Clear Creek Dam Fish Passage Assessment

First Annual Progress Report

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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 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 first 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.

Background

The local population of bull trout which spawns in the North Fork Tieton River was not officially recognized until 2004 when biologists observed juvenile fish (obtaining genetic samples from some) and documented spawning activity for the first time during a comprehensive fish census (USFWS 2005). This census occurred above Clear Lake, a relatively small (4,400 acre-feet) impoundment formed when Clear Creek Dam was constructed on the North Fork Tieton River (hereafter North Fork) in 1914. Clear Creek Dam is located slightly less than one kilometer above Rimrock Lake, a much larger (198,000 acre-feet) reservoir impounded by Tieton Dam in 1925. Both of these dams were constructed by the U.S. Bureau of Reclamation (Reclamation) and are operated by the agency's Yakima Field Office (YFO). There are two additional bull trout populations found above Tieton Dam which spawn in separate tributaries of Rimrock Lake, one in the South Fork Tieton River and the other in Indian Creek. To date it has been assumed that adults from the North Fork population also reside in Rimrock Lake when not spawning or migrating. There are data supporting this assumption which are presented in the *Population Monitoring* section below. All three of these bull trout populations display the adfluvial life history type, however, they undoubtedly had fluvial/ resident origins since neither Clear or Rimrock lakes were natural water bodies prior to impoundment.

Clear Creek and Tieton dams were constructed without fish passage facilities. Consequently, upon their completion anadromous salmonids were excluded from habitat upstream and resident fish populations above the dams were isolated. While Tieton Dam remains impassable, two fish ladders were constructed in the bedrock spillway channel of Clear Creek Dam in 1992. The lower "ladder" is actually a series of four denil ladders interspaced with resting pools located on the right bank of the spillway. The slopes of the four ladder sections range from 12.5 to 45 percent. The upper ladder is a pool-and-weir design constructed on the left side of the spillway channel. It contains 11 weirs with a two-foot hydraulic drop from weir to weir. The pool-and-weir ladder appears to be functional but this is not the case with the denil ladder. It is considered too steep and does not meet accepted criteria (USBR 2004) so it may have never passed fish with much success. It most certainly does not at present as it has not been maintained in years, is completely clogged with gravel, and is otherwise in disrepair. Photographs of both ladders are presented in Appendix A.

Without the benefit of serviceable ladders passage up the spillway channel for migrating fish is difficult at best. This channel, blasted out of bedrock, is approximately 140 meters long with two high gradient segments. The lower segment is approximately 70 meters long with an average gradient of 20-25 percent (all gradients are estimates); the upper segment is shorter (40 meters) but steeper with an average gradient of about 35 percent. In between these two segments is a low gradient section (< 5%) approximately 30 meters long which extends from the exit of the denil ladder to just below the entrance to the first pool of the upper ladder. The extent to which it is possible for bull trout to swim up the lower section of the spillway channel is unknown. Hydraulic conditions vary drastically depending on the volume of discharge coming down the spillway, consequently so does one's judgment as to whether fish could successfully swim up the channel. It is strongly suspected that fish cannot ascend the channel at high flows. In July, 2011 two bull trout were observed repeatedly trying without success. Photographs of hydraulic conditions in the spillway channel over a range of flows are presented in Appendix A.

In addition to the physical challenges of swimming up the spillway it has been hypothesized that migrating North Fork adults are not inclined to enter the spillway channel in summer months because water temperatures are too warm. According to this hypothesis these fish instead swim up the adjacent channel to the base of Clear Creek Dam where colder water is released through the gates and there they hold. This hypothesis has not been scientifically tested.

Interest in modifying the existing fish ladder at Clear Creek Dam began in 1999 when the YFO contracted with an engineering firm to conduct an evaluation. The firm's report (Harza 2000) described the ladder's deficiencies but resulted in no immediate action to correct them. Interest was rekindled in 2003 and Reclamation's Pacific Northwest Region Design Group produced three pre-design planning documents between June 2004 and August 2005 detailing several fish passage design alternatives at the dam (USBR 2004, USBR 2005a, USBR 2005b). All of these alternatives were extremely expensive and funding has not been pursued. Improved passage at the dam is included as an action in the recently completed Yakima River Basin Integrated Water Resource Management Plan (July 2011). However, actions contained in this plan still must go through a lengthy process to receive authorization and funding.

North Fork Tieton River

The North Fork flows into Rimrock Lake at its western end. The river originates in the Goat Rocks Wilderness Area and flows for an undetermined distance before entering Clear Lake. A waterfall exists about nine miles upstream of Clear Lake which represents an impassable barrier to migratory fish. The wilderness boundary is approximately four miles below this waterfall with the remaining five miles of the river located in the Okanogan-Wenatchee National Forest. Several small tributary streams enter the North Fork above Clear Lake, the largest being Scatter Creek. Clear Creek, which was once the most significant tributary of the North Fork, now flows into Clear Lake from the west. The North Fork Tieton River is designated Critical Habitat for bull trout (69 Fed. Reg. 60070; October 6, 2004).

