Evaluation of Bull Trout Movements in the Tucannon and Lower Snake Rivers

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Abstract

The Columbia River Distinct Population Segment of bull trout (*Salvelinus confluentus*) was listed as threatened under the Endangered Species Act in 1998. One of the identified major threats to the species is fragmentation resulting from dams on over-wintering habitats of migratory subpopulations. A migratory subgroup in the Tucannon River appeared to utilize the Snake River reservoirs for adult rearing on a seasonal basis. As a result, a radio telemetry study was conducted on this subgroup from 2002 – 2006, to help meet Reasonable and Prudent Measures, and Conservation Recommendations associated with the lower Snake River dams in the FCRPS Biological Opinion, and to increase understanding of bull trout movements within the Tucannon River drainage.

We sampled 1,109 bull trout in the Tucannon River; 124 of these were surgically implanted with radio tags and PIT tagged, and 681 were only PIT tagged. The remaining 304 fish were either recaptures, or released unmarked. Bull trout seasonal movements within the Tucannon River were similar to those described for other migratory bull trout populations. Bull trout migrated upstream in spring and early summer to the spawning areas in upper portions of the Tucannon River watershed. They quickly moved off the spawning areas in the fall, and either held or continued a slower migration downstream through the winter until early the following spring. During late fall and winter, bull trout were distributed in the lower half of the Tucannon River basin, down to and including the mainstem Snake River below Little Goose Dam.

We were unable to adequately radio track bull trout in the Snake River and evaluate their movements or interactions with the federal hydroelectric dams for the following reasons: 1) none of our radio-tagged fish were detected attempting to pass a Snake River dam, 2) our radio tags had poor transmission capability at depths greater than 12.2 m, and 3) the sample size of fish that actually entered the Snake River was small (n=6). In spite of this project's shortcomings, bull trout continue to be observed in low numbers at Snake River dam fish facilities. It is highly possible that bull trout observed at the Snake River dam fish facilities are originating from sources other than the Tucannon River. We suggest that these fish might come from upstream sources like the Clearwater or Salmon rivers in Idaho, and are simply following the outmigration of juvenile anadromous fish (a food supply) as they emigrate toward the Pacific Ocean.

Based on our study results, we recommend abandoning radio telemetry as a tool to monitor bull trout movements in the mainstem Snake River. We do recommend continuing PIT tagging and tag interrogation activities to help determine the origin of bull trout using the Snake River hydropower facilities. As a complementary approach, we also suggest the use of genetic assignment tests to help determine the origin of these fish. Lastly, several recommendations are included in the report to help manage and recover bull trout in the Tucannon subbasin.

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Introduction

The Endangered Species Act (ESA) listing of the Columbia River Distinct Population Segment of bull trout (*Salvelinus confluentus*) as threatened, identified one of the major threats to the species as fragmentation resulting from dams on over-wintering habitats of migratory subpopulations (Federal Register, 1998). At the time of listing, it appeared that a migratory subgroup in the Tucannon River may have utilized the mainstem Snake River for adult rearing on a seasonal basis (Underwood et al., 1995). The occurrence of bull trout in the hydropower system had been verified by a few incidental observations during sampling in Lower Monumental Pool (Buchanan et al. 1997 citing Ward), and in the adult passage facilities at Lower Monumental and Little Goose dams in the early 1990s (Kleist, in litt. 1993). Prior to 2001, documentation of fish movement past the adult fish counting windows at Lower Monumental Dam and Little Goose Dam occurred during spring, summer, and fall, but was suspended during winter months (November through March). The Federal Columbia River Power System (FCRPS) Biological Opinion (USFWS 2000) required the U. S. Army Corps of Engineers (USACE) to provide data detailing the movement of bull trout past the adult fish counting stations at Lower Monumental and Little Goose dams. This requirement prompted USACE to extend the collection of adult fish passage data into the winter months (i.e., November through March).

Time-lapse video counting did not document the presence of bull trout at Lower Monumental and Little Goose dams during the winter of 2003/2004 (Richards, pers. comm., 2004). However, bull trout have been observed at the fish viewing windows during spring and summer at both hydroelectric facilities since records were kept in 2001 (Anglea, et. al., 2004). Additionally, bull trout have been found in the adult/juvenile separator at the juvenile fish facility at Little Goose Dam in 2004 and 2005, and bull trout have also been caught incidentally during spring Chinook salmon recreational fisheries in the tailrace of Little Goose Dam (WDFW files). The origin of these fish is unclear.

Prior to our study, it remained unconfirmed if bull trout from the Tucannon River frequently utilize the mainstem Snake River for rearing and foraging (Underwood et al. 1995) as observed in large rivers for other Columbia Basin subpopulations (Elle 1995; Faler and Bair 1992; Kelly Ringell and DeLaVergne 2000 and 2001; Schriever and Schiff; 2003; Theisfeld et al. 1996;). This study has shown that some bull trout originating from the Tucannon River do indeed migrate into the mainstem Snake River, but it remains unknown if they attempt to pass the existing hydroelectric dams on a regular basis, or if the fishways are suitable for bull trout passage.

The potential for bull trout movements throughout the mainstem Snake River is high, but from the standpoint of future delisting and requirements set forth in the FCRPS Biological Opinion (USFWS 2000), the determination of temporal and spatial distribution in the mainstem is crucial in developing recovery actions, estimating “take”, and successful consultation on system improvement actions. This project was designed to help meet Reasonable and Prudent Measures, and Conservation Recommendations

associated with the lower Snake River dams in the FCRPS Biological Opinion, and to increase understanding of bull trout movements within the Tucannon River drainage.

Rieman and McIntyre (1993) describe unimpeded migratory corridors as important habitats to the persistence and interaction of local populations. They also indicate that disruption and/or modification of migratory corridors can increase stress, reduce growth and survival, and potentially result in the loss of migratory life-history types in a subpopulation. With these factors in mind, the primary question to be answered is: Does the existing hydropower system on the lower Snake River limit the capabilities of Tucannon River bull trout to complete their migratory behavior, or are the current hydropower operations compatible with recovery and conservation of the species? The secondary goal of the project is to examine the movements and spatial/temporal distribution of migratory bull trout within the Tucannon River and to determine the proportion of migratory fish that leave the Tucannon River to over-winter in the Snake River. The bull trout stock status in the Tucannon River was considered healthy by the Washington Department of Fish and Wildlife (WDFW 1998), but little was known about their migrations in the Tucannon and Snake river subbasins prior to this study. It should be noted that since 2004, a dramatic decline in adult bull trout has been observed at the Tucannon Hatchery weir. Martin et al. (1992) and Underwood et al. (1995) studied the interactions of bull trout, steelhead (*Onchorynchus mykiss*), and Chinook salmon (*Onchorynchus tshawytscha*) in the Tucannon River during the early 1990's. As part of this larger study, 16 bull trout were radio-tagged and tracked from July through November 1992. The authors indicated that two fish may have entered the mainstem Snake River by the last week of October, but they were unable to verify these movements (Underwood et al. 1995).

