**Department of Energy**

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

PUBLIC AFFAIRS

April 24, 2007

In reply refer to: DK-7

Darryll Olsen, Ph.D
Columbia-Snake River Irrigators Association
3030 W. Clearwater, Suite 205-A
Kennewick, WA 99336

RE: FOIA Request #07-021

Dear Dr. Olsen:

This letter responds to your request for information that you made to the Bonneville Power Administration (BPA), under the Freedom of Information Act (FOIA), 5 U.S.C. § 552. Your letter was received in this office on Thursday, March 15, 2007, and was assigned a control number 07-021.

You have requested for BPA ". . .to release to us any such analyses received to date." BPA has located and provided four responsive documents in their entirety. We received no objections from the State of Oregon. There will be no charge for this request.

If you are dissatisfied with our determination, you may make an appeal within thirty (30) days of receipt of this letter to Director, Office of Hearings and Appeals, Department of Energy, 1000 Independence Avenue SW, Washington, D.C. 20585. Both the envelope and the letter must be clearly marked "Freedom of Information Act Appeal."

I appreciate the opportunity to assist you with this matter. If you have any questions about this response, please contact me or Laura M. Atterbury, FOIA Specialist, at (503) 230-7305.

Sincerely,

*/s/ Christina J. Brannon*

Christina J. Brannon
Freedom of Information Act Officer

Enclosures: (Four responsive documents in their entirety)

**Minimum Operating Pool (MOP) affect on Water Transit Time (WTT), Fish Travel Time (FTT) and smolt-to-adult return rate (SAR) for yearling spring/summer Chinook salmon migrating through the FCRPS, 1998-2002.**

Tim Dalton
Oregon Department of Fish and Wildlife
October 25, 2006

In this analysis I examined associations among 1)Water Transit Time (WTT, in days), 2) Fish Travel Time (FTT, in days), 3) smolt-to-adult return rate (SAR, in percent) of yearling spring/summer Chinook salmon, 4) average spring flows, and 5) pool-levels in the McNary (MCN), John Day (JDA), The Dalles (TDA) and Bonneville (BON) pools. The ultimate purpose is to estimate increases in SARs associated with reductions in pool levels and, consequently, WTT and FTT. These increases would be expected to result in directly equivalent increases in adult returns. The following pool-level scenarios were evaluated: 1) all four pools at Normal Full Pool (JDA at Minimum Irrigation Pool (MIP)), 2) JDA pool at Minimum Operation Pool (MOP) and the other pools at Normal Full Pool (JDA at MIP), and 3) all four pools at MOP. Potential reductions in WTT and FTT, and consequent increases in SAR, associated with the two reduced pool-level scenarios were assessed for 1998-2002, employing relationships developed in recent white papers by Scheuerell and Zabel (2006) as well as Petrosky et al. (2006).

Reductions in pool level (volume) decrease WTT, which is a function of volume and flow (WTT=Volume/Flow). Based on average spring flow for each year, I estimated WTT for each of the four pools at Normal Full Pool (MIP for John Day) and at MOP. I then summed these individual pool WTTs according to each of the three pool-level scenarios for each year. To estimate expected FTTs for each year under each pool-level scenario I applied a linear regression relationship that relates WTT to FTT for hatchery and wild yearling Chinook salmon traveling from MCN to BON dams ($FTT = 0.6043*WTT + 3.6429$, $R^2=0.4685$, WTT data range: 4-14; Margaret Filardo, FPC, pers. comm.). Finally, subtraction of the WTT and FTT estimates for pool-level scenarios 2 and 3 from those for pool-level scenario 1 gave estimates of reductions in WTTs and FTTs that the two pool-level reduction scenarios would have achieved each year (Table 1).

Estimates of FTT were all slightly higher than WTT except in 2001 when estimated FTT was somewhat lower than WTT. In that year, however, WTT was beyond the range of the regression relationship. An alternative method for 2001 that estimated FTT for JDA individually and MCN, TDA, and BON together employed WTT values within the range of the regression relationship, and the total FTT was almost equal to total WTT. However, using this alternative method, the reductions in FTT between the pool-level scenarios were the same as with the method employed for the other years. Therefore, for consistency, 2001 FTT was estimated by the same methodology as the other years and the regression relationship itself, that is, over all four pools together.

Scheuerell and Zabel (2006) examined the dependence of SARs on "Arrival day below Bonneville Dam (days past April 1)" for the truncated data set of juveniles arriving 30-80 days past April 1 during 1998-2002. For each year, they derived two functions, one assuming that the relationship determined for arrival dates between 30-80 days past April 1 also held before and afterwards (<30 and >80) (symmetrical model), the other assuming that the SARs for these before and after periods were equal to the SARs on day 30 and day 80, respectively (extrapolated model). They standardized the results to show "Percent increase in SAR" as a function of "Shift in run distribution (days earlier)" for both of the SAR/"Arrival day below Bonneville Dam (days past April 1)" functions for each year. Employing both these relationships, I estimated percentage increases in SARs associated with the potential reductions in FTTs for the two pool-levels reduction scenarios for 1998-2002 (Table 2).

Petrosky et al. (2006) developed functions to predict SAR based on WTT for good, average and poor ocean conditions (i.e., at specific levels of Pacific Decadal Oscillation (PDO) and Upwelling indices). In these relationships, WTT was from the mouth of the Clearwater River to Bonneville Dam. Estimates of WTT that occurred under Normal Full Pool-Level operations (Michelle DeHart, FPC. pers. comm.) in 1998-2002 were adjusted downward by the reductions in WTT specific to the two reduced pool-level scenarios. These estimates of potentially reduced WTT were then employed in estimating potential percentage reductions in SAR using the relationship between the two in Petrosky et al. (2006). Although expected SAR varied with each ocean condition scenario, the potential increases in SAR were the same for each (Table 3).

