Appendix H

2011

Dworshak Operations

1. Introduction

The NOAA Fisheries 2010 Biological Opinion (2010 BiOp) calls for cold water releases from Dworshak Dam from July through August to reduce water temperatures on the lower Snake River as measured at Lower Granite tailwater fixed monitoring station. Without the cold water releases from Dworshak, water temperatures on the lower Snake River could reach up to 75^{o} F. The Technical Management Team (TMT) is responsible for making recommendations on the amount and temperature of water to be released from Dworshak Dam based on information provided by Walla Walla District (NWW). NWW presented the CE-QUAL-W2 model run results at the TMT meetings in July and August. This Appendix describes Dworshak Dam summer operations and its affect on the lower Snake River water temperatures.

2. 2010 BiOp, RPA Actions

The NOAA Fisheries 2010 BiOp, RPAs 4 and 15 calls for several actions associated with Dworshak Dam summer operations:

RPA 4 – Storage Project Operations:

1. Refill the reservoir by about June 30 to 1600 ft.
2. Draft the reservoir to elevation 1535 feet by the end of August and elevation 1520 feet (80 feet from full) by the end of September unless modified per the Agreement between the U.S. and the Nez Perce Tribe for water use in the Dworshak Reservoir.
3. Regulate outflow temperatures to attempt to maintain water temperatures at Lower Granite tailwater at or below the water quality standard of 68° F.

RPA 15 – Water Quality Plan:

4. Continued development of the CE-QUAL-W2 model for estimating river temperatures from Dworshak Dam on the Clearwater, Middle Snake River near the confluence with the Grand Ronde River (Anatone gauge) and through the lower Snake River (all four Corps lower Snake River projects). The model results are used to assist in real-time decision making for Dworshak Dam operations.

3. Dworshak Operations

The 2010 BiOp, RPA Actions 4 and 15 call for the following Dworshak Dam specific actions. Each specific action has the associated dam operation provided:

<u>RPA Action 4 - Storage Dam Operations:</u>

1. Refill the reservoir by about June 30 to 1600 feet.

Dworshak reservoir was refilled to elevation 1600 feet on July 13th. The inflows into Dworshak reservoir were above 14 kcfs (approximately full powerhouse discharge and 110 percent TDG spill) from May 9 to July 10, 2011 prohibiting an earlier refill date due to operations for flood risk management.

2. Draft the reservoir to elevation 1535 feet by the end of August and elevation 1520 feet (80 feet from full) by the end of September unless modified per the Agreement between the U.S. and the Nez Perce Tribe for water use in the Dworshak Dam.

Dworshak reservoir was drafted to elevation 1535 feet on September 4, and drafted to elevation 1520 feet on September 22, consistent with the agreement with the Nez Perce Tribe. The draft to elevation 1535 feet was later than August 31 due to the late runoff and refill. This was discussed at TMT and the target elevation was reached on September 4, with maximum releases from Dworshak not exceeding 110 percent TDG.

3. Regulate outflow temperatures to attempt to maintain water temperatures at Lower Granite Dam tailwater at or below the water quality standard of 68° F.

Dworshak reservoir outflows were managed to maintain water temperatures at Lower Granite Dam tailwater below 68^{o}F as shown on Figure H-1. There was one short period from August 5 to 7 in which the tailwater temperature at Lower Granite Dam exceeded 68^{o}F for 8 hours, but the daily average only reached 67.8^{o}F. During that period, Dworshak Dam released the maximum kcfs to avoid exceeding 110 percent TDG (14.6 kcfs) and the release temperatures were as cold as possible (45^{o}F). Seasonal average discharge temperatures during flow augmentation season from 2000-2011 are shown on Figure H-2. Dworshak operations were coordinated at TMT meetings eight times during July through September 2011, as shown on Table H-1.

RPA Action 15 - Water Quality Plan:

4. 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 (Anatone gauge) through the four lower Snake River dams to assist in real-time decision making for Dworshak Dam operations.

The CE-QUAL-W2 model was used from late June through early-September 2011 to support decisions regarding operation of Dworshak Dam for flow augmentation and temperature management on the lower Snake River. The results were presented and discussed routinely with TMT members and FCRPS Action Agencies to develop best management strategies. Table H-1 provides the dates that temperature model results were provided to TMT.

During 2010, NWW worked with a contractor and the model developer to make significant improvements in the pre- and post-processing of the data required to run the model and to display output. The updated model was used in 2011.

