North Fork Tieton Bull Trout Transport Project

2017 Progress Report

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March 26, 2018

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Foreword

A comprehensive assessment of fish passage conditions at Clear Creek Dam on the North Fork (NF) Tieton River was completed in 2015. The study spanned four years and was conducted by the Yakima Sub-Office of the USFWS' Mid-Columbia Fish and Wildlife Conservation Office. The investigation focused on Bull Trout (*Salvelinus confluentus)* which were listed as threatened under the Endangered Species Act in 1998. A population of Bull Trout spawns in the NF Tieton River above Clear Creek Dam. The river was among those in the Yakima River Basin designated as Critical Habitat for Bull Trout in 2004 (69 Fed. Reg. 60070; October 6, 2004).

The NF Tieton Bull Trout Transport Project (Transport Project) is a follow-up to the Clear Creek Dam Fish Passage Assessment (CCDFPA) which found that Bull Trout were unable or unwilling to migrate past the dam (Thomas and Monk 2016). In response to this finding, the Yakima Sub-Office decided that efforts were warranted to capture NF Tieton Bull Trout isolated below Clear Creek Dam and transport them above the structure. While a permanent upstream passage solution is in the planning stages as part of the Yakima Basin Integrated Water Management Plan, the construction of these facilities is several years in the future. Given the relatively small size of the current active spawning population and concerns related to its genetic integrity, the Transport Project was initiated in the spring of 2016. The first-year results of the project were reported in April, 2017 (Thomas et. al 2017). In 2017, the Transport Project continued and the results are reported herein. The extensive background information presented in the two reports cited above will not be repeated in this report. These reports can be downloaded on the U.S. Bureau of Reclamation's (USBR) website: https://www.usbr.gov/pn/programs/yrbwep/phase2/clearcreek/index.html. The primary funding for the Transport Project is provided through the U.S. Bureau of Reclamation's Yakima River Basin Water Enhancement Project.

Goals and Objectives

The ultimate goal of the Transport Project is to maintain the genetic diversity and increase the viability of the NF Tieton Bull Trout population by providing passage for fish currently excluded from natal spawning habitat in the NF Tieton River upstream of Clear Creek Dam. To achieve this goal the following objectives were developed:

- Capture adult Bull Trout in the stilling basin directly below Clear Creek Dam
- Surgically implant Half-Duplex (HDX) Passive Integrated Transponder (PIT) tags in captured Bull Trout and obtain tissue samples for genetic analysis
- Transport tagged fish above the dam and release them into Clear Lake
- Utilize fixed PIT tag interrogation sites established in the NF Tieton River and Clear Creek watersheds, and around the dam and spillway, to monitor the movement of tagged fish
- Assess the spawning success of transported fish

2016 Summary

The information presented here is only that which is directly relevant to the 2017 results. Greater detail can be found in the 2016 progress report cited above. During 2016, 17 NF Tieton Bull Trout were captured below Clear Creek Dam, transported above the structure and released into Clear Lake. Twelve additional genetically distinct Bull Trout, seven belonging to the Indian Creek population and five from the South Fork (SF) Tieton River, were also transported (along with a single Bull Trout x Brook Trout hybrid). All transported Bull Trout were implanted with HDX PIT tags. The number of Bull Trout captured which originated from the two other genetically distinct populations (hereafter referred to as “foreign”) was unexpected based on sampling results from previous years. It was not our intent to relocate that many individuals from other populations but it was unavoidable; in the first year of the project we did not receive confirmation of genetic origin until almost two months after samples were obtained. Transported Bull Trout were able to emigrate from Clear Lake and a few did, however fish could not return once they had migrated downstream of the dam.

Twenty of the 29 Bull Trout transported in 2016 were subsequently detected at the NF Tieton PIT tag detection array (antenna) located 0.75 mile upstream of Clear Lake. These included 14 of 17 NF Tieton transports which took, on average, three days to find and ascend the river. Two of these Bull Trout were later detected emigrating downstream past Clear Creek Dam after the spawning period. The six foreign Bull Trout detected up the NF Tieton River included four from Indian Creek and two from the SF Tieton River populations. Two of these, both from Indian Creek, also emigrated from Clear Lake. Four Bull Trout were detected in Clear Creek, a tributary to Clear Lake where the species had never been observed previously. All four were from the Indian Creek population and three of them were also detected in the NF Tieton River.

2017 Methods

Capture

All of the fish collected below the dam in 2016 were captured by hook-and-line. Considering the decline in angling success with each successive sampling date in 2016, we decided to add an alternative sampling method in 2017. On each sampling occasion angling was attempted first (methods were identical to those employed in 2016). When catch per unit effort diminished below an acceptable level, a tangle net was deployed. The net was 50 feet long and six feet deep, constructed from three-inch stretch mesh using eight-pound monofilament. The net was deployed from a tub on the front platform of a 12-foot cataraft while the oarsman rowed the raft as straight as possible in the swirling waters of the stilling basin (Figure 1). The net was allowed to set for about five-to-ten minutes and then was collected hand-over-hand back into the tub. As fish came to hand they were carefully removed from the net and placed in one of the large coolers strapped to the platform on either side of the tub. After a net had been emptied, and before redeployment, the catch was transferred to a holding pen located at the downstream end of the stilling basin in two to three feet of water (Figure 2).

Figure 1. Deploying a tangle net in the still basin of Clear Creek Dam in July, 2017

Figure 2. Transferring a Bull Trout from the raft to the holding pen in July, 2017

The dimensions of the holding pen (Figure 3) were 8 x 4 x 4 feet. It was built with an aluminum frame which held removable 4 x 4 foot perforated stainless steel panels that were 1/16 inch thick. The bottom of the pen was also constructed out of this material; the top consisted of two hinged 1/16 inch solid stainless panels which could be locked when closed. A plywood panel was inserted in the middle of the enclosure to separate it into two compartments.

