Appendix 11 — Climate Change Adaptation

Overview

As described in Chapter 2 of the EIS, project changes might become necessary to address potential effects from regional climate change in the coming years. Global changes in climate, specifically temperature, have occurred naturally throughout history; however, there has been a significant increase over the last 100 years (Brekke et al. 2009), and "human-induced emissions of heat-trapping gases" have been identified as the primary contributors to this increase (Karl et al. 2009). Water resources and ecosystems have been identified as specific sectors that are and will be affected by changes in climate. In the Pacific Northwest, these sectors include salmon habitat. Specific issues that could affect salmon stem from changes in summertime stream temperature, seasonal low flows, and flooding frequency and magnitude (Mantua et al. 2009).

The University of Washington (UW) Climate Impacts Group has developed two regional climate change models based on two greenhouse gas emission scenarios (A1B and B1), as recommended by the Intergovernmental Panel on Climate Change. The B1 scenario depicts a lower emissions scenario than the A1B scenario, based partly on the projected development of cleaner and more efficient technologies with B1. However, as shown in Figure 1, both models predict significant state-wide increases in August water temperatures beginning in about 10 years and continuing into the future (Mantua et al. 2009).

Water temperature is a critical component of salmon habitat (Mantua et al. 2009). When temperatures rise too high, aspects of the salmonid life cycle such as migration, spawning, and population distributions can be affected. High temperatures can also result in an increased risk of disease and even death. The maximum upper temperature within which fish can survive varies among salmonid species. Based on the best available evidence, for coho salmon the upper limit of water temperature is 74.1˚ F (23.4˚ C) (Eaton and Scheller 1996). However, even water temperatures as low as 59˚ F (15˚ C) can subject salmon to increased predation and an inability to compete with warm-water species. Table 1 describes EPA recommended temperature thresholds during different life history phases for Pacific salmonid species. Based on this data, the temperature increases predicted by the climate change models described above would likely result in more frequent and persistent thermal migration barriers and thermally stressed waters for salmon. Summer water temperatures are also predicted to start earlier and last longer (Mantua et al. 2009). These higher temperatures would likely have the most severe impacts on summertime fish migrations.