4. Dworshak Dam Storage Project Operations Summary

In 2011, water from Dworshak reservoir was drafted to meet BiOp reservoir pool elevations or for temperature moderation on the lower Snake River. These operations began on July 12 and continued through September 22, when the Dworshak reservoir elevation reached 1520 ft. The Dworshak Dam operations were coordinated with TMT eight times during July through September. Table H-1 summarizes the TMT requests and decisions on Dworshak Dam discharge temperatures and flows. TMT made specific requests for temperature moderation on August 3, 10 and 17 (see Table H-1). Note that the request made at the August 17 TMT meeting, to continue discharging 45^{o}F water was implemented but could not be maintained due to a shortage of 45^{o}F water available in mid to late August. The remainder of the summer period Dworshak releases were driven by attempting to meet BiOp pool elevations without exceeding 110 percent TDG per the Idaho State water quality standards. These operations resulted in a peak discharge rate of 14.6 kcfs and a total volume of 1.70 Maf from July 12 through September 22. The average discharge rate for the summer period was 11.9 kcfs.

Table H-1:
Dworshak Summer Operation Coordination with TMT
July 1 - September 22, 2011

TMT Meeting Date	Presented CE-QUAL-W2 Results at TMT	TMT Coordinated DWR Discharges in kcfs	TMT Coordinated DWR DischargesTemperature
7/13/2011	Yes	14	none stated at TMT
7/20/2011	Yes	14	none stated at TMT
7/27/2011	Yes	14.5	none stated at TMT
8/3/2011	Yes	14.2	Requested 45 ^{o}F
8/10/2011	Yes	not discussed	continue with 45 ^{o}F
8/17/2011	Yes	13.2 - 14	continue with 45 ^{o}F
8/31/2011	Yes	13.4	none stated at TMT
9/14/2011	Yes	5.9 kcfs until 9/15	none stated at TMT
9/14/2011	Yes	4.8 kcfs from 9/15 to 9/17	none stated at TMT
9/14/2011	Yes	2.4 kcfs from 9/17 to 9/22	none stated at TMT
9/14/2011	Yes	1.2 kcfs after 9/22	none stated at TMT

5. Effects of Cold Water Releases on Lower Granite Dam Tailwater Temperature.

Lower Granite Tailwater Temperature Summary.
The daily average tailwater temperatures at Lower Granite Dam did not exceed 68°F from July 1, 2011 to September 30, primarily because of these factors:

1) The above average precipitation in June; and
2) Dworshak cool water releases throughout the summer.

Water year 2011 resulted in above average inflows to Dworshak Reservoir, similar to many other tributary basins in the Snake River watershed. The precipitation on the lower Snake River above Ice Harbor Dam in June was 126 percent of normal, which resulted in additional cooler water for June. The late spring precipitation significantly improved the water year and assisted in providing increased flow for water temperature moderation in the lower Snake River during July through September.

Figure H-1 shows the TMT temperature requests for 45^{o}F water discharge and its impact on Lower Granite Dam and Dworshak Dam tailwater temperatures during July through September 2011. Figure H-1 shows that the TMT request on August 3 for 45^{o}F water resulted in about a 5^{o}F reduction in the Dworshak Dam tailwater temperatures, and about a 3^{o}F reduction in the Lower Granite Dam tailwater temperatures. This 3^{o}F reduction in the Lower Granite Dam tailwater temperatures prevented it from exceeding 68°F on a daily average. Without the cool water released from Dworshak Dam, there would have likely been temperature exceedances in August.

Figure H-1
TMT Decisions Affect on
Lower Granite and Dworshak Tailwater Temperatures
July 1- September 22, 2011