Estimated potential increases in SAR based on Scheuerell and Zabel (2006) methodology ranged from 0.33-2.83% for pool-level scenario 2 (JDA at MOP, the others at Normal Full Pool). Potential increases for scenario 3 (all four pools at MOP) ranged from 0.74-6.60 %. The greatest potential increases were estimated for 2001, when average spring flows were particularly low. The other four years had fairly similar, and substantially higher, average spring flows. There was little difference among the increases for 1998-2000, which were relatively low, but those for 2002 were somewhat higher. Petrosky et al. (2006) methodology predicted substantially greater potential increases in SAR; estimated potential increases were 2.32-5.79% for pool-level scenario 2, and 5.12-13.01% for pool-level scenario 3. The greatest potential increases were again estimated for 2001. The estimated increases for the other years were all similar, and, when compared to the estimates for these years based on Scheuerell and Zabel (2006), these increases were relatively high. The increases in survival for scenario 3 estimated for 2001 by Scheuerell and Zabel (2006) methodology are very similar to a recent estimate by S. Haeseker (5.8%), also based upon reductions in FTT. Haeseker's aggregate estimate in survival increase for 1995-2005 (2.5%) under scenario 3 is higher than those made here by Scheuerell and Zabel (2006) methodology but lower than those by Petrosky et al. (2006) methodology.

Scheuerell and Zabel (2006) developed relationships between increases in SAR and shifts in run distribution based on arrival time of fish at Bonneville Dam that were unique for each year from 1998-2002. WTT, the variable directly estimated for the pool-level scenarios, was not involved in these relationships. Therefore, to estimate increases in SAR associated with

the lowered pool scenarios, I translated estimates of WTT into estimates of FTT, and these were then used to estimate shifts in run distribution. Petrosky et al. (2006) developed models, based on data from 1954-2000, to relate SAR directly to WTT and a suite of ocean condition variables. Thus, in terms of relating SAR to WTT, the methodology of Scheuerell and Zabel (2006) was less direct, and involved conversion by a separate FTT/WTT regression relationship. However, the Petrosky et al. (2006) model did not include 2001-2002 data. The estimates of Haeseker were based on models that employed 1998-2005 data for PIT-tagged fish released at Lower Granite Dam. He employed WTT as well as spill and seasonality variables to explain FTT and mortality rate, and FTT and mortality rate together were used to estimate survival. Thus, this method also first modeled FTT as a function of WTT and then used the results to estimate changes in SAR.

Table 1. Water Transit Times (WTT) and Fish Travel Times (FTT) associated with the three pool-level Scenarios for MCN, JDA, TDA, and BON, 1998-2002. Reductions in FTT (ΔFTT) from those under Normal full pool operations (Scenario 1) are given for Scenarios 2 and 3. WTT, FTT, ΔWTT and ΔFTT are in days.

| | | Pool-level Scenario 1: All Normal Level 0 at MOP | | Pool-level Scenario 2: 3 Normal Level JDA at MOP | | | | Pool-level Scenario 3: 0 Normal Level All at MOP | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Average Spring Flow (kcfs) | WTT | FTT | WTT | FTT | ΔWTT | ΔFTT | WTT | FTT | ΔWTT | ΔFTT |
| 1998 | 287.8 | 8.08 | 8.53 | 7.69 | 8.29 | 0.39 | 0.24 | 7.23 | 8.01 | 0.85 | 0.52 |
| 1999 | 303.6 | 7.66 | 8.27 | 7.29 | 8.05 | 0.37 | 0.22 | 6.85 | 7.78 | 0.81 | 0.49 |
| 2000 | 243.4 | 9.56 | 9.42 | 9.09 | 9.14 | 0.46 | 0.28 | 8.55 | 8.81 | 1.01 | 0.61 |
| 2001 | 123.9 | 18.77 | 14.99 | 17.86 | 14.44 | 0.91 | 0.55 | 16.79 | 13.79 | 1.98 | 1.20 |
| 2002 | 269.3 | 8.64 | 8.86 | 8.22 | 8.61 | 0.42 | 0.25 | 7.73 | 8.31 | 0.91 | 0.55 |

Table 2. Percentage increases in smolt-to-adult ratio (SAR) associated with pool-level reduction scenarios and decreases in Fish Travel Time (FTT) estimated by relationships in Scheuerell and Zabel (2006).

| | Pool-level Scenario 2: 3 Normal Level JDA at MOP | | Pool-level Scenario 3: 0 Normal Level All at MOP | |
|---|---|---|---|---|
| Year | Symmetrical Model | Extrapolated Model | Symmetrical Model | Extrapolated Model |
| 1998 | 0.33% | 0.47% | 0.74% | 0.82% |
| 1999 | 0.34 | 0.52 | 0.76 | 0.91 |
| 2000 | 0.43 | 0.53 | 0.98 | 1.06 |
| 2001 | 2.83 | 2.73 | 6.60 | 6.43 |
| 2002 | 0.70 | 0.79 | 1.73 | 1.79 |

Table 3. Percentage increases in smolt-to-adult ratio (SAR) associated with pool-level reduction scenarios and decreases in Water Travel Time (WTT) estimated by relationships in Petrosky et al. (2006).

| Year | Pool-level Scenario 2: 3 Normal Level JDA at MOP | Pool-level Scenario 3: 0 Normal Level All at MOP |
|---|---|---|
| 1998 | 2.45% | 5.41% |
| 1999 | 2.32 | 5.12 |
| 2000 | 2.91 | 6.42 |
| 2001 | 5.79 | 13.01 |
| 2002 | 2.62 | 5.79 |

References

Scheuerell, R. and R. Zabel. 2006. Post-Bonneville Hypothesis/Question #2

Petrosky, C., H. Schaller and P. Wilson. 2006. Delayed Mortality of Columbia River Salmon. Exploring evidence concerning delayed hydrosystem mortality for Snake River spring/summer Chinook.

