FISH PASSAGE CENTER

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MEMORANDUM

TO: Charles Morrill, WDFW
Erick VanDyke, ODFW
Steven Hawley, citizen

FROM: Michele DeHart

DATE: October 28, 2015

RE: Requested data summaries and actions regarding sockeye adult fish passage and water temperature issues in the Columbia and Snake rivers.

The Fish Passage Center (FPC) staff received two similar requests for summaries of water temperature data, management actions, and adult sockeye passage in 2015. One request was submitted by Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife technical staff, and one was a citizen request precipitated by a Seattle Times Article on adult sockeye passage, water temperatures, and management discussions and actions (http://www.seattletimes.com/seattle-news/environment/snowpack-drought-has-salmon-dying-in-overheated-rivers/). Because these requests were similar, we developed the following single response to both requests. Our response is divided into the following sections:

- Historical Context, Analyses and Water Temperature Standards;
- Recent Research Findings, Water Temperature and Effects on Adult Salmon;
- 2015 Flow and Water Temperature Data with Comparisons to Past Years;
- Documentation of Historical Water Temperature Problems in the Federal Columbia River Power System (FCRPS) Affecting Fish Passage; and,
- Analyses of 2015 PIT-tag Adult Sockeye Passage, Travel Time, and Survival with Comparisons to Past Years.

As a result of this review, **our overall conclusion is that elevated water temperatures in the Columbia and Snake rivers, including adult fishways, is a long-recognized problem that to date remains largely unmitigated.** Significant long-term actions to address these temperature issues are necessary for the continued survival of salmon populations, particularly sockeye.

The FPC staff participates in Fish Passage Advisory Committee (FPAC) meetings, Fish Passage Operations and Maintenance Committee (FPOM) meetings, and Technical Management Team (TMT) meetings as technical support staff. The FPC does not represent any state, federal or tribal fishery management agency. To that end, we have relied on actual operations data, adult fish passage count data, water temperature data, and PIT-tag recapture data and analyses in developing this summary. We have relied on notes from FPAC meetings, FPOM meetings, and TMT meetings. Following are the conclusions from each of the sections that were outlined above.

- Historical Context, Analyses and Water Temperature Standards.
    - Hydrosystem development has had a significant effect on temperature in the mainstem Columbia and Snake rivers. By slowing water flow and increasing surface area for solar radiation, dams caused increased water temperatures in the reservoirs.
    - The inability to meet water quality standards with respect to temperature was initially identified as an issue beginning with the 1995 Biological Opinion (BiOp).
    - Efforts were underway by the EPA to develop TMDL for the mainstem Snake and Columbia rivers, resulting in a draft Temperature Total Maximum Daily Load (TMDL) in 2003.
    - The melding of the two processes (TMDL Development and BiOp Water Quality Plans) resulted in the termination of the temperature TMDL process in favor of the water quality approach outlined in the BiOp. The 2003 Draft TMDL was never finalized and a maximum load allocation was never established for temperature.
    - Despite continued development of Water Quality Plans (WQPs) over the years, the BiOp process has fallen short of ever really making an impact on water temperature beyond the actions initially identified in the 1990s. Over thirty measures were considered to address temperature, but due to identified issues were dropped from the WQP.

- Recent Research Findings, Water Temperature and Effects on Adult Salmon.
    - Higher water temperatures have a number of negative effects on adult sockeye migration, including migration delays and reduced survival.
    - These negative effects on migration have been observed at temperatures less than the 20°C (68°F) water quality standard.
    - Adult ladders often exhibit temperature gradients because the water sources differ throughout the ladder. At temperature gradients greater than 1°C, Chinook and steelhead adults have a higher likelihood of significantly delayed migration to spawning grounds, increased total thermal exposure, depletion of energetic resources, and decreased migration success.
    - Cumulative temperature exposure time is critical to adult salmon survival.

- 2015 Flow and Water Temperature Data with Comparisons to Past Years.
    - The 2015 water year produced the second lowest spring flows at both Lower Granite (LGR) and McNary (MCN) dams since the 1995 BiOp.
    - The 2015 summer flows at LGR were the second lowest since 1995 and fifth lowest at MCN.

    - Drum gate maintenance at Grand Coulee dam exacerbated the low flow conditions on the Columbia during the spring of 2015.
    - The summer low flow situation in the Columbia was somewhat alleviated by the Columbia River Treaty provision of the proportional draft of reservoirs under low flow conditions, providing approximately 5 million acre feet of water from Canadian Reservoirs in 2015.
    - In 2015, temperatures at Middle Columbia, Snake River, and Upper Columbia projects were higher, earlier in the season, than the previous ten years
    - In 2015, temperatures at nearly all FCRPS projects exceeded the 20°C (68°F) standard for 35%–46% of the passage season (April–August). The one exception was LGR, which is due to the temperature augmentation water that is provided from Dworshak Reservoir.
    - Over the previous ten years (2005–2014), temperatures exceeded the 20°C (68°F) standard for 20%–30% of the passage season (April–August) at FCRPS projects, except at LGR.
    - Overall, exceedances of the 20°C (68°F) standard in the Upper Columbia are less common. However, 2015 had the highest proportion of days exceeding the 20°C (68°F) standard at many of these sites, when compared to the previous ten years.

- Documentation of Historical Water Temperature Problems in the FCRPS Affecting Fish Passage.
    - The need to address elevated temperatures in the adult ladders was identified as early as the 1994 BiOp.
    - In the present adult fishway configuration, there appears to be some potential for improving ladder water temperatures at LGR and LGS using axillary pumps. However, sockeye adult survival observed in 2015 would not have been mitigated by these measures at LGR and LGS since most mortality occurred prior to adults reaching LGS.

- Analyses of 2015 PIT-tag Adult Sockeye passage, Travel Time, and Survival with Comparisons to Past Years.
    - In 2015, Snake River sockeye adult survival (BON-LGR) was 0.04, which was much lower than previous years (2009 to 2014), ranging from 0.44 and 0.77.
    - Snake River sockeye adults that were transported as juveniles had lower adult survival rates through the FCRPS than did adults that migrated in-river as juveniles.
    - Upper Columbia adult sockeye survival (BON-RIS) in 2015 was 0.46, the lowest among the years analyzed (2009–2015).
    - Based on PIT-tag detections, arrival timing at BON is generally earlier for Upper Columbia sockeye than for Snake River sockeye.
    - Snake River adult sockeye that migrated in-river as juveniles and Upper Columbia River adult sockeye had similar adult fallback rates at BON. However, Snake River adult sockeye that were transported as juveniles exhibited much higher fallback rates than both of the Snake River and Upper Columbia River non-transported groups.

- Snake River sockeye adults took longer to pass through the ladders at BON than Upper Columbia adults, especially in 2015. Much of this difference was attributed to Snake River adults that were transported as juveniles.
- The higher water temperatures, earlier in the year, contributed to the poor adult survivals in 2015 for both Snake River and Upper Columbia sockeye.
- The combination of the earlier high water temperatures and later arrival timing for Snake River sockeye adults resulted in longer exposure to temperatures in excess of 20°C (68°F).
- In 2015, both Snake River and Upper Columbia sockeye showed a decline in adult survival and migration speed (BON-MCN) as temperatures increased.
- At similar temperatures, Snake River sockeye that were transported as smolts had a much lower migration speed (BON-MCN) than did non-transported individuals from both the Snake and Upper Columbia rivers.
- Accounting for smolt transportation and adult arrival timing at BON helps to explain some of the observed differences in BON-MCN adult survival between Snake and Upper Columbia sockeye

Historical Context, Analyses and Water Temperature Standards

Hydrosystem development has had a significant effect on temperature in the mainstem Columbia and Snake rivers. This impact goes beyond the effect caused by naturally high temperatures that may have historically occurred in the mainstem and the tributaries (Note: while naturally high temperatures are often cited to have occurred, there is little consistent water temperature data available to document pre-development river temperatures). By slowing water flow and increasing surface area for solar radiation, dams increase water temperatures in the reservoirs created. The major impact on the daily-average, cross-section water temperature is due to the increase in width and depth resulting from the construction and operation of the impoundments (Yearsley et al., 2001).

In 1995, the National Marine Fisheries Service (NMFS) issued a BiOp concluding that modifications to FCRPS operations were needed to ensure long-term survival of salmon stocks in the Snake River that were protected by the Endangered Species Act (ESA) (NMFS, 1995). The inability to meet water quality standards with respect to temperature was identified as an issue. A temperature of 20°C (68°F) was established as a reference temperature, considered the upper incipient lethal limit for salmon. Focus was on the prioritization of cool water releases from Dworshak and Brownlee dams for juveniles, evaluation and improvement of water prediction temperature models, the development of surface passage routes to decrease forebay delay, and the provision of water temperature control in fish ladders. At that time the Corps of Engineers (COE) agreed to coordinate with the Environmental Protection Agency (EPA) regarding their concerns on water temperature.

The net effect of hydro development in the Columbia and Snake hydrosystem was described by EPA. In October 2000, the states of Oregon, Washington and Idaho signed a Memorandum of Understanding with the U.S. Environmental Protection Agency Region 10 that established EPA as the lead agency for the development of a Columbia/Snake TMDL. TMDL development is usually a state responsibility, but considering the interstate and international nature of the waters, EPA's technical expertise in the modeling effort, and EPA's Tribal Trust responsibilities, EPA agreed to take responsibility for the technical development of this TMDL.

EPA conducted a series of modeling exercises (Yearsley, 2003) designed to develop the TMDL. In the analysis the impact of the presence of each dam was assessed, relative to the background that would naturally occur. These modeling exercises also assessed the relative importance of point source pollutants and tributary inputs. The modeling exercises discounted point source pollutants as having any effect on mainstem water temperatures, and identified only the major tributaries as having any impact on mainstem temperatures. Only the Spokane, Snake and Willamette rivers were deemed large enough to potentially alter the temperature of the Columbia River by a measurable amount (0.14°C). And, only the Salmon, Grande Ronde and Clearwater rivers are large enough to potentially alter the temperature of the Snake River by a measurable amount (0.14°C). The modeling exercises also identified the impacts on temperatures of each hydroproject and the maximum impact ranges from negligible to large, depending on the dam. Based on the modeling, the impact of Grand Coulee alone could be as great as 6.23°C, and the Snake River dams collectively can have a maximum impact as large as 6.8°C (EPA, 2003).

Based on the estimated impact that the Lower Snake River impoundments alone could collectively contribute to an increase in river temperature that could exceed 6°F (EPA 2003), it was expected that this could be demonstrated with actual data. To determine if there was an observable trend in temperature pre- and post-Snake River impoundment we compared the maximum scroll case temperature at Bonneville Dam (BON) for the period 1950 to 2015. It can be noted that there was an increase in temperature that began around 1977, which coincided with the completion of the four Snake River dams (Figure 1).

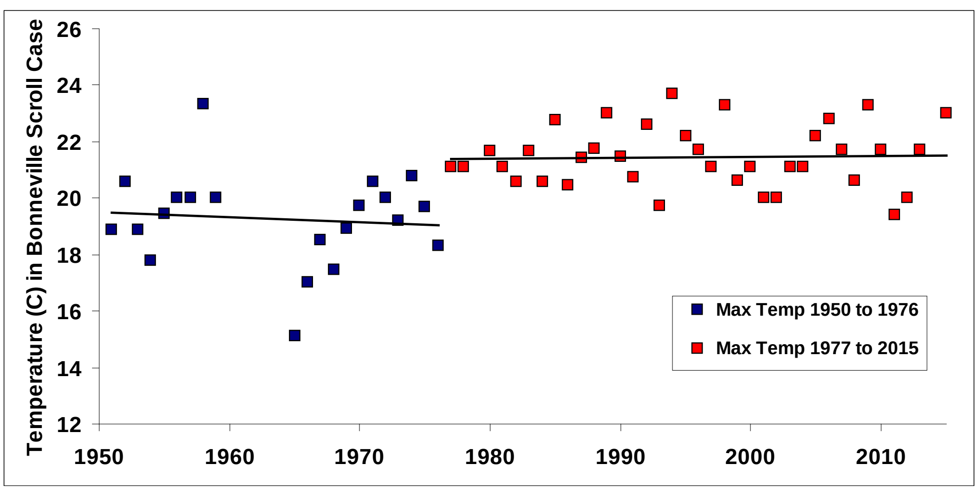

Figure 1. Maximum scroll case temperatures at Bonneville Dam in June and July for the years 1950 to 2015, with a break point at 1977 showing increased temperature coincident with the completion of the four Lower Snake River dams. Data source: Columbia River DART.

With the development of the call for the WQP in the 2000 BiOp (NMFS, 2000), a concurrent process was set to address both temperature and total dissolved gas. With time, the two processes merged and the Temperature TMDL process was no longer pursued in favor of the water quality approach outlined in BiOp. The 2003 Preliminary Draft TMDL (EPA, 2003) was never finalized and a maximum load allocation was never established for temperature.

Between the 2000 BiOp and 2004 BiOp, a Water Quality Team was established consisting of senior policy analysts supported by technical staff from the federal and state agencies, the tribal governments, and non-federal entities. The Water Quality Team developed the first WQP to incorporate the traditional TMDL development and implementation process with the new effort to improve water quality standards on the mainstem Columbia River.

Although initially supportive of developing the TMDL and also addressing adult ladder temperatures, the COE moderated their stance regarding the role of the hydrosystem in temperature occurrences above the States' criteria, or the 20°C (68°F) salmon reference temperature. The COE's official position (NMFS, 2004) was included as an appendix to the WQP that was part of the proposed Actions of the 2004 BiOp remand. The COE's position asserted that high mainstem temperatures occurred both pre- and post-impoundment and that, while the hydrosystem development and operation bore some responsibility for increasing mainstem water temperatures, they also wanted to recognize upstream influences (including the construction and operation of upstream dams, point source returns, agriculture practices, forestry practices and urban development) as well as climate change.

Despite continued development of WQPs over the years, the BiOp process has fallen short of ever really making an impact on water temperature beyond the actions initially identified in the 1990s. WQPs were developed in 2003, 2004, 2006, 2009 and 2014. The 2009 WQP included over thirty measures that could be considered to address temperature and identified issues, feasibility and timelines for implementation. By the 2014 WQP most actions were dropped and the WQP included only four actions for addressing temperature: Dworshak cool water releases; temperature modeling; temperature monitoring; and studies to identify thermal refugia. A more complete chronology of the process associated with temperature is included in Appendix A.

Recent Research Findings, Water Temperature and Effects on Adult Salmon

The 1995 BiOp included a river temperature upper limit of 20°C (68°F) (NMFS, 1995). This limit was set as the lethal limit for adult salmonids in the Columbia Basin. Temperatures have risen above this limit on many occasions since then, and negative impacts of high temperature on sockeye have been observed both above and below the BiOp standard.

Adult Sockeye Water Temperature Tolerances

The effects of high temperature on adult sockeye migration most obviously include direct mortality and migration delay, but can also include the depletion of energy resources for spawning (through delay and increased respiration), reduced gamete viability, and increased rates of disease (McCullough et al., 2001). Local adaptation for various source populations has created wide variations in thermal limits. Fraser River sockeye populations encounter river temperatures from 9°C (48°F) to 22°C (72°F), depending on the timing of migration (Eliason et al., 2011). Weaver Creek sockeye, a population that migrates in the cooler fall temperatures, has an optimal migration temperature of 14.5°C (58°F) (Eliason et al., 2011), with a significant decrease in survival at temperatures above 18°C (64°F) and no successful migrations at temperatures above 20.4°C (69°F) (Farrell et al., 2008). In contrast, summer migrating populations in the Fraser River have an optimal migration temperature of 17.2°C (63°F) (Eliason et al., 2011) with a 20% reduction in swimming ability at temperatures over 21°C (70°F) (McCullough et al., 2001).

Observations of thermal limits for sockeye are often observations of migration behavior at dams. In the Okanogan River, migration past the Zosel Dam stopped when temperatures were above 21.1°C (70°F) (Major and Mighell, 1967) or above 23°C (73°F) (Johnson et al., 2007). Migration appears to resume when temperatures decrease. High temperatures can also cause mortality in addition to a pause in migration. Weaver Creek sockeye (Fraser River) had reduced survival of 50% after being held in tanks at 18°C (64°F) when compared to 10°C (50°F) (Crossin et al., 2008). In the Columbia River, reduced survival was observed at temperatures exceeding 20°C (68°F) (Naughton et al., 2005). Crozier et al. (2014) observed reduced sockeye survivals at temperatures above 18°C (64°F), and Keefer et al. (2008) observed 100% mortality at 22°C (72°F).

Rather than observations of the effects of peak temperatures, a cumulative measure of thermal exposure may be the most appropriate measure of the effects of high water temperatures on sockeye migration and survival. From 2008 through 2013, Crozier et al. (2014) found that the cumulative thermal exposure can have more effect on adult survival than single point estimates of temperature through the migration period. However, uncertainty around thermal exposure measurements means the full impact is difficult to establish. Further studies with finer thermal resolution may clarify the impact of cumulative exposure to high temperatures rather than the peak temperatures experienced during migration.

Ladder Temperatures and Upstream Salmon Migration

Fish ladders often expose migrating adults to the highest temperatures and thermal stress encountered in the hydrosystem, due to warm surface water used for ladder flow (Keefer and Caudill, 2015). These high temperatures cause thermoregulatory behavior, such as exiting the ladder into the tailrace repeatedly. Additionally, ladders that use warm surface waters that flow into a cooler tailrace have a high thermal gradient, which also affects migration through the ladders. At temperature gradients of greater than 1^{o}C, Chinook and steelhead have a higher likelihood of entering the ladder multiple times followed by exits back into the tailrace (Caudill et al., 2013). This “in-and-out” movement in the ladder will significantly delay migration to spawning grounds, increase total thermal exposure, consume energetic resources, and decrease migration success (Caudill et al., 2013; Keefer and Caudill, 2015). The potential synergistic effects of high ladder temperatures combined with a high thermal gradient have not been studied.

2015 Flow and Water Temperature Data with Comparisons to Past Years

Biological Opinion Flow Targets in 2015

The 2015 water year produced the second lowest spring flows at both Lower Granite (LGR) and McNary (MCN) dams since the 1995 BiOp. The 2015 summer flows at LGR were the second lowest since 1995 and at MCN were the fifth lowest.

The spring low flow conditions at MCN were exacerbated by the need to draft Grand Coulee reservoir below its April 10^{th} BiOp elevation of 1,283 feet to 1,255 feet in order to conduct drum gate maintenance at the project. This caused spring inflow to be diverted to refilling an additional 30 feet, rather than passing inflows downstream to the lower river. BiOp spring flow objectives were not met at either LGR or MCN.

The BOP (Best Operational Point) summer flow objectives were also not met at either LGR or MCN. The 2015 flows are shown in comparison to the BiOp flow objectives in Figure 2. However, while summer average flow at MCN averaged only 142.6 Kcfs, it could have been much lower. The Columbia River Treaty between the United States and Canada provides for the proportional summer draft of Canadian Reservoirs during dry periods to maintain power reliability for customers in the United States. Treaty operations/flows into the U.S. are established based upon the Treaty Storage Regulation Study (TSR) as modified by any supplemental operating agreements in effect. In 2015, based on the TSR, over 5 million acre feet of water was released from Canadian reservoirs during the summer period aiding the low summer flows in the Columbia River.

