Trap and Haul at Kachess, Keechelus, and Bumping Dams

2019 Progress Report

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Foreword

Yakima Basin Bull Trout (*Salvelinus confluentus*) are part of the Mid-Columbia River Distinct Population Segment listed as Threatened under the Endangered Species Act (ESA). The Yakima Basin is home to 15 genetically distinct populations of Bull Trout, three of which have been extirpated. There are three generally accepted life history types exhibited by Bull Trout: resident, fluvial, and adfluvial, but in the Yakima Basin, most Bull Trout populations exhibit an adfluvial life history. Adfluvial Bull Trout spawn and juveniles rear in tributary habitats, however, sub-adults and adults forage and reside in lakes and reservoirs. One of the primary threats to Yakima Basin Bull Trout is entrainment at dams and fish not being able to return to their spawning grounds (U.S. Fish and Wildlife Service 2015). Impoundment has fragmented Bull Trout habitat and interim trap and haul measures are needed to move Bull Trout above dams when they are present. Given the prior success of Bull Trout trap and haul operations at Clear Creek Dam on the North Fork Tieton River (Thomas and Monk 2015, 2016; Thomas et al. 2017, 2018), trap and haul operations were expanded to include additional locations in the upper Naches and Yakima rivers. Therefore, the US Bureau of Reclamation (USBR) contracted the US Fish and Wildlife Service (USFWS), Mid-Columbia Fish and Wildlife Conservation Office (MCFWCO) to: 1) study the feasibility of trap and haul at Keechelus, Kachess, and Bumping dams, 2) monitor the movement and viability of transported fish, and 3), monitor water quality for fish health. As a part of our permit, USFWS Ecological Services requires determination of natal origin of the Bull Trout we collect and transport so that they are released into their natal stream. The spawning tributaries upstream of Kachess Dam (Kachess Lake) are the Kachess River and Box Canyon Creek. The primary spawning tributary above Keechelus Dam (Keechelus Lake) is Gold Creek. The primary spawning tributary above Bumping Dam (Bumping Lake) is Deep Creek, although a few redds have also been reported in the upper Bumping River (Divens 2019).

Goals and Objectives

The ongoing goal of the Bull Trout Transport Project is to maintain genetic diversity and increase the viability of Bull Trout populations by providing passage for fish currently excluded from natal spawning tributaries upstream of Keechelus, Kachess, and Bumping dams. Our specific objectives were to: 1) capture adult Bull Trout in the stilling basins directly below Kachess, Keechelus, and Bumping dams, 2) implant Passive Integrated Transponder (PIT) tags in captured Bull Trout and obtain tissue samples for rapid response genetic testing, 3) transport and release tagged fish above the dams into their natal tributaries as determined by rapid

response genetic testing, and 4), utilize fixed PIT tag interrogation sites established in Gold Creek and the Kachess River to monitor the movement of transported fish.

Methods

Fish Collection

The MCFWCO conducted snorkeling surveys from May-November 2019 at Bumping, Kachess, and Keechelus dams. Snorkel surveys first quantified the number of adult Bull Trout present (if any), with the starting point below each stilling basin as determined by the predominate instream conditions at the time of the survey. Snorkel surveys began mid-morning. Thurow and Schill (1996) found no significant difference between day and night abundance estimates of adult Bull Trout. The survey crew consisted of snorkelers and a data collector following the methods of Thurow and Schill (1996). We attempted to snorkel and sample at least three times below each dam provided water temperature was less than 15 °C, water clarity generally high for snorkeling, and flows were generally low enough to safely deploy nets and snorkel.

After snorkeling, Bull Trout were collected using gill nets with 7.5-cm stretch mesh and 3.5-kg monofilament (8-lb test). For fish collection, nets were generally fished using two methods. Nets were placed across stream reaches and snorkelers directed fish toward the nets or nets were placed and fished passively. In both cases, nets were constantly monitored, and fish were immediately removed from gill nets using standard dip nets. Captured Bull Trout were placed in a holding pen prior to processing. The holding pen was constructed of perforated stainless steel with lockable latches and submerged in the river where there was a continuous flow of freshwater (Figure 1).

Figure 1. Stainless steel pen (0.9 m x 1.2 m x 1.8 m) used for holding Bull Trout after collection and before rapid response genetic testing and transport.