**Biological Benefits of Lower Columbia MOP Operations**
**Oregon Department of Fish and Wildlife**
**November 7, 2006**

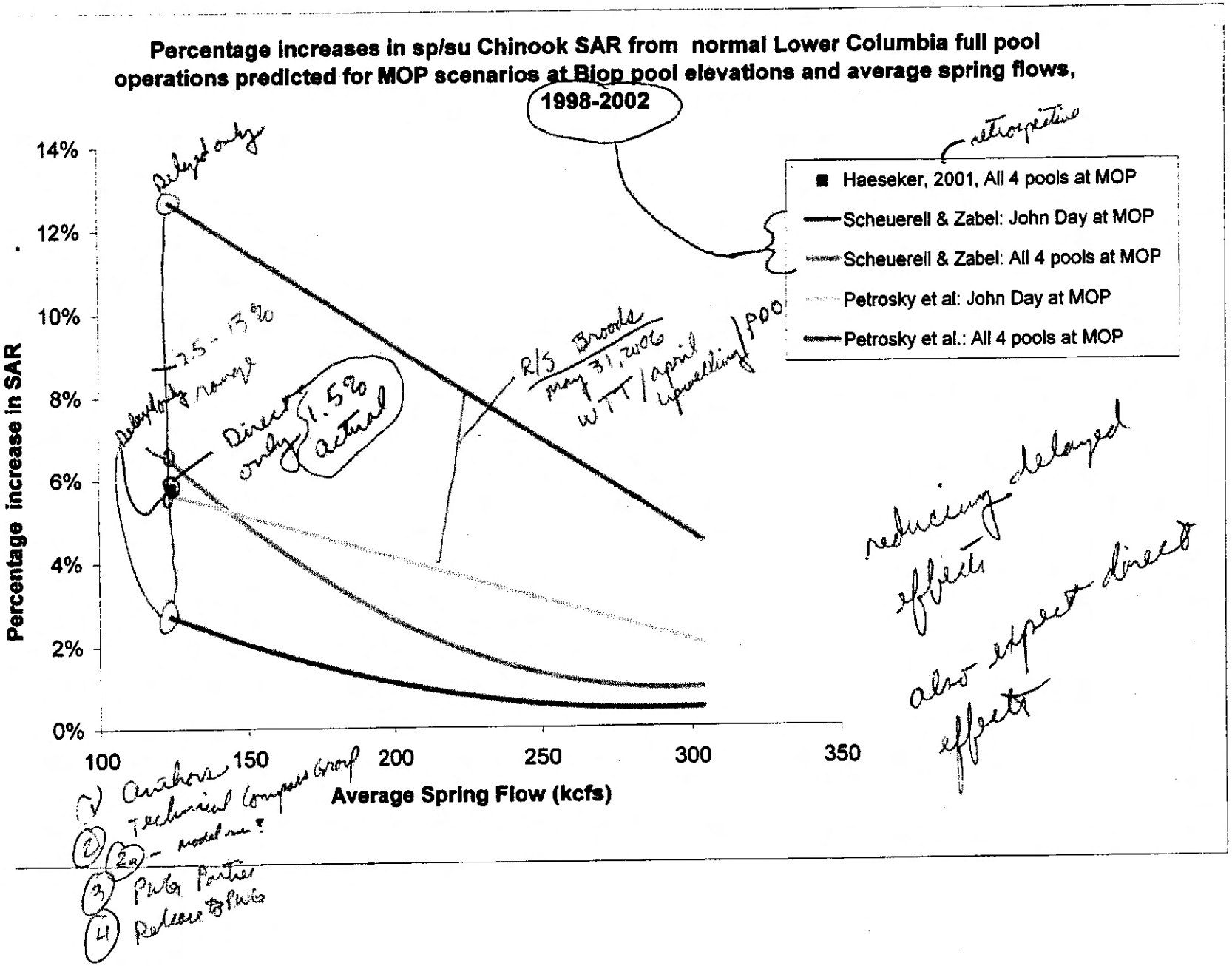
ODFW (Dalton memo October 25, 2006) examined the biological benefits of operating lower Columbia pools at MOP based on analyses recently developed by Scheuerell and Zabel (2006) and Petrosky et al. (2006) as alternative delayed mortality hypotheses in the BiOp Remand Framework work group (**attached**). We estimated decreases in WTT and FTT (**Table 1**) for two MOP operations scenarios relative to normal full pool operations (Scenario 1) in order to use the Scheurell and Zabel (based on FTT) and Petrosky et al. (WTT) relationships to predict increases in SAR. Decreases in McNary to Bonneville WTT and FTT ranged up to 0.9 and 0.6 days, respectively, in 2001 for Scenario 2 (JDA at MOP), and up to 2.0 and 1.2 days, respectively, in 2001 for Scenario 3 (all at MOP). Note that in 2001 FTT may be underestimated (FTT less than WTT) because WTT was beyond the bounds of the regression relationship to convert WTT to FTT.

Using Scheuerell and Zabel's models that relates SARs to arrival date past Bonneville, we estimated that for 1998-2002 SARs would be improved by 0.33-2.73% with John Day at MOP and 0.74-6.60% with all pools at MOP (**Table 2**). Using the Petrosky et al. model that related SARs (based on S/R recruitment functions) to WTT and several indices of ocean productivity, we estimated that improvements in SARs would be substantially higher:2.32-5.79% for John Day at MOP and 5.12-13.01% with all pools at MOP (**Table 3**). The survival benefits estimated from Petrosky's model may be the most robust estimates as a much longer data set (1954-2000) was used in the analysis than Scheuerell and Zabel (1998-2002). The USFWS (Haeseker) conducted a retrospective analysis of expected changes in direct survival of both yearling Chinook and steelhead under MOP operations; for 2001, a 5.8% (i.e., from 0.265 to 0.280) improvement in Chinook survival was estimated from Lower Granite to Bonneville and a 49% (.037 to .055) improvement was estimated for steelhead. This analysis provides insight into how direct effects from hydrosystem passage can be improved by MOP, and although not directly comparable to modeled SAR increases, these benefits would likely translate directly into adult return increases.

The **attached figure** summarizes the biological benefits of lower Columbia MOP operations using the two analytical approaches as well as the USFWS point estimate for 2001. Note that both models predict that survival benefits are roughly doubled at lower spring flows with all pools at MOP compared to only JDA at MOP.

Both models indicate that significant survival benefits would be provided to Snake River spring/summer Chinook by operating lower Columbia pools at MOP especially under low flow years. The **attached table** shows that the amount of flow augmentation to provide equivalent benefits in WTT as MOP operations is substantial, ranging from 1.9-5.8 maf in the spring for flows ranging from 100-300 kcfs and 1.5-4.4 maf in the summer. Additionally, unlike flow augmentation, the WTT benefit would be realized every year and especially under low flow years when flow augmentation is most needed and often not available.