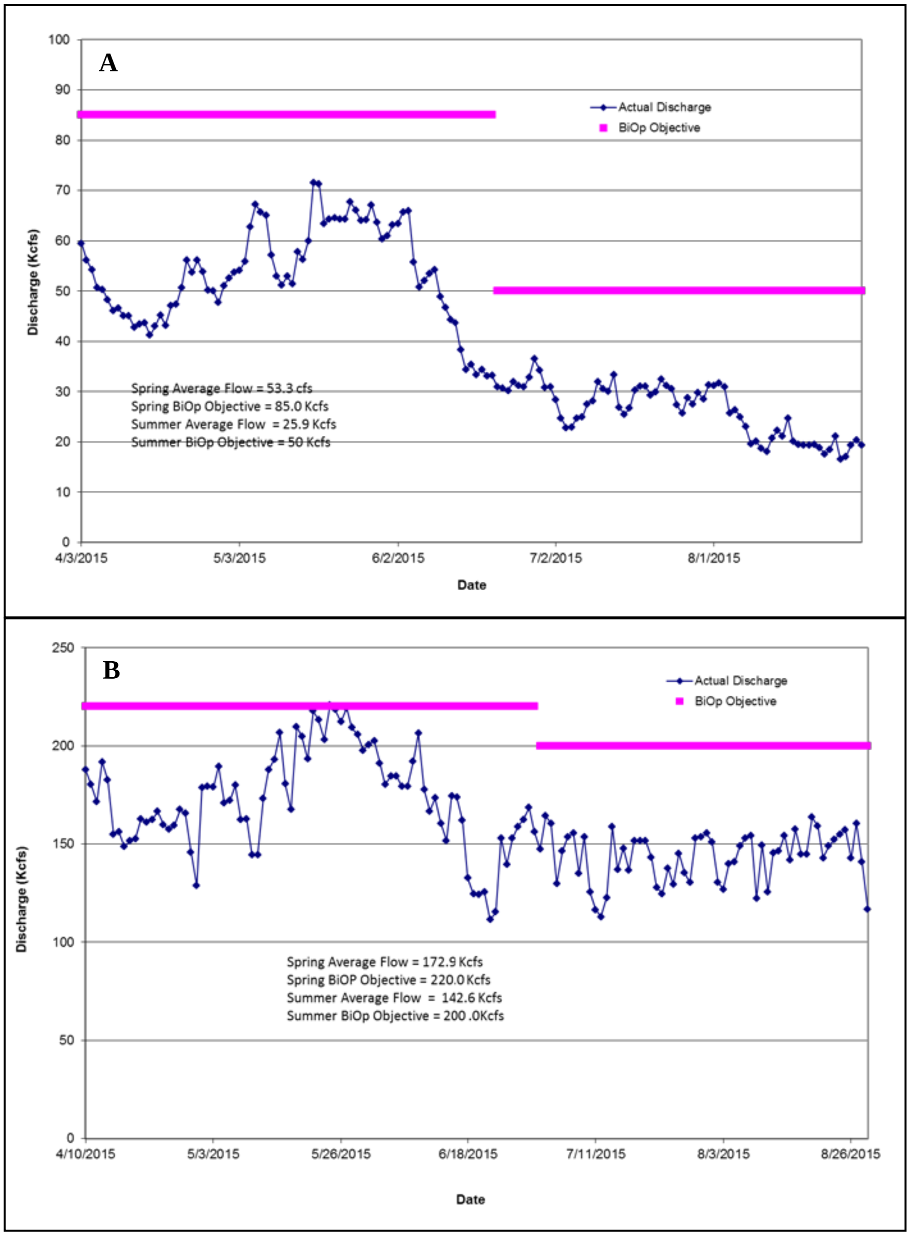

Figure 2. 2015 spring and summer flows at Lower Granite (A) and McNary (B) dams, in comparison to the 2014 Biological Opinion flow objectives.

2015 and Historical Water Temperatures

To put 2015 temperatures into context relative to the 20°C (68°F) water temperature criteria, temperature data from each of the eight FCRPS projects on the Middle Columbia and Snake rivers and the five Public Utility District (PUD) and two Bureau of Reclamation (BOR) projects on the Upper Columbia over the last eleven years (2005–2015) are presented below. The temperature data presented below are from the water quality monitors that are located both in the forebay and tailrace at each project, for the passage period of April 1st through August 31st. Below is a brief summary of the findings from this review.

In 2015, temperatures at Middle Columbia, Snake River, and Upper Columbia projects were higher, earlier in the season, than the previous ten years. Figures 3–5 are provided below to illustrate this pattern at three projects, one for each of the Middle Columbia, Snake, and Upper Columbia rivers (Appendix B provides figures for all projects reviewed).

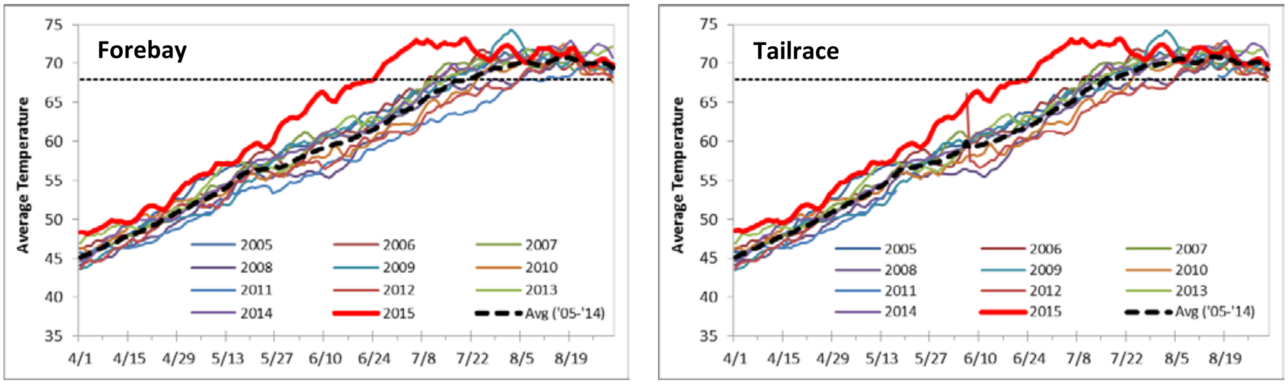

Figure 3. Daily average temperature (°F) at the Bonneville Dam water quality monitors in the forebay and tailrace (at Cascade Island) (B), April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

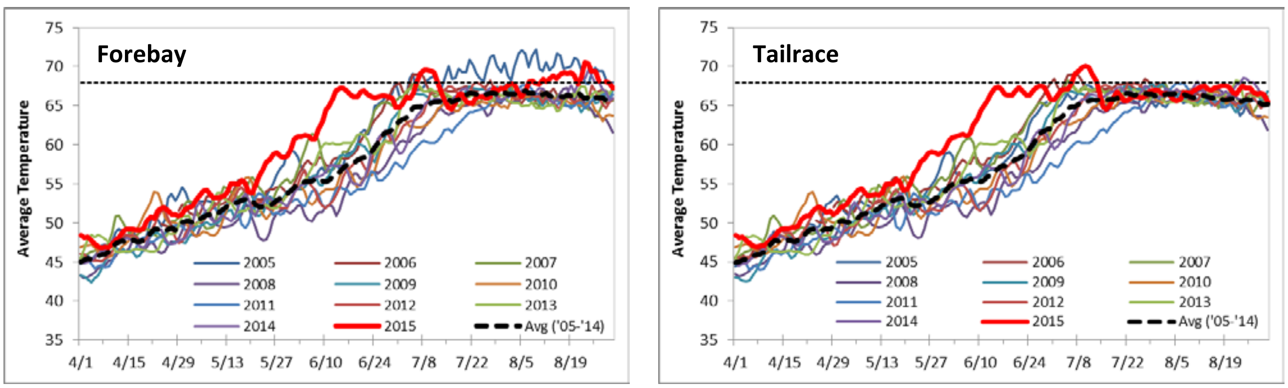

Figure 4. Daily average temperature (°F) at the Lower Granite Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

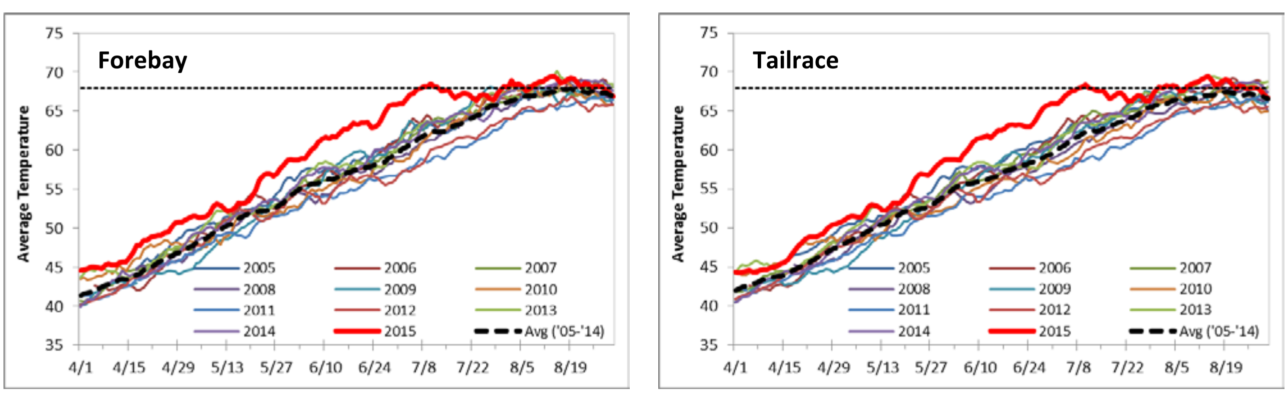

Figure 5. Daily average temperature (°F) at the Priest Rapids Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

In 2015 (April–August), temperatures exceeded the 20°C (68°F) standard at the Middle Columbia sites 43%–46% of the passage season (Tables B.1–B.4). While 2015 had the highest proportion of days exceeding the 20°C (68°F) standard, Middle Columbia sites commonly exceeded the 20°C (68°F) standard for 20%–30% of the passage season over the previous ten years (Figures B.1–B.4). These exceedances typically begin in mid-July or August whereas in 2015 exceedances began in late June.

In 2015 (April–August), temperatures exceeded the 20°C (68°F) standard 35%–45% of the season at Ice Harbor (IHR), Lower Monumental (LMN), and Little Goose (LGS) dams, but only 16% of the passage season in the forebay and 5% in the tailrace at Lower Granite Dam (LGR) (Tables B.5–B.8). The discrepancy in temperature standard exceedances between LGR and the other Snake River sites is due to the temperature augmentation water that is provided from Dworshak Reservoir (DWR). The effectiveness of temperature augmentation water from DWR is measured at the LGR tailrace. As with the Middle Columbia sites, it was common for LGS, LMN, and IHR to exceed the 20°C (68°F) standard for 20%–30% of the passage season (Figures B.5–B.7).

Overall, exceedances of the 20°C (68°F) standard in the Upper Columbia were much less common than what was observed at the Middle Columbia and Snake river sites (Tables B.9–B.15, Figures B.9–B.15). However, 2015 had the highest proportion of days exceeding 20°C (68°F) at many of the Upper Columbia sites, when compared to the previous ten years. In fact, at Priest Rapids (PRD) and Wanapum (WAN) dams, approximately 10%–20% of the days in 2015 exceeded the 20°C (68°F) standard.

Documentation of Historical Water Temperature Problems in the FCRPS Affecting Fish Passage

Historically, elevated temperatures in adult ladders have been documented as a significant issue for adult migration success. The 1992 Northwest Power Planning Council (NPPC) Strategy for Salmon (NPPC, 1992), Adult Salmon Measures #7 states:

> *Evaluate potential methods for decreasing water temperature in mainstem fish ladders and apply where appropriate.*

The 1994 and 1995 FCRPS BiOps that cover the 1994–1998 period recognized and included several references pertaining to high temperatures in the adult ladders. The following paragraph from these opinions (NMFS, 1994: pages 35, 37, and 39; NMFS, 1995: pages 54, 55, and 56) state:

> *High adult fish ladder temperatures at the Snake River projects during low water conditions may cause increases in adult salmon mortality. Reductions in ladder water temperatures as a result of ladder improvements are projected to begin in 1998. However, because no specific ladder modifications have been proposed, it is not possible to quantify the benefit to adult salmon passage.*

Furthermore, in Section IX (Conservation Recommendations) of the 1994 BiOp (NMFS 1994, pg. 76), NOAA directs the COE to address high water temperatures in adult fishways on an expedited basis with the following:

> *The COEs should develop and evaluate potential modifications for decreasing summer water temperatures in main stem Snake River project fish ladders. Effective modifications should be implemented on an expedited basis. This recommendation coincides with measures identified in NPPC Strategy for Salmon.*

Appendix A provides extensive detail regarding the transition from specific ladder water temperature criteria to an overall water quality/water temperature approach undertaken by the federal agencies.

More recently, in 2011, the COE issued a report (USACE, 2011) that outlines several alternatives to aid in reducing ladder temperatures at LGR. However, no action was taken to address the elevated ladder temperature at LGR until summer 2013 when adult passage at LGR was impeded by excessive temperatures in the ladder. The upper fishway at LGR reported water temperatures between 22°C (72°F) and 24°C (76°F), while the tailrace at the dam was reporting temperatures below 20°C (68ºF). The thermal gradient within the ladder restricted adult passage for all species. Of particular importance were the very low daily passage numbers for sockeye and the discrepancy between the counts of sockeye reported at LGS as compared to those reported at LGR.

In response to these concerns, three TMT calls were initiated between July 22, 2013, and July 24, 2013. After the initial call on July 22nd, the Action Agencies implemented an operation that prioritized Unit #1, effectively moving more water through the powerhouse and less water over the spillway, with all spilled water moving over the Removable Spillway Weir (RSW). Adult fish counts did not show a response to this operation.

On July 23, 2013, FPAC submitted SOR 2013-4 which asked the Action Agencies to immediately take actions that may increase adult passage and decrease the water temperature in the adult ladder. The proposed actions included: (1) cycling the navigation locks, (2) reducing the contribution of warm water from Diffuser #14, (3) utilizing additional pumps to provide cooler water to the ladder, (4) extending the intake to Diffuser #14 to draw cooler water to the ladder, and (5) modifying operations to facilitate adult passage during daytime hours and to provide juvenile protections during nighttime hours. These alternatives were consistent with the 1994 and 1995 BiOp Conservation Recommendations (NMFS, 1994; NMFS, 1995). In response, the COE agreed to implement the modified project operations outlined in the last bullet of SOR 2014-4 for a period of two days. The COE also agreed to investigate upper ladder options that would potentially aid in the reduction of warmest water contributions to the ladder. Subsequently, the COE utilized the emergency pumping system to draw cooler water from deeper in the forebay in an effort to reduce the temperature gradient in the ladder. Adults passing through the ladder did respond to the initiation of the emergency pumps.

A change to the Fish Passage Plan (FPP) was submitted by NOAA Fisheries in 2014 concerning temperatures and adult delay at LGR. This change form was not approved. However, in early August 2014, a combination of emergency pumps and rental pumps were utilized at LGR to facilitate the operation of the adult trap.

In 2015, sockeye passage throughout the Columbia and Snake rivers was impaired by high water temperatures and the only site with alternatives to address these high temperatures was LGR. Therefore, measures to address water temperature concerns and adult passage were primarily focused on LGR. Later, operations at LGS were modified to attempt to address adult passage delay. A full discussion on the actions considered at LGR and LGS to address elevated temperatures and adult passage issues at LGR and adult passage issues at LGS in 2015 are provided in Appendix C.

Analyses of 2015 PIT-tag Adult Sockeye Passage, Travel time, and Survival with Comparisons to Past Years

Methods

Currently, the COE collects ladder water temperatures at all FCRPS projects. However, there is no publically available database of these ladder water temperatures. Although requested, historical ladder temperatures were not provided for all projects and all years. In order to conduct the analyses of sockeye adult survival and effects of temperature, the relationship between forebay temperature and ladder temperature was investigated using the limited ladder temperature datasets we were able to obtain. Ladder temperatures were highly correlated with forebay temperatures (Figure 6). Therefore, forebay temperatures were utilized for these analyses. However, the use of forebay temperatures does not address high temperature spikes that were observed in the limited ladder temperature data provided by the COE, which would affect adult passage.

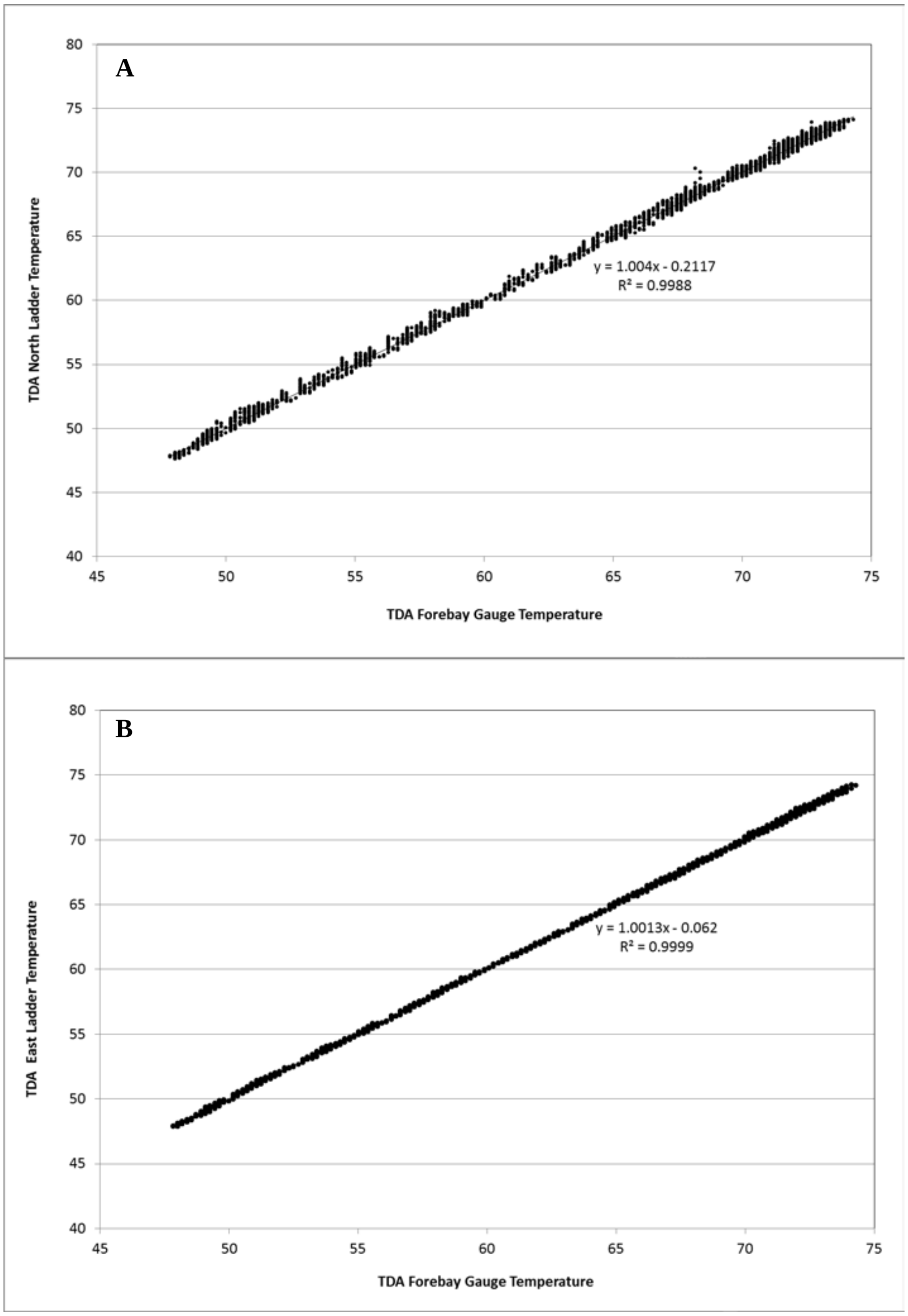

Figure 6. Relationship between forebay temperature and ladder temperatures in the North (A) and East (B) ladders at The Dalles Dam, 2015.

In this section, summaries of survival, migration and ladder travel times based on returning adult sockeye PIT-tagged as juvenile are presented. PIT-tag data from adults tagged at the BON adult fish facility are not included because summaries rely on previous juvenile migration history and ESU-origin which can only be determined from individuals PIT-tagged as juveniles.

Snake River Sockeye Adult Survival Estimates

Cormack-Jolly-Seber (CJS) estimates of adult survival from PIT-tagged sockeye are available starting in 2009. Prior to 2015, Snake River origin adult survival estimates from BON-LGR ranged from 0.44 (95% CI: 0.36–0.51) in 2013 to 0.77 (0.64–0.91) in 2010 (Table 1). In 2015, BON-LGR survival was 0.04 (0.02–0.05). Most of these returning adults never made it to MCN. In 2015, BON-MCN survival was 0.15 (0.12–0.18) and MCN-LGR survival was 0.25 (0.15–0.33). When standardizing for distance (i.e., survival per 100 river miles), the survival rate was nearly the same in the BON-MCN and MCN-LGR reaches, at 0.27 (0.23–0.31) and 0.24 (0.14–0.32), respectively.

