Clear Creek Dam Fish Passage Assessment

Second Annual Progress Report

U.S. Fish and Wildlife Service
Mid-Columbia Fishery Resource Office
Yakima Sub-Office

U.S. Bureau of Reclamation
Columbia-Cascades Area Office

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Foreword

The Clear Creek Dam Fish Passage Assessment is a cooperative investigation being conducted by staff from the U.S. Fish and Wildlife Service's Mid-Columbia River Fishery Resource Office (Yakima Sub-Office), the U.S. Bureau of Reclamation's Columbia-Cascades Area Office, and the Washington Department of Fish and Wildlife (Region 3). Planning for this study began in early 2012 and the assessment will continue through 2015. This is the second of three annual progress reports which will be prepared during the course of this study. A final report will be submitted during the first half of 2016.

The first annual progress report was produced in April, 2013 and contains an abundance of background information. It also described the methods which are being employed in this investigation. For the most part this information will not be repeated here. This report will focus on the expansion of the study during its second year, modifications made in response to things learned the first year, and results from year two of the assessment. The three sections which follow directly below also appeared in the first annual report. They are repeated in this report due to their importance in framing the study.

Study History and Funding

The USFWS Mid-Columbia River Fishery Resource Office (Yakima Sub-office) began submitting study proposals to investigate fish passage conditions at Clear Creek Dam in 2008. These proposals were submitted annually and sought funding through various sources for money that was limited and for which competition was heavy. The proposal did not receive funding for four consecutive years. Concurrently, Reclamation's Yakima Field Office (YFO) was seeking agency funding targeted for various ESA-related activities. In late 2011, they learned that funding was available to initiate this study and approached the USFWS about collaborating on the effort. Biologists with Region 3 of WDFW had been supportive of the proposed study from its inception. When informed that funding had been acquired to initiate the assessment, the Regional Office offered staff time and materials. The Washington Department of Ecology provided supplemental funding to WDFW to modify the fish trap used in the study. In addition to the initial funding secured in 2011, Reclamation's Yakima River Basin Water Enhancement Project (YRBWEP) has contributed significantly towards the assessment. The study is being managed by the USFWS.

Study Goal

The ultimate goal of this study is to ensure that the population of bull trout which spawns in the North Fork (NF) Tieton River can successfully reach spawning habitat in the river above Clear Creek Dam. It is not believed this population currently has such access on a consistent basis. Not only is this a current problem for this population but the severity of it may increase in the future. Climate change models developed for the Pacific Northwest are consistent in predicting warmer winters and decreased snowpack. It is essential that cold-water species such as bull trout have access to habitat at higher elevations if their populations are to persist. The data we obtain will enable us to advise the YFO on operations at Clear Creek Dam that will facilitate adult bull trout migration past the structure or lead to construction of new passage facilities.

Study Objectives

The three primary objectives of this investigation are: 1) to determine when NF Tieton River bull trout attempt to migrate upstream past Clear Creek Dam; 2) to assess their success at doing so under various hydrologic conditions; and 3) determining post-spawn migration timing and the extent to which the population uses Clear Lake. There are also several ancillary objectives which will add to the limited body of knowledge available for this population. The accomplishment of these should help fish managers proscribe appropriate actions to ensure the population's long-term health and persistence. The ancillary objectives include determining spawning frequency, collecting genetic samples, and estimating the effective population size.

Study Expansion and Modifications

Additional Antennae and Power Supply

As was described in the first annual report, two antennae were operating at the end of 2012. These were located at the top of the spillway channel (spanning the channel directly above the concrete weir on the spillway crest) and at the exit/entry portal of the pool-and-weir ladder. Both operated until the third week of December when weather conditions precluded access to the site and the batteries froze. Solar panels were installed at the site in March, 2013 (Figure 1) to charge the batteries which power these antennae and eliminate the need to exchange batteries. At the same time a new high-tension nylon rope with less stretch than the previous one was installed spanning the spillway weir and a turnbuckle was included at the right side anchor. This provided much greater tightening capability to prevent the loss of the antenna to high flows. Elevated mounting platforms for the tuning boxes for both the spillway and ladder antennae were also constructed to eliminate the possibility of submergence.

A new antenna was installed spanning the spillway channel just above its lower terminus on July 9, 2013 (Figure 2). PIT tag detections at this lower spillway site will provide confirmation that any bull trout detected at the top of the spillway channel actually left Clear Lake. They will also provide data to determine when tagged fish attempted to ascend the channel and the success they had in doing so.

