MOVEMENTS OF RADIO-TAGGED BULL TROUT THROUGH ROCKY REACH AND ROCK ISLAND DAMS AND RESERVOIRS: 2005 - 2009

Submitted To:
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Executive Summary

On 1 November 1999 bull trout were listed as threatened under the Endangered Species Act (ESA) by the United States Fish and Wildlife Service (USFWS). As such, Chelan PUD initiated research to monitor incidental take associated with the Rock Island and Rocky Reach dams and reservoirs. This study was developed to address that objective, and has been ongoing continuously since 2005. This is the final report for the bull trout research encompassing the period of 16 May 2005 through 19 June 2009.

During the period 14 April to 15 November 2009, a total of 83 bull trout were observed ascending the Rocky Reach Dam fishway. At Rock Island Dam, a total of 60 bull trout ascended the three separate fishways. Consistent with the original study design, no bull trout were tagged during the 2009 study period. Instead, fish tagged during the 2005-2007 study periods were monitored and provided data on survival and various metrics of passage at Rocky Reach and Rock Island dams. During the first three years of study, a total of 86 bull trout were tagged, with 38, 29, and 19 fish tagged in 2005, 2006, and 2007, respectively. Furthermore, of those 86 bull trout, 15 were tagged and released at Rock Island Dam and 71 at Rocky Reach Dam. All fish were tagged with radio transmitters having a two-year battery life expectancy.

Of the 86 bull trout tagged during the period of 2005 to 2007, a total of 17 active transmitters were detected at some time in 2009. Of those, we believe that 9 tagged fish were alive and active during the 2009 period. For the other 8 fish, we believe they either perished or shed their transmitters based on an extended stationary detection history. During the 2009 study period, no tagged fish were observed migrating either up or downstream of Rock Island Dam. At Rock Reach Dam, we observed a total of three passage events, with one downstream and two upstream events occurring. Furthermore, of the 9 active bull trout, seven migrated into the Entiat basin, one into the Methow basin, and another's transmitter failed before tributary entrance could be documented.

For the period of 2005 – 2009, a total of 41 upstream passage events were observed at Rocky Reach Dam. Based on those observations, we estimated that the median time tagged bull trout resided within the tailrace (Tailrace Residence Time) was 0.28 days; the median time spent migrating in and out of the fishway (Fishway Cycling Time) was 2.48 days; and the median time spent migrating up the fishway (Fishway Migration Time) after final entry was 0.25 days. Collectively, the overall median Project Migration Time from tailrace to exit was 3.84 days. At Rock Island Dam during the same period, a total of 5 upstream passage events were observed. For those events, the median tailrace, fishway cycling, and fishway migration times were 0.26 days, 0.84 days, and 0.23 days, respectively. Collectively, the overall Project Migration Time (median) for tailrace to exit was 1.38 days. Review of project migration times at Rocky Reach and Rock Island dams suggest that most of the time spent migrating upstream of the projects occurred at or near the fishway entrance (fishway cycling time). In comparison, relatively little time

was spent in the tailrace or within the fishway (fishway migration time) after last detection at the fishway entrance. For the 41 upstream passage events, no mortality was observed during the study period.

In addition to passage rates at Rocky Reach and Rock Island dams, we assessed in-river migration rates between projects and between projects and various tributaries during the 2005 to 2009 period. For tagged bull trout, the median migration time from Rock Island Dam to the fixed-telemetry site on the Wenatchee River was 6.87 days (5.3 km/d). For tagged trout migrating to Rocky Reach Dam from Rock Island Dam, the median migration time was 2.28 days (14.3 km/day). For tagged bull trout migrating from Rocky Reach Dam to either the Entiat River telemetry site or Wells Dam, the migration rates were 6.87 days (1.9 km/d) and 2.88 days (23.5 km/d). Clearly, the migration rate within the Columbia River to the next upstream project is much faster when compared to migrations upstream to the Wenatchee and Entiat river telemetry sites. This may suggest that tagged bull trout entering these tributaries may stage within the Columbia River or within the lower Wenatchee and Entiat rivers prior to migrating upstream and being detected at the tributary telemetry sites.

During the 2005 to 2009 study period there were a total of 56 downstream passage events at Rock Island and Rocky Reach dams combined; with 9 downstream passage events at Rock Island Dam and 47 passage events at Rocky Reach Dam. Of the 9 passage events documented at Rock Island Dam, 2 were through one of the two powerhouses, one through the spillway; and 6 through unknown routes. At Rocky Reach Dam, a total of 35 downstream passage events occurred at the powerhouse, 2 through the spillway, 2 through the Juvenile Bypass System, and 8 through unknown routes. For these 56 passage events observed over the entire study period, no documented mortality associated with downstream passage through either dam was documented.

There was no downstream passage movement of tagged bull trout following ladder exodus in 2005 or during the 2007-2009 period at Rocky Reach Dam. However, in 2006, four bull trout migrated back downstream of Rocky Reach Dam after an initial ascent of the fishway, only to re-ascend a second time. For those four fish, the mean elapsed time between fishway exit and downstream passage at Rocky Reach Dam was 3.56 hours (range of 0.68 to 5.91 hours). A fifth bull trout released upstream of Rocky Reach Dam after being tagged, subsequently migrated downstream of the project, and later re-ascended the fishway. For all five of these bull trout exhibiting this behavior, after re-ascending the Rocky Reach fishway they migrated upstream of the project.

Of the 86 bull trout that were tagged during the period of 2005-2007, thirty (34.9%) either perished or shed their transmitters during the course of the study. Of those recoveries, seven transmitters were recovered in 2005, four in 2006, eleven in 2007, and eight in 2008. No transmitters were recovered in 2009. Of the recoveries, 9 transmitters were recovered with a carcass, 19 without, and two were inconclusive. Furthermore,

20% of the transmitters were located within the mainstem Columbia River and 80% within tributaries of the Columbia River (i.e., Wenatchee, Entiat, and Methow basins).

