KLAMATH RIVER RENEWAL CORPORATION

Memorandum

To: State Water Resources Control Board

From: KRRC Recreation Technical Team

Date: January 30, 2018

Subject: ***Draft Water Temperature Data Collection at Shovel Creek***

This memorandum presents the water temperature data collected upstream and downstream of the Klamath Hot Springs, located just downstream of Shovel Creek on the Klamath River.

Purpose

The purpose of the Shovel Creek data collection effort was to fulfill a SWRCB request for this information and to understand whether the Klamath Hot Springs warms water sufficiently in the Klamath River to create a fish migration barrier.

Sampling Locations

Water temperature data was collected on November 1 and December 5, 2017 at the following locations, which are shown in Figures 1 and 2. All locations were sampled on both dates, except as noted below.

- Shovel Creek – at Ager Beswick Road
- Klamath River (upstream of Shovel Creek) – Fishing Access #5
- Klamath River (downstream of the hot springs) - Fishing Access #4 (November 1 only) and Copco Road (December 5 only)

The hot springs themselves were not observed or sampled.

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Figure 1. Water Temperature Sampling Locations – Shovel Creek and Upstream Location

Figure 2. Water Temperature Sampling Locations with Downstream Locations

Field Sampling

A YSI 556 MPS (Multiprobe System) was used to determine water temperature. The meter was calibrated twice prior to the sampling event, first by the equipment rental service prior to shipping and then by the field crew. The manufacturer specified temperature measurement accuracy is ±0.15 °C (or ±0.27 °F) and resolution is 0.1 °C (or about 0.18 °F).

A tape measure was used to measure the Shovel Creek channel dimensions at Ager Beswick Road. On November 1, the stream measured 18 feet across at the northern end (closest to Klamath River) and approximately 14 feet on the southern end, and had a depth of 17 inches. The channel dimensions were not measured on December 5.

An existing water level gauge was observed on the edge of the creek; however, it was not submerged by the water in the creek on either sampling event and was not used. See Figure 3 below.

Figure 3. Water Level Gauge in Shovel Creek at Bridge on Ager Beswick Road

Shovel Creek Flows

Flows in Shovel Creek were not measured in the field and are not continuously monitored and made public by any organization. However, as discussed above, channel dimensions and water depth were measured in the field. The following parameters were estimated using the average width of the channel, the depth of water, and an assumed channel slope of 0.005 (6-inch rise over 100 feet).

November 1

- Cross-sectional area – 22.7 square feet
- Velocity – 2.0 feet per second (from Manning's Equation for an open rectangular stream with gravel and cobble)
- Flow – 36.3 cubic feet per second (cfs)
    - A correction factor of 0.8 was applied to account for the non-uniform shape of the channel that would contribute to varying water depth and speed reducing the calculated flow from 45.4 cfs to 36.3cfs.

