Summary of Flow and Water Quality Conditions
Willamette Basin Science Review
February 4-6, 2014

Prepared by: U.S. Army Corps of Engineers, Portland District, January 2014

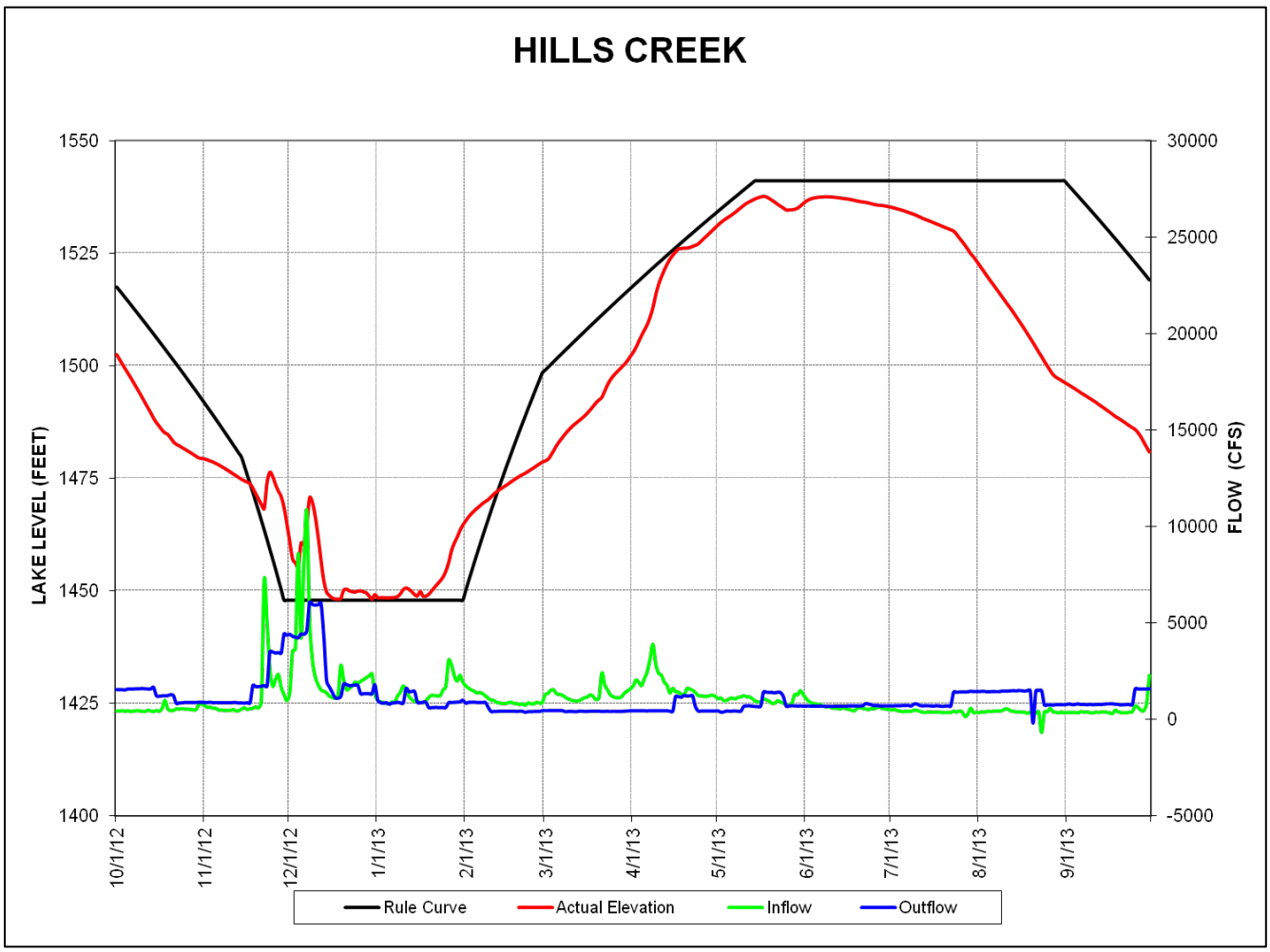
The following document summarizes Willamette Basin Project operations, water quality conditions, and flows as measured throughout the basin in Water Year 2013. This information can be used as a reference throughout the three-day conference. This information should be treated as draft, subject to change.

For additional information regarding the regulation of the Corps reservoirs and other associated water management activities in the Willamette Basin of Oregon during Water Year 2013, please refer to the *Willamette Basin Year in Review, WY 2013*, which was distributed to the WATER Flow Management and Water Quality Team (FMWQT) on January 2, 2014. Additional information describing water quality monitoring, data collection and improvement actions implemented throughout the Willamette Basin in 2013 can be found in the *Willamette Basin Annual Water Quality Report for 2013*, which will be distributed to the region via the WATER FMWQT in March 2014.

PROJECT OPERATIONS

Figures 1 through 11, below, show project operations for Water Year 2013. Rule curve (black line), actual elevation (red line), inflow (green line) and outflow (blue line) are graphed.

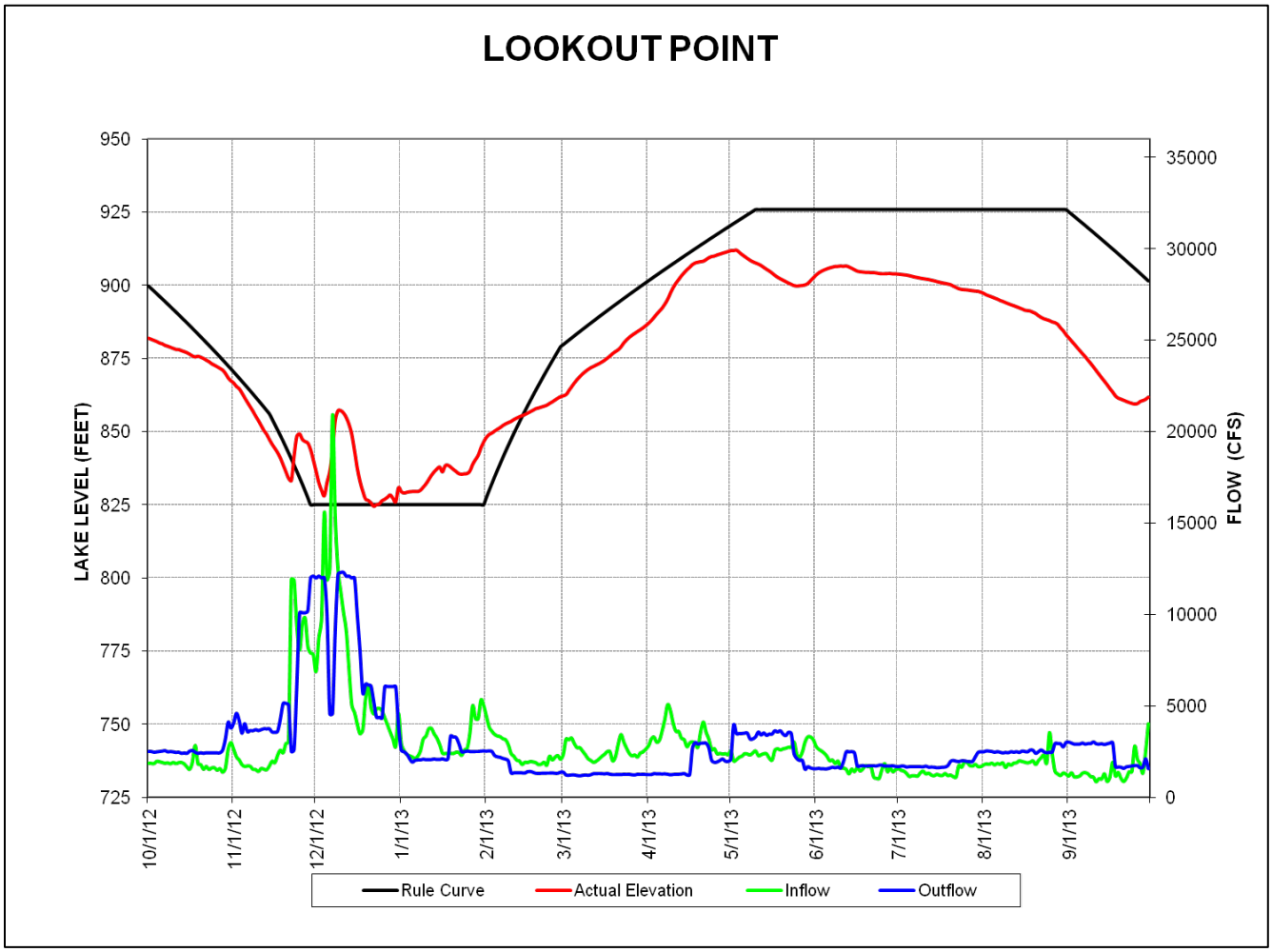
Figure 1. Hills Creek Observed Operation in WY 2013.



Hills Creek Reservoir refilled to maximum summer conservation pool elevation and provided summer recreation opportunities. There were no special operations conducted this water year. Storage in Hills Creek was used to keep Lookout Point above spillway crest to maintain operational temperature control throughout the summer.

Hills Creek outflow approached normal evacuation rate of 6,000 cfs in early December.

Figure 2. Lookout Point Observed Operation in WY 2013.

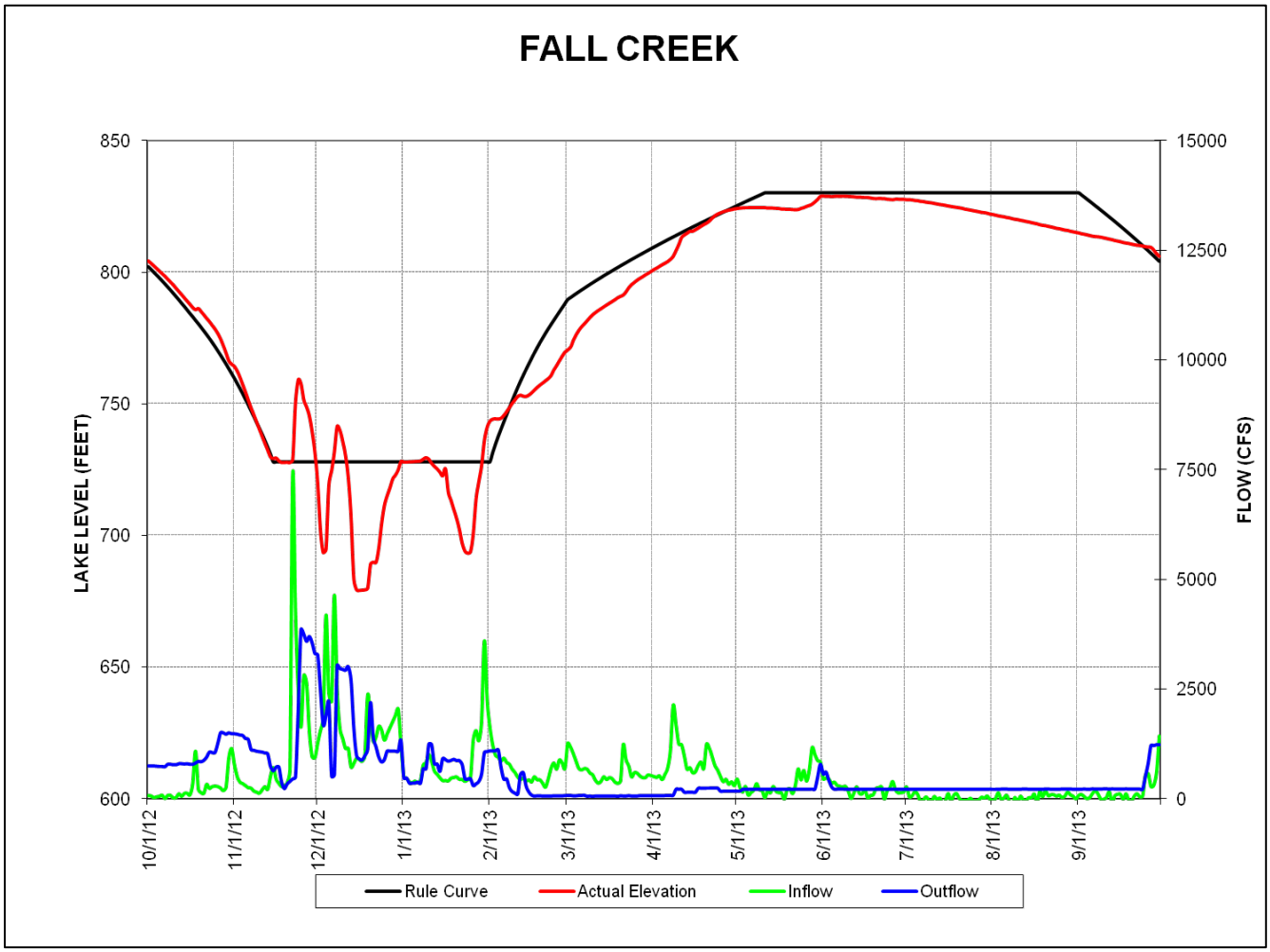


Lookout Point Reservoir was only allowed to refill to elevation 915 due to structural issues with the spillway gates. A modified operating plan with interim risk reduction measures (IRRM) was submitted to the Northwestern Division water management office for approval prior to the winter operating season. The winter spillway gate operating limit was not reached and special measures did not go into effect during the winter operating season.

Lookout Point was operated to provide downstream water temperature management by splitting flow between the powerhouse and spillway. Hills Creek stored water was used in late August and early September to keep the Lookout Point Reservoir above spillway crest for as long as possible, without jeopardizing fall flow needs. The temperature management operation was conducted from June 4 – August 21 by splitting flow rather evenly between the turbine and the spillway. The operation ended when the reservoir was drafted below spillway crest.

Dexter outflow approached normal evacuation rate of 12,000 cfs in December. These flows may provide downstream ecological benefits.

Figure 3. Fall Creek Observed Operation in WY 2013.



