) - EWP-4
Subject: RE: Draft SOW & Sole Source. Justification..

No problem at all, - it was interesting to hear your big picture overview of what you are setting out to do and also going off on some interesting tangents.

I think I passed on the peer review issue, although you might want to call and repeat part of the conversation. In my personal opinion, you were raising a very important consideration for being able to declare that you were independently responsible for the entire content of a peer reviewed paper without oversight from the Dept of Energy funding source. This could indeed turn out to be of top concern, given the likely scrutiny. We have had some discussions over here about the importance of being able to cite a peer reviewed study to back up our arguments in policy debates and in also whether NEPA documents can cite unpublished work.

I will continue to try to identify some potential sources of aggregated coded wire tag data for hatchery SARs in the lower Columbia (in our vocabulary, the 'estuary' is everything with some tidal influence below Bonneville dam – which does extent to rkm 146 or so.). This would hopefully save you from needing to locate individual hatcheries and managers.

Christine P.

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, August 19, 2016 11:48 AM
To: Creason,Anne M (BPA) - EWL-4
Cc: Zelinsky,Benjamin D (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4
Subject: RE: Draft SOW & Sole Source. Justification..

Thanks so much—I apologize for the confusion.

Erin did much of the leg work on putting these two files together during my two week's absence on holidays, and then left for two weeks vacation just before I got back. I guess I must have somehow incorrectly assumed that Christine assumed the lead.

As a result, I had an extensive phone discussion this morning with Christine about one issue—the need to be able to certify to journals (if we go for the full publication route) that BPA has not "influenced or directed" the study and that Kintama is solely responsible for the analysis and conclusions. This is obviously a delicate balancing act since BPA will be the funder, but one that in my view we should try to maintain. I suggest that you ask Christine for her "Readers Digest" version of the issue I laid out for her, and we can then touch base by telephone to discuss further if you have questions or concerns.

David

kintamav_RGB

Office: (250) 729-2600 (x) 223

Mobile (b) (6) [redacted]

From: Creason,Anne M (BPA) - EWL-4 [mailto:amcreason@bpa.gov]
Sent: Friday, August 19, 2016 11:41 AM
To: David Welch
Cc: Zelinsky,Benjamin D (BPA) - EWP-4
Subject: FW: Draft SOW & Sole Source. Justification..
Importance: High

Hi David—

Just wanted to make sure you have my correct email address. You had sent this email and information to Christine Peterson, who is more of a technical contact, and won't be the COTR on this.

I'll have a look and get back to you. I'm still waiting for Ben to get back to me on the funding part of this before I dive too much further into getting this submitted.

Thanks—

Anne

From: Petersen,Christine H (BPA) - EWP-4
Sent: Friday, August 19, 2016 11:37 AM
To: Creason,Anne M (BPA) - EWL-4
Subject: FW: Draft SOW & Sole Source. Justification..

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, August 19, 2016 11:14 AM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Aswea Porter; Erin Rechisky
Subject: Draft SOW & Sole Source. Justification..

Hi Anne-

Please see attached. As mentioned, if we can keep the specific reporting/check-in requirements as simple as possible, this will be helpful from the perspective of getting the papers published in high quality reputable journals where the authors need to certify that "*...the funders played no role in the design or execution of the study*". Ideally, the requirements here will simply state that Kintama will provide a white paper to BPA, and BPA will make a decision to support additional funding for the peer-reviewed publication at that time. Your contracting folks may want more details than this of course, to satisfy their own requirements.

I have also used **red font** for the summary of deliverables section, as you may want to look at this closely from BPA's scheduling perspective. There is a ***lot*** of work to do to meet these timelines, but I think it is just feasible if we start soon.

Finally, we will be glad to investigate the possibility of including Willamette R SARS in the SAR report, so please provide a contact if you have one for this data. However, to ensure that we scrupulously maintain a balanced perspective here, can you also advise on any other substantial sources of below Bonneville SAR data for the Columbia River that we should also try to incorporate?

I look forwards to your response. FYI, I have not CCed Ben Zelinski on this, as I leave it up to you to forward for comments as appropriate.

Thanks, David

David Welch, Ph.D.

kintamav_RGB

President, Kintama Research Services Ltd.

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david.welch@kintama.com

www.kintama.com

Browse animations of our

fisheries work on-line: http://kintama.com/media/videos/

P Please consider the environment before printing this e-mail

From: David Welch

Sent: Mon Aug 21 23:48:44 2017

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] Re: [EXTERNAL] RE: CWT based SARs

Importance: Normal

Attachments: image1.jpeg

Thanks for the suggestion, Christine. After mulling over your suggestion for the past few days, right now I don't think we want to get into the details of how individual hatcheries produce their survival estimates; I am sure that all of these records could be improved, but if we move from accepting the "official" survival data submitted to government agencies and the bi-national treaty organization (the PSC), we start taking on responsibility for assessing credibility.

So, at the point we want to evaluate how similar the SARS are, and if the results are important to the interpretation, we can then consider surveying the survival methodologies--but we don't want to do that until we know what sort of error magnitude is of importance first.

FYI, here is the updated plot of Fraser R chinook returns--catastrophic. □

David

image1.jpeg

David Welch, Kintama Research

Tel: +1 (250) 729-2600 x223
Cell: [redacted]
Sent from my iPad

On Aug 18, 2017, at 16:20, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi,

Chuck Peven had a memo he developed for a Willamette hatchery program that might provide some helpful background.

By the way – let me know if you'd like to ask Tracy Hillman for any information on upper Columbia hatchery program practices… I realize there must be a lot of information that one would only know via interviewing a large number of hatchery managers.

Christine

From: Chuck Peven [mailto:pci@nwi.net]
Sent: Friday, August 18, 2017 3:19 PM
To: Allen,Brady (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4
Cc: Jule,Kristen R (BPA) - EWP-4; Spear,Daniel J (BPA) - PGB-5
Subject: [EXTERNAL] RE: CWT based SARs

Hi Christine. The attached memo to Dan Spear was something I did last year regarding CWT SAR estimates for the N Santiam hatchery program. It does show how one can come up with vastly different estimates of SAR depending on the database used. Also has some background with my experience using the RMIS database. As far as a comparison between PITs and CWTs, you may want to ask Tracy Hillman who has been the lead on evaluating the hatchery programs in the Upper Columbia for a number of years and may have looked into that at one time.

Hope this is helpful,

Chuck Peven

<image001.jpg>

Peven Consulting, Inc.

3617 Burchvale Rd.

Wenatchee, WA 98801

Office – (509) 329-6169

cell - (b) (6) [redacted]

Home - [redacted]

Website – www.pevenconsulting.com

"In rivers, the water that you touch is the last of what has passed and the first of that which comes; so with present time."

Leonardo da Vinci

From: Allen,Brady (BPA) - EWP-4 [mailto:mballen@bpa.gov]
Sent: Friday, August 18, 2017 2:40 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Cc: Jule,Kristen R (BPA) - EWP-4 <krjule@bpa.gov>; 'Chuck Peven' <pci@nwi.net>
Subject: RE: CWT based SARs

I'm not sure about this, but I asked Chuck and he had some ideas. I cc'ed him here.

From: Jule,Kristen R (BPA) - EWP-4
Sent: Friday, August 18, 2017 1:19 PM
To: Petersen,Christine H (BPA) - EWP-4; Allen,Brady (BPA) - EWP-4
Subject: RE: CWT based SARs

Christine, Sorry I'm so behind on emails… did you and Brady already coordinate on this? Might Russ also have some insight?

Let me know how we can best follow up on this

From: Petersen,Christine H (BPA) - EWP-4
Sent: Tuesday, August 01, 2017 11:47 AM
To: Jule,Kristen R (BPA) - EWP-4; Allen,Brady (BPA) - EWP-4
Subject: CWT based SARs

Hi

I had some questions about best places or databases to get hatchery SARS based on coded wire tags that might be qa/qc 'd. For example DART has an area that they don't spend too much time updating, where they gathered SARS from several hatcheries, but many programs have fewer than 5 years of data. The RMIS database is a little bit challenging to work with. Is there anything in between, perhaps run by PSMFC or USFWS?

I guess I am not as interested in a comprehensive database as a few examples where CWT and PIT based estimates could be compared... perhaps an existing analysis?

Christine

Sent from my Verizon 4G LTE smartphone

<memo to DS on NS CWT recapture breakdown.docx>

From: Erin Rechisky

Sent: Tue Aug 22 13:27:18 2017

To: David Welch; Petersen,Christine H (BPA) - EWP-4

Cc: Aswea Porter

Subject: [EXTERNAL] RE: [EXTERNAL] RE: CWT based SARs

Importance: Normal

The memo really demonstrates how complicated it is to estimate SAR. Thanks for passing that on, Christine.

And the Fraser Chinook return is abysmal.

Erin

From: David Welch
Sent: August 21, 2017 11:49 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky; Aswea Porter
Subject: Re: [EXTERNAL] RE: CWT based SARs

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Christine

Sent from my Verizon 4G LTE smartphone

<memo to DS on NS CWT recapture breakdown.docx>

From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Dec 21 13:31:49 2017

To: david.welch@kintama.com; Erin Rechisky (Erin.Rechisky@kintama.com); Aswea Porter (Aswea.Porter@kintama.com)

Subject: SR steelhead AMIP Indicators

Importance: Normal

Thank you.

Yes – over here there has been some discussion about steelhead. There is a 'significant decline' trigger defined in the 2010 Biological Opinion, but NOAA determined it has not been met yet because it involves 5 year averages. With the current situation in court, the Irrigators association has been really fired up about transportation (while it is receding in attention among some other groups, whether warranted or not). They have been asking NOAA Science Center for the 2015 returns.

Steve Smith of NOAA presented early results with about 90% of the return in – towards the end of this presentation. It is interesting that there is a Chinook vs steelhead species contrast. Smith is presenting May numbers because that is when transport is started, however it is key to note that the run went out really early and so the outcome for April migrants will be important. Jennifer Gosselin et al. had a hard time sampling the run because they went out so early. The transported Chinook did much better than in-river, but both categories of steelhead had very poor SAR.

http://pweb.crohms.org/tmt/agendas/2017/1212_Agenda.html

I haven't heard from Fish Passage Center regarding data, but I did politely ask for the above Lower Granite survivals and SAR.

Christine

From: Sweet,Jason C (BPA) - PGB-5
Sent: Tuesday, December 19, 2017 4:02 PM
To: Sullivan,Leah S (BPA) - EWP-4; Bettin,Scott W (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4
Cc: Spear,Daniel J (BPA) - PGB-5
Subject: FW: [EXTERNAL] SR steelhead AMIP Indicators

FYI

From: Ritchie Graves - NOAA Federal [mailto:ritchie.graves@noaa.gov]
Sent: Tuesday, December 19, 2017 4:00 PM
To: Peters, Rock D NWD; Dykstra, Timothy A NWW; Sweet,Jason C (BPA) - PGB-5; Feil, Dan H NWD
Cc: Michael Tehan - NOAA Federal; Ponganis, David; Grimm,Lydia T (BPA) - A-7; Richard Zabel - NOAA Federal; Ryan Couch - NOAA Federal; Eitel, Michael (ENRD); Gelatt, Andrea (ENRD)
Subject: [EXTERNAL] SR steelhead AMIP Indicators

Following today's meeting with Scott Levy, I thought it would be important to document my current best estimates of the SR steelhead AMIP Indicators.

The AMIP Early Warning (20th %ile) trigger is 10,325

The AMIP Sig. Decline (10th %ile) trigger is 8,075

The Abundance Trend indicator is -0.24 (slope of the 5-year regression line).

Using current (as of 12/18/2017) dam counts, and estimates of proportion wild and proportion of the total run counted by 12/31 of each year (i.e., what proportion of the run passes LGR from 1/1 to 6/30 in the following calendar year), I have estimated the following for 2017 (pre-run reconstruction estimates) starting with a dam count of 69,380 adult steelhead:

5 YEAR AVERAGES

Assuming % passing July 1-Dec 31 is 93.8% of run and 24.0% of the run is wild...

Wild Abundance = 17,756

4-Year Mean Abundance = 30,573

Trend Indicator = -0.16

10 YEAR AVERAGES

Assuming % passing July 1-Dec 31 is 94.3% of run and 19.9% of the run is wild...

Wild Abundance = 14,620

4-Year Mean Abundance = 29,789

Trend Indicator = -0.20

2017-18 abundance of wild steelhead at LGR would have to drop to around 12,200 fish to trigger the abundance trend indicator (drop the regression line slope to -0.24) and even 0 returning fish would not drop the 4-year average below 26,000 fish.

My conclusion is that it is VERY unlikely that the 2009 AMIP Indicators will be triggered for SR steelhead as a result of the decreased abundance in the 2017-18 adult migration season.

-Ritchie

Ritchie Graves

Columbia Hydropower Branch

Interior Columbia Basin Office

NOAA Fisheries, West Coast Region

phone: 503-231-6891

cell: (b) (6) [redacted]

From: Petersen,Christine H (BPA) - EWP-4

Sent: Thu Jan 03 13:21:07 2019

To: Erin Rechisky; David Welch

Subject: RE: Howard Schaller

Importance: Normal

Attachments: Ethical_Guidelines_For_Peer_Reviewers_2.pdf

Hi Erin and David,

I was able to talk to Kristen but not Jody. Apparently the attorneys are deferring to our contracting officer (who is a legal expert of sorts), so I need to talk to Rachel Kulak. Then I assume that she will need to talk to Katie McDonald, who is the Bioanalyst manager who the question was initially directed to. I believe she is the one who might ask FPC who the review is for. At first, Jody wasn't happy that I had spoken to Blane at NOAA about it, when I first saw the email at a FPOM meeting because she wanted to carefully consider it first. I will recommend that we should talk to you about it, next week.

Kristen sees no need to give them the text from the second modified contract pertaining to current work. I try to reach Rachel soon, but in a sense, there is no major hurry.

Christine

From: Blane Bellerud - NOAA Federal [mailto:blane.bellerud@noaa.gov]
Sent: Friday, December 14, 2018 9:56 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] Re: FW: looking for a SOW on a BPA contract - KINTAMA WORK

As I noted earlier, this does not seem to be a legitimate course of inquiry for a reviewer to pursue. I can see no reason for someone who is supposed to be reviewing a paper for it's scientific merit to know the statement of work that funded the contract. Unless it is otherwise public information, I can see no reason for providing this information.

Blane

Hi Christine,

I was just re-reading your e-mail below and I have a few questions and comments.

Our contract with BPA seems irrelevant to a FPC review of our SAR paper. Have the attorneys and CO made a decision on whether to provide the FPC with it?