Figure 3. The Bull Trout holding pen utilized in the NF Tieton Bull Trout Transport Project in 2017.

Because a surprisingly large number of foreign Bull Trout had been caught and transported in 2016, rapid response genetic analysis (see Appendix A) was used in 2017 to determine the genetic origin of captured fish. Genetic samples taken from captured fish (only those that appeared to be Bull Trout) were taken on the day of capture to the USFWS Abernathy Fish Technology Center. The following morning a geneticist with the Conservation Genetics Program conducted analyses to determine if fish were pure Bull Trout and if so, their genetic origin based on a genetic baseline established in the Yakima Basin over the course of the past two decades. During the time these analyses were being conducted the captured fish were held in the locked pen located directly below Clear Creek Dam. Over the five sampling dates the time between sample acquisition and receiving genetic assignment results averaged just 23.1 hours.

Tagging

Fish were netted from the pen and scanned to determine if they had been PIT tagged in previous years. If so, those which were genetically distinct NF Tieton Bull Trout were placed in the half of the pen reserved for processed fish ready for transport. Previously tagged Bull Trout belonging to other populations were released downstream. Fish which had not been tagged were placed in an 80-quart cooler and anesthetized for tagging procedures. The anesthesia used was tricaine-s (i.e., MS-222) mixed at a 50mg/L concentration with river water. Since MS-222 is acidic, buffer ($NaHCO_3$, i.e., baking soda) was added to the solution to raise the pH back to the baseline level of the river. The pH was measured using a Eutech Instruments pHTestr20®. To ensure the consistency and safety of the solution the cooler was pre-marked to hold 25 liters of water and the amounts of MS-222 (1.25 grams) was premeasured and kept in individual bottles.

The fish were measured, photographed, and a visual attempt was made to determine their gender, which was not always possible. A small tissue sample was taken from the pectoral fin for genetic analysis and preserved in 100% ethanol. A scalpel was used to make a one-half inch vertical incision just posterior and ventral to the pectoral musculature near the end of the pectoral fin. This incision penetrated only the epidermal layer under which an HDX PIT tag was horizontally inserted. We used 23 mm x 3.65 mm tags (manufactured by Texas Instruments, Inc.) operating on the 134.2 kHz radio frequency identification standard for animal tagging. The tag was gently pushed in between muscle and skin towards the tail of the fish until barely visible, at which point a straw was used to implant it about one inch further. This surgical procedure did not require any sutures. After being placed in the anesthetic solution, full anesthetization usually occurred within 7-10 minutes. The time required to process each fish was 5-7 minutes. Upon completion of the procedures the fish were placed in PVC recovery tubes anchored in the streambed in flowing water. After full recovery (about 15 minutes) fish were placed back in the processed compartment of the holding pen. The pen separator was removed after the tagging operation was completed. This was done to provide more space for the fish during their overnight stay.

Transport

By mid-afternoon the day after tagging the results of the rapid response genetic analyses were known. Each fish was removed from the pen and scanned to determine its PIT tag code which was then matched with the corresponding genetic ID. NF Tieton Bull Trout were placed in coolers filled with fresh cold water secured in the back of a pickup truck. They were then transported above the dam to Clear Lake two or three at a time with each transport run taking less than 10 minutes. The fish were released in deep water adjacent to Clear Creek Dam (Figures 4 and 5). Bull Trout belonging to the SF Tieton River and Indian Creek populations were released into the riffle directly downstream of the stilling basin; Bull Trout x Brook Trout hybrids were euthanized.

Figure 4. Transport of adult Bull Trout to Clear Lake above Clear Creek Dam.

Figure 5. Release of adult Bull Trout into Clear Lake adjacent to the Clear Creek Dam.

Monitoring Movements of Transported Bull Trout

As was the case in 2016, five PIT tag detection antennas were operated in 2017 (Figure 6). All five antennas over-wintered without major damage and only required minor adjustments and tuning. Two were located in the pool-and-weir ladder, one at the exit into Clear Lake (upper ladder) and one seven weirs below it (lower ladder). A third antenna was located in the outlet channel approximately 70 meters below the stilling basin. The fourth PIT tag detection antenna spanned the channel of the NF Tieton River approximately 0.75 mile upstream of Clear Lake and a fifth was located in Clear Creek (another tributary to Clear Lake) about a half-mile upstream from the mouth. The construction materials, electronic components, installation methods, and power supply details for all of these antennas were similar (if not identical) and were described in the final report for the Clear Creek Dam Fish Passage Assessment (Thomas and Monk 2016).

All antennas were established and operational as soon as flow conditions would allow in-river work and prior to the time they were needed to accomplish the objectives of the project. The antennas were decommissioned when the power supply became consistently inadequate (i.e., reliable solar charging of the batteries became impossible due to low light conditions). This varied between sites (Table 1).

Table 1. Operational time periods for PIT antennas during the 2017 Bull Trout Transport Project. Antenna site abbreviations are in parentheses.

Antenna Location	**Start**	**End**
Upper Ladder (ULD)	May 8	November 6
Lower Ladder (LLD)	May 8	October 20
Outlet Channel (OCH)	May 18	October 20
NF Tieton (NFT)	May 23	October 19
Clear Creek (CLC)	June 23	September 28

The antennas were powered by six-volt batteries recharged with solar panels. Some were susceptible to short-term power outages on successive cloudy days and from topographical and/or forest canopy shading. Solar panels were placed such that maximum solar exposure could be achieved but it was not possible to avoid occasional power outages, particularly in the hours just before dawn. To conserve power two sites had to be run on a timer which shut the tag reader down during a time period when less Bull Trout movement was anticipated (this was based on several years of previous detection data). The most challenging site was on Clear Creek which was located in dense forest. This site was automatically shut off between 9:00 AM and 5:00 PM beginning in late-June. Even with this restriction the antenna had detection capability 67% of the time.