A new antenna was also installed in the NF Tieton River on August 1 (Figure 3). This channel-spanning antenna was located 0.75 mile upstream of Clear Lake. Detections at this site will reveal pre- and post-spawn migration timing (and residence time in the river), provide some insight into our trapping efficiency upstream, and provide essential data to assist in the development of a mark-recapture population estimation.

Figure 1. Solar panels installed to power the upper spillway and ladder antennae

Figure 2. Antenna installed at the lower terminus of the spillway channel on July 9, 2013

Figure 3. Antenna installed in the North Fork Tieton River on August 1, 2013

Antenna Construction and Installation

The NF Tieton and lower spillway antennae were constructed from General Cable Carol Super-VU Tron Supreme power cable, 12 gage with 4 strands. The North Fork antenna consisted of a single coil attached to the stream bed using rebar anchors in a flat-plate or pass over configuration. This antenna measured 20 meters (66 feet) long by about 1 meter (3 feet) wide. After dewatering the channel the lower spillway antenna was attached to the bedrock spillway using stainless steel anchor bolts with eye nuts attached. The antenna wire was run through the eyes and tied off for stability (Figure 4). This antenna was also in a flat-plate configuration measuring 16.3 meters (54 feet) long by about 0.6 meters (2 feet) wide. Both antennae operated on 12 volt DC current supplied by rechargeable deep-cycle batteries. Solar panels were mounted to recharge the batteries at the lower spillway site (Figure 5); The North Fork site lacked the necessary exposure for a solar configuration, thus the two six-volt batteries which powered the antenna were exchanged weekly. Antenna performance was evaluated periodically using test tags and through the use of timer tags, once installed, set to send a tag code to the reader every 31 minutes. Data was downloaded manually with a laptop computer and subsequently stored on Reclamation's Upper-Columbia Area Office network.

Figure 4. Installation of the lower spillway antenna on July 9, 2013

Figure 5. Solar panels installed to power the lower spillway antenna

Trap Modifications

The same picket-weir box trap that was used in 2012 was again utilized in 2013 but with some significant modifications. Having noted the escape of two bull trout from the capture box in 2012 and avoidance behavior (trap shyness) displayed by a few bull trout approaching the trap entrance, these modifications were deemed necessary. Figure 6 shows the trap configuration used in 2012. The trap box was directly connected to adjacent weir panels. The entrance to the trap (not pictured) was flat and perpendicular to the current with two wings extending into the trap where fish would pass through a vertical opening 4-5 inches wide. It was thought that trapped fish would be disinclined to go back through this opening but that turned out not to be the case on at least a couple of occasions. The entrance was modified so that a caged cone extended about three feet back from the entrance (Figure 7). This cone led to a 10-inch diameter opening to which a four-foot section of PVC pipe was attached. This pipe extended about two feet into the trap and was approximately six inches above the stream bed inside it. A burlap sleeve was then affixed to the end of the pipe to further dissuade captured fish from finding the opening. Finally, the entrance to the trap was painted flat black to minimize avoidance behavior. Figure 8 shows the trap entrance and the position of the trap relative to it. All modifications were done WDFW's Region 3 screen shop.

Figure 6. The picket-weir box trap use in 2012 on the North Fork Tieton River

Figure 7. Modification to the entrance of the 2013 trap in WDFW's screen shop

Trap Location

The trap was installed at the same location on the NF Tieton River in 2013 as it was in 2012. In this first annual report this location was incorrectly given as approximately five miles upstream of Clear Lake. A recalculation of this distance revealed that it is actually very close to 6.5 miles above the lake.

As was the case the previous year we were unable to take road vehicles to the trap base camp at the end of FS 1207 due to concerns about the flood-damaged Miriam Creek Bridge. Once again, we had to use ATVs to transport equipment and personnel to and from the site.

Water Temperature Monitoring

The collection of water temperature data got off to a late start in 2013 due to our concentrated efforts to build two new antennae and tune those installed in 2012. Data loggers were deployed at the location of the ladder and lower spillway antennae on July 25. Another was deployed in the NF Tieton River when the detection antenna was installed on August 1 and the fourth data logger was deployed on August 6 in the outlet channel of Clear Creek Dam. The data loggers used were Onset Hobo© Water Temp Pro v2 (#U22-001).