Has anyone asked Michelle D. who the review is for? There's nothing on the FPC website as of this afternoon.

I don't see how we can remove references to the second paper (survival rates) since a portion of the budget has been allocated to that paper in our current contract. If sections were redacted, the FPC would certainly come back and request the full contract.

Thank you,

Erin

From: Erin Rechisky

Sent: Thu Jan 03 13:35:55 2019

To: Petersen,Christine H (BPA) - EWP-4; David Welch

Subject: [EXTERNAL] RE: Howard Schaller

Importance: Normal

Thanks Christine.

We'll stand by.

Erin

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: January 3, 2019 1:21 PM
To: Erin Rechisky; David Welch
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I don't see how we can remove references to the second paper (survival rates) since a portion of the budget has been allocated to that paper in our current contract. If sections were redacted, the FPC would certainly come back and request the full contract.

Thank you,

Erin

From: David Welch

Sent: Thu Jan 03 16:00:34 2019

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky; Aswea Porter

Subject: [EXTERNAL] Re: Howard Schaller

Importance: Normal

Thanks, Christine.

From my perspective i don't have any fear about giving them a copy of the contract— I don't think that there is anything unreasonable in the contract, although given past history I think that the FPC is fully capable of spinning things anyway.

I am curious why they would even think that they are entitled to see the contract, so I would ask that they specifically explain their basis for thinking that they are entitled to request it... i.e., on whose request are they doing the review? (a) PLOS ONE, a credible peer reviewed journal? And if so, some rationale as to why they think that they need to see the contract would be interesting... we have reported all of the raw data or the original sources and we don't do anything more complex than compare means or medians (geometric means, in their lingo).

On the other hand, if this is just *"... because of a request from Oregon*" for their comments (and eventual deposition on their website as one of their memos to the world about why the paper is wrong and should be dismissed would be good to know ahead of time. (And this was the specific reason I was at pains not to apply sophisticated statistical methods to the analysis... the paper should have much more impact for policy makers if they think they can really understand it, and are not fearful that perhaps hidden in some complex methodology is a reason that all the SARs become similar when they actually aren't).

So from my perspective, the only issue I see is that if they use the justification stated, then get them to fully outline the justification.

David Welch, Kintama Research
Tel: +1 (250) 729-2600 x223
Cell: [redacted]
Sent from my iPad

On Jan 3, 2019, at 15:21, Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov> wrote:

Hi Erin and David,

I was able to talk to Kristen but not Jody. Apparently the attorneys are deferring to our contracting officer (who is a legal expert of sorts), so I need to talk to Rachel Kulak. Then I assume that she will need to talk to Katie McDonald, who is the Bioanalyst manager who the question was initially directed to. I believe she is the one who might ask FPC who the review is for. At first, Jody wasn't happy that I had spoken to Blane at NOAA about it, when I first saw the email at a FPOM meeting because she wanted to carefully consider it first. I will recommend that we should talk to you about it, next week.

Kristen sees no need to give them the text from the second modified contract pertaining to current work. I try to reach Rachel soon, but in a sense, there is no major hurry.

Christine

From: Blane Bellerud - NOAA Federal [mailto:blane.bellerud@noaa.gov]
Sent: Friday, December 14, 2018 9:56 AM
To: Petersen,Christine H (BPA) - EWP-4
Subject: [EXTERNAL] Re: FW: looking for a SOW on a BPA contract - KINTAMA WORK

As I noted earlier, this does not seem to be a legitimate course of inquiry for a reviewer to pursue. I can see no reason for someone who is supposed to be reviewing a paper for it's scientific merit to know the statement of work that funded the contract. Unless it is otherwise public information, I can see no reason for providing this information.

Blane

Hi Christine,

I was just re-reading your e-mail below and I have a few questions and comments.

Our contract with BPA seems irrelevant to a FPC review of our SAR paper. Have the attorneys and CO made a decision on whether to provide the FPC with it?

Has anyone asked Michelle D. who the review is for? There's nothing on the FPC website as of this afternoon.

I don't see how we can remove references to the second paper (survival rates) since a portion of the budget has been allocated to that paper in our current contract. If sections were redacted, the FPC would certainly come back and request the full contract.

Thank you,

Erin

<Ethical_Guidelines_For_Peer_Reviewers_2.pdf>

From: Petersen,Christine H (BPA) - EWP-4

Sent: Fri Jun 07 17:05:19 2019

To: David Welch

Cc: Erin Rechisky

Subject: RE: Resubmittal

Importance: Normal

Attachments: COMPASS Results CRSO MO2 MO3.pptx; crso lifecycle briefing may 2019.pdf

Hi

Thanks for your response, and I'm sorry I didn't get a chance to get back to you this week. It is sort of a crunch time for writing sections of the CRSO-EIS, and pinning down various details.

That would be really interesting to see any photos you have from your diving trip.

Yes – I think we are mostly aligned here. I will have a chance to talk to Jody again on Monday. For #5, they wanted to make clear that trying to publish the first paper is the highest priority because it could play a big role in the BA/BiOp process in the next year, but keeping it within budget is a major part of it. They have not yet worked out the tech services budget for the next year, but things are somewhat tight for both our primary program and tech services.

The Corps had the greatest budgetreduction of all, and they decided not to do a study with acoustic tags under the 125% TDG flex spill year in 2020 despite all the arguments for it. I am not sure whether to expect a restoration after the 2020 election. We are worried that we will have to pick up the cost for towing the flexible PIT antenna through the estuary, and avian studies. As an aside, I am wondering if we will even get there according to the current plan.

The tool that Susannah Iltis and Chris Van Holmes programmer at DART for assessing adult delay (people are referring to the black dots) is sort of popular. It is difficult to define a threshold where there is a delay vs a natural level of variation. Little Goose and Bonneville are the two dams with the most observations of delay due to spill. You have to sort of compare to 2017 where there were very high flows. Would there be a true emergency if we had low snowpack plus 125% spill at Little Goose?

http://www.cbr.washington.edu/dart/query/pitadult_reachdist

Furthermore, some parties are arguing that flex spill is not enough. http://www.fpc.org/documents/memos/7-19.pdf

Oh – I will also attach NOAA preliminary modeling results for the EIS alternatives (do not distribute further! A subtlety is that the CSS appears to contradict the Columbia river treaty results for high/low flow). The key slides are 6,7. Each of four alternatives is compared to the No Action Alternative NAA. Each has a set of measures, but MO3 stands out for containing Snake Dam breach. MO4 has high spill and MO2 is low spill. NOAA used trap-to-Lower Granite survivals to estimate the undammed Snake, and it is fairly sensitive to which trap you use. As you know, there are a lot of additional traps and hatcheries available, but each might tend to catch juveniles at a different lifestage and size. In short, your upstream, within, downstream of hydrosystem study will be timely because people will be focusing on this stuff when it is released at the end of the year. However, the SAR paper should be the priority.

Maybe I can reach you next week

Christine

From: David Welch [mailto:David.Welch@kintama.com]
Sent: Tuesday, June 04, 2019 12:09 PM
To: Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] Re: Resubmittal

Hi Christine—

Thanks for checking in.

Erin attended the Portland meeting and gave both our talks, as I was off on my long-planned dive trip. We have had more of our time occupied with getting logistics ready for this years' field work than I would like, but I am currently now back working full time on the SAR revision.

Perhaps after you read through this we can call you to discuss your thoughts:

1) On the BPA-funded work, I have switched to exclusively working on the SAR manuscript. I will not go back survival rate analysis & write-up until this is accomplished and back out to a reputable journal. (We will also need to identify a budget for that work, of course).

2) The revision to cut down the SARs paper by removing the management implications is the most straightforward issue…. Cutting is always faster than adding. This will still take a few weeks because two major criticisms of the reviewers were that (a) we were not sufficiently quantitative and (b) that we did not test a hypothesis. So we need to revise to address these criticisms—at this point I am not sure how much additional work this will be.

3) What is not clear-cut is whether we remove the literature review section containing the downstream freshwater (only) smolt survival data based on all published data (the original Fig. 2, attached). This received a torrent of criticism by a couple of reviewers. The part of the criticism that I think is valid is that we did not compare survival rates with time, only distance. However, the reason for that decision was because most other authors whose work we collated did not report travel time in their papers. I asked Erin to look into how much work it might be to go back and get the original data from the authors and extract travel times and she tells me that this will be "major". (She points out that there are about 129 survival estimates in the summary table we collated. For the majority, which lack published travel time information, we would need to get the original data from the authors, identify river mouth arrival time for each fish, subtract the release time, and then calculate the arrival time statistics.)

4) So it might be that it is best to exclude the freshwater survival comparison from this current paper to (a) keep within budget and (b) because to do it full justice we may need to expand the section quite a bit--the analysis gets complex because of the different tag types. In addition, adding the California (Sacramento river) would give us an additional long river to compare with the Fraser & Columbia River basin data and also remove the criticism that we exclude California with its very poor freshwater survival from the comparison. There are methods of addressing this, but let's discuss what is most important to address from your view—give me a time to call and we can discuss this. There is certainly a major published paper here, but it is going to be a battle to get it out over the (probably) heated objections of the FPC… see this Figure from my response to the FPC review that I sent BPA 6-8 weeks ago for my thinking and to frame a major paper around this—I am thinking we could add in all the other data sets we used in the current manuscript to flesh out this initial version.

California vs Columbia Survival Comparison.png

Text Box: Figure 4. Comparison of freshwater and marine survival estimates reported by Michel (2018) with the Columbia River survival estimates. The Columbia's SAR values are much more strongly determined by poor marine survival and much better freshwater survival than the California case reported by Michel (2018).

5) You mentioned "? From our viewpoint, you have to remember that we are thinking of your billable hours,". **I'm not sure of the meaning here. Do you just mean to say that you are concerned that we stay within budget? Or are you concerned about us getting things published and the timeline to do so? Please advise.**

Thanks, David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Monday, June 03, 2019 11:53 AM
To: Erin Rechisky; David Welch
Subject: Resubmittal

Hi Erin and David

I trust you are both back... although it seems like this would be the height of the field season if you are doing anything around Vancouver Island with smolts this year.

Sorry, I was unable to attend the Ocean conference in Portland a couple of weeks ago. I saw that you had two presentations. Jody Lando said that she was able to talk with you there, and also at the Salmon Ecology meeting.

How are things going generally, and with the redrafting of the Coastwide SARs manuscript? I would not prompt us to have a check in meeting unless it were really warranted. It seems like the redraft could become quite elaborate, with a host of considerations to deal with.

Jody has expressed that in light of the upcoming Biological Assessment and Biological Opinions (the process starting over again for 2020, just a year after the last one was finished), she would strongly prefer that you focus all of your energies on trying to publish the SARs paper.

Does this make sense to you? From our viewpoint, you have to remember that we are thinking of your billable hours, although I understand that in reality, you might be slowly piecing things together amidst your other work and cannot exactly speed up one task by slowing your mental effort and data collection for the second time indexed survival paper.

Christine Petersen

From: David Welch

Sent: Fri Sep 20 10:56:33 2019

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] FW: SAR for Sacramento--Inclusion in coastwide SAR paper?

Importance: Normal

Hi Christine—

The other point that escaped me during our phone conversation last night was that I think it makes sense to include the California SARs in the coast wide comparison. With your permission we will do so and update the figures to include California in the comparison. Cyril Michel's response below confirms that the data he published for California are the only reliable SAR data that has been peer-reviewed and published, so this makes this task relatively easy.

Cyril Michel's data show that California SARs are about the same as everywhere else (~1%). So it makes sense to include that in the SAR comparison for that reason.

However, the really interesting result will come as and when we can get back to the freshwater smolt survival comparison in the paper we propose to split off from the original SAR manuscript we submitted to

PLoS ONE. The quick graph I made back when I was preparing a response to the FPC memo last spring showed that freshwater smolt survival was far lower in the Sacramento R (California) than in the Columbia River (See attached). Interestingly, as Cyril's analysis allows us to now show, that in turn allows us to demonstrate that it is marine survival that very substantially "controls" the SAR in the Columbia, while in the California case freshwater & marine survivals are roughly equally important—freshwater habitat intervention can be more successful in the Sacramento River. (Another reason to publish the freshwater smolt survival analysis, once we can get the SAR comparison back out!)

Please confirm that splitting off the freshwater smolt survival comparison (excluding it from the next revision) is acceptable, and that adding published, peer-reviewed SAR data for California is also acceptable.

David

California vs Columbia Survival Comparison.png

Text Box: Figure 4. Comparison of freshwater and marine survival estimates reported by Michel (2018) with the Columbia River survival estimates. The Columbia's SAR values are much more strongly determined by poor marine survival and much better freshwater survival than the California case reported by Michel (2018).

From: David Welch
Sent: Friday, September 20, 2019 10:33 AM
To: Erin Rechisky; Aswea Porter
Subject: FW: SAR for Sacramento

FYI.

So I am taking this that Cyril's estimates are the only ones we are going to use... I am not prepared to try to establish the quality of any other estimates.

d

From: Cyril Michel - NOAA Affiliate [mailto:cyril.michel@noaa.gov]
Sent: Friday, September 20, 2019 10:30 AM
To: David Welch
Subject: SAR for Sacramento

Hey David,

Sorry for the late reply, was swamped this week and now I'm headed into the mountains for a little trip. Wanted to write back real quick with an answer. In short, if you want more SAR numbers for the Central valley, there are certainly other hatcheries that have cwted salmon, and there are also more years besides the ones I presented. However, to my knowledge, there isn't one paper or even a report that compiles many years of SAR data, besides mine. As a reminder, I just published data from two USFWS hatcheries, Coleman and Livingston stone. The other hatcheries are state run and I worried the data quality control might not be good enough, especially for data from the 80s and 90s. Also, the reason my datasets didn't go back further in time was because spawner ground surveys didn't exist yet and I was uncomfortable presenting those numbers side by side with later years when we did have that additional data source.

All that being said and caveats stated, you can get many more years of SAR data, from additional hatcheries here :

http://www.cbr.washington.edu/sacramento/data/cwtSAR/

Good luck!

Cyril

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Sent from Gmail Mobile

From: David Welch

Sent: Mon Oct 07 11:48:43 2019

To: Lando,Jody B (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] RE: Kintama Letter to FPC

Importance: Normal

Attachments: Harvest_Multiplier_05Oct19.tif

Hi Jody—

I agree with the desire to try to keep some level of civility in the proceedings. However, before we engage in yet another fishing expedition for more data, I think we should caucus by phone to go over what we have already established: I don't think that getting even more data at this point will be productive. We have already vastly exceeded what my original time budget was for getting the data sorted out—I had naively thought that most of our time would be spent analyzing the published SAR data and asking what it all meant, not in trying to "prove" the data was perfect (which is where the FPC is trying to push the debate).