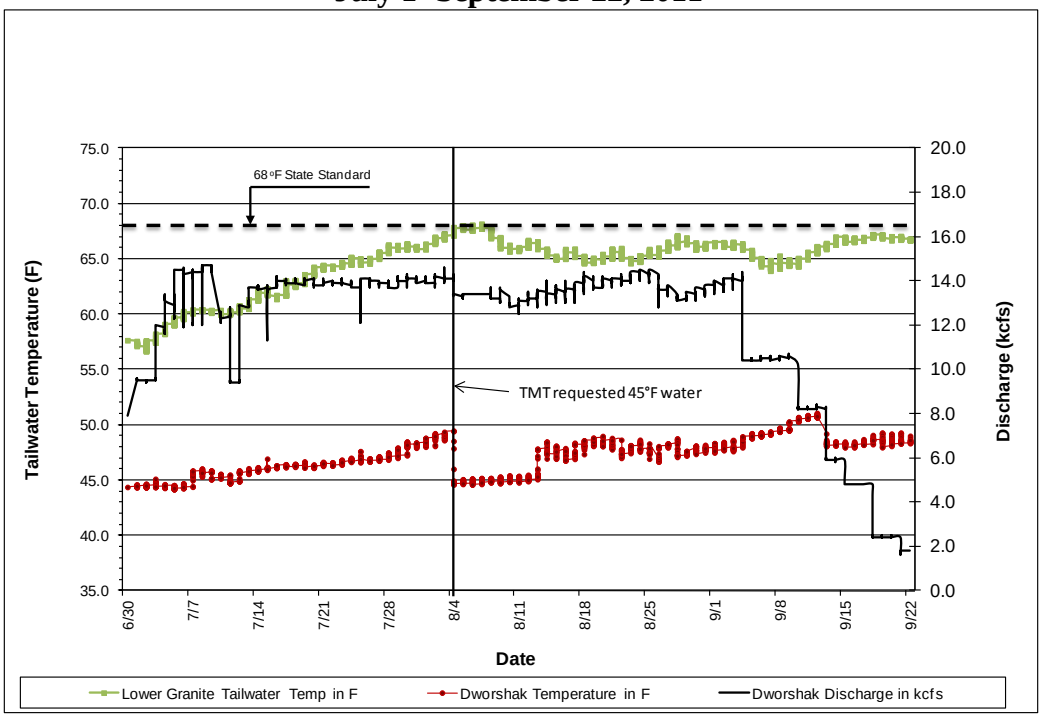
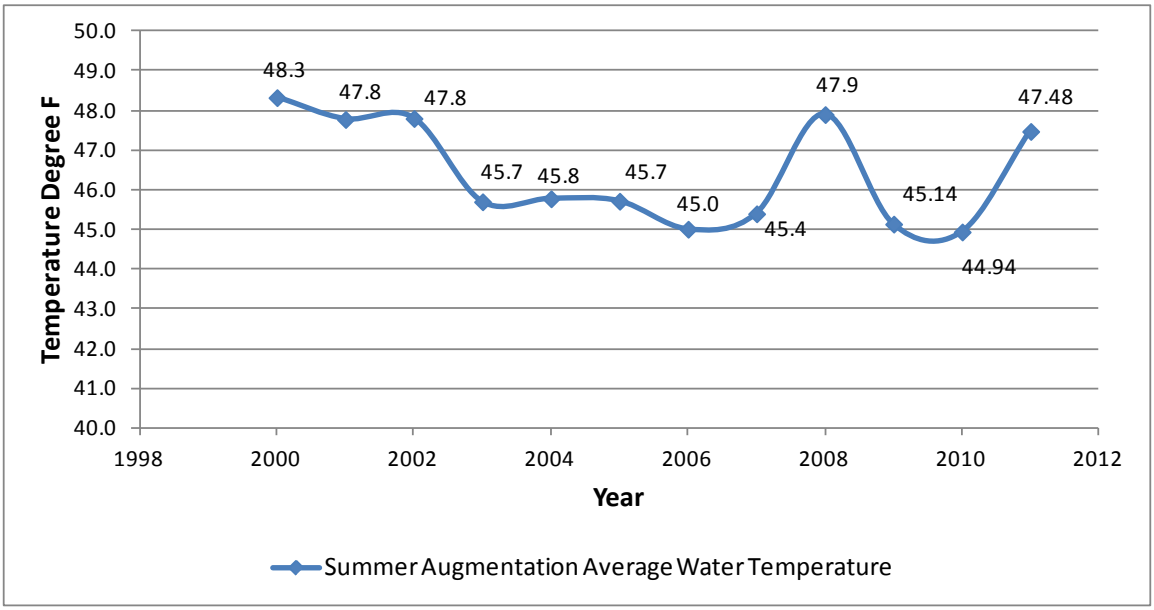
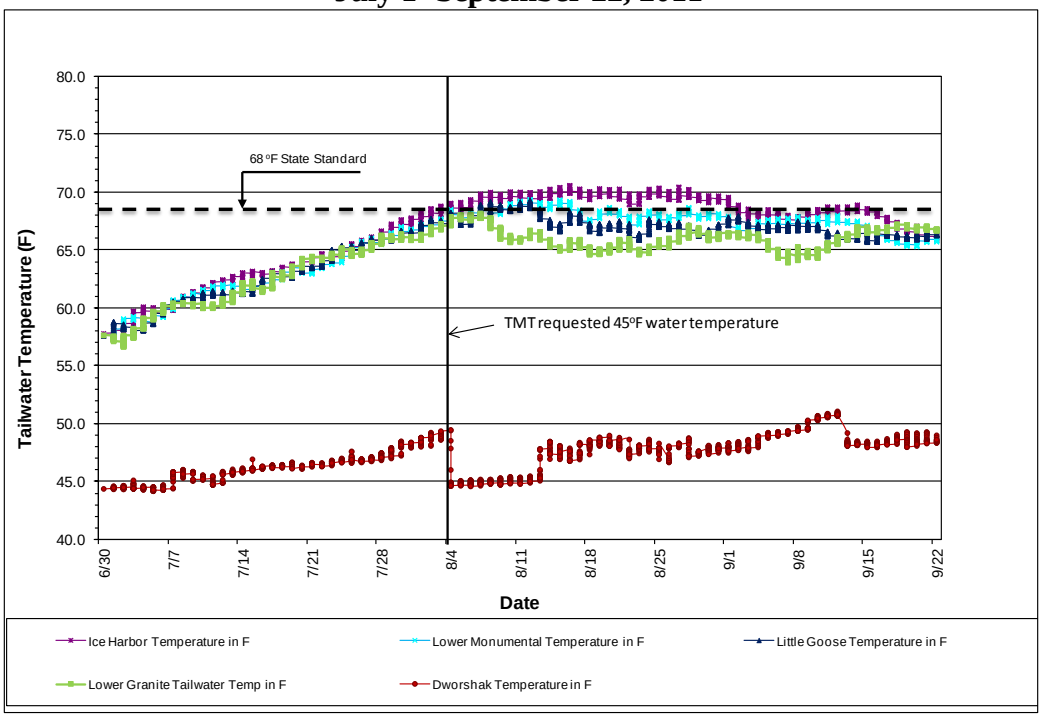