1.0 Introduction

Bull trout were listed as threatened under the ESA on 1 November 1999 (64 FR 58910). Because these fish can be affected by the operation of hydro-projects owned and operated by Chelan, Douglas, and Grant PUDs (Mid-Columbia PUDs), the Mid-Columbia PUDs initiated a radiotelemetry study in 2001 to assess the potential effects of their projects on bull trout passage. Radio tags were inserted into adult-sized bull trout collected at three Mid-Columbia River dams. These fish were tracked to describe their movements and migration patterns within the mid-Columbia basin. As part of the study, a total of 79 bull trout were tagged in 2001 and 2002, with 15 fish tagged at Rock Island Dam, 45 at Rocky Reach, and 19 at Wells Dam. About half of the fish were released upstream of the dam where they were captured, while the other half were released downstream of the respective dam. The radiotelemetry study identified no adverse effects on movement or survival of tagged bull trout (BioAnalysts 2002 and 2004). Furthermore, there were no documented cases of tagged bull trout being injured during upstream or downstream passage through Rock Island or Rocky Reach dams.

During the period of study, Chelan PUD began baseline work to initiate the federal relicensing process for Rocky Reach Dam. The relicensing process for the Rocky Reach Hydroelectric Project brought fisheries agencies, tribes, and interested parties together in a Natural Resources Working Group (NRWG) that provided opportunities for comprehensive review of current and future management priorities for fish resources potentially impacted by project operations. The NRWG was established to identify issues, develop study plans, review study reports, and develop long-term management plans for fish and wildlife species. As such, Chelan PUD, in conjunction with the NRWG, developed Comprehensive Bull Trout Management Plans (BTMP) for both Rock Island and Rocky Reach dams.

The goal of the BTMPs is to identify, develop, and implement measures to monitor and address ongoing impacts on bull trout resulting from project operations and facilities in a manner consistent with the U.S. Fish and Wildlife Service (USFWS) Biological Opinions, issued in May 2004 and February 2009; and the USFWS draft bull trout recovery plan for the Upper Columbia River Recovery Unit. The BTMP measures are designed specifically to meet the following objectives: 1) monitor incidental take associated with project dams and reservoirs; 2) identify and address any negative ongoing project-related impacts on adult bull trout passage; 3) investigate potential project-related impacts on upstream and downstream passage of sub-adult bull trout through Rock Island and Rocky Reach dams and reservoirs; and 4) investigate the potential for sub-adult entrapment or stranding in off-channel or backwater areas of Rock Island and Rocky Reach reservoirs as a result of project operations. This study was developed to address the first objective of the BTMPs and has been ongoing since 2005.

This year of research was the fifth and final year of a multi-year study, and spanned the period of 1 January 2009 to 19 June 2009. However, in addition to observations for the

2009 period, we also present results for the cumulative study period. That is, from 16 May 2005 to 19 June 2009.

1.1 Study Objectives

Specific objectives of the field studies were to:

- Assess mortality of tagged bull trout that migrate upstream or downstream through Rock Island and Rocky Reach dams, identified by the location of passage (i.e., the adult fishway, the powerhouse, spillway, or juvenile bypass facility).
- If mortality is identified, consult with the USFWS to determine if the cause of mortality was associated with the operation of the Projects.
- Describe the movements and migrations of bull trout at Rocky Reach and Rock Island dams and within their reservoirs.

1.2 Study Area

The primary study area encompassed the mainstem Columbia River from a point 1,000 feet downstream of Rock Island Dam to a point 1,000 feet downstream of Wells Dam. This corresponds to the reach of Columbia River in which Chelan PUD is required to measure the incidental take of bull trout. On occasion, we also tracked fish outside the primary study area to confirm fish movement, locations, and behavior. In some instances, fish tracking or recovery efforts were conducted to assist the USFWS with their bull trout telemetry project. Fish survey locations outside the primary study area include:

- The stretch of Columbia River from a point 1,000 feet downstream of Rock Island Dam to the southern tip of Quilomene Island (RK 693.8).
- From the southern tip of Quilomene Island to the Ringold Hatchery (RK 571.3).
- Wells Dam tailrace and forebay (data were provided by Douglas PUD).
- The Wenatchee River, Peshastin Creek, Ingalls Creek, Icicle Creek, Chiwawa River, and Lake Wenatchee.
- The Entiat (from its confluence to Entiat Falls) and Mad (from its confluence to Maverick Saddle) rivers.
- The Methow River (from its confluence to about Methow Pass), Wolf Creek, Early Winters Creek, Lost River, Twisp River, Chewuch River, Lake Creek, Black Lake, and Robinson Creek.

Consistent with the study design, mobile surveys outside the primary study area were not performed on a regular basis. These areas were only surveyed if a tagged fish had not been detected for some time in the primary study area and it was suspected to be in a particular stream. However, as part of our effort to coordinate studies between the USFWS and PUDs, we surveyed the Methow and Entiat basins to assist the USFWS with

the monitoring of their tagged bull trout. Various study tasks and telemetry data have been routinely shared between Chelan PUD, the USFWS, and Douglas PUD.

1.3 2009 Bull Trout Migration

During the period 14 April to 15 November 2009, a total of 83 bull trout were observed ascending the Rocky Reach Dam fishway (Table 1). At Rock Island Dam, a total of 60 bull trout ascended the fishways; 32 ascended the left bank fishway, one the center, and 27 the right bank fishway (Chelan PUD, unpublished data). Figure 1 summarizes the daily and cumulative passage of bull trout at the two projects and Figure 2 summarizes the diel passage of bull trout at both dams.

In 2009, bull trout passage at Rocky Reach Dam was the second lowest observed during any year for the period 2000 to 2009, and was down by about 20% from the previous year. At Rock Island Dam, bull trout passage increased from the three previous years, with an increase of about 67% from 2008. Although bull trout numbers passing Rocky Reach Dam in 2009 were generally lower than previous years, and passage at Rock Island in 2009 was higher than what has been observed since 2005, at both projects passage indices in 2009 were within the annual range of variability observed since bull trout counts at the dams first began (Table 1 and Figure 3).