Figure 8. The modified configuration of the trap used in 2013. Note the modified entrance leading to the PVC pipe extending into the trap. The trap itself sits about five feet from the entrance.

2013 Trapping and Tagging

Environmental Conditions

Environmental conditions during the trapping period (September 9-28) were unstable, much different than last year. The exception was air temperatures which again were comfortable. Unlike 2012, after the first week of the operation rain was persistent and heavy at times. Water temperatures ranged from 6°C to 13.5°C which were warmer than 2012 as might be expected since we started eight days earlier (double-digit temperatures were absent after the first 6 days). Hydrologic conditions on the other hand bore no similarity to the previous year when low, stable flows occurred and no turbidity was present. In 2013 river discharge was higher from the start and the stream was at least moderately turbid throughout the trapping and tagging period. Over the first 12 days (September 9-21) both discharge and turbidity fluctuated. For the first seven days of this time period river stage generally increased to a maximum of about three inches on September 16th and water clarity worsened. On September 17 the stage dropped about seven inches and remained relatively constant for the next four days with water clarity gradually improving. This was somewhat surprising because light rain had begun falling on a regular basis. However, air temperatures had cooled and the rain alone was apparently not heavy enough to produce significant runoff.

Heavy rain higher in watershed on September 22 ended this stability. The river rose over six inches by 12:00 PM and continued to rise during the afternoon and early evening until it crested approximately one foot higher than the stage observed at noon. Subsequently, discharge rapidly receded and the stage dropped approximately 12 inches by 11:00 PM. By 6:00 AM the next morning the river was slightly below its pre-storm level, however it rose several inches that evening before starting to recede again. For the next several days the river continued to drop gradually (with turbidity decreasing), reaching its lowest stage and best clarity of the entire trapping period by 12:00 PM on September 27. These conditions did not last the day. Heavy rains once again occurred in the upper watershed and by 6:00 PM the river had risen close to 12 inches. The upper basin rain continued and spread down-valley the next day. By mid-day on September 29 the river had risen over four feet.

Trapping

The trap was assembled on September 9, 2013 (eight days earlier than in 2012). As was noted above, the river was at a higher stage than had been observed at any time during the previous years trapping period (estimated at 4-6 inches) and was moderately turbid. As a result of the elevated flows, water velocities in the trap box were also higher so two sandbags were placed on each side of the box directly in front of the trap to provide velocity relief for trapped fish.

The trap was operated until the morning of September 28 (18.5 days). It was checked periodically over the course of the day and routine maintenance was performed. This maintenance included cleaning the weir panels of leaves and other small organic debris. It was also necessary to periodically remove gravel which had accumulated inside the trap, an activity unnecessary last year when flows were lower. One person was always present at the camp to monitor the trap during daylight hours, two were present at night. At night the trap was checked between 9:00 and 10:00 PM and again between 2:00 and 3:00 AM. The first check after sunrise occurred between 6:00 and 7:00 AM.

The trapping operation progressed without complications except for two notable exceptions. The first was the high flow event on September 22 when the river rose approximately 1.5 feet and partially collapsed the two eight-foot weir panels on the right bank (Figure 9). At 6:30 PM the crew worked quickly pulling pickets from the weir panels to reduce pressure on them. The structure incurred no further damage. At around 11:00 PM, after river stage had dropped about 12 inches, the partially collapsed panels were righted to the greatest extent possible and pickets were replaced in alternating holes in the weir panels. The trap was fishing again but with the possibility that fish could pass through the three-inch gap between alternating pickets. With intermittent rain still occurring throughout the day on September 23, all of the pickets were not replaced until the following morning. The panels on the right bank were also realigned and reinforced at that time. Surprisingly, two bull trout were captured in the trap over the course of this event but it is reasonable to assume that some escaped capture in the 36-plus hours the weir panels did not completely block the river.

The second high flow event began the afternoon of September 27 with a steadily rising river that seemed to level off by late night. However, heavy rains occurred the next day and by very early in the morning of September 29 the river was rising rapidly. Efforts to save the trap in the pre-dawn hours were halted because of dangerous conditions. A few hours later the trap began to disintegrate and washed downriver (Figure 10). Our trapping operation had come to a quick and decisive end. (Note: all of the weir and trap box components were recovered a few days later when the river had receded. Some had washed as much as 200 meters downstream).