The objectives of this study were to:

1. Determine the spatial distribution, migration timing, and movements of adult migratory bull trout in the Tucannon and Snake rivers.
2. Determine bull trout use and passage efficiency in fishways at Lower Snake River dams.
3. Estimate frequency of bull trout fall back at Lower Snake River dams.
4. Determine if bull trout losses result from movements out of Lower Monumental Pool.

The primary assumption associated with the study is that the movements of radio-tagged bull trout are not different from the movements of untagged bull trout in the subgroup. This assumption is critical to the project as a whole. Martin et al. (1995) found that surgically implanted dummy transmitters did not affect fish survival, growth, or gonad development in rainbow trout held in captivity. Radio transmitters have been used in other bull trout studies in recent years with good success (Elle 1995; Faler and Bair 1992; Hemmingson et al. 2001; Kelly Ringel and DeLaVergne 2000 and 2001; Mahoney

et al. 2006; Schriever and Schiff 2003; Underwood et al. 1995). Objectives 1, 2 and 4 have critical assumptions, in part, associated with each of those objectives. In order to determine distribution in the Snake River (Objective 1) and passage efficiency (Objective 2), we had to assume that a portion of our group of radio-tagged bull trout would enter the Snake River and at least attempt to pass through a fish ladder in the lower Snake River. Likewise, in order to estimate the extent of losses in Objective 4, there must be some movement (upstream or downstream) of radio-tagged bull trout out of Lower Monumental Pool and we also assumed that radio transmission would be adequate to track bull trout movements throughout the reservoirs.

Study Area

The Tucannon subbasin encompasses the entire Tucannon River watershed and all tributaries (approximately 1,300 square kilometers). The stream system originates in the Wenaha-Tucannon Wilderness Area, in the northeast portion of the Blue Mountains at an elevation of 1,900 meters (at Diamond Peak) and terminates at the Snake River (rkm 99.8) at about 164 meters elevation (Figure 1). Dryland agriculture and livestock grazing are the dominant land uses in mid-elevation upland areas, while forestry, recreation and grazing are the primary land uses at higher elevations. The subbasin is characterized by deep v-shaped valleys in headwater areas gradually widening into comparatively broad valley bottoms on the lower mainstem of the Tucannon River and Pataha Creek. The topography is the result of folding and faulting of extensive deposits of Columbia River basalts. Highly erodible loess soils on the plateau tops support extensive acreages of dryland farming. There is generally a large difference in elevation between the valley bottom of the drainage network and the surrounding plateaus. Intermittent and/or ephemeral streams are present throughout the watershed. Under typical conditions these streams do not convey much water, but during thunderstorms or rain-on-snow events they are capable of carrying immense debris torrents into the Tucannon River. The sediment moving capacity of these small streams is easily seen in the extensive alluvial fans deposited at their mouths. Habitat conditions in the Tucannon subbasin range from generally fair to good in the Tucannon River drainage to generally poor in the Pataha Creek drainage.

Salmonid bearing streams in the subbasin include Bear Creek, Sheep Creek, Cold Creek, Panjab Creek, Turkey Creek, Meadow Creek, Little Tucannon River, Hixon Creek, Cummings Creek, Tumalum Creek, Pataha Creek, and the mainstem Tucannon River. Summer steelhead/rainbow, spring Chinook, fall Chinook, resident rainbow trout, and bull trout are currently present. Summer steelhead/rainbow are presumed to be present in Kellogg and Smith Hollow creeks. Coho salmon (*Onchorynchus kisutch*) were historically present, and in recent years, they have again begun using the lower reaches of the Tucannon River. It is likely that the coho recently found in the Tucannon River watershed originated from stray individuals from nearby tribal hatchery reintroduction efforts in the Snake or Columbia basins.

The Tucannon River enters the Snake River at rkm 100.6 in Lower Monumental Pool, which is delineated by Lower Monumental and Little Goose dams on the downstream and upstream ends, respectively. Lyons Ferry Hatchery occurs a few kilometers downstream of the Tucannon mouth, at the confluence of the Snake and Palouse rivers. This portion of the Snake River is primarily a migration corridor for anadromous salmonids. Spring Chinook and summer steelhead use the Snake River to migrate to and from the ocean and/or between tributary streams, while fall Chinook use the Snake River for spawning, rearing and migration. Sockeye salmon (*Onchorynchus nerka*) migrate through this corridor to and from spawning grounds in Idaho's Salmon River basin.

Figure 1. Map of Southeast Washington showing the location of the Tucannon River in relation to the four Lower Snake River dams.

Methods and Materials:

The approach of the study was to use radio-telemetry to monitor adult bull trout movements within the Tucannon River basin, and as they emigrated to the Snake River to rear throughout the winter. In order to capture bull trout, we passively sampled them at the Tucannon Fish Hatchery Chinook salmon trap in spring and early summer, and actively angled in the fall and winter with lead-head jigs and spoons equipped with barbless hooks. Angling proved successful for capturing bull trout in September through February, and allowed us to capture and tag fish in the lower reaches of the river. Fish of appropriate size (≥ 50 times transmitter weight in air) were surgically implanted with

radio-tags. Surgical procedures generally followed those used by Faler et al. (1988), Faler and Bair (1992), Hemmingson et al. 2001; Kelly Ringel and DeLaVergne (2000 and 2001), Mahoney et al. (2006), and Schrieffer and Schiff (2003).

Radio-tags used during this study were obtained from Lotek Engineering and Advanced Telemetry Systems (ATS), and varied in size and life expectancy. Specifications for the different tags used can be found in Faler et al (2003 – 2007). During the last two years of the study, we solely utilized Lotek model NTC-6-2 3V micro coded fish transmitters which weighed 4.5 g in air, had a 294 day life expectancy, and were suitable for fish as small as 225 g.

Radio-tagged fish locations were monitored at least weekly in the Tucannon River from shore or aircraft. Individual fish locations were recorded by GPS coordinates during flights, and proximity to landmarks and/or road miles while tracking on ground. We also used four fixed telemetry stations to detect bull trout movements (Figure 2). The lowermost station, at rkm 2.6, was operated to identify the timing of movements out of the Tucannon subbasin and into the mainstem Snake River. The station at rkm 16.1 was established to determine if operation of the WDFW Snake River Laboratory steelhead weir impeded the downstream migratory movements of bull trout attempting to pass that location, as well as to provide an additional monitoring station to increase the efficiency of detecting bull trout movements in the lower Tucannon River. The two remaining fixed stations at the Tucannon Hatchery weir and Camp Wooten (rkm 59.2 and 69.2) were operated to record timing of fish movement into and out of the upper Tucannon River.

Figure 2. Fixed telemetry data logger stations (indicated by arrows) in the Tucannon subbasin, 2003-2006.