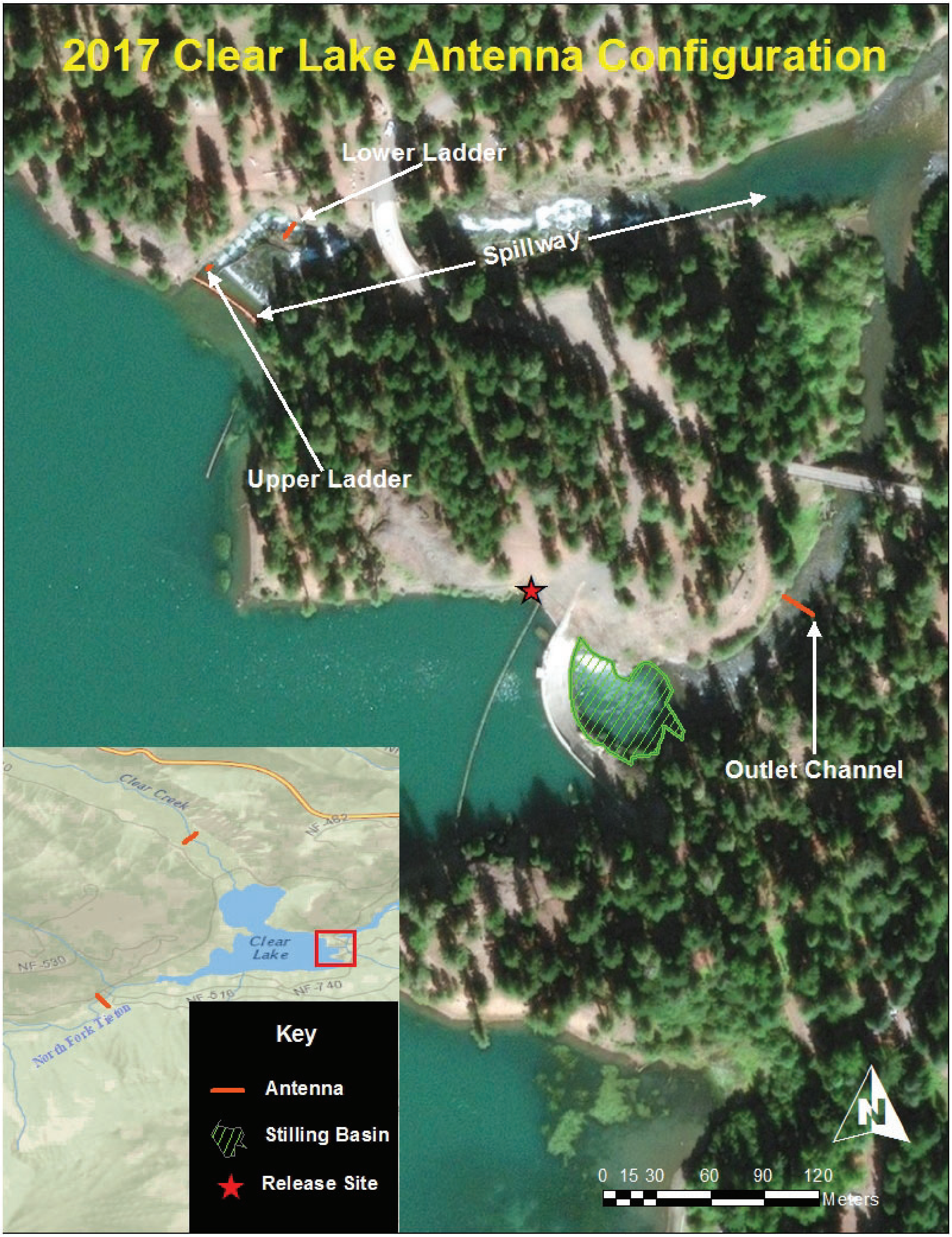

Figure 6. Map of the area around Clear Creek Dam on the NF Tieton River, Yakima County, WA. Shown on the main map are key areas and the location of the PIT tag detection antennas around the dam. The inset shows the location of the dam on Clear Lake as well as the PIT tag detection arrays in Clear Creek and the NF Tieton River.

A timer was also utilized for the Lower ladder antenna but for a much shorter amount of time; during its operational window the antenna had detection capability 94% of the time. The operational efficiencies of the other detection sites from June 27 (the date that the first Bull Trout were transported) to site decommissioning was as follows: Upper ladder (100%); Outlet channel (94%); and NF Tieton River (97%).

Assessing Spawning Success of Transported Bull Trout

Currently the only indicators that transported NF Tieton Bull Trout have joined the spawning population above the dam are PIT tag detections in the river above Clear Lake and an increase in the number of redds observed. In 2017, the migration of transported Bull Trout was monitored from May 23 (over three months prior to the known spawning period for the population) through October 19 (over a month later). These data provide some indication of the intent of these fish to spawn but not of their success. Bull Trout redd surveys have been conducted in the river annually since 2006. These surveys provide a measure of spawning population abundance and it should be expected that an increase in the number of redds observed would occur if significant numbers of transported fish have entered the spawning population. In 2017, as was the case in 2016, environmental conditions were good to conduct complete redd surveys. These surveys were conducted high in the watershed in an index reach extending approximately two river-miles downstream of a barrier waterfall. This reach has been identified as the primary spawning area for the NF Tieton Bull Trout population. Two survey passes, conducted about ten days apart, were completed each year.