Figure 9. North Fork Tieton River fish trap after the high flow event on September 22, 2013 had partially collapsed the two weir panels on the right bank and weir pickets had been pulled to relieve pressure on the panels. The photo was taken the next day after the river had receded.

Figure 10. North Fork Tieton River fish trap during the high flow event which occurred at the end of September, 2013. This photo was taken the morning of September 29th. The left weir panels have already washed downstream. The remaining panels and the box were gone soon after. The river continued to rise.

PIT tagging

All bull trout were worked immediately after being removed from the trap. Captured fish were netted out of the trap using long-handled dip nets. This task was a bit more challenging this year due to visibility issues associated with the turbid conditions. After capture the fish were transferred to an 80-quart cooler where they were anesthetized. 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. 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) and buffer (57 grams) needed were premeasured. Solutions were discarded away from the stream after each tagging session.

The fish were measured, sexed, and a small tissue sample was taken from the anal fin which was preserved in 70% isopropyl alcohol for genetic analysis. 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 a half-duplex PIT (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 cocktail straw was used to implant it about one inch further. This surgical procedure was fairly simple and did not require any sutures. We had also planned to insert a floy tag into each fish below the dorsal fin. However, difficulties inserting the tag were encountered during the first attempt and concern about harming the fish led to the decision to skip this procedure. After being place in the anesthetic solution full anesthetization usually occurred within 7-10 minutes. The time required to work each fish was between 5-7 minutes. No complications were encountered during HDX PIT tag implantation.

After completing the tag implantation an Oregon RFID® portable reader was used to scan the tag number and fish were placed in 6-inch diameter PVC flow-thru recovery tubes. These were secured in the channel where a light current existed with the head of the fish oriented upstream. Once placed in the holding tubes all of the bull trout were fully recovered within 15-20 minutes and released downstream.

Results

Trapping

A total of 18 adult bull trout were captured in 2013. Fourteen of these had not been encountered previously. Two, a male and a female, were fish that had been PIT tagged in 2012 (the male was recaptured again the next day, netted just downstream of the weir). The other two (both males) were recaptures of fish tagged previously, one the day before and the other two weeks previous. The recapture of a fish that had been tagged the previous day was obviously puzzling. Upon investigation, a gap of about three inches was found below the funnel entrance of the trap, the gravel having washed out below it. This persistent male must have squeezed back upstream through this gap only to find himself trapped again. The other 2013 recapture most likely migrated back upstream when weir pickets were removed during the high flow event on September 22. A sub-adult bull trout (estimated length 15-17 cm) was also captured in 2013. This fish was released downstream immediately. The persistent turbidity limited our ability to see bull trout in the vicinity of the trap although one was observed upstream of the weir on one occasion and another (other than the one recaptured) was observed downstream of the weir. No bull trout are known to have escaped from the trap. As was the case in 2012, no other fish species were captured and the only other animals found in the trap were a few frogs.

All but two of the 18 adult bull trout found in the trap in 2013 were captured during hours of darkness. Seven were found during the 9:00 to 10:00 PM trap check, four between 2:00 and 3:00 AM, and five between 6:00 and 7:00 AM. Fish were trapped between September 13 and September 27. Only two were captured prior to September 17 (the first day the trap was operated in 2012).

PIT Tagging

A total of 14 adult bull trout were implanted with HDX PIT tags in 2013, all within a two-week period. The first two of these were tagged on September 13 and the last two on September 26.

The average total length (TL) of the bull trout tagged in 2013 was 56 cm, three centimeters less than in 2012. They ranged from 43.5 to 75.5 centimeters (TL). Whereas six of the ten fish tagged in 2012 were males, nine of the fourteen tagged in 2013 were females. The total number of bull trout tagged now totals 24 (11 males and 13 females). A list of the fish tagged in 2013 along with relevant information about each is presented in Table 1 below.