Table 1. Annual bull trout passage at Rocky Reach and Rock Island dams during the period of 14 April to 14 November 2000-2007. Bull trout passage in 2008 and 2009 was for the period of 14 April to 15 November.

	Rock Island Fishway Counts			Total	
Year	**Left**	**Center**	**Right**	**Rock Island**	**Rocky Reach**
2000	45	3	40	88	212
2001	42	1	39	82	204
2002	41	2	41	84	194
2003	34	6	62	102	246
2004	47	8	59	114	161
2005	27	5	34	66	155
2006	20	1	14	35	132
2007	24	0	21	45	78
2008	20	1	15	36	104
2009	32	1	27	60	83

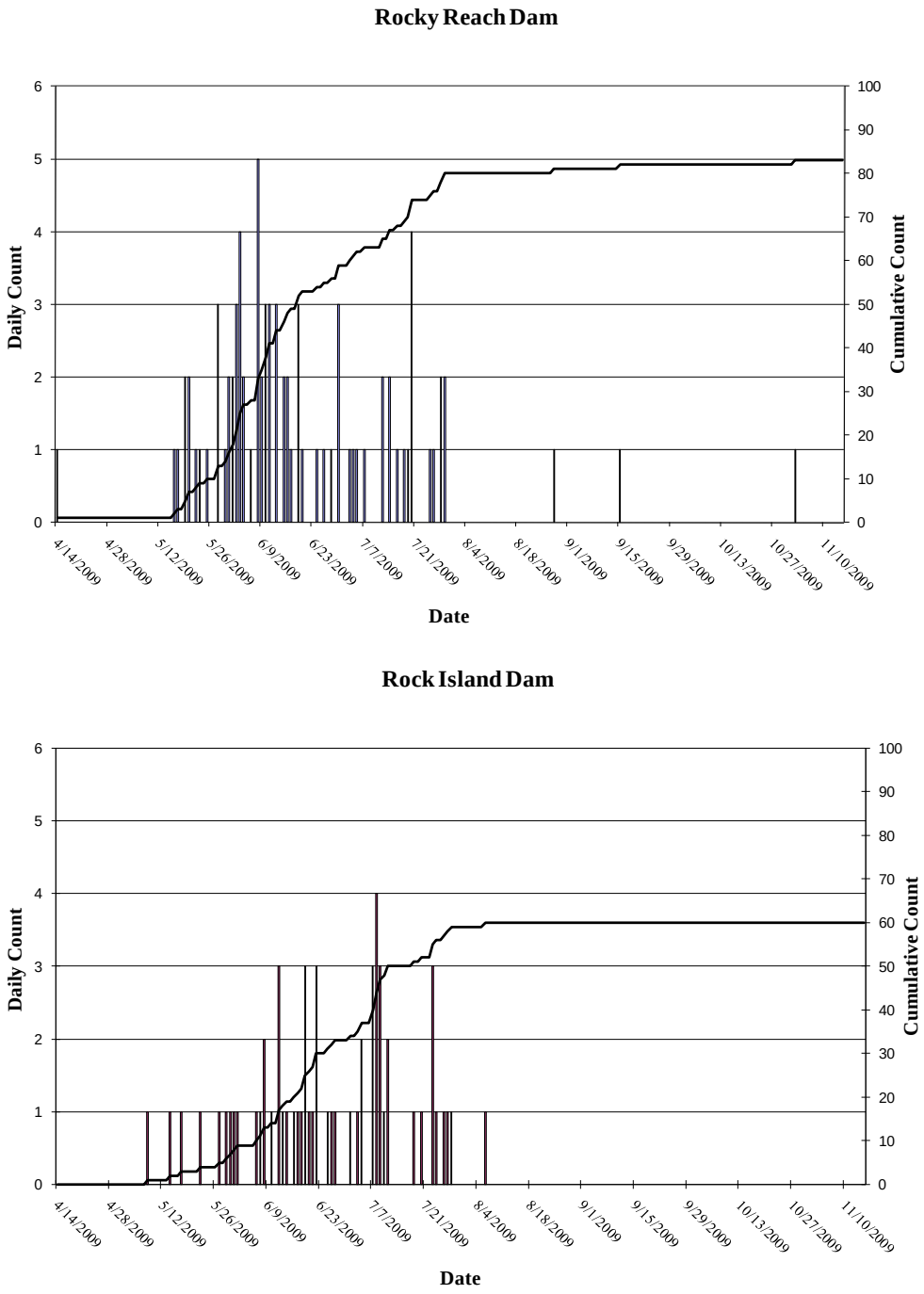

Figure 1. Daily and cumulative bull trout counts at Rocky Reach and Rock Island dams during the period of 14 April to 15 November 2009.