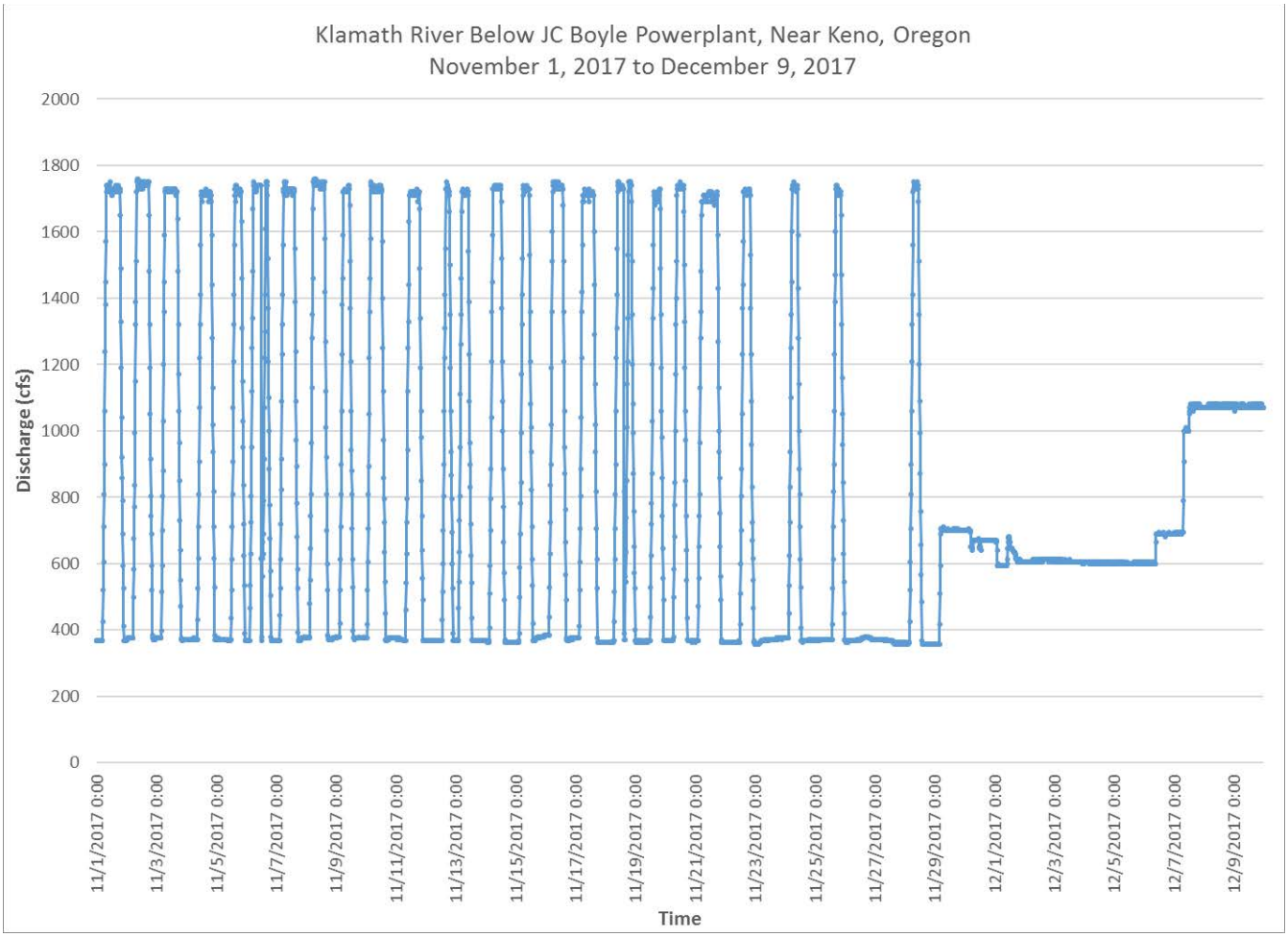
December 5

- Although the flow in Shovel Creek was not measured, the field crew observed an increase in wetted area of approximately 20 percent (compared to the November observations).

Klamath River Flows

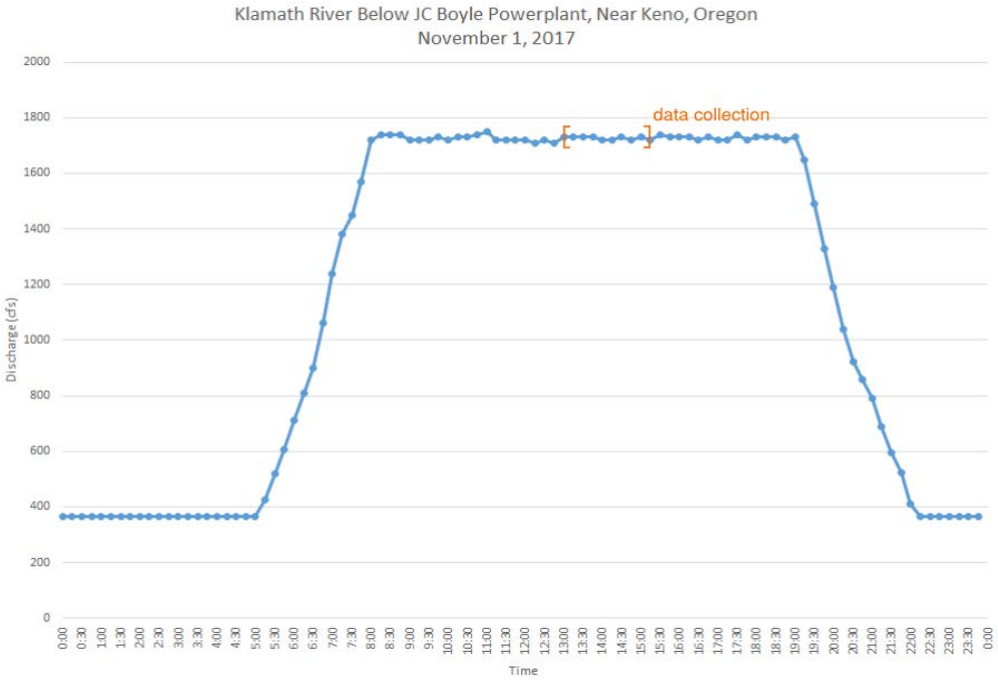
The United States Geological Survey (USGS) maintains a flow meter on the Klamath River below JC Boyle Powerplant, Oregon (USGS 11510700). This data is made available to the public through the USGS National Water Information System and is presented in Figures 4 through 6. The figures show flows ranging from 358 to 1,760 cfs from November to early December. The variation in flow is the result of daily power generation peaking occurring at the JC Boyle Powerhouse. No water temperature data was reported for USGS gage 11510700. The following flows were occurring in the Klamath River during sampling:

- November 1 – approximately 1,725 cfs
- December 5 – approximately 606 cfs



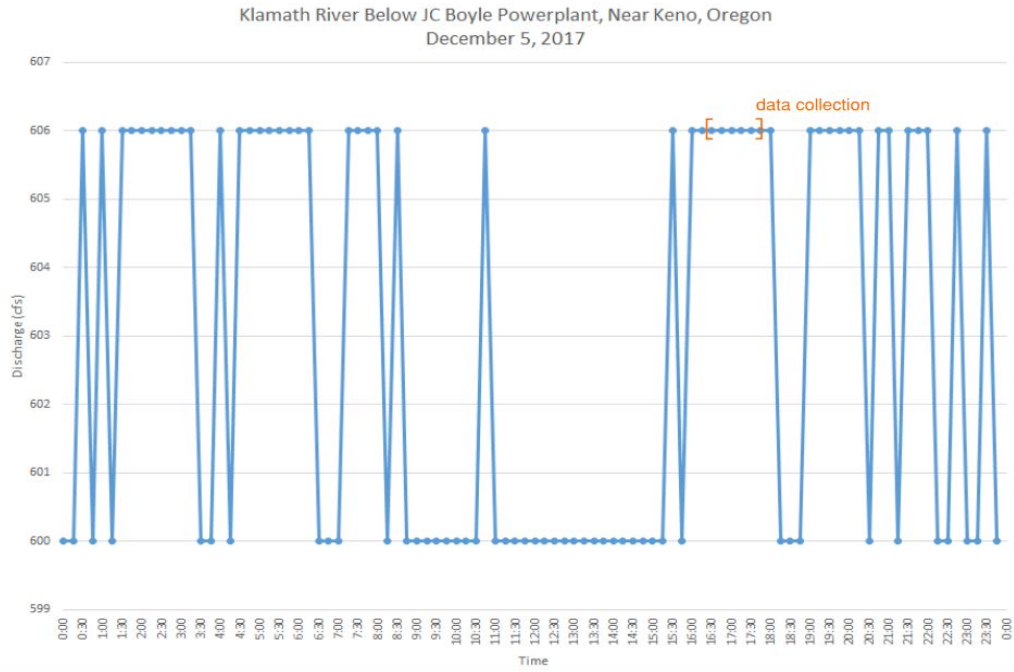
Source: USGS National Water Information System - USGS 11510700

Figure 4. Klamath River Flows below JC Boyle from November 1 to December 9



Source: USGS National Water Information System - USGS 11510700

Figure 5. Klamath River Flows below JC Boyle on November 1, 2017



Source: USGS National Water Information System - USGS 11510700

Figure 6. Klamath River Flows below JC Boyle on December 5, 2017

Water Temperature Data

Water temperature data was collected in early November and December of 2017. Water temperature and dissolved oxygen data is presented in Table 1 below. The data suggests the following:

November 1, 2017

- The water temperature in Shovel Creek was 3.3 degrees cooler than the upstream location on the Klamath River.
- The water temperature in the Klamath River, downstream of the hot springs, was 1.4 degrees warmer than upstream of the hots springs.

December 5, 2017

- The water temperature in Shovel Creek was 0.6 degrees cooler than the Klamath River.
- The water temperature in the Klamath River, downstream of the hot springs, was 0.2 degrees cooler than upstream of the hot springs.

During data collection, the outdoor temperature was 61 degrees Fahrenheit (°F) on November 1, 2017 and 37°F on December 5, 2017. Field Photos taken at Shovel Creek during each visit are shown in Figures 7 and 8.