Date captured	Time	Sex	Length (cm)	DNA code	PIT tag code	Tagger
13-Sep	7:00 AM	Female	43.5	13HJ1	180597354	P. Monk
13-Sep	7:00 AM	Male	47.5	13HJ2	180597450	P. Monk
17-Sep	9:00 PM	Female	59	13HJ3	180597244	J. Thomas
18-Sep	9:30 PM	Male	59	13HJ4	180597467	J. Thomas
18-Sep	9:30 PM	Female	68	13HJ5	180597446	J. Thomas
18-Sep	9:30 PM	Female	55	13HJ6	180597185	J. Thomas
19-Sep	3:00 AM	Female	68	13HJ7	180597211	J. Thomas
22-Sep	4:00 PM	Female	59	13HJ8	180597348	P. Monk
23-Sep	6:00 AM	Female	49	13HJ9	180597311	P. Monk
24-Sep	9:30 PM	Female	75.5	13HJ10	180597257	J. Thomas
24-Sep	9:30 PM	Male	49.5	13HJ11	180597493	J. Thomas
25-Sep	7:00 AM	Male	45	13HJ12	180597426	J. Thomas
26-Sep	2:45 AM	Female	54	13HJ13	180597333	J. Thomas
26-Sep	10:00 PM	Male	49	13HJ14	180597420	J. Thomas

Table 1. Adult bull trout captured and PIT tagged in the NF Tieton River in September, 2013.

Antenna Performance

Upper Spillway

In 2013 the upper spillway antenna was never tuned and operated successfully. A series of changes that were described previously (i.e., new rope, solar panel charging equipment) led to a loss of antenna performance requiring substantial effort to troubleshoot and diagnose. Determining the factors creating the problem(s) was confounded by the fact that the PIT tag interrogation equipment functioned properly at times but never for periods of significant duration. The loss of performance was intermittent and unpredictable. We struggled attempting to fix this antenna, to the point of pulling it out and completely rebuilding it, from the early days of April through August.

After thinking this through, we believe what most likely occurred was that the new solar charging system for the upper spillway and ladder site created “noise” or interference with the PIT tag interrogation equipment which for some reason only affected the much larger spillway antenna. We briefly considered the possibility that natural solar “noise” was the source of the problem but this hypothesis was discarded. Solar noise can cause interference with RFID electronics but it was illogical that it would only affect the upper spillway antenna. There was no apparent effect on the performance of either the ladder or lower spillway antennae which were both in close proximity. In addition, the specific effect was overheating of the electronics whereas in other documented cases solar interference appears to only reduce tag readability. Finally, the amount of time it took for overheating to occur was related to the ambient air temperature at the site. The electronics appeared to operate properly for a period of time that could vary from 5 minutes up to 30 minutes. This created false associations of actions with inconsistent failures.

In 2014 another attempt will be made to tune and operate the upper spillway antenna. Reconfiguring the wire and adding a timer to the circuit to isolate the RFID electronics from the solar power circuit are two steps that will be taken to solve the problems encountered in 2013. We are cautiously optimistic that these steps will work.

Ladder

The ladder antenna was up and running the morning of March 29, 2013 and operated continuously for 277.6 days through December 31. The read-range of this antenna, as has always been the case, was excellent at over one 36 inches. However, something peculiar was going on with the TAG reader between the evening of June 19 and the morning of July 9. When operating normally the timer tag is read every 31 minutes (45-46 times in a 24-hour period). Data downloaded on July 9 indicated that during this time period there were gaps in the timer tag readings that ranged from one hour to almost 12 hours (which occurred just once, on July 2). These gaps were most likely due to the intermittent loss of effective amperage. Between the gaps the reader appeared to be operating normally. We do not know what caused this problem but we retuned the antenna on July 9 and it did not occur again. The antenna may not have been operating properly at times during the 19 days between June 19 and July 9 but it was not possible to determine the total amount of time this may have occurred.

Lower Spillway

This antenna was constructed in a challenging location. It became operational the morning of July 9 with a read-range of 16-18 inches on either side of (and above) the antenna wires. The antenna operated for 12 consecutive days until about noon on July 21 at which time the reader stopped. The problem was diagnosed as a faulty voltage controller which took four days to correct. Detection capability was restored on the morning of July 25. Through August 14 (20 days) we believe the antenna was operating continuously but it was initially installed without a timer tag so this was difficult to judge. The problems we had previously encountered with the voltage controller introduced some doubt as to the antennas continuous detection capability. However, it was checked with a timer tag on three occasions during the period and successfully read the tags during each. On August 14 we disconnected the voltage controller so that the solar panel charged the batteries directly, exchanged the 24-volt panel (which was overcharging the batteries) for a 12-volt panel, and installed a timer tag. With these modifications, no further problems were encountered for a period of 24 days until the reader mysteriously quit reading the timer tag on September 6. This went unnoticed for about five days. When we arrived at the site on September 12 the reader was not shut down and it read a test tag; there was just a five-day gap in the data when the timer tag had not been read. It remains unknown whether the antenna was functioning during this period. Once the data were downloaded and diagnostics were run, the reader was restarted and the antenna operated continuously until the evening of September 27. At that time detection capability was lost, the result of the antenna wire breaking or wearing through where it ran through an anchor. We could not retrieve it to find out. Heavy rains had begun and flows in the spillway channel were dangerously high. Interestingly, a bull trout that was tagged four days earlier had been detected by the antenna just six hours prior to it breaking.