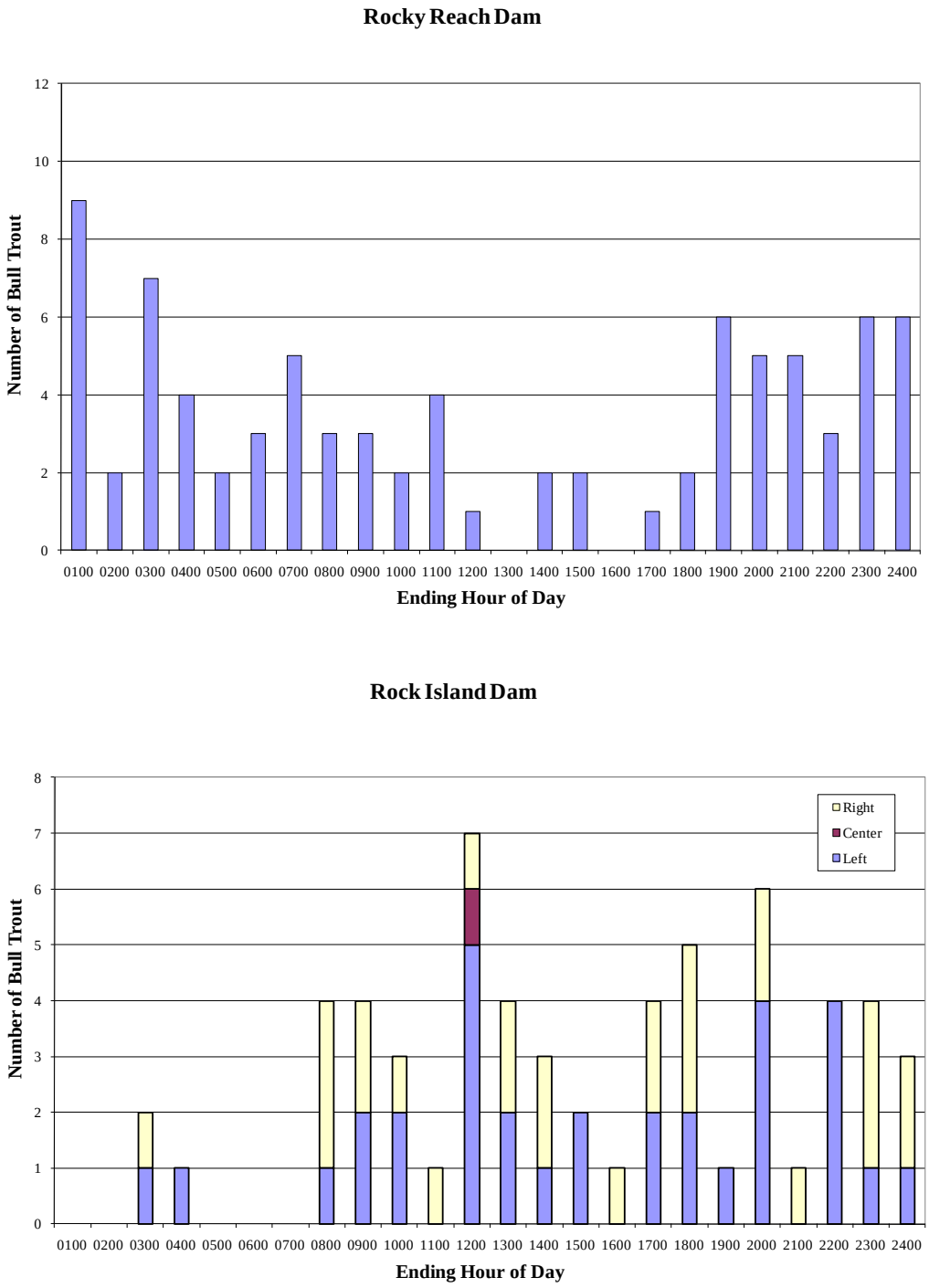

Figure 2. Diel timing of bull trout passage at Rocky Reach and Rock Island dams during the period of 14 April to 15 November 2009.

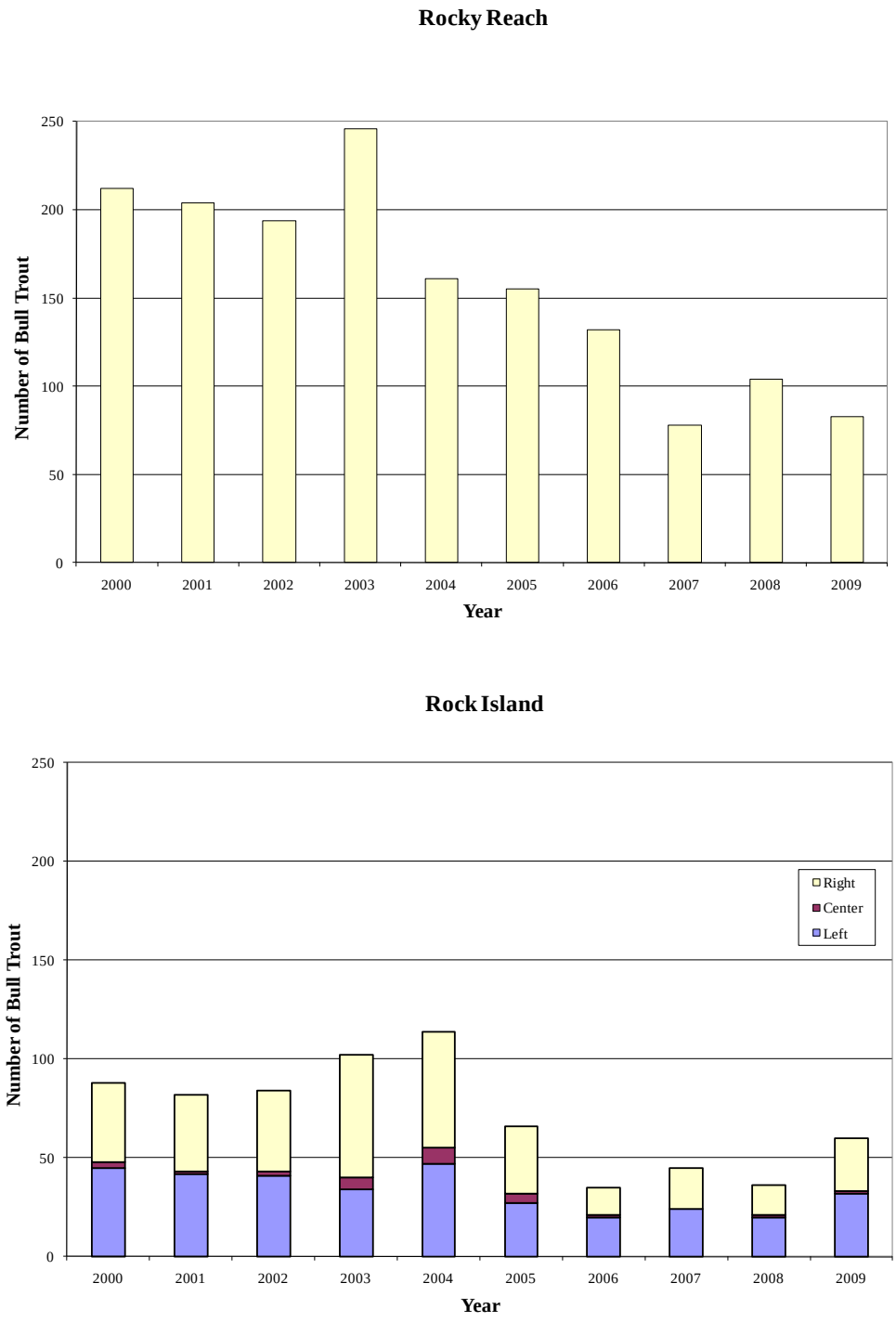

Figure 3. Annual bull trout passage at Rocky Reach and Rock Island dams during the period of 14 April to 14 November 2000-2007. Bull trout passage in 2008 and 2009 was for the period of 14 April to 15 November.