*File: Biop Remand\Biological Benefits of lower Columbia MOP*


Percentage increases in sp/su Chinook SAR from normal Lower Columbia full pool operations predicted for MOP scenarios at Biop pool elevations and average spring flows, 1998-2002
Haeseker, 2001, All 4 pools at MOP
Scheuerell & Zabel: John Day at MOP
Scheuerell & Zabel: All 4 pools at MOP
Petrosky et al: John Day at MOP
Petrosky et al.: All 4 pools at MOP
Percentage increase in SAR
14%
12%
10%
8%
6%
4%
2%
0%
100
150
200
250
300
350
Average Spring Flow (kcfs)
retrospective
delayed only
7.5 - 13%
Direct only 1.5% actual
R/S Brood may 31, 2006 WTT / April upwelling POO
reducing delayed effects
also expect direct effects
(1) Authors
Technical Compass Group
(2) (2a) - model run?
(3) Policy Parties
(4) Release to Policy

Reservoir Replacement model
Base Bruner FPC

| Spring Lower Columbia Water Travel Time | | | | | | | |
|---|---|---|---|---|---|---|---|
| | WTT BON-MCN at Low Flow (100 Kcfs), days | WTT BON-MCN at Medium Flow (200 Kcfs), days | WTT BON-MCN at High Flow (300 Kcfs) days | Percent Change Relative to Base case | Extra water needed under Base Case Conditions to achieve same WTT over 82 day Spring Period at low flow (100 Kcfs), MAF | Extra water needed under Base Case Conditions to achieve same WTT over 82 day Spring Period at medium flow (200 Kcfs), MAF | Extra water needed under Base Case Conditions to achieve same WTT over 82 day Spring Period at high flow (300 Kcfs), MAF |
| ***BASE CASE*** JDA at MIP; BON, TDA, MCN at Normal Full Pool | 23.3 | 11.6 | 7.8 | | | | |
| ***CASE #1*** JDA at MOP; BON, TDA, MCN at Normal Full Pool | 22.1 | 11.1 | 7.4 | - 5% | 0.85 | 1.70 | 2.55 |
| ***CASE #2*** JDA, BON, TDA, MCN at MOP | 20.8 | 10.4 | 6.9 | - 11% | 1.94 (11.9 Kcfs) | 3.88 (23.9 Kcfs) | 5.82 (35.8 Kcfs) |
| Base + Montana | 25 | 12.1 | 7.9 | 1-7% | | | |

Solve day = 50% of all imports / rule of thumb / in lower river

1 foot for load following

Implementation
- Hold all harmless except power, (loss of Head)
- not implemented unless as mitigated for other harms
- Some implemented right away but others later towards end of B.O.P
- Invest spill savings for implementing (BPA)
- working Table
- MIP vs MOP $175m cost

| Summer Lower Columbia Water Travel Time | | | | | | | |
|---|---|---|---|---|---|---|---|
| | WTT BON-MCN at Low Flow (100 Kcfs), days | WTT BON-MCN at Medium Flow (200 Kcfs), days | WTT BON-MCN at High Flow (300 Kcfs) days | Percent Change Relative to Base case | Extra water needed under Base Case Conditions to achieve same WTT over 62 day Summer Period at low flow (100 Kcfs), MAF | Extra water needed under Base Case Conditions to achieve same WTT over 62 day Summer Period at medium flow (200 Kcfs), MAF | Extra water needed under Base Case Conditions to achieve same WTT over 62 day Summer Period at high flow (300 Kcfs), MAF |
| ***BASE CASE*** JDA at MIP; BON, TDA, MCN at Normal Full Pool | 23.3 | 11.6 | 7.8 | | | | |
| ***CASE #1*** JDA at MOP; BON, TDA, MCN at Normal Full Pool | 22.1 | 11.1 | 7.4 | - 5% | 0.64 | 1.28 | 1.92 |
| ***CASE #2*** JDA, BON, TDA, MCN at MOP | 20.8 | 10.4 | 6.9 | - 11% | 1.47 (11.9 Kcfs) | 2.93 (23.9 Kcfs) | 4.40 (35.8 Kcfs) |

SOA map enters at MP about the same

TD, Bonne, MCN → Hanford issue -
↳ not as much of an issue for other 3 pools

need to be certain of Biological Potential
- direct effects for cumulative,
- Beyond Current operations, This is what is left
- Direct effects through Compass
  - Preliminary look at direct effects - Compass group

## Spring/Summer Lower Columbia Water Travel Time

| | WTT BON-MCN at Low Flow (100 Kcfs), days | WTT BON-MCN at Medium Flow (200 Kcfs), days | WTT BON-MCN at High Flow (300 Kcfs) days | Percent Change Relative to Base case | Extra water needed under Base Case Conditions to achieve same WTT over 144 day Spring/Summer Period at low flow (100 Kcfs), MAF | Extra water needed under Base Case Conditions to achieve same WTT over 144 day Spring/Summer Period at medium flow (200 Kcfs), MAF | Extra water needed under Base Case Conditions to achieve same WTT over 144 day Spring/Summer Period at high flow (300 Kcfs), MAF |
|---|---|---|---|---|---|---|---|
| ***BASE CASE*** JDA at MIP; BON, TDA, MCN at Normal Full Pool | 23.3 | 11.6 | 7.8 | | | | |
| ***CASE #1*** JDA at MOP; BON, TDA, MCN at Normal Full Pool | 22.1 | 11.1 | 7.4 | - 5% | 1.49 | 2.98 | 4.47 |
| ***CASE #2*** JDA, BON, TDA, MCN at MOP | 20.8 | 10.4 | 6.9 | - 11% | 3.41 MAF (11.9 Kcfs) | 6.81 (23.9 Kcfs) | 10.22 MAF (35.8 Kcfs) |

Out of range of Flow Avg.

# Biological benefits of lower Columbia Minimum Operating Pool (MOP) operations on survival of yearling spring/summer Chinook salmon

Oregon Department of Fish and Wildlife
November 17, 2006

Associations among 1) Water Transit Time (WTT, in days), 2) Fish Travel Time (FTT, in days), 3) average spring flows, and 4) pool-levels in the McNary (MCN), John Day (JDA), The Dalles (TDA) and Bonneville (BON) pools were examined and applied in three survival models for yearling spring/summer Chinook salmon. Two of these models address survival downstream from Bonneville Dam and thus deal with delayed (indirect) mortality, and the third is an in-river survival model (upstream of Bonneville Dam) and thus deals with direct mortality. One of the post-Bonneville survival models (Scheuerell and Zabel 2006) predicts changes in Bonneville-Lower Granite smolt-to-adult return rate (BON-LGR SAR), and the second (Petrosky et al. 2006) predicts changes in first year ocean survival (s3). The direct mortality model (Haeseker 2006) predicts changes in in-river passage survival from Lower Granite Dam to Bonneville Dam. The ultimate purpose of this paper is to estimate increases in survival associated with reductions in pool levels and, consequently, WTT and FTT. These increases would be expected to result in direct improvements in adult returns and survival improvements needed for recovery (GAPs) identified by NOAA Fisheries' Technical Recovery Teams.