Adult sockeye survival estimates above LGR are available only back to 2009. From 2009 to 2014, these estimates ranged from 0.32 (0.22–0.43) in 2013 to 0.77 (0.60–0.89) in 2010. In 2015, adult survival above LGR was 0.26 (0.06–0.46). The wider confidence interval for this estimate is due to very few PIT-tagged individuals (seven total) detected in the Sawtooth Valley in 2015. This resulted in an overall survival of 0.01 (0.00–0.02) from Bonneville Dam to the Sawtooth Valley in 2015. This extremely low estimate is also reflected by the extremely low returns of sockeye adults to the Sawtooth Valley (45 total PIT-tagged and non-PIT-tagged) (http://fishandgame.idaho.gov/public/fish/?getPage=29).

Table 1. Reach survival estimates with 95% confidence intervals in parenthesis of returning PIT-tagged Snake River sockeye salmon.

	Bonneville to McNary Dam	McNary to Lower Granite Dam	Lower Granite to Sawtooth Valley†	Bonneville to Lower Granite Dam	Bonneville Dam to Sawtooth Valley†
2009	0.74 (0.53-0.88)	1.00 (1.00-1.00)	0.65 (0.40-0.83)	0.74 (0.56-0.92)	0.48 (0.27-0.68)
2010	0.85 (0.70-0.93)	0.91 (0.80-1.02)	0.77 (0.60-0.89)	0.77 (0.64-0.91)	0.60 (0.44-0.76)
2011	0.67 (0.63-0.71)	0.97 (0.95-0.99)	0.74 (0.69-0.79)	0.65 (0.61-0.70)	0.48 (0.44-0.53)
2012	0.58 (0.49-0.67)	0.91 (0.83-0.99)	0.60 (0.48-0.72)	0.53 (0.44-0.62)	0.32 (0.24-0.40)
2013	0.68 (0.62-0.74)	0.65 (0.56-0.74)	0.32 (0.22-0.43)	0.44 (0.36-0.51)	0.14 (0.09-0.19)
2014	0.64 (0.59-0.69)	0.89 (0.85-0.93)	0.60 (0.53-0.68)	0.57 (0.51-0.62)	0.34 (0.29-0.39)
2015	0.15 (0.12-0.18)	0.27 (0.18-0.35)	0.29 (0.07-0.51)	0.04 (0.02-0.05)	0.01 (0.00-0.02)

† Survival estimates to Sawtooth Valley are based on detections of PIT-tagged sockeye adults in the Sawtooth Valley and does not include individuals that were collected for broodstock at LGR.

In recent adult return years (2013–2015), a seasonal survival effect has been evident, wherein the later arriving cohorts of the run survive much worse than those arriving earlier (Figure 7). This pattern was not evident from 2011–2012, and there were insufficient numbers of PIT-tagged returning adults to divide the run into quartiles in 2009 and 2010. In 2015, survival decreased from the first to third quartile of the run and remained flat thereafter, whereas in 2013 and 2014 there was no distinguishable trend in survival during the first three quartiles of the run followed by decline in survival in the fourth quartile of the run.

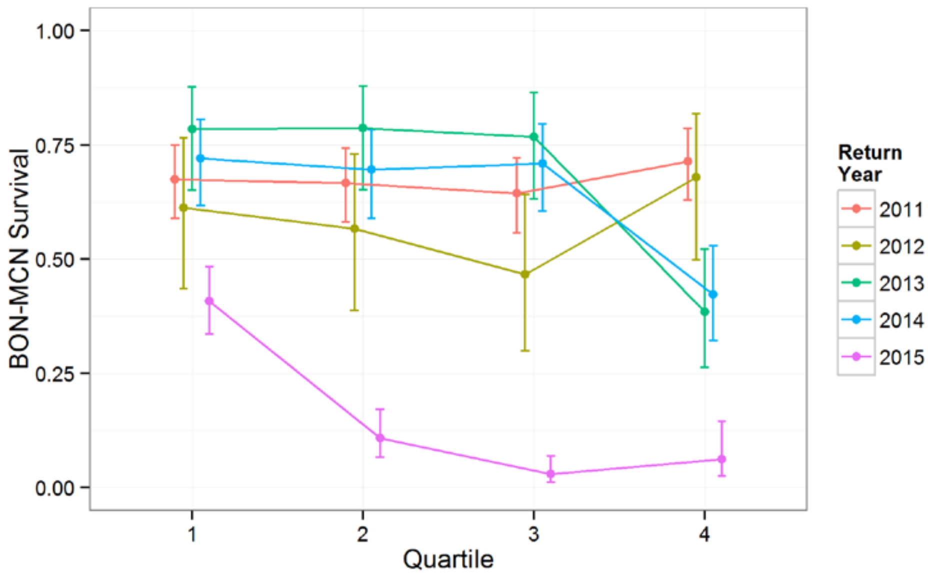

Figure 7. Survival from Bonneville to McNary Dam by run grouping determined by quartiles (i.e., first 25% of the run (1), 26%–50% of the run (2), etc.).

As documented in other studies (Keefer et al., 2008; Crozier et al., 2014), Snake River sockeye adults that were transported as juveniles did not survive as well, when compared to juveniles that migrated in-river (Figure 8). Return year 2011 was the one exception to this pattern, as differences in survival for transported and non-transported groups were indistinguishable in this year. As evidenced by non-overlapping confidence intervals, Snake River sockeye transported as juveniles had significantly lower survival than the non-transported groups in the BON-MCN reach in 2013, 2014 and 2015. This effect was also observed in the MCN-LGR reach in 2013 and 2015. Survival from MCN-LGR for sockeye that were transported as juveniles was 0.00 in 2015. This is based on the fact that eighteen sockeye adults that were transported as juveniles were detected at MCN in 2015 and none of these adults were detected at LGR. However, generating this survival estimate was still possible by assuming that non-transported and transported individuals have the same detection probability at and above Lower Granite Dam. There were insufficient numbers of PIT-tagged returning adult sockeye to estimate survival by juvenile migration history before 2011.

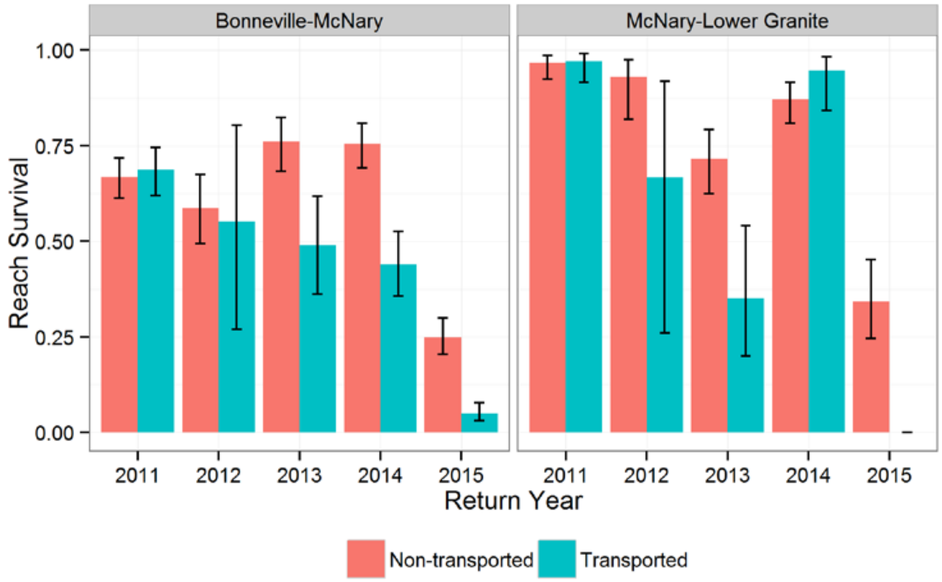

Figure 8. Snake River sockeye adult survival (95% confidence interval), from Bonneville to McNary, and McNary to Lower Granite Dam by return year and migration history.

Upper Columbia Sockeye Adult Survival Estimates

Adult sockeye survival in 2015 for Upper Columbia origin fish was also the smallest on record since 2009 (Table 2). Survival from BON-MCN was 0.61 (0.56–0.66) in 2015, where previous estimates ranged from 0.69 (0.65–0.72) in 2011 to 0.87 (0.83–0.91) in 2014. Survival from McNary to Rock Island Dam (RIS) in 2015 was 0.76 (0.71–0.81, which was also the lowest among the years analyzed.

Table 2. Reach survival estimates with 95% confidence intervals in parenthesis of returning PIT-tagged Upper Columbia sockeye salmon.

	Bonneville to McNary Dam	McNary to Rock Island Dam	Bonneville to Rock Island Dam
2009	0.80 (0.75-0.84)	0.94 (0.91-0.98)	0.75 (0.71-0.80)
2010	0.82 (0.79-0.84)	0.95 (0.93-0.96)	0.77 (0.75-0.80)
2011	0.69 (0.65-0.72)	0.86 (0.83-0.90)	0.59 (0.55-0.63)
2012	0.72 (0.68-0.75)	0.93 (0.91-0.96)	0.67 (0.63-0.71)
2013	0.79 (0.72-0.85)	0.89 (0.83-0.94)	0.70 (0.63-0.77)
2014	0.87 (0.83-0.91)	0.91 (0.86-0.96)	0.80 (0.74-0.85)
2015	0.61 (0.56-0.66)	0.76 (0.71-0.81)	0.46 (0.41-0.51)

A seasonal variation pattern in adult survival for Upper Columbia sockeye was evident in 2015, but this effect was not observed in previous return years (Figure 9). From 2011 to 2014, there was no distinguishable trend in adult survival from BON-MCN. In 2015, BON-MCN survivals steadily declined starting from the 2nd quartile of the run. There were insufficient numbers of PIT-tagged returning adults in 2009 and 2010 to divide the run into quartiles.

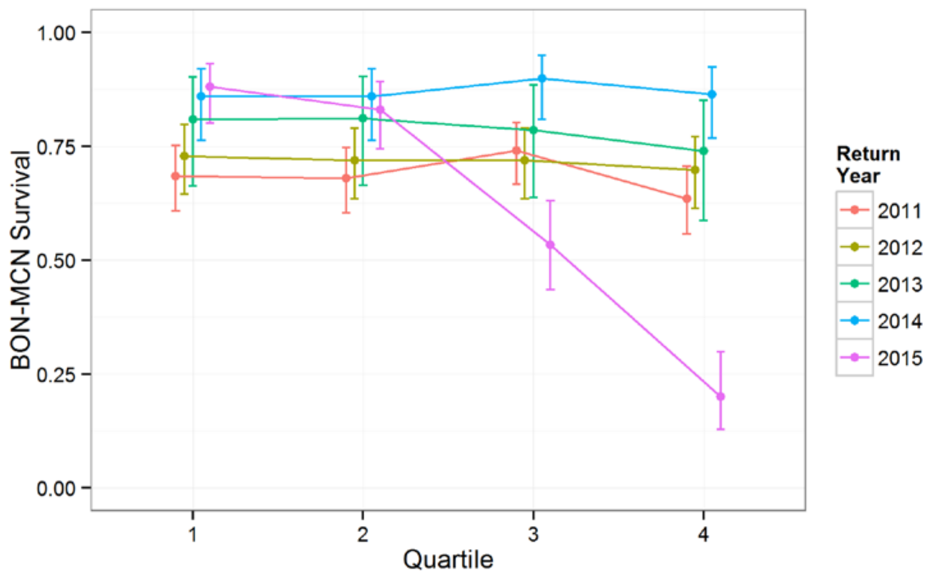

Figure 9. Survival from Bonneville to McNary Dam by run grouping determined by quartiles (i.e., first 25% of the run, 26%–50% of the run, etc.).

Snake River and Upper Columbia River Comparisons

In this section, summaries of timing, ladder delay and temperature are presented side-by-side for Snake River and Upper Columbia adult sockeye. These summaries are intended to help identify potential differences in survival for these two ESUs. It should be recognized, however, that there are many other important factors (see Crozier et al., 2014) that aren't considered here.

Arrival Timing

Snake River adult sockeye on average arrive at Bonneville Dam later than Upper Columbia sockeye (Figure 10). Among the years examined, the minimum difference in median arrival timing between Snake (both transported and non-transported) and Upper Columbia sockeye was three days in 2014. The maximum difference in median arrival timing was in 2012, where the median arrival dates for Snake River sockeye that were transported as juveniles versus migrated in-river were seven and 12 days later, respectively, than the median arrival date for Upper Columbia sockeye. In 2015, the median arrival dates for transported and non-transported Snake River sockeye were approximately 8 and 9 days later than that for Upper Columba Sockeye, respectively. Except for in 2012, there is no indication of a systematic difference in arrival timing between Snake River sockeye that were transported as juveniles versus those that migrated in-river. In all other return years, differences in median arrival timing for these two groups were within a day.

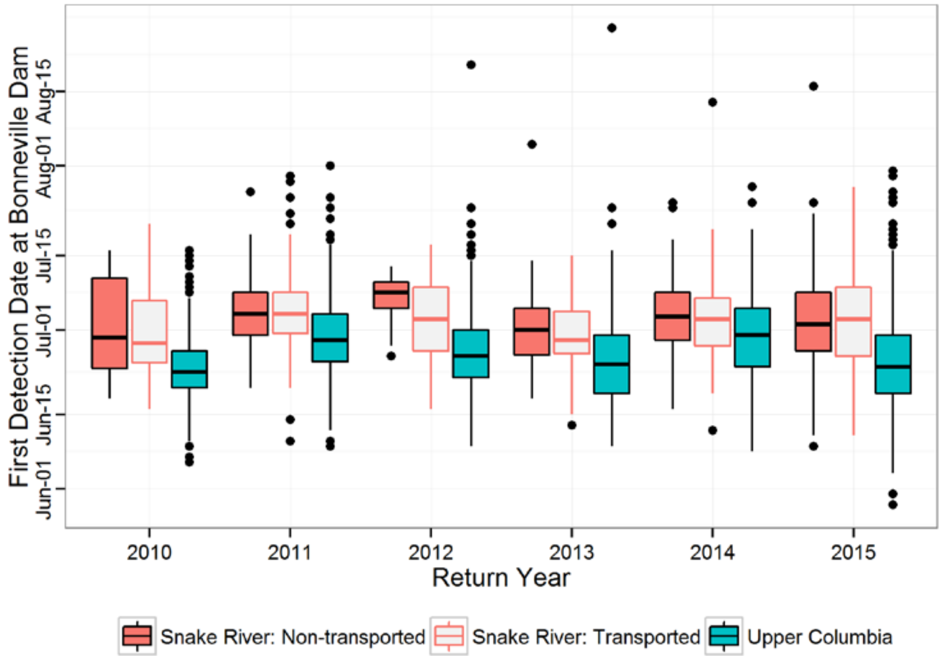

Figure 10. Boxplots of arrival timing at Bonneville Dam based first detection date for transported and non-transported Snake River and Upper Columbia sockeye adults.

Ladder Delay and Fallback

A comparison of adult fallback rates (i.e., re-ascensions through the ladder) at BON showed that Snake River sockeye fell back and re-ascended ladders at a higher rate than Upper Columbia sockeye during the same years (Figure 11). The differences in the percentage of adults that re-ascended between the Snake River and Upper Columbia stocks appeared mostly to do with the relatively high rate of re-detections of PIT-tagged Snake River sockeye adults that were transported as juvenile migrants. Fallback and re-ascension exposes fish to additional high temperatures in the ladders as well as increasing overall migration time.

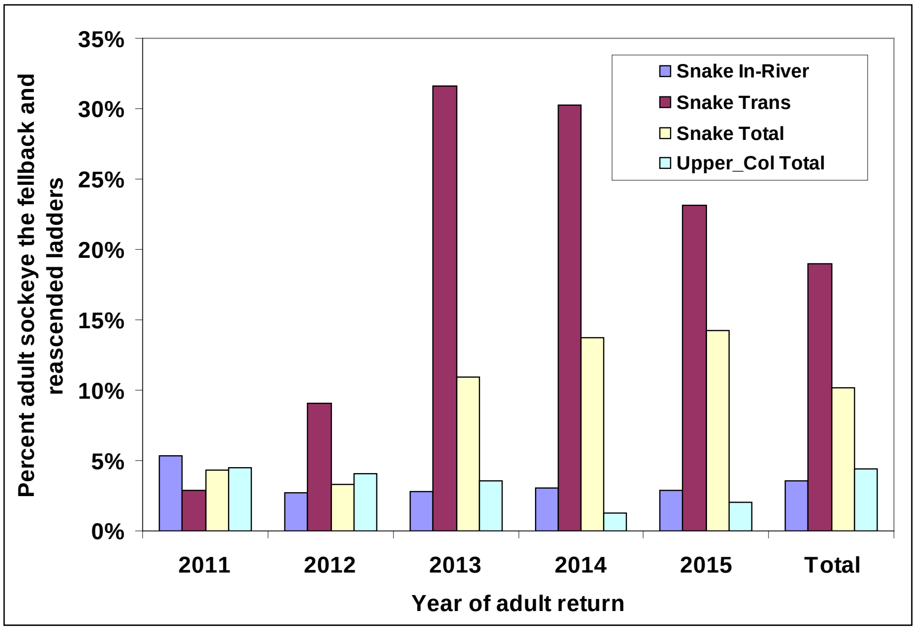

Figure 11. Adult sockeye fallback and re-ascension rates at Bonneville Dam in the years 2011 to 2015.

It appears that PIT-tagged Snake River origin sockeye adults took longer to pass through the ladders at BON than Upper Columbia River sockeye adults, when comparing the same ladders during the same year (Figure 12). Times represent that portion of the ladder between lower and upper PIT-tag coils and do not reflect total time spent in ladders. Increased travel time in ladders has been associated with large temperature differences between ladder entrance and ladder exit (Caudill et al., 2013). Longer ladder transit times result in longer exposure to high ladder temperatures.

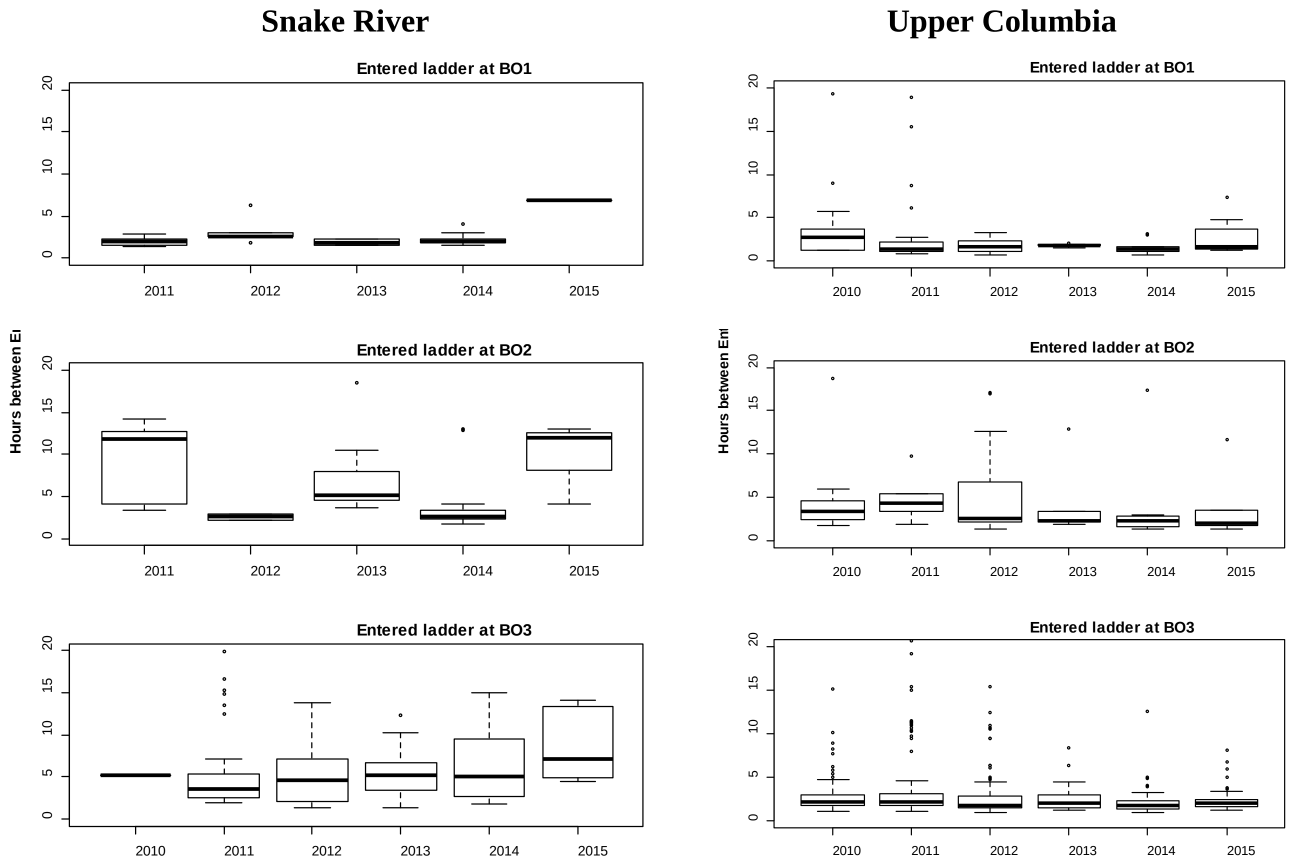

Figure 12. Box plots comparing relative time to pass through the adult ladders at Bonneville Dam for Snake River origin sockeye adults and Upper Columbia River sockeye adults. Passage times were restricted to those PIT-tagged adults that were detected at entrance coils and exit coils in the respective ladders.

