Movement and Survival of Radio-Tagged Bull Trout Near Albeni Falls Dam

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Eastern Washington University
Department of Biology
FISHERIES
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Prepared for the Department of the Army
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Executive Summary

Prior to construction of Albeni Falls Dam in 1951, salmonids in the Pend Oreille River, Washington and Idaho, were known to freely pass Albeni Falls in both upstream and downstream directions. The dam blocked the access of bull trout (*Salvelinus confluentus*) in Washington to Lake Pend Oreille, Idaho. Recent studies have indicated that adfluvial, adult bull trout, which spawn in tributaries of the Pend Oreille River located below Lake Pend Oreille, exhibit post-spawning movements where they drop out of the tributary into the mainstem of the Pend Oreille River, then swim upstream to over-winter in the lake. In the spring or early summer they make these movements in reverse, first swimming downstream to their home river, then migrating upstream to a specific home tributary where they repeatedly spawn. Albeni Falls Dam may prevent bull trout that spawn in tributaries below the dam from successfully completing this type of life-history strategy, thus contributing to the decline in their abundance. The dam may also prevent bull trout that spawn in tributaries of the lake or river above the dam from access to those tributaries if they are entrained at the dam. Entrainment could occur if a bull trout migrating downstream from Lake Pend Oreille overshoots its home tributary and arrives in the forebay. It is well documented that salmonids frequently overshoot home rivers and then backtrack to relocate them. Since their migration coincides with the spring freshet, the high discharge could increase the likelihood of entrainment of bull trout in the vicinity of the dam.

In the present study, we examined the migratory behavior of bull trout above and below Albeni Falls Dam by conducting radio-tracking investigations and attempting to recapture bull trout, marked in tributaries of the lake or river above the dam, during electrofishing surveys in the tailrace of the dam. Our objectives were to:

1. Determine if adult bull trout captured during their spawning season in a tributary (Middle Fork East River) of the Priest River exhibited the type of adfluvial life history described above, first migrating downstream in the Priest River, then upstream in the Pend Oreille River to over-winter in Lake Pend Oreille, and then following the reverse path in the spring to return to a

previously occupied spawning tributary. Alternately, it was possible that the fish would migrate downstream to Albeni Falls Dam;

2. Determine if sub-adult bull trout collected from the same spawning tributary exhibited a first time pattern of migration similar to adult fish collected from that tributary and migrated to Lake Pend Oreille, or if they traveled downstream and became entrained at Albeni Falls Dam; and

3. Determine if bull trout collected from the tailrace below Albeni Falls Dam bore marks indicating that their origin was from a tributary of the river or lake above the dam. Adult bull trout collected below the dam were implanted with radio transmitters to determine their interaction with the dam.

To address objective 1 (see Chapter 1), we contributed to an ongoing study initiated by the Idaho Department of Fish and Game (IDFG) and United States Fish and Wildlife Service (USFWS) in which 20 adult bull trout, captured in the Middle Fork East River (Priest River drainage) on August 14-16, 2002 about one month prior to spawning, were implanted with radio transmitters. IDFG had established a telemetry station at the mouth of the Priest River to monitor the post-spawning movements of the adults. Our contribution was to monitor long distance movements by establishing continuously recording telemetry stations at Albeni Falls Dam (8 km downstream from the Priest River) and at the Burlington Northern Railroad bridge at Dover, Idaho (26 km upstream from the Priest River at the outlet of Lake Pend Oreille). We also conducted periodic mobile tracking surveys from airplane or truck.

Fourteen of the 20 fish tagged by IDFG and USFWS apparently experienced post-spawning mortality and four of the remaining six fish became trapped behind beaver dams in the East River. The latter fish were moved around these dams on December 9, 2002 and released in the mainstem of the Priest River. One of the fish removed from the beaver ponds was recorded passing the monitoring station at the mouth of the Priest River on December 10, 2002 and at the Dover railroad bridge on December 14, 2002, after which it was not detected again. A second fish removed from the beaver ponds was recorded passing the monitoring station at the mouth of the Priest River on December 9,

2002. It was periodically detected in the Pend Oreille River during the winter of 2002-2003 by truck and airplane, near the mouth of the Priest River. It went undetected from February 23, 2003 to July 1, 2003, at which time it was located in the East River.

The third fish displaced from the beaver ponds was detected passing the Dover railroad bridge in an upstream direction on December 11, 2002. It was undetected from then until May 24, 2003, at which time it was detected passing the Dover bridge in a downstream direction. It was presumed to have over-wintered in deep waters of Lake Pend Oreille, which attenuated the radio signal making it undetectable. This fish was subsequently detected at the mouth of the Priest River on May 24, 2003, in the Lower East River on June 17, 2003, and in the Middle Fork East River from June 18 to September 2, 2003. The fourth fish displaced from the beaver ponds was located in the Pend Oreille River upstream from the mouth of the Priest River on February 4 and July 7, 2003.

In addition to the four fish removed from the beaver ponds, two fish migrated out of the Priest River before our receiver stations had been established. One of these was detected in Lake Pend Oreille near the U.S. Highway 95 bridge on November 14 and December 22, 2002, and on January 3 and February 4, 2003. It was next detected at the Dover railroad bridge from May 16 to 25, 2003, mouth of the Priest River on May 25, 2003, and Middle Fork East River from June 17 to September 2, 2003. The other fish was detected at the U.S. Highway 95 bridge on November 14 and December 20, 2002, and January 3 and February 4, 2003. On June 18 and July 7, 2003, this fish was last detected near the Dover railroad bridge.

The movements of two fish confirmed the round trip adfluvial migration of adult bull trout between a tributary of the Priest River and Lake Pend Oreille. Two other bull trout appeared to migrate to Lake Pend Oreille after spawning but contact was lost before we could determine if they returned to the Priest River drainage. The remaining two bull trout were tracked into the Pend Oreille River and one of these subsequently returned to the East River. The bull trout entered their home river before temperatures in the Pend Oreille mainstem became warm. None of the adult bull trout from the Priest River was ever detected in the vicinity of Albeni Falls Dam. The fact that these fish migrated

directly and rapidly into the Priest River, and did not appear to overshoot it during their downstream migration from Pend Oreille Lake, indicates that entrainment associated with overshooting may be minimal in this system. However, this conclusion is preliminary because of the low numbers of adult fish tracked (6 fish tracked, of which only 3 returned to the Priest River).

Objective 2 (see Chapter 2) was designed to evaluate if sub-adult bull trout out-migrants from the Middle Fork East River, after entering the Pend Oreille River, either 1) exhibited similar behavior to post-spawning adults and migrate upstream to Lake Pend Oreille or 2) migrated downstream and became entrained at Albeni Falls Dam. Sub-adult bull trout (n=131) were captured in the Middle Fork East River. Initially, we operated a rotary screw trap set near the mouth from April 21 to August 22, 2003 in an attempt to capture downstream migrants, but failed to catch a single bull trout. Eventually, bull trout were captured by backpack electrofishing during daylight (n = 5) on June 16-17, 2003 and snorkel dip-net surveys on the nights of June 23, 26-27, and 30, and July 2, 2003 (n = 126) at sites upstream from the trap. Fifteen of the largest fish (FL =136-169 mm, weight = 27-49 g) were implanted with miniature radio transmitters and passive integrated transponder (PIT) tags. The remainder received only PIT tags. Radio telemetry was conducted for several weeks until the short-lived batteries on the transmitters died.

All of the transmitter-equipped fish remained in the vicinity of their capture site. None emigrated into the Priest or Pend Oreille rivers, so we were unable to evaluate sub-adult migratory behavior. One possibility for the apparent lack of sub-adult out-migration is that sub-adults migrate before or after the period we monitored with the screw trap. The sedentary behavior exhibited by the transmitter-equipped bull trout, captured in late June or early July and tracked for several weeks, clearly indicated that the largest sub-adult fish found in the population were not migrating at that time. Instead, since the temperature at the capture sites was about 3°C cooler than the ambient temperatures monitored at the screw trap downstream from these sites, the fish appeared to be rearing or holding in the coldest water available to them. Perhaps the relatively higher temperatures in the East River create a thermal barrier that blocks downstream migration

from late June through early September (the period our transmitters remained operational).

The failure of the screw trap to capture sub-adult migrants in April or May was puzzling because this period was associated with peak discharge, a time that other investigators have observed migration in juvenile bull trout. It is possible that bull trout migrants escaped being caught in the trap during the spring freshet, as the trap did not sample all of the river's flow. However, it was positioned in the middle, at the deepest spot in the river where flow was greatest and two diversion dams directed the majority of the flow into the mouth of the trap. The trap did not wash out at any time during its operation and was not overtopped by discharge at any time so far as we know. Because we failed to determine if sub-adult bull trout from the Priest River drainage migrate upstream or downstream after entering the Pend Oreille River, we recommend that this study be repeated using active capture techniques (e.g., snorkel-dip net or backpack electrofishing) to catch the largest available sub-adult bull trout from February to April.

To address our third objective (see Chapter 3), we conducted electrofishing surveys in the tailrace from the foot of Albeni Falls Dam to Indian Creek (14 km downstream from the dam) in an attempt to capture fish that had been marked at sites upstream from the dam. In 1999, the Kalispel Tribe Department of Natural Resources had captured a bull trout in a weir at Indian Creek that had originally been marked at either Lightning or Trestle creeks, tributaries of Lake Pend Oreille. This fish was marked with a floy tag and released back into Indian Creek. The fish was subsequently caught by an angler in June 2000 near the mouth of Marshall Creek, which is located between Indian Creek and Albeni Falls Dam. Few bull trout (n ~ 7) have been captured during fish surveys conducted throughout Box Canyon Reservoir since 1988. By focusing our survey effort in the vicinity of the tailrace of Albeni Falls Dam, we hoped to increase the probability of detecting additional marked fish from above the dam.

We captured a total of 10 different adult bull trout in two electrofishing surveys conducted on July 8-9 and July 21-22, 2003. Nine of the ten fish were captured at a culvert located on the left bank of the river about 1.5 km below the dam. Water in the

culvert was about 0.6 meters deep and spring-fed. The water temperature in the culvert was 11.8-13.8^{o}C, compared to 21.7-22.0^{o}C ambient Pend Oreille River temperature below the dam and 18.0-19.0^{o}C in the vicinity of the culvert. The remaining bull trout was captured at the mouth of Indian Creek where Charr Springs adds cold water to the Pend Oreille River. One fish, captured during the day on July 8 at the culvert and displaced about 500 meters downstream, was recaptured at the culvert at about midnight on July 9. One fish captured at the culvert on July 8 was recaptured there on the night of July 21. All these fish were implanted with passive integrated transponder (PIT) tags.

Although none of the adult bull trout bore marks (e.g., fin clips, PIT tags, radio transmitters) from upstream sites, due to their large size, they most likely originated from above the dam and were congregating in the tailrace. If the fish were fluvial or adfluvial bull trout that spawned in tributaries of the Pend Oreille River below Albeni Falls Dam, then it is highly probable that they would have sought thermal refugia in home spawning tributaries, similar to the behavior described above for the Priest River adults.

From 1988 – 1990, a total of four bull trout were collected in a sample of 47,715 total fish during 216.6 hours of electrofishing effort conducted by Eastern Washington University at randomly selected sites throughout the Box Canyon Reservoir. The relative abundance (RA) and catch-per-unit-effort (CPUE) of bull trout in those surveys was respectively 0.008 percent and 0.02 fish per hour. In contrast, in the present survey, which targeted the tailrace area, bull trout relative abundance was 1.2 percent (6 bull trout in a sample of 505 total fish) and CPUE was 1.2 fish per hour (6 fish in 5.2 total hours of electrofishing effort). In addition, six other bull trout (including the two recaptures) were caught during surveys that were targeted for capturing bull trout only.

The seven adult bull trout (FL = 435-696 mm, weight = 719-3,363 grams) captured on July 21-22, 2003 were implanted with radio transmitters to better determine their interactions with Albeni Falls Dam. The fish captured at the mouth of Indian Creek and released at the culvert on July 21 (RF code 93) was located about 100 meters below the culvert on July 22 and detected by the spillway receiver at the dam on July 23 (17:21-22:59). The fish was then not relocated until August 14, when the transmitter was found

1.0 km below Indian Creek on the bottom of the river under the decomposing carcasses of several fish, one of which appeared to be a bull trout that was about the size of the fish that was implanted with this transmitter. The fish was too badly decomposed to determine the cause of death. Damage to the antenna indicated that the fish had been handled by a human, although we had no way of determining if this occurred pre- or post-mortem. The location is a location where anglers have historically fished for bull trout.

The second fish (RF code 94) was released on July 21 and relocated in the culvert on July 22. It was detected by the spillway receiver at the dam on July 30 (23:00-23:59), August 1 (00:00-05:50), August 2 (03:00-09:00) and August 3 (08:00-10:00). On August 5, 13, 14, and September 12 and 19 it was detected in a 6 meter deep pool below Cooks Island (about 6 km below the dam). It is unknown whether this fish was alive or dead at last contact. The third fish had originally been captured and released on July 9 at the culvert. It was recaptured there on July 21 and given RF code 97. It was subsequently detected in the culvert on July 22 and 29, and August 1, 3, 10, 13, and 19. It was observed by snorklers on August 3 and appeared healthy. It was detected by the receiver on the spillway at the dam on August 20 (13:58-20:01) and last located near Indian Island on September 12 and 19. It is not known if this fish was alive or dead at last contact.

The remaining four fish were all released at the culvert on July 22. One of these fish (RF code 95) was detected by receivers at the dam on July 23-24, after which contact was lost. The transmitter was found wedged under a rock on the left bank of the Pend Oreille River below Cooks Island on August 4, 2003, obviously placed there by a human. Another of these fish (RF code 96) was located at the culvert on July 25. It was subsequently logged by receivers at the dam on July 27 (18:38-18:42) and July 29 (14: 14-14:59). From August 3-20 the fish was logged intermittently by receivers at the dam and located in the middle of the river about 1 km below the dam. It was last logged at this site on September 12 and 19, 2003. It is not known if the fish was alive or dead at last contact.

Another fish (RF code 98) did not recover well from capture and handling. The partially eaten carcass was found on August 4 at the upstream end of the culvert. The transmitter

was about 15 meters away and appeared to have been chewed by an animal. The last fish (RF code 102) was located at the culvert on July 25 and 29, and August 1, 3, and 4. It was observed by a snorkler there, apparently in good health, on August 3. It was detected by the spillway receiver on July 22, 23-24, and 29. It was recovered dead at Cooks Island on August 14 in a weed bed.

Collectively, these data indicated that adult bull trout below Albeni Falls Dam spend a great deal of time at the culvert, which is a source of cool water available to them under certain flow and tailwater conditions. From here they appeared to periodically make forays into the river, moving upstream to near the base of the dam.

By early August, water levels in the culvert began to decrease due to receding water depth in the Pend Oreille River and water flow out of the spring was reduced to a trickle. This prevented fish migration into the culvert at that time. Shortly afterward, the fish were no longer detected there. A targeted electrofishing survey, specifically looking for bull trout was conducted in the vicinity of the culvert on August 8 but no bull trout were found. The loss of this habitat may have contributed to the high level of mortality observed in mid-August since there was no longer a thermal refuge. Access to Indian Creek was also blocked at that time.

Based upon the results of this study, we make the following recommendations:

1. Monitor the sub-adult population in the Priest River to determine when these fish enter the Pend Oreille River and Lake Pend Oreille. This objective of the present study remained unaccomplished because none of the sub-adult fish we captured were migratory. This does not imply that the fish from the East River that we tagged were a resident life history form, only that they were not observed migrating during the time of our study (mid-April to mid-August). In fact, recent studies conducted by the U.S. Fish and Wildlife Service in cooperation with the Idaho Department of Fish and Game determined that the East River stock was composed entirely of the migratory life history form because fish with total lengths of 200 – 300 mm, which typically are indicative of the presence of the resident form, were absent in the East River.

Hence, since first time migrants may be more prone to entrainment than post-spawning adults, this study will need to be repeated at a time that may be more biologically appropriate to detect and characterize the first-time emigration of these fish. Since our initial attempts failed to collect emigrating sub-adults from mid-April to mid-August, we suggest that future sub-adult migration studies be focused in fall (October to mid-December) as this time period coincides with that of post-spawning adult migration. Additionally, East River bull trout may have adapted to a fall migration schedule because spring discharge in the Pend Oreille River is too high for them to migrate 38 km upstream to Lake Pend Oreille; water temperatures of the Pend Oreille River are too warm for them to survive if migration was attempted in summer; and, by delaying their departure until fall, energy stores accumulated during the summer growing season would increase their fitness for upstream migration to (and over-winter survival in) the lake. While fall migration studies should receive priority, we recommend that spring migration studies be repeated to confirm initial results since it is more typical for adfluvial bull trout sub-adults to emigrate in the spring.

2. Capture bull trout in the tailrace of Albeni Falls Dam, move them above the dam and monitor their movement. Historical records indicate bull trout migrated from below Albeni Falls upstream to Lake Pend Oreille. Presumably the lake afforded refuge to immature bull trout (i.e., fish that have not reached reproductive maturity) from relatively higher temperatures present in the Pend Oreille River during the summer and provided them with abundant forage. Although our initial results suggest that bull trout found below the dam attempted to move upstream to the lake (or possibly a cold water refuge in a home spawning tributary), a more direct way to test the hypothesis that the dam is impeding their upstream movements to the lake (or a home tributary) would be to move them from below the dam, place them above it and track their movements. This study should be conducted at a biologically appropriate time when both the fish's physiological state and the river

environment are suited to a successful migration. Sexually mature adult bull trout in the Pend Oreille Basin migrate to and enter spawning streams in May and June, so this would be one appropriate time period that such a study should be conducted. The purpose of a study at this time would be to identify the spawning tributaries selected by the displaced fish. Biopsy samples collected from the transmitter-implanted fish could be compared to biopsy samples collected from bull trout in the tributaries that these fish enter to assess genetic similarity. Post-spawning adult bull trout and, possibly, first time sub-adult migrants in the Pend Oreille Basin migrate to Pend Oreille Lake in October to mid-December, so this would be a second biologically appropriate time to collect fish below the dam and displace them above it. The purpose of a study conducted at this time would be to determine if the displaced fish migrate to Lake Pend Oreille.