After collecting Bull Trout, we prepared an anesthetic solution of MS-222 at 50 mg/L using river water and a 75.7-liter (80-quart) cooler. Since MS-222 is acidic, a buffer ($NaHCO_3$; i.e., baking soda) was added to raise the pH to that of the river. The pH was measured using a Eutech Instruments pHTestr20 (Cole-Parmer, Vernon Hills, Illinois). Individual Bull Trout were removed from the pen using a dip net and placed in the cooler where the fish were anesthetized until sedation (7-10 min). After sedation, we recorded total length (mm) and collected a small tissue sample from the anal fin using sterilized surgical scissors. We inserted a PIT tag into the dorsal sinus at the base of the dorsal fin with a sterilized hollow needle. PIT tags were full duplex (FDX-B), measuring 12.5 mm x 2.1 mm and operating at a frequency of 134.2 kHz (APT-12, Biomark, Boise, Idaho). The process generally took less than two minutes. Vials were shipped to the USFWS Abernathy Fish Technology Center for rapid response genetic assessment to determine population origin. After processing, Bull Trout were placed in a perforated PVC recovery tube (1 m length, 15 cm diameter) with adequate flow to allow fish to recover before placing them back into the holding pen. Tagged and processed fish were kept separate from unprocessed fish until all fish were processed.

Rapid Response Genetic Testing and Transport

The USFWS requires natal origin prior to transport of Bull Trout. Additionally, we planned to euthanize all Brook Trout x Bull Trout hybrids, the identification of which can be difficult due to variance in coloration among and within Bull Trout populations in the Yakima Basin. To meet the requirements of natal origin and hybrid identification, we used a real-time genotyping and analysis method,hereafter referred to as rapid response, like the one described by DeHaan et al. (2011) to analyze Bull Trout. Fin clips were taken from each bull trout caught and were immediately sent to the laboratory for analysis. Upon arrival in the laboratory, genomic DNA was extracted from each individual twice to ensure consistency using a modified chelex extraction protocol (Miller and Kapuscinski 1996) with incubation at 55°C for 15 minutes then at 103°C for 8 minutes. Individuals were then genotyped at the following 16 microsatellite loci: *Omm1128, Omm1130* (Rexroad et al. 2001), *Sco102, Sco105, Sco106, Sco107, Sco109*, (WDFW unpublished), *Sco200, Sco202, Sco212, Sco215, Sco216, Sco218, Sco220* (Dehaan and Ardren 2005), *Sfo18* (Angers et al. 1995) and *Smm22* (Crane et al. 2004). Allele calling at each of these loci was previously standardized between our laboratory and WDFW Molecular Genetics Laboratory (WDFW-MGL) using a protocol similar to the one described by Stephenson (2009) to facilitate data sharing. Several of these loci have diagnostic differences in allele sizes between Bull Trout and Brook Trout and can be used for species ID and to identify individuals with hybrid ancestry.

We used the baseline genotypes described by Small et al. (2016) to assign fish to population groups. Prior to assigning any of the captured fish, we evaluated the power of the baseline to accurately assign individuals using a simulation approach. The probability for each individual originating from each population in the baseline was estimated using the methods of Rannala and Mountain (1997), as implemented in the computer program ONCOR (Steven Kalinowski; available at http://www.montana.edu/kalinowski/software/oncor.html). Preliminary leave-one-out simulations suggested a high probability (95 % - 100 %) of correct assignment to the 12 populations in the baseline (Table 1). Based on these results, it was decided that the baseline had enough power to assign individual Bull Trout to one of 12 populations. Each of the Bull Trout captured in 2019 were thus assigned to one of these populations.

The next day, Bull Trout were transported to their natal stream based on results from the rapid response genetic assessment and released. Bull Trout were loaded by hand into a transport vehicle outfitted with a large holding tank. The tank was 1,230 liters, had an O_2 bottle with air stones, and a 10-cm (4-inch) gate valve. We hand loaded and removed fish using a hand dip net. Water temperature was measured before fish were loaded into the tank and within the creek where fish were released.

Table 1. Results of simulations used to assess the accuracy with which the genetic baseline could be used to assign Bull Trout to 13 reporting groups. The left column indicates the true origin, and subsequent columns indicate numbers of fish assigned to each reporting group. Bold values indicate correct assignments.