Table 1. Data Collected Around the Klamath Hot Springs at Publicly Accessible Points on November 1, 2017

Main Water Body	Location	River Mile	Time	Air Temp (°F)	Avg. Water Temp (°F)	Avg. Flow (cfs)
Shovel Creek	Bridge on Ager Beswick Road - North side	n/a	13:28 / 13:53*	61	46.1	36**
Klamath River – Upstream	Fishing Access #5 (Pedestrian Bridge) 8-10ft off southern bank	211.2	13:46		49.5	1,725
Klamath River – Downstream	Cement Road Block near Fishing Access #4 (5ft off southern bank)	210.2	15:13		50.9	1,725
Upstream to Downstream Difference		1 mile			+1.4 degrees	

*Two data points were taken approximately 30 minutes apart and averaged.
**Flow estimated using measured channel dimensions and assumed slope of 0.005.

Table 2. Data Collected Around the Klamath Hot Springs at Publicly Accessible Points on December 5, 2017

Main Water Body	Location	River Mile	Time	Air Temp (°F)	Avg. Water Temp (°F)	Avg. Flow (cfs)
Shovel Creek	Bridge on Ager Beswick Road - North side	n/a	16:35 / 16:46*	37	39.9	Not measured
Klamath River – Upstream	Fishing Access #5 (Pedestrian Bridge) at southern bank	211.2	16:51		40.6	606
Klamath River – Downstream	Copco Rd at Bridge (northern bank)	207.7	17:19		40.4	606
Upstream to Downstream Difference		3.5 miles			-0.2 degrees**	

*Two data points were taken approximately 10 minutes apart and averaged.
**As discussed above, the YSI 556 is accurate to ± 0.27°F. The difference between the upstream and downstream readings are within this range and therefore essentially the same.

Figure 7. Shovel Creek at Bridge (South) on November 1 (left) and December 5 (right)

Figure 8. Shovel Creek at Bridge (North) Looking East on November 1 (left) and December 5 (right)

Summary

The following observations were made from the two sampling events:

- On November 1, the water temperature in the Klamath River was observed to increase by 1.44 degrees downstream of the hot springs. During data collection, flow in the Klamath River was recorded at 1,725 cfs, and flow in Shovel Creek was estimated at 36 cfs (approximately 2 percent of the Klamath River flow). Given the observed warming, it is possible that the hot springs are contributing to Klamath River warming.

- On December 5, the water temperature in the Klamath River was observed to decrease by approximately 0.2 degrees downstream from the hot springs. The downstream data point was collected at Copco Bridge, approximately three miles downstream from the hot spring and is therefore not directly comparable to the November 1 monitoring location. The Klamath River has no substantial tributaries between the hot springs and Copco Bridge that would provide river cooling and ambient temperatures were not significantly different from river temperatures (37 degrees vs. 40.5 degrees, respectively). During the December sampling, Klamath River flows were approximately one-third of the flows

recorded during the November sampling (606 cfs) and Shovel Creek and Klamath River water temperatures were similar.

Discussion

The data collected during the sampling periods are inconclusive on whether the hot springs are contributing to warming the river. If the hot springs are warming the river, we anticipate the data would have also shown a temperature increase during the December sampling event when Klamath River flows were approximately one-third of flows recorded in November (less Klamath River flow would amplify any warming effects of the hot springs). Additionally, the temperature differences between Shovel Creek and the Klamath River were less pronounced in December. When Shovel Creek is colder than the Klamath during other times of the year it should contribute to river cooling.

Following reservoir removal, it's assumed that flows in the Klamath River will be similar to flows released at Iron Gate Dam under the existing Klamath Project 2013 Biological Opinion which range from 900 cfs to 1,325 cfs (NOAA Undated). It is unlikely that a small incremental increase in river temperature attributable to the hot springs as potentially observed in November 2017, would by itself create a thermal barrier to anadromous fish migration. If absolute river water temperatures exceeded stress or survivability thresholds for salmonids (i.e. 68 °F [Carter 2005]) due to accretion from the hot springs, it is reasonable to expect the formation of a thermal barrier. Following dam decommissioning, Klamath River flows released from Upper Klamath Lake of 900 cfs or greater year-round will be the predominate factor affecting river water temperatures in the hot springs reach and will likely dictate temporal and spatial migration patterns of anadromous fish.

References

Carter, Katherine. 2005. The Effects of Temperature on Steelhead Trout, Coho Salmon, and Chinook Salmon Biology and function by Life Stage. August 2005. California Regional Water Quality Control Board.

National Oceanic and Atmospheric Administration (NOAA). Undated. Proposed Minimum Flows at Iron Gate Dam. Accessed on: January 29, 2017. Available at: http://www.westcoast.fisheries.noaa.gov/klamath/proposed_minimum_flows_at_iron_gate_dam.html