We believe we have worked out the bugs with the electronics at this site for 2014. We reconstructed the lower spillway antenna to better endure the extreme hydraulic conditions present at the site on April 29 and it was operational the next day.

North Fork Tieton

The NF Tieton antenna was operational at mid-day on August 1, 2013 with a read range of 20-22 inches. It was initially deployed without a timer tag but one was installed on August 19. The antenna ran 92.5 days without interruption until November 12. The electronic equipment was removed when the first snowstorms of the season occurred and access to the site became questionable.

Water Temperatures

Water temperatures at the top of the spillway (i.e. the ladder) and the bottom tracked closely and will not be differentiated here. On July 25 the mean daily temperature exceeded 18°C and for all but one day remained above 15°C (the temperature believed to limit bull trout distribution) until September 17 before beginning a steady decline (Figure 11). Temperature data for the outlet channel were a more limited because high releases from the dam had washed the data logger closer to the stream bank and it was left in the dry after October 13. By that time average water temperatures in both the outlet and spillway channels were fairly similar and below 8°C. This certainly was not the case through August and most of September when temperatures were much cooler in the outlet channel. The logger in the NF Tieton River only collected data for 19 days. It ran out of storage space on August 19 because it had mistakenly been set to record data every minute. The data that were collected showed average daily water temperatures ranging from 10-11.5°C.

In order to obtain a more complete temperature profile of the bull trout migration corridor, in 2014 we plan to deploy water temperature data loggers at all sites by late April.

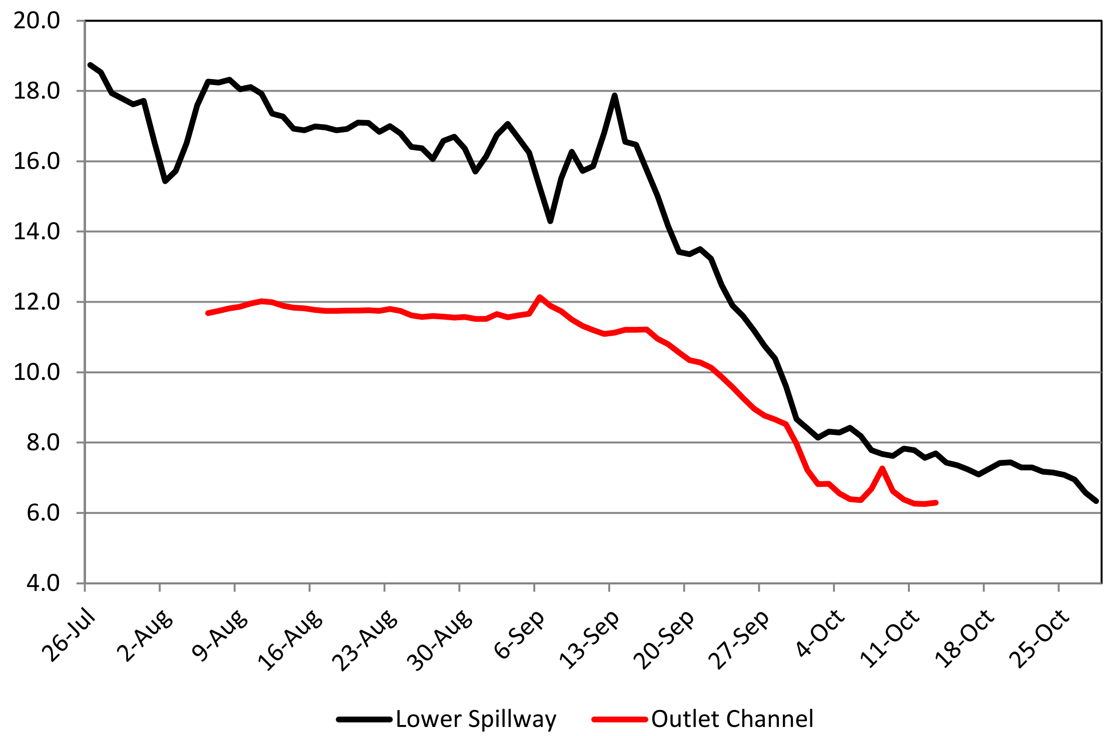

Figure 11. Average daily water temperatures (°C) for 2013 in the lower spillway and outlet channels of Clear Creek Dam on the North Fork Tieton River