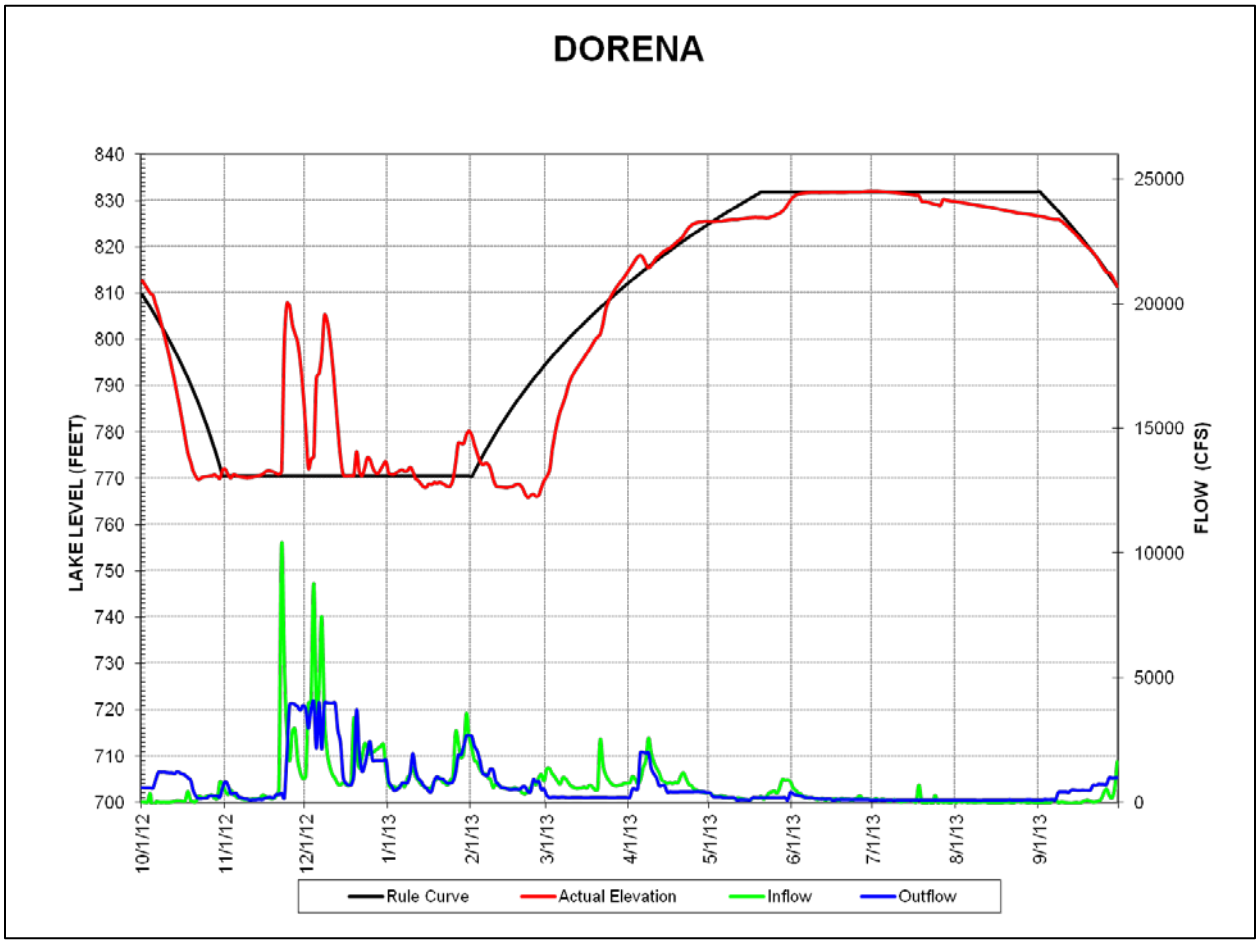
Fall Creek was drawn down for volitional downstream fish passage and predation management goals in December and January, 2012. There was very little lake left behind the dam at elevation 680 feet NGVD and the flow was channelized to the original river bed. During this operation, the USGS monitored downstream sediment and bedload transport. This information will be presented by Liam Schenk, USGS, on day two of the Willamette Basin Science Review.

Late in January, an additional drawdown to elevation 690 was implemented to allow for inspection of the lower fish horns and associated pipe-works to the adult fish trap. This information will be used to inform design of the new Fall Creek adult fish facility.

Throughout the year, the fish trap and fish horns were operated as normal.

Fall Creek outflow approached the maximum evacuation rate of 4,500 cfs in November and December. This flow may provide downstream ecological benefits.

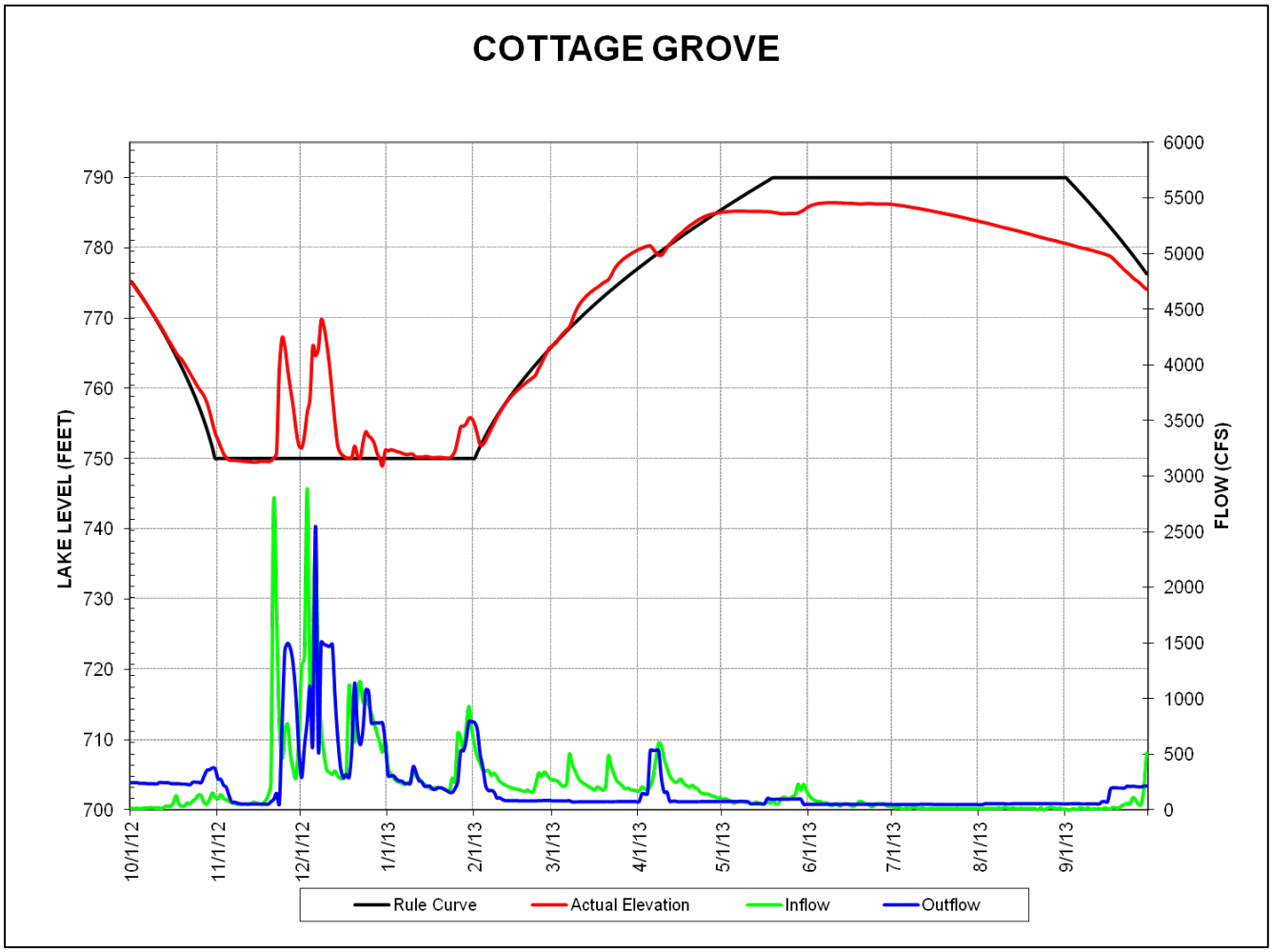
Figure 4. Dorena Observed Operation in WY 2013.



Dorena Reservoir was operated to meet the rule curve throughout the year. Outflow was reduced to the summer minimum flow in March, which helped the reservoir refill to provide summer recreation opportunities.

Construction of the private hydropower facility, authorized by the Federal Energy Regulatory Commission (FERC), began in late September 2012 and continued thru the year. The reservoir was held near minimum conservation pool in February to facilitate the drilling of the new penstock thru the dam.

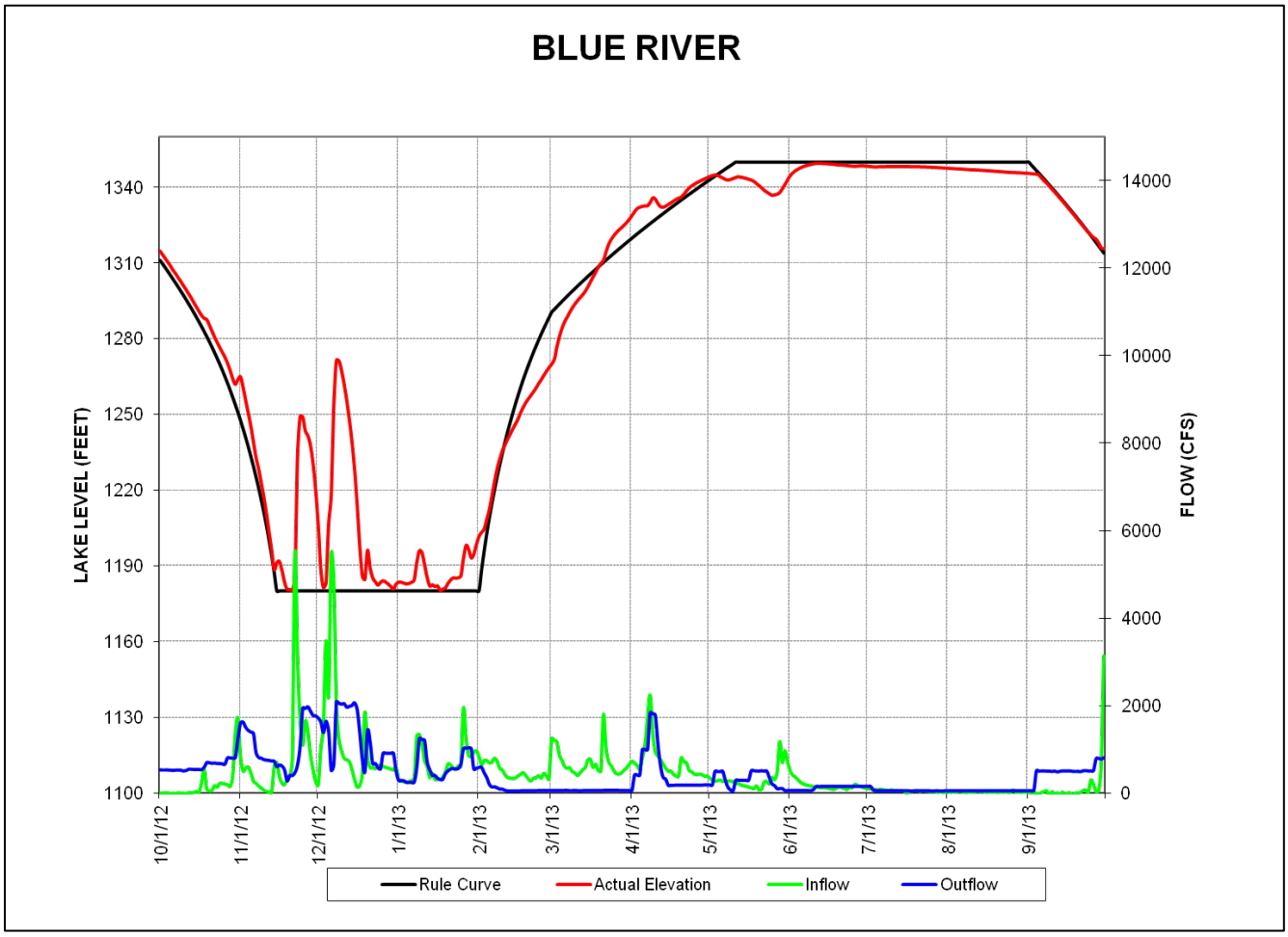
Figure 5. Cottage Grove Observed Operation in WY 2013.



Cottage Grove Reservoir was operated to meet the rule curve throughout the year. Outflow was reduced to the summer minimum flow in March, which helped the reservoir refill to provide summer recreation opportunities.

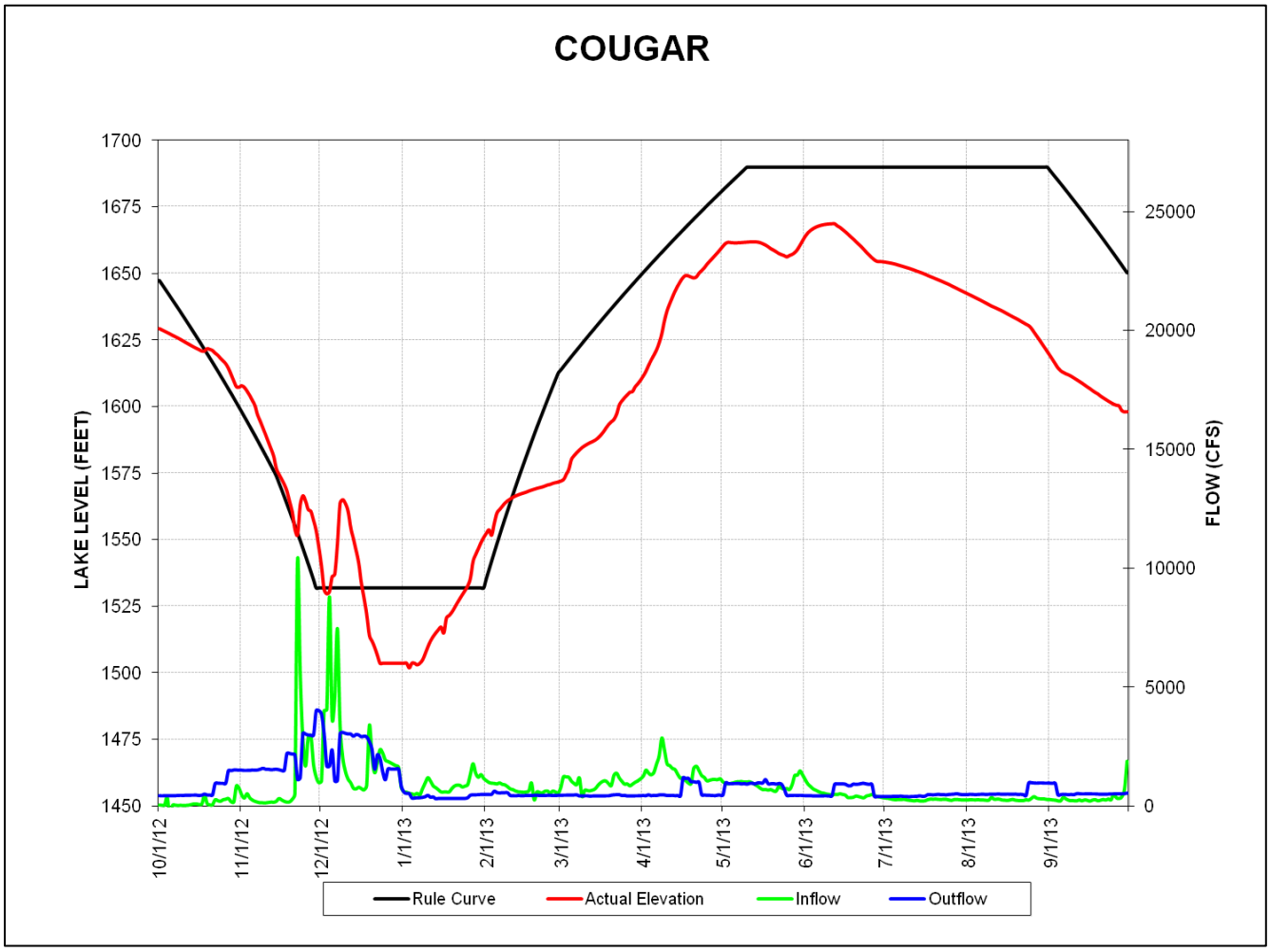
Cottage Grove outflow approached the normal evacuation rate of 2,500 cfs in early December. These flows may provide downstream ecological benefits.