2.0 Methods

Methods used in 2009 to monitor bull trout were consistent with those used during the 2001-2003 and 2005-2008 study periods. While no bull trout were tagged in 2009, bull trout tagged during the period of 2005 to 2007 were monitored to provide various metrics of passage. For those fish, methods used to capture, handle, tag, release, and monitor bull trout were consistent from year to year (BioAnalysts 2002 and 2004; and Stevenson et al. 2006, 2007, 2008, and 2009). The only notable differences between the early and later study periods involved release locations. During the 2001-2003 study period, fish were released both upstream and downstream of Rocky Reach and Rock Island dams. Only upstream releases were made in 2005-2007. At Rocky Reach Dam, the release site was located about 2.3 km upstream of the dam near the west shore (Figure 4). At Rock Island Dam, the release location was about 2.6 km upstream of the dam near the east shore (Figure 5). This modification was implemented to allow fish to recover from anesthesia and surgery upstream of forebay flows.

Telemetry methods used to monitor tagged fish in 2009 were identical to previous studies. Tailraces at both Rocky Reach and Rock Island dams were monitored with aerial telemetry systems. All ladder entrances at the dams were monitored with underwater antennas. Underwater antennas also monitored various critical locations within each fishway. A series of underwater antennas monitored the weirs leading to the fishway exits as well as the exits themselves. To assess downstream movement of bull trout, all turbine intakes, spillbays, and fish bypass structures were monitored with underwater antennas. As in previous studies, we monitored the Wenatchee and Entiat rivers with aerial systems at RK 12.5 and RK 4.8, respectively.

In addition to the fixed-telemetry sites identified above, we conducted aerial (fixed-wing aircraft) and boat surveys on a bi-weekly basis, alternating methods for each survey. Collectively, a total of 35 aerial, 39 boat, and 2 truck surveys were conducted during the course of the 2005 to 2009 study period. For a detailed description of the telemetry systems used, as well as the mobile surveys, see BioAnalysts, Inc. (2002 and 2004).

To assess potential mortality of bull trout that passed either Rock Island or Rocky Reach Dam, we used a number of tools and techniques developed specifically for this project. Mobile survey data were processed through a program developed by the University of Washington to determine the distance traveled by individual fish between surveys. If the distance was less than 400 m, the detection history of that fish was reviewed. If the fish in question had passed either upstream or downstream of Rock Island or Rocky Reach dams, then an attempt was made to either recover the fish, the transmitter, or verify that the fish was alive. Recovery of fish in the Columbia River relied on Scuba diving, while recovery within tributaries relied either on snorkeling or wading.