3. Make detailed investigations (continuous tracking) of fish behavior below the dam to inform fish passage engineers about requirements for designing fishway entrances. The present study documented that bull trout in the tailrace frequently interacted with the dam but did not identify specific migration routes, which would be important to know about when designing effective entrances to fish ladders or trap-and-haul facilities at the dam. These studies should be conducted at biologically appropriate times associated with migration of adult fish to home tributaries or adfluvial migration of post-spawning adults or first time sub-adult migrants to Pend Oreille Lake as described in recommendation # 2. In the Pend Oreille Basin, these events occur respectively from May to mid-June and October to mid-December. Conducting studies at these times would also reduce stress associated with capture and handling bull trout in warm water that we observed in the present study.

4. In concert with recommendation # 2 and #3, investigate the potential for using the culvert as a trap/capture-and-haul facility to provide immediate upstream passage for adult or sub-adult bull trout. Our investigation demonstrated that

the culvert with spring fed water on the left bank of the river below the dam was highly attractive to bull trout by acting as a cold water refuge for them. A trap/capture-and-haul facility at this site could potentially be constructed rather quickly at this location and, thus, could possibly begin helping immediately to prevent the loss of genetic variation. Even though the number of adult bull trout we captured in the tailrace (n = 10) was not large in absolute numbers, the number was substantial relative to the low populations in Pend Oreille River tributaries. For example, in the tributary closest to the dam that has known migratory bull trout populations, the East River spawning escapement was estimated at 30-40 adults in 2002 and 53-77 adults in 2003. If the fish we observed below the dam in 2003 were from the East River, their loss from the spawning population will cause loss of genetic variation in an already depressed population. While the Corps of Engineers, U.S. Fish and Wildlife Service and other agencies consult on the type, design and timeline for implementation of long-term fish passage and guidance at the dam, we suggest experimenting with trap/capture and haul fish passage at the culvert to evaluate its practicability and protect against further erosion of genetic variation. Further, we suggest that fish collected at the proposed facility in May to mid-June or October to mid-December could be used as a source of fish for the telemetry investigations described in recommendations # 2 and #3 (above). Sexually mature fish collected at the proposed facility during the summer (July to mid-August) could be used as a source for attempting to re-establish bull trout in a tributary of the Pend Oreille River below the dam as described in recommendation # 5 (below). We believe this would be an appropriate use for fish collected there in the summer since it is likely they will die without spawning when they are forced into the warm water of the Pend Oreille River as their access to the culvert becomes restricted. It would also not be realistic to move them into the Pend Oreille River above the dam at this time because the elevated temperatures would likely kill them. Using these fish as a source would. also prevent “mining” of bull trout from tributaries in Idaho where populations are already depressed

5. Attempt to re-establish adfluvial bull trout in a Washington tributary of the Pend Oreille River. At present, Washington tributaries of the Pend Oreille River are depauperate of bull trout. Confirmation that bull trout from the Priest River drainage make adfluvial migrations into Lake Pend Oreille indicates that it may be feasible to use a population with a similar life history in an attempt to recover bull trout in Washington tributaries. As noted in recommendation # 4, bull trout captured in the culvert during the summer may be an appropriate source for this attempt. Indian Creek, which is close to the dam and has relatively cold water temperatures, is one possible introduction site but whatever tributary below the dam that is deemed by the fish and land management agencies to have the best bull trout habitat could be used. We recommend that if such an attempt is made, the transplanted fish should be implanted with radio transmitters and their movements tracked to determine if they remain in the recipient stream and spawn there, or if they attempt to migrate back to the tailrace area. If it is shown that they attempt to return to the tailrace, a follow-up experiment could be conducted by attempting to sequester the fish in the selected tributary until after they spawn.

6. The U.S. Fish and Wildlife Service and/or Idaho Department of Fish and Game and Washington Department of Fish and Wildlife should conduct surveillance of the culvert and other areas downstream of Albeni Falls Dam to determine if poaching is occurring. Two of the four dead bull trout in this study appeared to be handled by humans because the transmitter was found off of the fish, either buried under a rock or badly damaged. Although we are uncertain if this interaction occurred before or after the fish died, it seems logical that hiding a transmitter is more consistent with the behavior of a poacher than someone finding a dead fish. In the latter case, it seems more likely that the finder would have reported the event to fish and wildlife authorities. Although the transmitters were clearly marked with Battelle, subsequent radio telemetry studies should use radio transmitters that are clearly marked with the name of the research group and a contact address or

phone number where the transmitter should be returned; a reward system should also be considered to encourage recovery of the transmitters.

7. Maintain water elevations in the Pend Oreille River to achieve a minimum water depth in the culvert so it will remain accessible to bull trout during August and September. The culvert area appears to be critical habitat for bull trout below Albeni Falls Dam. In our tracking investigation, bull trout survived as long as this habitat was available to them for a thermal refuge but mortality ensued as they were forced out of it by receding water surface elevations in Box Canyon Reservoir in August. Operations at both Albeni Falls and Box Canyon dams should be evaluated to determine if it is feasible to maintain bull trout access to this habitat.

Introduction

The US Army Corps of Engineers operates Albeni Falls Dam on the Pend Oreille River near the Washington – Idaho border (Figure 1). The impassable dam impounds approximately 45 km of the Pend Oreille River and regulates the elevation of Lake Pend Oreille. In 1998, bull trout (*Salvelinus confluentus*) in the Columbia River Basin, including the Pend Oreille River, were listed as threatened (63 FR 31647) under the authority of the Endangered Species Act. Although many factors have contributed to the overall decline of bull trout in the Columbia Basin, the abrupt decline of bull trout in the Pend Oreille system correlated with the construction and commencement of operation of Albeni Falls Dam between 1951 and 1955. In their Biological Opinion for the operation of the Federal Columbia River Power System (USFWS 2000), the Service noted that Albeni Falls Dam:

> *…is a barrier isolating about 50 miles of the Pend Oreille River and its tributaries from Lake Pend Oreille. These migratory bull trout subpopulations are believed dependent upon Lake Pend Oreille for sub-adult and adult rearing…Bull trout were abundant in the Pend Oreille River through 1957, and then abruptly their numbers decreased to the point that individual fish are now noteworthy. This abrupt decline correlates with the commencement of operation of Albeni Falls Dam in 1952. No other abrupt, or widespread threat can be identified for this portion of the Pend Oreille River basin during the 1950's. In the absence of passage, migratory bull trout remaining in the Pend Oreille River will continue to be harmed.*

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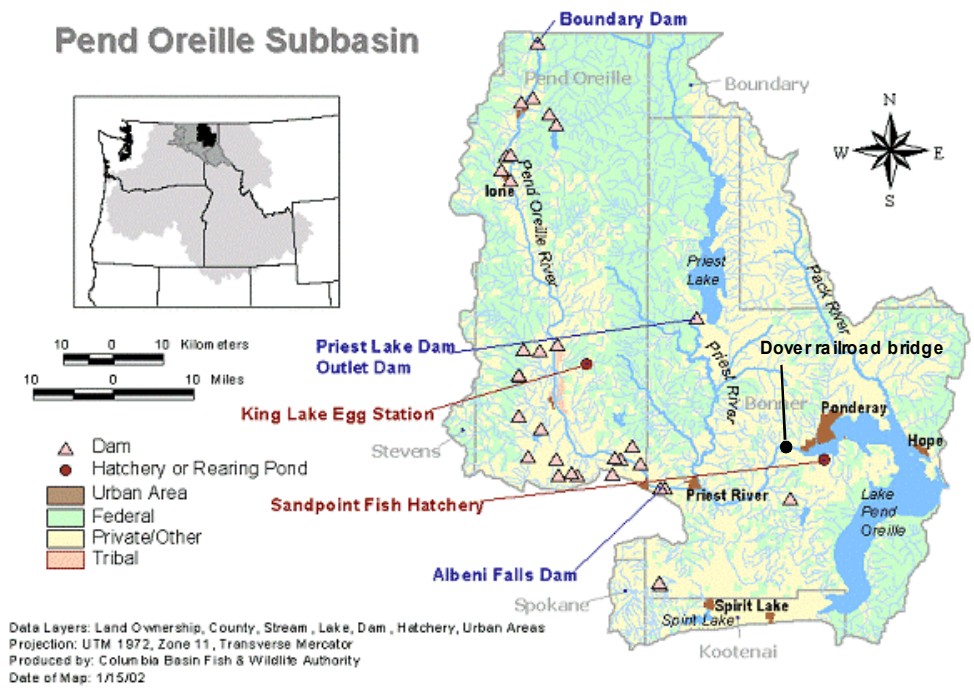

Figure 1. Pend Oreille Subbasin (source CBFWA website http://www.cbfwf.org)

To minimize take of listed species and to recover listed species populations, the Biological Opinion (USFWS 2000) required a series of reasonable and prudent measures for operation of the Federal Columbia River Power System, as implemented by specific terms and conditions. For the issue of fish passage at Albeni Falls Dam, the Biological Opinion (USFWS 2000) required:

> *Reasonable and Prudent Measure 10.A.1.3 – The action agencies shall evaluate the feasibility of reestablishing bull trout passage at Albeni Falls Dam. If the information from these studies warrants consideration of modifications to the Albeni Falls facility, then the Service will work with the action agencies to implement these measures, as appropriate, or to reinitiate consultation, if necessary.*
>
> *Terms and Conditions 11.A.1.3 – The following terms and conditions are established to implement reasonable and prudent measure #3 [see previous paragraph] for the Upper Columbia River (Albeni Falls Operations):*

a. *By October 1, 2004, the action agencies shall conduct a feasibility study for reestablishment of two-way passage of adult and sub-adult bull trout at Albeni Falls Dam. This study must include observations of movement and survival of radio-tagged bull trout from Lake Pend Oreille, and survival of adult and sub-adult bull trout passing through or over Albeni Falls Dam. The study must also analyze the feasibility of structural improvements such as fish ladders and measures to guide fish away from turbines.*

b. *Based on the results of the study, by October 1, 2005, the action agencies shall consult with the Service, as necessary, on the decision to reestablish fish passage at Albeni Falls Dam. If fish passage is determined to be necessary, the action agencies will seek appropriations for the construction of the facility by October 1, 2008.*

In response to the requirements in the Biological Opinion, the Seattle District of the Army Corps of Engineers funded Battelle Pacific Northwest and Eastern Washington University (hereinafter referred to as the Battelle Team) to conduct a bull trout migration study in the Pend Oreille River Basin. The goal of the study was to assist in clarifying the migratory behavior of sub-adult and adult bull trout in the Pend Oreille system with an emphasis on whether migration of adfluvial bull trout required passage over Albeni Falls Dam.

The study had three objectives. The first objective was to study the migratory behavior of adult bull trout that spawn in the Priest River drainage (Chapter 1 of this report). The Priest River enters the Pend Oreille River from the right bank 8 km upstream of Albeni Falls Dam and 38 km downstream of the Lake Pend Oreille. This drainage was selected as representative of populations that may have existed throughout the Pend Oreille River Basin prior to hydroelectric development. Completion of this objective was expected to provide managers with information on how the bull trout population in the pre-dam Pend Oreille River system likely interacted with Lake Pend Oreille, as well as provide

information on how the current Albeni Falls Dam may affect migratory bull trout in the post-dam Pend Oreille system.

The second objective was to assess when sub-adult bull trout from the Priest River migrate into the Pend Oreille River (Chapter 2). Although some information existed on the adult population in the Priest River, very little information was known about the sub-adult population and whether they migrated downstream toward the dam once they left the Priest River system.

The third objective was to document the presence and behavior of bull trout in the tailrace and reservoir downstream of Albeni Falls Dam (Chapter 3). Substantial numbers of sub-adult bull trout from areas upstream of the dam have been marked over the past several years and we were interested in whether targeted surveys in the tailrace of the dam would find any of the marked fish. Further, if bull trout located in the tailrace were tagged with radio transmitters, information on their behavior could be obtained that might be useful for designing and constructing fish passage facilities at Albeni Falls Dam.

Chapter 1 – Migration behavior of adult bull trout in the Priest and Pend Oreille rivers above Albeni Falls Dam, Idaho

Introduction

Bull trout (*Salvelinus confluentus*) currently exist in the Priest River drainage (Bjornn 1957; Fredericks et al. 2002; USFWS 2002a). The Priest River drainage includes Priest Lake and its tributaries, as well as the Priest River which flows out of Priest Lake into the Pend Oreille River approximately 8 km upstream of Albeni Falls Dam and 38 km downstream from the U.S. Highway 95 bridge across Lake Pend Oreille (Figure 1.1). The Middle Fork of the East River, a tributary to the Priest River, is the only known tributary within the Priest River drainage downstream of Priest Lake that is known to support bull trout (DuPont and Horner, in press). The bull trout spawning escapement in the Middle Fork East River during 2002 was conservatively estimated to be between 30 and 40 fish (DuPont and Horner, in press). In 2003, spawning escapement was estimated to range between 53 and 77 fish. Bull trout that use the Middle Fork East River are suspected to be of an adfluvial life history type and rely on a large body of water to forage. The most likely forage area would be Lake Pend Oreille because the dam at the outlet of Priest Lake is probably a passage barrier and the high water temperature in the Pend Oreille River (e.g., > 23°C) during the summer would appear to preclude fish from spending extended periods of time in the river (USFWS 2002a; Bennett and DuPont 1993).

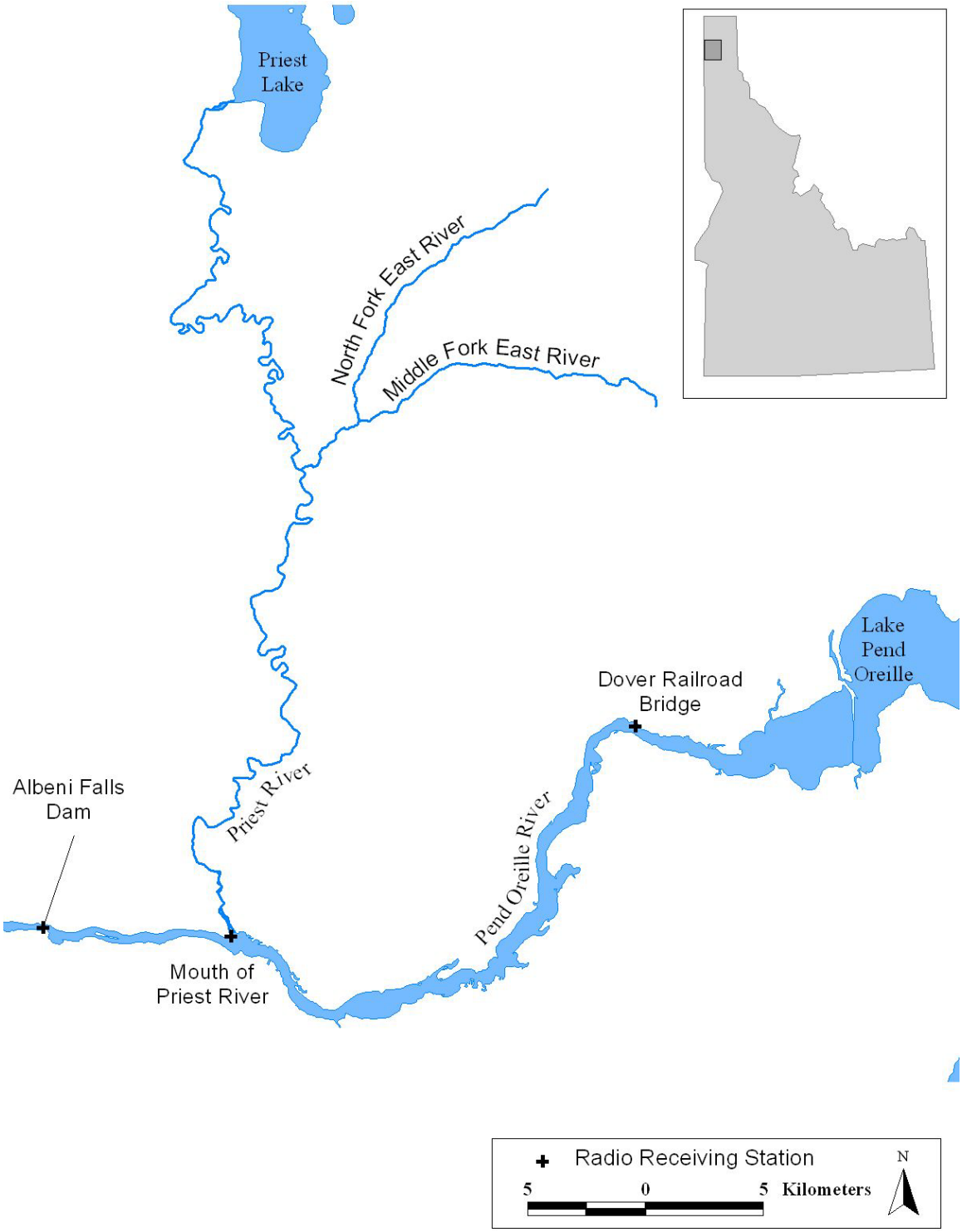

Figure 1.1. Priest River Bull Trout Study Area

If indeed bull trout that reside in the Middle Fork East River over-winter in Lake Pend Oreille, this population would be uncommon with respect to other adfluvial populations in that the pre-spawning adults first migrate downstream out of Lake Pend Oreille to the Priest River, and then move upstream to spawning areas. Juvenile and post-spawning adults would follow this path in reverse, moving down the Priest River to the Pend Oreille River, and then upstream to the lake where they would forage. The large size of bull trout historically captured in the Pend Oreille River and its tributaries suggests that this downstream migration pattern occurred throughout the entire Pend Oreille River basin in Idaho and Washington prior to dam construction (USFWS 2002b). Pre-dam Albeni Falls likely did not restrict upstream movement, thus would not have precluded both adults and juveniles migrating to Lake Pend Oreille at some point in their life history. Although not common, downstream migration strategy for pre-spawning adults has been documented in the Lake Wenatchee and Chewuck River (Washington), Bull Lake (Montana), and Kline River (Alberta) (reviewed in DuPont and Horner, in press; Scott Deeds, USFWS, unpublished data). However, the distance migrated by the Priest River population (approximately 38 km) is much further than reported for these other populations (< 8 km). As such, bull trout in the Priest River drainage may represent the last example of a downstream migratory life history type in the Pend Oreille basin (DuPont and Horner, in press).