Reporting Groups	Brook	Gold Creek	Box Canyon	Kachess River	NF Teanaway	Deep	American/ Union	Rattlesnake	Crow	NF Tieton	Indian	SF Tieton	Ahtanum	Percent Correct
Brook	**25**	0	0	0	0	0	0	0	0	0	0	0	0	100%
Gold Creek	0	**46**	0	0	0	0	0	0	0	0	0	0	0	100%
Box Canyon	0	0	**18**	1	0	0	0	0	0	0	0	0	0	95%
Kachess	0	0	0	**28**	0	0	0	0	0	0	0	0	0	100%
NF Teanaway	0	0	0	0	**10**	0	0	0	0	0	0	0	0	100%
Deep	0	0	0	0	0	**57**	0	0	0	0	0	0	0	100%
American Union	0	0	0	0	0	0	**56**	0	0	0	0	0	0	100%
Rattlesnake	0	0	0	0	0	0	1	**36**	0	0	0	0	0	97%
Crow	0	0	0	0	0	0	0	0	**24**	0	0	0	0	100%
NF Tieton	0	0	0	0	0	0	0	0	0	**46**	1	0	0	98%
Indian	0	0	0	0	0	0	0	0	0	1	**108**	3	0	96%
SF Tieton	0	0	0	0	0	0	0	0	0	0	1	**75**	0	99%
Ahtanum	0	0	0	0	0	0	0	0	0	0	0	0	**54**	100%

Monitoring Movements of Transported Bull Trout

We used PIT-antennas to monitor the movement of transported Bull Trout in the upper Kachess River- a tributary of Kachess Lake and Gold Creek- a tributary of Keechelus Lake. At the upper Kachess River and upper Gold Creek sites, we installed antenna 'arrays' consisting of two antennas at a site, while at the lower Gold Creek site, we installed a single antenna. The upper Gold Creek array was located about 4 km upstream from the Gold Creek mouth at Keechelus Lake. The lower Gold Creek antenna was located about 0.5 km upstream from its mouth between the eastern span of I-90 and National Forest Road 4832. Yakama Nation installed an antenna array in the upper Kachess River about 1 km upstream of the upper Kachess River mouth at Kachess Lake (Figure 2).