The North Fork is one of the higher elevation streams inhabited by bull trout in the Yakima Basin. Elevations range from 3,000 feet (above mean sea level) where it enters Clear Lake to about 4,000 feet at the barrier waterfall. Forest Service road 1207 parallels the river for most of the five miles below the wilderness boundary but is rarely close to it and thick forest separates the two. The main human activity in the watershed is recreation—primarily hiking and horseback riding on trails that are not directly on the river. There are no established campgrounds and dispersed campsites are limited and generally not in close proximity to the riverbanks. Timber harvest occurred in the past but well upslope of the river. The area is now designated as Late Successional Reserve and will receive very little future harvest. Road density in the drainage is low, and livestock grazing does not occur. In short, the North Fork Tieton River is undisturbed above the wilderness boundary and for the most part below it as well.

North Fork Tieton Bull Trout

Population Monitoring History

WDFW catch records from the 1950's document the presence of bull trout (then referred to as Dolly Varden) in Clear Lake but the first organized investigation of bull trout in the North Fork appears to have occurred much later. While not an investigation of this population per se, a fish salvage was conducted in August, 1992 behind a coffer dam constructed directly below Clear Creek Dam during reconstruction work. The capture of "well over one hundred" bull trout was reported. These fish ranged in size from 10 – 29.5 inches (fork length) with the majority from 15-20 inches (WDFW 1992).

In 1994 Central Washington University coordinated with WDFW to monitor the effectiveness of the fish ladders constructed in the spillway channel of Clear Creek Dam two years previous. No bull trout were observed in the ladders but nine adult bull trout were captured and tagged below the base of the dam. It is assumed that these fish were attempting to find a migration route upstream and would thus have belonged to the North Fork population, however there is no record of them being observed or captured again to confirm that. Two years later an adult bull trout was observed in the North Fork about six miles above Clear Lake during a snorkel survey (Craig 1996).

The fish census that led to official recognition of the North Fork Tieton population was conducted cooperatively by the USFWS and USFS in September, 2004. The night-snorkeling effort documented the presence of 14 bull trout including seven juveniles (<199 mm TL), five that were considered sub-adults (200-299 mm TL), and two large (>500 mm TL) adults (USFWS 2005). Genetic samples (fin clips) were obtained from 11 fish, six of which proved to be bull trout; five which were suspected hybrids turned out to be pure brook trout. In addition, spawning activity was confirmed with the discovery of a single redd and a couple of adults observed about a half-mile below the barrier waterfall.

WDFW radio-tracked five adult bull trout captured and tagged in the North Fork below Clear Creek Dam in July 2005. These fish all migrated downstream to Rimrock Lake by late fall to overwinter and returned to the area near the mouth of the North Fork by early June the following year. Only one of these fish eventually entered the river but it did not attempt to ascend the spillway channel (Mizell and Anderson 2008). Just one of the bull trout tagged below Clear Creek Dam in 2005 genetically assigned to the North Fork population (Small and Martinez 2011). The others assigned to either the Indian Creek or South Fork Tieton River populations.

Bull trout residing in Rimrock Lake are subject to entrainment through the unscreened outlet works of Tieton Dam. Entrainment was documented during three years of studies conducted in the early 2000's. In 2005, 37 bull trout were collected from the stilling basin directly below Tieton Dam in a fish salvage operation conducted during the construction of the Tieton hydroelectric project. An analysis of genetic samples taken from those fish revealed that two assigned to the North Fork Tieton population (Small et al. 2009).

In 2010, snorkel surveys coordinated by the USFWS were successful in collecting enough genetic samples from juvenile bull trout to supplement those obtained previously and enable an analysis of the genetic uniqueness of the North Fork Tieton River bull trout population. Results indicate that this population is genetically distinct from all other populations in the Yakima Basin including the other adfluvial populations residing in Rimrock Lake (Small and Martinez 2011). Three of the genetic samples analyzed were identified as brook trout/bull trout hybrids.

In 2011, the Bull Trout Task Force conducted creel surveys at Clear Lake during the summer months. Fifty five anglers were interviewed and no bull trout were reportedly caught by any of these anglers (WDFW 2011). Previous creel surveys and observations by WDFW biologists during annual fishing derbies also indicate that bull trout are not commonly caught in Clear Lake despite heavy fishing pressure throughout the summer season (E. Anderson, WDFW, pers. comm.).