Albeni Falls Dam probably affected bull trout in at least two ways. First, it blocked access to Lake Pend Oreille for adfluvial bull trout that spawned in tributaries below the dam. Second, the dam may also prevent bull trout that spawn in tributaries of the lake or river above the dam from access to those tributaries if they are entrained at the dam because the dam was constructed without a fish ladder. Entrainment could occur if a bull trout migrating downstream from the lake overshoots its home tributary and arrives in the forebay. It is well documented that migratory salmonids frequently overshoot their home river and then backtrack to relocate it (Johnsen and Hasler 1980; Hasler and Scholz 1983). Fish arriving in the forebay during the spring freshet season may be especially prone to entrainment owing to high discharge at that time.

The objective of our study was to determine the migratory behavior of adult bull trout that spawn in the Priest River drainage. Completion of this objective was expected to provide managers with information on how the bull trout population in the pre-dam Pend Oreille River system likely interacted with Lake Pend Oreille, as well as provide information on how Albeni Falls Dam may currently affect migratory bull trout in the Pend Oreille system.

Methods

Fish tagging

We monitored pre-spawn adult bull trout that were radio-tagged by the Idaho Department of Fish and Game (IDFG) in the Middle Fork East River. The Middle Fork East River flows about 15 km from its headwaters to where it joins the North Fork East River to form the East River. The East River flows approximately 4 km to where it enters the Priest River. Twenty pre-spawn bull trout, 400 to 752 mm TL, were captured in August, 2002, by backpack electrofishing in the Middle Fork East River between Tarlac and Keokee creeks and in Uleda Creek. Each fish was measured, implanted with a pulsed radio transmitter (Lotek model MBFT-5, 8.9 g air, 4.3 g water, 26 beats per minute, life expectancy ~290 d) and released near the capture site. A complete description of this drainage and the IDFG radio-telemetry study can be found in DuPont and Horner (in press).

Radio telemetry

The Battelle Team deployed a total of six radio receiving stations before October 19, 2002; four located at Albeni Falls Dam and two on the railroad bridge at Dover, Idaho (~26 km upstream of the Priest River; Figure 1.1). Each station consisted of an SRX-400 radio receiver connected to aerial Yagi antennas. The receivers were supplied with either AC or DC power; solar panels were used to re-charge DC power systems. At all locations a beacon tag was used to monitor receiver status. The beacon tag was programmed to transmit a signal for one minute every hour.

Of the four stations at the dam, two were located on the spillway, one was in the tailrace, and one was in the forebay (Figure 1.2). Each spillway station was connected to five Yagi antennas. One station covered the forebay side of the spillway and the second station covered the tailrace side of the spillway. The third station was located on the end of the log chute and connected to an antenna that was pointed out into the tailrace of the powerhouse. The fourth station at the dam was located on the forebay side of the dam on the cement bulkhead below the parking lot. The receiver at this location was attached to an antenna that was pointed south-southwest into the forebay. Calibration of the four stations at the dam showed that coverage was good except for a 7-9 m deep trench immediately upstream of the powerhouse intake, and downstream of the powerhouse. The areas of poor coverage were fairly small compared to the area of good coverage, and were assumed to not affect our ability to identify bull trout on the forebay-side of the dam. Power supply problems periodically disabled the two tailrace stations during the first month of the study. However, these failures did not compromise our ability to detect radio-tagged bull trout because redundant receiving stations in the forebay were operational at that time.

The fifth and sixth stations were located on the north and south sides of the Pend Oreille River on the railroad bridge at Dover (Figure 1.1). These sites were selected following a review of all potential sites between the Priest River and Lake Pend Oreille. Each station was connected to two Yagi antennas that were located on the bank in the railroad's right-of-way. Prior to installation, access was coordinated with Corps project personnel and Burlington Northern right-of-way agents. These stations were designed to cover the entire width of the river, and calibration tests showed excellent coverage.

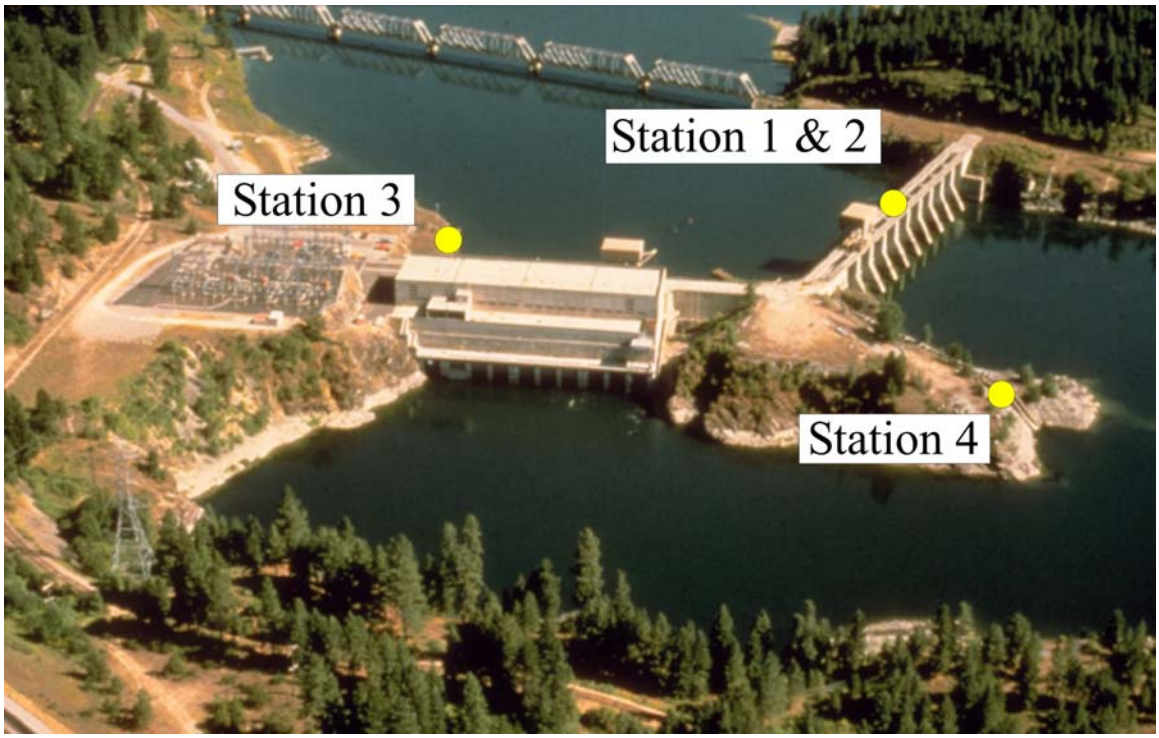

Figure 1.2. Locations of Radio Receiving Stations at Albeni Falls Dam

In addition to the radio receiving stations deployed by the Battelle Team, the IDFG and USFWS also deployed an SRX-400 receiver and Yagi antenna at the mouth of the Priest River.

All fixed-receivers were inspected and data downloaded approximately once every two weeks from October, 2002, to September, 2003. Data were backed-up on a laptop computer and a hard copy record was made of the start and end time the receiver operated. At the time of each inspection the power system was inspected and repaired if necessary. The beacon tag was also checked for proper operation.

Data processing consisted of reviewing each download file for active tags, beacon tag signals, and noise. Data summaries were prepared and used to target fish during mobile tracking efforts.

In addition to the fixed-stations, movements of tagged bull trout were monitored using radio receivers operated from fixed-wing aircraft and truck. Our surveys were coordinated with IDFG who conducted weekly surveys from August, 2002, through December, 2002, and then periodic surveys until March, 2003. In addition to these surveys, the Battelle Team conducted five aerial surveys of the Pend Oreille River: December 30, 2002, and January 2, February 4, July 7, and September 12, 2003. A fixed-wing aircraft out of Felts Field, Spokane, Washington was contracted to conduct these surveys. Flights were made along the Pend Oreille River from Albeni Falls Dam upstream to Lake Pend Oreille, and up the Priest River. Multiple passes were made in order to reduce the chance that tags would be missed. Any fish detected during the surveys were noted on a map, and if possible, an on-board Global Positioning System (GPS) was used to record the latitude and longitude of the fish location. Speed of the aircraft reduced the accuracy of the GPS positions. In addition to the aerial surveys, we also conducted periodic mobile surveys using a truck. Once a fish was detected, a GPS and existing landmarks were used to note fish position.

Results

After their capture in the Middle Fork East River in August 2002, IDFG personnel documented very little movement of adult bull trout during the first month of the telemetry study (DuPont and Horner, in press). Spawning behavior was noted to begin when water temperatures dropped below 10°C in September. By the first week of October, 2002, most of the spawning activity had been completed and fish were beginning to move downstream (DuPont and Horner, in press). About this time, IDFG researchers began noting significant post-spawn mortality; between October 3 and November 13, 2002, 11 different dead bull trout were documented. It appeared that environmental conditions in the East River made it difficult for bull trout to find their way to the Priest River after spawning. Low flow and extremely cold conditions in November, 2002, resulted in sections of the river freezing over and bull trout being trapped behind beaver dams. In fact, in December, 2002, four radio-tagged bull trout were removed from a beaver pond and transported to the Priest River where they were released. Consequently, at about the time we initiated our study, there were 12 confirmed

dead fish, 2 unconfirmed dead fish, and 6 live fish (DuPont and Horner, in press; Table 1.1).

None of the six East River adult bull trout that eventually migrated into the Pend Oreille River were detected at any of the four stations located at Albeni Falls Dam. Although power supply problems periodically disabled the tailrace stations, we are still certain that none of the tagged fish moved below the dam because no fish were detected moving downstream past the two forebay stations, which remained operational throughout the study. All systems functioned properly during the study based on the detection of the beacon tags.

Four of the six live fish migrated out of the Priest River drainage into Lake Pend Oreille to over-winter (Table 1.2; see appendix A for details on individual fish movements). One fish (149.020) that over-wintered in the lake was last located at the receiving stations at the Dover railroad bridge in early December, 2002 (Figure 1.3). This fish was removed from a beaver pond in the East River on December 9, 2002. It was detected at the Dover bridge stations on December 12, 2002 (19:21-22:01) and December 13-14, 2002 (22:34-0:35). Simultaneous readings from both sides of the river at the Dover bridge were recorded just after midnight on December 14, 2002. Based on distance between the release location and the receiving stations at the Dover bridge, it traveled 52 km in two days. We failed to locate this fish again after December 14 and assumed it migrated into Lake Pend Oreille because aerial surveys in January and February, 2003, did not detect it again. Possibilities for our inability to detect this fish included: 1) the fish moved into the deep waters of Lake Pend Oreille (which attenuated the radio signal, making it undetectable); 2) the transmitter failed; or 3) the fish was illegally harvested by an angler. Of these possibilities, we think the first is most likely because another fish (149.640) was also detected at the Dover bridge in mid-December and the signal disappeared shortly thereafter until it was detected again at the Dover bridge in May swimming downstream from the lake. However, unlike 149.640, 149.020 was not detected leaving the lake.

Table 1.1. The Status of Bull Trout At the End of November, 2002 (modified from DuPont and Horner, in press).

Frequency	Length (mm)	Status	Date of death
148.280	521	Dead	11/13/2002
148.299	584	Dead	9/19/2002
148.730	752	Dead	10/3/2002
148.750	400	Dead	11/6/2002
148.770	530	Dead	10/25/2002
148.960	590	Dead	10/8/2002
148.979	650	Dead	10/8/2002
149.020	497	Alive	--
149.100	545	Dead	10/8/2002
149.297	480	Dead	11/13/2002
149.430	615	Dead	10/15/2002
149.629	732	Alive	--
149.658	485	Dead	10/23/2002
149.690	722	Alive	--
150.179	590	Alive	--
150.210	515	Dead	11/13/2002
150.442	545	Unknown	--
150.860	550	Alive	--
151.000	450	Alive	--
151.889	540	Unknown	--

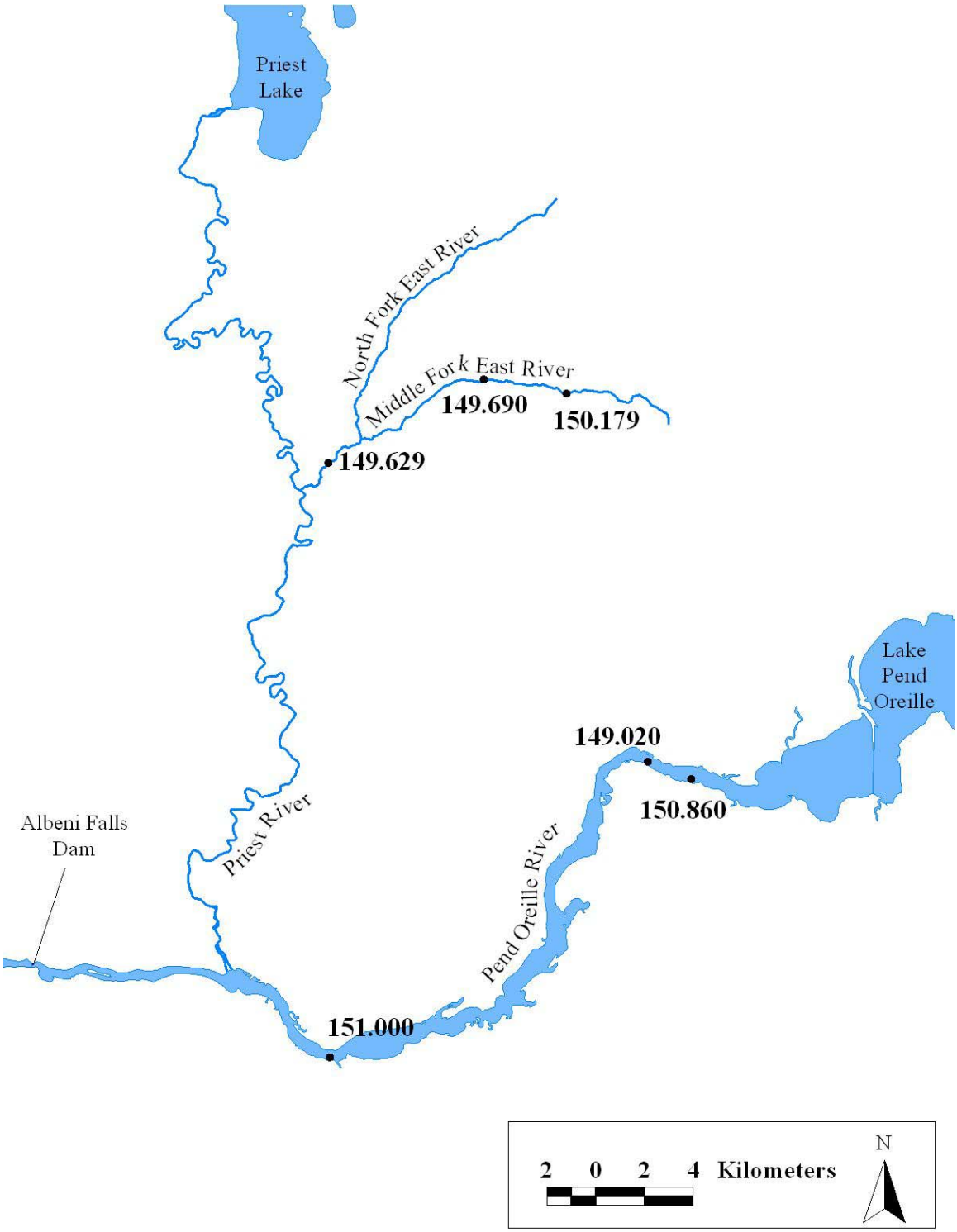

Figure 1.3. Last Known Location of Six Adult Bull Trout Tagged with Radio Transmitters in the Middle Fork East River, August, 2002

Table 1.2. Over-wintering Locations and Location of Last Detection of Six Adult Bull Trout Monitored November, 2002 through September, 2003.