Migration Temperatures

Since Snake River sockeye tend to arrive later than Upper Columbia sockeye, these fish should be exposed to higher temperatures at the start of their migration through Middle Columbia reservoirs, under the assumption that temperatures increase over the span of time when sockeye are present. This effect is shown in Figure 13, which displays BON forebay temperatures at the time an individual exited the BON adult ladder (i.e., last detection date). Return years 2014 and 2015 were the most extreme wherein the effect of entering BON reservoir later (characterized by the peak and right tail of the last detection date distribution) resulted in exposures near or above the 20°C (68°F) water temperature criteria.

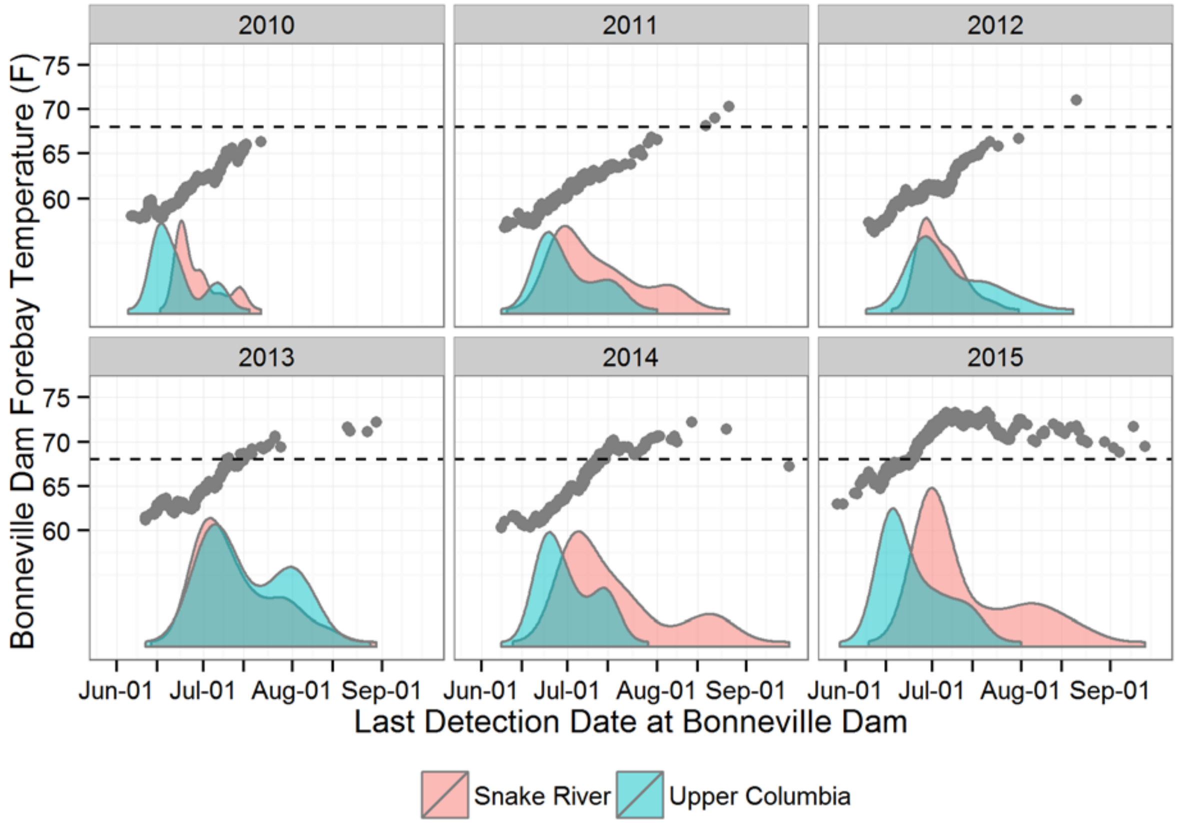

Figure 13. Observed Bonneville Dam forebay temperature upon Bonneville Dam ladder exit (i.e., last detect) (dots). Density plots of the distribution of exit dates for Snake and Upper Columbia River are shown below the scatterplot.

<u>Temperature Exposure</u>

Temperature exposure has been shown to be an important variable affecting adult sockeye survival (Crozier et al., 2014). Figure 14 shows boxplots of temperature exposure for Snake and Upper Columbia river stocks throughout the entire BON-MCN reach. Temperature exposure was calculated similarly as described in Crozier et al. (2014) by multiplying the reach travel time and the average of the downstream forebay and upstream tailrace temperature corresponding to the times forming the travel time estimate. Median temperature exposures were always higher in The Dalles Dam (TDA) to McNary Dam reaches from 2013–2015 for Snake compared to Upper Columbia river sockeye. Median temperature exposures from BON-MCN were also higher in return years 2013–2015 for Snake River sockeye compared to those from the Upper Columbia.

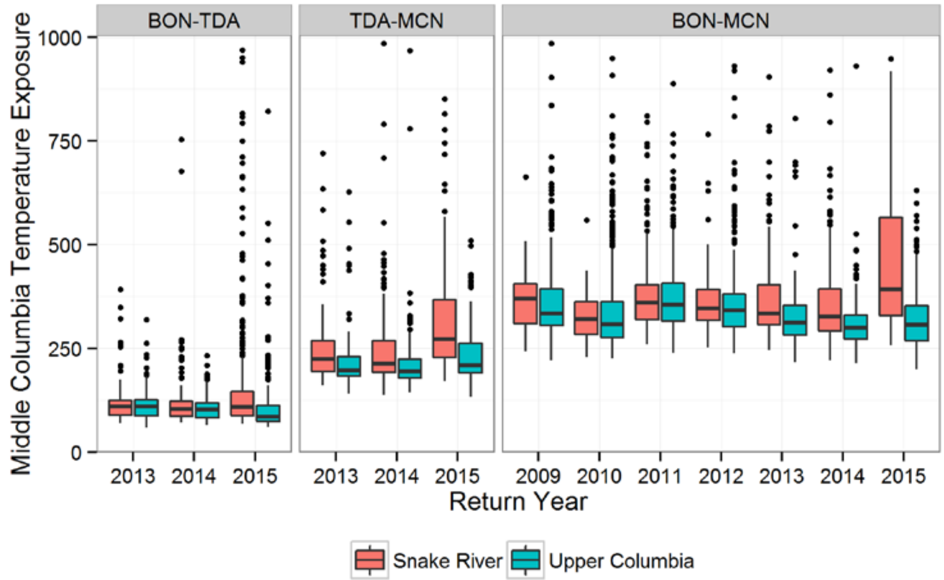

Figure 14. Temperature exposure from Bonneville to The Dalles, The Dalles to McNary, and Bonneville to McNary Dam by return year and origin. The y-axis was truncated at 1,000 for clarity.

Temperature and Survival Relationship

The relationship between temperature and BON-MCN survival for Upper Columbia and Snake River sockeye is shown in Figure 15. The temperature in the BON forebay associated with the last detection time at BON was used in order to examine this relationship. This temperature metric was chosen because it can be assigned to every PIT-tagged individual in this data set. The survival relationship was estimated from a CJS model with individual covariates. Return years 2014 and 2015 provided the greatest contrast between Snake River and Upper Columbia stocks (determined by visually examining non-overlapping confidence intervals). Upper Columbia sockeye survival did not change with increasing temperatures in 2014, whereas Snake River sockeye survival declined with increasing temperature. In the 2015 return year, both Snake River and Upper Columbia sockeye survival precipitately decreased with increasing BON forebay temperatures.

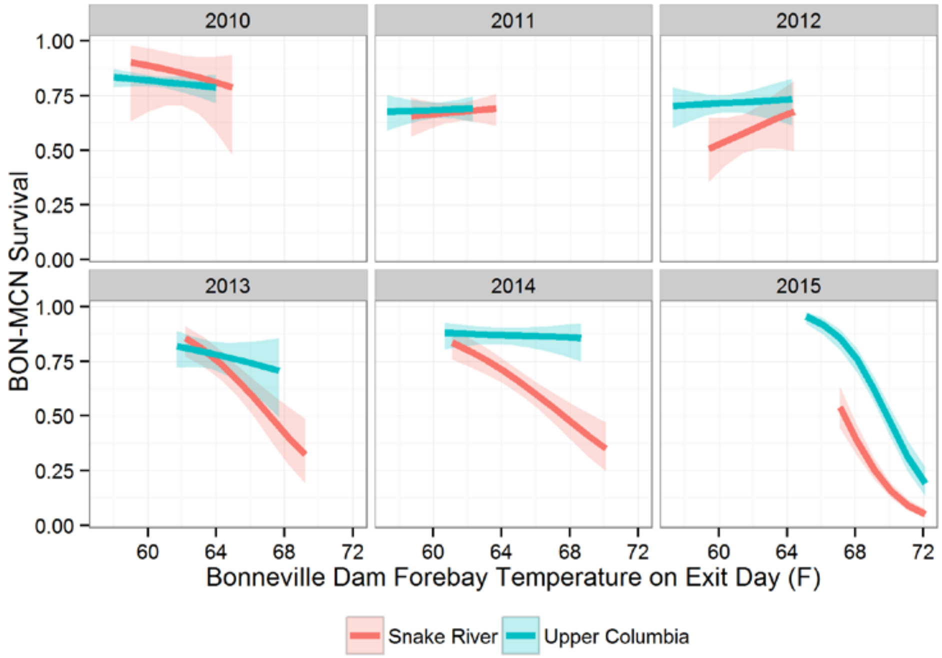

Figure 15. Estimated relationship between Bonneville Dam forebay temperature and Bonneville to McNary Dam survival by return year for Snake and Upper Columbia River adult sockeye. The shaded portion of the curves indicates 95% confidence intervals. All available data are used for the fitted relationship, but only the 2.5th to the 97.5th percentiles of observed temperatures in each return year are shown.

<u>Temperature and Migration Speed Relationship</u>

Previous analyses (Salinger and Anderson, 2006) showed that the swim speed of Chinook salmon increased with temperature below an optimal temperature, and decreased with temperature above the optimum. The relationship between temperature and migration speed for Snake River and Upper Columbia sockeye in 2015 is shown in Figure 16, where a quadratic relationship is fit to the observed MCN tailrace temperature (upon entrance) versus BON-MCN migration speed (miles per day). Only the 2015 return year was examined because this year provided the necessary contrast to examine a quadratic effect. With increasing temperatures beyond some optimum temperature, migration speeds decreased for both Snake River and Upper Columbia stocks. Furthermore, at similar temperatures, Snake River sockeye that were transported as smolts had a much lower migration speed than did non-transported individuals. This observation is consistent with previous observations showing that transported Snake River sockeye spend more time in the ladders than do non-transported Snake River sockeye and Upper Columbia sockeye.

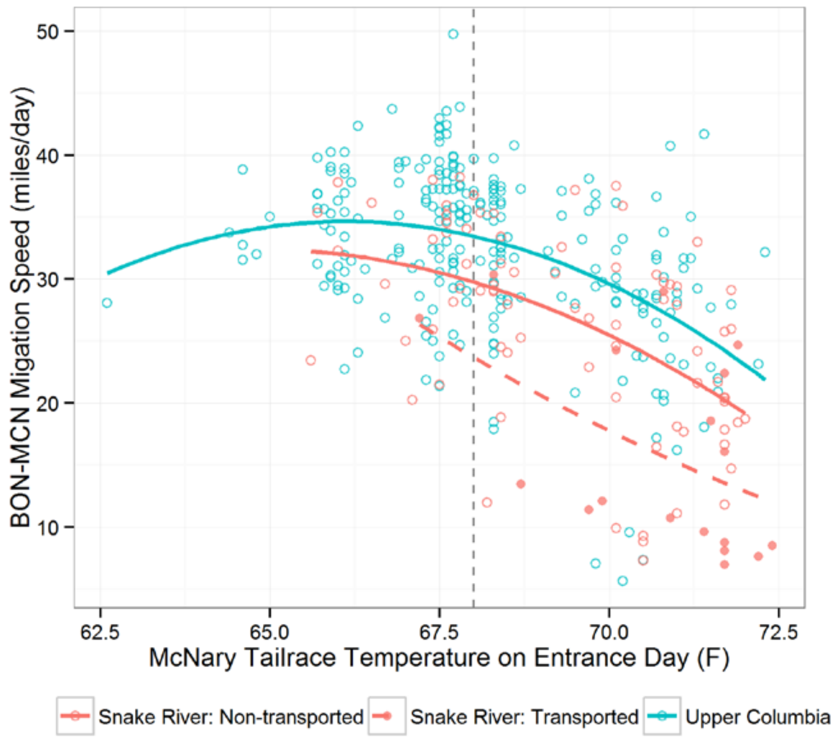

Figure 16. Estimated relationship between temperature and migration speed for PIT-tagged non-transported Snake River and Upper Columbia fish (solid lines and unfilled circles) and transported Snake River fish (dotted lines and filled circles) during the 2015 return year.

Weekly Comparisons

As presented above, Snake River sockeye adults that were transported as juveniles do not survive as well as those who were not transported as juveniles. In addition, Snake River sockeye tend to arrive later than Upper Columbia sockeye and are consequently exposed to higher temperatures. If transportation, later arrival, and exposure to higher temperatures are the primary mechanisms leading to reduced survival of Snake River adults compared to Upper Columbia River adults, then removing these effects should result in roughly equal survival for these two groups. In order to make this comparison, non-transported Snake River sockeye weekly and daily survival is compared to Upper Columbia sockeye survival. Temporal comparisons standardize for arrival effects and ensure that the two groups are exposed to the same environmental conditions upon arrival at BON.

Figure 17 shows weekly survival from BON-MCN of cohorts of 20 or more individuals exiting the BON adult ladder. Since not all return weeks have 20 or more individuals, a CJS model that used BON exit day as an individual covariate was also fit (Figure 18). This model assumes a linear relationship between the logit survival and BON exit day, whereas weekly survival estimates are allowed to vary freely. Results from these analyses indicate that accounting for smolt transportation and adult arrival timing at BON largely helps to explain much of the observed differences in BON-MCN adult survival between Snake and Upper

Columbia sockeye. However, there still may be other unexplained factors that contributed to the observed differences in survival between these two stocks, particularly in 2014 and 2015.

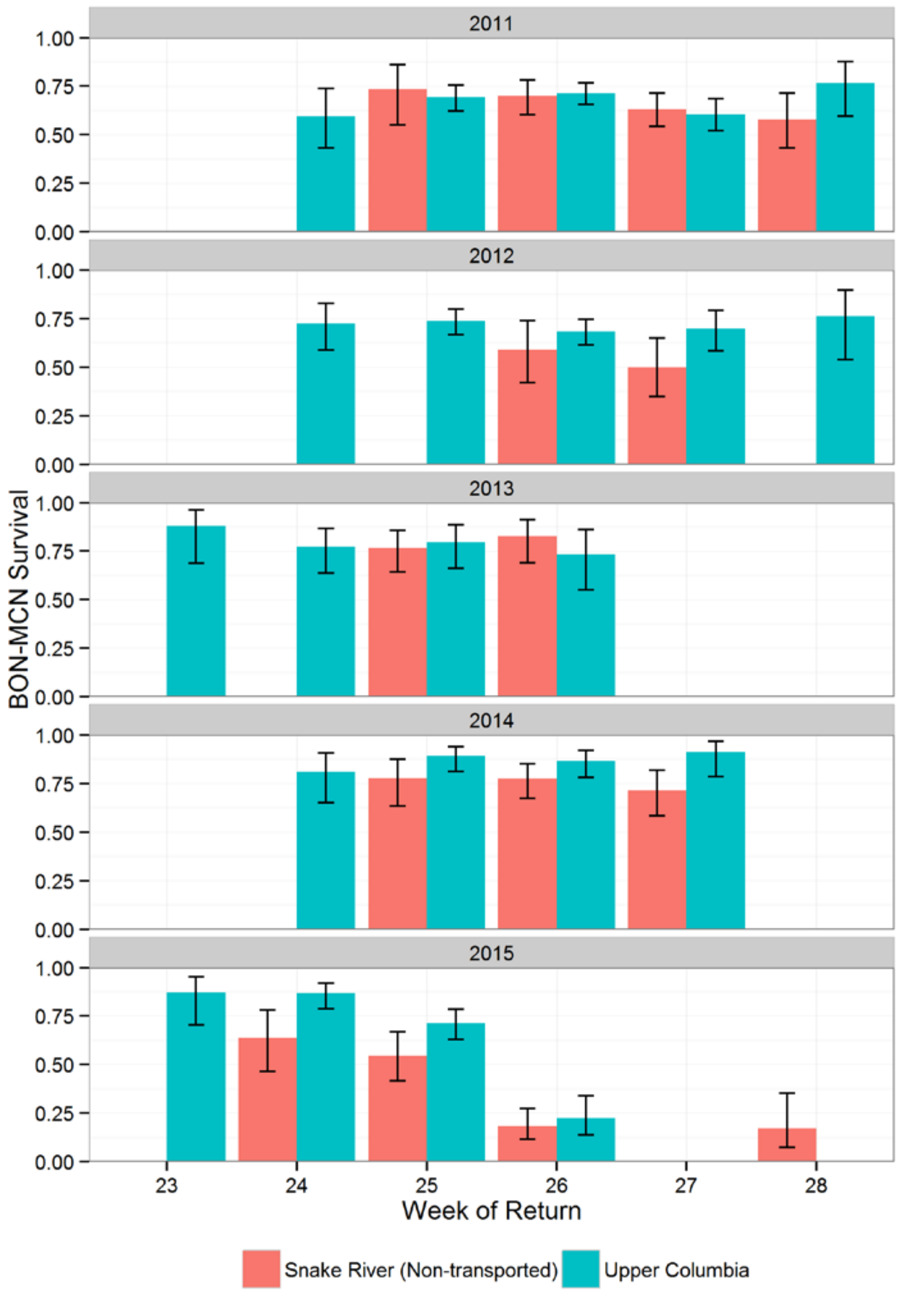

Figure 17. Survival (Bonneville to McNary) (95% confidence intervals) of non-transported Snake River and Upper Columbia sockeye adults by return week. Only return weeks with at least 20 individuals are displayed.