Population Distribution and Life History

From data collected to date it appears that all spawning activity occurs above the wilderness boundary with most of that occurring in the reach extending from the waterfall downstream for approximately two miles. Over the last four years bull trout have also been observed spawning in a very small unnamed tributary which enters the river from the west in this two-mile reach. The spawning period appears to occur during the month of September. The migration timing for adult bull trout entering the North Fork prior to spawning is unknown as is that for post-spawn fish leaving the river.

Juvenile rearing likely occurs throughout the reach above Clear Lake but all juvenile observations thus far have been above the wilderness boundary. It is presently assumed that the primary FMO (foraging, migrating and overwinter) habitat for adults and sub-adults is

Rimrock Lake. While the preponderance of evidence seems to indicate that this is true it technically remains unknown.

Population Trend

As is the case for all of the local bull trout populations in the Yakima basin annual redd counts are relied upon to ascertain a population trend. Beside the fact that the database for this population is relatively recent there have been other difficulties which have limited the ability to determine a trend for this population. The river is fed by glaciers and is usually turbid with glacial flour until late in the summer. Its hydrology is "flashy" and river discharge quickly changes from stable and clear to high and turbid after fall rains or high daytime temperatures, both of which are common during the bull trout spawning period. This results not only in difficult survey conditions but also in situations where redds become undetectable if an event occurs before or between surveys. Although the first redd was observed in the North Fork in 2004, a complete survey was not accomplished until 2007 and the surveys conducted in 2009 and 2010 were incomplete. During the four years that complete surveys were conducted the number of redds counted was 37, 28, 11, and 17 (in 2007, 2008, 2011 and 2012, respectively). A distinct population trend is not discernable from these data.

Population Status

Due to its recent recognition the status of this population has not been rated by either the WDFW or the USFWS. Based on limited redd count data it appears to be depressed but this determination should not be considered final. Much remains to be learned about the North Fork Tieton River bull trout population.

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, the YFO was seeking Reclamation funding targeted for various ESA-related activities. In late 2011, they learned that funding was available to initiate the study and approached the USFWS about partnering 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 for the effort. 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 this population of bull trout can successfully reach its spawning habitat in the North Fork above Clear Creek Dam. It is not believed that 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 should enable us to advise the YFO on operations at Clear Creek Dam that will facilitate adult bull trout migration past the structure. There is a strong possibility that the results of this study will lead to a decision to construct passage facilities at the dam or rebuild the facilities in the spillway channel.

Study Objectives

The three primary objectives are of this investigation are: 1) to determine when North Fork 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.

Methods

General Description

In order to track the movements of adult bull trout, fish were captured in a picket-weir box trap as they migrated downstream after spawning and surgically implanted with passive integrated transponder (PIT) tags. The fish were trapped and tagged on the North Fork about five miles above Clear Lake.

After release the tagged fish can be detected wherever a detection antenna array is installed. One antenna array was in operation during the fall and early winter of 2012. It was located at the top of the spillway and actually consisted of two antennae, one spanning the channel directly above the concrete weir on the spillway crest and the other at the exit/entry portal of the pool-and-weir ladder. This antenna array will detect downstream migrants and, in the remaining years of the assessment, those that have successfully ascended the spillway channel.

Beginning in 2013 at least two additional antennae will be utilized. One will be located close to the lower terminus of the spillway channel to detect bull trout which are presumably attempting to migrate upstream. Detections at this antenna will also provide confirmation that post-spawn bull trout detected at the top of the spillway actually left Clear Lake. The second antenna will be located in the North Fork about three miles upstream of Clear Lake to determine both pre- and post-spawn migration timing.

A third antenna might be installed in the dam's outlet channel adjacent to the spillway. This antenna would provide detection of tagged bull trout that may have been attracted to colder water released from the dam. This site however is a lower priority since only 10 fish were tagged in 2012 and the information that would be obtained from it is not considered as critical as that from the other sites. An antenna is still planned for the site but manpower and logistical complications will likely preclude its installation in 2013.

Trap Location

Relying on our previous knowledge of the river, and after several reconnaissance trips, the location to install the trap was selected approximately five miles upstream of Clear Lake, about a tenth of a mile above the Goat Rocks Wilderness boundary. This site was selected based on habitat considerations, access, and hydraulic characteristics.

With excellent bull trout holding habitat (e.g. deep pools and sizeable LWD complexes) existing downstream of the site it was believed prudent to trap fish before they might choose to hold temporarily prior to continuing their downstream migration. For logistical reasons it would only be possible to operate the trap for a limited period of time and excessive delays in migration would diminish the opportunity to collect adult bull trout during this operational window. While there was also holding habitat upstream, the site was about two miles below the primary spawning grounds and we believed the chances of capturing fish would be better with the trap located closer to this area.