2013 PIT Tag Detections

Twenty-two of the 24 adult bull trout tagged in 2012 and 2013 were detected at least once in 2013. The two bull trout that were not detected in 2013 were females, both tagged in 2012.

Bull trout tagged in 2012

Of the eight other bull trout tagged in 2012 six were males and two were females. Four of these (two each, male and female) were the only fish that we assume were on their pre-spawn migration as they were detected prior to September 1 (see first six rows of Table 2 below). All but one were detected only at the NF Tieton site, the exception being #180597363. This female was our busiest fish and the only one that had been detected in 2012 (October 28 at the ladder). In 2013, she passed the lower spillway antenna on July 18, exited the ladder a surprising 11 days later, and showed up at the NF Tieton site a month after that (August 29). Twenty-three days later she was detected there again, presumably on her way downriver although she had not shown up in the trap. She was last heard from on November 17 when she was detected at the ladder. Two of the 2012 bull trout (a male and female) were trapped again in 2013. One of these (#180597181) was detected at the NF Tieton site both entering and leaving the river, the other (#180597290) at the same site on October 13. The remaining three fish tagged in 2012 were detected only at the NF Tieton site between September 30 and October 5, all presumably leaving the river.

Date	Tag Number	Sex	Site	Year Tagged
18-Jul	180597363	F	Lower Spillway	2012
29-Jul	180597363	F	Ladder	2012
5-Aug	180597327	M	NF Tieton	2012
5-Aug	180597369	M	NF Tieton	2012
10-Aug	180597181	F	NF Tieton	2012
29-Aug	180597363	F	NF Tieton	2012
18-Sep	180597354	F	NF Tieton	2013
18-Sep	180597244	F	NF Tieton	2013
20-Sep	180597446	F	NF Tieton	2013
21-Sep	180597363	F	NF Tieton	2012
23-Sep	180597348	F	NF Tieton	2013
24-Sep	180597311	F	NF Tieton	2013
24-Sep	180597185	F	NF Tieton	2013
25-Sep	180597211	F	NF Tieton	2013
25-Sep	180597311	F	NF Tieton	2013
26-Sep	180597311	F	NF Tieton	2013
26-Sep	180597311	F	Ladder	2013
27-Sep	180597311	F	Lower Spillway	2013
27-Sep	180597333	F	NF Tieton	2013
29-Sep	180597450	M	NF Tieton	2013
29-Sep	180597420	M	NF Tieton	2013
30-Sep	180597333	F	Ladder	2013
30-Sep	180597199	M	NF Tieton	2012
1-Oct	180597493	M	NF Tieton	2013
1-Oct	180597181	F	NF Tieton	2012
1-Oct	180597493	M	NF Tieton	2013
2-Oct	180597467	M	NF Tieton	2013
3-Oct	180597257	F	NF Tieton	2013
3-Oct	180597382	M	NF Tieton	2012
3-Oct	180597426	M	NF Tieton	2013
4-Oct	180597493	M	NF Tieton	2013
5-Oct	180597295	M	NF Tieton	2012
5-Oct	180597420	M	NF Tieton	2013
6-Oct	180597493	M	Ladder	2013
13-Oct	180597290	M	NF Tieton	2012
17-Nov	180597363	F	Ladder	2012
2-Dec	180597493	M	Ladder	2013
4-Dec	180597333	F	Ladder	2013

Table 2. Bull trout detections in 2013. Shaded entries represent fish that were detected multiple times.

Bull trout tagged in 2013

All of the 14 bull trout tagged in 2013 were subsequently detected at the NF Tieton site between September 18 and October 5. Three were later detected at the ladder with one of these (#180597311) detected passing the lower spillway antenna 45 minutes later. The other two did not leave Clear Lake after their first ladder detection. One was first detected on September 30 and again on December 4, the other on October 6 and again on December 2. It is unknown if they left the lake after the second detection since detection capability downstream was lost with the breakage of the lower spillway antenna on September 27.