Frequency	Over-winter location	Location of last detection	Date last located
149.020	Lake Pend Oreille	Dover Bridge	12/14/2002
149.629	Pend Oreille River	East River	7/7/2003
149.690	Lake Pend Oreille	MF East River	9/2/2003
150.179	Lake Pend Oreille	MF East River	9/2/2003
150.860	Lake Pend Oreille	Pend Oreille River near Lake Pend Oreille	7/7/2003
151.000	Pend Oreille River	Pend Oreille River near Priest River	7/7/2003

As noted above, fish 149.690 over-wintered in Lake Pend Oreille. As with fish 149.020, this fish was removed from a beaver pond on December 9, 2002, and immediately traveled down the Priest River and up the Pend Oreille River where it was detected at both receiving stations at the Dover bridge on December 11, 2002 (14:27-14:53). In contrast to 149.020 which was not detected leaving the lake, 149.690 migrated out of Lake Pend Oreille in May 2003. On May 24, 2003, it was detected at both of the stations at the Dover bridge between 02:00 and 03:00, and then at mouth of the Priest River from 17:59-21:21, traveling 26 km in 15 h. It was next detected on June 17, 2003, approximately 1.6 km up the East River, and then the next day in the Middle Fork East River. It steadily progressed upstream in the Middle Fork East River over the next couple months, reaching river km 6.4 on July 22, 2003. Soon after (August 1, 2003) it was detected at river km 4.8 of the Middle Fork East River and was last detected on September 2, 2003, at this same location (Table 1.2; Figure 1.3).

The last two fish to over-winter in the lake (150.179 and 150.860; Table 1.2) were found by IDFG in Lake Pend Oreille during a mobile survey on November 14, 2002 (DuPont and Horner, in press). These fish were detected by IDFG in the Priest River in mid September, but they were not picked up at the mouth of the Priest River because the IDFG station was not functioning properly during the time they would have passed into the Pend Oreille River. They also were not detected during this time period on the receiving stations at the Dover bridge, likely because they moved through this area before the systems were operational (October 19, 2002). After IDFG found them in November, 2002, we repeatedly located these two fish during aerial and truck surveys near the Long Bridge in late fall and early winter.

Aerial and mobile surveys in the June and July, 2003, documented fish 150.860 in the Pend Oreille River near the lake. We were unable to pin-point its location, but it appeared to have moved downstream ~6.4 km near the city of Dover, Idaho, using the river where it flows out of the lake (Figure 1.3). We did not detect this fish on the receiving stations at the Dover bridge which were located 3.2 km downstream of the fish's location.

While 150.860 did not move out of this area, 150.179 migrated out of the lake, down the Pend Oreille River to the receiving station at the Dover bridge where it was detected daily from May 16 to May 23, 2003. It was next detected at the mouth of the Priest River around noon on May 25, 2003, one day after 149.690 moved past this location. On June 17, 2003, it was found in the Middle Fork East River where it was repeatedly located moving upstream until it was detected near Uleda Creek (approximately river km 10 of the Middle Fork East River) on August 1, 2003. Subsequent surveys on August 20 and September 2, 2003, found the fish near Uleda Creek where radio trackers observed it to be in good condition; this was the last detection of this fish (Figure 1.3).

Two fish (151.000 and 149.629) over-wintered in the Pend Oreille River (Table 1.2). Fish 151.000 was removed from the beaver pond on December 9, 2002, and immediately moved past the receiving station at the mouth of the Priest River into the Pend Oreille River. It was repeatedly observed about 4.8 km east of the mouth of the Priest River

within the Pend Oreille River from early 2002, to July, 2003. It was last documented on July 7, 2003, during an aerial survey of the Pend Oreille River near the mouth of the Priest River, indicating very little movement of this fish (Figure 1.3). It was not known if this fish was dead or alive.

Fish 149.629, another bull trout that over-wintered in the Pend Oreille River, was also removed from the beaver pond December 9, 2002, and moved into the Pend Oreille River soon thereafter. It was located in the Pend Oreille River near the mouth of the Priest River during aerial surveys in January and February, 2003. It was detected by the receiving station at the mouth of the Priest River on its way downstream during the fall, 2002, and periodically in January and February, 2003. Truck surveys during this period indicated the fish was not in the Priest River but rather in the Pend Oreille River, confirming the results from the aerial surveys. The next time 149.629 was detected, it was during a truck survey of the East River on July 1, 2003. A subsequent aerial survey on July 7, 2003, confirmed the fish was at approximately river km 1.6 of the East River. Although we suspect this fish was moving upstream to a spawning area, we were unable to detect this fish again (Figure 1.3).

Discussion

A total of six adult bull trout were monitored between November, 2002, and September, 2003. Four of the six bull trout exhibited a definite adfluvial life-history, using Lake Pend Oreille to over-winter. The other two used the Pend Oreille River to over-winter. Although over-wintering behavior in a river is typically classified as a fluvial life history, DuPont and Horner (in press) characterized these fish as adfluvial because the Pend Oreille River at this location is more like a reservoir than a river. Either way, the Middle Fork East River bull trout population appears to migrate into the Pend Oreille system to complete a portion of its life history.

It is likely that bull trout populations in the historic Pend Oreille River prior to construction of Albeni Falls Dam exhibited this life history behavior. Large bull trout (up to 12 kg) probably used the tributaries above and below the current site of Albeni Falls Dam for spawning, returning to either the lake or the river to forage. The likelihood

these fish moved over Albeni Falls seems high as the falls did not present much of a migration barrier (see review in USFWS 2000). If one accepts that bull trout currently present in the Priest River drainage exhibit similar life histories to bull trout populations historically present in tributaries below Albeni Falls Dam, then the results from our study substantiate the conclusion in the Biological Opinion (2000) that Albeni Falls Dam blocked the bull trout migration corridor from tributaries below Albeni Falls to the lake.

There was no indication that adult bull trout moved downstream of the Priest River into the vicinity of Albeni Falls Dam. Although we can not account for the final disposition of all 20 adult bull trout tagged by IDFG and USFWS, we do not believe these fish moved toward the dam because our receiving stations at the dam were operational prior to the last detections of all fish and our coverage at the dam was sufficiently redundant that if a radio-tagged fish had moved into the vicinity of the dam we had a high probability of detecting it. Further, none of the six fish we actively monitored exhibited behavior characteristics suggestive of using the Pend Oreille River downstream of the Priest River.

DuPont and Horner (in press) reported post-spawning mortality 60-70% for the adult bull trout tagged in this study. We can not offer an additional explanation for the high post-spawn mortality experienced by these fish. As DuPont and Horner (in press) point out, post-spawning mortality of bull trout can be over 60% in years of extreme environmental conditions as observed in the fall of 2002. In fact, the post-spawning mortality of bull trout in this study may be even higher as it would appear that two of the six live fish we monitored may have died before their transmitters expired (151.000 and 150.860). Although 151.000 was observed to move out of the Priest River into the Pend Oreille River following its removal from a beaver pond in December, 2002, we did not show any movement of this fish even as the Pend Oreille River heated up in the summer of 2003. Another fish (150.860), which was located in Pend Oreille Lake near the Highway 95 bridge in January and February, was detected at the Dover railroad bridge in June and July, its last recorded position. It appeared that this fish was starting to migrate downstream but, rather than moving quickly past the Dover bridge like other downstream migrants, it abruptly stopped. It should be pointed out that even though our telemetry

data suggested these fish were dead, we did not attempt to determine their specific position so it is unknown if these fish were able to persist in the Pend Oreille River by seeking out cool water refugia. Certainly this is possible as we observed this behavior in the tailrace of Albeni Falls Dam (Chapter 3 of this report).

Half of the adult bull trout monitored as part of this study returned to the East River, presumably to spawn, although we did not directly observe any of these fish spawning. Redd counts made in the Middle Fork East River in 2002 and 2003 suggest bull trout spawn in September from Tarlac Creek upstream to Keokee Creek and in Uleda Creek (DuPont and Horner, in press). Thus, our observations of fish moving into the East River and Middle Fork East River during June through September is consistent with a migration behavior that would position these fish near spawning areas at the time of spawning.

That these fish exhibit a downstream migration behavior is an interesting finding of the study. As DuPont and Horner (in press) point out, this life history behavior is somewhat unique among bull trout populations. Other populations are known to have downstream migration strategies similar to the East River population, but few, if any, migrate as far as the Middle Fork East River population. This unique migration behavior, as DuPont and Horner (in press) point out, will make it difficult to recover this population should it be extirpated. As such, we concur with DuPont and Horner (in press) that this population should be carefully monitored.

Chapter 2 – Capture and tagging of sub-adult bull trout in the Middle Fork East River, Idaho

Introduction

Adult bull trout (*Salvelinus confluentus*) from the Middle Fork East River appear to have an adfluvial life cycle that is unique among other bull trout populations (DuPont and Horner, in press; Chapter 1 this report). Sub-adult bull trout must swim downstream nearly 34 km to where the Priest River joins the Pend Oreille River, and then swim upstream another 38 km to Lake Pend Oreille. Although other outlet spawning populations of bull trout can be found, none appear to migrate as far as the Middle Fork East River population. Further, as they exit the Priest River, they are only 7 km above Albeni Falls Dam which does not afford them a second chance should they be entrained over the dam.

Although incidental catches of sub-adult bull trout had been made in the Middle Fork East River, very little was known about sub-adult migration behavior or their relative risk of entrainment at Albeni Falls Dam. For example, the size of sub-adult migrants will affect their swimming ability in the Pend Oreille River The timing of their entry to the Pend Oreille River will affect their risk of entrainment at Albeni Falls Dam. If they enter the Pend Oreille River during high flow (May and June), they are susceptible to being carried downstream to the dam. Conversely, if they enter the Pend Oreille River when it is low and warm (August and September), they would be susceptible to predation and thermal stress, potentially making them too weak to migrate upstream to the lake.

In order to answer these unknowns, we initiated a study of the sub-adult bull trout in the Middle Fork East River. Our objective was to radio-tag (and PIT-tag) and monitor sub-adult bull trout that would eventually make their way to the Pend Oreille River. This information was needed to determine the extent of entrainment at Albeni Falls Dam, the migration behavior of Priest River fish (fluvial or adfluvial), and fine-scale behavior of fish downstream of the dam.

Methods

Fish collection

A rotary screw trap was placed in the East River on April 21, 2003, approximately 2 km above its confluence with the Priest River and 2 km below its confluence with the Middle Fork East River (Figure 2.1). This location was approximately 5 km downstream of the primary bull trout spawning area in the Middle Fork East River (DuPont and Horner, in press). The trap was operated 3 to 5 days per week the first six weeks, and then every day from June 2 through July 10, 2003. Fish caught in the rotary drum were guided to a live box that was checked daily when the trap was operational. Fish other than bull trout were noted and released.

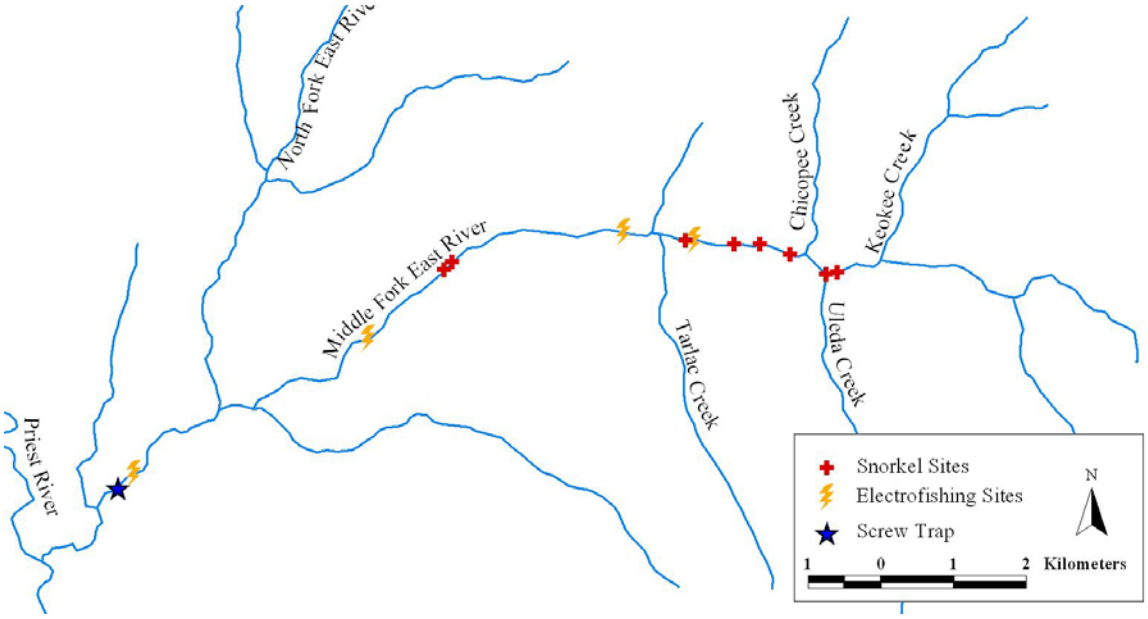

Figure 2.1. Location of Screw Trap and Sub-Adult Bull Trout Capture Sites.

Sub-adult bull trout were captured with a back-pack electrofisher at four sites in the Middle Fork East River on June 16 and 17, 2003 (Figure 2.1). Two of the sites were within 1.6 km upstream of the rotary trap and two sites were located near Tarlac Creek. Electrofishing surveys were conducted during the day. Sub-adult bull trout were also collected in the Middle Fork East River using hand dip-nets while snorkeling. Snorkeling

surveys were conducted at night on June 23, June 26-27, and June 30-July 2, 2003, at sites that were within and downstream of spawning areas (Figure 2.1).

Tagging

All fish captured during electrofishing and snorkeling surveys were placed in buckets containing fresh water. Species other than bull trout were noted and released. Bull trout were anesthetized (70-100 mg L^{-1} MS 222), weighed ($\pm$ 1 g), and measured (FL $\pm$ 1 mm). A hole-punch or partial fin-clip was used to collect a small piece of fin tissue for genetic analysis. Each fish captured during snorkel surveys was scanned with a PIT tag transceiver to determine if it had already been captured. All bull trout were given a Destron-Fearing PIT tag (DF TX 1400BE, 12 mm long, 134.2 KHz) according to protocols in the *PIT Tag Marking Procedures Manual* (CBFWA 1999).

Depending on the size of the fish, two types of radio transmitters were used. Fish that weighed 21-41 g were implanted with a Lotek NTC-3 radio transmitter (0.85 g in air, 27-d battery life), while fish >41 g (later changed to 33 g) were given a Lotek NTC-4S (1.65 g in air, 50-d battery life) radio transmitter. Both transmitters were coded, operating at a frequency of 148.520 MHz. It was necessary to reduce the minimum size criteria for the NTC-4S tag because our catch rates of fish >41 g were very low. In all cases, the transmitters represented $\leq$5% of the fish's body weight which was deemed appropriate after consulting swimming performance studies (Brown et al. 1999; Anglea et al. in press). Implantation of radio transmitters was done following methods described in Adams et al. (1998) and Brown et al. (1999). The exception was that prior to release, external antennas were trimmed to reduce impacts to swimming performance (Anglea et al. in press). After surgery, fish were transferred to a recovery bucket and monitored until upright and swimming normally. Fish were then released near the location where they were captured.

Radio telemetry

Fish position was determined using a combination of fixed and mobile telemetry. A fixed station was established at the mouth of the Priest River that consisted of an SRX-

400 receiver connected to a 6-element Yagi antenna. This system was powered by a DC-battery kept charged by a solar panel (or powered by AC after July 1). Existing fixed receiving stations at Albeni Falls Dam were kept in a mode to detect "beeper" tags (see Chapter 1) but could be quickly re-configured if sub-adult fish were detected leaving the Priest River.

In addition to the fixed-stations, we monitored movement of tagged bull trout using SRX-400 radio receivers operated from fixed-wing aircraft, truck, and by foot. Two aerial surveys were completed (July 7 and September 12, 2003). A fixed-wing aircraft out of Felts Field, Spokane, Washington was contracted to conduct these surveys. Flights were made along the Priest River, East River and the Middle Fork East River up to approximately Uleda Creek. Multiple passes were made in order to reduce the chance that tags would be missed. Any fish detected during the surveys were noted on a map, and if possible, an on-board global positioning system (GPS) was used to record the latitude and longitude of the fish location. Aircraft speed reduced accuracy of GPS positions.

Truck surveys were done with the use of a Lotek SRX-400 radio receiver connected to a 4-element Yagi antenna mounted on a rotator affixed to the bed of a pickup. The truck was driven up and down the road that runs along the stream and the antenna pointed toward the stream. When a radio frequency was logged, the truck position was noted using a hand-held GPS. Notes on distance to stream and general orientation of the antenna relative to the stream course and local landmarks were recorded. Surveys were also conducted by walking along the stream carrying an SRX-400 receiver connected to a 3-element Yagi antenna. This method allowed us to better determine fish position and note specific habitat features; the fish was often observed in the stream using this method.

Data analysis

Length-weight data of all fish were analyzed using regression analysis. Radio telemetry data were analyzed by noting the distance each fish traveled between surveys. Positions were plotted on a map. Stream kilometers were determined from the map to measure distance traveled.

Results

Screw trap

A total of 26 fish were captured in the screw trap including 13 longnose dace (*Rhinichthys cataractae*; 64-92 mm TL), 6 bridgelip suckers (*Catostomus columbianus*; 31-49 mm TL), 2 rainbow trout (*Oncorhynchus mykiss*; 122 and 153 mm TL), and 5 sculpin (*Cottus* sp.; only 1 measured at 65 mm TL). Most (23/26) of the fish were captured from June 5 through July 10, 2003. No bull trout were captured in the screw trap.

Water temperature recorded at the screw trap in April and May was 5°C, while temperature in early June was ~ 8°C. A continuous thermograph was installed at the trap site on June 13 and showed water temperatures increased from a daily average of 8.6°C to a maximum daily average of approximately 16.3°C in late July and early August, 2003 (Figure 2.2).