Access to the site was about as good as one can expect along the upper North Fork. The North Fork Tieton road (FS 1207) runs adjacent to the river for about five miles, ending at a turnaround at Scatter Creek at the wilderness boundary. However, for almost all of this distance the road is rarely close to the river and thick forest separates the two. Direct access to the river is not any easier adjacent to the turnaround but a cleared trail enters the wilderness there and essentially ends at the trap site (the trail actually goes on to ford the river just upstream of the site but the crossing has washed out and the trail is rarely used). While it was necessary to pack the trap components into the site, doing so on an established trail was considerably easier than bushwhacking to an alternative site along the road would have been. There was also a spacious primitive campsite (and outhouse) at the turnaround which served as the base camp for the crew manning the trap.

There was one complication with access that required coordination with the Forest Service and some fairly complex logistical planning. The bridge over Miriam Creek on FS 1207 was damaged during a flood event in 2011. This bridge is about 2.2 miles short of the turnaround and the Forest Service had closed and blockaded the road approximately 1.4 miles before that.

Consequently we had to use ATVs (supplied by WDFW) to transport all of our equipment and personnel to and from the base camp. The ATVs could squeeze past the ecology block barriers; the bridge was still passable utilizing the iron ramps used to load the ATVs on a trailer but these had to be placed and then removed every time the structure was crossed.

The hydraulic characteristics of the river at the trap site were nearly perfect at the flows we encountered. The channel was approximately 32 feet wide, gently sloping horizontally from the stream margins and nearly flat for a distance of about seven feet near the middle of the channel. Substrate materials consisting primarily of small cobbles (2-3 inch diameter) and gravels. The maximum water depth in the thalweg was 18-24 inches and maximum water velocities, although not measured, appeared to be between 1.0 and 1.5 feet per second.

Trap Construction and Installation

The trap was constructed by WDFW's Region 3 screen shop. The component parts of the picket-weirs and the capture box were made out of aluminum which was both durable and lightweight. The weir panel frames were eight-feet long by four-feet tall; approximately seventy spiked pickets (60" x 0.75") slipped through holes drilled in each frame and were pounded into the stream bed (spacing between pickets was about 0.6"). Adjacent panels were coupled together and all panels were braced from downstream. The dimensions of the capture box were 4 x 4 x 4 feet. It was assembled from four panels, used the same type of pickets as the weirs, and had a funnel opening. There was no aluminum top or bottom to the capture box.

Three eight-foot weir panels were coupled together and extended from the left bank downstream at about a 40 degree angle where they connected with the capture box; two panels were used on the right bank angled somewhat less. The capture box was situated in the thalweg of the channel, a location where the stream bed was relatively flat. With the braces, numerous sandbags strategically placed, and all pickets driven into the stream bed to the extent possible, the weir and the trap box were impressively solid. To prevent potential avian predation a tarp was draped over the top of the box and secured, burlap was wired to the top of the funnel opening to prevent captured fish from jumping out, and half-inch wide zip ties were affixed to the back of the vertical opening to dissuade captured fish from swimming back out. Photographs of the trap under construction and completed are presented in Appendix B.

Trapping

The trap was assembled on September 17th, 2012 and was operated through October 5th (18.5 days). At first the trap was monitored periodically over the course of the day with the last check coming around 9:00 PM. It would then be checked at around 7:00 AM the next morning. Drawing on the experience from previous bull trout trapping studies we anticipated capturing most bull trout at night. However, we assumed we would not need to work them immediately because of the relatively large size of the trap and the mellow hydraulic conditions. This assumption was invalidated just three days into the operation when two bull trout observed in the trap were gone less than two hours later. Obviously the trap was not escape-proof so thereafter the trap was checked every few hours over the course of the night in addition to the continued daytime monitoring. One person was always present at the camp to monitor the trap during daylight hours; two were present at night.

PIT tagging

Captured bull trout were netted out of the trap using long-handled dip nets and 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.

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. They were held and monitored until able to swim away freely. Photographs related to the tagging operation are presented in Appendix B.

Antenna Construction and Installation

A HDX PIT tag interrogation site was constructed at the top of the spillway of Clear Creek Dam during early September, 2012 and was functioning prior to trapping and tagging adult bull trout. HDX PIT tag readers and data loggers, manufactured by Texas Instruments, were procured from Oregon RFID®. A large, single loop antenna was constructed spanning the entire width of the spillway weir, approximately 27 m (85 ft) in length. The antenna was constructed out of 1/0 gage welding cable for the bottom of the loop and 8 gage THHN wire for the top. The top loop was affixed to 1.5 cm climbing rope which was stretched tight. The antenna operated on 18 volt DC current supplied by rechargeable deep-cycle batteries and was installed in a swim-through configuration (Zydlewski et al. 2006) to detect fish migrating over the weir. The detection range of the spillway antenna was approximately 0.3 m (1 ft) upstream and downstream throughout the entire loop.