The following pool-level cases were evaluated: 1) Base Case- John Day (JDA) at Minimum Irrigation Pool (MIP), Bonneville (BON), The Dalles (TDA), and McNary (MCN) at Normal Full Pool; 2) Case 1- JDA pool at Minimum Operation Pool (MOP), BON, TDA, and MCN at Normal Full Pool; and 3) Case 2- all four pools at MOP. Potential reductions in WTT and FTT, and consequent increases in survival, associated with the two reduced pool-level cases relative to the Normal Full Pool-Level operations Base Case were assessed for 1998-2002.

Reductions in pool level (volume) decrease WTT,a function of volume and flow (WTT (s)=Reservoir Volume $ft^3$/Flow $ft^3$/s, which is then converted to days; US Army Corps of Engineers, Walla Walla District). Based on average spring flow for each year, we estimated WTT for each of the four pools for each case and summed WTTs to get reach MCN-BON for each year. To estimate expected FTTs for each year under each pool-level case, we applied a linear regression relationship that relates WTT to FTT for hatchery and wild yearling Chinook salmon traveling from MCN-BON dams (FTT = 0.6043*WTT + 3.6429, $R^2$=0.4685, WTT data range: 4-14; Margaret Filardo, Fish Passage Center, pers. comm.). Finally, subtraction of the WTT and FTT estimates for pool-level reductions Case 1 and Case 2 from the Base Case gave estimates of reductions in WTTs ($\Delta$WTT) and FTTs ($\Delta$FTT) (Table 1).

Estimates of FTT were all slightly higher than WTT except in 2001 when estimated FTT was somewhat lower than WTT. In that year, however, WTT was beyond the range of the regression relationship. An alternative method for 2001 that estimated FTT for JDA

individually and MCN, TDA, and BON together employed WTT values within the range of the regression relationship, and the total FTT was almost equal to total WTT. However, using this alternative method, the reductions in FTT between the pool-level scenarios were the same as with the method employed for the other years. Therefore, for consistency, 2001 FTT was estimated by the same methodology as the other years and the regression relationship itself, that is, over all four pools together.

Scheuerell and Zabel (2006) examined the dependence of BON-LGR SARs on "Arrival day below Bonneville Dam (days past April 1)" for the truncated data set of juveniles arriving 30-80 days past April 1 during 1998-2002. For each year, they derived two functions, one assuming that the relationship determined for arrival dates between 30-80 days past April 1 also held before and afterwards (<30 and >80) (symmetrical model), the other assuming that the BON-LGR SARs for these before and after periods were equal to the BON-LGR SARs on day 30 and day 80, respectively (extrapolated model). They standardized the results to show "Percent increase in BON-LGR SAR" as a function of "Shift in run distribution (days earlier)" for both of the BON-LGR SAR/"Arrival day below Bonneville Dam (days past April 1)" functions for each year. Employing both these relationships, we estimated potential increases in BON-LGR SARs associated with the potential reductions in FTTs for the two pool-level reduction cases relative to the Base Case for 1998-2002 (Table 2). Potential increases in BON-LGR SARs ranged from 0.33% to 2.83% for pool-level Case 1 (Fig. 1) and 0.74% to 6.60% for Case 2 (Fig. 2). The greatest potential increases were estimated for 2001, when average spring flows were particularly low. The other four years had fairly similar, and substantially higher, average spring flows. There was little difference among the increases for 1998-2000, which were relatively low, but those for 2002 were somewhat higher.

Petrosky et al. (2006) developed functions to predict first year ocean survival (s3) based on WTT for three ocean environment conditions (i.e., good, average and poor, each at specific levels of Pacific Decadal Oscillation (PDO) and Upwelling indices). In these relationships, WTT was from the mouth of the Clearwater River to Bonneville Dam. Estimates of WTT that occurred under Base Case operations (Michelle DeHart, Fish Passage Center. pers. comm.) in 1998-2002 were adjusted downward by the reductions in WTT specific to the two reduced pool-level cases. These estimates of potentially reduced WTT were then employed in estimating potential percentage reductions in s3 using relationships between these two variables in Petrosky et al. (2006). Although expected s3 varied with each ocean condition scenario, the potential increases in s3 were the same for each (Table 3). This methodology predicted substantially greater potential increases in s3 than had been predicted for BON-LGR SARs; estimated potential increases were 3.59-9.02% for Case 1 (Fig. 1), and 7.96-20.65% for Case 2 (Fig. 2). The greatest potential increases were again estimated for 2001; the estimated increases for the other years were considerably lower and similar.

Haeseker (2006) developed models to predict in-river (direct) survival of juvenile spring/summer chinook migrating from Lower Granite Dam to Bonneville Dam under the three pool-level cases based on WTT, spill percentage and temporal period of migration for individual fish groups. The individual fish group survival estimates were then averaged for each pool-level case. We then estimated percentage increases in survival associated with the

two pool-level reduction cases relative to the Base Case for 1999-2002 (Table 4). There was a lack of data for passage from MCN to BON for 1998, therefore we made estimates of increased survival based on the average for 1999 and 2002 when average spring flows were similar. Estimated potential increases in survival were 0.56-1.68% for pool-level Case 1 (Fig. 1) and 1.60-5.08% for pool-level Case 2 (Fig. 2). Once again, the greatest potential increases were estimated for 2001; the estimated increases for the other years were all similar to one another and were considerably lower.

It is important to note that the estimated increases in in-river survival is additive to the estimated percentage increases in both BON-LGR SARs and s3. Estimated potential increases in in-river survival plus SAR were 0.99-4.43% for pool-level Case 1 (Fig. 1) and 2.43-11.60% for pool-level Case 2 (Fig. 2). Estimated potential increases in in-river survival plus s3 were 4.15-10.70% for pool-level Case 1 (Fig. 1) and 9.55-25.73% for pool-level Case 2 (Fig. 2). The greatest potential increases were estimated for 2001.

Scheuerell and Zabel (2006) developed relationships between increases in BON-LGR SARs and shifts in run distribution based on arrival time of fish at Bonneville Dam that were unique for each year from 1998-2002. WTT, the variable directly estimated for the pool-level cases, was not involved in these relationships. Therefore, to estimate increases in BON-LGR SARs associated with the reduced pool-level cases, it was necessary to convert estimates of WTT into estimates of FTT, and these were then used to estimate shifts in run distribution. The Petrosky et al. (2006) model did not require such a conversion, instead directly relating s3 to WTT and a suite of ocean condition variables based on data from 1966-1984 and 1992-2001. Also, whereas the Scheuerell and Zabel (2006) models applied directly to the years for which changes in survival associated with MOP conditions were assessed, the much more extensive data set of Petrosky et al. (2006) might yield better predictive power for other years and conditions.