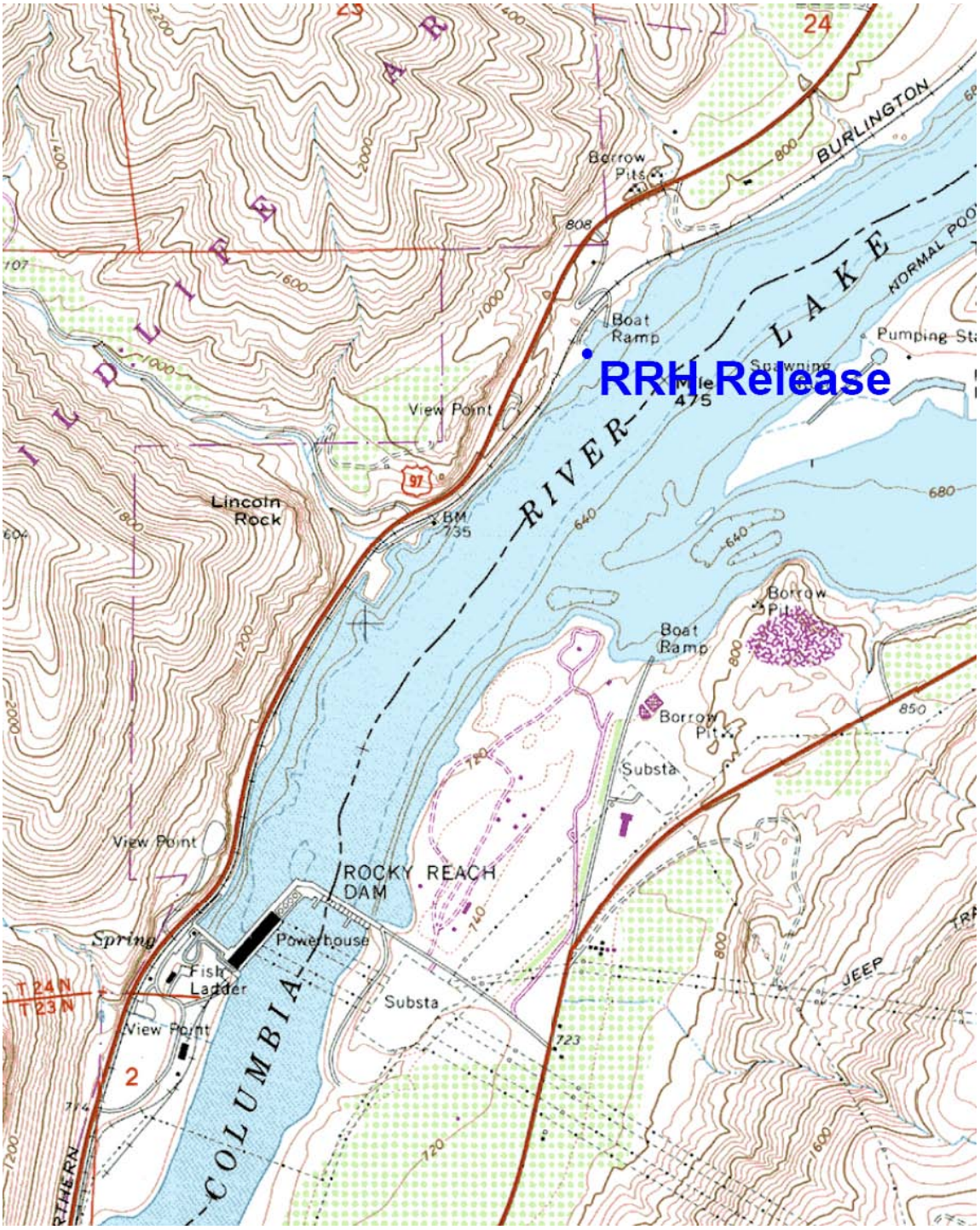

Figure 4. Release location for bull trout upstream of Rocky Reach Dam during the 2005 to 2007 study period.

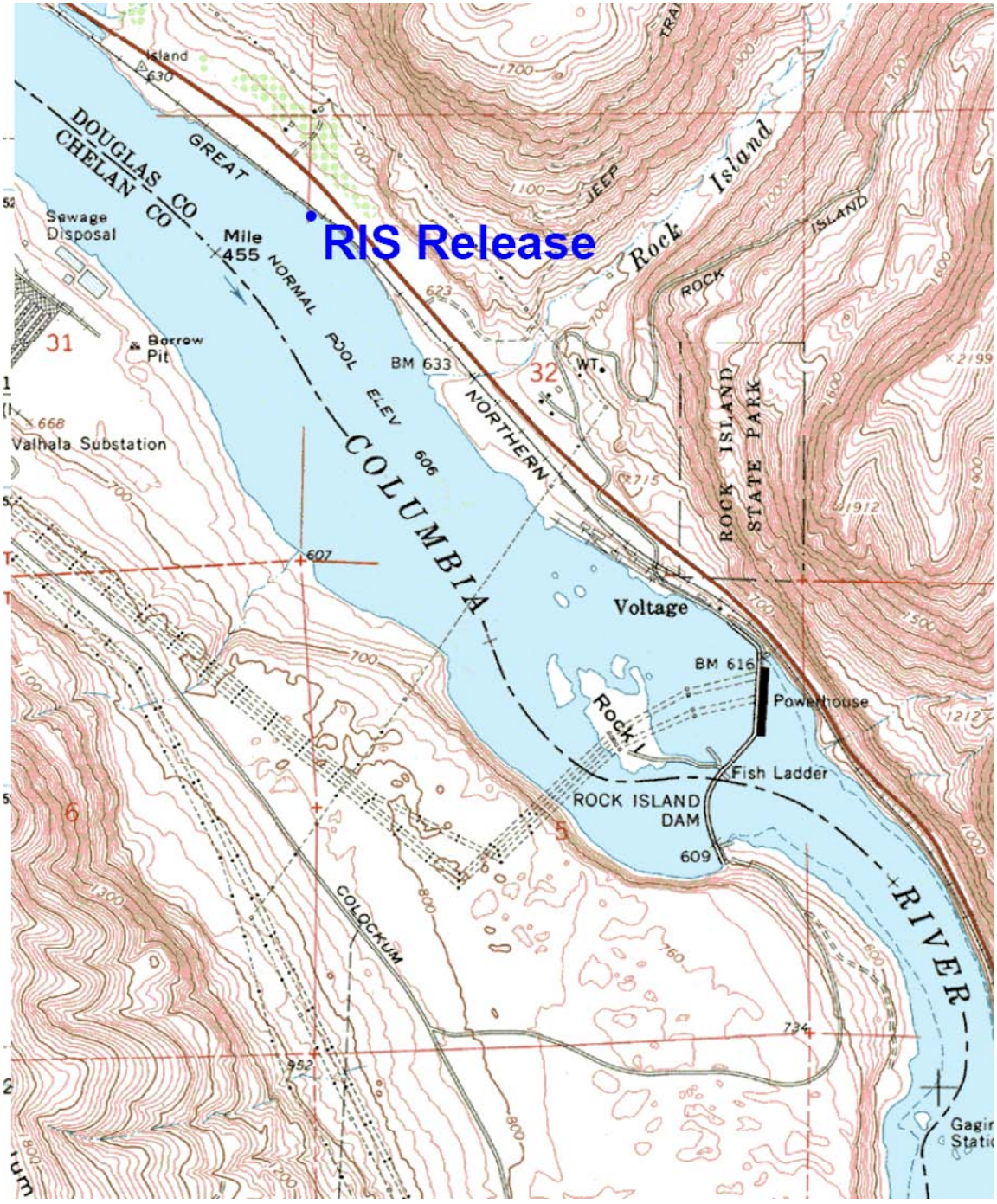

Figure 5. Release location for bull trout upstream of Rock Island Dam during the 2005 to 2007 study period.