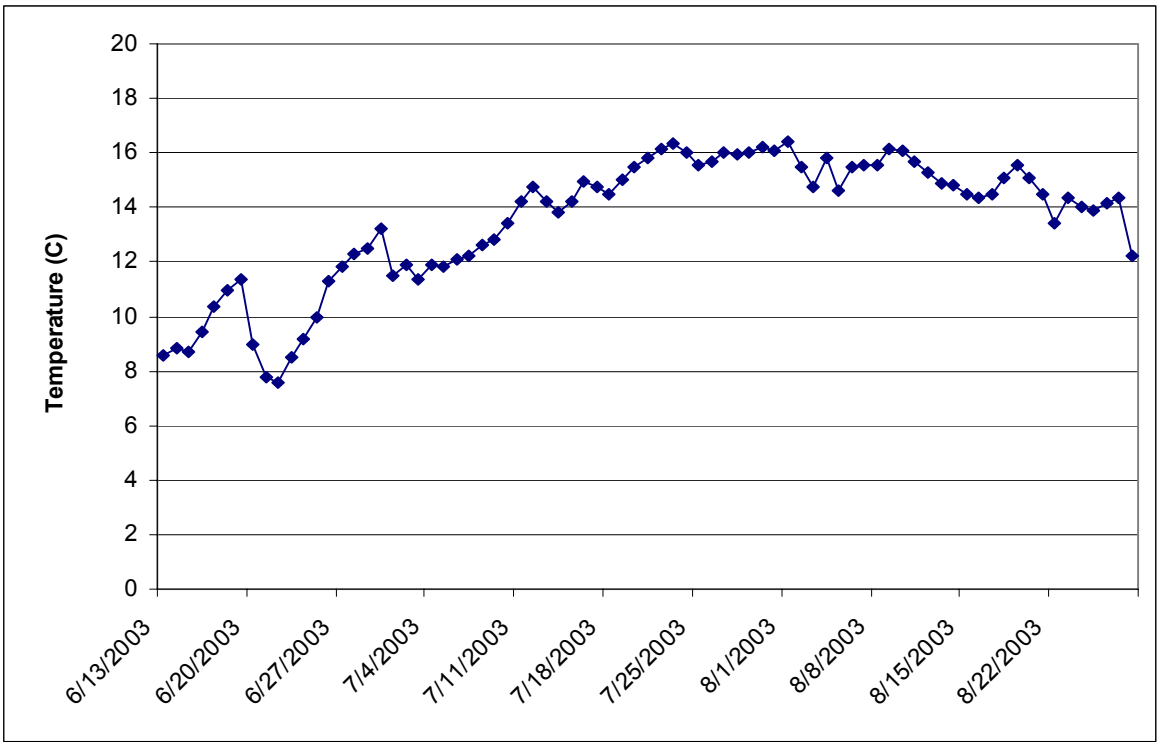

Figure 2.2. Water Temperature Recorded at the Rotary Screw Trap, East River, 2003.

Snorkeling and electrofishing surveys

A total of 4 electrofishing and 8 snorkel surveys were conducted in the East River and Middle Fork East River over 8 days between June 16 and July 2, 2003. These surveys resulted in the capture of 131 sub-adult bull trout with nearly all (n = 126) fish captured at night by snorkeling; electrofishing during the daylight was not effective. PIT tag codes, lengths, and weights of all fish are listed in appendix B. The average fork length of all sub-adult bull trout was 120 mm (range 76-169 mm) and the average weight was 19.4 g (range 5.0-51.2 g). Weight was related to fork length (r^2=0.97) by a power function of $Wt = FL^{2.8965}$ where Wt is weight (g) and FL is fork length (mm; Figure 2.3).

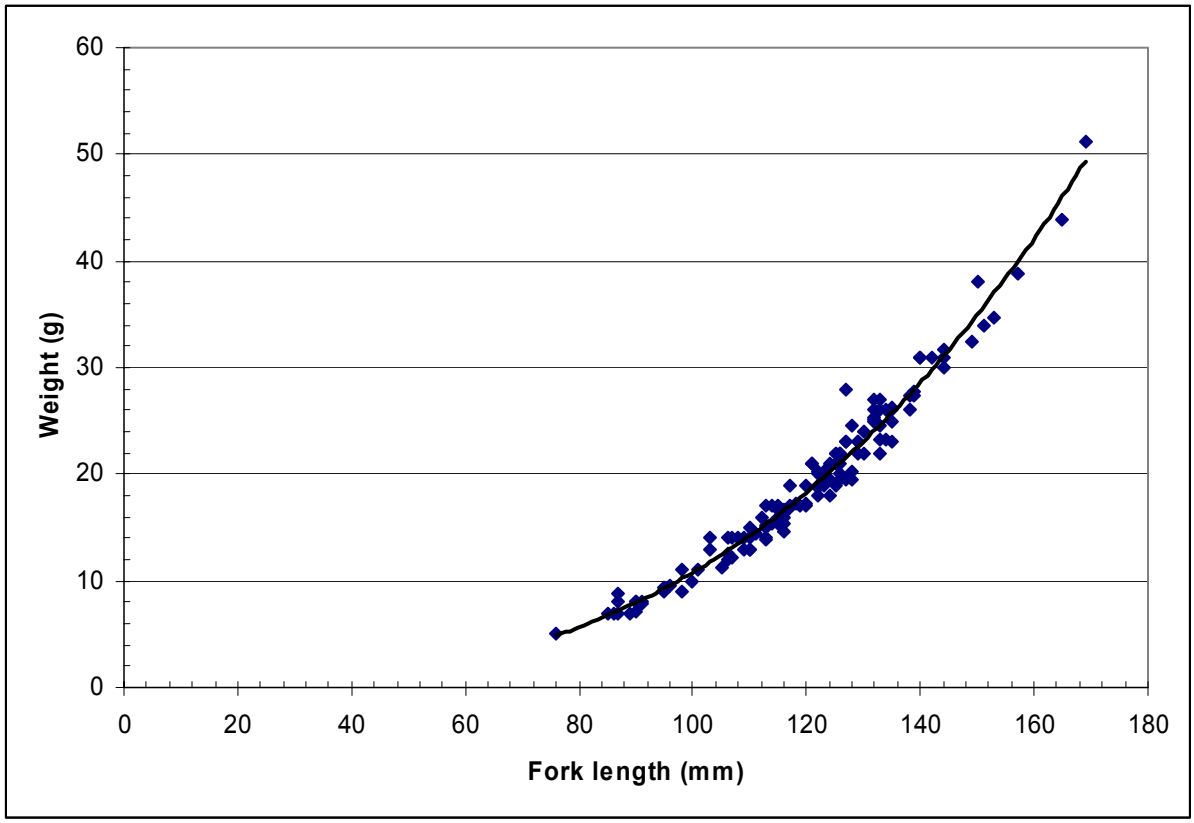

Figure 2.3. Relationship Between Length and Weight for Sub-Adult Bull Trout Captured in the Middle Fork East River, 2003.

The highest numbers of sub-adult bull trout observed and captured in the Middle Fork East River occurred upstream of Tarlac Creek. A total of 4 surveys between the screw trap and just below Tarlac Creek resulted in the capture of 4 sub-adult bull trout. In contrast, 6 surveys of the Middle Fork East River between Tarlac and Uleda creeks resulted in 111 sub-adult bull trout. There was no difference in size between fish captured above and below Tarlac Creek, although sample size below Tarlac Creek was low.

Sub-adult behavior

Of the 131 sub-adult bull trout captured in the East and Middle Fork East rivers, 52 (~40%) were ≥21 g which was the minimum body weight determined to be taggable with a radio transmitter. Of these, 10 were implanted with a NTC-3 radio transmitter (27-d life) and 5 were implanted with a NTC-4S radio transmitter (50-d life; Table 2.1). The 10 NTC-3 transmitters were not relocated after August 1, 2003, presumably because their batteries died, while the NTC-4S transmitters were still functional as of September 5, 2003. Of the 15 fish that were tagged with transmitters, one was never relocated after tagging. The one lost fish was never logged on the receiver at the mouth of the Priest River, or during manual or aerial tracking surveys of the East River or the Priest River. All of the juvenile fish were tracked multiple times by walking along the stream. Among the 14 fish tracked, no mortalities were suspected. Many of the fish were observed behaving normally during snorkeling surveys.

Table 2.1. Size of Sub-Adult Bull Trout Tagged with Two Different Radio Transmitters in the Middle Fork East River, 2003.

Group (sample size)	Mean fork length, mm (range)	Mean weight, g (range)
NTC-3 (n = 10[1])	141.0 (136.4-145.6)	28.9 (26.5-31.2)
NTC-4S (n = 5)	158.4 (147.9-168.8)	41.2 (33.0-49.4)

[1]An additional 5 NTC-3 transmitters were implanted in fish but were inadvertently not activated.

Movement of the 14 tracked fish was very limited (Figure 2.4; see also appendix C for information on individual fish movement). None of the fish moved out of the Middle Fork East River during the time they were tracked, and most of the fish moved much less than ~1 km. Of the 14 tracked fish, 8 made no noticeable movements. The other 6 fish moved a mean of 333 m (median of 200 m), with the majority (83%) of these movements upstream rather than downstream. All of these movements took place between July 10 and July 17, 2003.

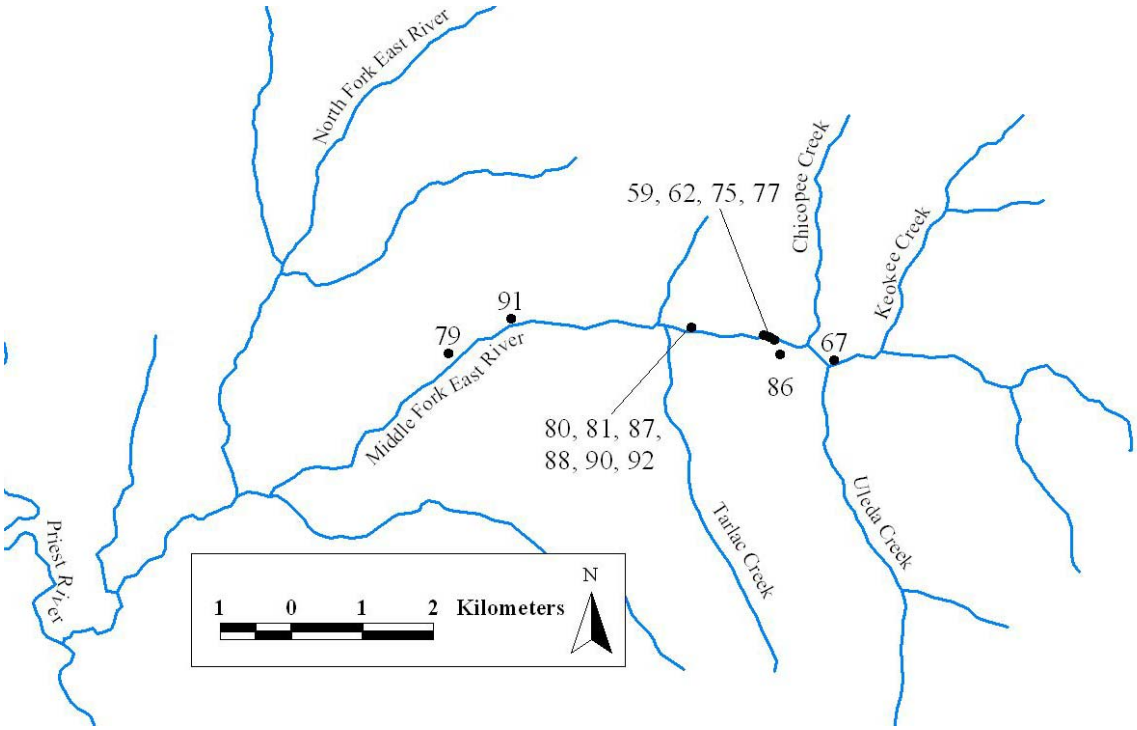

Figure 2.4. Last Known Location of Sub-Adult Bull Trout, Middle Fork East River, 2003.

Discussion

No sub-adult bull trout were determined to migrate downstream in the East River during the period from April to September, 2003. Consequently, we were not able to accomplish the objective of the study which was to document sub-adult migration behavior in the

Pend Oreille River. This is unfortunate because this population makes an unusual migration which may make it susceptible to entrainment at Albeni Falls Dam. Key questions that remain unanswered are when do these fish move downstream, at what size does the migration occur, and is their migration timed so that upstream movement in the Pend Oreille River is accomplished without being entrained, or does entrainment occur, thus removing these fish from the population? Additional information on these questions is warranted.

The U.S. Fish and Wildlife Service and Idaho Department of Fish and Game have determined that the stock of bull trout in the East River is entirely the adfluvial life history form. Their conclusion is based upon finding that bull trout in the 200 – 300 mm total length range, which is usually indicative of the resident life history form, were absent in the East River. If this is so, it will be especially important to answer questions about the timing of emigration and levels of entrainment.

Although we did not accomplish our objective, we did gain additional understanding on the bull trout population in the Middle Fork East River. For example, we learned that very little downstream movement occurs between April and September. The results on when downstream movement occurs in bull trout populations is mixed. Fraley and Shepard (1989) reported that juvenile bull trout migrated downstream in June, July, and August. In contrast, sub-adult bull trout in Trestle Creek (a tributary to Lake Pend Oreille) and from tributaries in the Bull River watershed, Montana, migrate in the spring (March through May) and fall (September through November) (Joe DosSantos, Avisita Cooperation, personal communication). We did not monitor other time periods, and are thus unable to document when bull trout move downstream in the East River.

The ability of the trap to catch fish may be a reason we did not sample migrating bull trout. Trap efficiencies were not determined, however, that the trap caught sub-adult rainbow trout ~120 to 150 mm suggests that if similar-sized bull trout were moving downstream, at least some of them would have been captured. We surveyed the river in the vicinity of the trap during June and did not find bull trout that were being missed by the trap. However, we did not conduct surveys prior to June and thus can not

conclusively state that bull trout did not migrate downstream past the trap without being caught.

The radio telemetry results also suggested little downstream movement of sub-adult bull trout. That the radio telemetry results showed that bull trout <169 mm did not migrate downstream between June and September suggests all the fish we tagged were rearing and not migrating. The low catch rates downstream of Tarlac Creek also provides evidence that few bull trout were located downstream of the spawning/rearing areas from June through July. This is difficult to interpret because of the variability in size of other migrating populations. Fraley and Shepard (1989) found that sub-adult bull trout emigrated from the Flathead River system primarily as age 2 (73 mm TL) and 3 (117 mm TL). Sub-adult bull trout that migrated out of tributaries in the Bull River drainage, Montana, in 2001 and 2002 ranged in size from 56 to 300 mm total length (TL; weight was 1 to 205 g); 90% of the total fish sampled (n = 441) were less than 180 mm (~50 g) (Joe DosSantos, Avista Corporation, unpublished data). In contrast, sub-adult bull trout emigrating from tributaries to Lake Pend Oreille were as large as 200 mm (Chris Downs, IDFG, personal communication).

Flow and temperature are both cues sub-adult bull trout use to determine when to migrate downstream. The movement of sub-adult bull trout tends to follow high flow events when temperature conditions are favorable for survival. Although there are no gage data specific to the East River, flows in the East River likely follow a similar pattern as observed at the USGS gage in the lower Priest River (USGS Gage 12395000, 1923-2002) which shows a spring peak in April-May and a much smaller fall peak in November. The screw trap was operational during April and May, the period of peak flows in the Priest River drainage. It may be that migrants were moving at this time, they just weren't being caught by the trap. More effective trapping may be possible in the fall when flows are lower.

Fraley and Shepard (1989) rarely found juvenile bull trout in streams with summer maximum temperatures exceeding 15°C. Daily average temperatures at the trap exceeded 15°C from about July 21 to August 19. Based on spot measurements of

temperature at survey sites, the water temperature in the spawning/rearing areas stayed about 3°C cooler during this time period. Thus, there may have been a temperature block in the lower East River that prevented sub-adults from moving downstream after the end of July.

Even though the tag weights exceed 2% of the body weight of the fish (Winter 1983), all the radio-tagged fish that we observed during snorkel surveys appeared to exhibit normal swimming activity. Research on whether the "2% rule" is reasonable show mixed results. Adams et al. (1998) found that gastric and surgically implanted radio transmitters that weighed 2.2-10% (in air) of the fish's body weight decreased the swimming ability of small (<120 mm fork length [FL]) Chinook salmon (*O. tshawytscha*) 1- and 21 days post-surgery. Large fish (>120 mm FL) surgically implanted with a radio transmitter swam as well as controls 21 days post-surgery, but significantly poorer than controls at 1 day post-surgery. Fish with either gastric or surgical implantations were eaten by smallmouth bass (*Micropterus dolomieui*) in significantly greater numbers than controls. In contrast, Brown et al. (1999) found that the swimming ability of juvenile rainbow trout (5-10 g; ~80-90 mm FL) was not decreased by the surgical implantation of a radio transmitter weighing 6-12% of the fish's weight in air. One major difference between these two studies was that transmitters tested by Brown et al. (1999) had the antennas trimmed to 2.5 cm, instead of being 2 to 3 times the length of the fish as Adams et al. (1998). The presence of an external antenna may create drag that would reduce swimming performance, or increase the incidence of predation by attracting predators or decreasing ability to avoid predators. Similar results to Brown have been reported by other researchers using acoustic transmitters which do not contain an external antenna. For example, Anglea et al. (in press) found that surgically implanted acoustic transmitters representing from 3.1 to 6.2% of the fish's body weight (in air) did not affect swimming performance of juvenile Chinook salmon (124-154 mm FL) 1 or 21 days post-surgery. Thus, it appears that swimming performance is affected more by the presence of a long antenna than by the mass created from the transmitter. We shortened the antennas on the transmitters placed in the sub-adult bull trout. Therefore, even though transmitters placed in some of the sub-adult bull trout weighed up to 5% of the fish's body weight, we do not

believe the burden imposed by the tag or the antenna posed a significant impact to their swimming performance.