I have what I wanted to achieve simply by sending the letter. The original criticism by the FPC to our prior analysis was in part that their published data wasn't the "right" data to use because it excludes upstream survival. If they now make that argument to the editor of the journal again, we will be able to stand firm and say that we tried to get "more correct" data, but were rebuffed. As we said in the original manuscript,

if it had worked out that the SARs for Puget Sound or British Columbia were in the 2-6% recovery target range that the Columbia wants to achieve there seems little doubt that those currently hostile to our analysis would have embraced it without question and used it as proof that the recovery targets were in fact achievable because river systems.

That being said, we do need to caucus and have a discussion soon. The points to discuss are:

1) *PIT tag SARs differ from CWT tag SARs in two ways:* (a) They lack any information on harvest (in effect, assume harvest is zero). (b) They exclude (deliberately) smolt survival and adult survival above the topmost dam from their SAR estimates. However, after a great deal of work on our part, it now seems clear that the approach of calculating SARs that exclude harvest is really misleading because the losses to harvest are far larger and more variable than anything I had originally (and naively) assumed. *This is a criticism true for all uses of PIT tags where the metric is adult survival and is critical to BPA*. Almost all of the policy decisions currently being made in the Columbia River basin revolve around what adult returns are predicted to be like under various changes to hydrosystem management (like boosting spill). But harvest rates have varied far more and in much more important ways than I had ever naively thought. These will have a major distorting effect on calculated SARs.

2) See the attached draft figure which shows by how much the published SARs should be multiplied by to account for the lack of info on harvest rates. (Note that for subyearlings the y-axis multiplier is on a log scale, while for yearling stocks the axis is arithmetic). If we are correct in what we are finding, relying on PIT tag-based SARs to make the determination of how adult returns (SARs) vary with hydrosystem manipulation should be a non-starter because the true SAR can vary from 1.5X to almost 4X higher than the reported SAR because of changes in harvest over time and between populations. Because these aren't factored into PIT tag analyses, both ocean climate events and harvest rate management decisions mask what is actually driving adult returns. In my view, the use of PIT tags should be restricted to measuring

smolt survival in the river, not adult returns uncorrected for harvest.

(a) Take Lyons Ferry Fall Chinook as an example. Around 2004 harvest was low, so we would only need to multiply the CSS' SAR estimate by "about" 1.3 to get the true adult survival… so the CSS estimate is biased low by 30%. Yet harvest rates changed rapidly after 2004 and the multiplier is just over 3 by 2012, so the CSS estimate is now only 1/3rd of the true value—the real value is 200% higher than what the CSS estimates using PIT tags. A statistical analysis looking at how any in-river differences would affect SARs would conclude that 2012 conditions were really bad for Chinook because only 1/3rd of the expected number of adults returned under those conditions, while many more returned under the 2004 river conditions, while in truth it was entirely dependent on what was happening to ocean harvest rates. All of the work that is based on interpreting adult returns using PIT tags (spill, TDG levels, flow, etcetera) seems to be subject to this exact same flaw. Note also how much the harvest rate multipliers vary between different populations and the same population in different years… there is no simple fix possible.

(b) For yearling Chinook (bottom panel) the same general comments apply but the magnitude of the errors will be smaller. Here our analysis is more of a work in progress and has significantly greater complicating factors (translation: it has been hard to dig out the data and there are substantial uncertainties still). However, it is clear that in-river harvest of returning adult Spring Chinook is still surprisingly high, and varies by population, so the same type of issues are important—just the magnitude of the errors aren't as big as for Fall Chinook.

3) The region's 2-6% SAR recovery targets seem to lack a clear & scientifically defensible technical definition. In short, there is circular reasoning going on here, and it needs to be identified as such. I am just trying to finish documenting the issue as best I can, so I don't want to go any farther out on a limb here than to say that this too seems like a bigger issue that hasn't been thought through carefully enough.

4) Irrelevant to the paper we are currently working up, but important to BPA: I think that the FPC/CSS have been burying earlier analyses on upstream smolt survival that did not square with what they originally set out to establish. (Whether this is deliberate or unwitting is unclear). Specifically, smolt survival to the first dam encountered is no better in the "natural" John Day River than for the Snake River populations migrating to LGR or the subsequent smolt survival from LGR to Bonneville Dam. To frame the magnitude of the effect, from the John Day River trap to McNary Dam median wild smolt survival is only 64% (just as bad as the survival experienced by Snake River smolts going through all 8 dams!) The early CSS reports stated that measuring smolt survival in the free running river sections above the hydrosystem was to be an important focus of their report; after a few years they moved the results to an appendix. After a few more years they dropped the analysis from the reports altogether, but never explained why. It seems to me that they did so because the data disagreed with their prior belief that Snake River smolt survival through the dams was horrible and the cause of poor performance; if it is just as bad for the pristine John Day River, one of their core beliefs must be wrong. I asked Aswea to try to quickly document a timeline on what happened. It is a complete side issue to our current contract, but the important point for BPA is that the effect was to ultimately suppress a lot of disturbing evidence that the really bad survival levels also happened in "natural" wild rivers free from anthropogenic modification. If that is true, how can manipulating the hydrosystem achieve recovery?

Lots of detail here—apologies in advance. We will walk you through this one step at a time in a phone call when it is convenient for you. Please consider everything we have outlined as preliminary until we can fully nail things down.

David Welch

From: Lando,Jody B (BPA) - EWP-4 [mailto:jblando@bpa.gov]
Sent: Friday, October 04, 2019 2:48 PM
To: David Welch; Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: RE: Kintama Letter

David – thanks for sharing your thoughts on the letter and regional responses. It's getting ample regional exposure. BPA supports Kintama's desire to secure necessary data. That said, I want to ensure we achieve success while also maintaining constructive relationships with regional partners. Based on points in Tim Copeland's email and Aswea's response below, could you provide BPA with a modified and specific request for FPC and other possible data sources (i.e. tagging agencies). We will have an internal discussion of how best to assist once we have a specific list.

Thanks very much and have a nice weekend

Jody B. Lando, Ph.D.
Research, Monitoring and Evaluation Lead | EWP-4

Bonneville Power Administration
jblando@bpa.gov | P 503-230-5809 | C (b) (6) [redacted]

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From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, October 04, 2019 11:31 AM
To: Petersen,Christine H (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] FW: Kintama Letter

Christine and Jody—

Not to belabor this point any further, but Aswea has documented that the FPC folks really do already generate the smolt survival above the topmost dam, at least for the Snake River populations. Just read the text highlighted in yellow, below.

No need to respond here, it is just that the FPC is claiming to us that this is hard to do (which it isn't), and already doing it for their own purposes in the 2018 CSS report.

From: Aswea Porter
Sent: Friday, October 04, 2019 11:20 AM
To: David Welch
Cc: Erin Rechisky
Subject: RE: Kintama Letter

Tim’s comments do have merit but he is talking about wild fish while Christine interpreted hatchery. Most of the CSS SARS are for hatchery fish. In our paper, we could describe Tim’s issue and use the release to LGR estimates as minimum survivals.

Although Tim’s email does address survivals from release to the top dam, there was room in our letter for the FPC to misconstrue that we would accept the S1 survivals (release to top dam).

The CSS should have S1 survivals release to the top dam based on their methods.

Where:

From: David Welch
Sent: October-04-19 15:14
To: Petersen,Christine H (BPA) - EWP-4
Cc: Lando,Jody B (BPA) - EWP-4; Erin Rechisky; Aswea Porter

Subject: RE: Kintama Letter

Hi Christine—

Thanks for these emails. They fit the common pattern, which is that when someone says something contrary to the conventional dogma in the Columbia River basin (and simple!!) the response nearly always seems to be along the lines of *"…well, wait a minute… here are all these possible complexities!!"*. The critic then provides a list of things that *might* affect the answer/conclusions… and then stop. I don't think I can recall a case yet where the critic actually rolls up their sleeves and digs into whether or not the possible issues means that the contradictory findings would really be undermined by the issues raised. It seems that no one actually wants to actually move things forward, just defend the status quo.

I have a call planned with Greg Ruggerone to ask him his perspective on a few things today. I am just waiting on our preparation of a summary graph to guide that discussion.

Could we set up a call with you very late this afternoon or (perhaps preferable) on Monday?

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]

Sent: Friday, October 04, 2019 9:49 AM
To: David Welch
Cc: Lando,Jody B (BPA) - EWP-4
Subject: FW: Kintama Letter

Hi David,

I am copying a response to the mass email from two days ago (just noticed they misspelled the address of Ritchey Graves). Anyhow, some of what Tim Copeland is saying is fairly valuable as far as actually being able to track down hatchery-to-hatchery SARs.

That we or you should have tried to approach groups operating hatcheries and wild traps at IDFG and other entities was not obvious. I will also admit to being somewhat surprised when Josh Murauskas suggested it would be not particularly time consuming to get the data from PTAGIS (would take him less than a week?). In 2017, my memory of the verbal conversation over at the FPC office (following an emailed request for data – which was to be used for our BA – (it's not quite fair to act like we were misleading them by saying it was for the BA)) was that Gabe Scheer said that it would take him months and months to get the Hatchery-to-hatchery SARs. This was primarily because there are some many year X site combinations. But they said that they could start working on it in the background. But because this was a verbal conversation, there is no record and people can walk away remembering something different. Carrying out the correspondence via written letter and then email is a bit more bold but it does get your and their position there on the record.

However, you will want to consider your next steps. What Tim is saying backs up the idea that CWT hatchery-to-hatchery SARs and PIT based SARs have many differences. In his response, I don't think that Tim understands that you are not trying to group the hatcheries together, but are requesting the data so that you can avoid doing that. Are these PIT based hatchery or trap SARs actually available from other entities?

By the way, Charlie Paulsen and a few others in the NOAA modeling circles have looked into the patterns of movement and survival upstream of Lower Granite. Size at tagging, by itself, could confound the rate of movement downstream from both traps and hatcheries (in the CSS study, it is assumed that the multiple tagging groups randomly enter into the Co (undetected) and C1 (detected) groups at Lower Granite, Little Goose). But size at tagging is just one factor for what is happening upstream – you have traps in warm tributaries like the Lemhi, traps in cold tributaries, hatcheries at varying distances to Lower Granite that raise their juveniles to different sizes at release. It is messy, just as Tim Copeland is saying.

I am going to talk to Jody later today. Perhaps we could arrange for a check in or update with you soon?

Christine Petersen

From: Copeland,Tim [mailto:tim.copeland@idfg.idaho.gov]
Sent: Wednesday, October 02, 2019 2:37 PM
To: Michele Dehart; Adam Storch (adam.j.storch@state.or.us); Erick VanDyke (Erick.S.VanDyke@coho2.dfw.state.or.us); Tucker Jones (tucker.a.jones@state.or.us); 'Tom Lorz (lort@critfc.org)'; 'Rob Lothrop (lotr@critfc.org)'; Robert Lessard (LESR@critfc.org); 'Christine Golightly'; 'ED.Bowles@state.or.us'; Hebdon,Lance; Rawding, Daniel J (DFW) (Daniel.Rawding@dfw.wa.gov); 'Bill Tweit (tweitwmt@dfw.wa.gov)'; Garrity, Michael D (DFW) (Michael.Garrity@dfw.wa.gov); Steve_Haeseker@fws.gov; David Swank; ritche.graves@noaa.gov; Jay Hesse (jayh@nezperce.org); zpenney@critfc.org
Cc: Jerry McCann; Brandon Chockley; Erin Cooper; Gabriel Scheer; Bobby Hsu; Petersen,Christine H (BPA) - EWP-4; Schrader,Bill; Bowersox,Brett
Subject: [EXTERNAL] RE: Kintama Letter

Hi Michele,

I'd like to make two points relevant to this letter.

Survival from release to Lower Granite Dam has always been the responsibility of the tagging agencies, not CSS. Much of the tagging in the Snake basin has been in cooperation with and assisted by CSS (in the form of extra PIT tags), but the traps where this tagging occurs were usually established for other reasons. In essence, CSS has been leveraging work done by other entities to generate more tags into the hydrosystem. This is an effective and efficient way for CSS to facilitate its analyses of events downstream of Lower Granite Dam. To come to my first point, Dr Welch was asking the wrong people.

Second, for wild salmon and steelhead in the Snake basin, we tend to define a smolt as a fish that has passed Lower Granite Dam. We treat the geographic location of the dam as our evaluation point for the life stage. That is because a majority of the juveniles exiting natal streams do so in the fall (see Copeland et al 2014 TAFS 143:1460-1475). There are literally hundreds of miles of river below some tagging sites with suitable habitat for little salmon and steelhead. Steelhead in particular may make extensive use of this habitat, residing several years before smolting in some cases. Hence mortality from initiation of smoltification is confounded with winter mortality (and more for steelhead). Further, fish that use downstream habitats often have a different SAR (LGR-BON) than those that remain in their natal stream until smolting. Again, Dr Welch was not asking the right people. I do not believe simplifying this diversity into a single number for easy comparison is justifiable.

Sincerely, Tim

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Timothy Copeland, PhD

Coordinator

Wild Salmon & Steelhead Monitoring Program

Idaho Department of Fish & Game

(208)287-2782

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Tim:

I agree with all of your points. Welch is doing this under contract with BPA. Although we have asked for the contract deliverables, BPA has not provided them. The Welch article submitted for publication in PLOS, illuminates the purpose/reason that Welch is asking for this data. Welch has already circulated this article to the region by submitting it to the NPCC Fish and Wildlife amendment process. Let me know if you do not have a copy of this article. The Welch request is for CSS tag data. We will provide the data to Welch. We will review whatever analyses Kintama does for BPA and make our comments available to the region.

Michele

From: David Welch

Sent: Wed Oct 09 16:10:51 2019

To: Petersen,Christine H (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] RE: Kintama Letter to FPC

Importance: Normal

Attachments: Harvest_Multiplier_09Oct19.tif

Erin is away on Thursday at another meeting, and [redacted] (b) (6)

My schedule is wide open on Friday, [redacted] (b) (6) **, otherwise, she seems to be free.**

I suggest that we let you & Jody set a time that works for you on Friday, and one or both of us will make sure we are able to cal in. Attached is an updated version of the harvest rate multiplier graph.

If Friday won't work both of our schedules look pretty open next week.