Results and Discussion

Bull Trout Sampling and Tagging

Between the years 2002 and 2006 we sampled 1,109 bull trout in the Tucannon River; 124 of these were surgically implanted with radio tags and PIT tagged (Tables 1 and 2), and 681 were only PIT tagged. The remaining 304 fish were either recaptures, or released unmarked. All bull trout were collected in the Tucannon River, primarily at the Tucannon Fish Hatchery adult trap in the spring and summer (1,026 fish), and secondarily with a screw trap, two temporary fish weirs, and angling in the fall and winter (83 fish).

Table 1. Bull trout trapping and tagging summary from the Tucannon Hatchery trap, 2002 - 2006.

Year	Total Number of Bull Trout Captured	Capture Dates (month/day)	Number Radio tagged	Number of radio tag recaps	Number of bull trout newly PIT tagged ^A	Number of PIT tag recaps	Number of PIT tags recaptured in-season (fallbacks)
2002 ^A	209	5/17–7/31	41	0	100	2	2
2003	261	3/14 – 7/24	20	7	175	19	10
2004	286	4/15 – 9/14	16	5	213	38	4
2005	165	3/21 – 7/21	0	8	86	57	3
2006	105	3/24 – 7/28	0	3	58	41	0
Total^B	1026	3/14 – 9/14	77	23	632	157	19

^A Gaps between trap pickets were reduced prior to the 2002 trapping season in order to maximize bull trout catch..

^B An additional 19 bull trout (not included in the total above) were PIT tagged in 2001, prior to the initiation of this telemetry study. See Table 3.

Table 2. Bull trout capture and tagging summary from fall/winter sampling efforts in the Tucannon River, 2003 – 2006.

Year	Total Number of Bull Trout Captured	Capture Dates (month/day)	Number Radio tagged	Number of Radio tag recaps	Number of bull trout newly PIT tagged	Number of PIT tag recaps
2003-2004	27	9/24 – 4/19	15	1	14	7
2004-2005	28	10/4 – 1/11	13	0	14	5
2005-2006	28	9/29 - 4/14	19	0	21	6
Total	83	9/24 - 4/19	47	1	49	18

Prior to implementing this project, bull trout were monitored and enumerated at the Tucannon Fish Hatchery weir, and in 2001 there were 19 bull trout PIT tagged and released there (Table 3). Two of these PIT tags were recaptured in 2002 at the weir. No additional fish from 2001 PIT tagging efforts were recaptured in subsequent years.

Table 3. Historical bull trout trapping and tagging summary from the Tucannon Hatchery trap, 1998 - 2001. Data from 1998 to 2001 was collected prior to this study (data from WDFW files).

Year	Total Number of Bull Trout Captured	Capture Dates (month/day)	Number of bull trout newly PIT tagged	Number of PIT tag recaps
1998	82	4/1 – 8/29	N/A	N/A
1999	39	5/20 – 7/12	N/A	N/A
2000	41	4/17 – 8/29	N/A	N/A
2001	39	5/12 – 6/27	19	N/A
Total	201	4/1 – 8/29	19	0

Tag Retention and Mortality

Some basic assumptions of radio-tagging fish to monitor their movements is that the implanted transmitters and the tagging process does not affect their movements, behavior, or survival, and that the movements of tagged fish are representative of the movements of untagged fish. We observed unusually high rates of immediate and delayed tag loss and fish mortality in this study (29.8%) (Table 4) as compared to other studies (Elle 1995; Faler and Bair 1992; Schriever and Schiff 2003) where rates of tag loss and/or mortality were reported as low as 10%. Of the 124 individual bull trout radio tagged during the five years of this study, 18 (14.5%) died or rejected the transmitters shortly after tagging and did not provide any useful movement data. Another 19 fish (15.3%) provided limited data to use for delineating movements. Our data also suggests that fall emigrant (post spawn) bull trout were 4 times more likely to immediately die or reject their tag than spring migrants (pre spawn), but were 1.4 times more likely to provide overwintering and movement results to meet the primary objective of this study. We attribute the immediate high mortality/tag loss of fall-tagged fish to the relatively weakened condition of the fish after spawning, and the poor overwintering performance of spring-tagged fish to post spawn mortality.

Table 4. Number of immediate and delayed losses of radio tags and/or bull trout in the Tucannon River, 2002 – 2006.

	Total Tagged	Immediate Losses (%)	Delayed Losses (%)
Spring Tagged	77	4 (5.2%)	10 (13.0%)
Fall Tagged	47	14 (29.8%)	9 (19.1%)
Total	124	18 (14.5%)	19 (15.3%)

We were able to monitor the movements of 87 fish (70.2%) successfully to contribute to at least a portion of our study objectives. Many of these fish contributed only one or two

seasons (performance categories) of movement data before the radio tag or the fish was lost to the study (Tables 5 and 6).

Table 5. Performance of bull trout radio-tagged during the spring in the Tucannon River, 2002-2005.

	Upstream movement onto spawning grounds.	Downstream movement post spawning & successful over-wintering	Upstream movement for a second spawning migration	
# of Fish	35 ¹	20	8	Total 63

¹ Tag loss/mortality occurred at spawning or shortly thereafter.

Table 6. Performance of bull trout radio-tagged during the fall and winter in the Tucannon River, 2003-2006.

	Over-wintered & began upstream movement in spring	Upstream movement onto spawning grounds	Downstream movement post spawning & over-wintering	
# of Fish	9	12	3	Total 24

Out of 124 bull trout radio-tagged, 77 were tagged during the spring migration to the spawning grounds, and 47 were tagged in the fall during the post spawn out-migration. Twenty eight (36.4%) of the spring tagged fish carried their tags through their first winter, whereas 24 (51.1%) of the fall tagged fish carried their tags through their first winter. The disparity of tag retention/survival between spring and fall tagged fish suggests that spawning mortality was a prominent source of fish and tag loss. In order to test this theory, we used length data collected during 2003 – 2005 to compare the length distributions of spring and fall migrants. We selected these years because the data were complete for both seasons and the sample sizes were relatively large. We used a two-sample Kolmogorov-Smirnov test to test ($\alpha = 0.05$) the hypothesis: the length distributions did not vary between seasons. This test relies on the calculation of “Dmax”, which identifies the fork length where the cumulative length frequency of spring migrants shows the greatest difference from the cumulative length frequency of fall emigrants. Tests were conducted separately by year based on preliminary analyses that suggested the data could not be pooled across years.

In two of three years (2004 and 2005), we found significant differences ($P < 0.05$) in the length distributions between spring and fall migrants (Figures 3 and 4). The 2003 length distributions of spring and fall migrants were not significantly ($P = 0.4$) different. The maximum difference between the 2004 length distributions ($D_{\text{max}} = 0.407$) was at 360 mm. Of the 2004 spring immigrants, 70% of the fish were greater than or equal to 360 mm long compared to 23% for the 2004 fall emigrants. The maximum difference between the 2005 length distributions ($D_{\text{max}} = 0.314$) was at 381 mm. Of the 2005 spring immigrants, 71% of the fish were greater than or equal to 381 mm long compared to 31% for the 2005 fall emigrants. These differences show that a portion of the larger spring migrants were not represented in the fall emigrant samples, and helps substantiate the theory that spawning mortality, and/or predation on the spawning grounds was a large factor in the high rate of tag loss that we observed. As a result of this loss, our ability to determine migration timing or movement behavior of out-migrant bull trout in the Snake River was greatly reduced.