Eventually it would be desirable to include another method to determine the spawning contribution of transported Bull Trout. All Bull Trout populations display annual variability in redd counts, a situation sometimes exacerbated by the difficulties encountered conducting surveys in remote areas. While conditions for conducting redd surveys have been favorable for the last three years on the NF Tieton River, this has not always been the case. The river derives from glaciers in the Goat Rocks Wilderness a short distance upstream of the spawning area. Even modest amounts of rainfall can result in a rapid increase in stream discharge which impacts both access and water clarity. Since the Bull Trout redd surveys began twelve years ago it has not been possible to conduct a complete survey in four of those years (2006, 2010, 2013, 2014). For this reason we have proposed to utilize genetic parentage analysis to document the spawning success of transported NFT Bull Trout in addition to redd surveys.

Juvenile Bull Trout may rear in the NF Tieton River for 1-4 years before migrating downstream (the exact timing is unknown). In order to evaluate spawning success, electrofishing and/or snorkel surveys will be conducted to collect genetic samples (fin clips) from juvenile Bull Trout. The samples will be preserved in 100% ethanol and later analyzed to determine parentage. The accomplishment of this objective will require considerable manpower and will be logistically complex. Since it requires genetic sampling of the offspring of transported Bull Trout, the effort could not commence until sufficient progeny were produced. Juvenile Bull Trout that are descendants of fish transported in 2016 are now likely inhabiting the river so it should be possible to begin collecting genetic material from them during the 2018 field season.

Results

Capture, Tagging, and Transport

There were five weekly sampling dates in 2017 beginning on June 26 and running through July 31 (the week of July 4 was skipped for obvious reasons). On each date, capture efforts began around 0930 hours and continued for about three hours. Angling was the only capture method used the first week but on all subsequent dates the net was deployed when angling success diminished; this occurred after 1.5 hours the second week (July 10) and just 25-30 minutes on all dates thereafter. Of the 43 fish captured in 2017 (all species included), twenty-seven (63%) were netted and sixteen were caught by hook-and-line. The most productive sampling date was July 10 when 13 Bull Trout were captured and the least productive was the last (July 31) with only four captured. Water temperatures on site ranged from 9°C on June 26 to 12°C on July 31 during these operations.

Thirty-four pure Bull Trout were captured below Clear Creek Dam in 2017 including nineteen which genetically keyed to the NF Tieton River population (Table 2). Of the 19, three were recaptures of Bull Trout tagged in previous years (one each from 2014, 2015, and 2016). The fish measured from 32.2 to 75.5 cm total length (TL), averaging 52.2 cm. Based on visual inspection, eight appeared to be females and five were males. The gender of the other six could not be determined. These were the smallest Bull Trout captured, ranging in size from 32-44 cm (TL). All nineteen of the NF Tieton fish were transported above the dam and released into Clear Lake. This was two more than the number of NF Tieton Bull Trout transported in 2016, bringing the two-year total to 36.

Fifteen Bull trout were captured that belonged to either the Indian Creek population (9) or the SF Tieton River population (6) as well as three hybrids (Brook Trout x Bull Trout). As had occurred in 2016, a number of the pure Bull Trout captured in 2017 had markings, primarily spots on the dorsal fin, which led us to believe they might be hybrids. None were. However, we did correctly identify two of the hybrids in the field (the other was a recapture from 2015). While some researchers have expressed confidence that hybrids of these two species can be reliably identified in the field by morphological characteristics (Popowich et. al 2011), this has not been our experience.

Several other salmonid species were captured below Clear Creek Dam in 2017. These included three West Slope Cutthroat Trout (*Oncorhynchus clarki lewsii*), two Rainbow Trout (*Oncorhynchus mykiss*), and one Brook Trout (*S. fontinalis*).

Table 2. Bull Trout captured in the NF Tieton River downstream of Clear Creek Dam on five sampling dates in 2017. Nineteen of these Bull Trout genetically keyed to the NF Tieton population and all were transported. The gray shading denotes different sample dates.

Tag #	Date	Sex	TL (cm)	Genetic Origin	Notes
191	26-June	Female	61.0	NF Tieton	Transported
193	26-June	Unknown	41.0	NF Tieton	Transported
317	26-June	Female	60.5	NF Tieton	Transported
391	26-June	Unknown	44.0	NF Tieton	Transported
417	26-June	Unknown	42.5	SF Tieton	Released Downstream
449	26-June	Female	59.5	Indian Creek	Released Downstream
269	10-July	Unknown	39.5	SF Tieton	Released downstream
294	10-July	Unknown	37.0	SF Tieton	Released downstream
296	10-July	Male	63.5	Indian Creek	Released downstream
320	10-July	Unknown	36.5	NF Tieton	Transported
361	10-July	Female	51.5	NF Tieton	Transported
407	10-July	Male	66.0	NF Tieton	Transported
452	10-July	Unknown	32.2	NF Tieton	Transported
476	10-July	Female	44.5	NF Tieton	Transported
479	10-July	Unknown	35.0	NF Tieton	Transported
483	10-July	Male	68.0	NF Tieton	Transported
484	10-July	Male	63.5	Indian Creek	Released downstream
243	10-July	Male	71.0	NF Tieton	2015 recap, Transported
197	17-July	Unknown	33.5	SF Tieton	Released Downstream
444	17-July	Female	65.0	NF Tieton	Transported
445	17-July	Male	45.5	NF Tieton	Transported
470	17-July	Female	46.0	NF Tieton	Transported
471	17-July	Female	63.5	NF Tieton	Transported
451	24-July	Female	51.0	NF Tieton	2016 recap, Transported
292	24-July	Male	49.0	SF Tieton	Released downstream
299	24-July	Male	62.0	Indian Creek	Released downstream
310	24-July	Male	53.5	Indian Creek	Released downstream
410	24-July	Male	61.0	Indian Creek	Released downstream
425	24-July	Female	51.5	Indian Creek	Released downstream
432	24-July	Male	58.0	Indian Creek	Released downstream
298	31-July	Unknown	32.0	SF Tieton	Released downstream
305	31-July	Female	55.0	Indian Creek	Released downstream
313	31-July	Unknown	34.5	NF Tieton	Transported
231	31-July	Male	75.5	NF Tieton	2014 Recap Transported