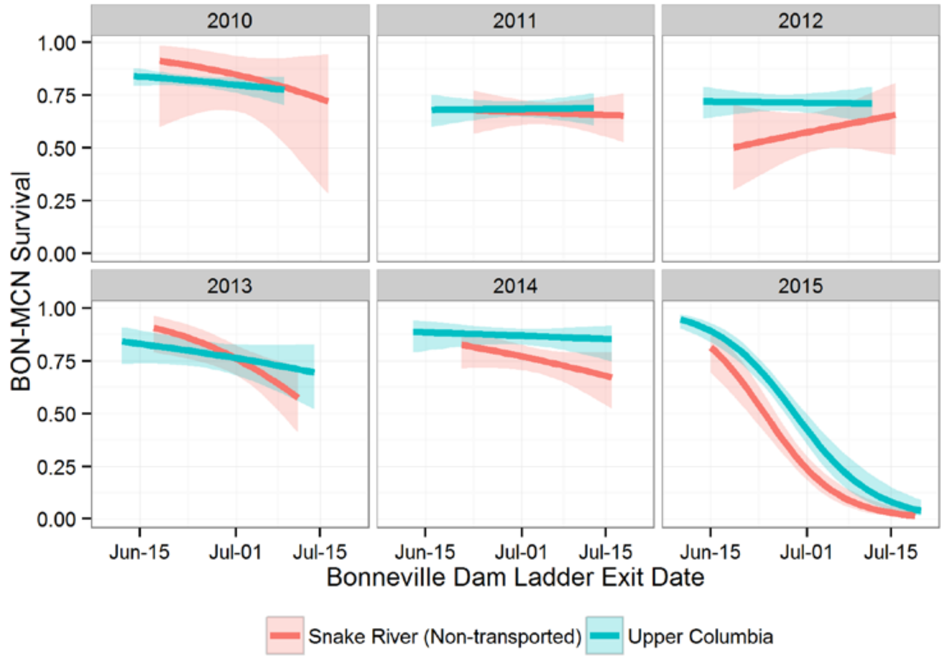

Figure 18. Estimated relationship between Bonneville Dam ladder exit date and Bonneville to McNary Dam survival by return year for non-transported Snake River and Upper Columbia adult sockeye. The shaded portion of the curves indicates 95% confidence intervals. All available data are used for the fitted relationship, but only the 2.5th to the 97.5th percentiles of exit dates in each return year are shown.

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Appendix A

The Historical Recognition of the Effect of FCRPS development and Operation on Water Temperatures

The issue of increased temperatures and the potential impacts to salmonid survival have long been recognized in the Columbia River hydrosystem. An early workshop occurred in 1963 recognizing the issues and the potential impacts that might occur from further hydrosystem expansion (Eldridge, 1963[1]). This review is intended to show the evolution of actions that were taken relative to temperature in the Snake and Columbia rivers under the implementation of the Clean Water Act (CWA) and the Endangered Species Act (ESA). The documents are voluminous and there are many. Consequently, some topics may have been overlooked. This appendix represents our best compilation of the various documents describing the process that occurred over the time span from the mid-1990s to the present.

1995–1999

In 1995, the National Marine Fisheries Service (NMFS) issued a Biological Opinion (BiOp) concluding that modifications to Federal Columbia River Power System (FCRPS) operations were needed to ensure long-term survival of salmon stocks in the Snake River that were protected by the ESA. The recommendations of the 1995 NMFS BiOp were adopted by the U. S. Army Corps of Engineers (COE) in a 1995 Record of Decision (ROD). In 1998, NMFS issued a supplemental BiOp for steelhead recommending further actions to the COE. The COE adopted these recommendations in a 1998 ROD. The 1998 ROD includes discussion of new information on continuing unresolved issues. They identify water quality standards with respect to total dissolved gas and temperature as one of these issues and, relative to temperature, offer: the prioritization of cool water releases from Dworshak for juveniles, the development of surface passage routes to decrease forebay delay, and to investigate adult ladder water temperature by collecting more information and evaluating engineering fixes. The COE states that they will coordinate with EPA regarding their concerns on water temperature.

In March of 1999, the National Wildlife Federation (NWF) filed a lawsuit with the district court contending that the COE's 1995 and 1998 RODs were arbitrary and capricious and contrary to law, since they did not address the COE's obligation to comply with state water quality requirements for temperature under the CWA. The plaintiffs contended that the documents failed to assure that the operation of the dams will comply with State water quality standards. The district court issued an opinion on February 16, 2001, stating that the COE had not addressed adequately in the 1995 and 1998 RODs the issue of the COE's obligation to comply with the CWA. The district court remanded the CWA issue to the COE for further consideration.

[1] Eldridge, Edward F., ed. Proceedings: Water temperature: influences, effects and control. US Dept. of Health, Education, and Welfare, Public Health Service, Pacific Northwest Water Laboratory, 1963.

In the late 1990s the EPA began studying the impacts of dams on the mainstem Snake and Columbia rivers temperature. They stated, "The presence of hydroelectric dams has modified natural temperature regimes in the mainstem Columbia River. Snake River basin reservoirs are known to affect water temperatures in the river (Yearsley 1999) by extending water residence times and by altering the heat exchange characteristics of affected river reaches."

2000–2004

2000 Biological Opinion

The 2000 BiOp recognized the effect of water quality, both total dissolved gas (TDG) and temperature, on federally listed anadromous fish. The BiOp lays out a path for the federal agencies (EPA, NMFS, USFWS, COE, BOR and BPA) to undertake efforts to address listed species under ESA, and create a tie to the water quality improvements under the CWA. Under the CWA, the Total Maximum Daily Loads (TMDLs) were being developed. The 2000 BiOp called for the development of a Water Quality Plan that incorporates the actions for achieving the standards outlined in the TMDL.

The 2000 BiOp states that:

> NMFS, in coordination with EPA, USFS, and the Action Agencies (the COE, BOR and BPA), has considered the respective ecological objectives of the ESA and the CWA. In many instances, actions implemented for the conservation of ESA listed species will also move toward attainment of water quality standards (e.g., reducing TDG and temperature). The overlap of statutory purpose is extensive; however, there are additional actions that are appropriate in a water quality plan, but are nonessential for the survival and recovery of the listed species. Thus, such actions are not required components of the ESA RPA. Further the water quality plan is likely to require lengthy study and implementation exceeding the duration of this biological opinion.

The 2000 BiOp calls for the federal agencies to address both TDG and water temperature. Most actions outlined to address TDG are not considered here. The following actions relate to the proposed actions for water temperature. The BiOp states that the federal agencies are committing to the establishment of a new Water Quality Team (senior policy level) and to the development of a Water Quality Plan (WQP) that is part of the annual planning process for the mainstem Columbia and Snake rivers. At the same time, it was recognized that the EPA and the states of ID, WA and OR, in coordination with the Columbia River tribes, are developing a Columbia and Snake river TMDL under court order. The water quality plan was to be integrated and consistent with TMDL limits and ongoing TMDL activities. The WQP was expected to include the following actions with respect to temperature:

- Make operational and capital investments;
- Reach consensus on offsite mitigation to attain water temp standards;
- Identify adequate physical and biological temperature monitoring;
- Implement and model to better assess and act on thermal problems;

- Develop emergency measures to address immediate and acute water temperature problems.

The WQP was also expected to consider specific reservoir operations for temperature regulation including Dworshak Reservoir cool water releases; Brownlee Reservoir cool water releases established through FERC relicensing; and McNary Dam operation and configuration to address thermal issues in the forebay and juvenile fish impacts. The WQP was also to address, among other things, improvements in long-term temperature monitoring and modeling, an evaluation of fish ladder temps, an evaluation of temperature effects on juvenile passage behavior and survival, and to identify adult passage losses

However, the 2000 BiOp specifically states that the development of neither a Draft TMDL, nor providing funding to develop tributary TMDLs, are included as 2000 BiOp Reasonable and Prudent Alternative (RPA) actions.

2001

In May of 2001, the COE issued the 2001 Record of Consultation and Statement of Decision (ROD). In the document the COE acknowledges that "the construction and existence of the dams may contribute to a shift in the temperature regime of the Snake River." The COE said it would take additional steps, consistent with the recommendations in the NMFS 2000 BiOp, to improve its operations for compliance with state water quality standards stating:

> The Corps has implemented several actions to help alleviate adverse water temperature conditions in the Columbia River Basin. Selective withdrawal systems to release water from one or more specific depths are present at Libby and Dworshak dams. Operation of Dworshak dam for flow augmentation for juvenile fish in the summer months has also aided in reducing water temperatures in the lower Snake River.

Other than the steps mentioned above, however, the COE said that it did not have reliable information that structural modification would reduce water temperature in the reservoirs or have a significant effect on temperature water quality standard exceedances. The COE concluded that the operation of the mainstem COE dams on the Snake and Columbia rivers has no significant impact on water temperatures.

The National Wildlife Federation (NWF) filed an amended complaint on August 24, 2001, challenging the 2001 ROD. In its amended complaint, the NWF contended that the 2001 ROD violated the Administrative Procedures Act since it failed to address adequately the issue of exceedances of state water temperature standards. The district court concluded that the 2001 ROD implemented "each of the specific operational actions prescribed in the NMFS 2000 BiOp intended to reduce water temperatures and that the 2001 ROD evaluated properly the COE's obligation to comply with state water quality standards as required by the CWA," and that "[t]here [was] no evidence in the record that the measures adopted in the [2001] ROD to reduce water temperatures in order to comply with the Endangered Species Act [were] not consistent with the COE's obligations under the Clean Water Act to mitigate temperature exceedances." The district court concluded that the 2001 ROD did not violate the Administrative Procedures Act. Both the NWF and the Nez Perce Tribe appealed the decision. The court however concluded that "the COE was not arbitrary and capricious and did not act contrary to law in concluding that there were no further steps it could take to reduce temperature exceedances in the lower Snake River."

2003 July Draft Temperature Total Maximum Daily Load

In October 2000, the States of Oregon, Washington and Idaho signed a Memorandum of Understanding with the U.S. Environmental Protection Agency-Region 10 (EPA) that established EPA as the lead agency for the development of a Columbia/Snake Mainstem Temperature TMDL. TMDL development is usually a state responsibility, but considering the interstate and international nature of the waters, EPA's technical expertise in the modeling effort, and EPA's Tribal Trust responsibilities, EPA agreed to take responsibility for the technical development of this TMDL. Once the EPA developed the TMDL, it was to be up to the states to develop a plan to implement the TMDL.

The EPA modeled the Columbia system using RBM10 (a peer reviewed, one dimensional energy budget model (Yearsley et al., 2001)) and assessed the impacts on natural water temperature (no human caused pollution or alterations) of point sources, tributary inputs and dams. They determined that:

1. The effect of existing point sources is very small and do not lead to water quality exceedances when averaged in with the total river flow;
2. Most of the tributaries have a negligible effect on the cross sectional average temperatures, with exception of the Spokane, Snake and Willamette, which are large enough to affect the temperature of the Columbia River and only the Grande Ronde, Salmon and Clearwater are large enough to potentially alter the Snake River. The magnitude of the effect is a function of temperature differential and flow volume.
3. Dams do have an effect on temperature in the mainstem. The maximum impact ranges from negligible to large, depending on the dam. Based on the modeling, the impact of Grand Coulee alone could be as great as 6.23°C, and the Snake River dams together can have a maximum impact as large as 6.8°C.

The TMDL was to provide a total increase within each reach within target sites to develop waste load allocations. However, the draft TMDL was never finalized and all activity on the TMDL ceased at this time. According to the WA Department of Ecology website (http://www.ecy.wa.gov/programs/wq/tmdl/TMDLsbyWria/tmdlColumbiaRvr.html), the status of the TMDL is **"Delayed to allow necessary discussions and information exchange."**

2004 Biological Opinion

The development of a WQP was initiated by the 2000 BiOp. Work on that Plan occurred between 2000 and 2004, when the Plan was incorporated into the 2004 BiOp as Appendix A.

The WQP addresses both total dissolved gas and temperature. The mainstem Snake and Columbia river water temperature was composed of five categories:

1. The background of water temperature issues in the Columbia and Snake rivers, the goal of the NMFS 2000 FCRPS BiOp and the TMDL process,
2. The monitoring of water temperature in the area covered by the plan,
3. A brief discussion addressing the RPAs in the BiOp that address water temperature and the long-term non BiOp (Clean Water Act) strategy to get temperature levels below 20°C.
4. A description of operational, structural and other changes that have been proposed that may have potential to lower water temperature levels or provide a better understanding of water temperature impacts to aquatic species.
5. A final summary and appendix.

The background section discusses the overlap of ESA and CWA and the responsibilities of the federal agencies. It also lays out the standards for temperatures for each of the states and the tribes. There is also a disclaimer from the COE stating that the historic temperatures exceeded 20°C (68°F) prior to the dams and hydropower can't be characterized as the only issue, citing climate change and upstream influences. A separate appendix (Appendix F) is also included in the BiOp that addresses the COE's perspective. The COE believes that water temperatures in the Snake and Columbia mainstem rivers are warmer today than they were historically. However, the Corps also believes that hydropower is not solely responsible for the change and implicates climate change and upstream influences for responsibility.

2005 to Present

2008 Biological Opinion

In the 2008 BiOp, the Action Agencies proposed to continue to operate the FCRPS to reduce water temperatures during periods of juvenile and adult fish migration, particularly in the lower Snake River, and to minimize the harmful effects of elevated levels of spill-generated TDG on anadromous and resident fish.

The BiOp continued the operation of Dworshak Dam to regulate outflow temperatures to attempt to maintain water temperatures at Lower Granite tailwater at or below the water quality standard of 20°C (68°F). Also, under RPA 1515 the Action Agencies agreed to continue to update the WQP for TDG and water temperature in the Mainstem Columbia and Snake rivers and implement water quality measures to enhance ESA-listed juvenile and adult fish survival, and mainstem spawning and rearing habitat. The WQP was to contain water quality measures needed to meet both ESA and CWA responsibilities. For purposes of the 2004 RPA that addressed the WQP, the WQP was to include the following measures to address water temperature to meet ESA responsibilities:

- Continued development of the CE-QUAL-W2 model for estimating river temperatures from Dworshak Dam on the Clearwater and Upper Snake River near the confluence with the Grand Ronde River (USGS Anatone gauge) through the lower Snake River (all four COE lower Snake River projects) to assist in real-time decision making for Dworshak Dam operations;

- Expansion of water temperature modeling capabilities to include the Columbia River from Grand Coulee to Bonneville dams to better assess the effect of operations or flow depletions on summer temperatures;
- Investigation of alternatives to reduce total mass loading of TDG at Bonneville Dam while maintaining juvenile survival performance, and
- Continued operation of lower Snake River projects at MOP (Minimum Operational Pool).

In the 2008 BiOp only the Lower Granite Dam ladder is addressed regarding the issue of increased temperatures and potential impacts to salmonid survival. RPA 28 calls for the modification of the Lower Granite fishway to improve upstream adult passage conditions impaired by temperature differential. A prototype was expected to be in place by 2011.

Water Quality Plan (WQP)

The WQP has been revised every few years. Despite continued development of WQPs over the years, the BiOp process has fallen short of ever really making any significant progress on actions to address water temperature beyond the actions initially identified in the 1990s. WQPs were developed in 2003, 2004, 2006, 2009 and 2014. The 2009 WQP included over thirty measures that could be considered to address temperature, and identified issues, feasibility and timelines for implementation. By the 2014 WQP most actions were dropped and the WQP only includes four actions for addressing temperature: Dworshak cool water releases; temperature modeling; temperature monitoring; and studies to identify thermal refugia.

2014 Biological Opinion

In this BiOp, water temperature is consistently identified as a limiting factor for salmonid survival. The BiOp acknowledges temperatures have increased, but seems to place more emphasis on the climate change rather than on the impact of dams. While climate change is undoubtedly a contributing measure, the impacts of the dams will only further exacerbate those effects.

The 2014 BiOp specifically discusses the issues that were observed in 2013 regarding passage at Lower Granite Dam. The emphasis is on Lower Granite ladder and developing a longer-term engineering fix beyond the presently implemented (since 2013) pump system. No other ladders appear to be discussed. It is interesting to note, however, the language shifts blame to co-managers for ranking other projects higher than fixing the ladder at LGR, stating "Since 2008, the co-managing agencies (including NOAA Fisheries) have generally ranked other activities higher than the Lower Granite adult ladder (called for in RPA Action 28) in the Corps' annual prioritization process."

Appendix B

Historical Water Temperatures at Middle Columbia, Lower Snake, and Upper Columbia Projects

Table B.1 – Summary of temperature data at Bonneville Dam collected at water quality monitors in the forebay and tailrace (Cascade Island). Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	Bonneville Forebay Monitors					Bonneville Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	153	47	0.31	71.9	16-Jul	153	47	0.31	72.0	16-Jul
2006	153	53	0.35	71.8	10-Jul	153	53	0.35	71.9	10-Jul
2007	153	52	0.34	71.2	11-Jul	153	52	0.34	71.1	11-Jul
2008	153	27	0.18	71.2	5-Aug	153	28	0.18	71.3	28-Jul
2009	153	46	0.30	74.3	17-Jul	153	46	0.30	74.2	17-Jul
2010	153	38	0.25	72.5	24-Jul	153	38	0.25	72.6	24-Jul
2011	153	19	0.12	70.7	13-Aug	61[A]	14	0.23	70.6	17-Aug
2012	153	27	0.18	71.3	5-Aug	113[B]	27	0.24	71.4	5-Aug
2013	153	48	0.31	72.2	15-Jul	151	47	0.31	72.0	14-Jul
2014	153	50	0.33	72.9	13-Jul	153	50	0.33	72.9	13-Jul
2015	153	69	0.45	73.2	24-Jun	153	69	0.45	73.2	24-Jun

[A] Due to high flows, the Bonneville tailrace monitor (at Cascade Island) was out of commission from May 18–August 17.
[B] Due to high flows, the Bonneville tailrace monitor (at Cascade Island) was out of commission from April 27–June 5.

Table B.2 – Summary of temperature data at The Dalles Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	The Dalles Forebay Monitors					The Dalles Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	153	48	0.31	72.0	15-Jul	153	48	0.31	72.2	15-Jul
2006	153	54	0.35	72.2	9-Jul	151	54	0.36	72.1	9-Jul
2007	153	53	0.35	71.6	10-Jul	153	53	0.35	71.5	10-Jul
2008	153	31	0.20	71.3	26-Jul	153	32	0.21	71.5	27-Jul
2009	153	46	0.30	73.7	17-Jul	153	47	0.31	73.9	16-Jul
2010	153	39	0.25	72.4	22-Jul	153	39	0.25	72.5	22-Jul
2011	153	25	0.16	70.5	6-Aug	153	27	0.18	70.6	5-Aug
2012	153	27	0.18	71.2	5-Aug	153	28	0.18	71.2	4-Aug
2013	152	49	0.32	72.2	14-Jul	153	49	0.32	72.4	14-Jul
2014	152	50	0.33	72.7	13-Jul	153	51	0.33	72.8	12-Jul
2015	153	71	0.46	73.7	22-Jun	153	71	0.46	73.8	22-Jun

Table B.3 – Summary of temperature data at John Day Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	John Day Forebay Monitors					John Day Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	153	47	0.31	72.0	16-Jul	153	48	0.31	71.9	15-Jul
2006	153	53	0.35	72.2	9-Jul	153	52	0.34	72.1	11-Jul
2007	151	53	0.35	71.4	10-Jul	153	53	0.35	71.3	10-Jul
2008	153	30	0.20	72.3	25-Jul	153	31	0.20	71.2	26-Jul
2009	153	45	0.29	74.7	17-Jul	153	44	0.29	73.8	19-Jul
2010	153	39	0.25	72.2	24-Jul	153	39	0.25	72.0	24-Jul
2011	153	26	0.17	70.7	6-Aug	153	27	0.18	70.5	5-Aug
2012	153	28	0.18	71.1	4-Aug	153	28	0.18	71.2	4-Aug
2013	153	49	0.32	72.7	14-Jul	153	49	0.32	72.5	14-Jul
2014	153	51	0.33	72.7	12-Jul	153	51	0.33	72.5	12-Jul
2015	153	69	0.45	74.3	24-Jun	153	69	0.45	73.8	24-Jun

Table B.4 – Summary of temperature data at McNary Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	McNary Forebay Monitors					McNary Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	153	42	0.27	70.8	21-Jul	153	42	0.27	71.0	21-Jul
2006	153	45	0.29	70.5	17-Jul	153	48	0.31	70.8	12-Jul
2007	153	45	0.29	69.9	12-Jul	153	48	0.31	69.7	11-Jul
2008	153	26	0.17	70.9	5-Aug	153	28	0.18	70.9	4-Aug
2009	153	43	0.28	72.0	20-Jul	153	45	0.29	72.3	18-Jul
2010	152	34	0.22	71.0	27-Jul	153	37	0.24	71.1	24-Jul
2011	153	14	0.09	69.8	18-Aug	153	13	0.08	69.9	19-Aug
2012	153	19	0.12	69.2	6-Aug	153	18	0.12	69.2	6-Aug
2013	153	43	0.28	71.7	20-Jul	153	43	0.28	71.5	20-Jul
2014	153	35	0.23	71.8	22-Jul	153	35	0.23	71.6	22-Jul
2015	153	66	0.43	71.9	27-Jun	153	67	0.44	72.1	26-Jun