Figure 6. Blue River Observed Operation in WY 2013.



Blue River Reservoir refilled and provided summer recreation opportunities. There were no special operations conducted this water year.

Figure 7. Cougar Observed Operation in WY 2013.



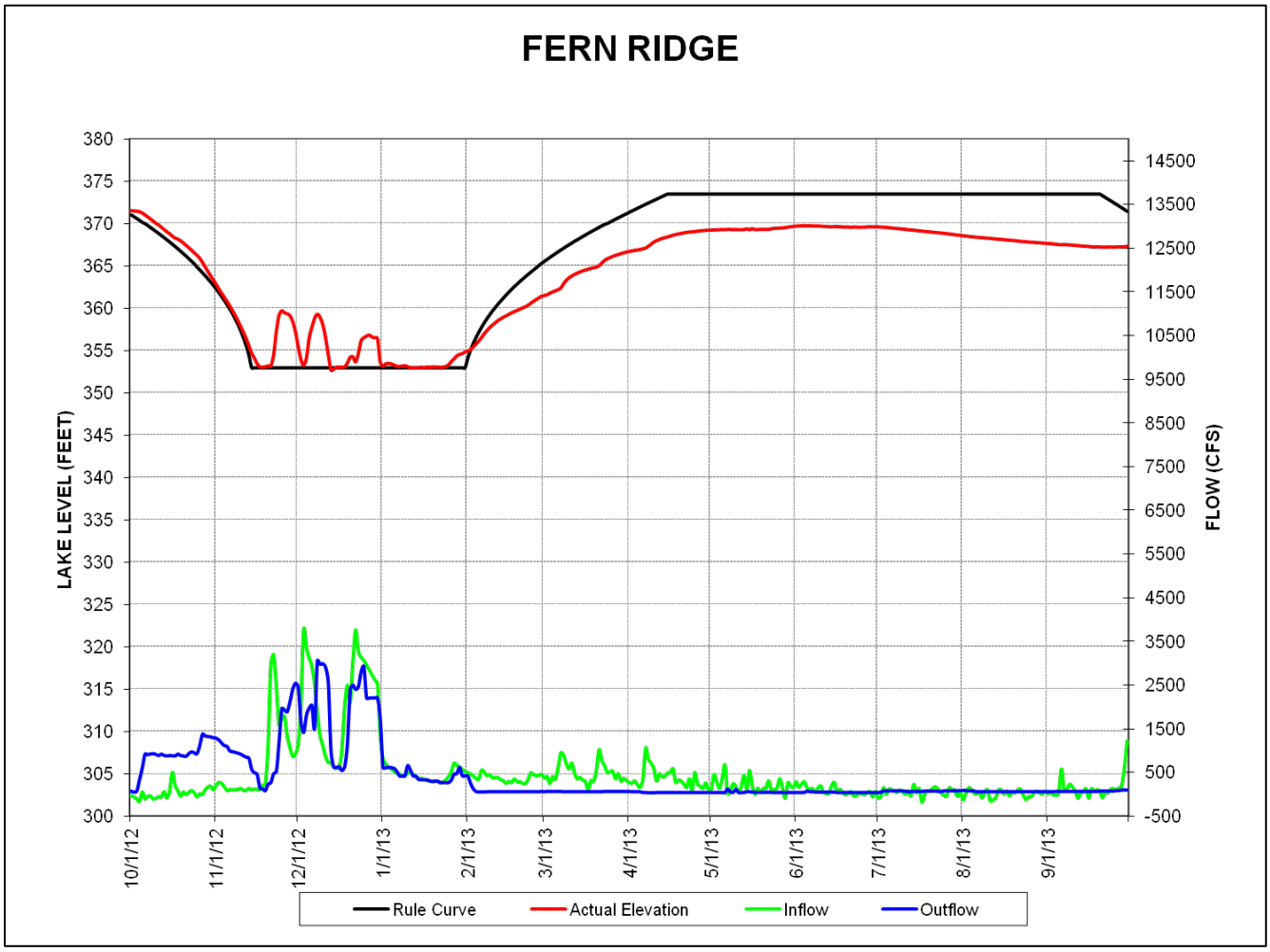
Cougar Reservoir was drafted early to avoid exceeding the maximum fall spawning flow of 580 cfs during drawdown. The lake became unusable to boaters after early August because of the early drawdown and no access to boat ramps.

The Cougar Water Temperature Control Tower was operated throughout the temperature control season (April – October) for temperature management.

A pulse of flow was released in early December to evacuate the reservoir but also to provide a winter pulse for downstream ecology.

A Special Operations Request (SOR) was approved and conducted for a deep drawdown during December. The reservoir was drafted below elevation 1510 feet from December 20- January 12, 2012.

Figure 8. Fern Ridge Observed Operation in WY 2013.



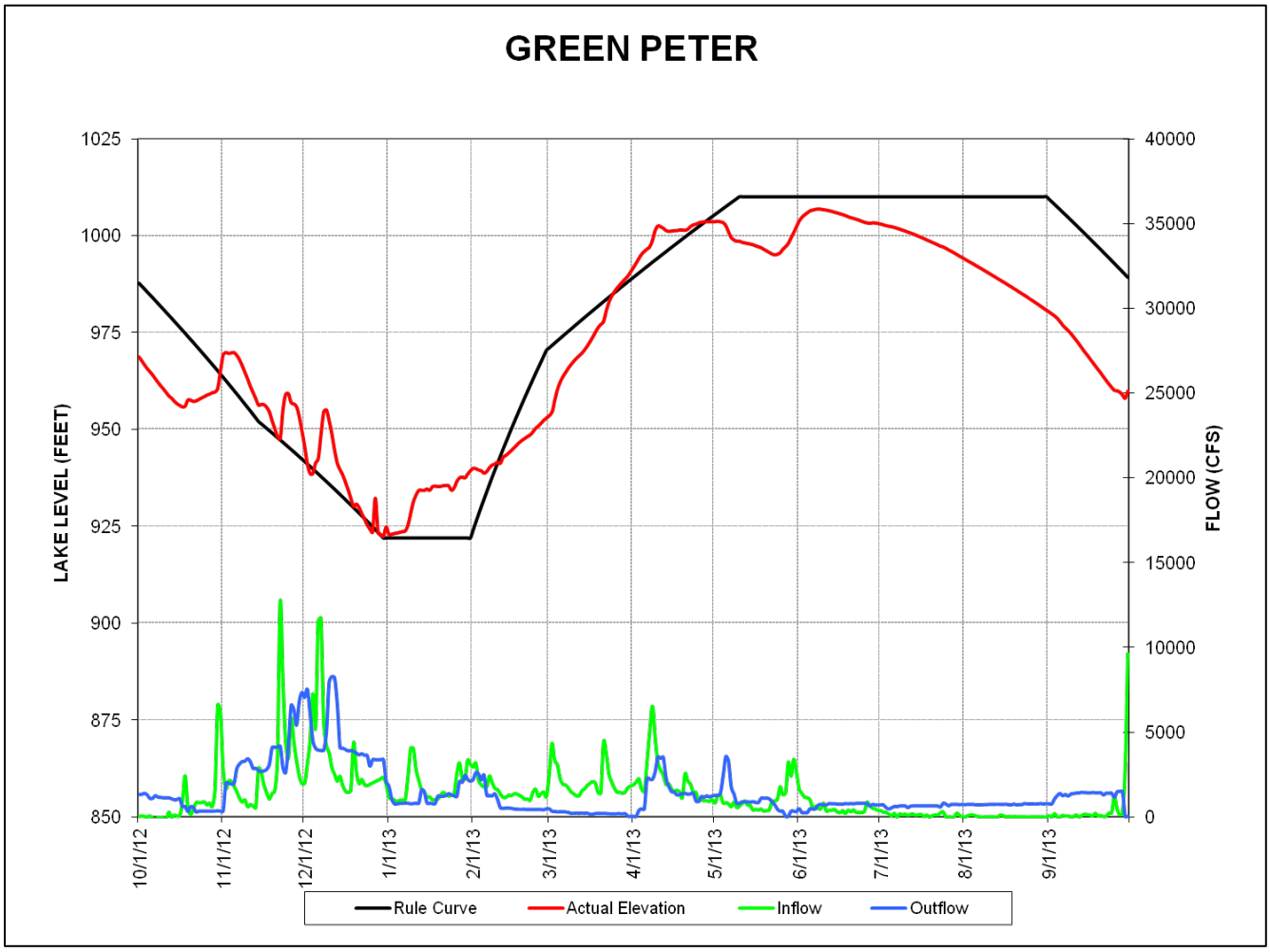
Fern Ridge did not refill to maximum summer conservation pool elevation and many of the sail boat owners expressed concern over the lake levels throughout the summer. There were no special operations conducted this water year.

The Junction City Irrigation District installed flash boards in the Lower Long Tom River to divert water at the Ferguson Drop structure to Fill Hulbert Lake for irrigation on May 30, 2012. A 100 cfs drop in flow at the Monroe gage was observed during this time.

Outflows were increased after October 15 for the fall drawdown ensuring that the local farmers and irrigators had adequate time to move equipment to winter storage after fall harvest. Christie Johnson at the Corps provided notice of the flow increase in mid-September.

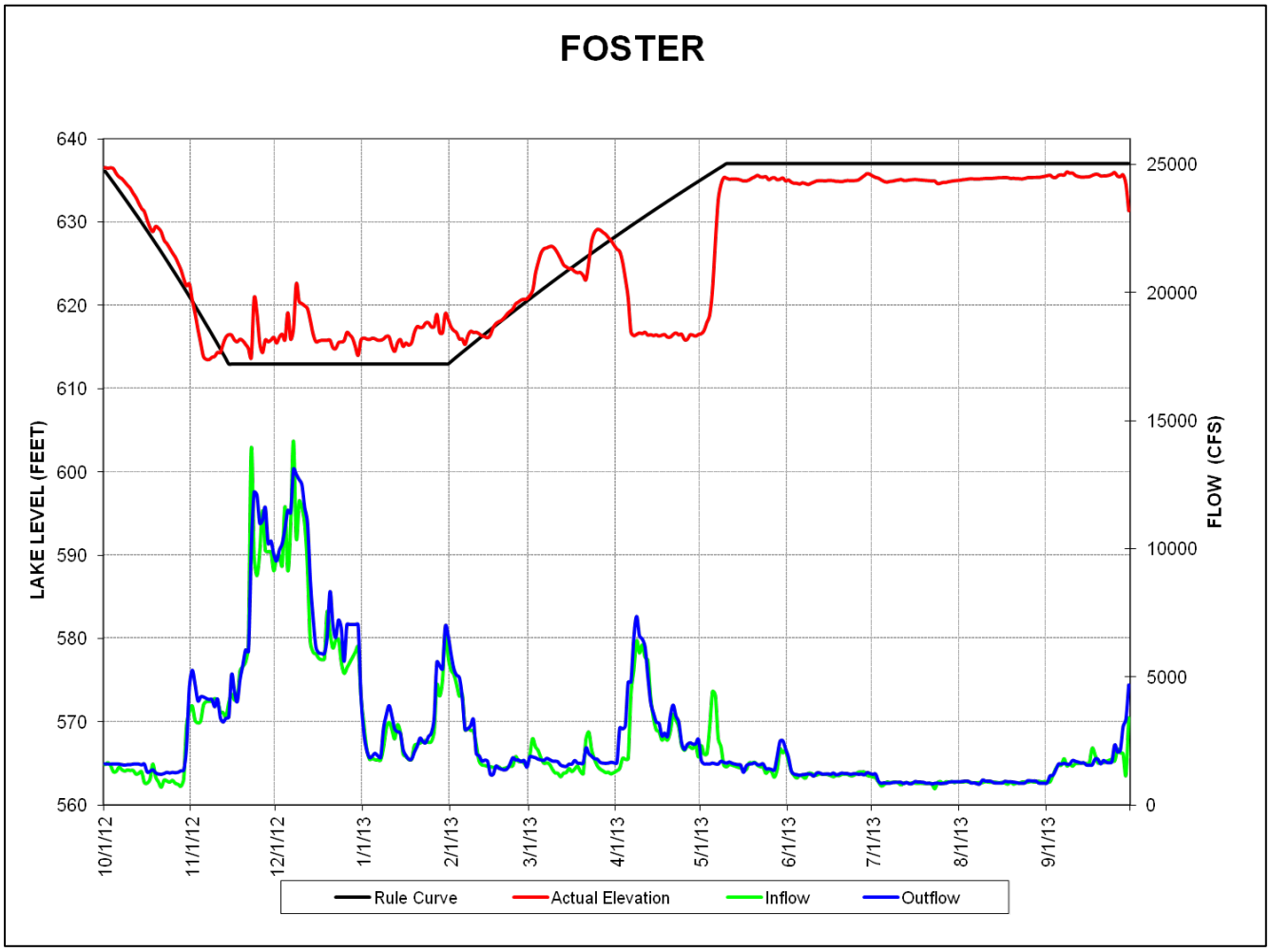
Waterbird nesting was greatly reduced at Fern Ridge because thousands of acres of emergent vegetation that grows above 369' msl and provides habitat to birds that nest in shallow water, was dry. There were also declines in the purple martin breeding population.

Figure 9. Green Peter Observed Operation in WY 2013.



Green Peter Reservoir refilled and provided summer recreation activities and fall spawning flows resulting in early drawdown. This is a common occurrence, as Green Peter Reservoir storage is typically used to meet mainstem flow targets throughout the summer.

Figure 10. Foster Observed Operation in WY 2013.