Water Temperatures

In 2017, water temperatures were recorded every two hours in the spillway and outlet channels as well in the NF Tieton River and Clear Creek. As in previous years, water temperatures in the spillway channel were much warmer than those in the outlet channel (Figure 7). Sometime between June 23 and July 5 the mean daily water temperature in the spillway rose above 15°C where it remained until September 24. Mean daily temperatures exceeded 17°C for all but a few days from July 22 through September 4 and were higher than 18°C for just over two weeks during that time period. By contrast, mean daily water temperatures in the outlet channel below the dam never got close to 15°C, reaching a maximum of just over 13°C during the first two weeks of August before receding. During the period when transport efforts were underway (June 26-July 31) mean daily water temperatures averaged over five degrees cooler in the outlet channel than in the spillway channel (11.6 versus 16.9°C).

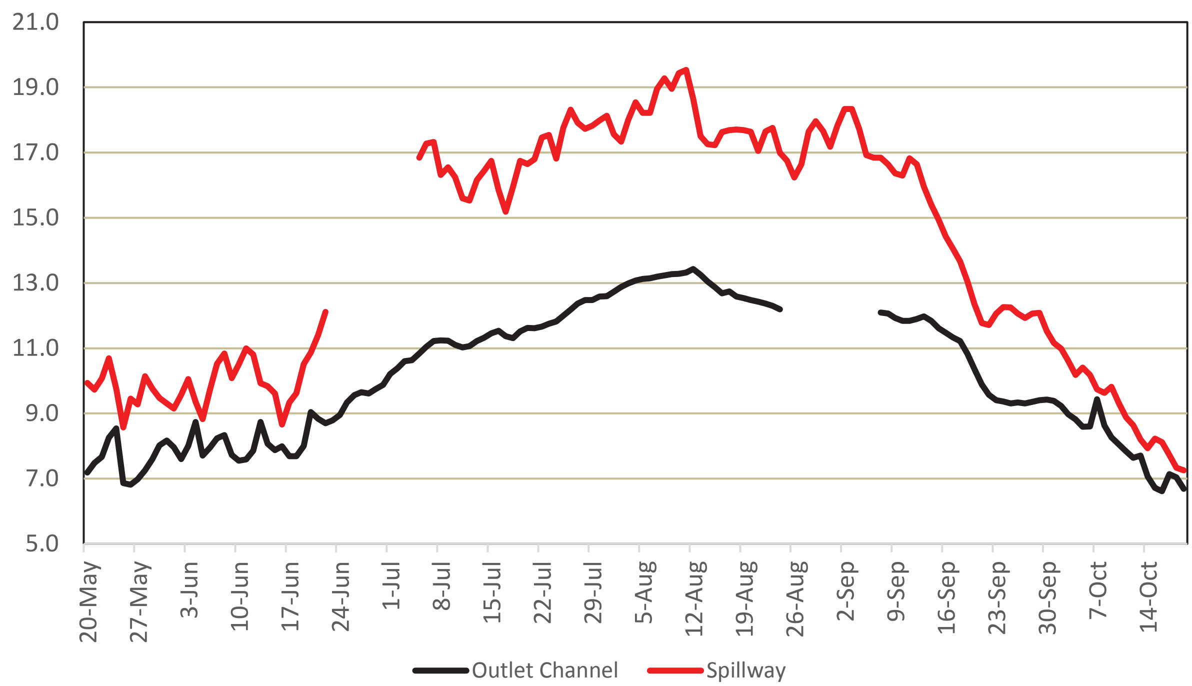

Figure 7. Mean daily water temperatures (°C) from May 20 through the October 19, 2017 in the spillway and outlet channels of Clear Creek Dam. The data gaps in both data sets were caused by undetected malfunctions of the temperature logger.

In 2016, four Bull Trout made their way into Clear Creek where none had ever been observed. These four fish genetically keyed to the Indian Creek population and were most likely wanderers searching for their natal stream. With only NF Tieton Bull Trout transported in 2017 we did not expect any tagged fish to enter Clear Creek but a PIT tag detection antenna was nevertheless established and a temperature logger was deployed. Temperature data were collected at two hour intervals from June 14 through September 28. Data showed that water temperatures were consistently cold with a range of just two degrees (5.4-7.4°C) over the summer (Figure 8). These temperatures indicate that Clear Creek is probably too cold to support adequate growth (~10-12°C) for juvenile Bull Trout and may explain why a population does not spawn in the stream.

Water temperatures in the NF Tieton River, as has been the case since data collection began in 2012, were highly suitable for Bull Trout (Figure 8). The mean daily temperature exceeded 12°C for just one day in August, averaging 9.5°C over the course of the summer. During the 40 days (June 27-August 1) that transport operations were underway mean daily water temperatures ranged from 7.5-11.0°C.