Figure H-2
Dworshak Dam Seasonal Average Discharge Temperature
2000-2011



As Figure H-3 shows, the Dworshak Dam cool water releases also reduced water temperatures in lower Snake River below Lower Granite Dam. Although the lower Snake River water temperatures exceeded 68°F at Ice Harbor, it was lower than it would have been without the Dworshak cool water releases.

Figure H-3
TMT Decisions Affect on Lower Snake River Temperatures
July 1- September 22, 2011



6. Water Temperature Modeling

a. CE-QUAL-W2 Model Summary.

The CE-QUAL-W2 model was used from late June through early-September 2011 to support decisions regarding operation of Dworshak Dam for temperature management on the lower Snake River. The results were presented and discussed routinely with TMT members and FCRPS Action Agencies to develop best management strategies. Table H-1 lists the dates of model presented to TMT during July through September, 2011. The CE-QUAL-W2 modeling performed during the 2011 Dworshak Dam summer operations fulfilled the specific requirements of RPA 15.

b. Water Quality Model Improvements.

During 2011, NWW worked with a contractor McMillen, LLC to upgrade the pre-processor functions in the existing Dworshak model. Most of the improvements were made in the pre-processor "Create input files" sub-routines. Some improvement was made in the ability for the preprocessor to produce additional Lower Granite files and

the ability of the pre-processor to convert .csv files to .npt files was improved. Significant effort was applied prior to the temperature monitoring season to make repairs to the contractor provided meteorological pre-processor subroutine. Unfortunately, the NWW staff was unable to use this portion of the McMillen update. For monitoring season 2011, NWW staff continued to use the Agrimet spreadsheet from the SYSTDG model to compile met files. The simulation program was updated to run in either CE-QUAL-W2 version 3.2 or 3.6 models.

Several updates and improvements were made to the model by NWW staff. A script was written in python to systematically go out to the various websites and force update the weather database provided by the Corps Engineering Research and Development Center. A model archive and un-archive script was written in python to keep model runs from previous dates for QA/QC and diagnostic purposes. The most impressive contribution made by NWW staff to the model functionality was the creation of a Nash-Sutcliffe model efficiency program. Written in python, the model coefficient is expressed by:

$$E = 1 - \frac{\sum_{t=1}^{t}(Q_t^t - Q_m^t)^2}{\sum_{t=1}^{t}(Q_t^t - Q_m^t)^2}$$

The Nash-Sutcliffe was used for the determination of best fit when selecting analog years to use in the model simulation as a surrogate. Considerable time saving was realized when using the Nash-Sutcliffe calculations.

7. Conclusion

Overall, the Dworshak summer operation to cool the lower Snake River was successful. The Dworshak cool water releases played an instrumental role in preventing water temperature exceedances of the state temperature water quality standards at Lower Granite Dam tailwater.