Table B.5 – Summary of temperature data at Ice Harbor Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	Ice Harbor Forebay Monitors					Ice Harbor Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	153	49	0.32	71.7	14-Jul	151	52	0.34	71.8	11-Jul
2006	151	57	0.38	71.7	6-Jul	151	58	0.38	72.2	5-Jul
2007	153	54	0.35	72	9-Jul	153	54	0.35	72.4	9-Jul
2008	153	30	0.20	70.9	28-Jul	153	35	0.23	70.6	27-Jul
2009	153	50	0.33	71.9	13-Jul	153	51	0.33	72.3	12-Jul
2010	153	40	0.26	70.8	23-Jul	153	40	0.26	70.8	23-Jul
2011	153	28	0.18	70.0	4-Aug	153	30	0.20	70.2	2-Aug
2012	153	48	0.31	71.2	15-Jul	153	49	0.32	71.7	14-Jul
2013	153	50	0.33	71.2	13-Jul	153	51	0.33	71.6	12-Jul
2014	153	46	0.30	71.6	17-Jul	153	47	0.31	71.6	16-Jul
2015	153	68	0.44	72.8	25-Jun	153	69	0.45	73.0	24-Jun

Table B.6 – Summary of temperature data at Lower Monumental Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	Lower Monumental Forebay Monitors					Lower Monumental Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	153	40	0.26	70.0	14-Jul	153	44	0.29	69.9	14-Jul
2006	148	57	0.39	70.8	5-Jul	151	57	0.38	70.3	5-Jul
2007	153	45	0.29	70.9	10-Jul	153	46	0.30	70.6	9-Jul
2008	153	13	0.08	69.5	15-Aug	153	14	0.09	69.4	14-Aug
2009	153	32	0.21	70.9	13-Jul	152	31	0.20	70.9	15-Jul
2010	153	30	0.20	70.2	28-Jul	153	32	0.21	69.9	24-Jul
2011	153	17	0.11	69.4	6-Aug	153	15	0.10	69.1	7-Aug
2012	153	44	0.29	69.9	16-Jul	152	44	0.29	70.0	16-Jul
2013	153	53	0.35	70.1	10-Jul	152	50	0.33	69.9	12-Jul
2014	153	45	0.29	70.0	18-Jul	153	47	0.31	70.0	16-Jul
2015	153	69	0.45	71.8	24-Jun	153	69	0.45	71.7	24-Jun

Table B.7 – Summary of temperature data at Little Goose Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	Little Goose Forebay Monitors					Little Goose Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	153	19	0.12	69.8	14-Jul	153	19	0.12	69.3	14-Jul
2006	151	51	0.34	70.8	3-Jul	151	45	0.30	70.2	3-Jul
2007	153	35	0.23	70.9	9-Jul	153	34	0.22	69.8	9-Jul
2008	153	7	0.05	69.6	15-Aug	153	6	0.04	68.6	15-Aug
2009	153	23	0.15	70.2	11-Jul	153	18	0.12	70.4	25-Jul
2010	153	12	0.08	71.0	2-Aug	153	11	0.07	69.8	9-Aug
2011	153	11	0.07	69.3	4-Aug	153	7	0.05	68.9	7-Aug
2012	153	32	0.21	69.8	16-Jul	153	30	0.20	69.4	16-Jul
2013	153	33	0.22	69.5	7-Jul	153	30	0.20	69.2	9-Jul
2014	153	40	0.26	69.9	19-Jul	153	39	0.25	69.4	19-Jul
2015	153	56	0.37	71.9	20-Jun	153	54	0.35	71.2	21-Jun

Table B.8 – Summary of temperature data at Lower Granite Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	Lower Granite Forebay Monitors					Lower Granite Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	153	50	0.33	72.2	4-Jul	150	0	0.00	67.6	N/A
2006	151	5	0.03	69.2	5-Jul	151	8	0.05	69.0	1-Jul
2007	153	0	0.00	67.9	N/A	153	1	0.01	68.2	5-Jul
2008	153	0	0.00	67.3	N/A	153	0	0.00	67.1	N/A
2009	153	0	0.00	67.6	N/A	153	0	0.00	67.9	N/A
2010	153	0	0.00	66.8	N/A	153	0	0.00	67.4	N/A
2011	153	0	0.00	67.6	N/A	153	0	0.00	67.9	N/A
2012	153	0	0.00	68.0	N/A	153	0	0.00	67.9	N/A
2013	153	0	0.00	67.5	N/A	153	2	0.01	68.2	22-Aug
2014	153	5	0.03	69.6	22-Aug	153	3	0.02	68.6	24-Aug
2015	152	25	0.16	70.5	7-Jul	153	7	0.05	70.1	7-Jul

Table B.9 – Summary of temperature data at Grand Coulee Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	Grand Coulee Forebay Monitors					Grand Coulee Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	153	18	0.12	70.8	13-Aug	153	0	0.00	66.7	N/A
2006	153	22	0.14	69.7	6-Aug	153	0	0.00	67.5	N/A
2007	153	17	0.11	69.1	7-Aug	153	0	0.00	67.5	N/A
2008	153	1	0.01	70.0	24-Aug	153	0	0.00	66.3	N/A
2009	153	14	0.09	71.2	18-Aug	153	0	0.00	65.7	N/A
2010	153	14	0.09	71.4	16-Aug	153	0	0.00	65.9	N/A
2011	153	0	0.00	66.7	N/A	151	0	0.00	65.7	N/A
2012	153	0	0.00	66.3	N/A	149	0	0.00	64.1	N/A
2013	145	8	0.06	70.8	24-Aug	145	0	0.00	66.7	N/A
2014	153	5	0.03	70.1	24-Aug	153	0	0.00	66.6	N/A
2015	149	3	0.02	69.3	24-Aug	153	0	0.00	67.1	N/A

Table B.10 – Summary of temperature data at Chief Joseph Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	Chief Joseph Forebay Monitors					Chief Joseph Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	152	0	0.00	67.0	N/A	153	0	0.00	66.7	N/A
2006	150	0	0.00	67.3	N/A	153	0	0.00	67.2	N/A
2007	153	0	0.00	67.4	N/A	153	0	0.00	67.2	N/A
2008	134	0	0.00	66.4	N/A	143	0	0.00	65.8	N/A
2009	152	0	0.00	66.1	N/A	153	0	0.00	65.3	N/A
2010	153	0	0.00	66.1	N/A	153	0	0.00	65.3	N/A
2011	152	0	0.00	65.1	N/A	153	0	0.00	64.9	N/A
2012	153	0	0.00	64.3	N/A	153	0	0.00	64.2	N/A
2013	152	0	0.00	67.4	N/A	152	0	0.00	67.1	N/A
2014	153	0	0.00	67.2	N/A	153	0	0.00	66.9	N/A
2015	151	0	0.00	67.5	N/A	152	0	0.00	67.5	N/A

Table B.11 – Summary of temperature data at Wells Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

Year	Wells Forebay Monitors					Wells Tailrace Monitors				
	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	149	0	0.00	66.9	N/A	149	0	0.00	66.8	N/A
2006	153	0	0.00	67.8	N/A	153	0	0.00	67.6	N/A
2007	148	0	0.00	67.5	N/A	13	0	0.00	42.6	N/A
2008	140	0	0.00	67.4	N/A	61	0	0.00	67.4	N/A
2009	153	0	0.00	66.4	N/A	153	0	0.00	66.3	N/A
2010	135	0	0.00	66.4	N/A	141	0	0.00	66.1	N/A
2011	147	0	0.00	65.8	N/A	145	0	0.00	65.8	N/A
2012	148	0	0.00	64.7	N/A	148	0	0.00	64.6	N/A
2013	152	0	0.00	67.9	N/A	152	0	0.00	67.7	N/A
2014	139	0	0.00	67.2	N/A	109	0	0.00	67.3	N/A
2015	146	0	0.00	67.9	N/A	146	1	0.01	68.1	14-Aug

Table B.12 – Summary of temperature data at Rocky Reach Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

Year	Rocky Reach Forebay Monitors					Rocky Reach Tailrace Monitors				
	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	153	0	0.00	67.4	N/A	153	0	0.00	67.3	N/A
2006	143	1	0.01	68.1	28-Aug	141	1	0.01	68.1	28-Aug
2007	132	0	0.00	67.7	N/A	132	0	0.00	67.7	N/A
2008	153	0	0.00	67.8	N/A	153	0	0.00	67.7	N/A
2009	153	0	0.00	66.5	N/A	153	0	0.00	66.4	N/A
2010	153	0	0.00	66.5	N/A	153	0	0.00	66.5	N/A
2011	153	0	0.00	66.3	N/A	153	0	0.00	66.1	N/A
2012	153	0	0.00	64.8	N/A	153	0	0.00	64.7	N/A
2013	153	0	0.00	67.7	N/A	143	0	0.00	67.6	N/A
2014	153	0	0.00	68.0	N/A	153	0	0.00	68.0	N/A
2015	153	6	0.04	68.4	13-Aug	153	7	0.05	68.4	13-Aug

Table B.13 – Summary of temperature data at Rock Island Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

Year	Rock Island Forebay Monitors					Rock Island Tailrace Monitors				
	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	151	0	0.00	67.6	N/A	153	0	0.00	67.6	N/A
2006	143	1	0.01	68.2	28-Aug	143	2	0.01	69.6	28-Aug
2007	143	2	0.01	68.6	30-Aug	132	0	0.00	68.0	N/A
2008	152	0	0.00	67.6	N/A	153	0	0.00	67.9	N/A
2009	153	0	0.00	66.7	N/A	153	0	0.00	66.9	N/A
2010	151	1	0.01	68.8	8-Aug	153	0	0.00	66.8	N/A
2011	153	0	0.00	66.2	N/A	153	0	0.00	66.2	N/A
2012	153	0	0.00	65.0	N/A	153	0	0.00	66.6	N/A
2013	153	0	0.00	67.9	N/A	153	0	0.00	67.9	N/A
2014[A]	152	2	0.01	68.3	19-Aug					
2015	153	11	0.07	68.7	10-Aug	153	12	0.08	68.6	10-Aug

[A] Tailrace temperatures not available due to Wanapum drawdown—gauge was often out of water. Not able to assess exactly when this occurred.

Table B.14 – Summary of temperature data at Wanapum Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

Year	Wanapum Forebay Monitors					Wanapum Tailrace Monitors				
	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	111	2	0.02	68.3	3-Aug	111	0	0.00	66.9	N/A
2006	149	17	0.11	70.9	5-Aug	148	8	0.05	68.7	18-Aug
2007	150	7	0.05	68.8	14-Aug	153	1	0.01	68.1	31-Aug
2008	135	10	0.07	69.4	14-Aug	135	1	0.01	68.1	20-Aug
2009	153	15	0.10	70.6	25-Jul	153	0	0.00	67.3	N/A
2010	153	6	0.04	69.4	2-Aug	153	0	0.00	67.7	N/A
2011	151	1	0.01	68.1	28-Aug	151	0	0.00	67.0	N/A
2012	153	0	0.00	67.3	N/A	153	0	0.00	66.1	N/A
2013	151	25	0.17	70.7	7-Aug	151	17	0.11	69.0	11-Aug
2014	153	18	0.12	68.8	12-Aug	153	14	0.09	68.5	14-Aug
2015	153	32	0.21	69.9	8-Jul	149	14	0.09	69.0	3-Aug

Table B.15 – Summary of temperature data at Priest Rapids Dam collected at water quality monitors in the forebay and tailrace. Data are summarized for the April 1–August 31 period, 2005–2015. Fill colors indicate magnitude of Proportion of Days Exceeding 68°F water quality standard (white = lowest values, yellow = 50th percentile, red = highest values).

	Priest Rapids Forebay Monitors					Priest Rapids Tailrace Monitors				
Year	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F	Num. Days	Days Exceeding 68°F	Prop. Days Exceeding 68°F	Max. Temp. (°F)	First Day Exceeding 68°F
2005	111	0	0.00	67.3	N/A	109	0	0.00	67.7	N/A
2006	148	13	0.09	69.1	7-Aug	149	11	0.07	69.2	14-Aug
2007	153	1	0.01	68.2	31-Aug	153	1	0.01	68.1	31-Aug
2008	135	11	0.08	68.7	15-Aug	134	0	0.00	68.0	16-Aug
2009	151	4	0.03	68.6	27-Jul	153	0	0.00	67.6	27-Jul
2010	153	5	0.03	68.6	2-Aug	153	0	0.00	67.7	16-Aug
2011	151	0	0.00	67.2	N/A	151	0	0.00	67.0	N/A
2012	153	0	0.00	66.9	N/A	153	0	0.00	66.3	N/A
2013	151	22	0.15	70.1	10-Aug	151	22	0.15	69.4	10-Aug
2014	153	22	0.14	68.9	4-Aug	153	18	0.12	68.8	13-Aug
2015	153	31	0.20	69.4	8-Jul	153	23	0.15	69.4	9-Jul

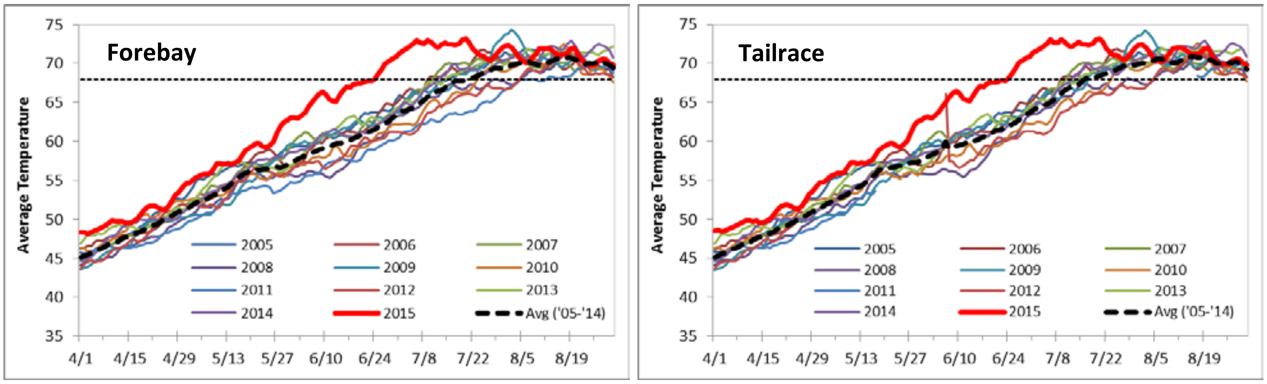

Figure B.1 – Daily average temperature (°F) at the Bonneville Dam water quality monitors in the forebay and tailrace (at Cascade Island), April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

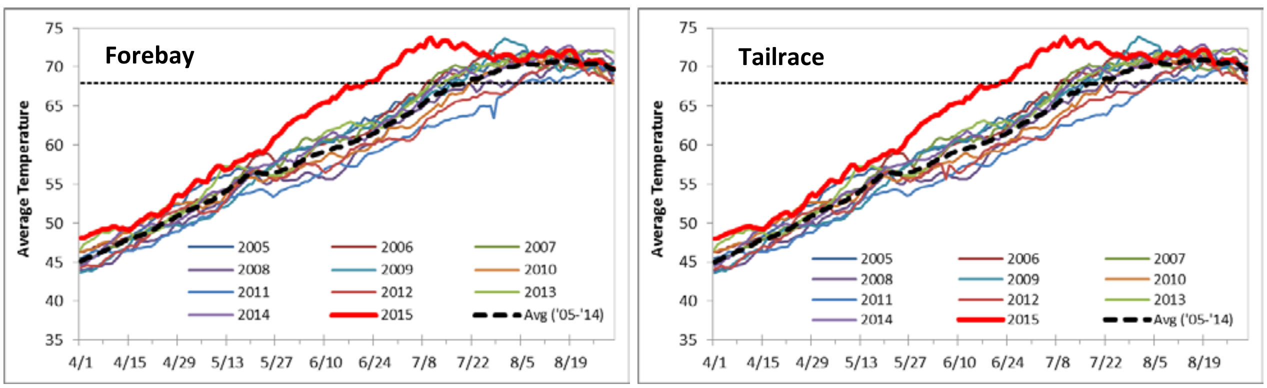

Figure B.2 – Daily average temperature (°F) at The Dalles Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

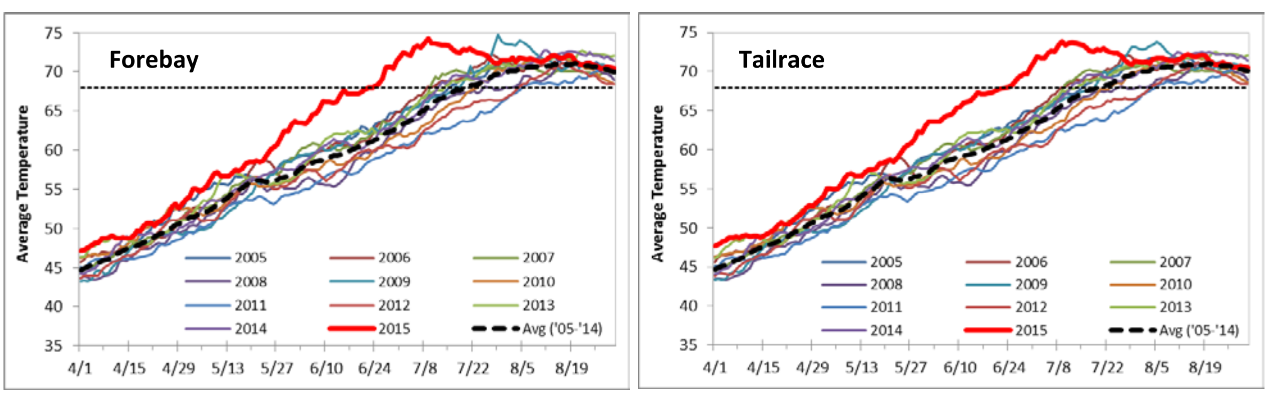

Figure B.3 – Daily average temperature (°F) at the John Day Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

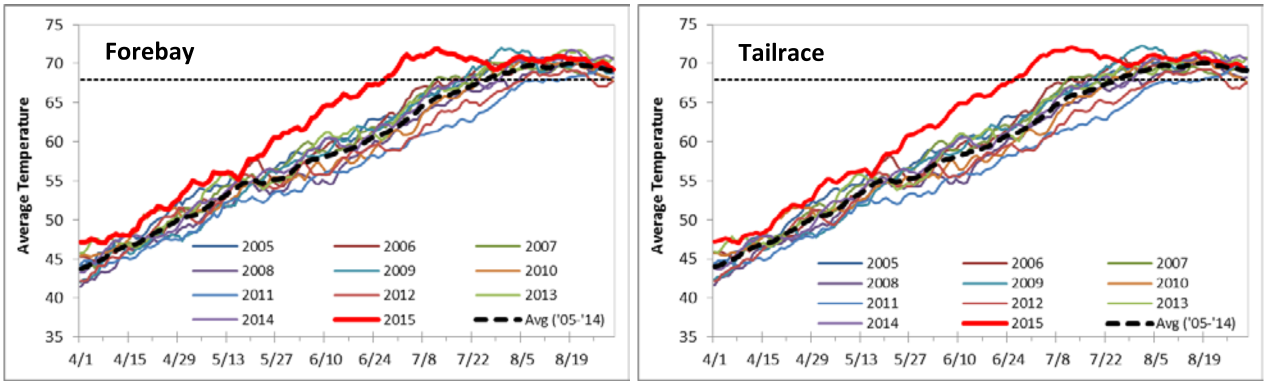

Figure B.4 – Daily average temperature (°F) at the McNary Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