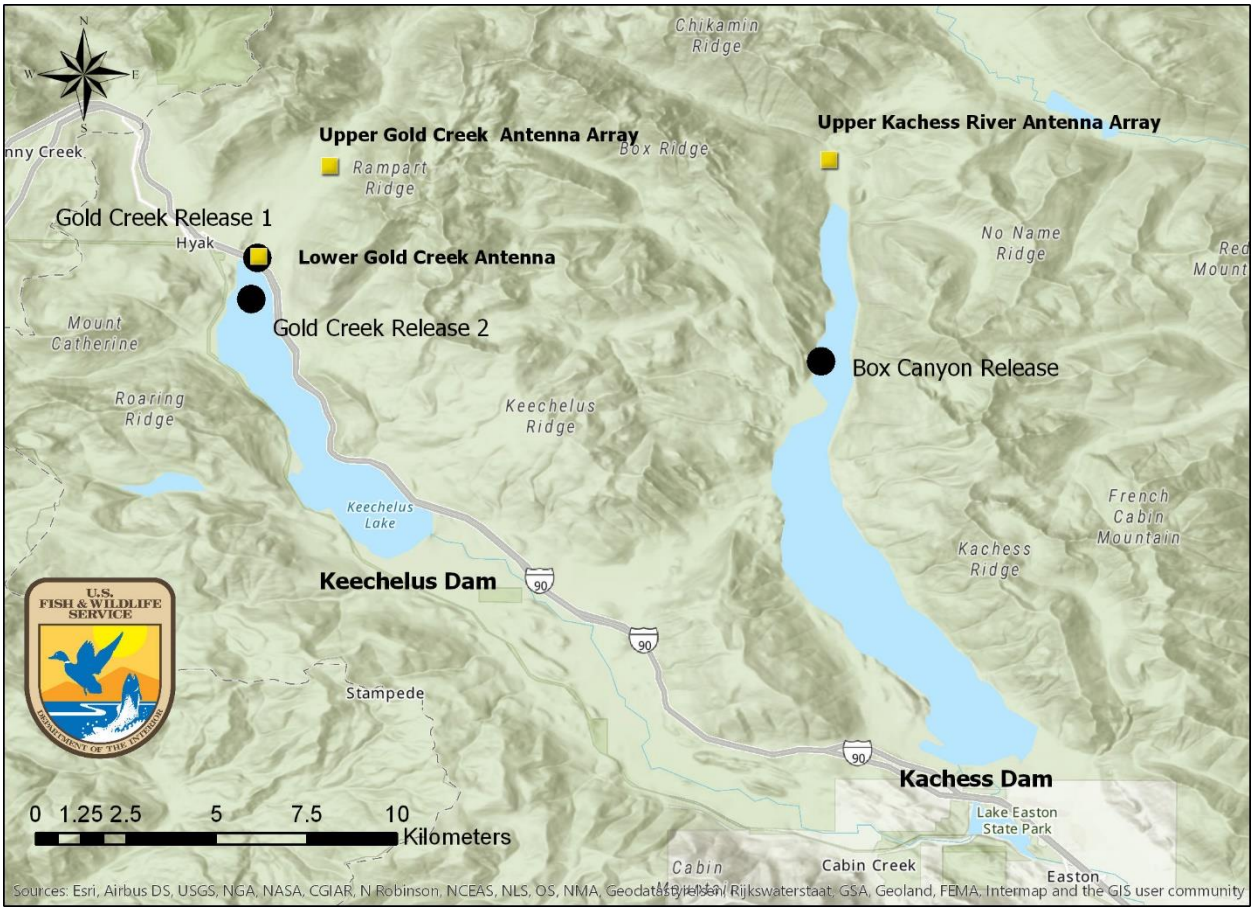

Figure 2. Map of the study site in the upper Yakima River Basin, Washington. The map includes Keechelus and Kachess dams, PIT antenna locations (yellow squares), and Bull Trout release sites (black dots). Bumping Dam not pictured.

Each antenna array consisted of two antennas placed about 20 m apart along the course of the stream bed. Each antenna consisted of an IS1001, 24V antenna control node (Biomark Inc.,

Boise, Idaho) housed within a waterproof case (Pelican Products, Inc., Torrance, California). External power chords and antenna wires were attached to the control board within the case. Power was supplied to the control board using DC power from four, 6V batteries wired together in a 24V configuration. Batteries were charged by 300W/24V solar panels (Grape Solar, Eugene, Oregon) mounted to a wooden frame that faced 120° - 150° north. The output of the solar panels was regulated by a solar controller (ProStar PS-15, Morningstar Inc., Newtown, Pennsylvania). The batteries and solar controller were housed in a steel storage chest (Ridge Tool Company, Elyria, Ohio).

Antenna coils were housed in polyethylene piping installed in either a 'pass-through' or 'flat-plate' configuration (Figure 3). The antenna coil was 12-gauge, fine copper Litz wire running inside of the piping. The piping was connected to the waterproof case via a 5.1-cm (2-inch) PVC 'T' fitting, which housed both ends of the coil, the hydrovolt cable (AK Industries, Rancho Domingo, California), and the appropriate capacitor based on the inductance of the antenna coil. Piping was affixed to the stream bed with 0.8-cm (5/16-inch) rebar stakes with 2.5-cm (1-inch) thread-less eye nuts welded about 10 cm from the top of the stake. The stakes were driven into the stream bed using a sledgehammer and drive rod. Each antenna was secured to the anchors with nylon straps (NRS Inc., Moscow, Idaho).

Figure 3. 'Flat-plate' antenna design installed in Gold Creek, Washington to monitor the movement of PIT tagged Bull Trout.

The upper Kachess River antennas were setup in a rectangular 'pass-through' configuration measuring 10.7 m x 2.1 m (35 ft x 7 ft). An antenna support cable was affixed from one bank to the other with each end attached to a 3.1-m (10-ft) post. Zip ties or straps were used to affix

the antenna to the support cable. The Gold Creek antennas were setup in a flat plate configuration lying flat on the creek bed in a rectangular shape about 10.7 m x 1.1 m (35 ft x 3.5 ft). Twenty-six rebar stakes were used to affix a single antenna to the creek bed and the antennas were secured to the stakes utilizing the nylon straps. The waterproof cases were attached to t-posts on the bank next to each corresponding antenna to keep them dry as water elevation increased.