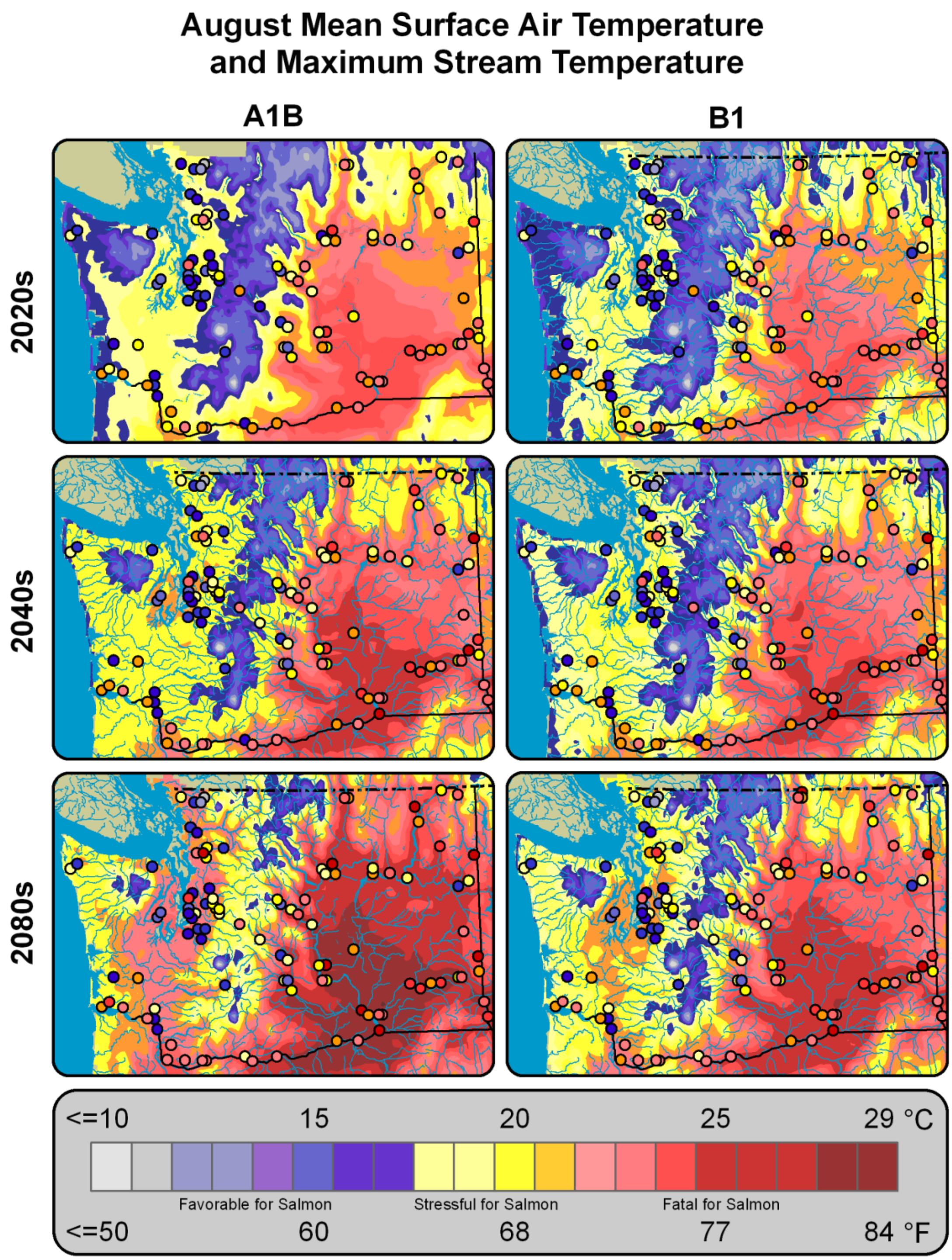

Figure 1. Future climate scenarios for several decades including the 2020s, 2040s, and 2080s are provided based on both climate scenarios (A1B and B1). Circles represent water temperatures (Figure from Mantua et al. 2009, pg 228).

Table 1. Recommended temperature thresholds for Pacific salmon by life history phase.	
Salmonid Life History Phase Terminology	**EPA-Based Recommended Temperature Thresholds to Protect Salmon and Trout[1]**
Adult migration	<68°F (<20°C) for salmon and trout migration
Incubation	<55°F (<13°C) for salmon and trout spawning, egg incubation, and fry emergence
Juvenile rearing (early year)	<61°F (<16°C) for salmon "core" juvenile rearing
Smoltification	<59°F (<15°C) for salmon smoltification <57°F (<14°C) for steelhead smoltification
Juvenile rearing (late year)	<64°F (<18°C) for juvenile salmon and steelhead migration
[1]The EPA identified temperature unit is: Seven day average of the daily maximum water temperature. *Source: EPA 2003.*	

Climate change is also predicted to affect seasonal stream flows and flooding frequency and magnitude through changes to the watershed. Both the Wenatchee and Methow basins currently are snowmelt-dominant watersheds. Model predictions suggest that the those watersheds will become largely transient–runoff (transition) dominant in the future, with the change occurring sooner in the Wenatchee basin than in the Methow (see Figure 2 below).

There are several repercussions to this change in watersheds. Flooding, both frequency and magnitude, is predicted to increase in December and January in transient–runoff watersheds. In transient–runoff dominant watersheds, the size of summer low flows is predicted to decrease, while their duration is expected to increase (Mantua et al. 2009). These watershed changes could result in changes to groundwater recharge rates and in the availability of water from local springs, further exacerbating water temperature issues. Changes in stream flows could also result in increased erosion rates, which could lead to increased sedimentation and further temperature changes.

In order to put this in context, the UW Climate Center developed a graphic illustrating the potential climate-related impacts on freshwater habitat for both steelhead and salmon. This illustration is re-created in Figure 3. All of these potential changes could affect acclimation sites and hatchery infrastructure, operations, and production as water temperature and hydrology change from current conditions.