Because our study covered the primary time in which sub-adult bull trout are known to migrate downstream in other systems (spring) but did not find any evidence of migration at that time, focusing future studies in the fall should be a priority. Bull trout from the East River may have adapted over time to make their initial migration to Pend Oreille Lake in the fall. The data presented in Chapter 1 of this report indicated that adult bull trout made post-spawning migrations back to Pend Oreille Lake in the fall, so fall migration has been documented in this stock of fish. Fall migration may be even more advantageous for first time migrants than post-spawning adults for several reasons. First, small juvenile migrants may be unable to stem the current of the Pend Oreille River during its spring freshet for a 38 km upstream migration to reach the lake. Second, water temperatures in the Pend Oreille River are presently too warm for them to survive if they were to attempt a summer migration. Third, the additional growing season in a cool tributary would allow them to put more energy into somatic cell growth, thereby increasing their fitness for upstream migration to (and survival in) Pend Oreille Lake.

Chapter 3 – Migration behavior of adult bull trout in the Pend Oreille River below Albeni Falls Dam, Idaho

Introduction

Historically, bull trout (*Salvelinus confluentus*) populations existed in tributaries above and below the current location of Albeni Falls Dam. Large bull trout (up to 12 kg) used the tributaries for spawning in late September and October (see review and references provided in USFWS 2002a). Although resident bull trout were likely present, the large size of the spawners would indicate these fish were migrating to a larger body of water to forage which would include either the Pend Oreille River (fluvial life history) or Lake Pend Oreille (adfluvial life history). The falls at the current site of Albeni Falls Dam was not a passage barrier. "*These falls are scarcely more than pretty steep rapids and would not interfere at all with the ascent of salmon,*" (Gilbert and Evermann 1895). Rathbun (1895) observed that trout (species not indicated) "*pass freely up the falls*". Gilbert and Evermann (1895) also reported that bull trout are "*abundant in the Pend Oreille River. At La Claires we saw in the possession of an Indian several fine specimens, the largest of which was 26 inches long, 11 inches in greatest circumference, and weighed 5 pounds and 1 ounce."* Jordan and Evermann (1908) identified the Box Canyon Reach as one of the nation's premiere bull trout waters: "*It has been our pleasure to fish for Dolly Varden trout* (i.e., bull trout) *in many different waters, among which we recall with particular satisfaction the Pend d'Oreille River from the Great Northern Railroad to the international boundary*." Gilbert and Evermann (1895) described the waters in this reach as, "*clear and pure and cold— an ideal trout stream*."

The construction of Albeni Falls and Box Canyon dams severely altered the Pend Oreille River. Box Canyon Dam, constructed in 1955 and owned and operated by Pend Oreille County Public Utility District Number 1, is located ~90 km downstream of Albeni Falls. Box Canyon Reservoir extends upstream to the base of Albeni Falls Dam. Neither Albeni Falls or Box Canyon dam were constructed with upstream fish passage facilities.

Box Canyon Dam converted the Pend Oreille River from a "*beautiful, clear stream, with a good strong current*" (Gilbert and Evermann 1895) to an impounded reservoir where temperatures can reach 25°C in the summer and dissolved gas can exceed Washington's total dissolved gas standard of 110% during certain times of the year (Stovall et al. 2001). Albeni Falls Dam blocked the adfluvial bull trout migration corridor from tributaries below Albeni Falls to the lake, and converted the old river channel between the dam and the outlet of the lake into a reservoir which does not stratify and offers little cool water refuge for bull trout during summer months (Bennett and DuPont 1993). Fluvial populations of bull trout that remained downstream of Albeni Falls Dam would have been limited by the warm water temperatures within Box Canyon Reservoir during the summer. Adfluvial populations (as well as fluvial populations entrained over Albeni Falls Dam) would have been blocked from returning to Lake Pend Oreille. These alterations in the physical environment of the Pend Oreille River have played a key role in the observed population declines of bull trout in the basin.

For example, in three years of sampling throughout Box Canyon Reservoir (1988-1990), only five bull trout were collected in a sample of 52,812 fish captured during 216 hours of electrofishing, 761 hours of 100 meter long research gill net sets, and 2.25 km of beach seine hauls using a 15 meter long bag seine (Ashe and Scholz 1992). In a concurrent study (1989-1990), only two bull trout were captured in a sample of 29,213 fish collected by electrofishing, gill netting and beach seining at randomly selected sites between Box Canyon and Albeni Falls dams (Bennett and Liter 1991). From August 1991 to July 1992, no bull trout were captured in a sample of 5,930 fish collected during 27 hours of electrofishing, 154 hours of gill net sets, and 1 km of beach seine hauls in Box Canyon Reservior between Dalkena, Washington and the confluence of Cee Cee Ah Creek on the Kalispel Indian Reservation (Skillingstad 1993).

The objective of this study was to conduct a focused search for bull trout in the tailrace of Albeni Falls Dam and, if some were found, examine them for PIT tags and other indicators of their origin above Albeni Falls Dam. A second objective was to implant them with radio transmitters to monitor their movement. This information would be useful to managers assessing the risk of bull trout being entrained from above Albeni

Falls Dam. Further, if bull trout located in the tailrace were tagged with a radio transmitter, information on their behavior would be available that could inform engineers in the design and construction fish passage facilities at Albeni Falls Dam.

Methods

Fish capture and tagging

A survey of the Pend Oreille River downstream of Albeni Falls Dam was completed on July 8 and 9, 2003. The primary purpose of this survey was to determine the relative abundance of bull trout below Albeni Falls Dam and ascertain if any of them bore marks indicating that they had originated above the dam. A total of 10 sites located between Indian Creek and the dam (Figure 3.1) were sampled using a Smith-Root 5.4 m electrofishing boat (150-200 volts, 2-4 amps, 120 pulsed DC). Sites 1-6 were between the dam and the highway 2 Bridge at Newport, Washington, while sites 7-10 were between the bridge and Indian Creek. All sites were sampled during the late afternoon on July 8, but only sites 1-6 were re-surveyed after dark the evening and early morning of July 8-9. At each site, a hand-held global positioning system (GPS) was used to record the start and end points of the electrofishing transect. Site 6 was electrofished for 5 min and all other sites for 10 min. All stunned fish were netted, identified, measured for length (TL $\pm$ 1 mm), and released. Bull trout were anesthetized (70-100 mg L^{-1} MS 222), weighed ($\pm$ 1 g), measured (TL $\pm$ 1 mm), and given a Destron-Fearing PIT tag (DF TX 1400BE, 12 mm long, 134.2 KHz) according to protocols in the *PIT Tag Marking Procedures Manual* (CBFWA 1999). A hole punch was used to remove a small piece of fin tissue for genetic analysis. Genetics samples were delivered to the Kalispel Tribe Department of Natural Resources, who are coordinating genetics work in the Pend Oreille Basin.

A second survey of the tailrace was completed on July 21 and 22, 2003. The primary purpose of this trip was to implant adult bull trout with radio transmitters in order to monitor their behavior. Additional data were also collected on relative abundance. Adult bull trout were captured using the same electrofishing boat and methods as previously described and also by snorkeling at night. During the snorkel surveys, block-nets were

used to concentrate fish, and snorkelers used hand-held nets to catch fish. Adult bull trout were placed in containers of water at the same temperature as their capture site. Following a similar procedure used on July 8-9 survey, bull trout were anesthetized, weighed, measured (FL $\pm$ 1 mm), given a PIT tag, and sampled for genetic analysis. A Lotek radio transmitter (MCFT 3EM, 8.9 g, 5 s pulse interval, 399 d tag life), bearing an ID label stating the tag belonged to Battelle Laboratories, Richland, Washington, was surgically implanted in adult bull trout > 500 g following the procedure described in Adams et al. (1998). The coded transmitters operated at a frequency of 148.520 MHz, which was the same frequency of transmitters used in the sub-adult study (Chapter 2).

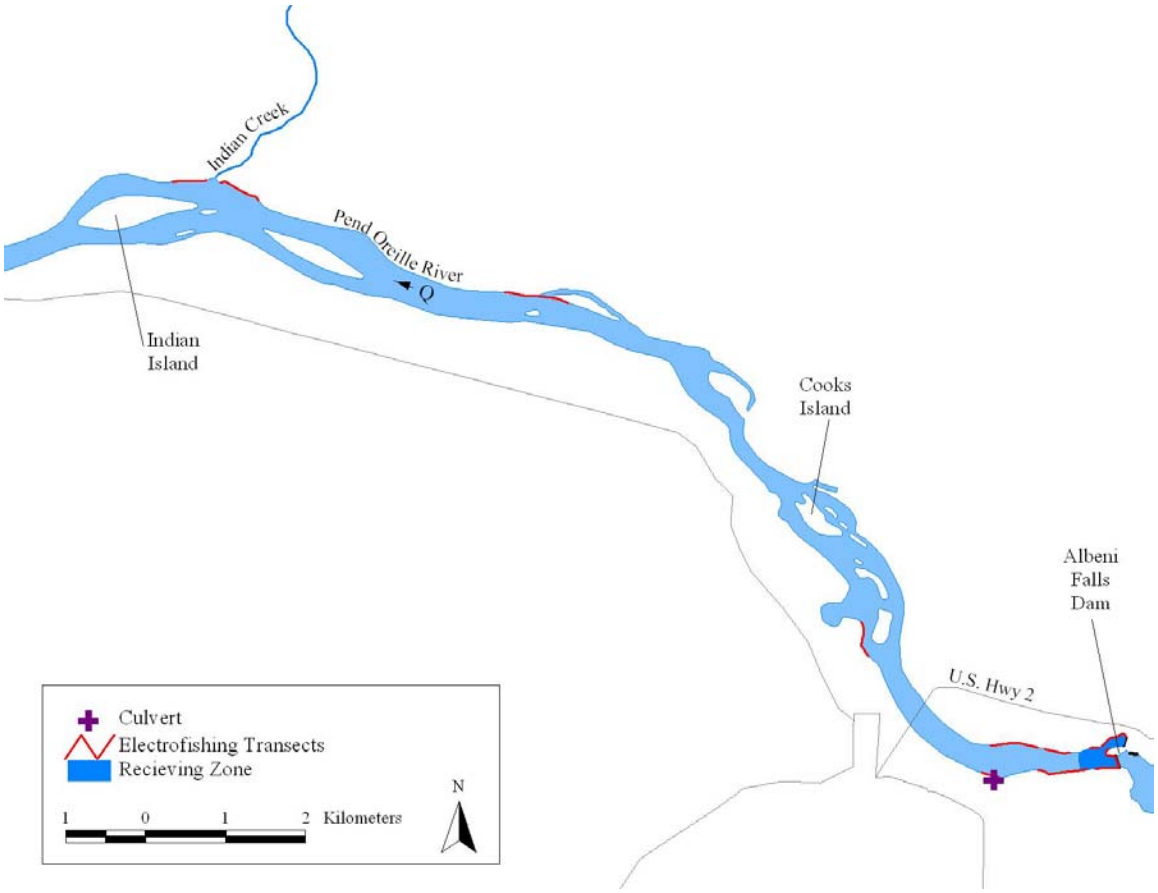

Figure 3.1. Bull Trout Sample Locations Downstream of Albeni Falls Dam.

A third survey was conducted on August 8, 2003. This survey targeted only bull trout for the purpose of implanting additional transmitters but none were caught.

Radio telemetry

Locations of radio-tagged fish were determined using mobile and fixed telemetry. Mobile surveys were conducted using SRX-400 radio receivers operated from fixed-wing aircraft, truck, boat, and by foot. An aerial survey was completed on September 12, 2003. A fixed-wing aircraft out of Felts Field, Spokane, Washington was contracted to conduct this survey. The flight was made along the Pend Oreille River from approximately Indian Creek upstream to Albeni Falls Dam. Multiple passes were made in order to reduce the chance that tags would be missed. Any fish detected during the survey was noted on a map, and if possible, an on-board GPS was used to record the latitude and longitude of the fish location, although the speed of the aircraft resulted in these positions being inaccurate representations of fish position.

A total of 10 mobile surveys were conducted by truck, walking, and boat between July 22 and September 19, 2003 (July 22, 25, 29; August 1, 3, 5, 10, 13-14; and September 19) using a Lotek SRX-400 radio receiver connected to a 4-element Yagi antenna. Boat surveys were done from below Indian Creek to the dam; trucks followed the highway on the northeast side of the river. Positions of logged fish were recorded using a GPS. Other notes were made regarding the general location and unique habitat features. Surveys were also conducted by walking along the river near the culvert at Site 6, carrying an SRX-400 receiver connected to a 3-element Yagi antenna. This method allowed us to better determine fish position and note specific habitat features.

Two fixed-telemetry receiving stations located at Albeni Falls Dam (see Chapter 1 of this report) were re-configured to receive signals from the tailrace. One receiver located on the tailrace spillway was connected to five antennas that pointed both upstream (into the forebay) and downstream into the tailrace (stations 1-2 in Figure 1.2). A second receiver, located at the end of the old log chute on the island (right bank) of the tailrace (station 4 in Figure 1.2), was connected to an antenna that pointed out into the tailrace of the powerhouse. Receiving stations that monitored the tailrace were tested for their ability to

receive and de-code an adult transmitter similar to those placed in the bull trout. A boat equipped with a GPS was driven along transects in the tailrace. A transmitter attached to a weight on a metered rope was lowered from the boat to a depth between 1 and 5 m below the water surface. The receiver was simultaneously operated to detect and decode the transmitter's signal. Signal strength and tag position (horizontal and vertical) were recorded, and later translated to a GIS map coverage. Based on these maps we concluded that the maximum distance from the dam at which one of the receivers could consistently decode (at power levels > 100) a tag at 1 m depth was approximately 550 m from the receiving station on the island, and approximately 360 m from the spillway.

Results

On July 8, 9, 21 and 22, a total of 505 fish were collected during 5.2 total hours of electrofishing (32 transects) during relative abundance surveys (Table 3.1; see appendix D for individual fish information), including six adult bull trout (Table 3.2). One of the bull trout was captured twice. The most numerous fish we encountered were northern pikeminnow (*Ptychocheillus oregonensis*) and largescale suckers (*Catostomus macrocheilus*; Table 3.1). Water temperatures at the sample sites ranged from 19.5 - 20.4°C on July 7-8 and 22.0-23.1°C on July 21-22.

Four different bull trout (one twice = total of five) were captured in the Pend Oreille River adjacent to a culvert located 1.56 km below Albeni Falls Dam on the left bank (48° 10' 36" N, 117° 1' 10" W; Figure 3.2). One bull trout was captured the afternoon of July 8, and then recaptured along with 3 more adult bull trout at the same location at 01:00 on July 9 (Table 3.2). The other bull trout was captured at the mouth of Indian Creek (Site 9; 48° 14' 36" N, 117° 9' 5" W) on July 21. Bull trout ranged in length from 435 to 722 mm (TL) and in weight from 676 to 2,945 g. None of the fish had any identifying marks (e.g., fin clips, PIT tags, etc.) and all appeared to be in relatively good condition. Relative abundance of bull trout during relative abundance surveys was 1.2 percent (6 fish in a total sample of 505). Catch-per-unit-effort (CPUE) in relative abundance surveys was 1.2 bull trout per hour.

Table 3.1. Electrofishing Catch, Relative Abundance Surveys, Albeni Falls Dam Tailrace, July 8-9 and July 21-22, 2003.

Species	Number (% of total catch)	Average TL, mm (range TL)
Northern pikeminnow *Ptychocheillus oregonensis*	114 (22.6%)	254.9 (77-543)
Largescale sucker *Catostomus macrocheilus*	79 (16.5%)	365.0 (30-540)
Yellow perch *Perca flavescens*	75 (14.9%)	151.5 (60-191)
Peamouth *Mylocheilus caurinus*	29 (5.7%)	238.9 (27-291)
Tench *Tinca tinca*	30 (5.9%)	317.8 (119-423)
Rainbow trout *Oncorhynchus mykiss*	21 (4.2%)	294.5 (173-502)
Largemouth bass *Micropterus salmoides*	17 (3.4%)	175.1 (81-353)
Mountain whitefish *Prosopium williamsoni*	41 (8.1%)	261.6 (84-479)
Pumpkinseed *Lepomis gibbosus*	31 (6.1%)	112.8 (72-137)
Longnose sucker *Catostomus catostomus*	25 (5.0%)	291.5 (160-443)
Brown trout *Salmo trutta*	18 (3.6%)	369.1 (221-526)
Smallmouth bass *Micropterus dolomieui*	9 (1.8%)	268.8 (143-457)
Kokanee *Oncorhynchus nerka*	5 (1.0%)	216.8 (204-229)
Bull trout *Salvelinus confluentus*	6 (1.2%)	546.5 (435-722)
Slimy sculpin *Cottus cognatus*	1 (0.3%)	77 (-)
Redside shiner *Richardsonius balteatus*	1 (0.3%)	114 (-)
Lake trout *Salvelinus namaycush*	1 (0.3%)	700 (-)

Figure 3.2. Culvert 1.56 km below Albeni Falls Dam (left bank).

Targeted surveys were completed near the culvert in an attempt to capture bull trout for radio telemetry investigations; note these data were not used in the relative abundance estimates reported above. Five new bull trout and one bull trout previously captured on July 9, 2003 were collected there on July 21, 22 at night. Four of these fish were captured by boat electrofishing and two using snorkeling and nets. These six fish plus the one caught at Indian Creek on July 21 were implanted with radio-transmitters and released at the culvert. The Indian Creek fish was released at the culvert (tagging location) because we did not believe it would survive the trip back to Indian Creek.

Table 3.2. Adult Bull Trout Captured in the Tailrace of Albeni Falls Dam, July, 2003. The complete PIT tag code for each fish can be determined by combining the 9 digits shown in parentheses of the column heading with the last 4 digits in the table (e.g., Fish #1 would be 3D9.1BF.198COEB).