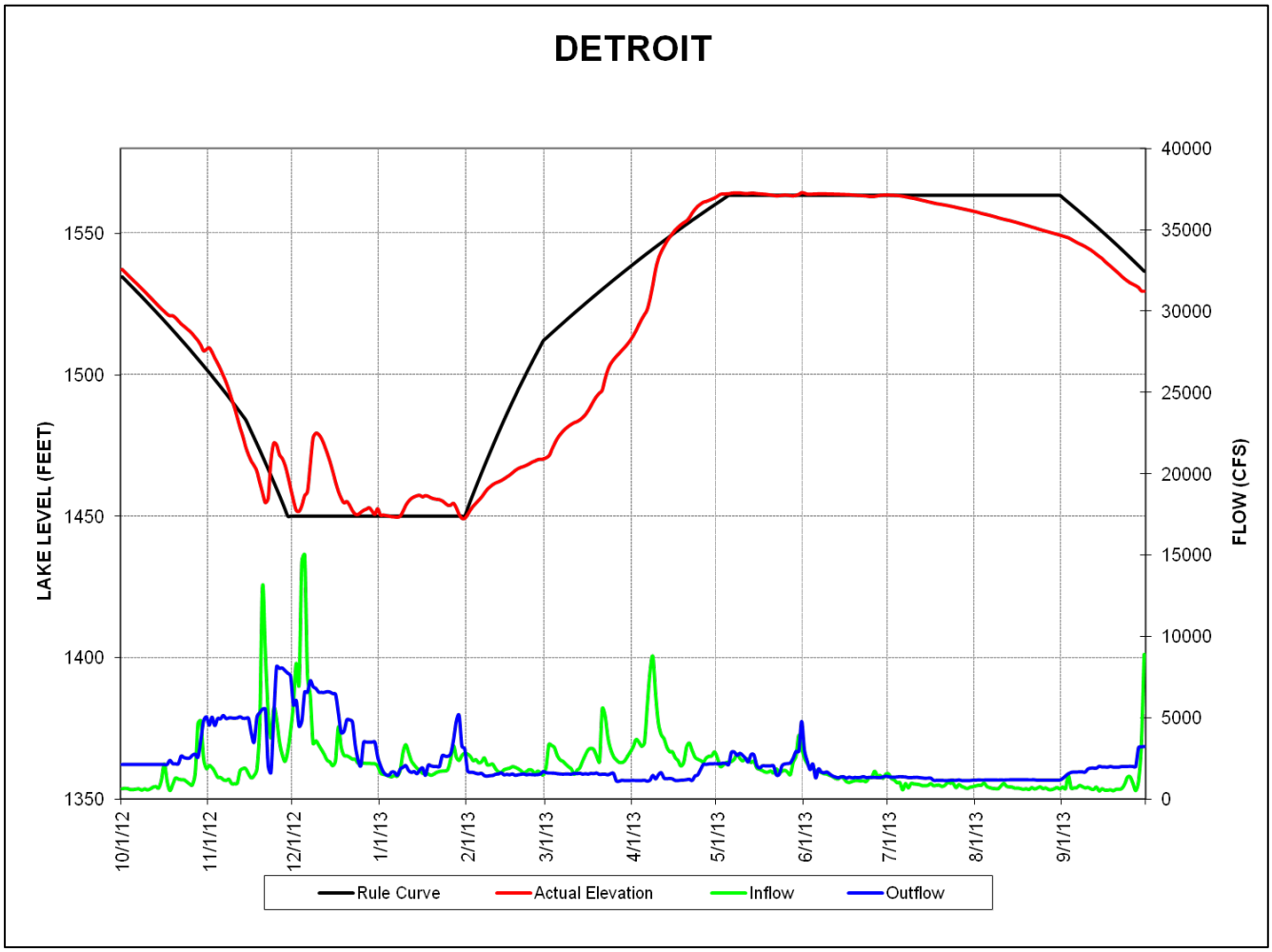


Foster Reservoir was operated for downstream fish passage from April 15 through September by using the spillway fish weir. Typically the fish weir has only been used from April through May 15; however, a special operation was approved and conducted, allowing the fish weir to remain in operation throughout the summer with the reservoir near full pool (elevation 634 feet).

Operating Foster near 634 feet for a summer fish weir operation did not have a major impact on recreation. Linn County Parks reported that visitors to the lake seemed to like the additional beach as a result of the lower lake level. The day-use docks at Lewis Creek Park need to be extended to accommodate larger boats, but the docks at Sunnyside Park Marina were usable because the water level did not drop too low.

Foster outflow approached the normal evacuation rate of 12,000 cfs in December. This flow may provide downstream ecological benefits.

Figure 11. Detroit Observed Operation in WY 2013.



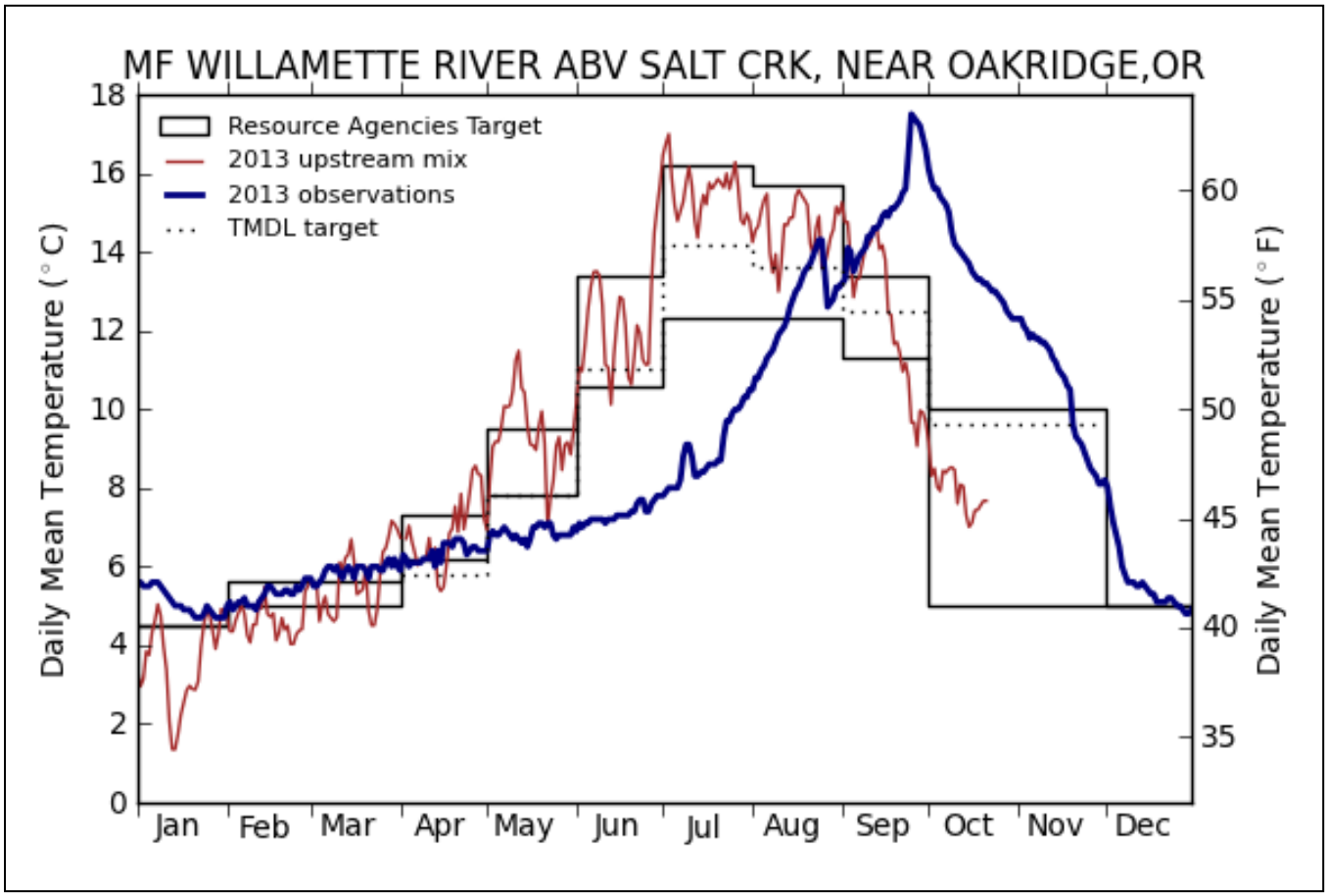
Detroit outflow was reduced to the summer minimum flow in March, which helped the reservoir refill to maximum summer conservation pool elevation to provide summer recreation opportunities.

Detroit Reservoir was operated to provide downstream temperature management from June 1 through September 9 by blending water from the turbine with water over the spillway. Downstream water temperature data measured below Detroit Dam is shown in the section below.

WATER TEMPERATURE CONDITIONS

Water temperatures were monitored throughout the Willamette Basin in 2013 and are compared to estimated upstream conditions and water temperature Figures 12-22 below.

Figure 12. Water Temperatures Measured Upstream and Downstream of Hills Creek Dam as Compared to Resource Agency and TMDL Targets.

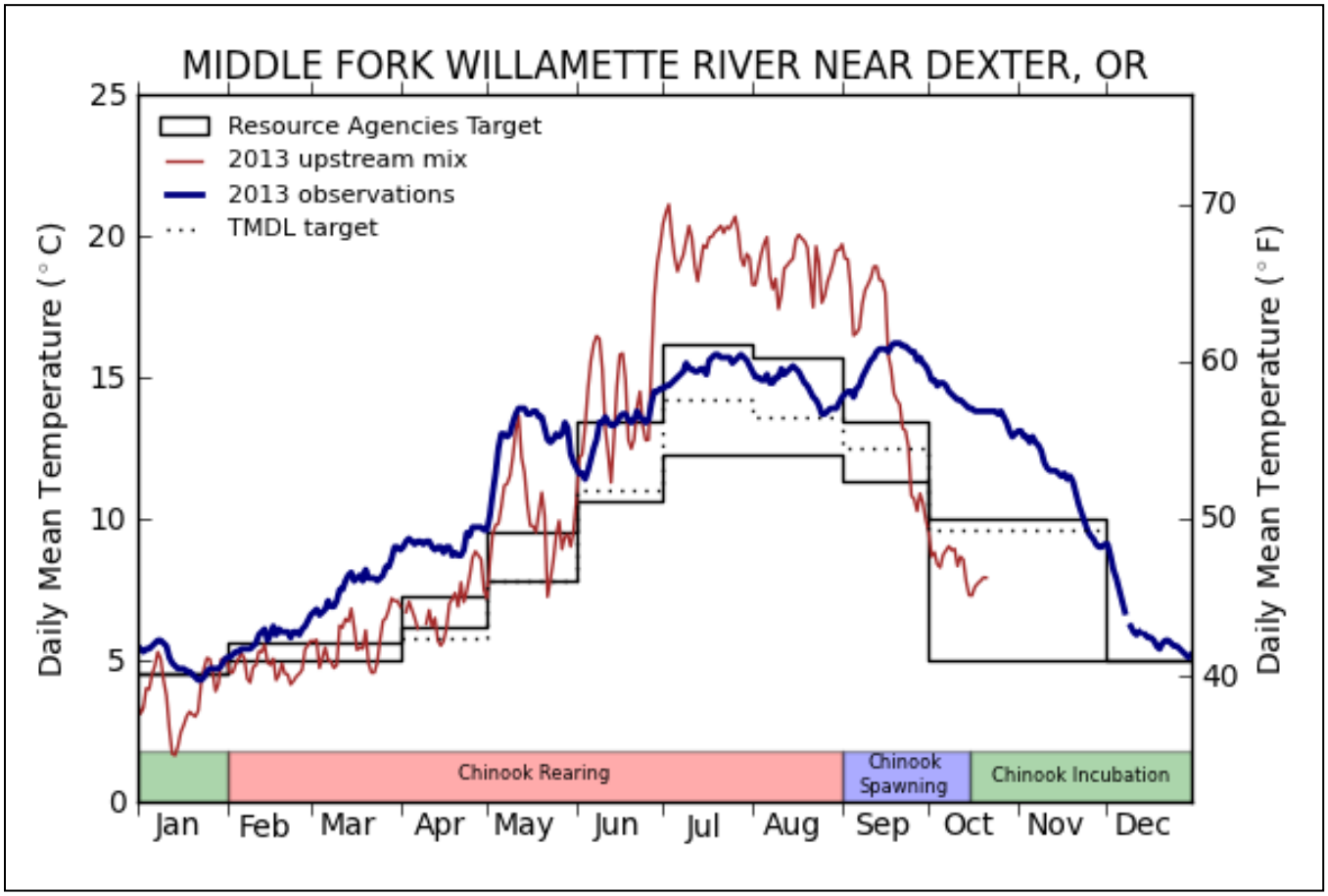


Water temperatures were measured downstream of Hills Creek Dam at the USGS gage, *MF Willamette River Abv Salt Crk, Near Oakridge, OR,* and compared to upstream mixed conditions, Total Maximum Daily Load (TMDL) targets and temperature targets developed by the resource agencies (originally for the South Fork McKenzie River below Cougar Dam).

The upstream mix conditions are based on regression equations that USGS developed which includes a warming factor that is applied to the inflows. The estimates of temperature without a reservoir, termed 'upstream mix', were calculated based on flow weighted averages of inflowing temperature plus an adjustment for downstream warming, based on Rounds (2010).

As evident by the downstream water temperatures (Figure 12), no operational temperature management operations were performed at Hills Creek Dam in 2013. Hills Creek Dam outflow temperatures peaked in the fall as a result of the prioritization of powerhouse operations and the release of unseasonably cold water throughout the summer. By fall, this cold water was mostly depleted leaving warmer water behind for release. In contrast, the upstream mix followed a more normal trend, peaking in the summer months and cooling during the fall and winter months.

Figure 13. Water Temperatures Measured Upstream and Downstream of Lookout Point and Dexter Dams as Compared to Resource Agency and TMDL Targets.