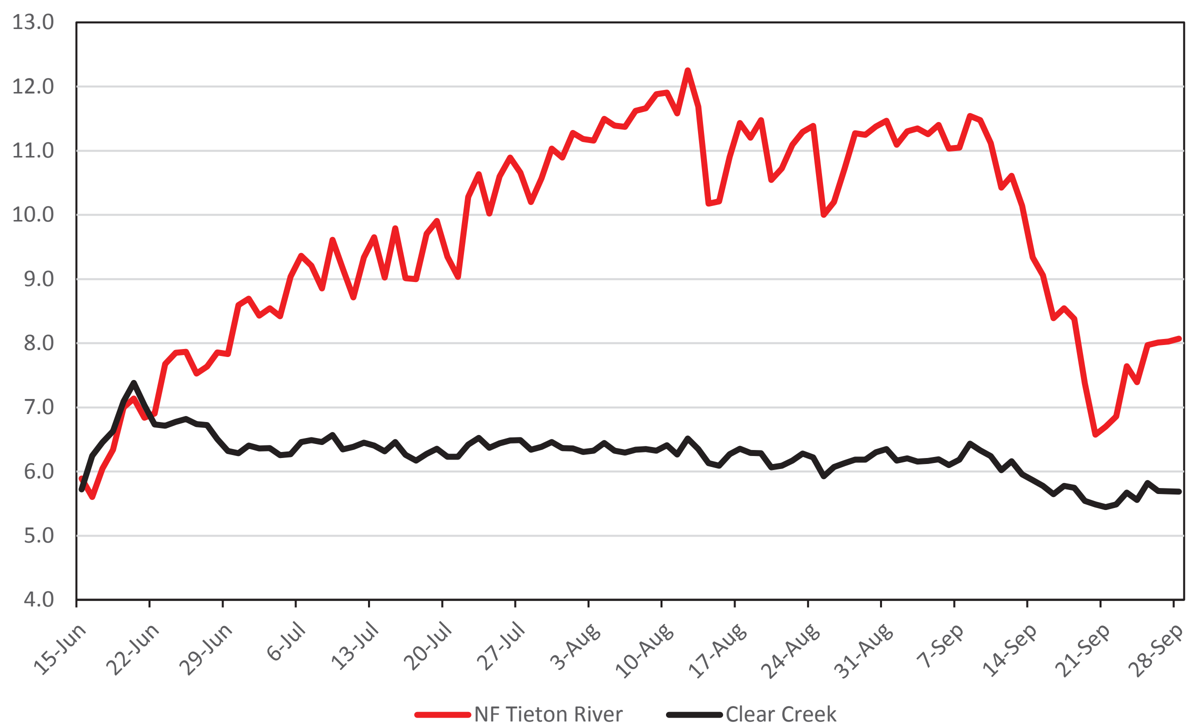

Figure 8. Mean daily water temperatures (°C) from mid-June through the end of September, 2017 in the NF Tieton River and Clear Creek.

Movements of Transported Bull Trout

2016 Fish

Seven of the 17 NF Tieton Bull Trout transported in 2016 were detected in the NF Tieton River in 2017. These included six which had also been detected in 2016 and one which had not been detected anywhere previously. Eight of the transported Bull Trout which migrated up the NF Tieton River in 2016 were not detected there in 2017. Two NF Tieton Bull Trout transported in 2016 have not been detected anywhere since they were released. Interestingly, two SF Tieton Bull Trout transported in 2016, both of which had been detected in the NF Tieton River after transport, showed up again in 2017. These were the only foreign fish to display this behavior.

2017 Fish

Fourteen of the 19 NF Tieton Bull Trout transported above Clear Creek Dam in 2017 were subsequently detected up the NF Tieton River (the same number of NF Tieton immigrants counted in 2016). The other five were not detected anywhere after transport. The migration timing for the 2017 fish was quite a bit different than their 2016 cohorts. Whereas the 2016 transports were detected up the NF Tieton River, on average, just three days after release (half were there within 24 hours), the 2017 fish spent an average of 11 days making the migration with only two detected within 24 hours. The reason for this is unknown. Environmental conditions (stream discharge and water temperatures) were similar during both years and well within a normal range. The movements of the NF Tieton Bull Trout transported in 2017 are presented in Table 3.

Emigration

Just one NF Tieton Bull Trout transported in 2016 or 2017 was confirmed to have emigrated from Clear Lake after the spawning period in 2017. This fish, a 2017 transport, was detected at both the upper and lower ladder PIT tag interrogation sites on October 8. Four others (all 2017 transports) were detected at the upper ladder antenna in late-October suggesting they may have left, however they were not detected in the lower ladder which would have provided confirmation. The lower ladder antenna was experiencing persistent power outages by that time and was decommissioned on October 26. It is also possible for Bull Trout to leave Clear Lake undetected over the crest of the spillway. If this happens there is a good probability they would be detected in the outlet channel the next summer. There were no such detections in 2017 of Bull Trout which had been transported in 2016.

Table 3. PIT tag detections of NFT Bull Trout transported above Clear Creek Dam in 2017. Blue tag numbers are recaptured fish which were tagged in previous years.

Tag #	Date Transported	2017 NF Tieton	Upper ladder	Lower Ladder
191	27-June	30-July, 29-Sep		
193	27-June	8-July, 19-Sep		
317	27-June	8-July, 29-Sep		
391	27-June	10-July, 2-Oct	24-Oct, 2-Nov	
243	11-July	12-Aug		
320	11-July	Not detected		
361	11-July	24-July		
407	11-July	21-July, 7-Oct	8-Oct	8-Oct
452	11-July	Not detected		
476	11-July	Not detected		
479	11-July	Not detected		
483	11-July	12-July, 4-Oct	7-Oct	
444	18-July	25-July,27-Sep	30-Oct	
445	18-July	Not detected		
470	18-July	22-July, 13-Oct		
471	18-July	22-July, 19-Sep		
451	25-July	29-Jul, 12-Oct	28-Oct, 29-Oct	
231	1-Aug	13-Aug, 7-Oct		
313	1-Aug		26-Oct, 6-Nov	

Fish Kill Follow-up

Around September 20, 2016 a mysterious fish kill occurred in the stilling basin below Clear Creek Dam. Hundreds of dead and dying Kokanee Salmon (*O. nerka)* were found. Observing dead Kokanee in this location was not unusual as the species spawns in the outlet channel during that time of year and dies afterward. However, the number observed and the behavior of the dying fish was abnormal. Three fresh adult Bull Trout carcasses were also found, one in the stilling basin and two others about 0.5 mile downstream. The water in the stilling basin, usually very clear, was off-color and opaque but did not have an unusual odor.