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Wednesday, October 09, 2019 4:04 PM
To: David Welch; Lando,Jody B (BPA) - EWP-4
Cc: Erin Rechisky
Subject: RE: Kintama Letter to FPC

Jody, David, Erin,

Would 1-2pm tomorrow (Thursday) be a good time for a phone call? We could check in on this particular subject, and also how things are going in general.

I know Jody is juggling multiple things. Please let me know if Friday or next week would be better (we have a federal holiday on Monday). It would be nice to go over this, especially if it was a burning issue to inquire with Tim Copeland as to how to get hatchery or trap-to Bonneville SARs from any particular groups. However, I know that you have been discussing how to proceed on multiple elements of your revision.

Christine

From: David Welch [mailto:David.Welch@kintama.com]

Sent: Monday, October 07, 2019 11:49 AM
To: Lando,Jody B (BPA) - EWP-4; Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] RE: Kintama Letter to FPC

Hi Jody—

I agree with the desire to try to keep some level of civility in the proceedings. However, before we engage in yet another fishing expedition for more data, I think we should caucus by phone to go over what we have already established: I don't think that getting even more data at this point will be productive. We have already vastly exceeded what my original time budget was for getting the data sorted out—I had naively thought that most of our time would be spent analyzing the published SAR data and asking what it all meant, not in trying to "prove" the data was perfect (which is where the FPC is trying to push the debate).

I have what I wanted to achieve simply by sending the letter. The original criticism by the FPC to our prior analysis was in part that their published data wasn't the "right" data to use because it excludes upstream survival. If they now make that argument to the editor of the journal again, we will be able to stand firm and say that we tried to get "more correct" data, but were rebuffed. As we said in the original manuscript, if it had worked out that the SARs for Puget Sound or British Columbia were in the 2-6% recovery target range that the Columbia wants to achieve there seems little doubt that those currently hostile to our analysis would have embraced it without question and used it as proof that the recovery targets were in fact achievable because river systems.

That being said, we do need to caucus and have a discussion soon. The points to discuss are:

1) *__PIT tag SARs differ from CWT tag SARs in two ways:__* (a) They lack any information on harvest (in effect, assume harvest is zero). (b) They exclude (deliberately) smolt survival and adult survival above the topmost dam from their SAR estimates. However, after a great deal of work on our part, it now seems clear that the approach of calculating SARs that exclude harvest is really misleading because the losses to harvest are far larger and more variable than anything I had originally (and naively) assumed. *__This is a criticism true for all uses of PIT tags where the metric is adult survival and is critical to BPA__*. Almost all of the policy decisions currently being made in the Columbia River basin revolve around what adult returns are predicted to be like under various changes to hydrosystem management (like boosting spill). But harvest rates have varied far more and in much more important ways than I had ever naively thought. These will have a major distorting effect on calculated SARs.

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(a) Take Lyons Ferry Fall Chinook as an example. Around 2004 harvest was low, so we would only need to multiply the CSS' SAR estimate by "about" 1.3 to get the true adult survival… so the CSS estimate is biased low by 30%. Yet harvest rates changed rapidly after 2004 and the multiplier is just over 3 by

2012, so the CSS estimate is now only 1/3rd of the true value—the real value is 200% higher than what the CSS estimates using PIT tags. A statistical analysis looking at how any in-river differences would affect SARs would conclude that 2012 conditions were really bad for Chinook because only 1/3rd of the expected number of adults returned under those conditions, while many more returned under the 2004 river conditions, while in truth it was entirely dependent on what was happening to ocean harvest rates. All of the work that is based on interpreting adult returns using PIT tags (spill, TDG levels, flow, etcetera) seems to be subject to this exact same flaw. Note also how much the harvest rate multipliers vary between different populations and the same population in different years… there is no simple fix possible.

(b) For yearling Chinook (bottom panel) the same general comments apply but the magnitude of the errors will be smaller. Here our analysis is more of a work in progress and has significantly greater complicating factors (translation: it has been hard to dig out the data and there are substantial uncertainties still). However, it is clear that in-river harvest of returning adult Spring Chinook is still surprisingly high, and varies by population, so the same type of issues are important—just the magnitude of the errors aren't as big as for Fall Chinook.

3) The region's 2-6% SAR recovery targets seem to lack a clear & scientifically defensible technical definition. In short, there is circular reasoning going on here, and it needs to be identified as such. I am just trying to finish documenting the issue as best I can, so I don't want to go any farther out on a limb here than to say that this too seems like a bigger issue that hasn't been thought through carefully enough.

4) Irrelevant to the paper we are currently working up, but important to BPA: I think that the FPC/CSS have been burying earlier analyses on upstream smolt survival that did not square with what they originally set out to establish. (Whether this is deliberate or unwitting is unclear). Specifically, smolt survival to the first dam encountered is no better in the "natural" John Day River than for the Snake River populations migrating to LGR or the subsequent smolt survival from LGR to Bonneville Dam. To frame the

magnitude of the effect, from the John Day River trap to McNary Dam median wild smolt survival is only 64% (just as bad as the survival experienced by Snake River smolts going through all 8 dams!) The early CSS reports stated that measuring smolt survival in the free running river sections above the hydrosystem was to be an important focus of their report; after a few years they moved the results to an appendix. After a few more years they dropped the analysis from the reports altogether, but never explained why. It seems to me that they did so because the data disagreed with their prior belief that Snake River smolt survival through the dams was horrible and the cause of poor performance; if it is just as bad for the pristine John Day River, one of their core beliefs must be wrong. I asked Aswea to try to quickly document a timeline on what happened. It is a complete side issue to our current contract, but the important point for BPA is that the effect was to ultimately suppress a lot of disturbing evidence that the really bad survival levels also happened in "natural" wild rivers free from anthropogenic modification. If that is true, how can manipulating the hydrosystem achieve recovery?

Lots of detail here—apologies in advance. We will walk you through this one step at a time in a phone call when it is convenient for you. Please consider everything we have outlined as preliminary until we can fully nail things down.

David Welch

From: Lando,Jody B (BPA) - EWP-4 [mailto:jblando@bpa.gov]
Sent: Friday, October 04, 2019 2:48 PM
To: David Welch; Petersen,Christine H (BPA) - EWP-4
Cc: Erin Rechisky
Subject: RE: Kintama Letter

David – thanks for sharing your thoughts on the letter and regional responses. It's getting ample regional exposure. BPA supports Kintama's desire to secure necessary data. That said, I want to ensure we achieve success while also maintaining constructive relationships with regional partners. Based on points in Tim Copeland's email and Aswea's response below, could you provide BPA with a modified and specific request for FPC and other possible data sources (i.e. tagging agencies). We will have an internal discussion of how best to assist once we have a specific list.

Thanks very much and have a nice weekend

Jody B. Lando, Ph.D.
Research, Monitoring and Evaluation Lead | EWP-4

Bonneville Power Administration
jblando@bpa.gov | P 503-230-5809 | C (b) (6) [redacted]

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From: David Welch [mailto:David.Welch@kintama.com]
Sent: Friday, October 04, 2019 11:31 AM
To: Petersen,Christine H (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] FW: Kintama Letter

Christine and Jody—

Not to belabor this point any further, but Aswea has documented that the FPC folks really do already generate the smolt survival above the topmost dam, at least for the Snake River populations. Just read the text highlighted in yellow, below.

No need to respond here, it is just that the FPC is claiming to us that this is hard to do (which it isn't), and already doing it for their own purposes in the 2018 CSS report.

From: Aswea Porter
Sent: Friday, October 04, 2019 11:20 AM
To: David Welch
Cc: Erin Rechisky
Subject: RE: Kintama Letter

Tim's comments do have merit but he is talking about wild fish while Christine interpreted hatchery. Most of the CSS SARS are for hatchery fish. In our paper, we could describe Tim's issue and use the release to LGR estimates as minimum survivals.

Although Tim's email does address survivals from release to the top dam, there was room in our letter for the FPC to misconstrue that we would accept the S1 survivals (release to top dam).

The CSS should have S1 survivals release to the top dam based on their methods.

Where:

From: David Welch
Sent: October-04-19 15:14
To: Petersen,Christine H (BPA) - EWP-4
Cc: Lando,Jody B (BPA) - EWP-4; Erin Rechisky; Aswea Porter
Subject: RE: Kintama Letter

Hi Christine—

Thanks for these emails. They fit the common pattern, which is that when someone says something contrary to the conventional dogma in the Columbia River basin (and simple!!) the response nearly always seems to be along the lines of "*...well, wait a minute... here are all these possible complexities!!*". The critic then provides a list of things that *might* affect the answer/conclusions... and then stop. I don't think I can recall a case yet where the critic actually rolls up their sleeves and digs into whether or not the possible issues means that the contradictory findings would really be undermined by the issues raised. It seems that no one actually wants to actually move things forward, just defend the status quo.

I have a call planned with Greg Ruggerone to ask him his perspective on a few things today. I am just waiting on our preparation of a summary graph to guide that discussion.

Could we set up a call with you very late this afternoon or (perhaps preferable) on Monday?

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, October 04, 2019 9:49 AM
To: David Welch
Cc: Lando,Jody B (BPA) - EWP-4
Subject: FW: Kintama Letter

Hi David,

I am copying a response to the mass email from two days ago (just noticed they misspelled the address of Ritchey Graves). Anyhow, some of what Tim Copeland is saying is fairly valuable as far as actually being able to track down hatchery-to-hatchery SARs.

That we or you should have tried to approach groups operating hatcheries and wild traps at IDFG and other entities was not obvious. I will also admit to being somewhat surprised when Josh Murauskas suggested it would be not particularly time consuming to get the data from PTAGIS (would take him less than a week?). In 2017, my memory of the verbal conversation over at the FPC office (following an emailed request for data – which was to be used for our BA – (it's not quite fair to act like we were misleading them by saying it was for the BA)) was that Gabe Scheer said that it would take him months and months to get the Hatchery-to-hatchery SARs. This was primarily because there are some many year X site combinations. But they said that they could start working on it in the background. But because this was a verbal conversation, there is no record and people can walk away remembering something different. Carrying out the correspondence via written letter and then email is a bit more bold but it does get your and their position there on the record.

However, you will want to consider your next steps. What Tim is saying backs up the idea that CWT hatchery-to-hatchery SARs and PIT based SARs have many differences. In his response, I don't think that Tim understands that you are not trying to group the hatcheries together, but are requesting the data so that you can avoid doing that. Are these PIT based hatchery or trap SARs actually available from other entities?

By the way, Charlie Paulsen and a few others in the NOAA modeling circles have looked into the patterns of movement and survival upstream of Lower Granite. Size at tagging, by itself, could confound the rate of movement downstream from both traps and hatcheries (in the CSS study, it is assumed that the multiple tagging groups randomly enter into the Co (undetected) and C1 (detected) groups at Lower Granite, Little Goose). But size at tagging is just one factor for what is happening upstream – you have traps in warm tributaries like the Lemhi, traps in cold tributaries, hatcheries at varying distances to Lower Granite that raise their juveniles to different sizes at release. It is messy, just as Tim Copeland is saying.

I am going to talk to Jody later today. Perhaps we could arrange for a check in or update with you soon?

Christine Petersen

From: Copeland,Tim [mailto:tim.copeland@idfg.idaho.gov]
Sent: Wednesday, October 02, 2019 2:37 PM
To: Michele Dehart; Adam Storch (adam.j.storch@state.or.us); Erick VanDyke (Erick.S.VanDyke@coho2.dfw.state.or.us); Tucker Jones (tucker.a.jones@state.or.us); 'Tom Lorz (lort@critfc.org)'; 'Rob Lothrop (lotr@critfc.org)'; Robert Lessard (LESR@critfc.org); 'Christine Golightly'; 'ED.Bowles@state.or.us'; Hebdon,Lance; Rawding, Daniel J (DFW) (Daniel.Rawding@dfw.wa.gov); 'Bill Tweit (tweitwmt@dfw.wa.gov)'; Garrity, Michael D (DFW) (Michael.Garrity@dfw.wa.gov); Steve_Haeseker@fws.gov; David Swank; ritche.graves@noaa.gov; Jay Hesse (jayh@nezperce.org); zpenney@critfc.org
Cc: Jerry McCann; Brandon Chockley; Erin Cooper; Gabriel Scheer; Bobby Hsu; Petersen,Christine H (BPA) - EWP-4; Schrader,Bill; Bowersox,Brett
Subject: [EXTERNAL] RE: Kintama Letter

Hi Michele,

I'd like to make two points relevant to this letter.

Survival from release to Lower Granite Dam has always been the responsibility of the tagging agencies, not CSS. Much of the tagging in the Snake basin has been in cooperation with and assisted by CSS (in the form of extra PIT tags), but the traps where this tagging occurs were usually established for other reasons. In essence, CSS has been leveraging work done by other entities to generate more tags into the hydrosystem. This is an effective and efficient way for CSS to facilitate its analyses of events downstream of Lower Granite Dam. To come to my first point, Dr Welch was asking the wrong people.

Second, for wild salmon and steelhead in the Snake basin, we tend to define a smolt as a fish that has passed Lower Granite Dam. We treat the geographic location of the dam as our evaluation point for the life stage. That is because a majority of the juveniles exiting natal streams do so in the fall (see Copeland et al 2014 TAFS 143:1460-1475). There are literally hundreds of miles of river below some tagging sites with suitable habitat for little salmon and steelhead. Steelhead in particular may make extensive use of this habitat, residing several years before smolting in some cases. Hence mortality from initiation of smoltification is confounded with winter mortality (and more for steelhead). Further, fish that use downstream habitats often have a different SAR (LGR-BON) than those that remain in their natal stream until smolting. Again, Dr Welch was not asking the right people. I do not believe simplifying this diversity into a single number for easy comparison is justifiable.

Sincerely, Tim

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Timothy Copeland, PhD

Coordinator

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Tim:

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From: Lando,Jody B (BPA) - EWP-4

Sent: Wed Oct 09 17:43:01 2019

To: David Welch; Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: RE: Kintama Letter to FPC

Importance: Normal

It would be good to talk, but next week would be much better than this week.

Christine – please use my calendar to find a time that works.

Jody B. Lando, Ph.D.
Research, Monitoring and Evaluation Lead | EWP-4

Bonneville Power Administration
jblando@bpa.gov | P 503-230-5809 | C (b) (6) [redacted]

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From: David Welch [mailto:David.Welch@kintama.com]

Sent: Wednesday, October 09, 2019 4:11 PM
To: Petersen,Christine H (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4
Cc: Erin Rechisky
Subject: [EXTERNAL] RE Kintama Letter to FPC

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My schedule is wide open on Friday, but it looks from [redacted]**, otherwise, she seems to be free.**

I suggest that we let you & Jody set a time that works for you on Friday, and one or both of us will make sure we are able to cal in. Attached is an updated version of the harvest rate multiplier graph.