Figure 3. Length frequencies of spring migrant (Pre-Spawn), and fall emigrant (Post-Spawn) bull trout during 2004 in the Tucannon River, indicating length at maximum difference between spring and fall samples at 360 mm.

Figure 4. Length frequencies of spring migrant (Pre-Spawn), and fall emigrant (Post-Spawn) bull trout during 2005 in the Tucannon River, indicating length at maximum difference between spring and fall samples at 381 mm.

We observed the capability of a bull trout to physically expel a surgically implanted radio-tag, heal, and survive. For example, on May 17, 2002, a 410 mm bull trout was captured and radio-tagged at the Tucannon Fish Hatchery trap. Approximately one year later, on May 20, 2003, this same individual was recaptured, and identified by its PIT-tag, at the Tucannon Fish Hatchery trap. It had grown 45 mm in length, and was now 455 mm fork length. As shown in Plate 1, this individual had completely expelled the radio-tag implanted in 2002, and the expulsion site on the abdomen showed a darkened, scarred area. Similar expulsion of radio-tags had been observed in the Touchet River by WDFW (Mendel et al. 2003).

Additionally, our data showed that at least one other bull trout expelled a surgically implanted radio-tag. On January 11, 2005, a 440 mm bull trout was captured by hook and line and implanted with a radio tag (code 104), and a PIT-tag. It was subsequently recaptured on June 21, 2006, in the Tucannon Fish Hatchery trap. Although the PIT tag was interrogated, we did not notice a radio-tag or scarring to indicate that this individual had been radio-tagged prior to this recapture. Additionally, we tracked the movement of this fish from the date of tagging until August 31, 2005. From the initial tagging date until the last date we were able to locate this tag, the tag remained in a reach of the Tucannon River ranging from rkm 11.9 to 22.9, approximately 36 to 47 km downstream of the Tucannon Fish Hatchery trap (rkm 59.2). This fish apparently expelled its radio-tag in the lower river during late winter or spring, and survived to initiate an upstream migration to the spawning grounds in early summer.

Plate 1. Photo showing the abdominal scarring as a result of radio tag expulsion.

Results from the spring tagging efforts in 2002 and 2003 proved that we were relatively unsuccessful at providing more than a few viable radio-tagged fish post spawning and into winter. In order to increase the number of tagged fish in the winter, we attempted fall sampling techniques and tagging in 2003 and 2004. As a result, we abandoned spring tagging efforts in 2005, and emphasized tagging during fall and winter for the remainder of the project. A comparison of our spring and fall tagging in 2005 shows that we were able to enhance the monitoring of fish movements into the Snake River by capturing and tagging fish in the fall and winter (Table 7).

Table 7. Comparison of available radio tagged fish for winter tracking and entry into the Snake River between spring and fall/winter tagging in the Tucannon River, 2002 - 2006.

Year	Tagged in Spring			Tagged in Fall or Winter		
	Tagged	Carried tag to Jan.	Fish to Snake R.	Tagged	Carried tag to Jan.	Fish to Snake R.
2002	41	5	0	NA	NA	NA
2003	20	4	0	15	7	0
2004	16	1	0	9	6	2
2005	NA	NA	NA	21	10	3
2006	NA	NA	NA	2	2	1

Bull Trout Movements within the Tucannon River

Bull trout seasonal movements within the Tucannon River were similar to those described for other migratory bull trout populations (Bahr and Shrimpton 2004; Budy et al. 2006; Mahoney et al. 2006; Mendel et al. 2003; Moore et al. 2006). Bull trout annual movements typically consisted of an ascent of the river in spring and early summer to the spawning areas in upper portions of the watershed, then quickly moving off the spawning areas in the fall, and either holding or continuing a slower migration downstream until March or April (Figures 5 and 6). By the first of June, most bull trout had ascended the Tucannon River upstream of Marengo (rkm 39.9) as they migrated back to the spawning grounds. Only two radio tagged bull trout (codes 121 and 104) remained below Marengo after June 1 during the 5 years of this study. During mid-summer (approximately July 15 - August 15) bull trout generally continued to move upstream to spawning areas with only 6 of the 40 radio tagged fish (15%) that remained between the Tucannon Hatchery and Panjab Bridge. All other radio-tagged fish during that time period continued to move until they were upstream of Panjab Bridge.

Figure 5. Seasonal upstream and downstream movements of radio-tagged bull trout in the Tucannon River from the Tucannon Fish Hatchery dam/ladder/trap facility (rkm 59.2) downstream to the Turner Road bridge at Marengo (rkm 39.9), 2002 – 2006 data combined.

Figure 6. Seasonal upstream and downstream movements of radio-tagged bull trout in the Tucannon River from the mouth of the Tucannon River upstream to Turner Road bridge at Marengo (rkm 39.9), 2002 – 2006 combined.

Radio tagged bull trout moved into all known spawning areas during this study, in addition to some areas between the Little Tucannon River and Panjab Bridge during spawning season. Those fish that resided downstream of Panjab Bridge may have found cold water seeps or springs, and spawned at these locations, or may have foregone spawning and held in suitable cold water sites during summer. The WDFW has documented a small number of bull trout redds between Panjab Creek and the Little Tucannon River while conducting spring chinook salmon or bull trout spawning surveys during September and early October (Mendel et al. 2008).

Those migratory bull trout that survived spawning quickly left the spawning areas and moved downstream in September and October. Post-spawned bull trout that we captured at downstream traps, or with hook and line, often were thin and emaciated, and we observed a common incidence of external fungal infections during September and October 2003 (likely *Saprolegnia spp.*). We don't know if these infections represent typical conditions for bull trout after spawning or whether it was specific to that one year.

We also don't know the amount of delayed mortality (if any) that might occur from these infections.

We observed migratory bull trout generally holding or over-wintering from above the Tucannon Fish Hatchery downstream to, and including the Snake River during this study. Most of our fall radio tagged bull trout were initially captured downstream of the Tucannon Fish Hatchery, so our winter movement and migration data may not adequately reflect the distribution of bull trout that do not migrate below the hatchery. It should be noted, however, that sampling attempts to capture bull trout upstream of the hatchery were relatively unsuccessful when compared to the sampling efforts in the immediate vicinity of, and downstream of the hatchery. For this reason, we believe there are few migratory fish that over-winter upstream of the hatchery. Of the 28 spring tagged bull trout with successful over-wintering data available, there were six fish (21.4%) that did not return downstream as far as the Tucannon Fish Hatchery (rkm 57.9), and only one of those over-wintered upstream of Watson lake (rkm 62.0). Of the remaining spring tagged bull trout that we successfully tracked over the winter, 12 (42.9%) remained between the Tucannon Fish Hatchery and Marengo, and 10 (35.7%) migrated downstream of Marengo (at rkm 39.9) in the lower half of the river. Some bull trout continued to sporadically move throughout the winter and early spring until they reversed direction in March through June, to ascend the river towards the spawning grounds.