The cause of the kill was not positively determined but evidence pointed to oxygen deprivation. We postulated that Clear Lake may have turned over resulting in anoxic conditions in the depths of the lake where water is released through the gates of the dam. This hypothesis was supported by the observation that no dead fish were found downstream of the spillway channel where discharge is derived through surface spill. Considering contaminants, there were no reported spills and even the possibility that one might have occurred is more than unlikely as only forest roads, and no rail lines, are located in the watershed. In addition, a fish kill was not observed in Clear Lake.

An event such as this had not been observed over the course of the four-year CCDFPA although one of very limited duration might have gone unnoticed. Hoping this was an anomaly, water quality conditions in the stilling basin were monitored during the summer and fall of 2017. Water temperatures were suitable for Bull Trout throughout this period (Figure 7). Within the interval when the fish kill occurred in 2016 (September 15- October 15) the mean daily water temperature was 11.2°C (range: 6.7-11.6°C) with no abrupt changes that would indicate a turnover had occurred in Clear Lake. Dissolved Oxygen was also monitored using an Onset® HOBO U26 Dissolved Oxygen Data Logger. Dissolved Oxygen measurements (taken every two hours) averaged 9.65 mg/L between 26 June and 23 October (minimum: 8.13); from mid-September through mid-October the average was 9.87 mg/L (minimum: 9.20). The concentrations for both time periods were well fully suitable for Bull Trout which call for a minimum of 6.5 mg/L (Maret and Schultz 2013). As was the case with water temperature there were no abrupt changes that would indicate a lake turnover had occurred. A fish kill was not observed below Clear Creek Dam in 2017.

Discussion

The second year of the NF Tieton Bull Trout Transport Project was a success. Nineteen NF Tieton Bull Trout trapped below Clear Creek Dam were afforded the opportunity to join the spawning population above the dam. This was two more than were transported the previous year and brings the two-year total to 36. The decision to use the rapid genetic analysis was wise. Not only were Bull Trout from other populations not subjected to an ordeal that likely costs them the opportunity to spawn that season, but the logistics of utilizing the technology proved far simpler than anticipated. We believed that a longer holding period (48+ hours) would be required to complete the analyses when less than half that was actually necessary. Finally, the use of the tangle nets was effective for the most part. On each sampling date except the first, angling success decreased markedly after 30-45 minutes. Had we not been prepared to deploy the net far fewer Bull Trout would have been captured.

As was the case in 2016, none of the Bull Trout transported in 2017 showed any sign of ill health upon release; all disappeared quickly into the deep water next to the dam. That 14 of them were later detected up the NF Tieton River (the same number as in 2016) strengthens our confidence that the mortality rate was very low. It is true that five fish went undetected after release but four of those were the smallest Bull Trout transported, averaging just 34.4 cm (TL), and may not have been sexually mature yet (the average length of the fish which migrated was 58 cm).

The ultimate measure of success is a confirmed increase in spawners. At this point the only indicator of this is annual redd counts. The difficulties encountered in acquiring complete redd counts in the NF Tieton River were previously described. Nevertheless, complete counts were obtained in seven of eleven years from 2006 through 2016. An average of 23 redds were observed annually over this period, ranging from 11 (2001) to 37 (2007). Of perhaps greater interest, complete counts were obtained in five of six years between 2011 and 2016. The average count for these years was 19, ranging from 11 (2001) to 27 (2015). After two years of transporting Bull Trout, 39 redds were counted in the NF Tieton River in September, 2017. This number doubled the recent five-year average and was a new record, surpassing that obtained ten years earlier.

A single data point is not enough to declare success in the effort to increase the viability and genetic integrity of the NFT Bull Trout population but the 2017 results were encouraging. Only passage at Clear Creek Dam will provide the permanent relief this population needs. Until that becomes a reality efforts to relocate Bull Trout trapped below the dam will continue.

Acknowledgements

A special thanks goes out to Jennifer Von Bargen with the Conservation Genetics Program at the USFWS' Abernathy Fish Technology Center. Jennifer conducted the rapid response genetic analyses which enabled us to transport only pure NF Tieton Bull Trout. John Easterbrooks and Eric Anderson from the Washington Department of Fish and Wildlife (Region 3) assisted on one of our sampling days as did Arden Thomas with Washington Water Trust. Their assistance was appreciated and we thank them for their support. Finally, we would like to thank several folks in the Bureau of Reclamation's Yakima Field Office. Joe Wathen did a superb job constructing our holding pen which was a thing of beauty. Chris Lynch and Doug Call coordinated seamlessly with us to ensure that we had the proper hydrologic conditions below Clear Creek Dam to conduct our operations. Thanks to all.

References

Maret, T.R. and J.E. Schultz (2013). Bull Trout (*Salvelinus confluentus)* movement in relation to water temperature, season, and habitat features in Arrowrock Reservoir. Idaho, 2012: U.S. Geological Survey Scientific Investigations Report 2013-5158, 28p.

Popowich, R.C., P.A Venturelli, J.D. Stelfox, and E.B Taylor (2011). Validation of Morphological Characteristics Used for Field Identification of Bull Trout x Brook Trout Hybrids. North American Journal of Fisheries Management, 31:3, pp. 548-553.