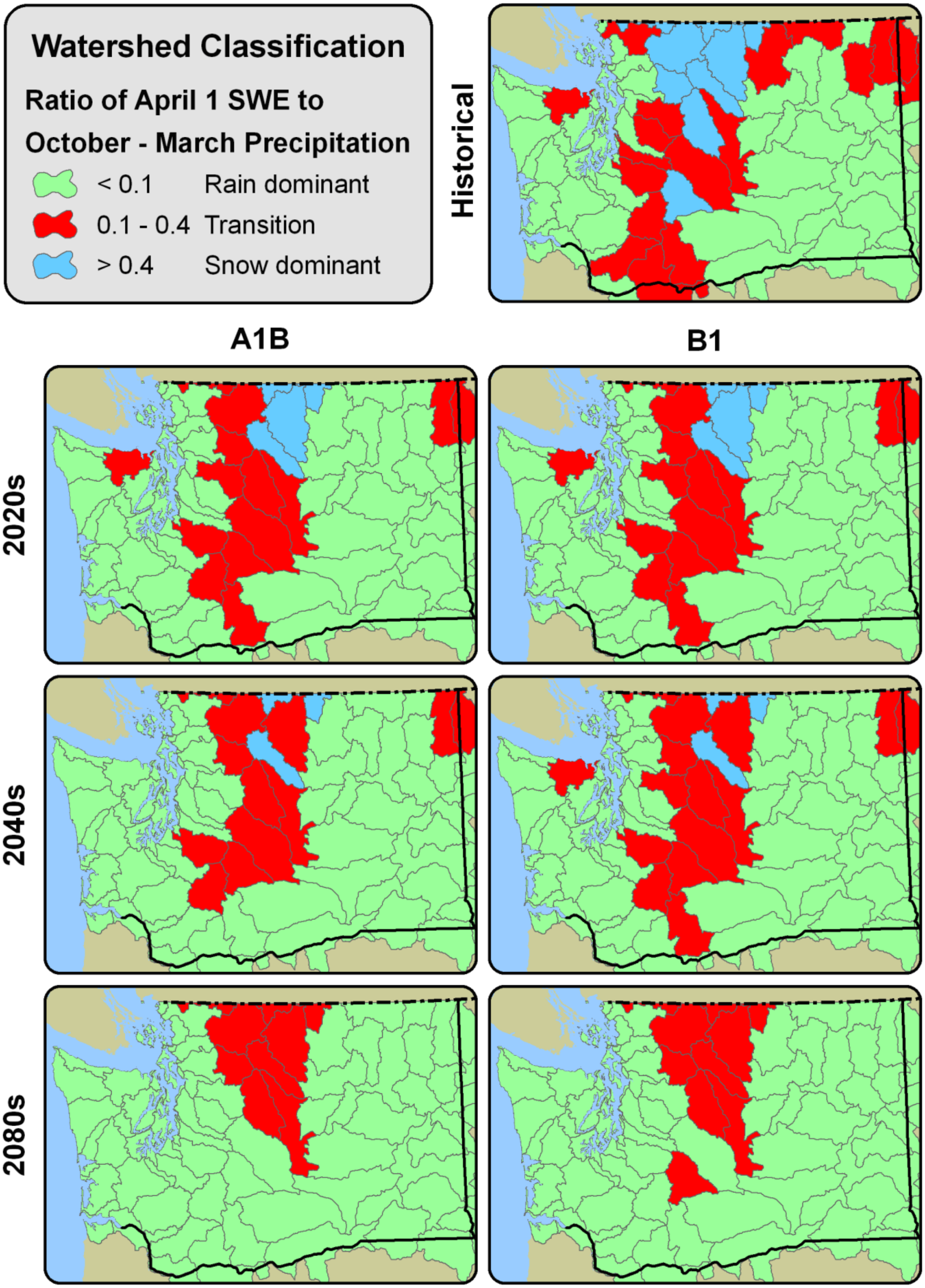

Figure 2. Watershed classification maps for simulated runoff in the historic period (1970-99), 2020s, 2040s, and 2080s. Simulations both climate scenarios (A1B and B1; Figure from Mantua et al. 2009, pg 234).