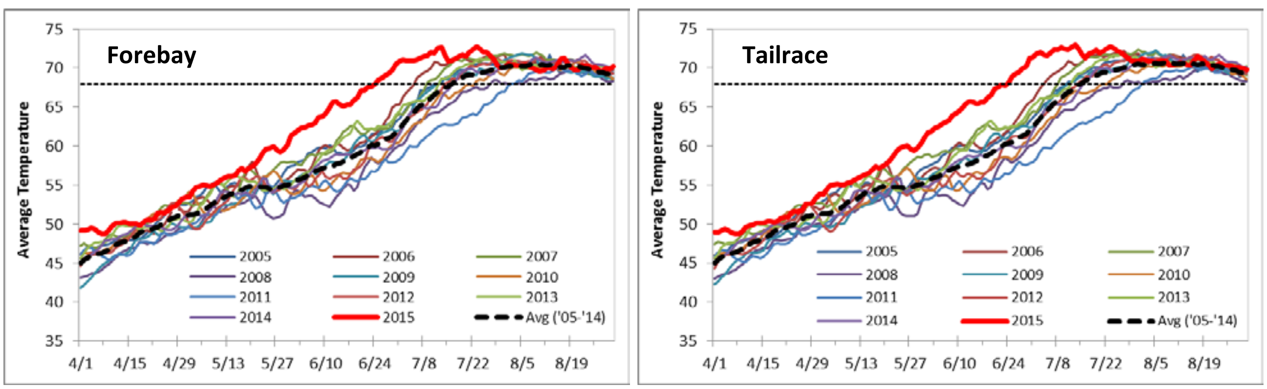

Figure B.5 – Daily average temperature (°F) at the Ice Harbor Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

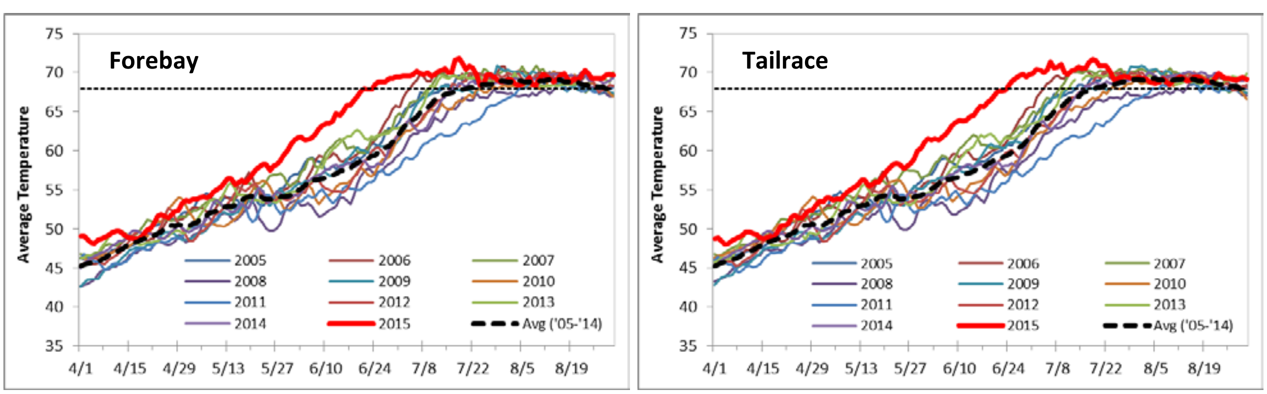

Figure B.6 – Daily average temperature (°F) at the Lower Monumental Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

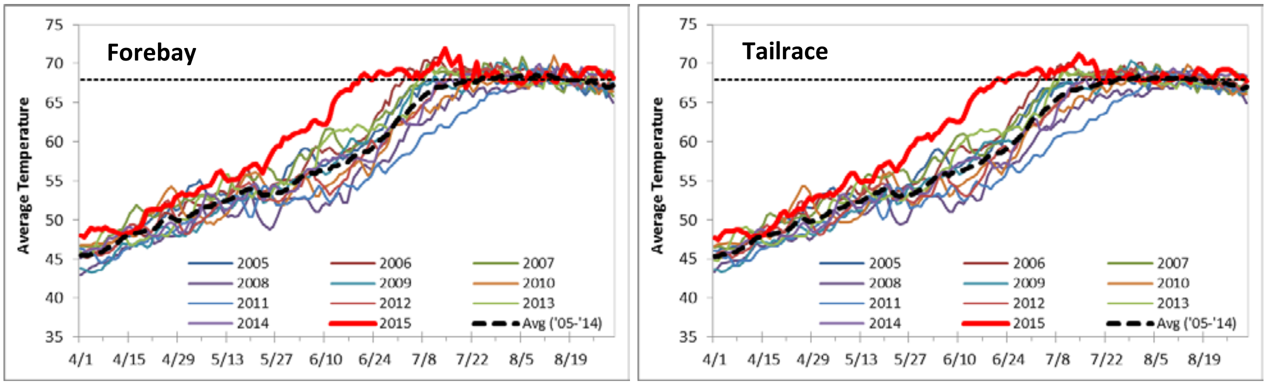

Figure B.7 – Daily average temperature (°F) at the Little Goose Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

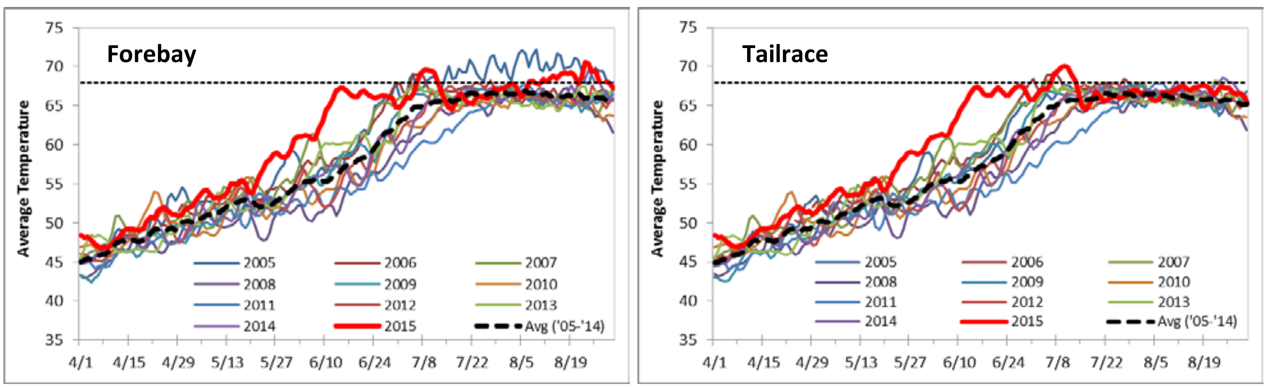

Figure B.8 – Daily average temperature (°F) at the Lower Granite Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

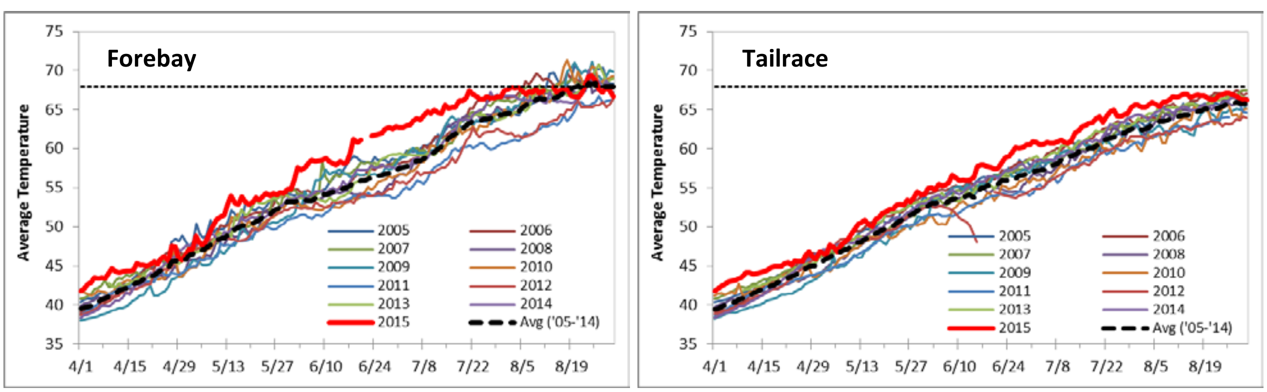

Figure B.9 – Daily average temperature (°F) at the Grand Coulee Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

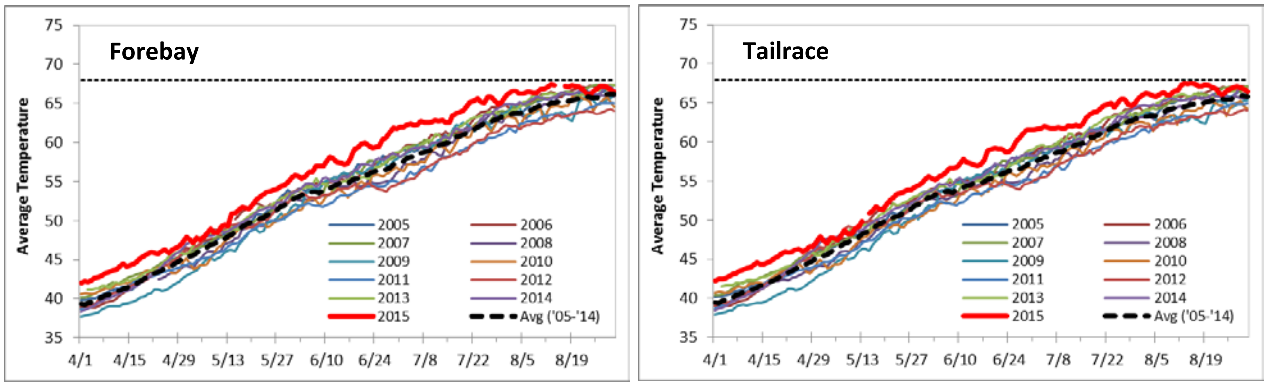

Figure B.10 – Daily average temperature (°F) at the Chief Joseph Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

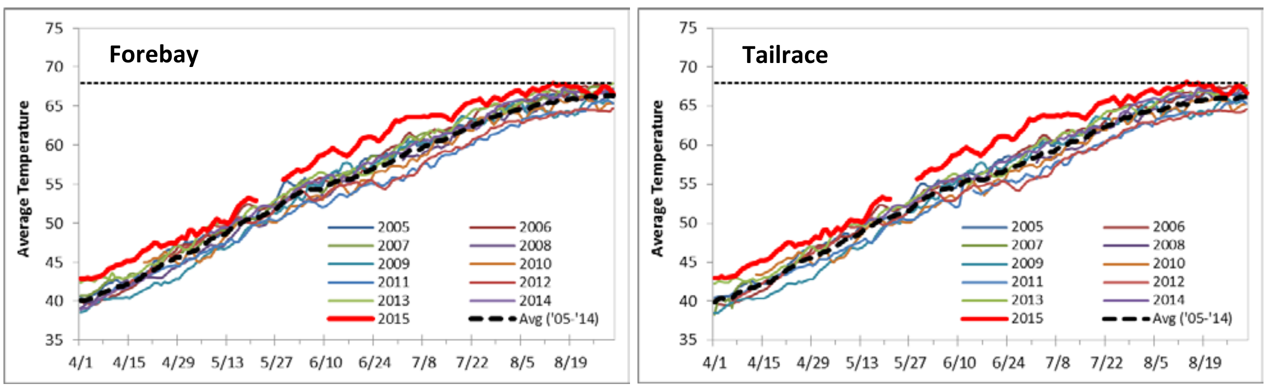

Figure B.11 – Daily average temperature at the Wells Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

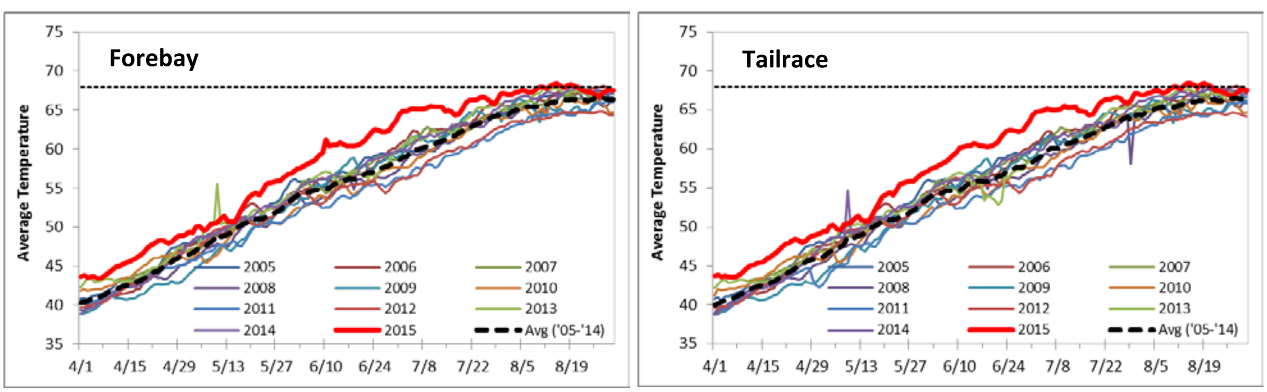

Figure B.12 – Daily average temperature (°F) at the Rocky Reach Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

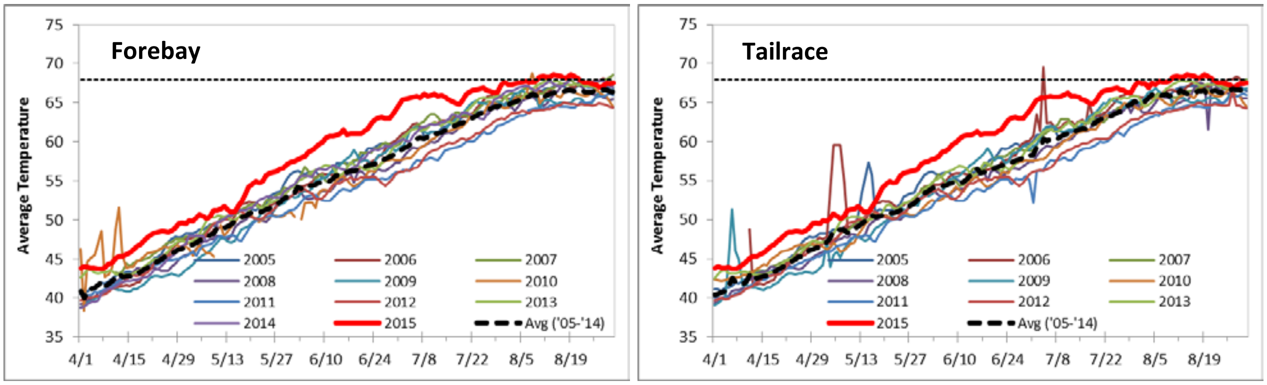

Figure B.13 – Daily average temperature (°F) at the Rock Island Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard. *Wanapum drawdown operations in 2014 caused the tailrace monitor to be in and out of the water. Therefore, 2014 data for this monitor are not provided.*

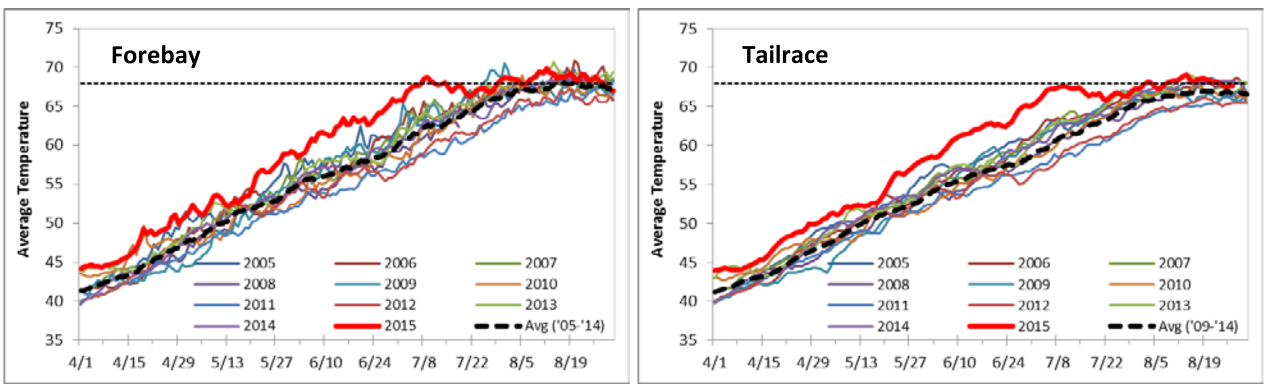

Figure B.14 – Daily average temperature (°F) at the Wanapum Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

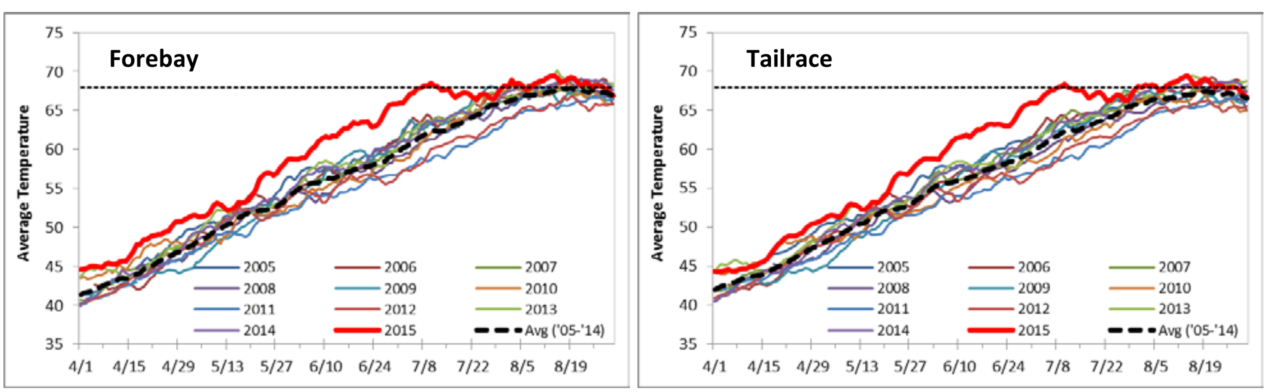

Figure B.15 – Daily average temperature (°F) at the Priest Rapids Dam water quality monitors in the forebay and tailrace, April 1–August 31, 2005–2015. Dashed line represents the 10-year average (2005–2014). Horizontal dashed line is provided at 68°F for perspective relative to the water quality standard.

Appendix C

2015 Chronology of Events Associated with Adult Sockeye

The temperature issues at the Snake River projects began in late June as local temperatures became increasingly hotter. There are few actual tools that can be implemented to address temperature issues. One is the release of cool water from a limited volume in Dworshak Reservoir to ameliorate temperature at Lower Granite Dam tailrace. The second is the implementation of additional fish pumps (at Lower Granite Dam only) to draw deeper, cooler water from the forebay reservoir to decrease adult fish ladder temperatures. These two tools were fully implemented in 2015 and the passage issues and mortality of sockeye continued. This lack of viable alternatives led to the consideration of actions that had an associated cost in juvenile and adult mortality including: emergency trapping and hauling at high water temperatures and changing spill operations that decreased juvenile passage protection. The cost to juvenile and adult survival and the lack of a plan for evaluation of operations led to differences in recommendations among the salmon managers.

Following is a brief summary put together by the Fish Passage staff of the sequence of events regarding the development of alternative operations during what became a declared fish emergency. It is the FPC staff's recollection of the important aspects of each of the conversations that had taken place, and, unintentionally, may not include all points discussed. Not all meetings are recorded and the re-creation is based on staff memory. Additional information can be obtained through the Fish Passage Advisory Committee notes and audio recordings (http://www.fpc.org/documents/fpac_minutes/fpac_minutes_currentyear.html) and the Corps of Engineers (COE) Technical Management notes (http://www.nwd-wc.usace.army.mil/tmt/agendas/2015/). Notes for the COE's Fish Passage Operations and Maintenance meetings that occur outside of the scheduled monthly meeting are not publicly available.

July 1 - Technical Management Team Meeting

Prior to July 1st, the usual Dworshak operations are for the project to be filling over June to its "full" elevation (1,600 feet) by or about June 30th. A portion of that water (to elevation 1,535 feet by August 31st or 1,520 feet by mid-September) is then available for flow augmentation and temperature regulation. At the July 1st meeting the COE reported that on June 27th DWR discharge was increased to 12.5 Kcfs based on predicted "soaring temps." However, these temperatures did not materialize and DWR was decreased on June 29th to full powerhouse discharge.

Based on their model results the COE predicted that discharges of 5.3 Kcfs were good enough to maintain Lower Granite temperatures below 68°F through the July 4th weekend. At this meeting there was some concern expressed by the Salmon Managers regarding sockeye conversion through the Snake River and advised they were monitoring the passage numbers.