3.0 Results and Discussion

3.1 Trapping and Tagging Activities

As previously discussed, no bull trout were tagged in 2008 and 2009. Instead, fish tagged during the period of 2005 to 2007 and still alive with active transmitters were monitored to assess survival and provide metrics of passage at Rock Island and Rocky Reach dams. During the 2005 to 2007 tagging period, a total of 86 bull trout were collected and tagged at Rock Island and Rock Reach dams (Table 2). For those fish, the mean length and weight were 56.1 cm and 2,342 g, respectively. Of the 86 tagged fish, 15 were trapped and tagged at Rock Island, and 71 fish at Rocky Reach. For the 15 fish tagged at Rock Island Dam, the mean length and weight were 50.0 cm and 1,658 g, respectively. For fish tagged at Rocky Reach Dam, the mean length and weight were 57.4 cm and 2,476 g, respectively (Table 2). Trends observed for fish size are consistent with data collected during the earlier study period of 2001 to 2003; that is, fish size is greater for fish collected at upstream dams relative to downstream projects. During the 2001 to 2003 study period, fish collected at Rocky Reach Dam were larger both in length and weight than fish collected at Rock Island Dam. Likewise, fish trapped and tagged at Wells Dam were larger than fish collected at Rocky Reach Dam (BioAnalysts, Inc. 2002 and 2004).

We considered two, size-related variables when selecting fish for tagging. The first related to the relative weight of the transmitter compared to the weight of the fish (as weighed in air). To minimize potential impacts associated with surgical implantation of a transmitter into the body of a fish, we used the 2% criterion developed by Winter (1983). Following this criterion, it was possible to tag fish as small as 320 g. This was not an issue, however, because the smallest trout tagged was 910.0 g. The second variable considered was fish length. Based on previous years of study, we have observed that fish less than 40 cm in length (fork measurement) do not appear to adequately accommodate the transmitters used in this study, even though these smaller fish may meet the 2% criterion of Winter (1983). We therefore limited the size of fish to be tagged to 40 cm or larger. During the years of tagging, the smallest fish tagged measured 40.0 cm in length.

The 86 bull trout were surgically implanted with radio-transmitters with an expected tag life of 761 days when programmed with a 5-second burst rate. As such, the expectation was that few if any transmitters would be functional during the 2009 study period. However, a total of 17 transmitters were detected at some time during 2009, and of those, 9 fish had detection histories consistent with live fish. The remaining 8 transmitters were stationary for some time and based on past detection histories, those fish were believed to have died or shed their transmitters. Of the 17 transmitters detected in 2009, four were implanted into fish during the 2006 tagging year; the other 13 transmitters were implanted into fish in 2007. Furthermore, of the 9 bull trout assumed to be alive with active transmitters, seven were confirmed to have entered the Entiat basin during the period of fall/winter residence (Table 3).

Table 2. Summary information on bull trout tagged at Rock Island (RIS) and Rocky Reach (RRH) dams from 2005 to 2007.

Tag	Release Information					Weight
Code	Year	Date	Time	Location	Length (cm)	(g)
1	2005	19-May	2:58 PM	RIS	61.5	2,971
2	2005	26-May	3:33 PM	RIS	43.0	990
3	2005	30-May	11:54 AM	RIS	45.0	1,244
4	2005	02-Jun	11:24 AM	RIS	46.0	1,224
5	2005	15-Jun	10:17 AM	RIS	49.0	1,318
6	2005	16-Jun	6:37 PM	RIS	48.0	1,347
7	2005	20-Jun	5:48 PM	RIS	44.0	1,207
8	2005	24-Jun	3:10 PM	RIS	48.0	1,453
151	2006	18-May	10:20 AM	RIS	57.0	2,300
152	2006	06-Jun	4:18 PM	RIS	65.0	3,671
153	2006	13-Jun	11:36 AM	RIS	55.5	1,972
154	2006	29-Jun	3:46 PM	RIS	47.0	1,243
101	2007	30-May	12:49 PM	RIS	51.5	---
102	2007	12-Jun	4:16 PM	RIS	40.0	910
103	2007	13-Jun	10:16 AM	RIS	49.5	1,367
				RIS Mean:	**50.0**	**1,658**
16	2005	19-May	11:33 AM	RRH	55.0	1,834
17	2005	20-May	5:12 PM	RRH	59.0	2,343
18	2005	24-May	10:28 AM	RRH	48.0	1,419
19	2005	24-May	12:30 PM	RRH	59.0	2,602
21	2005	24-May	3:30 PM	RRH	62.0	3,029
22	2005	24-May	4:30 PM	RRH	58.0	2,390
23	2005	25-May	5:16 PM	RRH	57.5	2,400
24	2005	26-May	8:40 AM	RRH	56.0	2,228
25	2005	26-May	11:54 AM	RRH	59.0	2,471
26	2005	26-May	12:48 PM	RRH	64.0	3,144
27	2005	26-May	1:57 PM	RRH	70.0	4,199
28	2005	27-May	11:10 AM	RRH	64.5	3,284
18	2005	24-May	10:28 AM	RRH	48.0	1,419
29	2005	30-May	6:28 PM	RRH	53.5	1,853
30	2005	31-May	3:36 PM	RRH	83.0	8,163
31	2005	31-May	4:47 PM	RRH	52.0	1,586
32	2005	01-Jun	3:53 PM	RRH	47.5	1,127
33	2005	03-Jun	10:37 AM	RRH	58.5	2,227
34	2005	06-Jun	5:28 PM	RRH	46.5	1,222
35	2005	07-Jun	10:26 AM	RRH	49.5	1,399
36	2005	07-Jun	12:12 PM	RRH	49.0	1,485
37	2005	07-Jun	1:13 PM	RRH	46.5	1,316
38	2005	07-Jun	4:32 PM	RRH	49.5	1,384
39	2005	08-Jun	10:23 AM	RRH	45.5	1,123
40	2005	16-Jun	1:29 PM	RRH	54.0	1,892
41	2005	16-Jun	3:35 PM	RRH	45.5	1,070
42	2005	16-Jun	4:33 PM	RRH	47.0	1,214
43	2005	20-Jun	4:14 PM	RRH	49.5	1,425
44	2005	27-Jun	3:51 PM	RRH	46.5	1,259
45	2005	29-Jun	5:14 PM	RRH	54.5	1,980
46	2005	30-Jun	10:39 AM	RRH	51.5	1,420