If Friday won't work both of our schedules look pretty open next week.

David

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Cc: Erin Rechisky
Subject: RE: Kintama Letter to FPC

Jody, David, Erin,

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I know Jody is juggling multiple things. Please let me know if Friday or next week would be better (we have a federal holiday on Monday). It would be nice to go over this, especially if it was a burning issue to inquire with Tim Copeland as to how to get hatchery or trap-to Bonneville SARs from any particular groups. However, I know that you have been discussing how to proceed on multiple elements of your revision.

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David Welch

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Sent: Friday, October 04, 2019 2:48 PM
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Cc: Erin Rechisky
Subject: RE: Kintama Letter

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Thanks very much and have a nice weekend

Jody B. Lando, Ph.D.
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Bonneville Power Administration
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To: Petersen,Christine H (BPA) - EWP-4; Lando,Jody B (BPA) - EWP-4
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Christine and Jody—

Not to belabor this point any further, but Aswea has documented that the FPC folks really do already

generate the smolt survival above the topmost dam, at least for the Snake River populations. Just read the text highlighted in yellow, below.

No need to respond here, it is just that the FPC is claiming to us that this is hard to do (which it isn't), and already doing it for their own purposes in the 2018 CSS report.

From: Aswea Porter
Sent: Friday, October 04, 2019 11:20 AM
To: David Welch
Cc: Erin Rechisky
Subject: RE: Kintama Letter

Tim's comments do have merit but he is talking about wild fish while Christine interpreted hatchery. Most of the CSS SARS are for hatchery fish. In our paper, we could describe Tim's issue and use the release to LGR estimates as minimum survivals.

Although Tim's email does address survivals from release to the top dam, there was room in our letter for the FPC to misconstrue that we would accept the S1 survivals (release to top dam).

The CSS should have S1 survivals release to the top dam based on their methods.

Where:

From: David Welch
Sent: October-04-19 15:14
To: Petersen,Christine H (BPA) - EWP-4
Cc: Lando,Jody B (BPA) - EWP-4; Erin Rechisky; Aswea Porter
Subject: RE: Kintama Letter

Hi Christine—

Thanks for these emails. They fit the common pattern, which is that when someone says something contrary to the conventional dogma in the Columbia River basin (and simple!!) the response nearly always seems to be along the lines of *"…well, wait a minute… here are all these possible complexities!!*". The critic then provides a list of things that *might* affect the answer/conclusions… and then stop. I don't think I can recall a case yet where the critic actually rolls up their sleeves and digs into whether or not the possible issues means that the contradictory findings would really be undermined by the issues raised. It seems that no one actually wants to actually move things forward, just defend the status quo.

I have a call planned with Greg Ruggerone to ask him his perspective on a few things today. I am just waiting on our preparation of a summary graph to guide that discussion.

Could we set up a call with you very late this afternoon or (perhaps preferable) on Monday?

David

From: Petersen,Christine H (BPA) - EWP-4 [mailto:chpetersen@bpa.gov]
Sent: Friday, October 04, 2019 9:49 AM
To: David Welch
Cc: Lando,Jody B (BPA) - EWP-4
Subject: FW: Kintama Letter

Hi David,

I am copying a response to the mass email from two days ago (just noticed they misspelled the address of Ritchey Graves). Anyhow, some of what Tim Copeland is saying is fairly valuable as far as actually being able to track down hatchery-to-hatchery SARs.

That we or you should have tried to approach groups operating hatcheries and wild traps at IDFG and other entities was not obvious. I will also admit to being somewhat surprised when Josh Murauskas suggested it would be not particularly time consuming to get the data from PTAGIS (would take him less than a week?). In 2017, my memory of the verbal conversation over at the FPC office (following an emailed request for data – which was to be used for our BA – (it's not quite fair to act like we were misleading them by saying it was for the BA)) was that Gabe Scheer said that it would take him months and months to get the Hatchery-to-hatchery SARs. This was primarily because there are some many year X site combinations. But they said that they could start working on it in the background. But because this was a verbal conversation, there is no record and people can walk away remembering something different. Carrying out the correspondence via written letter and then email is a bit more bold but it does get your and their position there on the record.

However, you will want to consider your next steps. What Tim is saying backs up the idea that CWT hatchery-to-hatchery SARs and PIT based SARs have many differences. In his response, I don't think that Tim understands that you are not trying to group the hatcheries together, but are requesting the data so that you can avoid doing that. Are these PIT based hatchery or trap SARs actually available from other entities?

By the way, Charlie Paulsen and a few others in the NOAA modeling circles have looked into the patterns of movement and survival upstream of Lower Granite. Size at tagging, by itself, could confound the rate of movement downstream from both traps and hatcheries (in the CSS study, it is assumed that the multiple tagging groups randomly enter into the Co (undetected) and C1 (detected) groups at Lower Granite, Little Goose). But size at tagging is just one factor for what is happening upstream – you have traps in warm tributaries like the Lemhi, traps in cold tributaries, hatcheries at varying distances to Lower Granite that raise their juveniles to different sizes at release. It is messy, just as Tim Copeland is saying.

I am going to talk to Jody later today. Perhaps we could arrange for a check in or update with you soon?

Christine Petersen

From: Copeland,Tim [mailto:tim.copeland@idfg.idaho.gov]
Sent: Wednesday, October 02, 2019 2:37 PM
To: Michele Dehart; Adam Storch (adam.j.storch@state.or.us); Erick VanDyke (Erick.S.VanDyke@coho2.dfw.state.or.us); Tucker Jones (tucker.a.jones@state.or.us); 'Tom Lorz (lort@critfc.org)'; 'Rob Lothrop (lotr@critfc.org)'; Robert Lessard (LESR@critfc.org); 'Christine Golightly'; 'ED.Bowles@state.or.us'; Hebdon,Lance; Rawding, Daniel J (DFW) (Daniel.Rawding@dfw.wa.gov); 'Bill Tweit (tweitwmt@dfw.wa.gov)'; Garrity, Michael D (DFW) (Michael.Garrity@dfw.wa.gov); Steve_Haeseker@fws.gov; David Swank; ritche.graves@noaa.gov; Jay Hesse (jayh@nezperce.org); zpenney@critfc.org
Cc: Jerry McCann; Brandon Chockley; Erin Cooper; Gabriel Scheer; Bobby Hsu; Petersen,Christine H (BPA) - EWP-4; Schrader,Bill; Bowersox,Brett
Subject: [EXTERNAL] RE: Kintama Letter

Hi Michele,

I'd like to make two points relevant to this letter.

Survival from release to Lower Granite Dam has always been the responsibility of the tagging agencies, not CSS. Much of the tagging in the Snake basin has been in cooperation with and assisted by CSS (in the form of extra PIT tags), but the traps where this tagging occurs were usually established for other reasons. In essence, CSS has been leveraging work done by other entities to generate more tags into the hydrosystem. This is an effective and efficient way for CSS to facilitate its analyses of events downstream of Lower Granite Dam. To come to my first point, Dr Welch was asking the wrong people.

Second, for wild salmon and steelhead in the Snake basin, we tend to define a smolt as a fish that has passed Lower Granite Dam. We treat the geographic location of the dam as our evaluation point for the life stage. That is because a majority of the juveniles exiting natal streams do so in the fall (see Copeland et al 2014 TAFS 143:1460-1475). There are literally hundreds of miles of river below some tagging sites with suitable habitat for little salmon and steelhead. Steelhead in particular may make extensive use of this habitat, residing several years before smolting in some cases. Hence mortality from initiation of smoltification is confounded with winter mortality (and more for steelhead). Further, fish that use downstream habitats often have a different SAR (LGR-BON) than those that remain in their natal stream until smolting. Again, Dr Welch was not asking the right people. I do not believe simplifying this diversity into a single number for easy comparison is justifiable.

Sincerely, Tim

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Timothy Copeland, PhD

Coordinator

Wild Salmon & Steelhead Monitoring Program

Idaho Department of Fish & Game

(208)287-2782

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Tim:

I agree with all of your points. Welch is doing this under contract with BPA. Although we have asked for the contract deliverables, BPA has not provided them. The Welch article submitted for publication in PLOS, illuminates the purpose/reason that Welch is asking for this data. Welch has already circulated this article to the region by submitting it to the NPCC Fish and Wildlife amendment process. Let me know if you do not have a copy of this article. The Welch request is for CSS tag data. We will provide the data to Welch. We will review whatever analyses Kintama does for BPA and make our comments available to the region.

Michele

From: Petersen,Christine H (BPA) - EWP-4
Sent: Fri May 22 14:35:04 2020
To: 'David Welch'; Erin Rechisky; Aswea Porter
Subject: RE: 18th
Importance: Normal
Attachments: IWR W912HQ20F0011 CRSO Ecological Models Final Model Report_May 4 2020.pdf

Hi David,

Sorry for the slow response. Things really have been quite busy with the two Biological Opinions, and writing individual responses to a thousand public comments on the EIS (there were a lot more comments than this, but we wrote responses to the unique ones that were not form letters). They are public, so I could possibly share it later. It was interesting to see what people brought up, and we were able to cite your papers in a few cases. There were a few people outside the agencies who showed good understanding of what is going on, and there were a lot who were emphasizing the killer whale themes and other talking points.

Regarding the proposal – I will talk to Jody again when she emerges from the USFWS Biological Opinion review. She primarily asked if you could circulate a '1 pager' for any proposal ideas rather than try to fit it all into a one hour presentation. It was not necessarily a call for doing a large amount of extra work.

Discussing a telemetry proposal would be fairly complex, so that might be something we would have to set up as a follow up phone call. I could remind everyone that we have this second data analysis in the contract that was halted while we asked you to focus on this revision, and I could also let everyone know that you do have additional concepts including field work.

We should all have a sort of renewed perspective on the next few years, with a variety of new research objectives expressed in the Biological Opinions from NOAA and USFWS. I will also share a public review that the IEPR panel made based on the set of models used in the CRS environmental impact statement which included CSS, Compass, the NOAA lifecycle model framework, and UW's TDG models. They spent a lot of time making a series of recommendations regarding TDG, including using 3-d computational fluid dynamics models, using advanced telemetry to get depth and time distribution data in the tailraces, and also integrate all the results into population exposure and survival models. In helping the Corps write the response to these recommendations, I was a little unsure about what we would be committing the Corps to doing, if I wrote "yes, we agree with your recommendation, we should include these objectives in future monitoring plans".

I could hunt for the Columbia treaty modeling results, but I know that some of the official final reports have been embargoed, and they aren't being distributed for some reason.

Christine

From: David Welch <David.Welch@Kintama.com>
Sent: Thursday, May 7, 2020 4:39 PM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>; Erin Rechisky <

Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: [EXTERNAL] RE: 18th

Thanks—

1) You wrote "there are papers describing at least 3-5 different potential mechanisms of 'carryover effect', some of which appear to be more realistic than others"**. Are these papers available for us to read?**

2) A complete proposal is going to be a lot of work on our end, of course, and the price tag is inevitably large because we will be proposing an array stretching all the way to northern tip of Vancouver Island (replicating past measurements from 2006-2011, so we can compare new measurements with old as part of the TDG & latent mortality tests). Before we try to put a major proposal together, we need to have a discussion that there is a willingness to find the funding if it passes the scientific rigor and relevance tests. (I am already assembling parts of that proposal, but obviously before we go too far with this we need to have a discussion about the initiative—but I do believe it will directly address all the issues Tom Karier identifies (and more)).

3) We will focus on presenting the findings of the revised paper on May 29th. Your colleagues in principle should be somewhat aware of them, but our last check in was November 1st, as I recall. It will be good timing to review the substance again in light of the EIS, which we will read in the interim.

4) As you are working on the EIS review, remember that both the NOAA's COMPASS model and the CSS study will have been calibrated using PIT tag-based SARs. If SARs are badly distorted because the PIT tags fail to incorporate harvest, *both* NOAA's & CSS' recommendations may be distorted for the same reasons. Food for thought!

5) Do you have an idea of where the original Haeseker analysis is? I would like to take a look at it, starting from first principles. However, there seem to be various iterations of it around (or at least varying citations), so I wanted to read the original analysis that underlays the whole higher spill/TDG argument.

From: Petersen,Christine H (BPA) - EWP-4 < chpetersen@bpa.gov>
Sent: Thursday, May 07, 2020 12:27 PM
To: David Welch < David.Welch@Kintama.com>; Erin Rechisky < Erin.Rechisky@Kintama.com>; Aswea Porter < Aswea.Porter@Kintama.com>
Subject: RE: 18th

Hi,
Sorry for the slow response.

We moved the day of the presentation because many of us are really stretched for time what with the review of two Biological Opinions, and Leah Sullivan and John Skidmore potentially couldn't attend.

I spoke with Jody Lando. We are very much interested in your new ideas. This month is a challenging time to review a proposal under our technical services procedure but June could be a much better period. Plus we would approach this with a lot of new perspective based on the new 'Conservation Measures' list that NOAA is requiring (this replaces the RPA table from the 2008 Biological opinion). I wish I could copy and paste this for you to scan, but the document says it is in draft form so I cannot. There are elements calling for studying the manner of transportation to improve outcomes, quite a bit for TDG and water quality monitoring under the new flexible spill operation, more estuary habitat restoration, they want to reduce the northern pikeminnow rewards program. I like how they describe uncertainty for ocean conditions under climate change. As Tom Karier addressed in the paper you forwarded, NOAA was choosing to present both their own survival model, Compass, but also kept referring to the CSS study, and magnitude of hypothetical delayed mortality due to spill (which is a specific mechanism – there are papers describing at least 3-5 different potential mechanisms of ' carryover effect', some of which appear to be more realistic than others).

I find that restarting the time indexed survival rates paper would be the easiest from a contracting standpoint, but we should be ready to discuss multiple ideas in June. For the presentation on Friday the 29th, we should be primarily focusing on your revised paper and management implications.