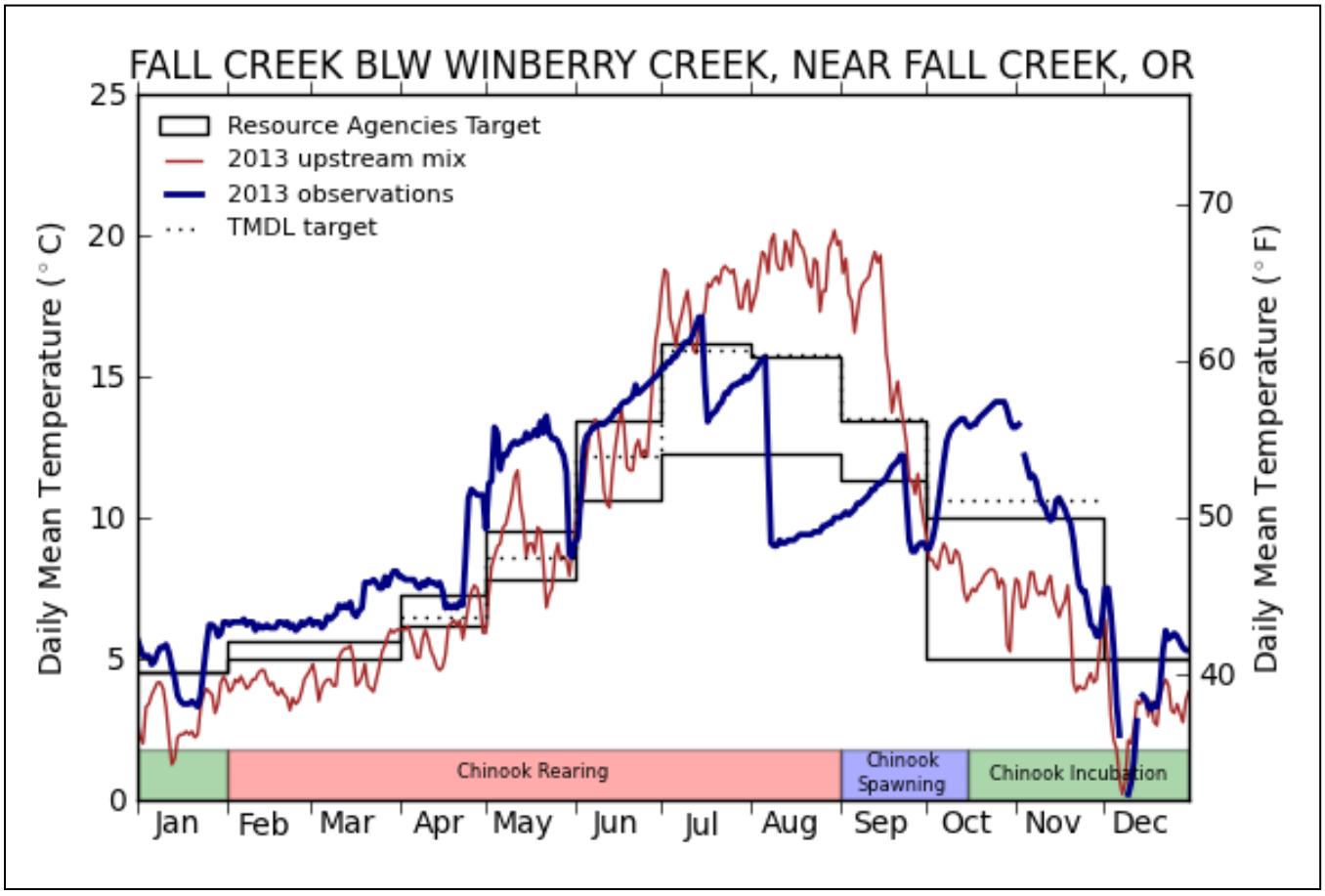


Water temperatures were measured downstream of Dexter Dam at the USGS gage, *Middle Fork Willamette River near Dexter,OR*, and compared to upstream mixed conditions, Total Maximum Daily Load (TMDL) targets and temperature targets developed by the resource agencies (originally for the South Fork McKenzie River below Cougar Dam).

The upstream mix conditions are based on regression equations that USGS developed which includes a warming factor that is applied to the inflows. The estimates of temperature without a reservoir, termed 'upstream mix', were calculated based on flow weighted averages of inflowing temperature plus an adjustment for downstream warming, based on Rounds (2010).

Water temperature management operations were conducted at Lookout Point Dam throughout the summer from June through August 21, 2013. Water temperatures measured below Dexter Dam were within the targeted temperature ranges until late summer. These targets, however, could not be met in the fall and winter and exceeded targets for spawning and incubation due to warm discharges from Hills Creek and Lookout Point Dams (Figure 13).

Figure 14. Water Temperatures Measured Upstream and Downstream of Fall Creek Dam as Compared to Resource Agency and TMDL Targets.

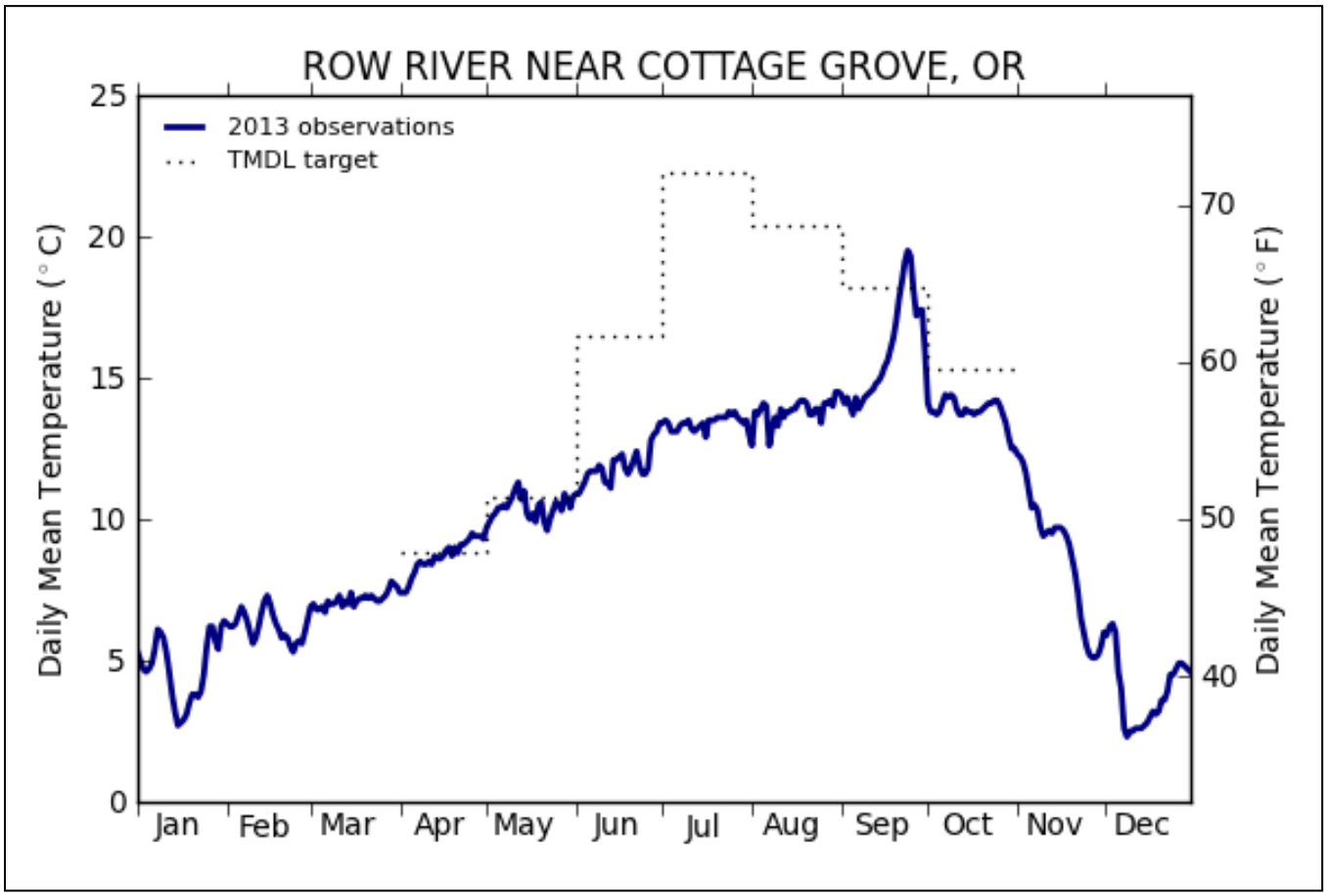


Water temperatures were measured downstream of Fall Creek Dam at the USGS gage, *Fall Creek Blw Winberry Creek, near Fall Creek, OR,* and compared to upstream mixed conditions, Total Maximum Daily Load (TMDL) targets and temperature targets developed by the resource agencies (originally for the South Fork McKenzie River below Cougar Dam).

The upstream mix conditions are based on regression equations that USGS developed which includes a warming factor that is applied to the inflows. The estimates of temperature without a reservoir, termed 'upstream mix', were calculated based on flow weighted averages of inflowing temperature plus an adjustment for downstream warming, based on Rounds (2010).

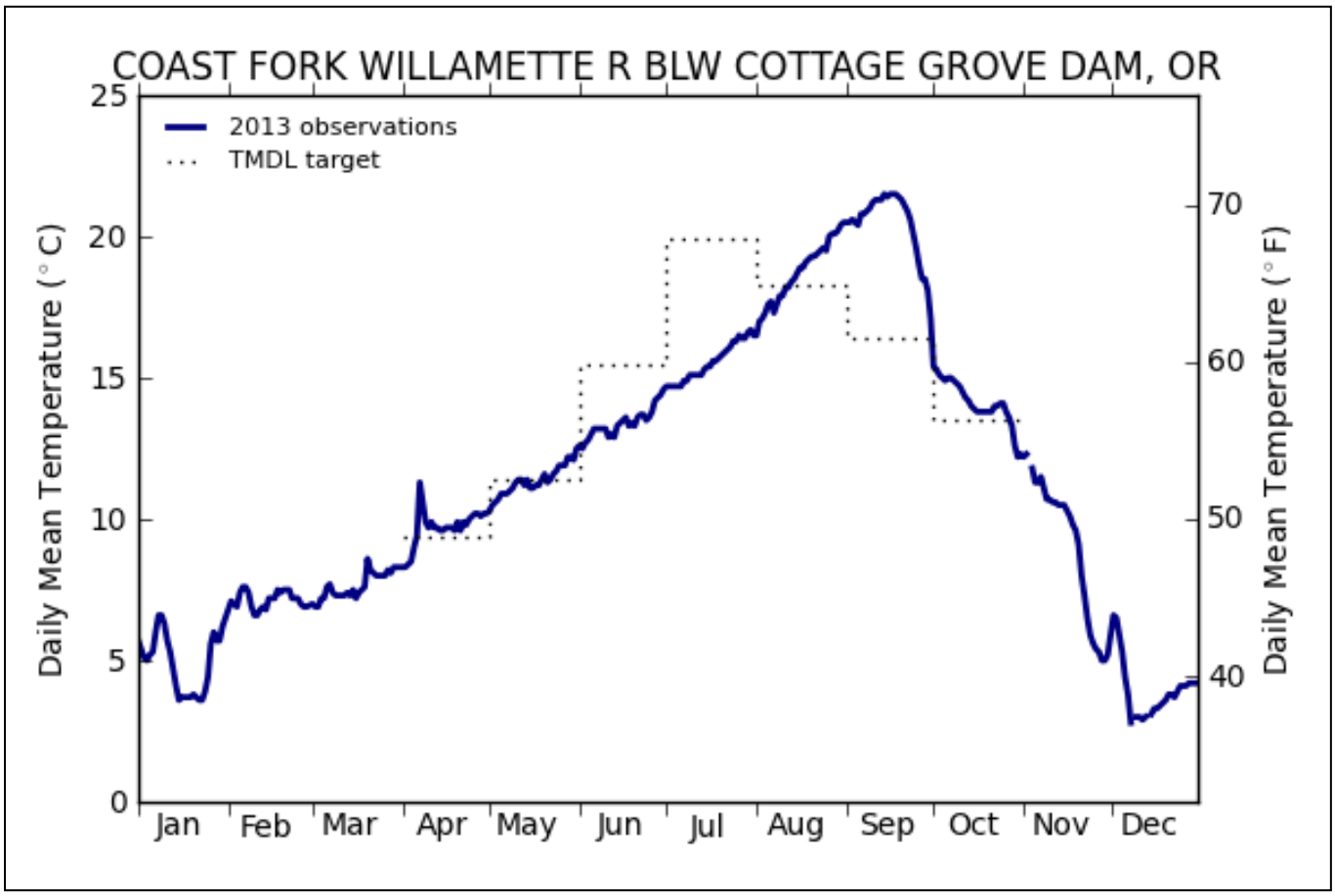
Fall Creek Dam has limited ability to manage outflow water temperatures due to the dam's structural limitations (i.e., fish horn elevations) and because the spillway gates are for emergency use only. Despite these limitations, Fall Creek Dam temperature management goals were achieved for a good portion of the spring and summer (Figure 14). Water temperatures increased and decreased below Fall Creek Dam as the fish horns and regulating outlets were adjusted to meet adult fish facility and in-river water temperature needs. Due to the limited design of Fall Creek Dam, some of these adjustments caused rather significant increases and decreases in water temperature, as observed in August for example. The operation of the RO's during reservoir drawdown released much of the cold water storage in Fall Creek Reservoir. From October to mid- November 2013, outflow temperatures climbed and were above the 50 ºF maximum target. As a result, temperatures in the fall and winter exceeded targets for spawning and incubation due to the lack of availability of cooler water.

Figure 15. Water Temperatures Measured Downstream of Dorena Dam as Compared to TMDL Targets.



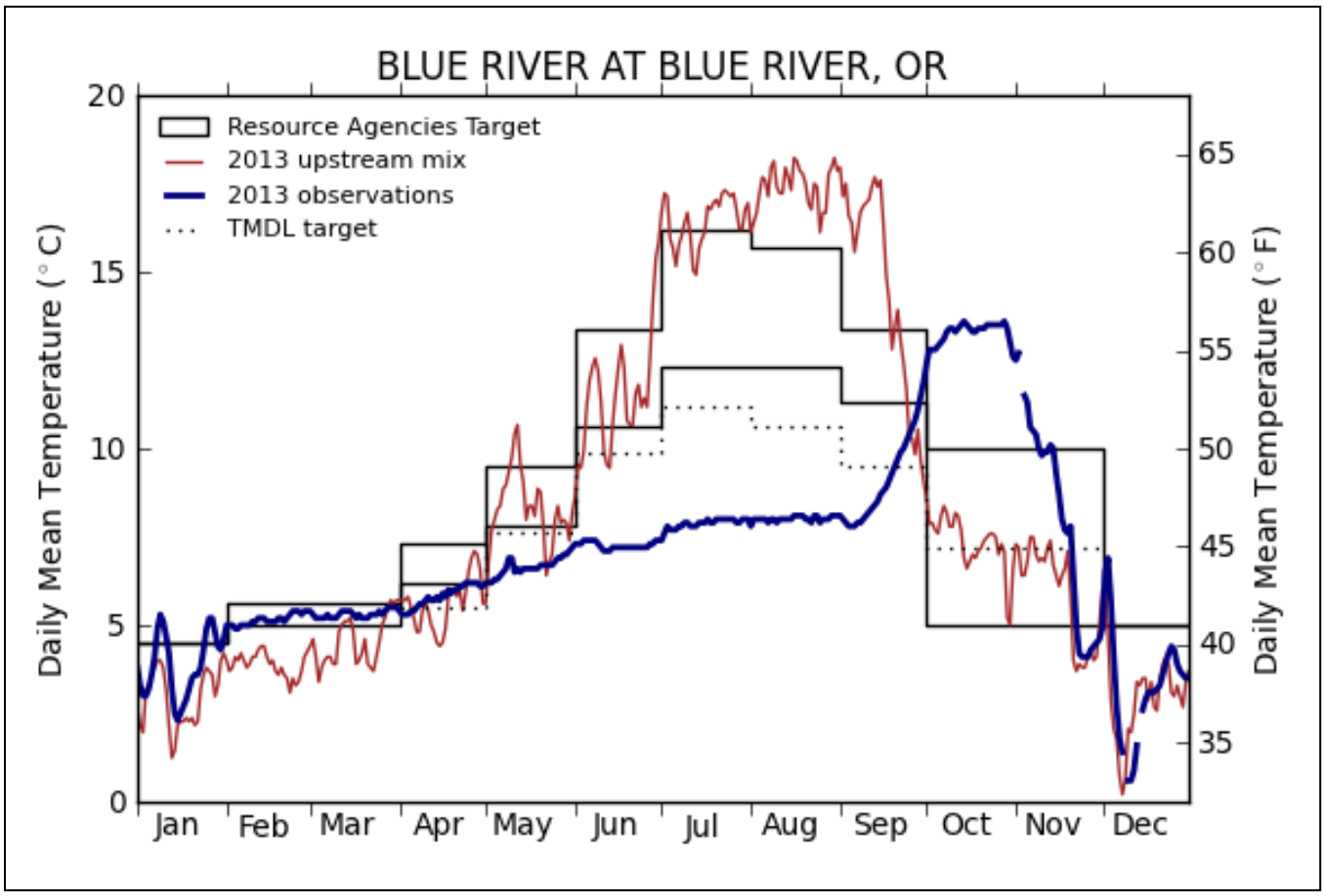
Water temperature management operations were not conducted at Dorena Dam. As shown in Figure 15, dam operations produced downstream water temperatures that remained below Total Maximum Daily Load (TMDL) targets for most of the 2013 year.