July 8 - Technical Management Team Meeting

On July 7th DWR discharge increased to 7.5 Kcfs to address the fact that Lower Granite temperatures increased considerably over the July 4th weekend with the decreased outflow from Dworshak. Conditions did not occur as COE had expected on July 1st (i.e., weather hotter and no storms as predicted).

July 8 - Fish Passage Operations and Maintenance Conference Call

Concern had been expressed regarding sockeye passage. The RSW was said to be causing the formation of an eddy near the ladder entrance that may be impeding passage. The recommendation was made to implement an operation with the RSW off and the provision of uniform spill pattern through the conventional spill bays. This spill was to be implemented through Monday July 13th. This was not opposed by the parties. ***On July 8th at 1:00 PM, the COE closed the Lower Granite RSW based on TMT and FPOM coordination. The project operated with spill in a uniform pattern with no RSW.***

July 10 - Fish Passage Operations and Maintenance Conference Call

Visual counts at LGR appeared to increase (July 1st to July 7th counts ranged from 2 to 25 and the July 8th and 9th counts were 12 and 17). However, at this point, concern was expressed by the Nez Perce Tribe, USFWS and ODFW that they were uncertain whether this was a natural variability observed in the dam counts or a response of the LGR operational change (Unit 2, RSW off).

IDFG mentioned normal adult conversion BON-LGR is 70%; 2015 so far was 25%. IDFG believed warm temperatures were stalling fish and, therefore, declared an adult emergency. Due to the declared fish emergency, the trap at Lower Granite Dam could be operated at temperatures that are above the operational limit if permitted by NOAA. IDFG initiated a trap and haul operation at LGR on July 13th to collect adult sockeye and transport them to Eagle Hatchery as captive broodstock (trapping to occur 5 days/week for four hours during the cooler morning period). They intended to collect 400 fish and were working with NOAA on the permit.

At this meeting a discussion occurred regarding the use of the Ice Harbor Dam trap, and the COE agreed to look into its operation. All parties agreed to continue Unit 2, with no RSW operation until after an FPOM discussion that was scheduled for Monday, July 13th.

July 13 - Fish Passage Operations and Maintenance Conference Call

IDFG announced that they had looked into operating the trap at IHR, but because of personnel and transport vehicle limitations had decided they would not pursue this operation further. At this meeting NOAA recommended that in addition to the RSW change, they would like to switch the priority unit operation from Unit 2 to Unit 1. After the counts during the first two days of 12 and 17, the next three days had counts of 8, 5 and 6. NOAA and the COE expressed concern that operating Unit 2 causes an eddy to form near the adult ladder entrance that may be impeding passage. They verbally presented information they said showed that Unit 1 operation in 2013 had much higher passage than Unit 2 operation. IDFG researchers believed that any change in operation causes a change in ladder counts and were supportive of this operation. The Nez Perce and ODFW did not support the change. Unit 1 is a fixed blade unit that operates at a higher hydraulic capacity and, therefore, decreases spill and juvenile passage protection when flows are low. The FPC requested an explanation of what criteria would be used to determine the success of an operation. The COE responded that they did not have a criterion, but would be able to determine if a change was positive after they saw the adult ladder counts.

In spite of the lack of consensus, since NOAA recommended the change, the COE agreed to make the change. ***On July 13th at 4:00 PM, the project switched to Unit 1 priority***. ***The project operated with more flow through the powerhouse and decreased spill in a uniform pattern, with no RSW.***

July 17 - Fish Passage Operations and Maintenance Conference Call

This call was held to check on the operation at Lower Granite Dam. The adult sockeye counts for the past four days were 13, 17, 19 and 25. There was claim of successfully increasing adult sockeye passage under the Unit 1 operation. However, there was caution expressed regarding the fact that at the same time the ambient temperatures cooled and it was likely that ladder temperatures also cooled, leading to the increase in adult passage. The COE was asked to supply the ladder temperatures. They claimed they would have to see because there were limited resources and they may not be able to collect the data. The COE continued operation of Unit 1 with the RSW off and uniform spill.

Note: A formal request was made by the FPC via e-mail to COE for the ladder temperature data at all the ladders for this year and any historic data as well.

July 20 - Fish Passage Operations and Maintenance Conference Call

Prior to the meeting FPC had distributed a short memo to FPAC outlining the results of the Unit 1 operation and ending with a recommendation to return to Unit 2 operation. The adult sockeye counts for the previous three days were 13, 2 and 2. In addition to a discussion regarding whether Unit 1 operation was successful, or whether we were just observing changes in ladder temperatures, NOAA initiated a discussion of switching to full powerhouse/no spill at LGR, instead of Unit 1/Spill rest.

The operation was left unchanged based on NOAA's recommendation. The same parties (ODFW, NPT, WDFW and USFWS) did not agree with this operation. At this point, while agencies did not agree, they did not announce that they would formally object to the operation and initiate a policy-level review.

July 21 - Fish Passage Advisory Committee Meeting

IDFG made a proposal to change to Unit 2 at LGR for two days plus deep spill. At LGS they proposed a no spill operation for 24 hours alternating with two day blocks of FOP operations. CRITFC/Umatilla suggested modifying the LGS operations to no spill during daylight hours and spill everything in excess of one unit during nighttime hours. The Nez Perce, ODFW and USFWS supported change to Unit 2 at LGR, but they were waiting for ladder temperatures before making any decision at LGS.

July 21 – Fish Passage Operations and Maintenance Conference Call

A special FPOM conference call was requested after the FPAC meeting. At the meeting IDFG presented their modified proposal. The USFWS discussed an analysis that they had just conducted on the temperature data that had been released an hour before the meeting. USFWS pointed out that there is a relation between the ladder exit temperature and adult counts. After the discussion, the COE stated they were continuing Unit 1 at LGR as per the NOAA recommendation and agreed to the LGS test. USFWS, ODFW and Nez Pierce objected to the LGS operations. WDFW did not agree, but would not object. At this point Walla Walla was going to proceed with LGR, but not LGS due to disagreement, but the COE RCC (Reservoir control center) asked if people were objecting, but not elevating to RIOG. It was made clear that the objecting parties would be discussing with their policy staff to determine if the issue would be elevated.

Later that afternoon the COE sent an e-mail (see below) saying they were not going to implement the operations.

July 21 - COE e-mail 5:48 p.m.
TMT Members and Alternates,
Upon further coordination with Corps Legal and Policy Staff and NOAA Fisheries the Corps will not be implementing The Little Goose Dam operation discussed during today's unscheduled FPOM Emergency Call (daytime no spill and nighttime one unit minimum generation spill the remainder of inflow). The Corps will provide additional coordination with Regional Salmon Managers regarding potential operations to improve sockeye passage in the Snake River. Regarding operations at Lower Granite Dam we are continuing with the current operation with unit 1 as the priority unit and spilling a uniform pattern without operation of the RSW until further notice. The Corps will provide an update on this operation during the TMT meeting scheduled for tomorrow at 9am. Conference call information for the TMT meeting may be found on the following website:
http://www.nwd-wc.usace.army.mil/tmt/agendas/2015/0722_Agenda.html
Regards,
Doug
Doug Baus
US Army Corps of Engineers
Northwestern Division
Fisheries Biologist

July 22 – Technical Management Team Meeting and Subsequent e-mail Conversations

The proposed operations were discussed. Prior to the meeting USFWS distributed to FPAC a memo describing the analysis conducted between ladder temperatures and LGS passage. This analysis was discussed at the meeting. The following poll was taken and recorded at the TMT meeting regarding the proposed operations:

- Idaho – Support.
- Montana – Support.
- NOAA – Support.
- Washington – Does not support; no objection.
- Colville – Does not support; no objection.
- Nez Perce – Object.
- USFWS – Object.
- Oregon – Object.
- Umatilla – Object.
- BPA [not polled at TMT, however, supports the Corps decision].
- Corps [not polled at TMT, support].
- Bureau of Reclamation [not polled at TMT]

After the poll the COE summarized their intent to maintain Unit 1 priority at Lower Granite with uniform spill and the RSW shut off:

> In accordance with NOAA's request, the COE will consider operating Little Goose for daytime generation only, with no spill from 4 am-8 pm, and one unit at minimum generation at night, spilling the remainder of outflow from 8 pm-4 am. Based on TMT's feedback today, the COE will consult with legal and policy staff on this operation and email TMT its decision this afternoon.

Later that day (July 22nd) the following e-mail was sent, implementing the operations.

July 22 - COE e-mail at 9:49 p.m.
TMT Members, Alternates, and Interested Parties,

Regarding experimental emergency operations discussed today at TMT to increase adult Snake River Sockeye passage at Little Goose (LGS) and Lower Granite (LWG) dams, the Corps will implement NOAA Fisheries recommended experimental emergency operation at LGS. This operation will include a period of no spill during the daylight hours of 4am to 8pm and a period of a single unit operation at minimum generation while spilling the remainder of outflow during the nighttime hours of 8pm to 4am. The experimental emergency LGS operation will occur for 2 days beginning on Thursday, July 23, at 4am and will continue through Saturday, July 25 at 4am. LGS will resume operations that were underway prior to this experimental operation on Saturday, July 25 at 4am. Regarding LWG operations, the Corps will continue to implement NOAA Fisheries recommended operation to maintain unit 1 priority and deep spill (no spillway weir). The Corps has scheduled a TMT meeting for Monday, July 27, at 9 am and will provide

the TMT with information about current conditions; and will be prepared to discuss this experimental emergency operation and recommendations for continuation of this operation or alternatives with TMT representatives. In addition the Corps will provide an update on this operation during the FPOM conference call on Friday, July 24.
Regards,
Doug
Doug Baus
US Army Corps of Engineers
Northwestern Division
Phone: (503) 808-3995
Douglas.M.Baus@usace.army.mil

The next morning (July 23rd), ODFW sent an official request raising the issue to RIOG.

July 23 - ODFW e-mail at 8:33 a.m.
Given Oregon and others earlier objection to this planned operational change at Little Goose Dam and the solidification of a similarly premised special operation that did not clearly demonstration an association between the operational changes at Lower Granite Dam and adult sockeye passage over Lower Granite Dam, we feel it necessary to elevate this discussion to the Regional Implementation Oversight Group process.

Since the original elevation process has been altered by what has been described as the last elevation to RIOG, it is my understanding that TMT direct link to this elevation process is not being followed for this this request. Further, It is my understanding the expected process will require that Oregon's RIOG representative deliver the formal request to the RIOG chair. I will provide that information to the Oregon's representative and expect he will deliver an additional formal request to elevate this discussion as soon as possible. Given Oregon's and others objection to the plan below and our intent to elevate this discussion, we anticipate that no action will be taken to implement the operation described below until the RIOG process is completed.

Erick Van Dyke
Oregon Department of Fish and Wildlife
17330 SE Evelyn Street
Clackamas, Oregon 97015

COE distributed an e-mail recognizing that the issue was being raised to RIOG. The e-mail included two attached documents from NOAA as justification for their decision: (1) A NOAA letter which advised implementation based on their technical review of the impact on juveniles and (2) NOAA's technical review. See below for COE's e-mail.

July 23 - COE e-mail 3:19 p.m.
TMT Members, Alternates, FPOM Lower Granite Dam Special Operations Team, and Interested Parties,

After consideration of the information provided by sovereign representatives at TMT (and in previous discussions with FPOM), consideration of technical analyses provided by NOAA Fisheries (see attachments), and the need to make a timely decision given the immediate need to address endangered adult sockeye passage, the Corps initiated the 2-day experimental emergency operation at LGS as outlined in my email below.

The attached NOAA Fisheries memos were considered by the Corps to inform our decision to implement the 2-day emergency experimental operation. The Corps is providing these memos for your consideration, and to assist upcoming discussions at FPOM (July 24) and TMT (July 27) on proposals and actions to address the emergency conditions impacting ESA listed adult sockeye (and other adult migrants), and support other ongoing activities, such as NOAAs trapping of adult sockeye at LWG and IDFGs transport efforts. Some TMT members have objected to the 2-day emergency operation at LGS, and have expressed an intent to elevate this emergency action to the RIOG, so additional coordination may be necessary.
Regards,
Doug
Doug Baus
US Army Corps of Engineers
Northwestern Division
Fisheries Biologist

July 24 – Fish Passage Advisory Committee Meeting

The meeting was called to prepare for FPOM later that day. Three documents were shared — (1) USFWS provided an update to their ladder counts and adult passage analysis, (2) NOAA, on the Thursday afternoon prior to the meeting, after official request, sent a document with two pictures of tailrace conditions in 2013, and (3) the increased passage analysis that was conducted on the 2013 passage data, which was NOAA's justification for operating Unit 1 at LGR.

FPC provided a graph of LGR project operations under the three recently implemented configurations; discussed the discrepancies between projects in annual counts and suggested using caution when using counts to assess sizes of populations stalling; and provided recommendations of some additional changes that might be considered for implementation to improve sockeye passage at projects without decreasing juvenile passage protection by decreasing spill, including:

1. Cycling locks at the projects to allow adult sockeye an alternate route of passage upstream.
2. Securing additional pumps to allow adding cooler water drawn from deeper depths in the forebay to decrease ladder temperatures at Little Goose Dam.

NOAA also distributed an Excel file that provided 2015 conversion rates at the Snake River projects based on PIT-tagged fish. In addition, NOAA distributed a graph of individual PIT-tagged adults showing that early in the season most adult sockeye converted to LGR, in the middle of the Bonneville run many fish did not convert well from Bonneville, and recently no fish converted from the lower Columbia to the Snake.

July 24 – Fish Passage Operations and Maintenance Conference Call

This meeting was held after only one day of the no spill operation at LGS. Concern was expressed that the NOAA proposal was for the test to continue without considering the outcome of the first 2-day block. It was clarified that the first 2-day block would be considered on July 27th before going forward. At this meeting the Nez Perce told the group that, in discussion with the manager from Lyons Ferry Fish Hatchery the previous day, sockeye adults were observed jumping at the ladder entrance to the hatchery where cooler spring water is used. IDFG wanted to immediately look into the feasibility of trapping at the facility. COE noted that they had been made aware of this observation earlier in the week, but did not think it was feasible due to hatchery construction work and, therefore, had not pursued it. The Nez Perce representative believed it would be fine based on her conversation with the hatchery manager.

USFWS suggested some additional changes be considered to improve sockeye passage at projects without decreasing juvenile passage protection by decreasing spill, including:

1. Cycling locks at the projects to allow adult sockeye an alternate route of passage upstream.
2. Securing additional pumps to allow adding cooler water drawn from deeper depths in the forebay to decrease ladder temperatures at Little Goose Dam.

COE responded that maintenance issues at LGS precluded their cycling the lock, and contractual and monetary issues precluded pursuing additional pumps, although they agreed to look into this further.

July 27 – Technical Management Team Conference Call

The operations were reviewed at the meeting. Many believed the information was inconclusive and no decisions were made pending discussion at the FPOM meeting and pending the outcome of the RIOG meeting planned for Tuesday morning (July 28th). COE stated that the LGS operation had clear effect on decreasing temperature in LMN forebay. Other TMT members did not agree with this observation.

July 27 – Fish Passage Operations and Maintenance Conference Call

Trap operations were updated. The decision on LGS operations was still on hold until after RIOG on Tuesday (July 28th). COE reiterated that they do not understand why trapping operations are not being extended, particularly given current ladder temperatures.

An update was given on the Lyons Ferry Hatchery: The adult ladder has been opened and so far only adult Chinook and steelhead (no sockeye) have been seen.

NOAA seems to believe that LGS operation was more successful than not, and would like to collect another "data point" by repeating the test. NOAA seemed to have shifted the measure of success as getting fish to LGR trap and that is how they will measure success of these operations. ODFW suggested that low counts at the end of the run, as currently being seen, makes it difficult to assess success of operational changes. ODFW suggested that NOAA should look at variability in 2015 counts for the last portion of run compared to other years. Is variability in 2015 different from other years?

July 27 - COE e-mail at 6:40 p.m.

TMT Members, Alternates, FPOM Lower Granite Dam Special Operations Team, and Interested Parties,

The Corps received a recommendation from NOAA Fisheries today, July 27, 2015 at 5:51 pm to initiate the second 2-day experimental emergency operation at Little Goose Dam (LGS) beginning tomorrow, July 28 at 4am, and continuing through Thursday, July 30 at 4am. The Corps has reviewed NOAA's recommendation and the accompanying rationale, as well as considered the discussions and information provided by sovereign representatives at the recent TMT and FPOM meetings (July 22, 24, and 27), and reviewed the available data on adult sockeye passage and water temperature from the first experimental emergency 2-day operation. Based on our review and consideration of the above, and in light of current moderate weather conditions and forecasted resumption of very warm conditions, along with prospective Hells Canyon releases later this week, the Corps decided to begin implementation of the NOAA recommended operation for the next 2 days. Consistent with the first experimental emergency 2-day operation (see email below), this operation will include a period of no spill during the daylight hours of 4am to 8pm and a period of a single unit operation at minimum generation while spilling the remainder of outflow during the nighttime hours of 8pm to 4am. LGS will resume operations that were underway prior to this experimental operation on Thursday, July 30 at 4am.

The Corps acknowledges there are regional sovereigns that support this experimental 2-day operation and others that oppose; however, a timely decision was necessary given the immediate need to attempt to improve passage conditions for the endangered adult sockeye passage. If you have new information that has not yet been shared, please send to me as soon as possible. Additionally, if you have new proposals to address adult sockeye passage (and other adult migrants) for the Corps' consideration or have other information regarding this 2-day experimental operation, please send to me and we will discuss at our next TMT meeting on Wednesday, July 29 at 9am.

Regards,
Doug
Doug Baus
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Phone: (503) 808-3995
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July 28 – Fish Passage Advisory Committee

Concern was expressed that decisions are being made outside of the process and agreed upon time lines. Although FPAC members understood that no decision was to be made until after the RIOG meeting on Tuesday, July 28th, NOAA recommended that the COE implement the experimental blocks this morning (see above e-mail from COE on July 27th) in an attempt to assist upriver migration as soon as possible with the hope that adults passing LGS during this operation would arrive at LGR prior to the weekend and, therefore, would have higher likelihood of being captured at LGR during trap and haul operation.

USFWS provided graphs of forebay temperatures at LGR, LGS, and LMN. They pointed out that the graphs demonstrated that LMN forebay temperatures did not appear to be as obviously correlated with LGS operational changes as the COE had claimed during the TMT and FPOM calls on Monday (July 27th), since both Lower Granite and Little Goose showed similar decreases in temperature.

At the meeting it was asked if NOAA had any more recommendations that may "surprise" FPAC members, and they said they were considering halting the operation of the RSW at LMN—but at this point no decisions have been made.

IDFG determined that collecting sockeye at Lyons Ferry Hatchery was not feasible.

July 29 – Technical Management Team Meeting

In response to the COE's July 27th meeting, the FPC distributed the ladder temperature analysis from USFWS and requested that the COE discuss the implementation of additional actions that may be taken, such as securing pumps at Little Goose Dam. The COE said that they did not find the temperature information "compelling." They said that cycling the locks at Little Goose Dam was not possible because of damage to the lock that presently needed to be addressed. They did not discuss cycling the locks at the other projects. With regard to the pumps they stated it was not feasible due to: (1) funding, (2) contracting issues, and (3) work orders (such as wiring) that would be necessary at the project. The Nez Perce brought up the fact that discussion of this was in the sense of an "emergency" and yet maybe actions weren't being taken in the sense of an "emergency."

The first day of the second LGS test produced adult counts of 1.

A TMT was called for the following day to discuss operations going forward.

July 30 – Technical Management Team Conference Call

NOAA proposed no additional testing at Little Goose Dam.

IDFG proposed two options to discontinue emergency trapping at LGR.

1. Trapping will end at noon on July 31, 2015.

2. Researchers continue to press that when there are any changes made to operations they observe an initial increase in adult passage. Therefore, commence operation of Unit 2 on Monday morning and collect fish until Wednesday at noon.

There was agreement to implement the second option. Operations will return to Unit 2 priority at Lower Granite Dam and will continue in that configuration unless further operational changes are recommended later in the month. All flow in excess of that needed to operate Unit 2 will be spilled in a uniform pattern and the RSW will not be operated.