Bull Trout Movements in the Snake River

Monitoring bull trout movements and establishing migration patterns within the Snake River was a primary goal of this study. We observed migrations into the reservoir influence area of the lower Tucannon River and/or the Snake River for six individuals (codes 55, 106, 121 in 2006, codes 111 and 103 in 2005, and ATS radio tag frequency 151.164 in 2004 - see Appendix A for tracking summaries of all six bull trout that entered the Snake River). All six of these fish were tagged during fall/winter sampling efforts, and represent 18.1% of all fall tagged fish that successfully carried their transmitters through the winter. Two of these fish never returned to the Tucannon River. This was the case for ATS frequency 151.164 that was recovered in lower Alkali Flat Creek, and Lotek radio tag code 55 that remained in the Snake River downstream of the Tucannon River and was never recovered. In three cases, we tracked movement into the Snake River, and back into the Tucannon River (tag codes 106, 121 and 103). Code 103 made multiple movements to and from the Snake River near the mouth of the Tucannon River, but it spent much of the winter within the reservoir influence area of the Tucannon River. Lastly, code 111 spent a considerable amount of time in the reservoir influence area of the Tucannon River, but it remained within the Tucannon River proper (Appendix A). Radio-tagged bull trout that entered the reservoir influence area or the Snake River ranged from 275 to 565 mm (Table 8).

Table 8. Sizes of radio-tagged bull trout that entered the Snake River (by fish, N=6).

Individual tagged with radio tag code:	Fork Length (mm)	Wt (g)
151.164 (ATS tag)	565	2,150
111 (Lotek tag)	327	320
106 (Lotek tag)	410	580
121 (Lotek tag)	378	420
55 (Lotek tag)	275	200
103 (Lotek tag)	483	1,250

Two additional incidents, one each in 2002 and 2004, have suggested the use of the lower Snake River dams by PIT tagged bull trout from the Tucannon River. The details associated with each of these incidents are summarized below:

1. Personnel from the NOAA Northwest Science Center Avian Predation Study interrogated one of our PIT tags from a bull trout tagged in the Tucannon River in 2002. When they realized the tag had been implanted in a bull trout rather than one of their target anadromous species, all data associated with the interrogation was deleted from their database. The interrogation file was never submitted to PTAGIS, and as a result, we can only conclude that a PIT-tag originating from a Tucannon River bull trout was scanned on one of the many Columbia River islands that was being monitored by NOAA's Avian Predation Study. NOAA personnel cannot remember on which island the tag was interrogated. The closest islands sampled are upstream of Pasco, WA, and if it was interrogated there, then the fish most likely moved downstream through Lower Monumental and Ice Harbor dams before meeting its fate. It is also possible, but highly unlikely that the fish and tag was ingested by a bird in or near the Tucannon River, and transported by air to the islands upstream of Pasco. In contrast, if the tag was interrogated on one of the estuary islands, it may be logical to assume that the fish was inadvertently loaded onto a barge via one of fish bypass collection systems, and transported below Bonneville Dam before being released.
2. One of our PIT-tagged bull trout from the 2003 trapping and tagging efforts was detected in the Grande Ronde River Basin at the Catherine Creek acclimation pond on March 18, 2004. The interrogation occurred at an automated detection device at the outlet tube of the acclimation pond. If this detection and tag code is not in error, the fish would have either needed to be: 1) in the pond during release and detected while exiting, or 2) attempting to travel up the tube as it subsequently triggered the tag detector. In either case, this fish would have moved upstream through Little Goose and Lower Granite dams, in addition to a steelhead weir 16 km below the acclimation pond. These detailed assumptions must be accepted in order to believe this interrogation is valid. Because of these fine details, this detection has been considered to be in error by Umatilla Tribe

and Pacific States Marine Fisheries Commission staff. It should be noted however, that the mechanisms of such an error at an automated, computerized tag detector have not been explained.

We were unable to adequately radio track bull trout in the Snake River and evaluate their movements or interactions with the federal hydroelectric dams. One reason for this was none of our radio-tagged fish attempted to pass a Snake River dam. Additionally, our radio tags had little to no transmission capability at depths greater than 12.2 m (Faler et al 2004 and 2005). Our data indicates that those fish that migrated into the Snake River appeared to descend to 12.2 m or more, and hold at those depths, until a few weeks prior to their return to the Tucannon River (Faler et al 2007). Another reason for poor tracking capability in the Snake River is the small sample size of individuals that actually entered the Snake River. In addition, we were able to observe only one radio tagged bull trout near one of the Snake River dams. This fish (code 106) was located during a radio telemetry flight downstream of Little Goose Dam and it later returned to the Tucannon River. Because of small numbers of radio tagged bull trout that entered the Snake River, and poor tracking success within the Snake River, we were unable to evaluate their movements within the Snake River, and at or near, the Snake River dams. However, bull trout continue to be observed in low numbers at Snake River dam fish facilities. If the results of this study are considered with the continued occurrence of bull trout at the Snake River dams, it suggests that bull trout observed at the Snake River dam fish facilities are likely originating from sources other than the Tucannon River. One possibility is that these fish are following the outmigration of juvenile anadromous fish (a food supply) as they emigrate toward the Pacific Ocean. If this is the case, these bull trout could be originating from populations in the Clearwater, Salmon, Grande Ronde, and/or Imnaha Rivers.

Bull Trout PIT Tag Recaptures, Size and Growth

We recaptured many PIT tagged bull trout during the course of this study at the Tucannon Fish Hatchery trap, and while sampling in the lower river (Tables 1 and 2). We compiled all PIT tag and associated length and weight data for individual bull trout captured from the following methods/locations: the Tucannon Fish Hatchery trap, hook and line sampling, the temporary downstream migrant trap located at the Tucannon Fish Hatchery, the WDFW Snake River Laboratory smolt trap, and the WDFW Snake River Laboratory adult steelhead trap (below Highway 12). From these sources of data, there were a total of 1,128 bull trout capture/sampling events in which either: 1) an individual bull trout was weighed, measured, and PIT-tagged (initial capture event), or 2) an individual was weighed, measured, and the existing PIT-tag code was recorded (recapture event).

Of the 1,128 individual capture events, 894 included implanting a new PIT tag, or recording a PIT tag from a recaptured fish (including the 19 fish PIT tagged in 2001). Bull trout that were recaptured at least once consisted of 145 individuals (two total

capture events); . 39 of which were recaptured at least twice (three total capture events), 7 were recaptured three times (four total capture events), and 3 individuals that were recaptured a fourth time (five total capture events).

Using the length and weight data obtained from the initial capture and subsequent recapture(s) of individual bull trout, we were able to determine an average growth rate and length-weight relationships. The overall average annual growth rate for 142 Tucannon River bull trout was 75.9 mm in length, and 457.1 grams in weight. The length-weight regression was calculated for 135 individual bull trout recaptured during the five years of this study (Figure 7).