Figure 16. Water Temperatures Measured Downstream of Cottage Grove Dam as Compared to TMDL Targets.



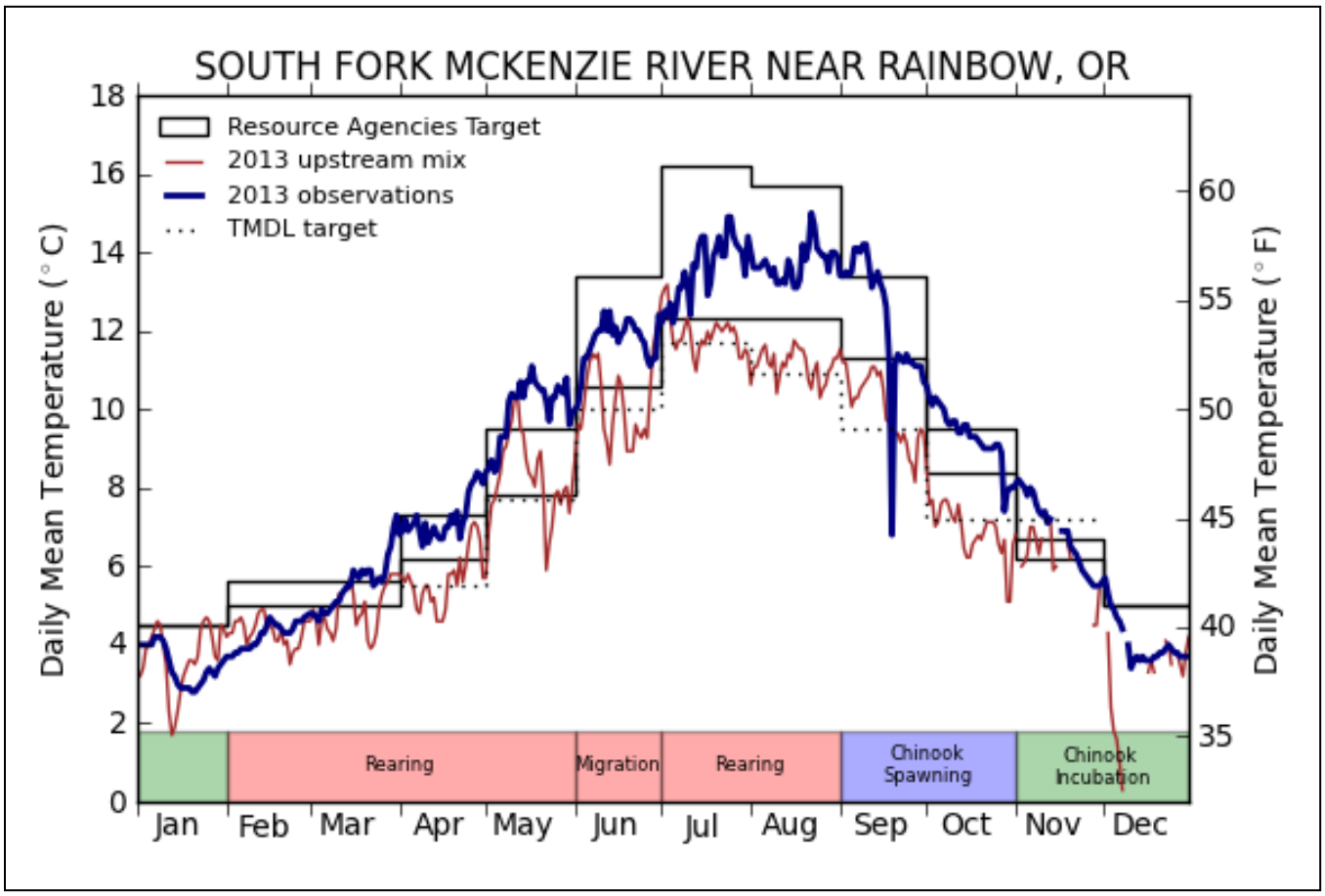
Water temperature management operations were not conducted at Cottage Grove Dam. As shown in Figure 16, dam operations produced downstream water temperatures that remained below Total Maximum Daily Load (TMDL) targets except for the late summer/early fall timeframe (mid-August through October) 2013.

Figure 17. Water Temperatures Measured Downstream of Blue River Dam as Compared to TMDL Targets.



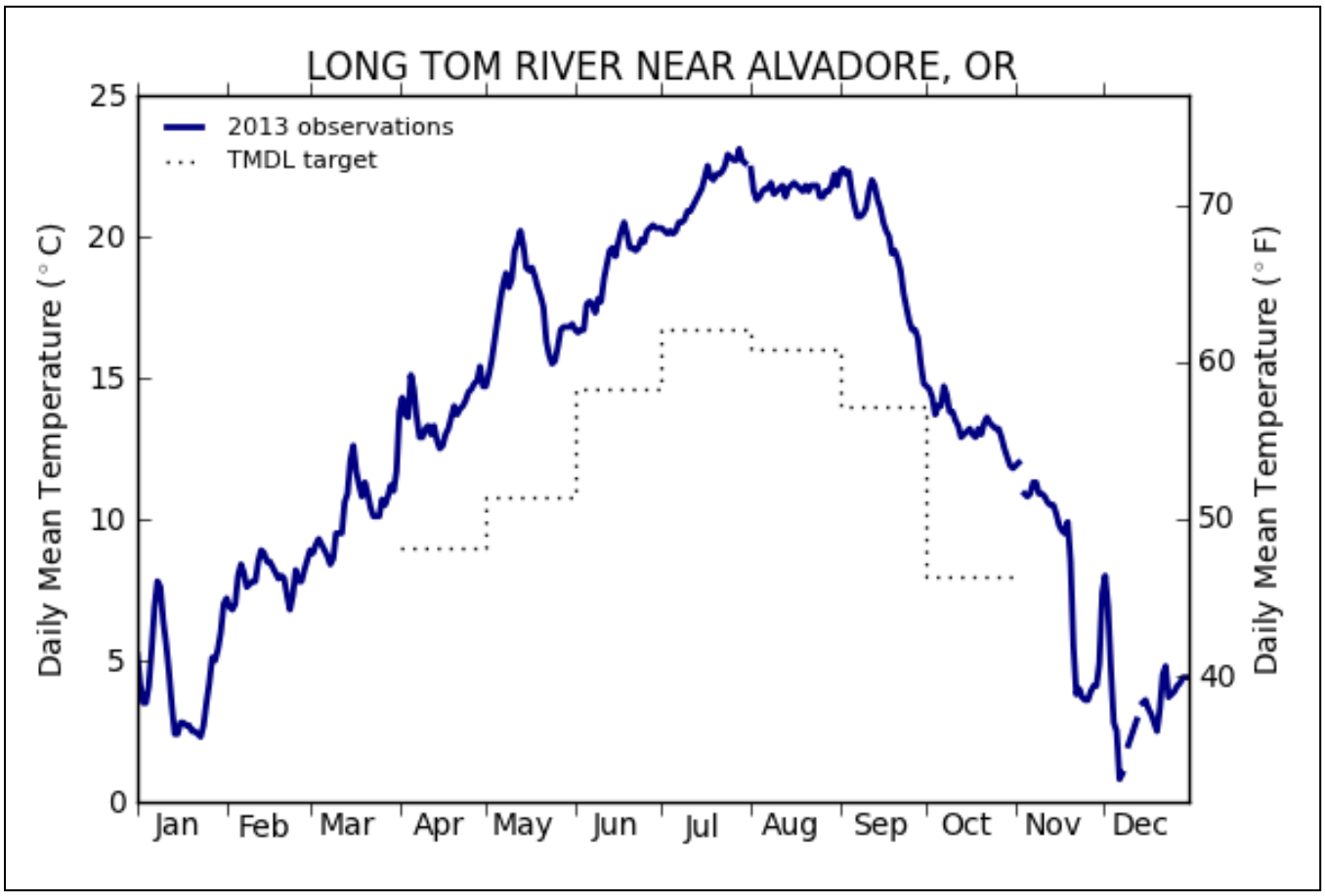
Water temperature management operations were not conducted at Blue River Dam. As shown in Figure 17, dam operations produced downstream water temperatures that were much colder than resource agency targets in the summer and warmer than these targets in the fall/early winter. The temperature regime measured below Blue River Dam in 2013, was indicative of dam operations prioritizing hydropower production over downstream water temperature management. In contrast, mixed conditions upstream of Blue River Dam followed a more normal trend, peaking in the summer months and cooling during the fall and winter months.

Figure 18. Water Temperatures Measured Upstream and Downstream of Cougar Dam as Compared to Resource Agency and TMDL Targets.



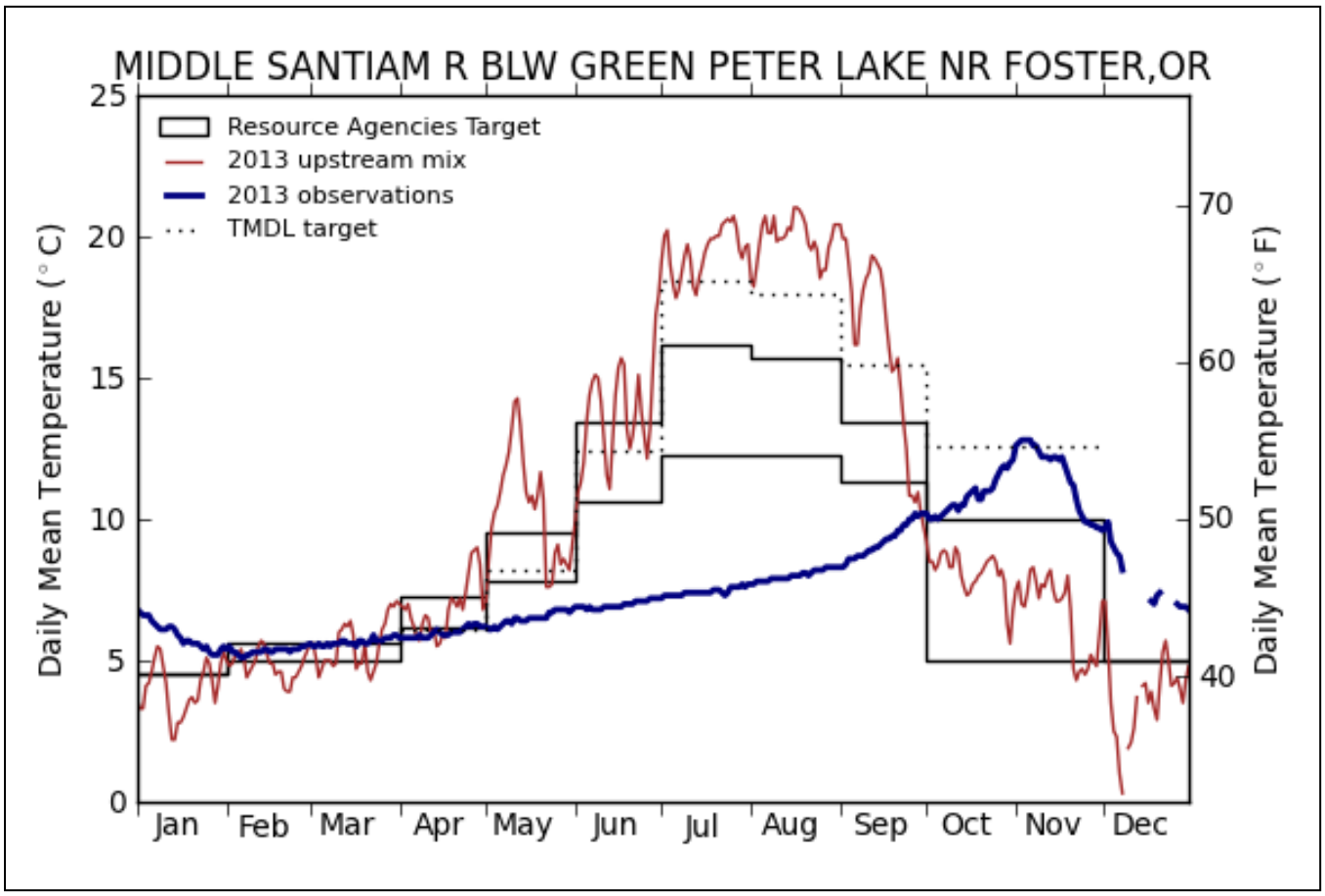
Water temperatures measured downstream of Cougar Dam at the USGS gage, *South Fork McKenzie River near Rainbow, OR*, generally fell within the temperature target range for the majority of the 2013 year. The success of water temperature management in the South Fork McKenzie River below Cougar Dam can be attributed to the effective use of the Cougar Water Temperature Control Tower, which has been in operation since 2005.

Figure 19. Water Temperatures Measured Downstream of Fern Ridge Dam as Compared to TMDL Targets.