A second antenna was installed in a swim-through configuration on the upstream exit of the pool-and-weir fish ladder. This antenna was approximately 1 m x 1.5 m (3 ft x 5 ft) in size, constructed from 3 wraps of 12 gage THHN wire housed in a PVC pipe frame and mounted to the wall of the fish ladder. Operating on a 12 volt DC current, also supplied by rechargeable deep-cycle batteries, the detection range of the ladder antenna was approximately 1.0 m (3 ft) upstream and downstream of the antenna. Antennae performance was evaluated periodically during the study using test tags and by using timer tags set to send a tag code every 31 minutes. Data was downloaded manually with a laptop computer and subsequently stored on Reclamation's Upper-Columbia Area Office network. Photographs of the spillway and ladder antennae are provided in Appendix C.

Results

Trapping Operation

A total of 10 adult bull trout were captured and implanted with HDX PIT tags. As noted previously, two fish (that we know of) escaped from the trap but this happened on just the fourth morning of trapping so they may have been recaptured later. Eight of the fish captured were found in the trap but the other two required a more active capture approach. Both were hanging immediately upstream of the weir, refusing to enter the trap. One was eventually herded into the trap using dip nets, the other was netted (another adult bull trout which accompanied this fish fled upstream). All of these fish appeared to display "trap shyness". It is possible that two were the fish that had escaped several days before and were thus wary. But this behavior has been observed in at least one other study that we know of (J. McCubbins, Avista Corp., pers. comm.) and is definitely worthy of consideration.

Adult bull trout were also observed directly downstream of the weir on three nights, consistently around 9:00 PM (one to three individuals each night, seven total). Some of them were actually bumping the pickets in their attempt to pass upstream. Efforts made to capture these fish with dip-nets were mostly unsuccessful but one was finally netted and examined. It proved to a fish that had been tagged three days earlier and released downstream. All bull trout encountered in 2012 were either captured or observed during the course of the night. Curiously, the only other animal caught in the trap over the duration of the operation was a frog.

Environmental conditions during the trapping operation were stable. Water temperatures ranged from 10°C to 3°C with the lowest temperatures experienced during the last few days. Air temperatures were relatively comfortable, not dropping below freezing at night until near the end date. There was no precipitation and river stage changed little, fluctuating just 2-3 inches above or below the level present at the start of the operation. After the first stage increase an additional four-foot weir panel was added on the left bank for insurance. As expected there was some organic material being transported downstream. This was easily cleaned off the weir and trap using a rake or by hand - a duty regularly performed.

PIT Tagging Operation

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. We initially believed we wanted to implant tags during daylight hours only. However, subsequent to our decision to avoid leaving fish in the trap any longer than necessary we found that there was no disadvantage in conducting the implantation surgery under artificial lighting (i.e., headlamps). Six of the fish tagged were tagged between the hours of 10:00 PM and 4:00 AM.

Four of the ten fish tagged were captured the second night the trap was in operation (September 19). None were captured during the last six days of the trapping operation. A list of the fish tagged along with relevant information about each is presented in Table 1 below.

Date captured	Time	Sex	Length (cm)	DNA code	PIT tag code	Tagger
19-Sep	7:00 AM	Female	60	12AG30	180597181	J. Thomas
19-Sep	7:00 AM	Male	49	12AG25	180597290	P. Monk
19-Sep	7:00 AM	Female	70	12AG43	180597236	J. Thomas
19-Sep	7:00 AM	Male	48	12AG56	180597199	P. Monk
24-Sep	12:15 AM	Female	46.5	12AG10	180597363	P. Monk
24-Sep	4:00 AM	Male	70.5	12AG12	180597327	P. Monk
26-Sep	4:00 AM	Male	82	12AG23	180597369	P. Monk
29-Sep	10:00 PM	Male	52.5	12AG59	180597295	J. Thomas
29-Sep	10:00 PM	Female	57	12AG26	180597398	J. Thomas
30-Sep	3:15 AM	Male	55	12AG22	180597382	J. Thomas

Table 1. Adult bull trout captured and PIT tagged in the NF Tieton River in September, 2012.

Once placed in the holding tubes in the stream all of the bull trout were fully recovered within 15-20 minutes and released downstream

Detection Monitoring

Both antennae at the top of the spillway channel were operating well a week before the first bull trout was tagged. They continued to operate until the end of the third week in December when several sequential snowstorms prevented access to the site and the batteries died. Problems associated with the power supply were common during the first season of operation. We were unsure in the beginning how long batteries would last before an exchange was necessary so a great deal of attention was paid to their status. We found that the rate of drawdown between batteries was somewhat erratic. This was due in part to a few that were defective. These were quickly identified and replaced but still the rate at which the power supply would deplete was hard to predict. The power system required consistent attention and short-term outages were not uncommon. Batteries were generally exchanged at least weekly with numerous exchanges occurring even more frequently.