Discussion

The second year of the study presented some challenges we would rather not repeat. Chief among these was the environmental conditions during the trapping operation. The slightly higher flows and turbidity we encountered were somewhat difficult in terms of weir and trap maintenance as well as visually inspecting the trap for fish presence and the removal of those trapped. We dealt with those conditions and in fact they may have been helpful in one respect- a possible reduction in the trap shyness and avoidance behavior that we observed in 2012. The relatively extreme high flow events are another matter. Clearly the weir and trap cannot withstand the pressures exerted by such events and there is really nothing we can further do to reinforce this equipment. 2014 will be the last year of tagging for this study and we would like to tag an additional 10 bull trout, 20 if possible. We plan to start the trapping operation on about the same date and hope for more stable environmental conditions.

We will also attempt to capture adult bull trout through hook-and-line sampling directly below the dam. Bull trout were clearly present in significant numbers in early August but we were reluctant to angle for potentially gravid fish. We now know that late September is not a good time either. Therefore, we will begin to check for bull trout presence below the dam in early May of 2014. We are confident that we will be able to capture and tag bull trout below the dam in 2014, perhaps a significant number of them. However, there is no guarantee they will be NF Tieton fish with two other adfluvial populations residing in Rimrock Lake. Nevertheless, it will be interesting to see if some show up at any of our PIT tag detection sites and/or in the trap. For those that don’t, the genetic samples we obtain will allow us to determine if NF Tieton bull trout are attracted to the colder water released from the dam to such an extent that they may not even attempt to migrate up the much warmer water in the spillway channel. Water temperatures in the spillway channel are probably not prohibitively warm for migrating bull trout until late spring. Earlier deployment of temperature loggers in 2014 will allow us to make that determination.

It remains unknown when individuals from this population attempt to migrate past Clear Creek Dam. In fact, it remains unknown if the majority of them ever leave Clear Lake. In two years we have scant evidence that they do. We know one of the ten bull trout tagged in 2012 definitely left the lake. Her movements were described above. We know she left not because we detected her leaving but because she was detected coming back in 2013. We also know that one fish definitely left Clear Lake in 2013, having detected her at the ladder and subsequently at the lower spillway site in late September. But that is it. This does not mean that more did not migrate downstream. The upper spillway was operating intermittently in the fall of 2012 and we had not yet installed the antenna on the lower spillway. It did not help that the periods when the upper spillway antenna was inoperable occurred during high flow events when one might expect fish to migrate. But if more left in 2012 why were they not detected coming back in 2013? While the lower spillway site was not installed until July 9, the ladder began operating on March 29. Yet we detected seven other fish tagged in 2012 up the NF Tieton River in 2013 and trapped two of them. As described previously, there is some question regarding the continuous operation of the ladder antenna between June 19 and July 9 but it seems implausible that these seven fish all ascended the ladder undetected during this period. It is possible that some proportion, perhaps significant, of the NF Tieton bull trout population lives in Clear Lake.

In 2013 the upper spillway antenna was completely inoperable and we lost detection capability on the lower spillway on September 27. Obviously we have no way of knowing how many tagged bull trout may have migrated downstream of Clear Lake after September 27. As described above, two were detected at the ladder twice with the second detections occurring in early December. But the fact that they were detected twice provides clear indication that no conclusions can be drawn regarding eventual movement downstream without detection capability lower down the spillway.

As mentioned above, the lower spillway antenna was reinstalled on April 29-30, 2014. This is a key location to achieve the goals and objectives of this study and it is important that this site has continuous detection capability. On April 29, we also installed a new antenna further down in the fish ladder. This antenna will provide confirmation of the downstream movement of fish detected above as well as an indication of residence time in the ladder for immigrating bull trout. Finally, it is important that we solve the mystery of the upper spillway antenna. We believe we are on the right track to fix the problems we have had at this site over the last year. Fortunately we have some time to work with this antenna. It is useful solely for downstream migration; conditions (slope and hydraulics) in the upper spillway channel adjacent to the ladder render upstream passage impossible. The next year of this study will be an important one. With 24 bull trout now tagged we are hopeful that answers will be forthcoming for many of the questions discussed here.

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