PIT antennas were installed in summer when flows were low enough to allow in-river work. In upper Gold Creek (GC1, GC2), our antennas operated from July 19 – October 10, but only sporadically after September 14 when the site became shaded for most of the day (Figure 4). Lack of solar exposure after this date limited antenna operations and subsequent detections of fish that we released in Gold Creek and Keechelus Lake. On October 11, a large rain event unanchored both flat plate coils and rendered the array inoperable. After flows receded, we installed a pass-through antenna in lower Gold Creek which operated from November 5 until December 11. We had no antennas operating in Gold Creek from October 11- November 4 which further limited our ability to detect Bull Trout released in Gold Creek and Keechelus Lake. In the upper Kachess River, the upstream antenna (KR1) operated from July 31 – October 8 and the downstream antenna (KR2) operated from July 11 – December 18 (Figure 4).

At our lower Gold Creek PIT antenna site, we used water temperature data collected by the Kittitas Conservation Trust (KCT) to compare Bull Trout movement past our antennas with the seasonal change in water temperature. The KCT logger was deployed from July 1 to October 24 and recorded water temperature every 15 min.

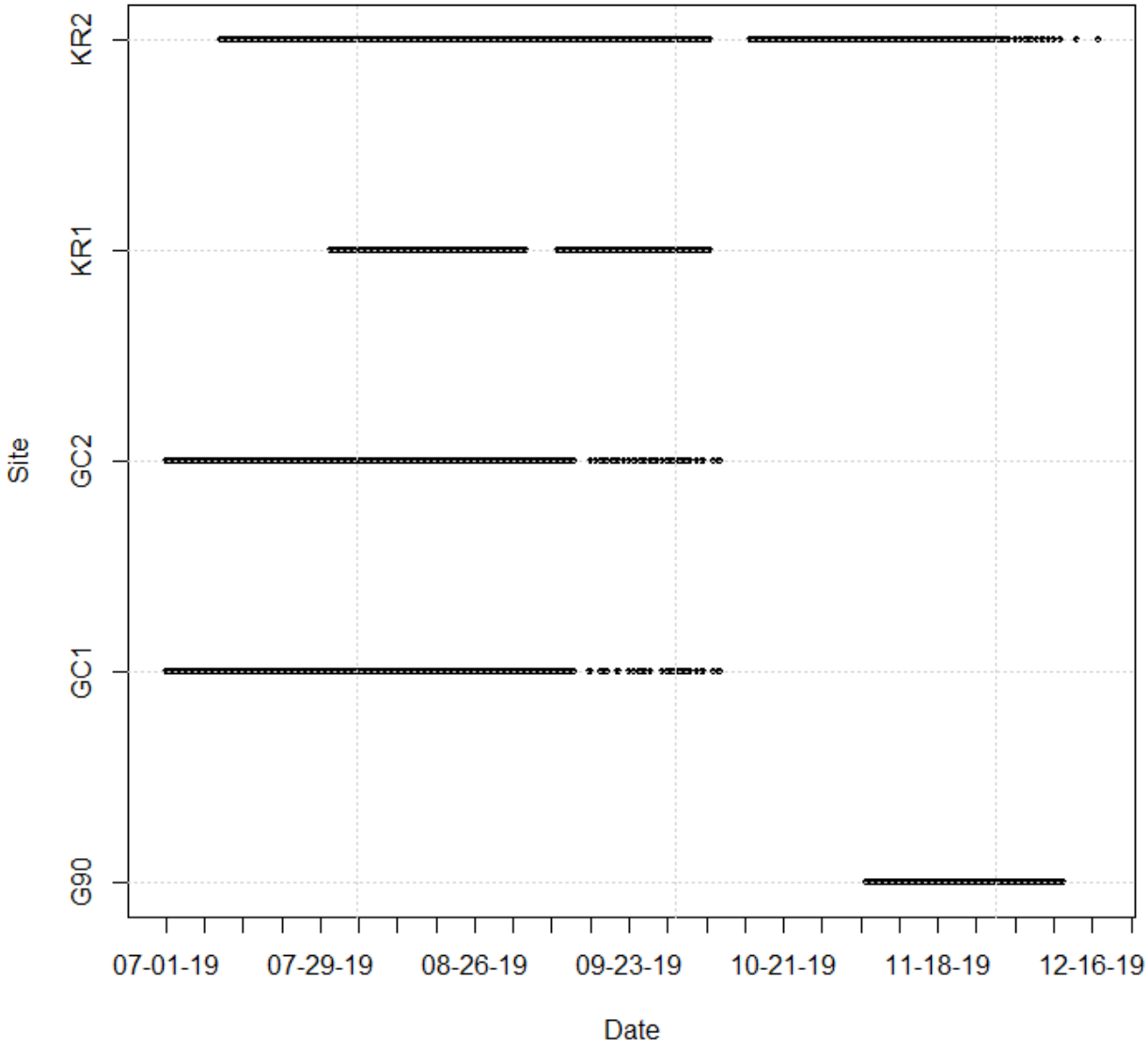

Figure 4. Antenna operations during the 2019 field season. Each 'dot' represents an hour in which the antenna was operational (KR2 = upper Kachess River downstream antenna, KR1= upper Kachess River upstream antenna, GC2 = upper Gold Creek downstream antenna, GC1 = upper Gold Creek upstream antenna, G90 = lower Gold Creek antenna).

Results

Fish Collection

The MCFWCO conducted snorkeling on one day at the Bumping Dam stilling basin, three days at the Kachess Dam stilling basin, and four days at the Keechelus Dam stilling basin. Overall, we collected 15 adult Bull Trout at Keechelus Dam, but none at the other dams (Table 2). During our single attempt at Bumping Dam, we observed one juvenile Bull Trout, after which water temperature exceeded 15 °C, thereby precluding us from further attempts at Bull Trout collection. At Kachess Dam, we observed no Bull Trout despite three efforts to capture fish there. At Keechelus Dam we observed 16 adult Bull Trout and were able to collect and transport 15 after genetic typing identified their natal origin (Table 3). No Brook Trout x Bull Trout hybrids were collected during our trap and haul efforts in 2019.