Figure 7. The relationship between length and weight for 135 migratory bull trout recaptured at the Tucannon Hatchery Trap (logarithmic equation $Y=32.629e^{0.0074x}$).

Population Limitations

We documented bull trout mortalities and man-made passage restrictions that likely limit bull trout populations in the Tucannon River basin. The most obvious and unexpected mortality occurred during or immediately post spawning in the upper portion of the watershed. As mentioned previously, we found that many of our radio-tagged fish did not survive the spawning season. It is apparent that our initial emphasis to tag large fish

that were capable of accepting larger, longer life radio-tags, could have meant that many of these fish were on their last spawning return, and near the last few months of their life. Smaller, younger bull trout that spawned would not reflect as high a loss during spawning. We also found evidence of predation or scavenging during all times of the year. Great blue herons apparently injured or took several fish during the project and a radio tag was recovered below a heron rookery during nesting in spring in 2003 and 2006. Several other radio-tags were found in bank dens or burrows, and several bull trout carcasses had been partly or mostly consumed by predators or scavengers.

This study produced evidence, or direct documentation, of human activities in the Tucannon River nearly every year that either killed bull trout or blocked their migration. Illegal harvest of bull trout was documented or suspected for 7 radio tagged bull trout (4 spring tagged, and 3 fall tagged fish). Illegal harvest was confirmed for one radio-tagged bull trout (code 33) when the angler proudly displayed his catch with a photograph, and did not recognize it as a bull trout. We found numerous hand-made dams of either wood or stone that had been constructed by recreationists, especially along Meadow and Panjab creeks, that were barriers for bull trout migrating to or from spawning areas. The largest and most involved dam (Plate 2) was made of small logs and saplings, and was apparently built during the Labor Day weekend after some bull trout had already accessed the spawning grounds in Meadow or Panjab creeks. A radio-tagged bull trout that tried to descend the stream after spawning became trapped and died (Plate 3). Similar rock or log temporary dams have been found every year on lower Panjab and Meadow creeks and apparently have excluded migratory bull trout from reaching spawning grounds on some years as indicated by few or no documented redds in those years (Mendel et al. 2008).

Plate 2. Dam built by recreational campers on Panjab Creek.

Plate 3. Radio-tagged bull trout carcass (code 47) found impinged within a dam built by campers on Panjab Creek. This fish successfully spawned, but was trapped in the dam during downstream post-spawn migration.

Recommendations

As a result of this study we recommend the following:

- 1) Continuing PIT tagging and monitoring PIT-tag detections of bull trout in the Tucannon River at the Tucannon Fish Hatchery, the PIT-tag antenna arrays in the lower river, as well as elsewhere. This can provide valuable growth, relative survival, and movement data (especially for bull trout moving upstream or downstream of the PIT-tag antennas in the lower river).
- 2) The USACE and/or BPA should continue funding the operation and maintenance of the instream PIT-tag antenna arrays in the lower Tucannon River. The results and our experience from this radio telemetry study were instrumental in the decision for the USACE and Biomark Inc. to install PIT-tag antennas in the lower Tucannon River in an effort to increase the number of bull trout documented entering the Snake River in winter or spring. As we phased out the radio telemetry effort we were able to test the efficiency of the PIT-tag antennas and use them to supplement the radio telemetry study. In the fall of 2005 and beginning of 2006 we had three radio tagged bull trout that moved past the two PIT-tag antenna locations (below the smolt trap/above Highway 261, and two

antennas at the top of the reservoir influence zone in the lower Tucannon River). Based on the tracking summary and PIT-tag detections for these three fish (Appendix A) the antennas successfully detected the PIT-tagged fish 8 of the 11 times (72.7%) they should have been detected.

- 3) Query PTAGIS annually and summarize data for bull trout interrogations at Snake River dam fish passage facilities. Work with the USACE to have PIT-tag antennas installed at all possible fish passage routes at mainstem dams so PIT-tagged bull trout could be tracked at these dams.
- 4) The USACE and/or BPA should fund the collection of tissue samples from bull trout at Snake River dams and other areas, and the use genetic assignment tests to determine the likely sources of these fish. Genetic characterization for bull trout in the Tucannon River is being completed by a collaborative study between the USFWS and WDFW and it should be available in 2008. Genetic analyses of bull trout from Asotin Creek will be completed by both USFWS and WDFW in late 2008. Additional genetic analyses are needed for bull trout in the Clearwater, Grande Ronde, and Salmon rivers to help determine the likely sources of bull trout at the Snake River dams.
- 5) Monitor bull trout presence and fate in fish collections at Snake River dams (especially at Lower Granite, Little Goose and Lower Monumental dams) and evaluate likely sources and impacts of Snake River dams on migratory bull trout. This should include the quantification and effects of incidental barging of bull trout collected in the juvenile fish facilities.
- 6) Continue monitoring bull trout spawning distribution and relative abundance with redd surveys annually, or periodically, to evaluate stock status.
- 7) Provide additional monitoring, education and enforcement to prevent the summer or fall construction of barrier dams by recreationists that prevents bull trout migration to or from spawning areas.
- 8) Provide additional education and enforcement to prevent illegal harvest, or hooking mortality, of bull trout in the Tucannon River.

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Appendix A. Summary of location information for those radio tagged bull trout from the Tucannon River that entered the Snake River, or the reservoir influence zone of the Snake River, during this study.