Another factor which caused power interruptions affecting detection capability was significant short-term variation in hydrologic conditions. Because of its small size Clear Lake is subject to rapid increases in lake elevation, and thus spillway flow, during storm events. With the top loop of the spillway antenna stretched a bit less than two feet above the spillway weir, the antenna is vulnerable to submersion under these circumstances. Two such events occurred in October, 2012. One occurred mid-month and resulted in breakage of the antenna and the other (two weeks later) submerged it and stretched the rope to which it was attached. Both resulted in the loss of detection capability for over two days before repairs could be made. The ladder antenna was not affected in either case.

Despite these setbacks the antennae were operable a large percentage of the time with the ladder operating 93% of the monitoring period and the spillway 82%. The operational details for both antennae are presented in Table 2 below and graphically in Appendix D.

Statistic	**Ladder Antenna**	**Spillway Antenna**
Total days operating	88.2	78.1
Total days not operating	6.8	16.9
Percent of time operating	92.8%	82.2%
Percent of time not operating	7.2%	17.8%
Number of times operation was interrupted	8	12
Longest extended period of operation	40 days	17.2 days
Shortest period without interruption	1.5 days	1.5 days
Average period of operation without interruption	10 days	6.5 days
Longest extended period of interruption	1.7 days	2.9 days
Shortest period of interruption	4.8 hours	4.8 hours
Average period of interruption	20 hours	1.4 days

Table 2. Operational details of the two antennae located at the top of the Clear Creek Dam spillway channel in 2012.

During the 95 days of detection monitoring only one bull trout potentially leaving Clear Lake was detected. The fish, a female tagged on September 24th, was picked up by the tag reader for the ladder antenna on the morning of October 28th. With no antenna at the downstream end of the spillway channel it was not possible to determine if this fish continued downstream. Since the detection range for the antenna is about one meter it may have just neared the ladder exit or it could have gone in briefly and come back out.

Discussion

The detection of just one of the ten bull trout PIT tagged was surprising. The evidence currently available leads to the assumption that bull trout which spawn in the North Fork Tieton River utilize Rimrock Lake to forage and overwinter. Therefore, it was expected that their residence time in Clear Lake would be relatively short. This is either not the case or we failed to detect fish leaving the lake via the spillway during a period when the antenna was inoperable. As has been noted, the spillway antenna was operating 82% of the time during the monitoring period. However, it was down between 2.2 and 2.9 days on three occasions in October. Two of these outages occurred during hydrologic events that resulted in rapid increases in lake elevation and spillway flow. Spikes in the hydrograph often trigger migratory fish to move and it is entirely possible we may have failed to detect fish leaving Clear Lake during these events. Indeed, the single detection of a fish by the ladder antenna happened during the rising limb of the hydrograph for the event which occurred at the end of October. Due to this uncertainty the role that Clear Lake plays in the life cycle of North Fork Tieton bull trout remains unknown after the first year of this study. We have already taken steps to fill this data gap.

In addition to the detection array which will be installed at the lower end of the spillway channel, other adjustments have been made early in the 2013 field season. In March, a new high-tension nylon rope with much less stretch than the previous one was installed spanning the spillway weir and a turnbuckle was included at the right side anchor. This will provide much greater tightening capability and should prevent the loss of the antenna to high flows. Although the tuning boxes for both the spillway and ladder antennae were never submerged in 2012, elevated mounting platforms were installed for both as a precaution.

Considering the problems encountered with the power supply in 2012, the decision was made to use solar power at the upper and lower spillway PIT tag interrogation sites in 2013. In March, solar power was installed at the upper spillway site. As of this writing the lower site still must be installed but it is our intent to utilize solar power at it as well. This will eliminate the short-term power outages that occurred when the batteries were depleted and the necessity to haul heavy deep-cycle batteries back and forth for exchange.

The final issue we are in the process of addressing concerns fluctuating Clear Lake surface elevations and concomitant spillway flows. As mentioned previously, the surface elevation of the lake is subject to rapid increases. On four occasions in October and November the lake elevation increased over seven inches in a 24-hour period. During the two which occurred on October 28th and November 19th the elevation increased 20 and 17 inches, respectively. These increases are impossible to control unless hydrologic conditions are anticipated and dam releases are adjusted accordingly. Currently the gates of Clear Creek Dam are manually operated requiring both time and manpower. With the spillway weir controlling lake elevations within an acceptable range it has not previously been a priority to alter releases from the dam to manage spillway flow. The problems we encountered during the high flow events last October have made it one. This is not just an issue of antenna breakage. Although we have strengthened the top loop of the spillway antenna to withstand potential submersion it is probable that detection efficiencies are significantly diminished at excessively high flows. We also speculate that water surface elevations which are too low inhibit bull trout from passing over the spillway weir. Obviously elevations below that of the weir (3011.0 ft.) would fall under this category but it is also possible that some minimum depth of water on the weir is necessary for bull trout to attempt migration.