Table 2. Stilling basin, survey date, number of Bull Trout observed, and the number of Bull Trout collected during trap and haul efforts in 2019.

Stilling Basin	Survey Date	Bull Trout Observed	Bull Trout Collected
Bumping	8/14/2019	1	0
Kachess	10/16/2019	0	0
Kachess	10/24/2019	0	0
Kachess	10/28/2019	0	0
Keechelus	9/30/2019	6	6
Keechelus	10/9/2019	9	9
Keechelus	10/21/2019	1	0
Keechelus	10/28/2019	0	0

Table 3. Capture location, date, gender, length (cm), Genetic ID, PIT Tag, and genetic assignment of fish collected through MCFWCO trap and haul in 2019.

Capture Location	Collection Date	Gender	Length (cm)	Genetic ID	PIT Tag ID	Population ID
Keechelus Dam	9/30/2019	M	66.0	19IL1	3D9.1C2DFFFBBC	Gold Creek
Keechelus Dam	9/30/2019	M	68.0	19IL2	3D9.1C2DFE98DE	Gold Creek
Keechelus Dam	9/30/2019	M	62.0	19IL3	3D9.1C2DFF9E19	Gold Creek
Keechelus Dam	9/30/2019	F	73.0	19IL4	3D9.1C2E05F357	Gold Creek
Keechelus Dam	9/30/2019	M	59.5	19IL5	3D9.1C2DFFB34C	Gold Creek
Keechelus Dam	9/30/2019	M	56.6	19IL6	3D9.1C2DFE5673	Gold Creek
Keechelus Dam	10/9/2019	M	66.0	19IL10	3D9.1C2E063A88	Gold Creek
Keechelus Dam	10/9/2019	M	72.5	19IL11	3D9.1C2E05D17D	Gold Creek
Keechelus Dam	10/9/2019	M	53.5	19IL12	3D9.1C2E053353	Gold Creek
Keechelus Dam	10/9/2019	F	61.5	19IL13	3D9.1C2DFFB2A8	Gold Creek
Keechelus Dam	10/9/2019	U	55.5	19IL14	3D9.1C2E05F518	Gold Creek
Keechelus Dam	10/9/2019	M	69.0	19IL15	3D9.1C2E063552	Gold Creek
Keechelus Dam	10/9/2019	F	63.0	19IL16	3D9.1C2DFE7126	Kachess River

Keechelus Dam	10/9/2019	M	61.5	19IL17	3D9.1C2E057F21	Gold Creek
Keechelus Dam	10/9/2019	F	66.5	19IL18	3D9.1C2E063A57	Gold Creek

Fish Injuries

Nearly all the Bull Trout that we collected below Keechelus had tissue damage on the caudal peduncle, opercles, and maxillaries (Figure 5). We determined that these injuries were from rubbing against concrete surfaces in the Keechelus Dam stilling basin, consistent with injuries salmon acquire while moving through fish ladders in the Columbia River hydropower system (Kenneth Lujan, USFWS, personal communication).