Thomas, J.A. and P. Monk (2016). Final Report for the Clear Creek Dam Fish Passage Assessment. United States Fish and Wildlife Service, Mid-Columbia River Fishery Resource Office, Yakima Sub-Office. Yakima, WA. 54 p. https://www.usbr.gov/pn/programs/yrbwep/phase2/clearcreek/index.html

Thomas, J.A., P. Monk, and R. Randall (2017). N.F. Tieton Bull Trout Transport Project, 2016 Progress Report. United States Fish and Wildlife Service, Mid-Columbia Fish and Wildlife Conservation Office, Yakima Sub-Office. Yakima, WA. 18p. https://www.usbr.gov/pn/programs/yrbwep/phase2/clearcreek/index.html

Appendix A

Rapid Response Genetic Analysis

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Materials and Methods

We used a real-time genotyping and analysis method (also referred to as "rapid-response" protocol) similar to the one described by DeHaan et al. (2011) to analyze 34 bull trout caught below Clear Creek Dam. 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*, (Washington Dept. of Fish and Wildlife 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 Washington Department of Fish and Wildlife Molecular Genetics Laboratory (WDFW-MGL) using a protocol similar to the one described by Stephenson et al. (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 as described by Small et al. (2016) to assign fish caught below Clear Creek Dam to population groups. 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 (96%, 98% and 99%, respectively) of correct assignment to the NF Tieton, Indian and SF Tieton populations in the baseline (Table 2). Based on these simulations, we assigned the "rapid response" individuals to one of three reporting groups: NF Tieton, Indian or SF Tieton; or they were listed as a Hybrid or Brook Trout (Table 3).

Table 1. Sampling dates and numbers of fish captured for Clear Creek Dam Bull Trout rapid response analysis 2017.

Event	Date	Number analyzed
1	6/27/2017	6
2	7/11/2017	11
3	7/18/2017	6
4	7/22/2017	7
5	8/1/2017	4

Table 2. Results of leave-one-out tests used to assess the accuracy with which the genetic baseline could be used to assign Bull Trout to three reporting groups: North Fork Tieton, Indian Creek, and South Fork Tieton. 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	North Fork Tieton	Indian Creek	South Fork Tieton	Percent Correct
North Fork Tieton	**48**	2	0	96%
Indian Creek	2	**105**	0	98%
South Fork Tieton	0	1	**78**	99%

Table 3. Genetic assignment results for thirty-four bull trout captured at Clear Creek Dam in 2017.

Sample ID	Most Likely Population of Origin	Probability
17GF01	NF Tieton	1.000
17GF02	SF Tieton	1.000
17GF03	Indian	1.000
17GF04	NF Tieton	1.000
17GF05	NF Tieton	1.000
17GF06	NF Tieton	1.000
17GF07	NF Tieton	1.000
17GF08	NF Tieton	1.000
17GF09	Indian	1.000
17GF10	Indian	1.000
17GF11	NF Tieton	1.000
17GF12	NF Tieton	1.000
17GF13	NF Tieton	1.000
17GF14	SF Tieton	1.000
17GF15	NF Tieton	1.000
17GF16	SF Tieton	1.000
17GF17	NF Tieton	1.000
17GF18	NF Tieton	1.000
17GF19	SF Tieton	1.000
17GF20	NF Tieton	1.000
17GF21	NF Tieton	1.000
17GF22	NF Tieton	1.000
17GF23	NF Tieton (Hybrid)	1.000
17GF24	Indian	1.000
17GF25	Indian	1.000
17GF26	Indian	1.000
17GF27	Indian	1.000
17GF28	Indian	1.000
17GF29	NF Tieton (Hybrid)	1.000
17GF30	SF Tieton	1.000
17GF31	Indian	1.000
17GF32	Brook Trout	1.000
17GF33	NF Tieton	1.000
17GF34	SF Tieton	1.000

References

Angers, B., L. Bernatchez, A. Angers, and L. Desgroseillers. 1995. Specific microsatellite loci for brook char reveal strong population subdivision on a microgeographic scale. Journal of Fish Biology 47(supplement A):177-185.

Crane P.A., C.J. Lewis, E.J. Kretschmer, S.J. Miller, W.J. Spearman, A.L. DeCicco, M.J. Lisac, and J.K. Wenburg. 2004. Characterization and inheritance of seven microsatellite loci from Dolly Varden, *Salvelinus malma*, and cross-species amplification in Arctic Char, *S. Alpinus*. Conservation Genetics 5:737-741.

DeHaan, P.W. and W.R. Ardren. 2005. Characterization of 20 highly variable tetranucleotide microsatellite loci for Bull Trout (*Salvelinus confluentus*) and cross-amplification in other *Salvelinus* species. Molecular Ecology Notes 5:582-585.

DeHaan, P. W., Shana R. Bernall, et al. (2011). "Use of genetic markers to aid in re-establishing migratory connectivity in a fragmented metapopulation of Bull Trout (Salvelinus confluentus)." Canadian Journal of Fisheries and Aquatic Sciences 68(11): 1952-1969.

Miller, L.M. and A.R. Kapuscinski. 1996. Microsatellite DNA markers reveal new levels of variation in northern pike. Transactions of the American Fisheries Society 125:971-997.

Rannala, B., and J. L. Mountain. 1997. Detecting immigration by using multilocus genotypes. Proceedings of the National Academy of Science 94:9197-9201.

Rexroad, C.E., R. L. Coleman, A.M. Martin, W.K. Hershberger, and J. Killefer. 2001. Thirty-five polymorphic microsatellite markers for rainbow trout (*Oncorhynchus mykiss*). Animal Genetics 32:317-319.

Small, M. P., J. Thomas, P. Monk, and C. Bowman. (2016). 2016 North Fork Tieton Bull Trout Transport Project. Washington Department of Fish and Wildlife Molecular Genetics Lab, Conservation Unit, 1111 Washington St. SE, Olympia, WA 98501.

Stephenson, J. J., M. R. Campbell, J. E. Hess, C. Kozfkay, A. P. Matala, M. V. McPhee, P. Moran, S. R. Narum, M. M. Paquin, O. Schlei, M. P. Small, D. M. Van Doornik, and J. K. Wenburg. 2009. A centralized model for creating shared, standardized, microsatellite data that simplifies inter-laboratory collaboration. Conservation Genetics 10(4):1145-1149.