With conditions frequently changing, attempting to manage lake elevations and spillway flow is a balancing act which is at best difficult under current circumstances. Automating operations at Clear Creek Dam so the gates can be remotely operated from the YFO is the obvious solution to this problem. The System Operations Advisory Committee (SOAC) submitted a recommendation in February, 2013 urging Reclamation to pursue this action as soon as possible. When it will actually happen is presently unknown. In the meantime we will work closely with the YFO to manually manage spillway flow to achieve study objectives.

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The initiation of the Clear Creek Dam fish passage assessment was a significant and labor intensive undertaking which required complex planning and coordination. The first year of the study was successful not only because of the dedicated efforts of staff from the USFWS and USBR but also because of the contributions of the individuals and organizations acknowledged here.

John Easterbrooks and Eric Anderson from the Washington Department of Fish and Wildlife were instrumental in designing and overseeing the construction of the fish trap which was constructed by WDFW's Region 3 screen shop. They were responsible for procuring the ATVs necessary to travel to and from the trap site and for providing the required training to operate the vehicles for some of those participating in the trapping and tagging operation. They also made available WDFW's Nelson Springs facility to hold the rainbow trout, provided by WDFW, which were used to train study participants in PIT tag implantation procedures. Finally, both worked on the trap installation team and put in several days as part of the crew manning the trap. Several other people participated in the trapping and tagging operation. These included Ashton Bunce and Cassandra Anderson from the 2012 Bull Trout Task Force and David Child, a biologist with the Yakima Basin Joint Board.

We would also like to acknowledge the following people who greatly assisted us in key technical aspects of the study. Ryan Koch (USFWS, Columbia River Fisheries Program Office) and Mark Nelson (USFWS, Mid-Columbia River FRO) both provided guidance and training in the art of PIT tag implantation. Warren Leach at Oregon RFID provided technical support related to PIT tag detection technology and Vince Tranquilli from the Oregon Department of Fish and Wildlife graciously provided advice and training related to antenna design and construction.

Finally we would like to acknowledge Reclamation's Yakima Field Office, the Columbia River Fisheries Enhancement Group, and the U.S. Forest Service (Naches Ranger Station). Their cooperation with various aspects of this study are greatly appreciated.

Appendix A

Photographs of the spillway channel and

existing fish ladders


Lower spillway channel at Clear Lake elevation of 3012.8 feet


Lower spillway channel at Clear Lake elevation of 3011.6 feet


Lower spillway channel at Clear Lake elevation of 3011.4 feet


Lower spillway channel at Clear Lake elevation of 3011.0 feet


Upstream terminus of the Denil ladder completely clogged with bed load


Totally dewatered downstream sections of the Denil ladder


Upper spillway channel at lake elevation 3012.2 feet (left) and 3011.6 feet (right)


Upper spillway channel at lake elevation 3011.4 feet (left) and 3011.0 feet (right)


Pool-and-weir fish ladder in upper spillway channel

Appendix B

Photographs of the fish Trap on the North Fork Tieton River

and the bull trout PIT tagging operation

Weir and trap installation on the North Fork Tieton River (September 17, 2012)

Weir and trap installation on the North Fork Tieton River (September 17, 2012)