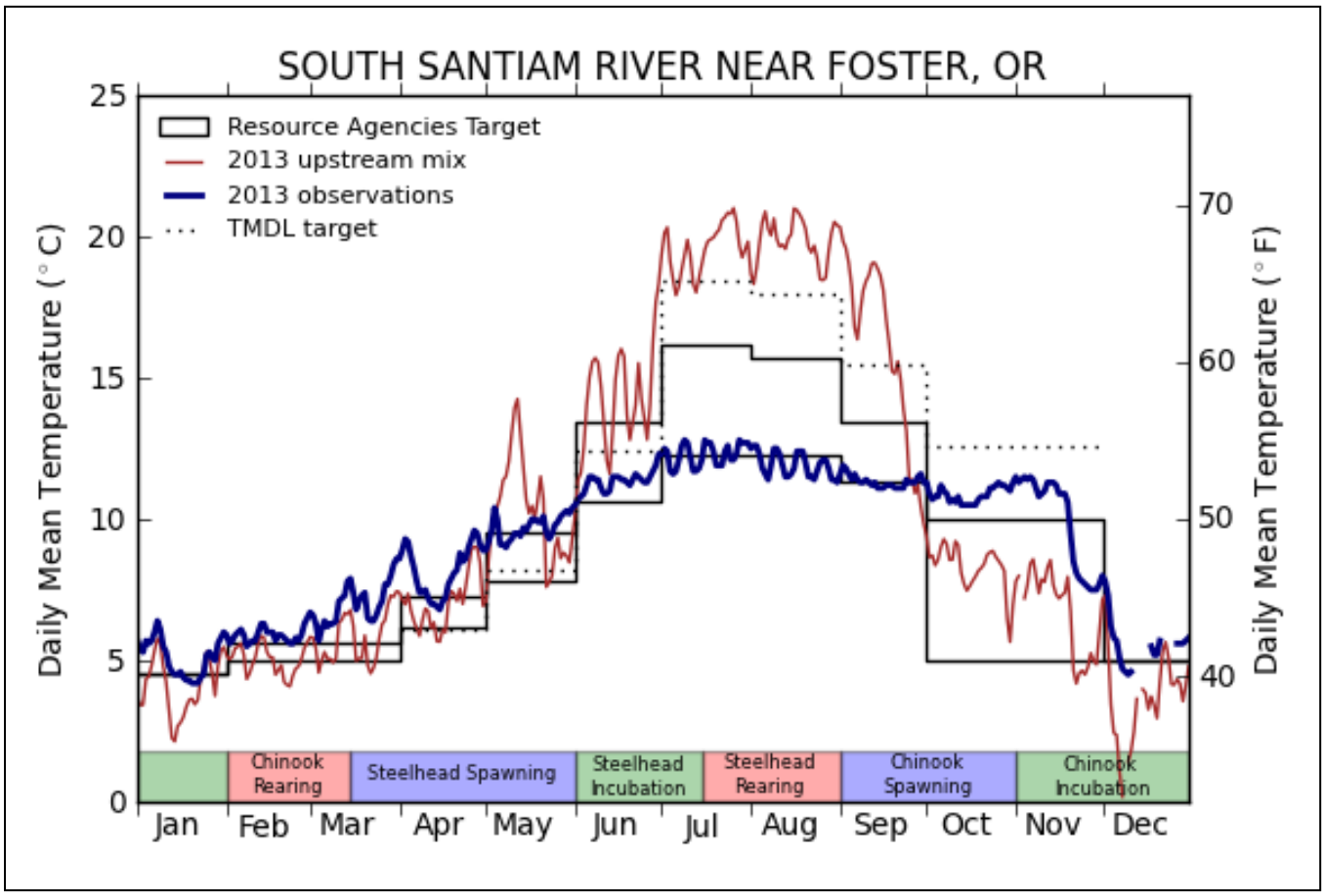
Water temperature management operations were not conducted at Fern Ridge Dam. As shown in Figure 19, dam operations produced downstream water temperatures that exceeded the Total Maximum Daily Load (TMDL) targets throughout the 2013 year. These water temperatures, however, followed a fairly normal bell-shaped curve of peaking during the summer months and cooling off during the fall and winter.

Figure 20. Water Temperatures Measured Upstream and Downstream of Green Peter Dam as Compared to Resource Agency and TMDL Targets.



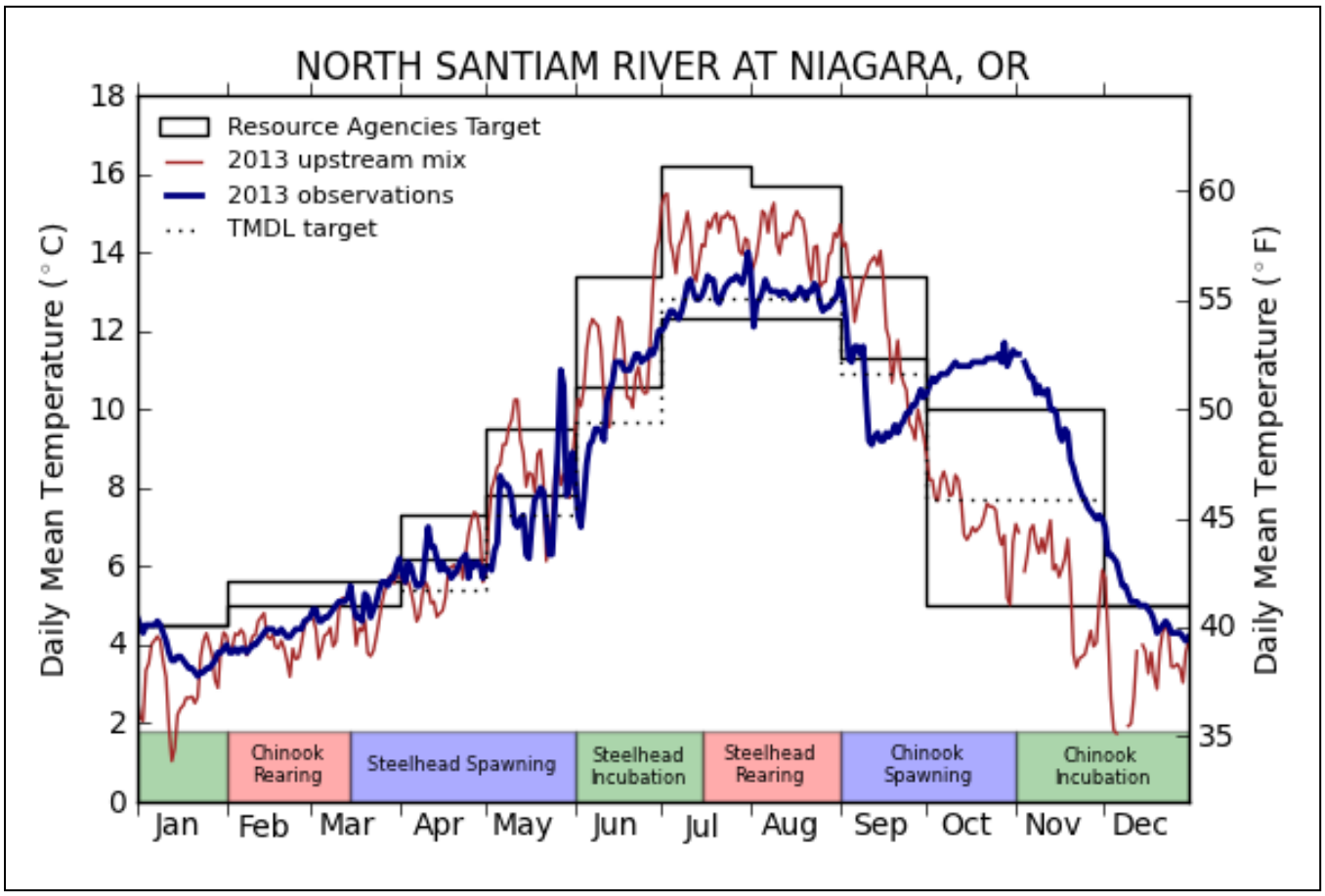
Water temperatures measured downstream of Green Peter Dam at the USGS gage, *Middle Santiam R Blw Green Peter Lake Nr Foster, OR*, were much cooler than the upstream mixed conditions and temperature targets throughout the summer (Figure 20). Green Peter Dam outflow temperatures peaked in November as a result of the prioritization of powerhouse operations and the release of cold water stored deep in the reservoir throughout the summer. By fall, this cold water was mostly depleted leaving warmer epilimnetic (surface) water behind. In contrast, mixed conditions upstream of Green Peter Dam peaked during the summer, cooling off rapidly in the fall.

Figure 21. Water Temperatures Measured Upstream and Downstream of Foster Dam as Compared to Resource Agency and TMDL Targets.



Water temperatures measured downstream of Foster Dam at the USGS gage, *South Santiam River near Foster, OR*, were much cooler than water temperature targets throughout the summer (Figure 21). These outflow temperatures, however, were not as cold as those measured below Green Peter Dam (Figure 20), due to the influence of unregulated South Santiam River and Wiley Creek. During the fall and early winter, outflow water temperatures measured below Foster Dam exceeded the maximum water temperature target, but were cooler than conditions below Green Peter Dam, likely due to environmental cooling and further influence from the South Santiam River and Wiley Creek.

Figure 22. Water Temperatures Measured Upstream and Downstream of Detroit and Big Cliff Dams as Compared to Resource Agency and TMDL Targets.



Water temperatures were measured downstream of Big Cliff Dam at the USGS gage, *North Santiam River at Niagara, OR*, and compared to upstream mixed conditions, Total Maximum Daily Load (TMDL) targets and temperature targets developed by the resource agencies (originally for the South Fork McKenzie River below Cougar Dam).

The upstream mix conditions were based on regression equations that USGS developed which includes a warming factor that is applied to the inflows. The estimates of temperature without a reservoir, termed 'upstream mix', were calculated based on flow weighted averages of inflowing temperature plus an adjustment for downstream warming, based on Rounds (2010).

Water temperature management operations were conducted at Detroit Dam throughout the summer, from June through September 09, 2013. Temperature targets downstream of Detroit/Big Cliff Dams were successfully met for most of the summer months by utilizing both the spillway and penstocks to discharge outflows (Figure 22). In September, downstream outflow temperatures began to warm as Detroit Reservoir was drafted and warm surface water was passed through the powerhouse. By October, temperatures were about 51 °F, slightly exceeding the maximum temperature target. The Detroit upper regulating outlets were not

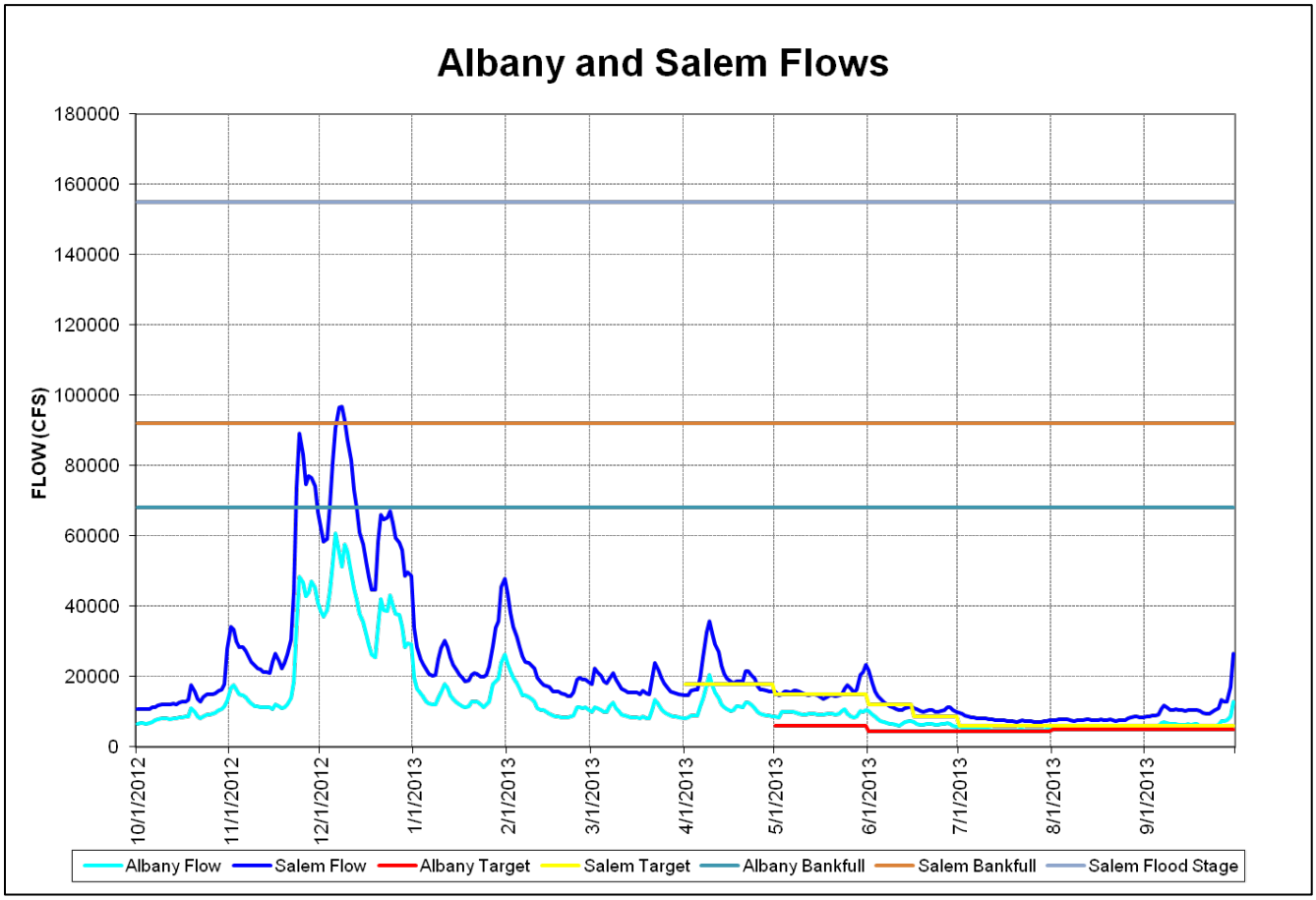
operated, as had been done in past years, and water temperatures peaked to about 53 °F by the end of October.