We calculated the amount of flow augmentation that would be required to achieve WTT equivalent to those for Case 1 and Case 2 under hypothetical low (100 kcfs), medium (200 kcfs), and high (300 kcfs) spring discharges (Table 5). For spring, 0.85 million acre feet (MAF) to 2.55 MAF would be required to achieve the WTT reductions associated with pool-level Case 1 under the three flow conditions and 1.94-5.82 MAF would be required to achieve the reductions for Case 2. For summer, the range for Case 1 would be 0.64-1.92 MAF and 1.47-4.40 MAF would be required for Case 2. For spring and summer combined, 1.49-4.47 MAF would be required for Case 1 and 3.41-10.22 MAF for Case 2. It must be remembered that unlike flow augmentation from upriver storage, improvements in WTT from MOP operations in lower Columbia pools would be provided each year and even during years of low flow when flows are most needed and storage is scarce. Additionally, for the first time, improvements in WTTs would be made during spring months, as currently flows are generally not specifically augmented during this period; rather, reservoirs are managed to insure refill and to provide flow augmentation during summer months.

Table 1. Water Transit Times (WTT) and Fish Travel Times (FTT) associated with the three pool-level cases for MCN, JDA, TDA, and BON, 1998-2002. Reductions in FTT (ΔFTT) from those under the Base Case are given for Case1 and Case 2. WTT, FTT, ΔWTT and ΔFTT are in days.

| | Average Spring Flow | Base Case: 3 Normal Level JDA at MIP | | Case 1: 3 Normal Level JDA at MOP | | | | Case 2: All at MOP | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | (kcfs) | WTT | FTT | WTT | FTT | ΔWTT | ΔFTT | WTT | FTT | ΔWTT | ΔFTT |
| 1998 | 287.8 | 8.08 | 8.53 | 7.69 | 8.29 | 0.39 | 0.24 | 7.23 | 8.01 | 0.85 | 0.52 |
| 1999 | 303.6 | 7.66 | 8.27 | 7.29 | 8.05 | 0.37 | 0.22 | 6.85 | 7.78 | 0.81 | 0.49 |
| 2000 | 243.4 | 9.56 | 9.42 | 9.09 | 9.14 | 0.46 | 0.28 | 8.55 | 8.81 | 1.01 | 0.61 |
| 2001 | 123.9 | 18.77 | 14.99 | 17.86 | 14.44 | 0.91 | 0.55 | 16.79 | 13.79 | 1.98 | 1.20 |
| 2002 | 269.3 | 8.64 | 8.86 | 8.22 | 8.61 | 0.42 | 0.25 | 7.73 | 8.31 | 0.91 | 0.55 |

Table 2. Percentage increases in smolt-to-adult return ratio (BON-LGR SAR) associated with pool-levels Case 1 and Case 2 and decreases in Fish Travel Time (FTT) estimated by relationships in Scheuerell and Zabel (2006).

| | Case 1: 3 Pools Normal Level JDA at MOP | | Case 2: Four Pools at MOP | |
|---|---|---|---|---|
| Year | Symmetrical Model | Extrapolated Model | Symmetrical Model | Extrapolated Model |
| 1998 | 0.33% | 0.47% | 0.74% | 0.82% |
| 1999 | 0.34 | 0.52 | 0.76 | 0.91 |
| 2000 | 0.43 | 0.53 | 0.98 | 1.06 |
| 2001 | 2.83 | 2.73 | 6.60 | 6.43 |
| 2002 | 0.70 | 0.79 | 1.73 | 1.79 |

Table 3. Percentage increases in first year ocean survival (s3) associated with pool-level Case 1 and Case 2 and decreases in Water Travel Time (WTT) estimated by relationships in Petrosky et al. (2006).

| Year | Case 1: 3 Pools Normal Level JDA at MOP | Case 2: Four Pools at MOP |
|---|---|---|
| 1998 | 3.79% | 8.42% |
| 1999 | 3.59 | 7.96 |
| 2000 | 4.49 | 10.03 |
| 2001 | 9.02 | 20.65 |
| 2002 | 4.05 | 9.02 |

Table 4. Percentage increases in direct survival of in-river migrants associated with pool-level Case 1 and Case 2 and decreases in Fish Travel Time (FTT) estimated by relationships in Haeseker (2006).

| Year | Case 1: 3 Pools Normal Level JDA at MOP | Case 2: Four Pools at MOP |
|---|---|---|
| 1998 | 0.64% | 1.99% |
| 1999 | 0.56 | 1.60 |
| 2000 | 0.65 | 1.84 |
| 2001 | 1.68 | 5.08 |
| 2002 | 0.71 | 2.13 |

Table 5. Flow augmentation (MAF) required to achieve WTT equivalent to Case 1 and Case 2 under low flow (100 Kcfs), medium flow (200 Kcfs) and high flow (300 Kcfs) conditions during spring (62 days), summer (82 days), and spring and summer combined (144 days) seasons. Flow level equivalents (Kcfs) for Case 2 are also provided.

| Flow Condition | Case 1: 3 Pools Normal Level JDA at MOP | Case 2: 0 Pools Normal Level Four Pools at MOP | |
|---|---|---|---|
| | MAF | MAF | Flow (Kcfs) |
| Spring | | | |
| Low | 0.85 | 1.94 | 11.9 |
| Medium | 1.70 | 3.88 | 23.9 |
| High | 2.55 | 5.82 | 35.8 |
| Summer | | | |
| Low | 0.64 | 1.47 | 11.9 |
| Medium | 1.28 | 2.93 | 23.9 |
| High | 1.92 | 4.40 | 35.8 |
| Spring + Summer | | | |
| Low | 1.49 | 3.41 | 11.9 |
| Medium | 2.98 | 6.81 | 23.9 |
| High | 4.47 | 10.22 | 35.8 |