By the way, bringing up Haeseker's result below. There is a contradiction as far as the flow vs. SAR between the Columbia River treaty modeling work that Steve did for upper Columbia circa 2015 or 2016, and the current Lessard/Schaller/Petrosky Grande Ronde lifecycle model material that is being used in the EIS and their recent presentations. Namely, Haeseker showed a big boost in SAR resulting from increased spring 'natural freshet' flow from Grand Coulee for steelhead (and an improvement in inriver survival for Chinook), while the recent Snake River CSS chinook model is showing decreased survival with increased flow because spill passage efficiency is greater under low flows hence powerhouse passage is decreased. NOAA's survival curves show a strong temperature relationship, and flow vs survival is moderately positive over large volumes of increased flow. Anyway, this hadn't really been actively debated (and I think people have forgotten the treaty results, even though the treaty has not been signed yet). But a couple weeks ago(see link), there was a signal that FPC had won over several participants at the TMT forum, where they essentially overrode NOAA when they were calling for extra flow during the peak weeks of juvenile outmigration. We still have to compose our thoughts over here regarding what to do next as far as analysis, or being prepared to discuss this in the future. Nick Beer and Jim Anderson have estimated some 3 dimensional flow vs TDG vs survival curves at each of the dams.

https://grok.newsdata.com/cgi-bin/viewpdf.cgi?iss=cup1951&cid=IFJrjXxjxeiQ

Talk to you soon,
Christine Petersen

From: David Welch < David.Welch@Kintama.com>
Sent: Friday, May 1, 2020 12:53 PM
To: Erin Rechisky < Erin.Rechisky@Kintama.com>; Petersen,Christine H (BPA) - EWP-4 < chpetersen@bpa.gov>; Aswea Porter < Aswea.Porter@Kintama.com>
Subject: [EXTERNAL] RE: 18th

Yes, reaching a bigger audience and getting broader feedback is probably wise. With the self-isolation likely to go on in a very substantive way for a long while, I am sure we can accommodate whatever works for you; I certainly have nothing planned in the way of travel!

A question—does a discussion on starting the next contract need to come after the presentation? Obviously, I would prefer to nail that contract down asap. I would also like to further discuss a small contract to re-evaluate Steve Haeseker and other's work that projects big increases in adult returns from increased flow—I suspect that their analysis may not hold up to scrutiny once we add in the missing adults intercepted by the fisheries. As mentioned, we should be able to turn the re-analysis around fast, and it might even be published before the SARs paper comes out. (I was thinking North American Journal of Fisheries Management for high impact and relevance to the Columbia River).

I wanted to also get some feedback on the history of the TDG/Spill initiative from BPA's perspective. I think it was Steve Haeseker that initiated this line of reasoning, so it would make sense to re-do that original analysis with harvest added in, and also using the "most credible" current analysis informing the legal decision to raise gas caps. It would be quite instructive if neither dataset (initial or current) supports the conclusions once harvest is accounted for.

Your thoughts?

David

From: Erin Rechisky < Erin.Rechisky@Kintama.com>
Sent: Friday, May 01, 2020 12:08 PM
To: Petersen,Christine H (BPA) - EWP-4 < chpetersen@bpa.gov>; Aswea Porter < Aswea.Porter@Kintama.com>; David Welch < David.Welch@Kintama.com>
Subject: RE: 18th

(b) (6)
[redacted]

Erin

From: Petersen,Christine H (BPA) - EWP-4 < chpetersen@bpa.gov>
Sent: May 1, 2020 10:56 AM
To: Aswea Porter < Aswea.Porter@Kintama.com>; Erin Rechisky < Erin.Rechisky@Kintama.com>;

David Welch < David.Welch@Kintama.com>
Subject: 18th

Hi,
I got some feedback that a few people feel really time crunched for the whole month because we will receive two Biological Opinion documents to quickly review so they have already signed up to do overtime and have no time to spare at all, plus we have the added situation of people having kids at home and being less efficient. They were recommending a day May 27th or later.

I will take a look for a different day that we could potentially move this to. Maybe the afternoon of the 29th? I would like to give you the opportunity to talk to a fairly large audience.

Christine

From: David Welch

Sent: Tue Nov 24 09:35:43 2020

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] FW: [EXTERNAL] RE: Interest in virtually presenting to the Trinity River Restoration Program?

Importance: Normal

Hi Christine—

Just a few quick catch up points:

1. I haven't heard anything from Judy Lando (or you) about further work. My current understanding is that it seems that we may need to go through the entire contracting process again, rather than just pick up on the work Erin did several years ago entering the information into PICES. Is that correct?
2. We would be keen to discuss support for
    a. restarting the ocean vs freshwater survival rate analysis we started off on originally with BPA (before the focus was shifted to the SAR analysis just wrapped up) and
    b. a re-analysis and update of Steve Haeseker's original analysis indicating that increasing spill & TDG will increase SARs many-fold. (I strongly suspect that conclusion may change once harvest is brought into the analysis).
3. You probably have seen that Steve Hawley wrote a Guest Commentary in the Columbia Basin Bulletin on our

work. We have been granted the OK to write a response, which will appear in this Friday's version. (Still working on it, or I would send it along).

4. We are making some progress with our message about salmon conservation—but outside of the Columbia Basin (of course). See the email invitation below to speak to a restoration conference in California next month. Also, note the apparent difficulty in moving all the invested agencies along: "*However, selling the broader 8-agency Trinity River Restoration Program on that concept will be a long battle*".

Regards, David

From: Lee, James C <jclee@usbr.gov>
Sent: November 23, 2020 3:13 PM
To: David Welch <David.Welch@Kintama.com>; Dixon, Michael D <MDixon@usbr.gov>
Cc: Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: Re: [EXTERNAL] RE: Interest in virtually presenting to the Trinity River Restoration Program?

Hello Dr. Welch,

Thanks again for accepting our invitation to speak to the Trinity Management Council at their quarterly meeting! We have you down for a time slot from 1500-1600 PST on Wednesday, 16 December. We'd like to reserve a good bit of time (15-30 minutes) for the discussion that is sure to follow.

There is a lot that I can tell you about the Trinity River Restoration Program, our mission, and the people and agencies involved. It would be a lot more efficient to discuss it over the phone, and I can give you a call tomorrow.

I'm most available during the mid-day hours of about 1000 to around1500. Is there any particular time that works best for you?

Thanks,

James Lee

From: Lee, James C <jclee@usbr.gov>
Sent: Friday, November 20, 2020 10:52
To: David Welch <David.Welch@Kintama.com>; Dixon, Michael D <MDixon@usbr.gov>
Cc: Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: Re: [EXTERNAL] RE: Interest in virtually presenting to the Trinity River Restoration Program?

Hello Dr. Welch,

As I'm in the email chain, I wanted to introduce myself and thank you for your willingness to present to our program. I'm going to read the PLOS-submitted version because I'm very interested in the steelhead analysis and your thoughts on salmon management, and then Mike and I will discuss and we'll give you a little bit more detail on our request. I thought your Fish and Fisheries paper was a much-needed dose of reality, and as Mike mentioned it's already generated a lot of great discussion here.

Best Regards,

James Lee

James Lee | Science Coordinator | Trinity River Restoration Program | U. S. Bureau of Reclamation | 1313 S. Main St., Weaverville, CA 96093 | 530-623-1812 (desk) [redacted] (mobile) | jclee@usbr.gov

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From: David Welch <David.Welch@Kintama.com>
Sent: Friday, November 20, 2020 09:39
To: Dixon, Michael D <MDixon@usbr.gov>
Cc: Lee, James C <jclee@usbr.gov>; Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: [EXTERNAL] RE: Interest in virtually presenting to the Trinity River Restoration Program?

Hi Mike—

Thanks for your interest—I would be both pleased and honored to do so.

Both days are open for me, so fit me in as you see fit. (I laughed—somewhat ruefully—when I checked my calendar... on the 17th of December I see that I was scheduled to fly to Hawai'i as part of a long-planned family gathering at Christmas!).

Such is life. Perhaps we could discuss by phone/Teams/Zoom exactly what your group's goals are, and that will help me tailor something to the group? We should also discuss the length of the presentation, as I have lots of material that could be presented, but I will need to know more about how I can best help your group.

Incidentally, there is an earlier version of the paper that included a parallel analysis of steelhead and a long section I had included detailing examples of "Cognitive Dissonance in Salmon Management" that might be interesting to bring into the discussion. That version of the paper was rejected by the journal PLoS ONE a year earlier, mainly because the reviewers all argued that we hadn't proven that survival was the same and that we were amalgamating results for hatchery and wild fish. (In the interest of full transparency, I'm happy to share those earlier, negative, reviews from PLoS ONE if they are of interest). I will readily admit that the paper wasn't nearly as well-written as the current version published at Fish & Fisheries is, but I do stand by those analyses as well and I think that the issues around cognitive dissonance merit broader discussion. That pre-print is available here and may be worth taking a look at, given your interest: https://www.biorxiv.org/content/10.1101/476408v1

British Columbia has just gone into a two week "near" lockdown to try to get our COVID numbers under control. My mobile # (below) doesn't work well at my house, but feel free to call me on the home landline if you would like to discuss (b) (6) [redacted]

Thanks for your interest, David

David Welch, Ph.D.

President, Kintama Research Services

755 Terminal Avenue, Nanaimo, BC Canada V9S 4K1

[redacted]

Our new paper looking at coastwide survival of Chinook salmon has just been published.

Summary for Policy Makers-

Animation: https://youtu.be/FN7yp3FefB8

Text:https://www.scientia.global/wp-content/uploads/David_Welch/David_Welch.pdf

The research paper: **https://onlinelibrary.wiley.com/doi/10.1111/faf.12514**

From: Dixon, Michael D <MDixon@usbr.gov>
Sent: November 20, 2020 7:58 AM
To: David Welch <David.Welch@Kintama.com>
Cc: Lee, James C <jclee@usbr.gov>
Subject: Interest in virtually presenting to the Trinity River Restoration Program?

Good morning Mr. Welch,

The recent paper you and your colleagues published has caused quite a stir in the restoration community. I honestly think it was only a matter of time before something like this came out; the writing has been on the wall for quite a while now. We circulated the paper internally in my program office and it stimulated great discussion of shifting to ecosystem-driven objectives focused on climate adaptation, rather than our ongoing chinook-centric focus. However, selling the broader 8-agency Trinity River Restoration Program on that concept will be a long battle.

I wonder if you would be willing to give a brief presentation on your study and its findings to our governing board, the Trinity Management Council? Our next quarterly meeting is December 16-17 and we can be flexible to your availability. Please let me know if this is something you could accommodate.

Mike Dixon, PhD (he/him) **| Executive Director** | Trinity River Restoration Program | U. S. Bureau of Reclamation | 1313 S. Main St., Weaverville, CA 96093 | 530-623-1811 (desk) | (b) (6) [redacted] (mobile) | mdixon@usbr.gov | "...ignorance more frequently begets confidence than does knowledge." - Charles Darwin

From: Petersen,Christine H (BPA) - EWP-4

Sent: Mon Nov 30 10:44:24 2020

To: 'David Welch'

Cc: Erin Rechisky

Subject: RE: Interest in virtually presenting to the Trinity River Restoration Program?

Importance: Normal

Hi,

Let's see – Jody was asking me whether and when you had presented the Power Council's ISRP or to NOAA, and I related the webex presentation you did with the Science Center folks in the early stages of this project.

My understanding is that we could reinitiate the survival analysis that Erin was focusing on without redoing the sole source justification. One of the main considerations is basically timing and scheduling of work via our Technical Services budget, which our managers have some influence over.

I did not see the Hawley article. Can you forward it? When Columbia basin Bulletin had to start charging subscriptions, there are a dozen people around here who have a password, but I can't as easily access articles. Yes, Steve Hawley hasn't left a good impression. When his movie came out, some of us viewed a copy at lunch. It had good drone footage, but they really never question the basis for labeling the Snake River dams as the top limiting factor for salmon recovery, among all the other factors which do have some potential for improvement. Joe Norton is a biologist with the Corps in Walla Walla who coordinates several research projects including the transportation study; he has worked as a fishing guide in other areas (I think he worked in New Hampshire or Vermont for some time). He approached Hawley when he showed his film in Walla Walla and he was really dismissive and essentially called him names, when he tried to introduce himself. Not very open minded.

There was a major article in the Seattle Times again this week. It is long and I found it did include some of the most relevant details somewhere inside the article – such as the success of fall Chinook recovery, and the existence of dams without passage blocking habitat, but it ends up being out of context because most people will still walk away with the impression that lower Columbia/Snake dams are the top and primary limiting factor. It does have a good treatment about the perspective of the Nez Perce Tribe.

Climate change is an interesting angle, with respect to your recent paper. In the previous round of litigation, the Nez Perce tribe wasn't not a primary plaintiff, but submitted supporting declarations that mostly focused on climate change, and a lack of consideration of current and future effects of climate change in the Biological Opinion and planning. It raises interesting questions with respect to ESA related regulation where there are anthropogenic impacts, but also climate change. I imagine with an endangered reptile, amphibian, or plant, we would regulate land uses with respect to the species presence, but also should apply a climate projection for the future viable habitat for that species, but I don't understand how mitigation responsibilities would work out. You could interpret the relative success of fall Chinook compared with spring Chinook and steelhead in the Snake as an indicator of climate effects. Concluding that juvenile dam passage is the top limiting factor, in a way, is a denial of climate effects. ***yet***, when NOAA and others use lifecycle models to analyze survival and impacts in different life stages (e.g. starting with those models that Kareiva et al. published in the late 1990s), it is a common strategy to mitigate for adverse impacts in one lifestage by improving conditions in a later stage, provided that density effects won't just cancel or minimize the benefits – this is exactly what we're doing right now in assessing whether avian management for different seabird species in the estuary results in compensatory mortality with regards to the number of returning adults. Determining what we could do to mitigate for climate change would require a depoliticized environment, where we can evaluate the four Hs, and depending on the location and species, the most effective strategy might be different. I think in the southern and interior part of the range, some habitats might become unviable unless the populations can evolve different run timing faster than the rate of climate change.

https://www.seattletimes.com/seattle-news/environment/salmon-people-a-tribes-decades-long-fight-to-take-down-the-lower-snake-river-dams-and-restore-a-way-of-life/

Christine

From: David Welch <David.Welch@Kintama.com>
Sent: Tuesday, November 24, 2020 9:36 AM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Cc: Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: [EXTERNAL] FW: [EXTERNAL] RE: Interest in virtually presenting to the Trinity River Restoration Program?

Hi Christine—

Just a few quick catch up points:

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Sent: November 23, 2020 3:13 PM
To: David Welch <David.Welch@Kintama.com>; Dixon, Michael D <MDixon@usbr.gov>
Cc: Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: Re: [EXTERNAL] RE: Interest in virtually presenting to the Trinity River Restoration Program?

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There is a lot that I can tell you about the Trinity River Restoration Program, our mission, and the people and agencies involved. It would be a lot more efficient to discuss it over the phone, and I can give you a call tomorrow. I'm most available during the mid-day hours of about 1000 to around1500. Is there any particular time that works best for you?