Fish #	Capture date (recap date)	Fork length (mm)	Weight (g)	PIT Tag Code (3D9. 1BF.198)	Radio Tag Code (148.520 MHz)
1	7/8/03 (7/9/03)	567*	1540	COEB	-
2	7/9/03 (7/21/03)	440	719	BB52	97
3	7/9/03	435*	676	CEA9	-
4	7/9/03	528*	1217	CFB8	-
5	7/21/03	672	2945	D13F	93
6	7/21/03	405	719	B3F9	94
7	7/21/03	532	1471	CF46	96
8	7/22/03	570	1802	C29C	95
9	7/22/03	558	1716	C8F1	102
10	7/22/03	696	3363	E862	98

*Total lengths.

Bull trout implanted with transmitters ranged from 405 to 696 mm (FL), and weighed 719-3,363 g (Table 3.2). Except for Fish #5, which had a PIT tag we had placed in it on July 8, none of these fish had been previously marked. All seven were given a PIT tag (except for #5 which already had one) and a radio tag, and released.

Ambient water temperature of the Pend Oreille River at the time the fish were captured ranged from 19.5-20.4°C on July 8-9 and 22.0-23.1°C on July 21-22. On July 17, the ambient temperature of the river ranged from 21.7-22.0°C, compared to a temperature in the culvert of 11.8 °C (bottom) to 13.8°C (top) and a temperature in the river adjacent to the culvert of 18.0-19.0°C. The water in the culvert was about 0.7 meters deep on that date. On July 21-22 the temperature at the entrance of the culvert was 15°C and the temperature at the entrance of Indian Creek was about 21.1°C. A deep pool of cold water was present at the entrance of the culvert and many of the bull trout were lying in it. The connection between Indian Creek and the reservoir was a trickle and the channel depth was about 0.2 meters. By August 8, corresponding to a decline in surface elevation of Box Canyon Reservoir, the depth at the entrance of the culvert was reduced to about 0.3 meters and the channel at Indian Creek had virtually dried up. Later in August, the culvert area was inaccessible to bull trout.

Immediately after tagging and releasing the fish, we began monitoring their position. As of September 19, 2003, none of the seven radio-tagged fish were in the vicinity of their release site (Table 3.3; Figure 3.3). Four of the radio-tagged fish (RF codes 93, 95, 98, and 102) were known to be dead because the tags were retrieved. Three of the adult fish (RF codes 94, 96, and 97) were located in the same location on repeated surveys and it is unknown whether these fish are alive or dead. Most (6 of 7) fish were logged on at least one of the two receivers located in the tailrace of Albeni Falls Dam with signal strengths strong (>100) for five of the six fish, which suggested they moved within a few hundred meters of the dam. Below is a specific accounting of each fish's movements from the time it was tagged to its ultimate destination (see appendix E for additional information including maps of fish positions).

Table 3.3. Location of Last Detection and Status of Seven Radio-Tagged Bull Trout Monitored in the Tailrace of Albeni Falls Dam, 2003.

RF code	Location of last detection	Date last located	Status
93	½ mile below Indian Creek	8/14/2003	Dead – recovered tag and carcass
94	West of Cooks Island	9/19/2003	Unknown – position unchanged
95	Downstream of Cooks Island	8/4/2003	Dead – recovered tag
96	Between Albeni Falls Dam and Culvert	9/19/2003	Unknown – position unchanged
97	Indian Island	9/19/2003	Unknown – position unchanged
98	Culvert	8/4/2003	Dead – recovered tag and carcass
102	East side Cooks Island	8/14/2003	Dead – recovered tag and carcass

RF code 93 (Fish #5). This bull trout was captured July 21, 2003, at the mouth of Indian Creek by electrofishing. Water temperatures measured in creek about 100 meters above its confluence with the Pend Oreille River were typically about 18°C, or about 4-5°C lower than the main channel. This fish was transported upstream to the culvert where it was tagged. After surgery the fish was released in the river near the base of the culvert where water temperature was 15°C. During a walking survey of the culvert on July 22, it was determined to be approximately 100 m downstream of the culvert. On July 23, 2003, this fish was logged on the spillway receiver from 17:21 until 22:59 with signal strength readings ranging from 41 to 200. The strongest signals were logged around 17:30 and

22:51. This fish was never relocated by manual tracking until the transmitter was recovered on August 14, 2003, about a 0.8 km below the mouth of Indian Creek. A badly decomposed carcass was floating in a weed bed above the transmitter which may have been the tagged bull trout. The fish was too badly decomposed to determine the cause of death. There were also several other dead fish in the weed bed. The transmitter was located directly below the carcass in the same weed bed. The Teflon cover had been pulled almost completely off of the antenna, and because this is not something which is readily removable, it likely indicates human involvement either before or after the fish died.

RF code 94 (Fish #6). This bull trout was captured by snorkeling and netting in the culvert on July 21, 2003. On July 22, it was heard in the culvert but not de-coded. Fairly strong signals (47-175) from this transmitter were logged on the spillway receiver periodically between 11:00 and 23:59 on July 30; during this time it was also periodically logged on the receiver located on the north side of the tailrace between the powerhouse and the spillway. Early in the morning on July 31, strong signals (up to 193) from this fish were detected on this same receiver until around 05:00 when it left the detection area. Weak signals (36-85) were detected on the north shore receiver on August 2 from 03:00 to 09:00 and around midnight, and on August 3 from about 08:00 to 10:00. This was the last time it was logged on the dam receivers. On August 5, 13, and 14, and on September 12 and 19, 2003, the signal was detected from a 6 m deep pool on the west side of Cooks Island (48° 12’ 22” N, 117° 3’ 16” W) only a few hundred meters from where RF tag codes 102 and 95 were retrieved. It is not known for certain whether this fish is alive because neither the tag or the fish has been recovered. However, surface water temperatures at this location recorded in July and August were 24°C, leading one to speculate the fish would not be alive unless it was able to find refugia from these warm temperatures.

RF code 95 (Fish #8). This bull trout was captured by electrofishing July 22, 2003, just outside the culvert. A walking survey on July 22 found the fish just downstream of the culvert. The fish was heard from the receivers at Albeni Falls Dam from July 23 at 12:52 until July 24 at 12:43, with signal strengths ranging from 40 to 232 (maximum). Signal

strengths varied considerably during this period indicating it was moving. The transmitter could not be heard at the culvert during a mobile survey on July 25, 2003. Soon after on August 4, 2003, the transmitter was found a short distance downstream of Cooks Island (48º 12' 53" N, 117º 3' 54" W) where it was wedged under two rocks on the west side of the river several meters up the bank from the shore. It was obvious that someone placed the transmitter under these rocks.

RF code 96 (Fish #7). This bull trout was captured July 22, 2003, by electrofishing just outside the culvert . It was subsequently located inside the culvert on a mobile survey on July 22 and July 25. Shortly after this, the transmitter was logged on a receiver at the dam on July 27, 2003, from 18:38-18:42 and on July 29, 2003, from 14:14-14:59. Signal strength was low (maximum of 76) during both of these days. Between August 3 and August 20, 2003, this fish was intermittently logged every day on the receivers at the dam, with most of the signal strengths low (<100) but occasionally reaching a maximum of 145. During this same time period, mobile surveys by boat and on foot (August 4, 5, 10, and 13, and September 12 and 19, 2003) determined the tag was in the middle of the Pend Oreille River between the dam and the culvert in an area of abundant logs and debris (48º 10' 45.8" N, 117º 0' 44.3" W). This location was downstream ~1 km from the dam. We were unable to determine whether this fish is alive or dead.

RF code 97 (Fish #2). This bull trout was captured on July 21, 2003 by snorkeling and netting in the culvert. It was relocated inside the culvert July 22, July 29, August 1, 3, 10, 13 and 19, 2003; the fish was observed by snorkelers on August 3 and 13 when it appeared to be healthy. The fish was logged by the receivers on the dam August 20, 2003, from 13:58 until 20:01, where fairly strong signals (up to 186) were received. Subsequent surveys of the culvert on August 25 and September 5, 2003, did not find the fish. During an aerial survey on September 12, 2003, and then again during a boat survey September 19, 2003, the signal was last located in the vicinity of Indian Island (48º 13' 43.9" N, 117º 6' 47.6" W) which is approximately 16 km downstream from the culvert. The trackers determined the transmitter was located near some pilings along the shore, but were unable to see or retrieve it. It is not known for certain if this fish was alive or dead.

RF code 98 (Fish #10). This bull trout was captured by electrofishing at the culvert on July 22, 2003. This fish did not recover well from the capture and handling, reacting badly to the electrofishing. It was the largest fish we handled. Since the amount of current absorbed by a fish is proportional to body size (Reynolds 1996), it is possible that the fish was damaged by electrofishing operations. Voltage and current output of the electrofishing boat were adjusted to the lowest possible levels that could still attract fish, but because these bull trout were in a shallow lens of cold water, it is possible they could absorb a sufficient amount of current to cause damage, especially individuals with a large surface area for absorption of current. The fish did recover from anesthesia and was swimming upright in the recovery live well before it was released, but appeared lethargic. This fish was never logged on the receivers at the dam. The tag and a partially eaten carcass were recovered August 4, 2003, in the south (upstream) end of the culvert. The tag was about 15 m away from the carcass and appeared to have been bitten by an animal. It is uncertain if the difficult recovery from capture and handling was a factor in the death of this fish either by directly causing the death or possibly indirectly contributing to its demise by reducing its fitness in escaping predators. The water in the culvert was approximately 0.7 meters deep at its deepest point and became shallower as the water level dropped in Box Canyon Reservoir. This may make these fish fairly accessible to predators.

RF code 102 (Fish #9). This bull trout was captured by electrofishing just outside the culvert on July 22, 2003. It was relocated near the culvert July 22, July 25, July 29, August 1, August 3, and August 4, 2003; on August 3 it was observed by a snorkeler and the fish looked healthy. This fish made several forays out of the culvert into the river as evident from its being logged on the receivers on the dam on July 22, 23-24, and July 29, 2003; the strength of the signals was strongest (43-211) on July 23 at 18:00. This fish was not located in the culvert during tracking on August 10, 2003. On August 14, 2003, the fish and tag were recovered on the east side of Cooks Island about 50 m from the island in the middle of a weed bed in water that was about 1.5 m deep. The fish appeared to have been gutted. It had cut marks on one side and it also had a series of bite marks, possibly from a dog.

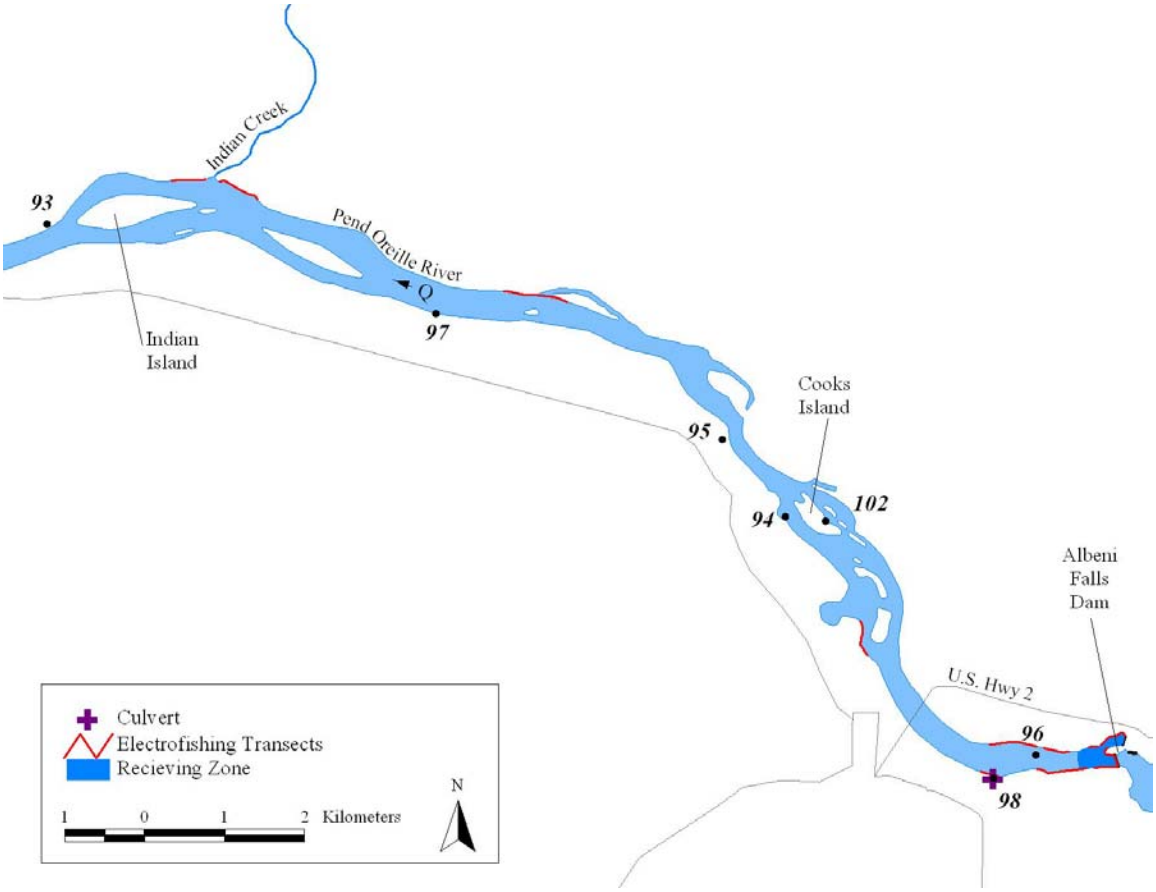

Figure 3.3. Last Known Location of Seven Adult Bull Trout Monitored Below Albeni Falls Dam, 2003

Discussion

Ten adult bull trout were captured during July, 2003, within Box Canyon Reservoir immediately downstream of Albeni Falls Dam. Nine of the ten bull trout were captured within a very small area near (or inside) a culvert located 1.5 km downstream from the dam on the left bank. The tenth was captured at the mouth of Indian Creek. In addition to the ten that were captured, two or three other large salmonids that were likely bull trout were observed but not caught. Further, other salmonids that are typical of cold-water habitat (e.g., Lake Pend Oreille) were found near the culvert, including lake trout, rainbow trout, and kokanee (*O. nerka*).

Bull trout and other salmonids still existed in the Pend Oreille River below Albeni Falls after the dam was built (USFWS 2002b). "*In the early 1950s, during spawning seasons, heavy concentrations of whitefish and Dolly Varden [bull trout] could be found at the mouth of Le Clerc Creek .... Large five to ten pound Dolly Varden could be caught in the Pend Oreille River at Charr Springs and around Indian Creek ...*" (USFWS 2002b, p. 9). As recently as 1957 "*many large Dolly Varden (i.e., bull trout)*" were caught in sport fisheries within Box Canyon Reservoir (reviewed in Ashe and Scholz 1992). Bull trout are currently harvested from the Pend Oreille River near the Mill by Newport on the Highway 2 side (personal communication between Tom Shuhda, USFS, and Mr. Joel Tolbert, local resident as summarized in an email to Geist from Shuhda on July 3, 2003). During the course of our study, area residents remarked to us about the harvest of bull trout in the tailrace of Albeni Falls Dam. As evidence of this, one of the fish we captured had a hook in its stomach and fishing pressure in the vicinity of the culvert may be high based on a well worn trail leading to it from the road.

That so many adult bull trout were located within the tailrace of Albeni Falls Dam (i.e., Box Canyon Reservoir) in this study was surprising. As reviewed in the Biological Opinion (USFWS 2000), bull trout populations downstream of Albeni Falls Dam are depressed to the point where individual sightings are noteworthy. A three-year study, employing a combination of electrofishing, gill netting and beach seining from 1988 through 1990, found a total of 4 adults and 1 juvenile bull trout in the 88 km long Box Canyon Reservoir (Ashe and Scholz 1992). *"Bull trout, rainbow trout and cutthroat trout captures were so infrequent during the three year study period that the relative abundance of all three species added together didn't even compose a tenth of a percent of the total abundance of fish species in the reservoir."* (Ashe and Scholz 1992). In 1989 and 1990, only 2 bull trout were captured during electrofishing and gill netting at randomly selected sites in the reservoir (Bennett and Liter 1991). In 1991 and 1992, Skillingstad (1993) sampled the area from Dalkena to Cee Cee Ah Creek and collected no bull trout. Collectively, these various surveys sampled an aggregate total of 87,955 fish, yielding a total of just 7 bull trout.

Only one bull trout was captured in five tributaries to Box Canyon Reservoir, and no reproducing populations of bull trout were found (Ashe and Scholz 1992). Within the Pend Oreille Core Area (Pend Oreille River from Canadian border to Albeni Falls Dam; see USFWS 2002b), individual sightings of bull trout have occurred in LeClerc Creek, Mill Creek, Cedar Creek, Indian Creek, Sullivan Creek, Sweet Creek, Marshall Creek, and Slate Creek (USFWS 2002b), but there are no known healthy populations of bull trout in any of these tributaries.

The study most comparable to ours was the electrofishing surveys conducted by Ashe and Scholz (1992) between 1988 and 1990. Their surveys employed the same boat and 10 minute electrofishing transect method used in the present study, but they sampled sites throughout Box Canyon Reservoir whereas we sampled sites only at the upstream end of the reservoir below Albeni Falls Dam. Ashe and Scholz (1992) captured 4 bull trout in a sample of 47,715 fish during 216.6 hours of electrofishing effort. The relative abundance of bull trout was 0.008 percent and the catch-per-unit-effort (CPUE) was 0.02 bull trout per hour. In contrast, we captured 6 bull trout in a sample of 505 total fish with 5.2 hours of electrofishing effort during relative abundance surveys. Relative abundance of bull trout was 1.2 percent and CPUE was 1.2 bull trout per hour. Additionally, we caught 6 bull trout in targeted surveys. Overall, we captured 10 different bull trout, two of which were recaptured. Thus, bull trout appear to be concentrated in the vicinity of the Albeni Falls Dam tailrace.