Figure 5. Examples of tissue damage of Bull Trout collected below Keechelus Dam, October 2019.

Fish Release and Movement

We released Bull Trout in different locations based on their natal determination and the water level at the time of release. The six Bull Trout collected on September 30, 2019 were identified as Gold Creek fish and were subsequently released below the National Forest Road 4832 bridge spanning lower Gold Creek (Gold Creek Release 1; Figure 2). The nine Bull Trout collected on October 9, 2019 were released in two locations based on their population identification. One fish was identified as a Kachess River fish and was released at the mouth of Box Canyon Creek (Box Canyon Release; Figure 2). The other eight Bull Trout were identified as Gold Creek fish but were released in the Keechelus Lake reservoir bed about 0.5 km downstream of the Gold Creek

mouth (Gold Creek Release 2; Figure 2) because water level at the Gold Creek Release 1 site was too shallow.

At our PIT antenna sites, we detected three of the fifteen Bull Trout that we collected below Keechelus Dam and transported to our release sites. The first was a Bull Trout that we released at the National Forest Road 4832 bridge and detected 8.4 days later at our Upper Gold Creek array. The second Bull Trout was the only fish that we identified as originating from the Kachess River. After releasing this Bull Trout at the Box Canyon Creek Release site, we detected it 16.5 days later at the upper Kachess River antenna array. The third Bull Trout we detected was released at the Gold Creek Release 2 site and detected 27.4 days later at the lower Gold Creek antenna after our upper Gold Creek antenna array became inoperable (Table 4). We detected this fish five more times with the last detection occurring November 10, 2019, but our ability to accurately assess travel time for this fish was limited by antenna failure.

Table 4. Tag ID, release, and detection timing of Bull Trout trapped below Keechelus Dam and released into their natal origin as determined by rapid response genetic typing.

PIT Tag ID	Release Location	Release Date	Detection Location	First Detection Date	Travel Time (days)
3D9.1C2DFE98DE	Lower Gold Creek- NF Road 4832 Bridge	10/1/19	Upper Gold Creek	10/9/19	8.4
3D9.1C2DFE7126	Upper Kachess Lake –Box Canyon Creek Mouth	10/10/19	Upper Kachess River	10/27/19	16.5
3D9.1C2E05F518	Upper Keechelus Lake- 0.5 km downstream of Gold Creek	10/10/19	Lower Gold Creek	11/6/19	-

Water Temperature

Water temperature in Gold Creek at I-90 ranged from less than 5 °C in late October to almost 15 °C in early September. Mean daily temperatures ranged from a low of 4.7 °C in late October to a high of 13.8 °C in early August. Although water temperatures fluctuated daily, they generally increased during the month of July from 8-13 °C, remained constant between 12-13 °C during the month of August, and then decreased to 5 °C until the end of our monitoring in

late October (Figure 6). We detected Bull Trout when mean daily water temperature in lower Gold Creek was generally less than 8 °C.