Code	Date	Time	Physical location reference and comments	River (mi)	River (km)
151.164	10/12/03	N/A	tag implanted, fish released (fish captured in temporary downstream migrant trap) PIT tag code 3D9.1BF1C6A891	36.0	57.9
151.164	10/21/03	13:23	vicinity of SRL adult steelhead trap (Highway 261 milepost 2.2)	10.5	16.9
151.164	2/19/04	11:10	tag within Alkali Flat Creek at a point adjacent to Little Goose Dam Road milepost 13.5 -- location determined via helicopter	0.7	1.1
151.164	2/19/04	15:00	Tag recovered from top of boulder laying in undercut bank at waters edge. Tag hidden by thick screen of vegetation.	0.7	1.1
111	12/17/04	N/A	Fish radio-tagged and released adjacent to Tucannon Road milepost 1.0 PIT tag code 3D9.1BF1F7C20D	14.3	23.0
111	12/22/04	N/A	Tucannon Road milepost 0.2	13.5	21.7
111	12/29/04 -- 1/3/05	N/A	tag detected on fixed receiver at Snake River Lab adult steelhead trap	10.3	16.6
111	1/3/05	12:30	Highway 261 milepost 2.1	10.8	17.4
111	1/4/05	10:30	vicinity of the Snake River Lab fish trap (River Mile 10.3) adjacent to HWY 261 milepost 2.2 -- location determined via helicopter.	10.6	17.1
111	1/6/05	9:48	vicinity of the Snake River Lab fish trap (River Mile 10.3) adjacent to HWY 261 milepost 2.3	10.4	16.7
111	1/7/05	9:05	slightly upstream of the Snake River Lab smolt trap adjacent to Highway 261 milepost 2.5	10.5	16.9
111	1/10/05	N/A	slightly upstream of the Snake River Lab smolt trap adjacent to Highway 261 milepost 2.5	10.5	16.9
111	1/13/05	N/A	adjacent to Highway 261 milepost 1.9	10.8	17.4
111	1/15/05	20:41 -- 21:31	tag detected on fixed receiver at SRL adult steelhead trap	10.0	16.1
111	1/18/05	10:04	adjacent to Highway 261 milepost 7.4	5.0	8.0
111	1/21/05	13:30	adjacent to Highway 261 milepost 9.3	2.8	4.5
111	1/22/05	1:24 -- 1:33	tag detected on fixed receiver at WDFW Snake River Laboratory smolt trap	1.8	2.9
111	1/24/05	N/A	adjacent to parking area at the COE Tucannon Habitat Management Unit	0.7	1.1
111	1/31/05	14:43	adjacent to parking area at the COE Tucannon Habitat Management Unit	0.7	1.1
111	2/7/05	N/A	adjacent to parking area at the COE Tucannon Habitat Management Unit	0.7	1.1
111	2/9/05	14:10	adjacent to Highway 261 milepost 11.3	0.7	1.1
111	2/14/05	12:16	adjacent to Highway 261 milepost 11.3	0.7	1.1
111	2/22/05	14:27	adjacent to Highway 261 milepost 11.3	0.7	1.1
111	2/24/05	11:20	adjacent to parking area at the COE Tucannon Habitat Management Unit	0.7	1.1
111	3/2/05	8:21	adjacent to parking area at the COE Tucannon Habitat Management Unit	0.7	1.1
111	3/9/05	12:32	adjacent to Highway 261 milepost 11.3	0.7	1.1
111	3/16/05	N/A	vicinity of the Highway 261 bridge	1.7	2.7
111	3/19/05	2:19 -- 19:34	tag detected on fixed receiver at WDFW Snake River Laboratory smolt trap	1.8	2.9
111	3/25/05	8:52	slightly upstream of mouth of Kellog Hollow Creek	4.3	6.9
111	3/31/05	N/A	slightly upstream of mouth of Kellog Hollow Creek	4.3	6.9
111	4/11/05	N/A	Highway 261 milepost 3.9	8.6	13.8
111	4/22/05	13:26	adjacent to Highway 261 milepost 2.8	10.1	16.3
111	5/11/05	13:51	adjacent to Highway 261 milepost 3.9	8.6	13.8
111	5/13/05	14:56 -- 20:38	tag detected on fixed receiver at SRL adult steelhead trap	10.0	16.1
111	8/11/05	12:25	vicinity of Highway 261 milepost 9.0	3.1	5.0
111	9/14/05	14:34	adjacent to Highway 261 milepost 8.8	3.3	5.3
111	9/20/05	13:42	adjacent to Highway 261 milepost 8.8	3.3	5.3
55	2/17/06	N/A	fish tagged and released near WDFW smolt trap PIT tag code 3D9.257C5FD0AB	1.8	2.9
55	2/18/06 -- 2/21/06	12:47 -- 18:30	tag detected on fixed receiver at WDFW Snake River Laboratory smolt trap	1.8	2.9
55	2/20/06	19:11	PIT tag interrogated at upper PIT tag array	1.7	2.7
55	4/11/06	13:10	near where the Lyons Ferry railroad trestle meets the south bank of the Snake River	N/A	N/A
55	4/27/06	N/A	near where the Lyons Ferry railroad trestle meets the south bank of the Snake River	N/A	N/A
55	6/20/06	9:30	near where the Lyons Ferry railroad trestle meets the south bank of the Snake River	N/A	N/A
55	7/26/06	N/A	~100 yards downstream of the Lyons Ferry railroad trestle, south bank of Snake River	N/A	N/A
103	1/6/05	N/A	Fish radio-tagged and released downstream of the Snake River Lab fish trap at river mile 10.3 PIT tag code 3D9.1BF1C71902	10.3	16.6
103	1/6/05	11:33	downstream of the private bridge adjacent to Highway 261 milepost 2.7	9.9	15.9
103	1/7/05	00:13 --	tag detected on fixed receiver at WDFW Snake River Laboratory smolt trap	1.8	2.9