Thanks,

James Lee

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Sent: Friday, November 20, 2020 10:52
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Subject: Re: [EXTERNAL] RE: Interest in virtually presenting to the Trinity River Restoration Program?

Hello Dr. Welch,

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Best Regards,

James Lee

James Lee | Science Coordinator | Trinity River Restoration Program | U. S. Bureau of Reclamation | 1313 S. Main St., Weaverville, CA 96093 | 530-623-1812 (desk) | (b) (6) [redacted] mobile) | jclee@usbr.gov

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From: David Welch <David.Welch@Kintama.com>
Sent: Friday, November 20, 2020 09:39
To: Dixon, Michael D <MDixon@usbr.gov>
Cc: Lee, James C <jclee@usbr.gov>; Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: [EXTERNAL] RE: Interest in virtually presenting to the Trinity River Restoration Program?

Hi Mike—

Thanks for your interest—I would be both pleased and honored to do so.

Both days are open for me, so fit me in as you see fit. (I laughed—somewhat ruefully—when I checked my calendar… on the 17th of December I see that I was scheduled to fly to Hawai'i as part of a long-planned family gathering at Christmas!).

Such is life. Perhaps we could discuss by phone/Teams/Zoom exactly what your group's goals are, and that will help me tailor something to the group? We should also discuss the length of the presentation, as I have lots of material that could be presented, but I will need to know more about how I can best help your group.

Incidentally, there is an earlier version of the paper that included a parallel analysis of steelhead and a long section I had included detailing examples of "Cognitive Dissonance in Salmon Management" that might be interesting to bring into the discussion. That version of the paper was rejected by the journal PLoS ONE a year earlier, mainly because the reviewers all argued that we hadn't proven that survival was the same and that we were amalgamating results for hatchery and wild fish. (In the interest of full transparency, I'm happy to share those earlier, negative, reviews from PLoS ONE if they are of interest). I will readily admit that the paper wasn't nearly as well-written as the current version published at Fish & Fisheries is, but I do stand by those analyses as well and I think that the issues around cognitive dissonance merit broader discussion. That pre-print is available here and may be worth taking a look at, given your interest: https://www.biorxiv.org/content/10.1101/476408v1

British Columbia has just gone into a two week "near" lockdown to try to get our COVID numbers under control. My mobile # (below) doesn't work well at my house, but feel free to call me on the home landline if you would like to discuss [redacted]

Thanks for your interest, David

David Welch, Ph.D.

President, Kintama Research Services

cid:image001.jpg@01D6C245.2AC7FDD0

755 Terminal Avenue, Nanaimo, BC Canada V9S 4K1

(m) [redacted]

Our new paper looking at coastwide survival of Chinook salmon has just been published.

Summary for Policy Makers-

Animation: https://youtu.be/FN7yp3FefB8

Text:https://www.scientia.global/wp-content/uploads/David_Welch/David_Welch.pdf

The research paper: **https://onlinelibrary.wiley.com/doi/10.1111/faf.12514**

From: Dixon, Michael D <MDixon@usbr.gov>
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Subject: Interest in virtually presenting to the Trinity River Restoration Program?

Good morning Mr. Welch,

The recent paper you and your colleagues published has caused quite a stir in the restoration community. I honestly think it was only a matter of time before something like this came out; the writing has been on the wall for quite a while now. We circulated the paper internally in my program office and it stimulated great discussion of shifting to ecosystem-driven objectives focused on climate adaptation, rather than our ongoing chinook-centric focus. However, selling the broader 8-agency Trinity River Restoration Program on that concept will be a long battle.

I wonder if you would be willing to give a brief presentation on your study and its findings to our governing board, the Trinity Management Council? Our next quarterly meeting is December 16-17 and we can be flexible to your availability. Please let me know if this is something you could accommodate.

Mike Dixon, PhD (he/him) **| Executive Director** | Trinity River Restoration Program **|** U. S. Bureau of

Reclamation | 1313 S. Main St., Weaverville, CA 96093 | 530-623-1811 (desk) | [redacted]
(mobile) | mdixon@usbr.gov | "...ignorance more frequently begets confidence than does knowledge." - Charles Darwin

From: David Welch

Sent: Mon Nov 30 16:37:21 2020

To: Petersen,Christine H (BPA) - EWP-4

Cc: Erin Rechisky

Subject: [EXTERNAL] RE: Interest in virtually presenting to the Trinity River Restoration Program?

Importance: Normal

Attachments: Hawley-GUEST COLUMN- IT DOESN'T TAKE A DEGREE IN MARINE BIOLOGY TO SEE DAMS ARE BAD FOR FISH (20 Nov 2020).docx; It Shouldn't Take a Degree in Marine Biology to See the Obvious-FINAL (25 Nov 2020).docx

Attached is Steve Hawley's Guest Column, and also my response. I would be interested in getting your & your colleagues' perspective on my response to Steve Hawley—I kept it civil (of course) but I decided it was time to be quite blunt and say that the Columbia's problems are really in the ocean and not with the dams. This is perhaps the first time that I have been quite so explicit in calling out the region on continuing to blame the dams for the lack of adults returning when it is very clear that the real issues are not with the dams. (Recall, too, that the 52% freshwater survival I mention that we see through the FCRPS is to a large extent due to bird predation (and some fish) not a real effect of the dams). Of course, no one wants to actually say this because so many jobs (& associated funding) is tied up in the status quo.

Feel free to pass it around, judiciously, as required. I don't want to undercut the CBB's ability to pay their staff salaries, but I sympathize with your predicament—Erin has our subscription, so I have to ask her to get me articles behind the CBB paywall because I don't want to have to pay for both of us!

I would be very keen to avoid inflicting the work of redoing the sole source contract again, and just move forward with what was originally planned. I guess part of the issue for BPA is that with the amount of time that has passed, is there a legal constraint on just re-starting that piece of the work or a technical constraint on re-doing what Erin had put into PICES 2 (3?) years ago. And, of course, there is the whole separate issue of whether a budget can still be found.

Perhaps you, Erin, and I can have an initial chat to discuss what is practical from your perspective? I currently am tied up in calls as follows:

Tuesday: 10-11; 2-4

Wednesday: 1-4

Thursday: 12-1; 2:30-4

Friday: 1:30-2:30

From: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Sent: November 30, 2020 10:44 AM
To: David Welch <David.Welch@Kintama.com>
Cc: Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: RE: Interest in virtually presenting to the Trinity River Restoration Program?

Hi,

Let's see – Jody was asking me whether and when you had presented the Power Council's ISRP or to NOAA, and I related the webex presentation you did with the Science Center folks in the early stages of this project.

My understanding is that we could reinitiate the survival analysis that Erin was focusing on without redoing the sole source justification. One of the main considerations is basically timing and scheduling of work via our Technical Services budget, which our managers have some influence over.

I did not see the Hawley article. Can you forward it? When Columbia basin Bulletin had to start charging subscriptions, there are a dozen people around here who have a password, but I can't as easily access articles. Yes, Steve Hawley hasn't left a good impression. When his movie came out, some of us viewed a copy at lunch. It had good drone footage, but they really never question the basis for labeling the Snake River dams as the top limiting factor for salmon recovery, among all the other factors which do have some potential for improvement. Joe Norton is a biologist with the Corps in Walla Walla who coordinates several research projects including the transportation study; he has worked as a fishing guide in other areas (I think he worked in New Hampshire or Vermont for some time). He approached Hawley when he showed his film in Walla Walla and he was really dismissive and essentially called him names, when he tried to introduce himself. Not very open minded.

There was a major article in the Seattle Times again this week. It is long and I found it did include some of the most relevant details somewhere inside the article – such as the success of fall Chinook recovery, and the existence of dams without passage blocking habitat, but it ends up being out of context because most people will still walk away with the impression that lower Columbia/Snake dams are the top and primary limiting factor. It does have a good treatment about the perspective of the Nez Perce Tribe.

Climate change is an interesting angle, with respect to your recent paper. In the previous round of litigation, the Nez Perce tribe wasn't not a primary plaintiff, but submitted supporting declarations that mostly focused on climate change, and a lack of consideration of current and future effects of climate change in the Biological Opinion and planning. It raises interesting questions with respect to ESA related regulation where there are anthropogenic impacts, but also climate change. I imagine with an endangered reptile, amphibian, or plant, we would regulate land uses with respect to the species presence, but also should apply a climate projection for the future viable habitat for that species, but I don't understand how mitigation responsibilities would work out. You could interpret the relative success of fall Chinook compared with spring Chinook and steelhead in the Snake as an indicator of climate effects. Concluding that juvenile dam passage is the top limiting factor, in a way, is a denial of climate effects. ***yet***, when NOAA and others use lifecycle models to analyze survival and impacts in different life stages (e.g. starting with those models that Kareiva et al. published in the late 1990s), it is a common strategy to mitigate for adverse impacts in one lifestage by improving conditions in a later stage, provided that density effects won't just cancel or minimize the benefits – this is exactly what we're doing right now in assessing whether avian management for different seabird species in the estuary results in compensatory mortality with regards to the number of returning adults. Determining what we could do to mitigate for climate change would require a depoliticized environment, where we can evaluate the four Hs, and depending on the location and species, the most effective strategy might be different. I think in the southern and interior part of the range, some habitats might become unviable unless the populations can evolve different run timing faster than the rate of climate change.

https://www.seattletimes.com/seattle-news/environment/salmon-people-a-tribes-decades-long-fight-to-take-down-the-lower-snake-river-dams-and-restore-a-way-of-life/

Christine

From: David Welch <David.Welch@Kintama.com>
Sent: Tuesday, November 24, 2020 9:36 AM
To: Petersen,Christine H (BPA) - EWP-4 <chpetersen@bpa.gov>
Cc: Erin Rechisky <Erin.Rechisky@Kintama.com>
Subject: [EXTERNAL] FW: [EXTERNAL] RE: Interest in virtually presenting to the Trinity River Restoration Program?

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This email has been received from outside of DOI - Use caution before clicking on links, opening attachments, or responding.

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David Welch, Ph.D.

President, Kintama Research Services

755 Terminal Avenue, Nanaimo, BC Canada V9S 4K1

(m) (b) (6) [redacted]

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Text:https://www.scientia.global/wp-content/uploads/David_Welch/David_Welch.pdf

The research paper: https://onlinelibrary.wiley.com/doi/10.1111/faf.12514

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Mike Dixon, PhD (he/him) **| Executive Director** | Trinity River Restoration Program | U. S. Bureau of Reclamation | 1313 S. Main St., Weaverville, CA 96093 | 530-623-1811 (desk) | (b) (6) [redacted] (mobile) | mdixon@usbr.gov | "...ignorance more frequently begets confidence than does knowledge." - Charles Darwin

From: David Welch

Sent: Mon Mar 22 13:28:02 2021

To: Ben Zelinsky

Subject: [EXTERNAL] FW: Analysis and data issues with Fish and Fisheries 22:194-211

Importance: High

Attachments: Concerns_with_Welch.et.al.2021.pdf

Hi Ben-

In confidence, late last week I was CCed on this email from IDF&G biologists on our paper; they sent their email to the journal editors suggesting that the issue they have uncovered may require "*the retraction or major revision*" of our recent paper.

We dug into the issue the IDF&G biologists uncover and found that they are correct in one important claim--overwinter mortality of tagged parr in the reported Alaskan wild survival estimates is not accounted for in doing our coastwide comparison. However, it only applies to one of four major comparisons we did (Hatchery Fall; Hatchery Spring; Wild Fall, & ***Wild Spring*** Chinook) we reported in our paper, and our preliminary look at incorporating the data indicates that including the issue that IDF&G found will simply bring the survival estimate of 5 Wild SE Alaskan Chinook SAR estimates up to almost exactly equal to the Snake River values. ***Their finding thus improves and clarifies that Snake River SAR values are now essentially identical to Alaskan values.***

-

It is not quite that easy of course, although I am confident that there won't be a major change to this conclusion. However, we will also need to address a couple of other points the IDF&G folks have made in their email. There needs to be a significant amount of additional work done to nail this down because it isn't entirely straightforward, but I am confident that we can do so and publish a quick update further strengthening the conclusions from the already published paper. In addition, we would add in to the submitted paper some additional analysis that we did in preparation for the ISAB review last February 5th. This should strengthen and further buttress the findings in the paper we have already published.

There is a real opportunity here—once the editors of the journal contact me about the IDFG email, I am prepared to write back immediately, say that we agree that there is a small correction possible as a result of the IDF&G work, and then propose to the editors that we will write a short, updated paper for peer-review in their journal ***and invite the three IDF&G biologists to be co-authors*** in recognition of their contribution (digging out the obscure Alaskan grey literature they found).

The benefits here are that if they accept co-authorship, we make progress in getting IDFG to formally acknowledge via that co-authorship that salmon SARs are now similar coastwide & further boost the credibility of our results. And, if they decline co-authorship, then they signal their unwillingness to really collaborate, merely carp about the results.

The issue here is that Kintama have spent the past ~18 months unfunded working on these issues with staff. I just can't keep doing this without bringing in financial support. Would BPA be willing to fund a $40K contract to consolidate all the additional work we have done and incorporate the IDFG point about Alaskan wild SARs?

Feel free to have someone contact me to discuss this further, but I thought it best to email you directly because the issue steps more into the policy sphere. The timing would also tie in well with the internal review you were hoping to do—we can provide your staff with the new results as we generate them. I can outline why they will be important to your review if you like.

Regards, David

David Welch

(m) +1 [redacted]

From: Hebdon,Lance <lance.hebdon@idfg.idaho.gov>
Sent: March 18, 2021 4:31 PM
To: arlinghaus@igb-berlin.de; faf.editormolecular@bangor.ac.uk; pbh@leicester.ac.uk
Cc: Ebel,Jonathan <jonathan.ebel@idfg.idaho.gov>; David Welch <David.Welch@Kintama.com>
Subject: Analysis and data issues with Fish and Fisheries 22:194-211

Drs. Arlinghaus, Carvalha, and Hart:

During the review of the recently published article, " **A synthesis of coast-wide decline in survival of west coast Chinook salmon. Fish and Fisheries 22: 194-211**", we encountered several errors in the analysis which would invalidate some of the authors' conclusions. We confirmed our findings by corresponding with the biologists responsible for a key portion of the data presented. Unfortunately, the article has already received substantial publicity in the northwestern United States because of the sweeping conclusions the authors claim their analysis supports. Yet, the conclusions of the article as applied to wild fish are not supported because of the authors' misunderstanding and subsequent misuse of the data. The issues with the data may require retraction or major revision of Welch et al (2021) because these data cannot yield reliable results and provide reliable conclusions about wild Chinook salmon populations.