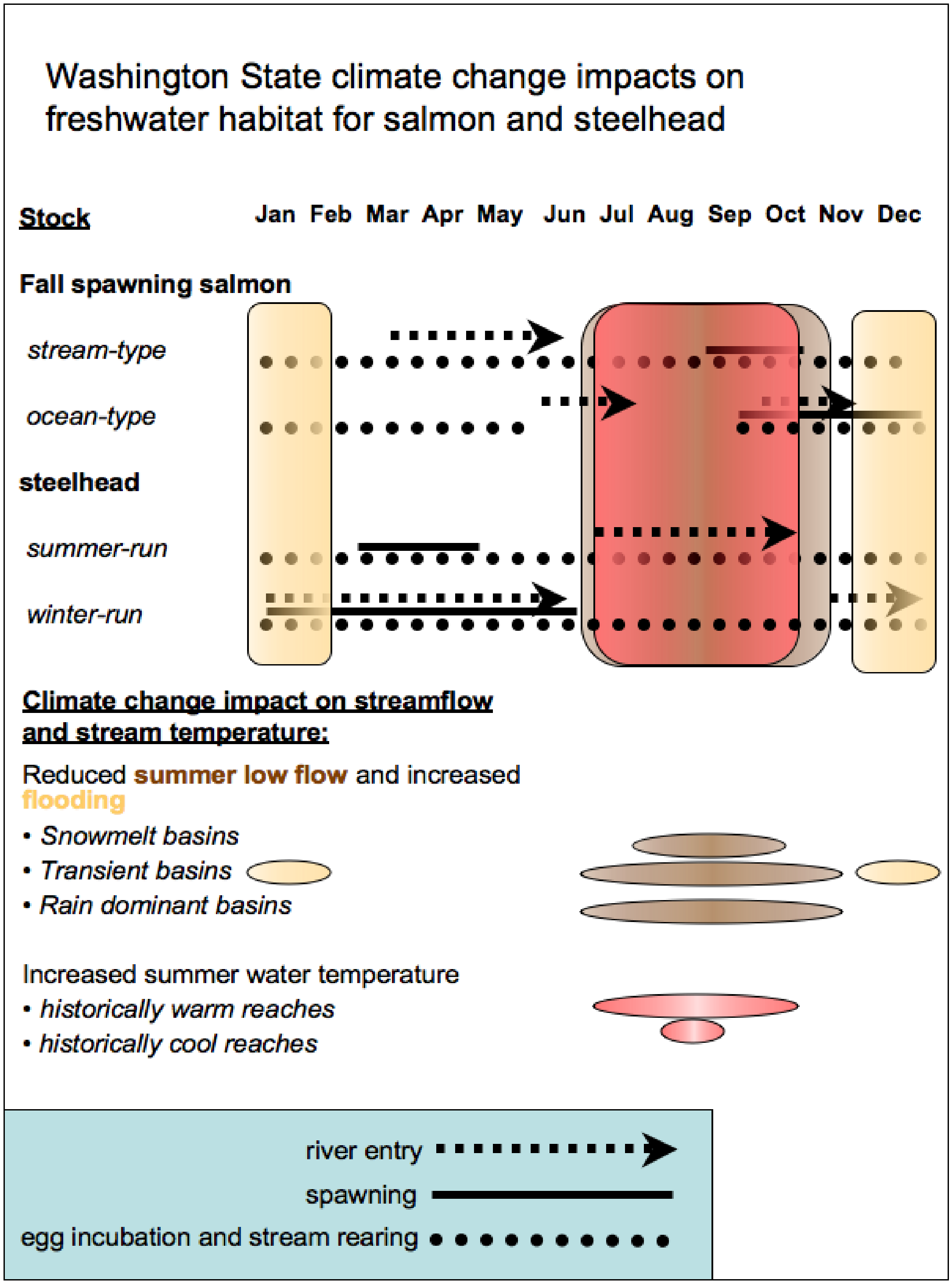

Figure 3. Potential climate change impacts of increased flooding, summer temperatures, and reduced summer low flow in freshwater habitat for salmon and steelhead. Example life history stages are shown for adult river entry (broken arrows), spawning (solid lines), and egg incubation and rearing periods (dotted lines) for generalized stocks. Tan shading highlights periods of increased flooding, brown shading indicates periods with reduced summer/fall low flows, and red shading indicates periods with increased thermal stress (Mantua et al. 2009, pg. 239).

Potential Future Responses

The reduction in habitat for naturally spawning coho and thermal exceedances that migrating fish could experience downstream of the facilities as a result of climate change are largely outside of the project's control. However, some actions might be necessary in the future to ensure that project operations can be maintained if environmental conditions change before the project's proposed conclusion in 2028. As described in Chapter 2, these actions would likely require additional environmental review and permitting, but are described here to illustrate changes that might be necessary in the future.

Infrastructure changes

Water Intake—Water intake structures and pumps may need to be modified (e.g., extended deeper, relocated, etc.) as seasonal changes in stream flows and lower flows are experienced, especially in summer months.

Water Intake—Water intakes may need to be modified (e.g., installation of filters, settling pools, etc.) as sedimentation increases to reduce turbidity levels in hatchery water.

Adult ladders—Adult fish ladder entrances may need to be modified (e.g., extensions added, flows changed, etc.) to address changes in seasonal flows.

Flood protection—Additional measures may be required to reduce the risk of flood damage to the hatchery facilities.

Spring Intake—Intake and pumps may need to be modified to ensure necessary water supply over time.

Water Discharge—Water discharges may need to be carefully monitored and manipulated to ensure the proper temperature is maintained for hatchery water discharges as stream temperatures increase over time.

Operation and Production changes

Acclimation Areas—Areas for acclimating fish may need to be re-evaluated to ensure appropriate water temperatures.

Acclimation Timing—Timing for fish acclimation and releases may need to shift as a result of changes in stream flow and temperature.

Hatchery Water Use—Depending on the air temperature and water temperatures, changes in the mixing ratios for water used in the hatchery and raceways may need to be modified.

Monitoring

Future monitoring of climate change will rest primarily with experts in the region. Project staff will be able to review monitoring data as it becomes available and use it to assist them in making changes to infrastructure, operations, and production. Using the updated monitoring data will allow staff to compare predictions to actual changes in the local environment and allow them to better meet changing conditions through time.

References

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