		00:17			
103	1/7/05	9:33	vicinity of the parking area at the COE Tucannon Habitat Management Unit	0.8	1.3
103	1/10/05	8:51	vicinity of the parking area at the COE Tucannon Habitat Management Unit	0.8	1.3
103	1/11/05	N/A	vicinity of the parking area at the COE Tucannon Habitat Management Unit	0.8	1.3
103	1/13/05	N/A	vicinity of the parking area at the COE Tucannon Habitat Management Unit	0.8	1.3
103	1/18/05	9:19	vicinity of the parking area at the COE Tucannon Habitat Management Unit	0.8	1.3
103	1/21/05	13:19	vicinity of the parking area at the COE Tucannon Habitat Management Unit	0.8	1.3
103	1/24/05	N/A	vicinity of the parking area at the COE Tucannon Habitat Management Unit	0.8	1.3
103	1/31/05	14:43	vicinity of the parking area at the COE Tucannon Habitat Management Unit	0.8	1.3
103	2/7/05	N/A	signal is strongest at Highway 261 milepost 12.0 ("point-to-point" mouth of Tucannon River)	0.0	0.0
103	2/9/05	14:06	vicinity of the parking area at the COE Tucannon Habitat Management Unit	0.8	1.3
103	2/14/05	12:19	adjacent to Highway 261 milepost 11.3	0.7	1.1
103	2/22/05	14:38	adjacent to Highway 261 milepost 11.8	0.2	0.3
103	2/24/05	11:16	adjacent to Highway 261 milepost 11.8	0.2	0.3
103	3/2/05	8:32	adjacent to Highway 261 milepost 11.3	0.7	1.1
103	3/9/05	12:26	adjacent to Highway 261 milepost 11.3	0.7	1.1
103	3/16/05	N/A	adjacent to Highway 261 milepost 11.4	0.6	1.0
103	3/20/05	22:24 -- 23:20	tag detected on fixed receiver at WDFW Snake River Laboratory smolt trap	1.8	2.9
103	3/21/05	15:29	adjacent to Highway 261 milepost 8.9	3.2	5.1
103	3/25/05	9:00	Highway 261 milepost 5.6	6.8	10.9
103	3/31/05	16:00 -- 21:08	tag detected on fixed receiver at SRL adult steelhead trap	10.0	16.1
103	3/31/05	N/A	Highway 261 milepost 2.7	9.9	15.9
103	5/11/05	12:58	Tucannon Road milepost 0.5	13.8	22.2
103	5/20/05	13:10	Tucannon Road milepost 7.0	20.6	33.2
103	5/24/05	11:52	Tucannon Road milepost 9.9	23.7	38.1
103	6/3/05	12:02	vicinity of Rainbow Lake	36.3	58.4
103	6/10/05	10:05	0.1 mile upstream of Beaver and Watson Lakes bridge	38.8	62.4
103	6/16/05	11:07	vicinity of Curl Lake	41.2	66.3
103	6/22/05	14:10	0.2 mile downstream of USFS Tucannon Guard Station	41.3	66.5
103	6/23/05	11:55	vicinity of Curl Lake	41.2	66.3
103	7/5/05	11:48	vicinity of Camp Wooten State Park	42.8	68.9
103	8/5/05	12:18	0.4 mile downstream of entrance to Camp Wooten State Park	41.9	67.4
103	8/31/05	11:21	0.2 mile upstream of the entrance to Camp Wooten State Park	42.5	68.4
103	9/9/05	12:48	0.2 mile upstream of the entrance to Camp Wooten State Park	42.5	68.4
103	9/14/05	13:21	0.3 mile upstream of the entrance to Camp Wooten State Park	42.6	68.6
103	9/20/05	11:10	0.2 mile upstream of the entrance to Camp Wooten State Park	42.5	68.4
103	9/29/05	N/A	0.2 mile upstream of the entrance to Camp Wooten State Park	42.5	68.4
103	10/7/05	10:04	0.2 mile upstream of the entrance to Camp Wooten State Park	42.5	68.4
106	10/27/05	N/A	fish radio tagged and released 0.2 mile downstream of Blue Lake PIT tag code 3D9.257C6480C7	35.3	56.8
106	10/28/05	11:41	0.1 mile downstream of Blue Lake	35.4	57.0
106	11/10/05	11:43	vicinity of Blue Lake	35.5	57.1
106	11/29/05	14:30	Tucannon RD milepost 18.9	32.6	52.5
106	12/2/05	19:23 -- 20:46	tag detected on fixed receiver at SRL adult steelhead trap	10.0	16.1
106	12/4/05	1:18	PIT tag interrogated at upper PIT tag array	1.7	2.7
106	12/4/05	15:32	PIT tag interrogated at upper PIT tag array	1.7	2.7
106	12/5/05	1:14 -- 1:17	tag detected on fixed receiver at WDFW Snake River Laboratory smolt trap	1.8	2.9
106	03/26/06 -- 3/27/06	18:50 -- 00:21	detected on fixed receivers in LGS tailrace	N/A	N/A
106	4/10/06	15:05 -- 16:01	tag detected on fixed receiver at WDFW Snake River Laboratory smolt trap	1.8	2.9
106	4/11/06	12:50	vicinity of Kellog Hollow bridge, Starbuck (location determined from air)	8.0	12.9
106	4/12/06	11:24	corner of Pataha Street and 6th Street, Starbuck	8.1	13.0
106	4/25/06	15:02	Highway 261 milepost 3.5	9.1	14.6
106	4/27/06	16:26 -- 17:52	tag detected on fixed receiver at SRL adult steelhead trap	10.0	16.1
106	5/2/06	10:24	vicinity of Territorial Road bridge	12.2	19.6
106	5/9/06	14:17	0.1 mile upstream of Territorial Road bridge	12.3	19.8
106	5/25/06	N/A	Tucannon Road milepost 4.0	17.6	28.3
106	6/6/06	13:42	Tucannon Road milepost 17.8	31.7	51.0
106	6/12/06	1:42 -- 19:32	tag detected on fixed receiver at WDFW Tucannon Hatchery fish trap	36.8	59.2

106	6/13/06	14:21	0.1 mile downstream of WDFW W. T. Wooten Wildlife Area campground #5	37.9	61.0
106	6/20/06	12:24	vicinity of USFS Tucannon Guard Station	41.5	66.8
106	6/28/06	11:11	0.1 mile downstream of the access road into Camp Wooten State Park	42.2	67.9
106	7/5/06	11:30	USFS 47 -- 0.3 mile downstream of Cow Camp bridge	44.3	71.3
106	7/13/06	11:00	vicinity of Panjab bridge	46.1	74.2
106	7/19/06	11:03	USFS 4712 milepost 2.8	48.9	78.7
106	7/26/06	N/A	0.2 mile downstream of Ladybug Flat campground	48.0	77.2
106	10/12/06	20:26	PIT tag interrogated at lower PIT tag array	0.8	1.3
121	10/27/05	N/A	fish radio-tagged and released near Cummings bridge PIT tag code 3D9.257C5F51EA	34.9	56.2
121	10/28/05	11:47	WDFW W. T. Wooten Wildlife Area headquarters	33.9	54.6
121	11/10/05	11:23	vicinity of WDFW W. T. Wooten Wildlife Area campground #1	34.6	55.7
121	11/18/05	11:49	vicinity of Cummings bridge	34.9	56.2
121	11/28/05	3:52 -- 3:59	tag detected on fixed receiver at SRL adult steelhead trap	10.0	16.1
121	11/29/05	13:45	Highway 261 milepost 3.8	8.7	14.0
121	12/2/05	1:50 -- 1:57	tag detected on fixed receiver at WDFW Snake River Laboratory smolt trap	1.8	2.9
121	12/2/05	1:58	PIT tag interrogated at upper PIT tag array	1.7	2.7
121	3/28/06	9:01	PIT tag interrogated at upper PIT tag array	1.7	2.7
121	3/28/06	9:01	PIT tag interrogated at lower PIT tag array	0.8	1.3
121	3/29/06	23:24	PIT tag interrogated at lower PIT tag array	0.8	1.3
121	4/11/06	13:45	tag detected within cove at Lyons Ferry Marina; location determined from air	N/A	N/A
121	4/14/06	12:47	PIT tag interrogated at upper PIT tag array	1.7	2.7
121	4/16/06	10:03 -- 11:21	tag detected on fixed receiver at WDFW Snake River Laboratory smolt trap	1.8	2.9
121	4/25/06	14:44	Highway 261 milepost 5.5	6.9	11.1
121	5/2/06	10:16	Highway 261 milepost 2.7	9.9	15.9
121	5/4/06 -- 5/5/06	6:53 -- 20:34	tag detected on fixed receiver at SRL adult steelhead trap	10	16.1
121	5/9/06	13:42	vicinity of the WDFW Snake River Laboratory steelhead trap at river mile 10.3	10.3	16.6
121	5/15/06	13:27	0.2 mile upstream of the Highway 12 bridge	13.5	21.7
121	5/25/06	N/A	Tucannon Road milepost 1.0	14.3	23.0
121	6/2/06	16:27	Tucannon Road milepost 5.4	18.7	30.1
121	6/8/06	12:46	Tucannon Road milepost 11.4	25.1	40.4
121	6/14/06	12:14	Tucannon Road milepost 18.2	32	51.5
121	6/18/06	4:15 -- 21:57	tag detected on fixed receiver at WDFW Tucannon Hatchery fish trap	36.8	59.2
121	6/20/06	12:36	0.3 mile upstream of Rainbow Lake	36.3	58.4
121	6/28/06	N/A	vicinity of USFS Tucannon Guard Station	41.5	66.8