First, the authors included overwinter freshwater mortality in calculations of smolt to adult return rates (SAR) for the Alaska wild spring Chinook Salmon stocks resulting in low biased estimates while overwinter mortality was excluded from the Snake River stocks. The corrected SAR values adjusted for overwinter mortality are provided in the attachment to this email. There was also an issue with under estimates of harvest which would further bias low the SARs presented for the Alaska stocks though we were unable to correct for this source of bias. If the exclusion of overwinter mortality and underestimated harvest is accounted for the conclusion would be opposite of what Welch et al. (2021) has provided.

Second, the only wild Snake River yearling stock used in the regional comparison of recent coded wire tag (CWT)-based estimates was the Tucannon River. The estimate provided for the Tucannon River is run reconstruction-based estimate, not a CWT-based estimate, and is probably biased high relative to the CWT SAR estimates. Moreover, the Tucannon River wild stock poorly represents the entire Snake River regional populations. This makes Welch et al. (2021)'s Figure 4 a false comparison.

Third, for the whole time series comparison the authors acknowledged that wild Snake River stock SARs from Raymond et al (1988) are biased high relative to CWT-based estimates, but then further inflated the median value of the Snake River stocks by including an early period of the time series that was not present for any stock outside the Columbia basin. The time period included was also prior to the completion of dams in the Lower Snake River and during a period of good ocean conditions, which alters the interpretation of Welch et al. (2021)'s Figure 3.

We have provided a detailed summary of the issues in data quality and analysis in the attachment.

I would welcome correspondence regarding the review,

Lance

Lance Hebdon

Anadromous Fishery Manager

Idaho Department of Fish and Game

208-287-2711

EmailLogo

From: Zelinsky,Benjamin D (BPA) - E-4

Sent: Mon Mar 22 14:46:59 2021

To: David Welch

Subject: RE: Analysis and data issues with Fish and Fisheries 22:194-211

Importance: Normal

Hello David,

Thanks for the update. I'm on spring break this week but will dive into this and respond early next week. My apologies for the delay – (b) (6) [redacted]

Ben

From: David Welch <David.Welch@Kintama.com>
Sent: Monday, March 22, 2021 1:28 PM
To: Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>
Subject: [EXTERNAL] FW: Analysis and data issues with Fish and Fisheries 22:194-211
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Regards, David

David Welch

(m)(b) (6) [redacted]

From: Hebdon,Lance <lance.hebdon@idfg.idaho.gov>
Sent: March 18, 2021 4:31 PM
To: arlinghaus@igb-berlin.de; faf.editormolecular@bangor.ac.uk; pbh@leicester.ac.uk
Cc: Ebel,Jonathan <jonathan.ebel@idfg.idaho.gov>; David Welch <David.Welch@Kintama.com>
Subject: Analysis and data issues with Fish and Fisheries 22:194-211

Drs. Arlinghaus, Carvalha, and Hart:

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I would welcome correspondence regarding the review,

Lance

Lance Hebdon

Anadromous Fishery Manager

Idaho Department of Fish and Game

208-287-2711

EmailLogo

From: David Welch

Sent: Mon Mar 29 09:08:28 2021

To: Ben Zelinsky

Subject: [EXTERNAL] FW: Analysis and data issues with Fish and Fisheries 22:194-211

Importance: Normal

Ben-

Just a reminder that I think that there is a real opportunity here, if we can convince the IDFG biologists to co-write an updated paper with us—we can incorporae the info that they have found, but it will not substantively change the story we already reported—but that analysis will be significantly buttressed by the new work we have partially completed since publication.

Regards, David

From: Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>
Sent: March 22, 2021 2:47 PM
To: David Welch <David.Welch@Kintama.com>
Subject: RE: Analysis and data issues with Fish and Fisheries 22:194-211

Hello David,

Thanks for the update. I'm on spring break this week but will dive into this and respond early next week. My apologies for the delay – [redacted]

Ben

From: David Welch <David.Welch@Kintama.com>
Sent: Monday, March 22, 2021 1:28 PM
To: Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>
Subject: [EXTERNAL] FW: Analysis and data issues with Fish and Fisheries 22:194-211
Importance: High

Hi Ben-

In confidence, late last week I was CCed on this email from IDF&G biologists on our paper; they sent their email to the journal editors suggesting that the issue they have uncovered may require "*the retraction or major revision*" of our recent paper.

We dug into the issue the IDF&G biologists uncover and found that they are correct in one important claim--overwinter mortality of tagged parr in the reported Alaskan wild survival estimates is not accounted for in doing our coastwide comparison. However, it only applies to one of four major comparisons we did (Hatchery Fall; Hatchery Spring; Wild Fall, & ***Wild Spring*** Chinook) we reported in our paper, and our preliminary look at incorporating the data indicates that including the issue that IDF&G found will simply bring the survival estimate of 5 Wild SE Alaskan Chinook SAR estimates up to almost exactly equal to the Snake River values. ***Their finding thus improves and clarifies that Snake River SAR values are now essentially identical to Alaskan values.***

-

It is not quite that easy of course, although I am confident that there won't be a major change to this conclusion. However, we will also need to address a couple of other points the IDF&G folks have made in their email. There needs to be a significant amount of additional work done to nail this down because it isn't entirely straightforward, but I am confident that we can do so and publish a quick update further strengthening the conclusions from the already published paper. In addition, we would add in to the submitted paper some additional analysis that we did in preparation for the ISAB review last February 5th.   This should strengthen and further buttress the findings in the paper we have already published.

There is a real opportunity here—once the editors of the journal contact me about the IDFG email, I am prepared to write back immediately, say that we agree that there is a small correction possible as a result of the IDF&G work, and then propose to the editors that we will write a short, updated paper for peer-review in their journal ***and invite the three IDF&G biologists to be co-authors*** in recognition of their contribution (digging out the obscure Alaskan grey literature they found).

The benefits here are that if they accept co-authorship, we make progress in getting IDFG to formally acknowledge via that co-authorship that salmon SARs are now similar coastwide & further boost the credibility of our results. And, if they decline co-authorship, then they signal their unwillingness to really collaborate, merely carp about the results.

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Lance

Lance Hebdon

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Idaho Department of Fish and Game

208-287-2711

EmailLogo

From: David Welch

Sent: Mon Mar 29 13:23:20 2021

To: Ben Zelinsky

Subject: [EXTERNAL] FW: Analysis and data issues with Fish and Fisheries 22:194-211

Importance: Normal

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Note the graphs I have included comparing the annual SAR ratio of each other region with the Snake River—it is quite clear that our original analysis holds up well to the perhaps only potentially credible criticism that the FPC made—that perhaps our earlier findings were "somehow" a result of an imbalance in the number of years of data available in the 5 yr period 2010-2014 that we compared SARs. I am confident that with the new results we outline below we will further support and buttress our earlier paper—and, if we can get IDFG to join as co-authors, there will begin to be some institutional buy-in.

David

From: David Welch <David.Welch@Kintama.com>
Sent: March 29, 2021 10:05 AM

To: Hart, Paul (Prof.) <pbh@leicester.ac.uk>; Hebdon,Lance <lance.hebdon@idfg.idaho.gov>
Cc: Robert Arlinghaus <arlinghaus@igb-berlin.de>; faf.editormolecular@bangor.ac.uk; Ebel,Jonathan <jonathan.ebel@idfg.idaho.gov>; Erin Rechisky <Erin.Rechisky@Kintama.com>; Aswea Porter <Aswea.Porter@Kintama.com>
Subject: RE: Analysis and data issues with Fish and Fisheries 22:194-211

Dear Paul & Lance-

I was waiting for Paul to respond before I made any comment on behalf of my co-authors & I.

First, we agree with the IDF&G biologists that the overwinter losses of tagged parr prior to smolt migration the next spring is an important finding. Second, we would like to thank Lance & colleagues for the professional way that they have brought this issue forward.

Over the past week we made an initial assessment of the impact of accounting for overwinter mortality of wild SE Alaska tagged parr. This has brought the SARs of SE Alaska wild Chinook up to "about" the level of the Snake River wild population we have data for in recent years (Tucannon). However, incorporating overwinter losses does not materially change the conclusion that coastwide SARs have decreased everywhere to roughly similar levels; in the case of SE Alaska relative survival has fallen more than ten-fold for both hatchery & wild comparisons. (See the graph).

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As Lance and colleagues will be aware, our original paper had a large impact, particularly in the Pacific Northwest states of the US. We have already addressed comments made by two other groups as part of a formal review of our paper by the Independent Scientific Advisory Board on February 5th of this year, and as part of that review we presented the figures below in response to a criticism by the Fish Passage Center that, perhaps, an imbalance in the number of years of available SAR data was somehow distorting our comparison of the SAR ratios we presented for the five-year period 2010-2014.

In our response tabled at the ISAB review we addressed that issue by confining the boot-strapped SAR ratio comparison to individual years (see below). These graphs show that the Fish Passage Center conjecture was not an issue, but presented a far richer picture of the coastwide decline in relative SARs towards unity (equivalency). In the graphs below you can see this because the SAR ratio relative to all available data in a given year decreases from up to ~10X higher SARs around 1990 (after the Raymond study has no influence) for, say, WCVI subyearlings to equal or lower SARs in recent years. A similar story is evident for Yearling Chinook (see SEAK, Strait of Georgia, Puget Sound, & LCOL as examples) where the decline towards very similar SARs with the Snake River is evident (the horizontal dashed red line indicates equality).

We still need to do some work to incorporate Lance et al's comments about the relationship between Tucannon SARs and the other Snake River SAR time series that are available, which are based on PIT tags. Nevertheless, the ratio graphs I present below are important new insight, as are the issues that Lance & colleagues have presented. I would like to propose that my colleagues and I at Kintama work together with Lance & his colleagues and try to wrote a consensus paper that incorporates both the IDFG comments and our updated analysis outlined in the graphs below. I have some thoughts about how to also address the IDFG team's comments about some of the catch in SE Alaskan fisheries not being properly accounted for, and we would certainly appreciate IDFG's expertise and advice as we try to resolve the issue of possible differences between the Tucannon and other wild Snake River populations.

Would a short jointly authored paper be something that everyone can agree to? That will, to my mind, sidestep to potential issue of having two follow-up papers that each only address a subset of the issues. Of course, if consensus cannot be reached both groups would be free to publish their own views.

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Cc: Robert Arlinghaus <arlinghaus@igb-berlin.de>; faf.editormolecular@bangor.ac.uk; Ebel,Jonathan <jonathan.ebel@idfg.idaho.gov>; David Welch <David.Welch@Kintama.com>
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With best wishes.

Paul

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Department of Neuroscience, Psychology and Behaviour
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Fish and Fisheries http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1467-2979

The Marine Biological Association of the UK http://www.mba.ac.uk
The Secchi Disk Foundation http://www.secchidiskfoundation.org
Fisheries Society of the British Isles https://www.fsbi.org.uk

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Anadromous Fishery Manager

Idaho Department of Fish and Game

208-287-2711

<image001.png>

<Concerns_with_Welch.et.al.2021.pdf>

From: Zelinsky,Benjamin D (BPA) - E-4

Sent: Tue Mar 30 12:03:21 2021

To: David Welch

Subject: RE: Analysis and data issues with Fish and Fisheries 22:194-211

Importance: Normal

If you could set it up that would be great David – might be easier logistically.

Thank you!

From: David Welch <David.Welch@Kintama.com>
Sent: Tuesday, March 30, 2021 10:34 AM
To: Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>
Subject: [EXTERNAL] RE: Analysis and data issues with Fish and Fisheries 22:194-211

Thanks for the response, Ben—my sympathies on the email issue!

Friday at 11 works. Will you set up a call from your end or shall I?

From: Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>
Sent: March 30, 2021 10:25 AM
To: David Welch <David.Welch@Kintama.com>
Subject: RE: Analysis and data issues with Fish and Fisheries 22:194-211

Hello David,

Finally catching up on emails. Do you have time for a call later this week? Would Friday at 11 work?

Ben

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Fish and Fisheries http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1467-2979
The Marine Biological Association of the UK http://www.mba.ac.uk
The Secchi Disk Foundation http://www.secchidiskfoundation.org
Fisheries Society of the British Isles https://www.fsbi.org.uk

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Drs. Arlinghaus, Carvalha, and Hart:

During the review of the recently published article, " **A synthesis of coast-wide decline in survival of west coast Chinook salmon. Fish and Fisheries 22: 194-211**", we encountered several errors in the analysis which would invalidate some of the authors' conclusions. We confirmed our findings by corresponding with the biologists responsible for a key portion of the data presented. Unfortunately, the article has already received substantial publicity in the northwestern United States because of the sweeping conclusions the authors claim their analysis supports. Yet, the conclusions of the article as applied to wild fish are not supported because of the authors' misunderstanding and subsequent misuse of the data. The issues with the data may require retraction or major revision of Welch et al (2021) because these data cannot yield reliable results and provide reliable conclusions about wild Chinook salmon populations.

First, the authors included overwinter freshwater mortality in calculations of smolt to adult return rates (SAR) for the Alaska wild spring Chinook Salmon stocks resulting in low biased estimates while overwinter mortality was excluded from the Snake River stocks. The corrected SAR values adjusted for overwinter mortality are provided in the attachment to this email. There was also an issue with under estimates of harvest which would further bias low the SARs presented for the Alaska stocks though we were unable to correct for this source of bias. If the exclusion of overwinter mortality and underestimated harvest is accounted for the conclusion would be opposite of what Welch et al. (2021) has provided.

Second, the only wild Snake River yearling stock used in the regional comparison of recent coded wire tag (CWT)-based estimates was the Tucannon River. The estimate provided for the Tucannon River is run reconstruction-based estimate, not a CWT-based estimate, and is probably biased high relative to the CWT SAR estimates. Moreover, the Tucannon River wild stock poorly represents the entire Snake River regional populations. This makes Welch et al. (2021)'s Figure 4 a false comparison.

Third, for the whole time series comparison the authors acknowledged that wild Snake River stock SARs from Raymond et al (1988) are biased high relative to CWT-based estimates, but then further inflated the median value of the Snake River stocks by including an early period of the time series that was not present for any stock outside the Columbia basin. The time period included was also prior to the completion of dams in the Lower Snake River and during a period of good ocean conditions, which alters the interpretation of Welch et al. (2021)'s Figure 3.

We have provided a detailed summary of the issues in data quality and analysis in the attachment.

I would welcome correspondence regarding the review,

Lance

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