Completed picket-weir and box trap

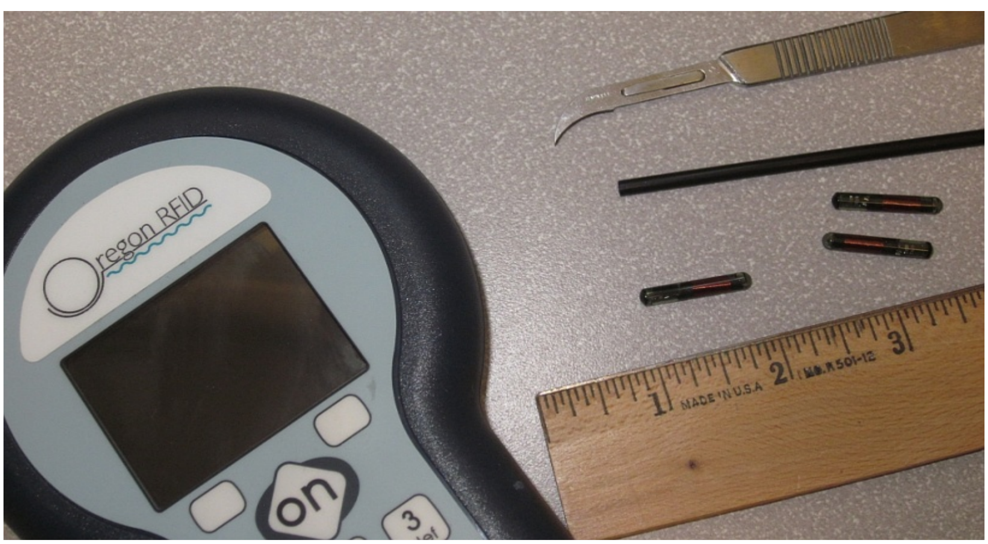
The capture box

Downstream side of trap

Trapping station (Jeff Thomas & Arden Thomas)

Tagging Supplies

PVC recovery tubes



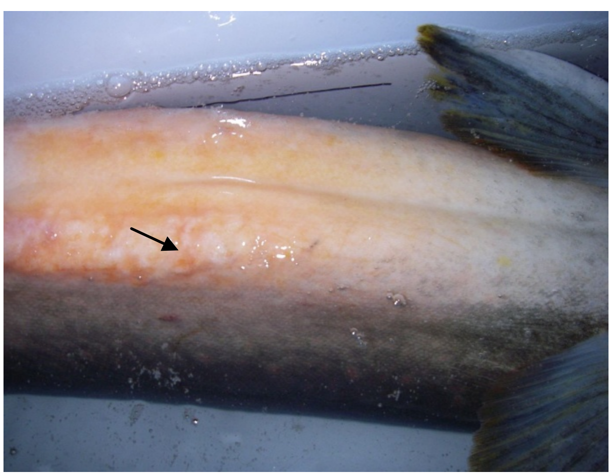
HDX PIT tags, scalpel, insertion straw and Oregon RFID® portable tag reader

Male (70.5 cm TL) tagged September 24, 2012

Making the incision to insert the HDX PIT tag

Inserting the HDX PIT tag

Pushing the tag in between muscle and skin



Finished. Arrow points to inserted PIT tag

Largest bull trout tagged (Male, 82 cm TL)

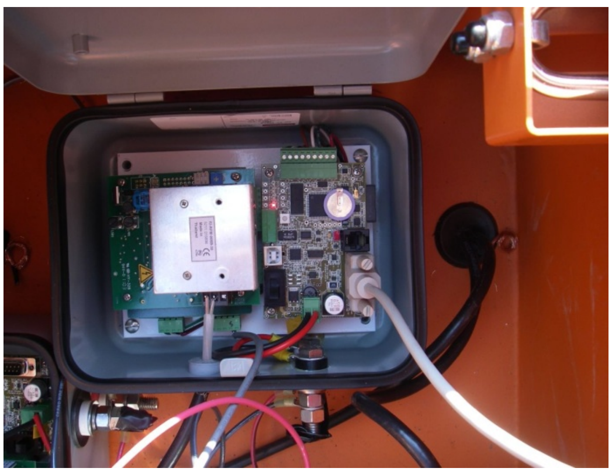
Appendix C

Photographs of the detection antenna array at the top

of the Clear Creek Dam spillway channel

Antenna spanning the spillway weir

Antenna at exit of pool-and-weir fish ladder



HDX PIT tag reader in job box

Steel job box holding batteries and tag readers

October high flow event which submerged and stretched the spillway antenna (photo on left)

Appendix D

Operational details for the two antennae located at the top

of the Clear Creek Dam spillway channel

Graphical presentation of Clear Creek Dam antenna operations, 2012

* Green shading indicates antenna was operating

* Red shading indicates periods when antenna was down

*numbers in or below blocks represent days

Antenna **September**

Date	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ladder	1.5	1.0				4.8		1.2			4.4			0.6
Spillway	1.5	1.0				4.8		1.2			4.4			0.6

Antenna **October**

Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ladder	3.7 (since Oct. 29)															
Spillway	3.7 (since Oct. 29)								10.6							2.5
				0.2												

Antenna **October**

Date	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Ladder		17.3 (since Oct. 4)				0.8	1.7					8.2			
Spillway		4.2					2.9		2.8			2.2			

Antenna **November**

Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ladder		0.9													
Spillway			6.8 (since Oct. 29)						9.4						.5

0.2

Antenna **November**

Date	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ladder															
Spillway								17.2 (until Dec. 2)							

Antenna **December**

Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Ladder					39.6 (since Nov. 2)								8.5 (through Dec. 20)			
Spillway			2.0				6.3				1.6		6.4 (through Dec. 18)			

0.4 (ladder)