Although none of the adult bull trout bore marks (e.g., fin clips, PIT tags, radio transmitters) from upstream sites, it was nevertheless apparent that they most likely originated from above the dam. If the fish were fluvial or adfluvial bull trout that spawned in tributaries of the Pend Oreille River below Albeni Falls Dam, then it is highly probable that they would have sought thermal refugia in home spawning tributaries, similar to the behavior described for the Priest River adults (see Chapter 1 of this report). Concurrent catches of lake trout and kokanee in the same location as the bull trout also support our assumption that bull trout were entrained over the dam. Whether they originated from the Priest River drainage or from the lake is not known; perhaps genetic analyses being conducted by the Kalispel Tribe will shed some light on this. Clearly this

has implications because if these were bull trout overshooting the Priest River, they represent a notable proportion of the estimated escapement to that drainage (30-40 in the Middle Fork East River in 2002 and 53-77 in 2003; DuPont and Horner, in press). Thus, even though the number of bull trout we captured in the tailrace was not large in absolute numbers, relative to the low populations in the Pend Oreille River, the numbers were substantial.

Bull trout and other cold-water salmonids are able to inhabit the very warm Pend Oreille River below Albeni Falls Dam by utilizing cold water refugia like those provided in the culvert and in Indian Creek. Water temperatures at both these locations were up to 6°C cooler than the main river during our surveys. There was abundant prey in the vicinity of the culvert which adult bull trout may have been utilizing. With the exception of one fish with a blind eye, most of the fish we observed were noted to be in good condition, with condition factors (Le Cren 1951) ranging from 0.89 to 1.2.

Six of the 7 adult bull trout moved upstream toward Albeni Falls Dam after being implanted with a radio transmitter, usually within 1 day (range 1 to 6 days) of it last being detected at the release site. Although we did not monitor fish continuously from the time they were released, the observations suggest the initial movement of each fish was upstream toward the dam, rather than downstream away from the dam. This initial movement usually occurred within a few days of tagging, but at least one fish (97) stayed at the release site for 27 days before moving upstream. After reaching the dam, all fish were detected on the receivers for more than 2 hours and usually up to three days. We did not conduct fine-scale tracking of fish position within the immediate tailrace of the dam and our fixed receiving systems were designed to detect presence/absence. Thus, we have no information on specific locations bull trout used while they were near the dam.

We used signal strength recorded by the radio receivers to determine fish position relative to the dam. The testing of the receiving arrays showed that if signal strengths were consistently above 100, the test tag was within a few hundred meters of the dam. Using the criteria generated from the tests we conducted of the fixed-station receiving stations, at least five of the six fish came within a few hundred meters of the dam. Only one fish

(RF code 96) was received by the dam's receiving station at the same time it was detected during mobile surveys greater than 500 m from the dam. Although this fish's signals were received by the receiving stations at the dam, the majority of the signals were weak in strength (< 100). However, there were occasionally signals from this fish recorded by the receivers at the dam that were above 100, and yet subsequent mobile surveys suggested the fish was not within a few hundred meters of the dam. It is possible this fish was periodically moving toward the dam and then back to a holding area where the mobile surveys detected it. Conversely, the receiving zone of the dam's receivers may have been slightly larger than the tests showed. This isn't surprising – signal strength is a not a conclusive predictor of transmitter position because it can be affected by many factors other than distance to an antenna (e.g., water depth, electrical conductance of the water, antenna configuration, noise, and the position of the transmitter relative to the fish's body). However, we are confident that a tagged fish in front of or within the culvert would not have been decoded by the receiving system at the dam at a power level >100. As such, we are also confident in our conclusion about the preponderance of upstream movement exhibited by tagged bull trout.

Of the seven fish that were tagged, four are confirmed dead and the status of three is unknown. One of the four deaths was likely due to our handling. Water temperature of the Pend Oreille River at the time we captured and tagged all the fish was 19-23°C. We attempted to control impacts to the fish using ice baths and minimizing handling time, however, this fish did not recover well from the electrofishing. Alternative capture methods to electrofishing may be worth investigating.

We do not know what caused the confirmed deaths of the other three bull trout. Their mortality cannot be explained by handling alone as some of the fish made substantial migrations following tagging. That the fish made upstream movements toward the dam, and then were found downstream of the dam, leads us to believe these fish recovered from the surgeries and suffered mortality from some other factor.

Another possibility is that some of these fish were taken by poachers at the culvert and moved downstream. Two of the transmitters apparently had been tampered with (wedged

under rocks or Teflon pulled off antenna wire), while the third had bite marks on it resembling those of a dog. Whether these events occurred after the fish died or were a cause of the mortality is unknown.

Mortality of these three fish was also possibly related to the loss of cold water habitat (e.g., culvert and Indian Creek). Conditions near the culvert and Indian Creek deteriorated over the course of the summer, related to the lowering of the surface elevation of Box Canyon Reservoir. By the middle of August, water levels within the culvert were significantly lower and access to and from the culvert was restricted. Extensive macrophytes had collected in front of both areas and a biofilm was noted on the rocks and plants, suggesting decomposition of organic matter may be creating anoxic conditions. Electrofishing efforts did not reveal more bull trout and movements of tagged trout away from the culvert occurred at this time. The energetic cost to leave areas of thermal refugia to find forage in the main channel of the Pend Oreille River during warm summer months would appear to be significant and fish may have to continuously feed to maintain body weight. The stress of trying to live in warm water may have contributed to their deaths.

The three bull trout that are unknown to be dead or alive were last detected in the Pend Oreille River from the dam downstream to Indian Island. The fact that they did not appear to change position from about mid-August to mid-September indicates, perhaps, that they are dead. While we cannot conclusively prove the stress of capturing and tagging did not contribute to their behavior, their movements toward the dam after exiting the culvert suggested that they had recovered from capture and handling. In fact, the fish that stayed in the culvert for 27 days (and was last located near Indian Island) was observed to be in good condition by snorkelers just before it exited the culvert. All of these fish exited the culvert as access to it was becoming restricted.

Collectively, it seems probable that the bull trout we captured in the tailrace originated from upstream of Albeni Falls Dam. It is possible that some of them were adults that were entrained as they made their way out of Lake Pend Oreille in search of spawning streams during high flow events in the spring. Although our radio telemetry study of

Priest River adult bull trout did not show fish moving downstream of the Priest River (Chapter 1 of this report), we did not have a large sample size upon which to draw conclusions. It is also possible that some of the adult bull trout we observed below the dam were entrained as sub-adults, persisted below the dam until adulthood, and were trying to return to natal streams above the dam. In either case, the upstream movements of radio-tagged bull trout from the culvert to the tailrace is consistent with the hypothesis that these fish originated upstream of Albeni Falls Dam.

Recommendations

The findings of this study should be of interest to managers attempting to mitigate impacts from Albeni Falls dam on bull trout in the Pend Oreille system. The results suggest that bull trout in tributaries to the Pend Oreille River exhibit an adfluvial life history. The adfluvial migration of bull trout between tributaries and Lake Pend Oreille makes them susceptible to entrainment at Albeni Falls Dam. The dam then acts as an upstream migration barrier because it lacks passage facilities. At the present time, this appears to be the main effect of the dam because any adfluvial bull trout populations that formerly spawned in tributaries below the dam are now functionally extirpated. However, if an attempt is made to restore adfluvial bull trout in tributaries of the Pend Oreille River below the dam, then upstream passage to Lake Pend Oreille will be necessary.

Although our study suggested bull trout that probably originated above the dam are concentrated below it, the overall number of bull trout that we collected below the dam was not large in absolute numbers (only 10 fish with two recaptures). Also, radio telemetry studies revealed that adfluvial adult bull trout from the Priest River precisely relocated the Priest River and home spawning tributary during their spawning migration, and were not detected in the forebay of Albeni Falls Dam, which suggests that entrainment losses owing to overshooting the home river during the downstream migration from Lake Pend Oreille may be minimal. However, these conclusions are preliminary because of the low numbers of adult fish tracked (6 fish tracked, of which only 3 returned to the Priest River). Additionally, since none of the radio-tagged sub-adult fish from the Priest River were migratory during the period we monitored them, the interaction of first time sub-adult adfluvial migrants with the dam still needs to be determined. The potential for entrainment may be greater for first time migrants than for returning adults, both when they first drop out of the Priest River and the first time they return to it during a spawning migration. Clearly this has implications because if bull trout are being entrained over Albeni Falls Dam, this represents a notable impact to the Priest River population.

Based upon the results of this study, we make the following recommendations (based on the following rationale):

1. Monitor the sub-adult population in the Priest River to determine when these fish enter the Pend Oreille River and Lake Pend Oreille, and if they become entrained at Albeni Falls Dam either during their first downstream migration out of the Priest River or first spawning migration as adults into the Priest River. This objective in the present study remained unaccomplished because none of the sub-adult fish we captured were in a migratory state. Recent studies conducted by the U.S. Fish and Wildlife Service in cooperation with the Idaho Department of Fish and Game determined that the East River stock was composed entirely of the migratory life history form. Since first time migrants may be more prone to entrainment than post-spawning adults, the study we attempted in 2003 should be repeated at a time that may be more biologically appropriate to detect and characterize the first time emigration of these fish. Since East River sub-adults were not in a migratory state from mid-April to mid-August, we suggest that in future sub-adult migration studies, priority should be given to capturing fish in the fall. As described in Chapter 1, it is already known that post-spawning adults from the East River migrate back to Pend Oreille Lake in the fall. East River sub-adult bull trout may have adapted to a fall migration schedule for several reasons. First, the spring discharge of the Pend Oreille River may be too high for them to successfully migrate 38 km upstream to Lake Pend Oreille. Second, water temperatures of the Pend Oreille River are too warm for them to survive if migration was attempted in summer. Third, by delaying their departure until fall, energy stores accumulated during the summer growing season would increase their fitness for upstream migration to (and over-winter survival in) the lake. While fall migration studies should receive priority, we recommend that spring migration studies be repeated to confirm initial results since it is more typical for adfluvial bull trout sub-adults to emigrate in the spring.

2. Capture bull trout in the tailrace of Albeni Falls Dam, move them above the dam and monitor their movement. Historical records indicate bull trout migrated from below Albeni Falls upstream to Lake Pend Oreille. Presumably the lake afforded refuge to immature adults (i.e., fish that have not yet made a spawning migration) from relatively higher temperatures present in the Pend Oreille River during the summer and provided them with abundant forage. Although our initial results suggest that bull trout found below the dam attempted to move upstream to the lake (or possibly a cold water refuge in a home spawning tributary), a more direct way to test the hypothesis that the dam is impeding their upstream movements to the lake (or a home tributary) would be to move them from below the dam, place them above it and track their movements. This study should be conducted at a biologically appropriate time when both the fish's physiological state and the river environment are suited to migration. Sexually mature adult bull trout in the Pend Oreille Basin migrate to and enter spawning streams in May and June, so this would be one appropriate time that such a study should be conducted. The purpose of a study at this time would be to identify the spawning tributaries selected by the displaced fish. Biopsy samples collected from the transmitter-implanted fish could be compared to biopsy samples collected from bull trout in the tributaries that these fish enter to assess genetic similarity. Post-spawning adult bull trout and, possibly, first-time sub-adult migrants in the Pend Oreille Basin migrate to Pend Oreille Lake in October to mid-December, so this would be a second biologically appropriate time to collect fish below the dam and displace them above it. The purpose of a study conducted at this time would be to determine if the displaced fish migrate to Lake Pend Oreille.

3. Make detailed investigations (continuous tracking) of fish behavior below the dam to inform fish passage engineers about requirements for designing fishway entrances. The present study documented that bull trout in the tailrace frequently interacted with the dam but did not identify specific

migration routes, which would be important to know about when designing effective entrances to fish ladders or trap-and-haul facilities at the dam. These studies should be conducted at biologically appropriate times associated with migration of adult fish to home tributaries or adfluvial migration of post-spawning adults (and first time sub-adult migrants) to Pend Oreille Lake as described in recommendation # 2. In the Pend Oreille Basin, these events occur respectively from May to mid-June and October to mid-December. Conducting studies at these times would also reduce stress associated with capture and handling bull trout in warm water that we observed in the present study.

4. Investigate the potential of using the culvert for a trap-and-haul facility on an interim basis until a more permanent solution to fish passage at the dam can be developed. Our investigation demonstrated that the culvert with spring fed water on the left bank of the river below the dam was highly attractive to bull trout by acting as a cold water refuge for them.

   Even though the number of adult bull trout we captured in the tailrace (n = 10) was not large in absolute numbers, the number was substantial relative to the low populations in Pend Oreille River tributaries. For example, in the tributary closest to the dam that has known migratory bull trout populations, the East River spawning escapement was estimated at 30-40 adults in 2002 and 53-77 adults in 2003. If the fish we observed below the dam in 2003 were from the East River, their loss represented 11-16 percent of the spawning population. A reduction in spawning population of this magnitude would cause a substantial loss of genetic variation in an already depressed population. This amounts to an incidental take of fish from the spawning population by entrainment at Albeni Falls Dam.

   In sections 10.A.13 and 11.A.13 of the December 2000 Biological Opinion, the U. S. Fish and Wildlife Service identified that the U.S. Army Corps of Engineers shall evaluate the feasibility of re-establishing two-way fish

passage of adult and sub-adult bull trout at Albeni Falls Dam. If warranted by the results of these studies, the Corps was directed to make structural modifications at the dam to allow two-way fish passage and guide downstream migrating bull trout away from turbines into a bypass system. These measures are intended to reduce incidental take by the dam.

While the Corps, U.S. Fish and Wildlife Service and other agencies consult on the type, design and timeline for implementation of long-term fish passage and guidance at the dam, we suggest experimenting with trap/capture-and-haul fish passage at the culvert to evaluate its practicability and protect against further erosion of genetic variation.

We recognize that a trap/capture-and-haul facility remote from the dam will not meet the letter of the Biological Opinion because it will pass fish in one direction only and does not address issues related to guidance of downstream migrating bull trout away from turbines. Additionally, it is unclear if bull trout will be attracted to the culvert site in the May-June and October-December periods when bull trout are migrating and the temperature of the Pend Oreille River is cooler. This is an important point because, for a trap/capture-and-haul facility to be useful in helping to recover bull trout, fish will need to be collected and transported above the dam at biologically appropriate time when the fish are physiologically in a migratory state and the Pend Oreille River is sufficiently cool to permit migration.

However, it will likely take considerable time (possibly several years) to discuss, design and make permanent structural modifications at the dam. During this time there will be a continuing loss of genetic variation if entrained fish are unable to spawn. In contrast, an interim trap/capture-and-haul facility could probably be implemented rather quickly and potentially help to reduce the loss of genetic variation.

Further, we suggest that fish collected at the proposed facility in May to mid-June or October to mid-December could be used as a source of fish for the

telemetry investigations described in recommendations # 2 and # 3 (above). Sexually mature fish collected at the proposed facility during the summer (July to mid-August) could be used as a source for attempting to re-establish bull trout in a tributary of the Pend Oreille River below the dam as described in recommendation # 5 (below). We believe this would be an appropriate use for fish collected there in the summer because they will likely die without spawning when they are forced into the warm water of the Pend Oreille River as their access to the culvert becomes restricted. It would also not be realistic to move them into the Pend Oreille River above the dam at this time because the elevated temperatures would likely kill them. Using these fish as a source for seeding a tributary below Albeni Falls Dam would also prevent "mining" of bull trout from tributaries in Idaho, where populations are depressed, for this purpose.

5. The U.S. Fish and Wildlife Service and/or Idaho Department of Fish and Game and Washington Department of Fish and Wildlife should conduct surveillance of the culvert and other areas downstream of Albeni Falls Dam to determine if poaching is occurring. Two of the four dead bull trout in this study appeared to be handled by humans because the transmitter was found off of the fish, either buried under a rock or badly damaged. Although we are uncertain if this interaction occurred before or after the fish died, it seems logical that hiding a transmitter is more consistent with the behavior of a poacher than someone finding a dead fish. In the latter case, it seems more likely that the finder would have reported the event to fish and wildlife authorities. Although the transmitters were clearly marked with Battelle, subsequent radio telemetry studies should use radio transmitters that are clearly marked with the name of the research group and a contact address or phone number where the transmitter should be returned; a reward system should also be considered to encourage recovery of the transmitters. As a corollary, creel surveys should be accomplished in this area from mid-April to mid-June to determine if juvenile downstream migrating bull trout are being

caught below the dam. We received numerous reports from various sources that juvenile bull trout were caught below the dam at that time but were unable to confirm them because a creel survey was beyond the scope of the present study.

6. Attempt to re-establish adfluvial bull trout in a Washington tributary of the Pend Oreille River. At present, Washington tributaries of the Pend Oreille River are depauperate of bull trout. Confirmation that bull trout from the Priest River drainage make adfluvial migrations into Lake Pend Oreille indicates that it may be feasible to use a population with a similar life history in an attempt to recover bull trout in Washington tributaries.

7. Maintain water elevations in the Pend Oreille River to achieve a minimum water depth in the culvert so it will remain accessible to bull trout during August and September. The culvert area appears to be critical habitat for bull trout below Albeni Falls Dam. In our tracking investigation, bull trout survived as long as this habitat was available to them for a thermal refuge but mortality ensued as they were forced out of it by receding water surface elevations in Box Canyon Reservoir in August. Operations at both Albeni Falls and Box Canyon dams should be evaluated to determine if it is feasible to maintain continuous access of bull trout to this habitat.

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