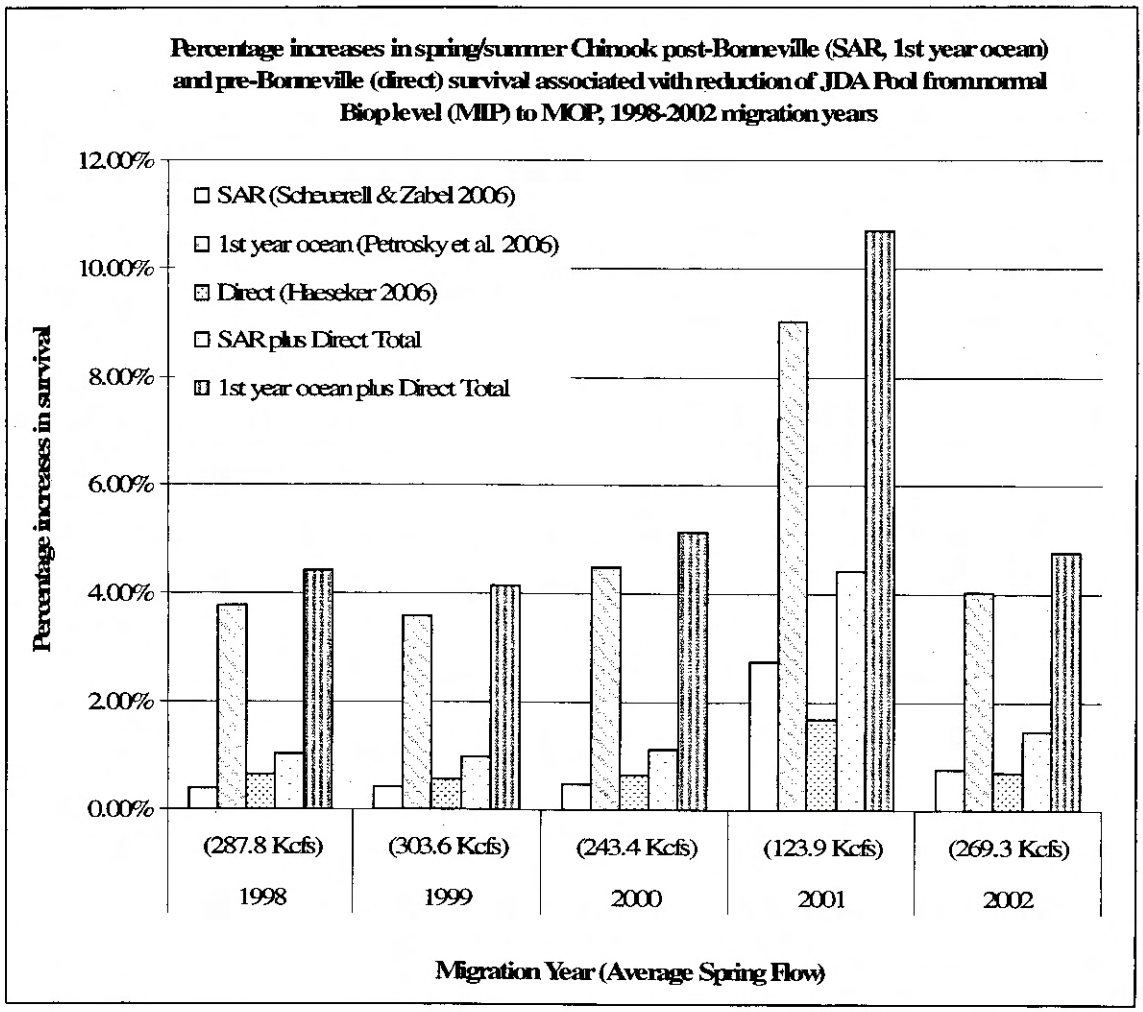



Figure 1. Percentage increases in BON-LGR smolt-to-adult return rates (SAR) (Scheuerell and Zabel 2006), 1st year ocean survival (s3) (Petrosky et al. 2006), and in-river survival (Direct) (Haeseker 2006) associated with pool-level Case 1 (JDA at MOP only), 1998-2002.