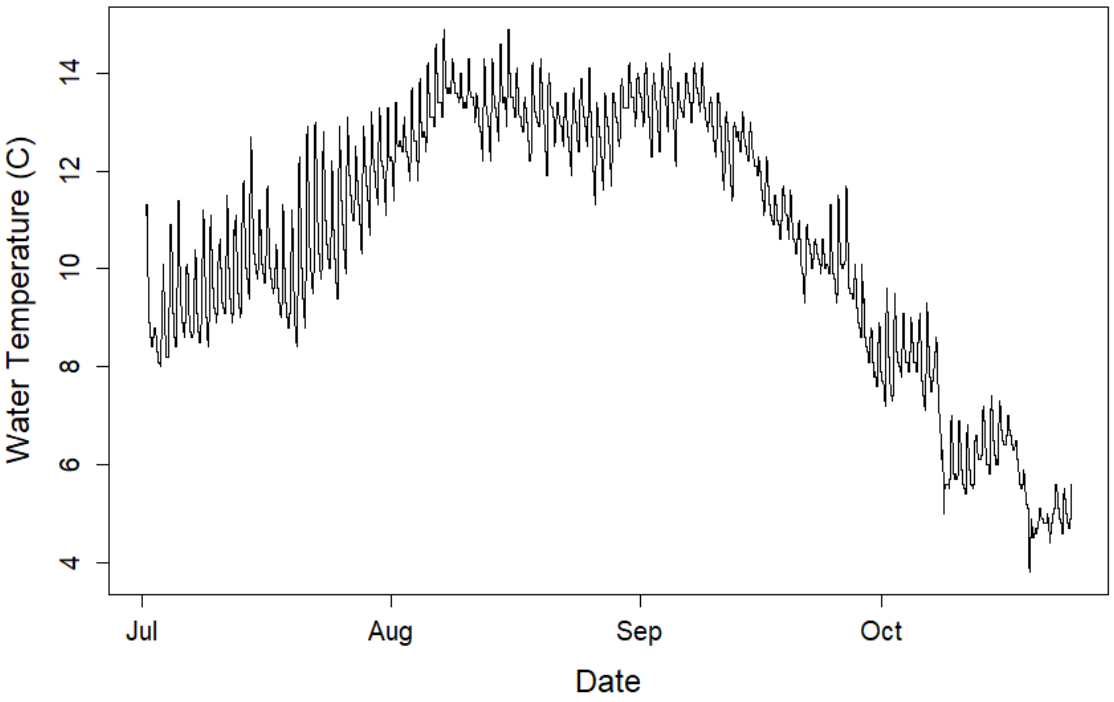

Figure 6. Seasonal change in water temperature collected in Gold Creek at I-90 July 1 – October 24, 2019.

Discussion

We collected 15 Bull Trout below Keechelus Dam but none below Kachess or Bumping dams. We released 14 of these Bull Trout into or just downstream of Gold Creek, but only detected two of these fish at our antenna sites. Lack of detections is likely due to sporadically operating antennas due to lack of solar exposure at the upstream site and timing of installation of the lower Gold Creek site.

The Washington Department of Fish and Wildlife has conducted annual redd surveys in Gold Creek since 1984 and in the upper Kachess River since 1998. Using years where complete surveys were conducted, Gold Creek exhibited an average of 17.6 redds/year within a 10.9-km (6.8-mile) index reach (Range: 2-51 redds; Divens 2019). Over the last five years, the average has been 12.0 redds with 2019 having the highest number (N=27). The 14 Bull Trout that we transported in 2019 were probably a significant contribution to the total number of spawners in

Gold Creek this year, but do to the high water events that destroyed our upper Gold Creek antennas, many of the fish that we transported could have ascended and spawned in Gold Creek without being detected due to antenna failure. In contrast, the single Bull Trout released into Kachess Lake was detected upstream at the upper Kachess River antenna array. In the upper Kachess River, annual redd surveys conducted by WDFW since 1998 exhibited an average of 13.6 redds/year observed within a 1.3-km (0.8-mile) index survey. Over the last five years, the average has been 15.4 with 2019 having 23 redds observed (Range: 0-33 redds; Divens 2019).

Our activities indicate that some Bull Trout originating in tributaries of both Kachess and Keechelus lakes pass downstream of Keechelus and Kachess dams and then attempt to return, upstream presumably to spawn. Although we collected no fish below Kachess Dam, our genetic data indicated that at least one fish moved downstream past Kachess Dam before being captured below Keechelus Dam. Given the small numbers of redds in the spawning areas associated with Kachess (upper Kachess River and Box Canyon Creek) and Keechelus (Gold Creek) lakes, the 15 Bull Trout we collected below Keechelus Dam are probably a significant portion of the Bull Trout spawning population that otherwise would not have returned to their natal spawning grounds.

In 2020, Yakama Nation and MCFWCO will install antennas in the lower portion of the upper Kachess River near its mouth at Kachess Lake and in lower Box Canyon Creek. The antenna array in upper Gold Creek, the antenna in lower Gold Creek, and the antenna array in the upper Kachess River, as described in this report, will be maintained. In summer 2019 Yakama Nation collected Bull Trout as water diminished in Gold Creek and the upper Kachess River. These fish were held over the winter at La Salle fish hatchery and Yakama Nation plans to release them in 2020. During 2020, our antennas will be used to monitor juveniles released in 2020, adults tagged in 2019, and adults that will be tagged in 2020. Finally, we fully expect to increase our effort to collect more Bull Trout not only below Kachess and Keechelus dams, but also below Bumping and Tieton dams.

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