MAINSTEM AND TRIBUTARY FLOWS

The daily and weekly Biological Opinion (BiOp) threshold flows were exceeded throughout the period of April – September on the Mainstem Willamette River at Albany and Salem

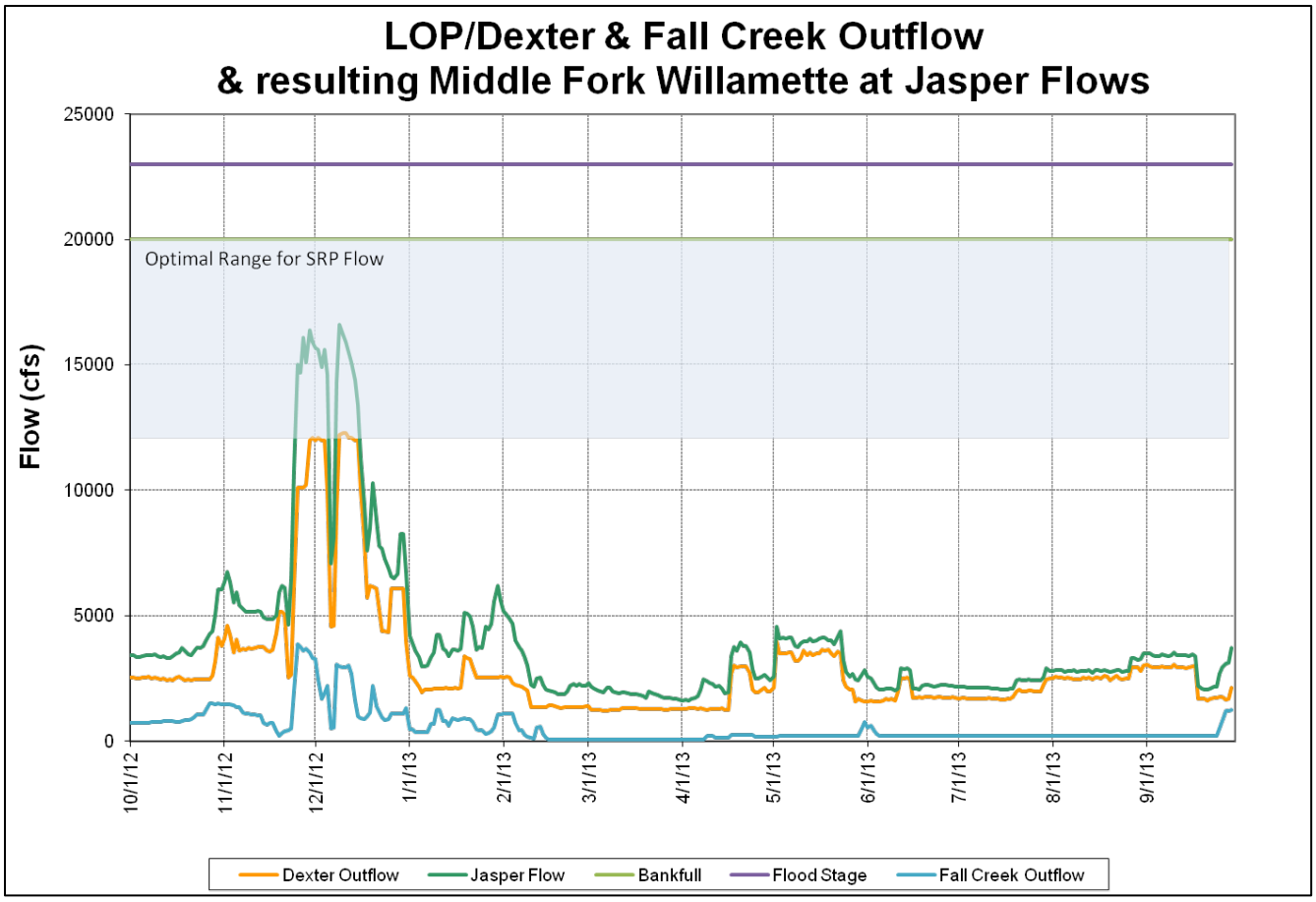
Figure 12 shows the observed flow on the Mainstem Willamette River at Albany (turquoise line) and Salem (blue line) for Water Year 2013. The threshold flows are represented by the red and yellow lines in the figure for Albany and Salem, respectively. Three horizontal lines represent bankfull at Salem and Albany and flood stage at Salem.

Figure 23. Observed Flow on the Mainstem Willamette River at Albany and Salem for Water Year 2013.



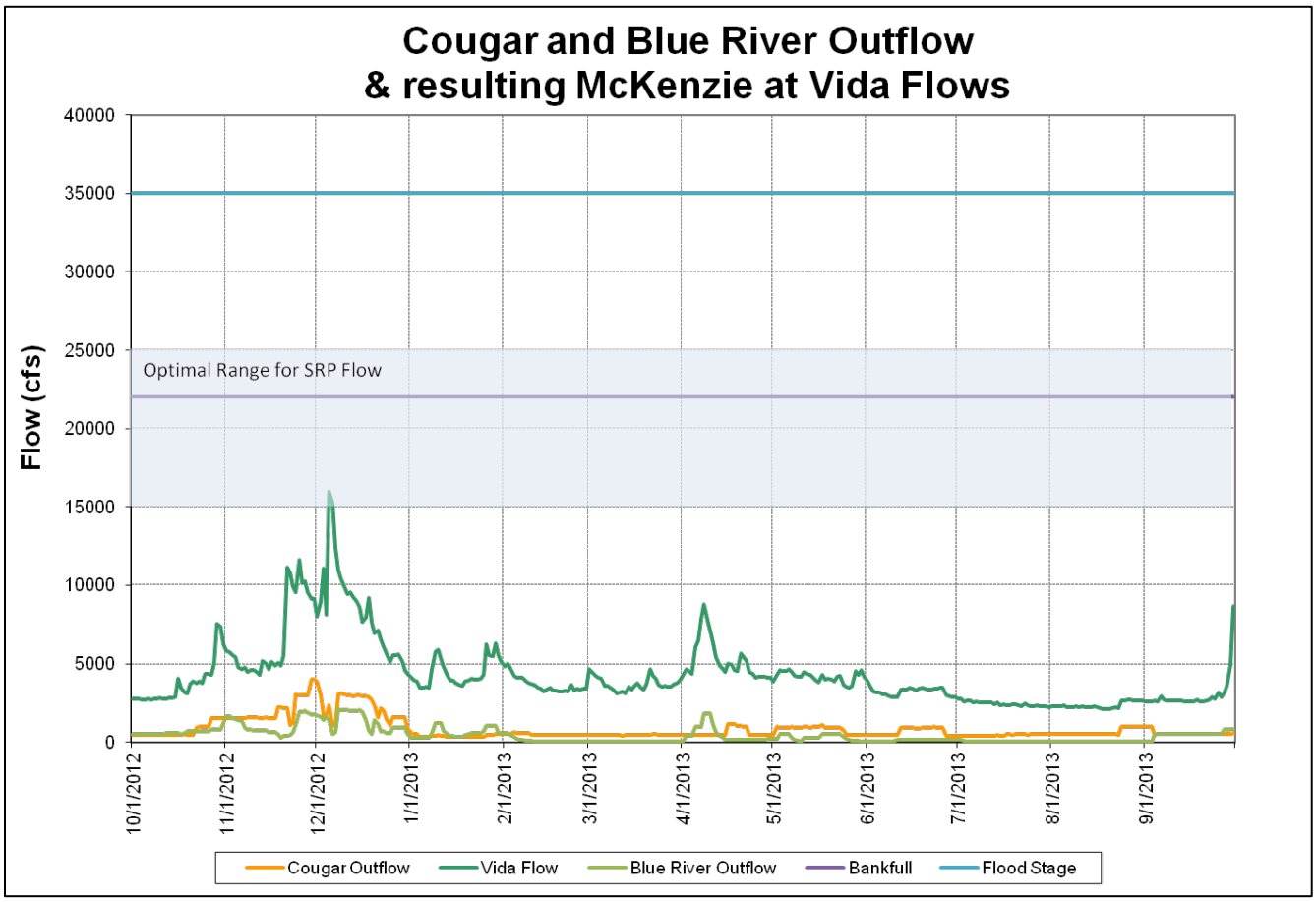
Figures 13 – 16 show project outflows and resulting flow at the downstream gage with the optimal range for the sustainable river flow shaded blue. The title of each figure describes the project and gage locations and the legend identifies the line colors.

Figure 24. Observed outflow from Dexter and Fall Creek Dams and flow downstream on the Middle Fork Willamette River at Jasper.



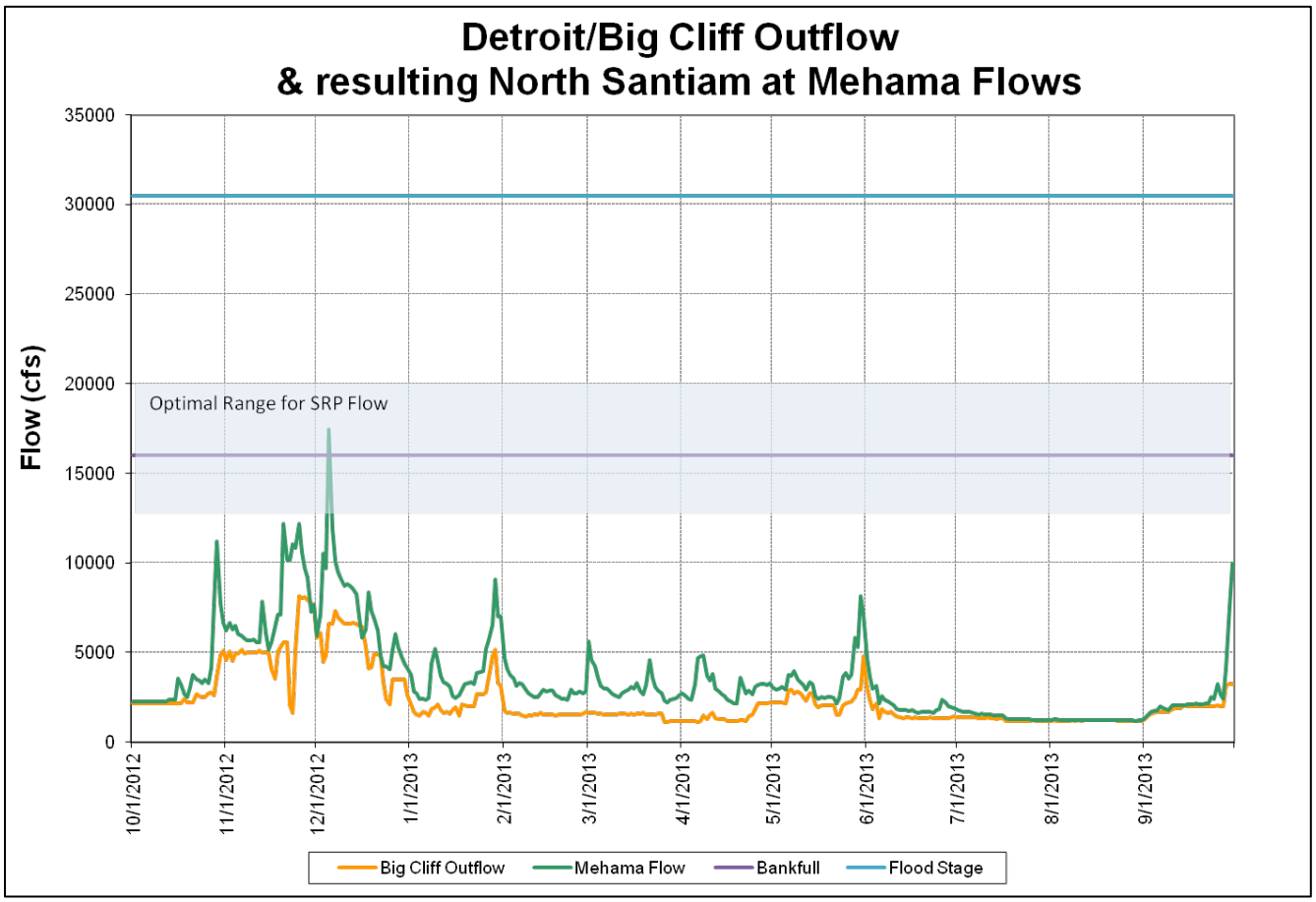
The Sustainable Rivers Program (SRP) optimal flow range is identified as the optimal winter high flow range for in-stream ecology.

Figure 25. Observed outflow from Cougar and Blue River Dams and flow downstream on the McKenzie River at Vida.



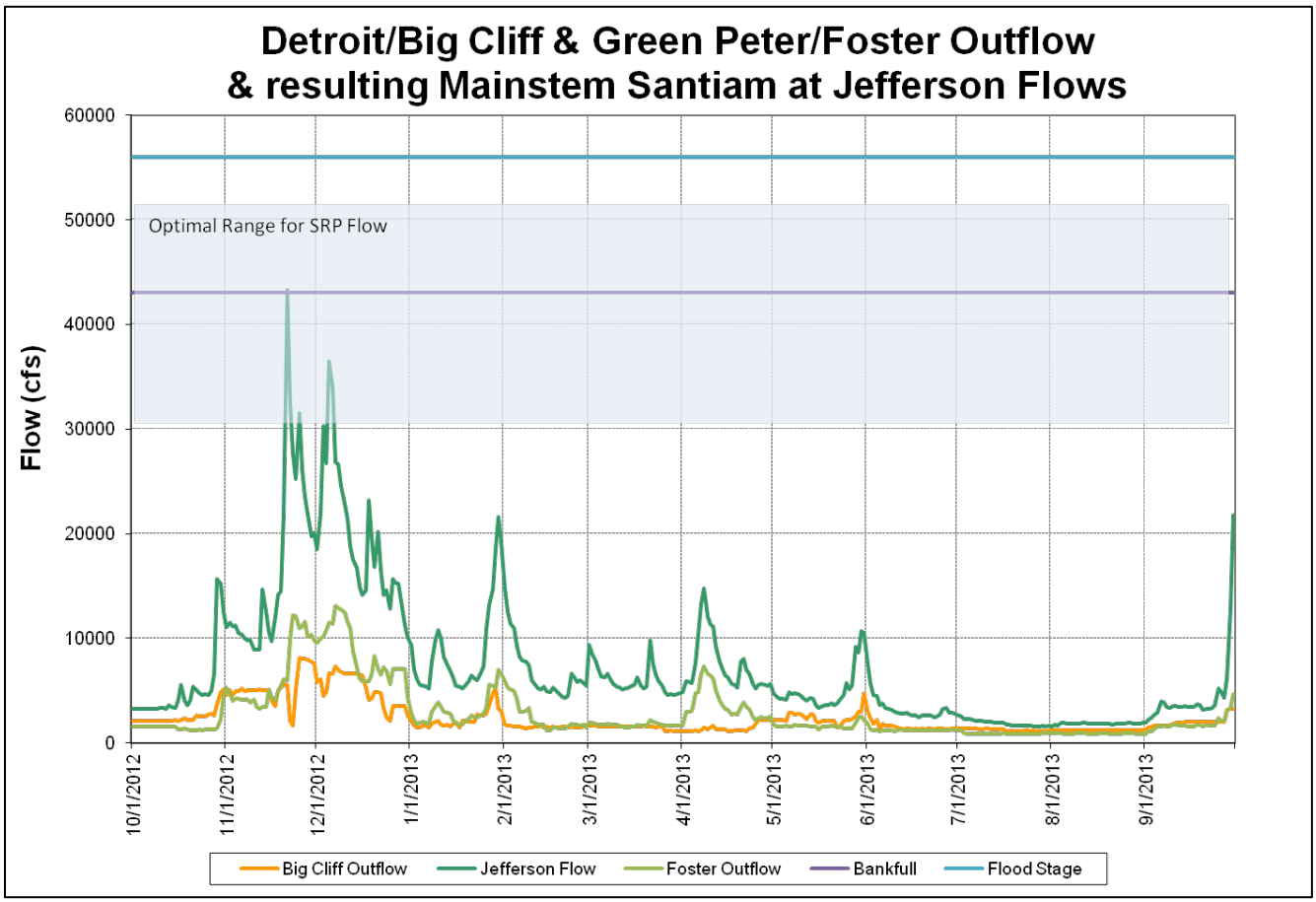
The Sustainable Rivers Program (SRP) optimal flow range is identified as the optimal winter high flow range for in-stream ecology.

Figure 26. Observed outflow from Big Cliff Dam and flow downstream on the North Santiam River at Mehama.



The Sustainable Rivers Program (SRP) optimal flow range is identified as the optimal winter high flow range for in-stream ecology.

Figure 27. Observed outflow from Big Cliff and Foster Dams and flow downstream on the Santiam River at Jefferson.



The Sustainable Rivers Program (SRP) optimal flow range is identified as the optimal winter high flow range for in-stream ecology.