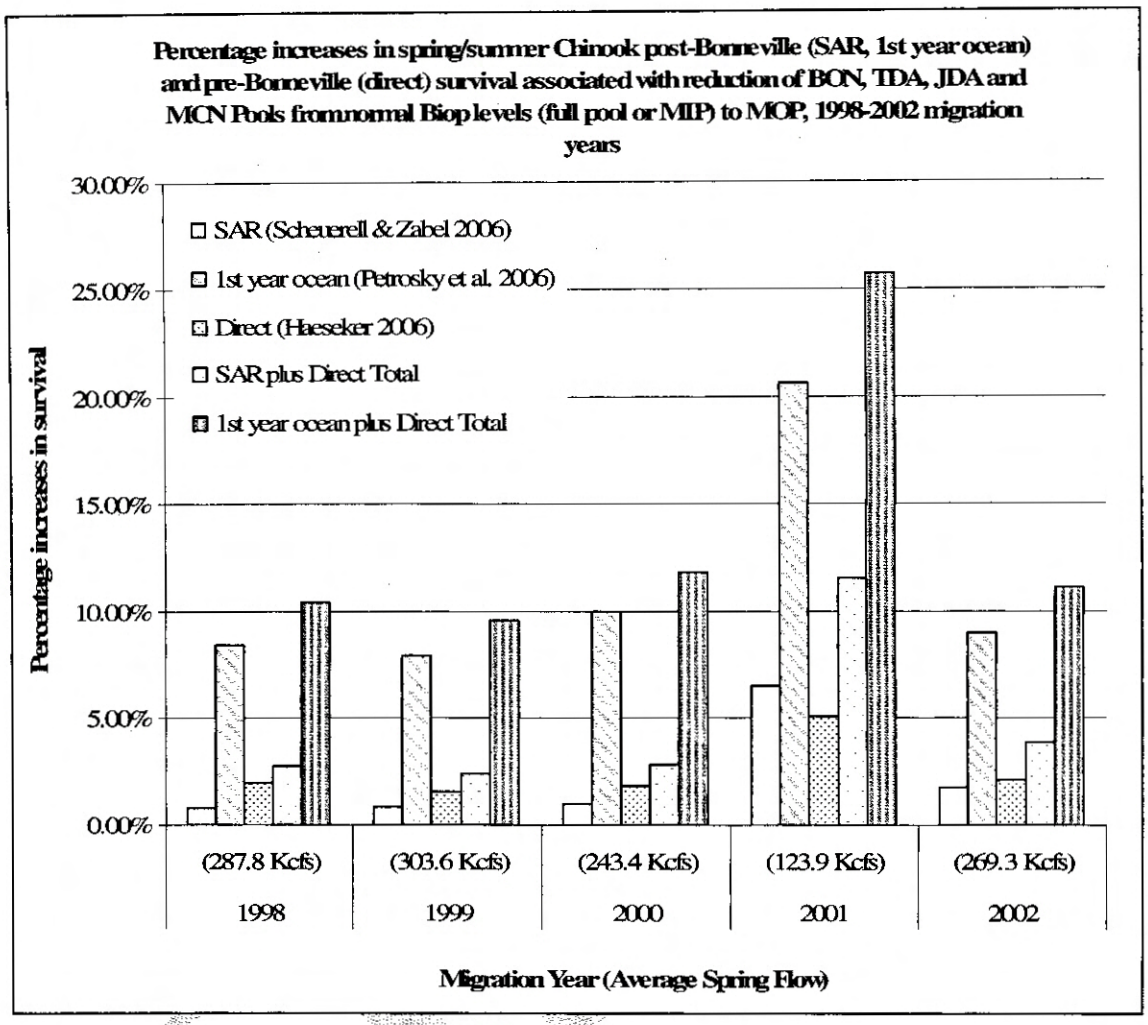



Figure 2. Percentage increases in BON-LGR smolt-to-adult return rates (SAR) (Scheuerell and Zabel 2006), 1st year ocean survival (s3) (Petrosky et al. 2006), and in-river survival (Direct) (Haeseker 2006) associated with pool-level Case 2 (BON, TDA, JDA, MCN at MOP), 1998-2002.

References

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Impacts of operating John Day Project at Minimum Operating Pool for hatcheries, wildlife areas and the Umatilla National Wildlife Refuge. **DRAFT 11-28-06**

| Condition/Question | Umatilla Hatchery | Irrigon Hatchery | Umatilla National Wildlife Refuge | ODFW Wildlife Areas |
|---|---|---|---|---|
| **Current physical or operational status at Full Pool** | o Original design capacity: 15,000 gpm<br>o Actual: 1994 9,000 gpm<br>2006 7,500 gpm | o Original design capacity: 25,000 gpm<br>o Current: 18,000 gpm<br>o Liquid Oxygen installed in 1996 | o One intake pump affected by operations<br>o Five center pivots may be affected | o None specified |
| **Actual Impacts of John Day Pool at Minimum Irrigation Pool (MIP)** | o 2,000 gpm capacity loss summer months<br>o Lost aquifer storage, coincident with summer pump loss<br>o No anticipated impact on production<br>o Already operating to worst case scenario at 5,500 gpm with early fish transfers<br>o Lost all water at MOP in 4-5 day operation in 1996/97.<br>o Reduced flow and feeding rates<br>o ChS transferred now mid-Nov and mid-Jan<br>o Have found early transfers benefit SARs | o 2,000 gpm capacity loss Dec-Mar.<br>o Production goals reduced with early transfers<br>o Pumps cavitate and draw in sand, increases wear on equipment and pumping costs | o Estimate over one-third loss of open water area in all back-water areas<br>o Substantial loss in aquatic bed and emergent wetland area<br>o Reduction in shoreline areas (changes not analyzed yet)<br>o Loss in waterfowl use and nesting not analyzed, assume similar 1/3rd reduction as in area<br>o Widespread tree (cottonwood, willows, dogwood) & shrub mortality continues<br>o Tree replacement growth often non-native (Russian olive, false indgo)<br>o Hunting opportunities losses (9 of 27 blinds, undetermined free-roaming hunting loss) | o Wetland habitat reduction 40%<br>o Shallow water wetlands dried up<br>o Reduction of deep water wetlands<br>o Deep water wetlands became shallow wetlands<br>o Open water habitats succession to cattail stands<br>o Waterfowl habitat reduced<br>o Western pond turtle (OR Sensitive Species) lost large percentage of open water habitat<br>o Significant reductions in WPT population<br>o Historically one of largest WPT populations in Col. R. Basin |
| **Has any mitigation for losses at MIP been provided?** | o No | o No | o No.<br>o Refuge has spent hundreds of thousands in riparian and wetland restoration | o Pond rehabilitation to deepen emergent ponds<br>o Great expense to ODFW |
| **Incremental Impacts of operation at Minimum Operating Pool (MOP)** | o Production in April and May would be impacted/lost<br>o Any reduction in pool elevation below MIP has exponential water loss. | o Water needs decreased by April<br>o May not be noticeable impact<br>o Lower aquifer recharge over | o Significant reduction in biological and recreational benefits<br>o MOP drawdown in no way amenable to current Refuge management<br>o Highly popular hunting programs | o **Irrigon WA**: Loss of open water pond rehabilitation<br>o Loss of another 40% wetland habitat<br>o WPT reduction to remnant |

| Condition/Question | Umatilla Hatchery | Irrigon Hatchery | Umatilla National Wildlife Refuge | ODFW Wildlife Areas |
|---|---|---|---|---|
| **Incremental Impacts of operation at Minimum Operating Pool (MOP) (continued)** | o Pumping costs increase from restricted pump output<br>o Hatchery would be out of fish and domestic water within two weeks | time may impact | further diminished<br>o Backwater wetlands be entirely or nearly entirely dewatered<br>o Submerged aquatic vegetation (aquatic beds) would be lost<br>o Emergent plant survival questionable<br>o Expansive areas of non-native and invasive plants would colonize large areas | population<br>o **Willow Cr WA**: Extend mud flat delta north toward Col. R. channel<br>o If permanent , ecosystem reset to new shoreline, conversion of aquatic habitat to terrestrial<br>o Waterfowl lose protected nesting & upland, riparian species benefit from increased shoreline<br>o If seasonal, riparian reset lost with reduction in riparian habitat.<br>o **Coyote Spr WA**: Water source is surplus irrigation water (WEID)<br>o Alternative irrigation pumping likely reduce surplus water, reducing reduced wetland resources |
| **What mitigation measures would be needed for losses from MIP to MOP?** | o Find other sources of water to replace 5,5000 gpm<br>o Previous feasibility study (mid-90s) est. $27M to replace water supply<br>o Only source is Columbia River with many attendant issues | o May be fine if outside maximum water use period of Dec-mar. | o Mitigation to make Refuge "whole" not possible<br>o Significant mitigation measures would be required at significant cost | o None specified |
| **Any other significant issues?** | o Domestic well would go dry | o No | o River islands and north shore of McCormack Unit | o Seasonal drawdown to MOP will cause reversal of natural spring high flow pattern contributing to seasonal wetland complexes |