Tag	Release Information					Weight
Code	Year	Date	Time	Location	Length (cm)	(g)
166	2006	17-May	10:22 AM	RRH	64.5	3,392
167	2006	17-May	12:43 PM	RRH	72.0	4,163
168	2006	25-May	3:25 PM	RRH	70.0	4,167
169	2006	25-May	3:26 PM	RRH	59.0	2,736
170	2006	25-May	4:46 PM	RRH	60.0	2,796
171	2006	25-May	4:47 PM	RRH	65.0	3,308
172	2006	25-May	5:37 PM	RRH	66.0	3,640
173	2006	26-May	12:31 PM	RRH	67.5	3,763
174	2006	26-May	1:49 PM	RRH	58.5	2,752
175	2006	26-May	3:03 PM	RRH	59.0	2,632
176	2006	29-May	2:46 PM	RRH	66.0	3,495
177	2006	30-May	10:51 AM	RRH	58.0	2,394
178	2006	30-May	1:36 PM	RRH	52.5	1,675
179	2006	30-May	2:53 PM	RRH	60.0	2,482
180	2006	31-May	4:50 PM	RRH	55.0	2,136
181	2006	01-Jun	11:19 AM	RRH	53.5	1,864
182	2006	02-Jun	3:36 PM	RRH	62.0	3,191
183	2006	02-Jun	4:29 PM	RRH	54.0	1,796
184	2006	05-Jun	2:15 PM	RRH	53.0	1,814
185	2006	12-Jun	1:36 PM	RRH	51.0	1,525
186	2006	14-Jun	3:16 PM	RRH	45.0	1,062
187	2006	16-Jun	11:20 AM	RRH	55.0	1,929
188	2006	22-Jun	3:19 PM	RRH	45.0	1,040
189	2006	25-Jun	2:46 PM	RRH	69.5	3,668
190	2006	29-Jun	2:05 PM	RRH	51.5	1,976
111	2007	16-May	4:18 PM	RRH	59.0	2,576
112	2007	17-May	3:56 PM	RRH	64.0	3,897
113	2007	18-May	11:09 AM	RRH	55.0	2,114
114	2007	21-May	5:17 PM	RRH	69.0	4,006
115	2007	24-May	2:02 PM	RRH	68.5	4,157
116	2007	29-May	1:02 PM	RRH	65.0	3,547
117	2007	29-May	3:25 PM	RRH	71.0	4,422
118	2007	01-Jun	9:31 AM	RRH	61.5	2,619
119	2007	04-Jun	3:36 PM	RRH	61.5	3,005
120	2007	04-Jun	6:29 PM	RRH	61.0	2,580
121	2007	12-Jun	9:54 AM	RRH	61.5	2,423
122	2007	12-Jun	11:32 AM	RRH	50.0	1,642
123	2007	12-Jun	1:26 PM	RRH	43.0	1,128
124	2007	13-Jun	12:55 PM	RRH	58.5	2,680
125	2007	19-Jun	1:12 PM	RRH	55.0	2,165
126	2007	19-Jun	3:27 PM	RRH	60.0	2,979
				RRH Mean:	57.4	2,476
				Mean	**56.1**	**2,342**
				Median	**55.3**	**2,165**
				Minimum	**40.0**	**910**
				Maximum	**83.0**	**8,163**

Table 3. Summary of bull trout winter residence for fish detected during the 2005-2009 study period. Winter residence is defined as the tributary that each tagged fish entered without subsequent entry into another tributary of the Columbia River.

	Basin				
Year	**Columbia**	**Wenatchee**	**Entiat**	**Methow**	**Total**
2005	5	6	25	2	38
2006	4	6	29	7	46
2007	1	4	26	8	39
2008	7	1	18	2	28
2009	0	0	7	0	7
Total:	**17**	**17**	**105**	**19**	**158**

3.2 Transport and Release

Transport and release protocols were similar to those used in previous years (BioAnalysts, Inc. 2002 and 2004; and Stevenson et al. 2006). We followed the same general transport procedures at release sites near Rock Island and Rocky Reach dams. Following surgery, fish were placed into the recovery/transport vessel, which was a large volume cooler. The cooler was plumbed with PVC tubing that was in turn connected to an in-river pump that supplied ambient river water. During fish recovery, water within the recovery vessel was aerated. Fish were allowed to recover to the point where equilibrium was regained, which usually required about 15 minutes. At Rock Island Dam, the transport vessel was then transported by truck to the boat dock, which was approximately 150 m from the surgical station. At Rocky Reach Dam, the surgical station was located near the fishway exit, and as such, the transport vessel could be transported by hand to a waiting boat. At both locations, the transport vessel was loaded onto a boat and transported upstream to be released. Due to the short distance to both release sites, there was no need to provide supplemental oxygen or attempt to regulate water temperature.

At the release site, we recorded the water temperature within the vessel and within the river. The vessel was then lowered into the river and gently rolled onto its side. The lid was then opened allowing the fish to swim free of the vessel. The swimming behavior of the fish was observed and any abnormalities were noted. All 86 tagged bull trout appeared to be healthy and vigorous at the time of release.

3.3 General Observations for 2009

Of the 17 bull trout transmitters still active and detected in 2009, we believe that 9 bull trout were alive. For the other 8 fish, based on an extended stationary detection history we believe the fish either died or shed their transmitters.

Of the nine active bull trout, it was possible to confirm that 3 migrated past Chelan PUD projects. In addition to these three fish, a fourth was believed to have migrated upstream of both Rock Island and Rocky Reach dams and then eventually entered the Entiat River. However, detection histories of this fish suggest that the transmitter was failing, emitting a "Code 255", which is indistinguishable from electrical noise or possibly other transmitters in the early phase of failing. Since this transmitter could not be uniquely identified, we could not assess migration times.

For the three fish that passed either up or downstream of a Chelan PUD project, all three migrated past Rocky Reach Dam. There were no passage events documented at Rock Island Dam in 2009. One fish, code 117, was detected upstream of Rocky Reach Dam near Turtle Rock Island during a mobile survey on 17 February 2009, and was subsequently detected in the tailrace of Rocky Reach Dam on 26 April. For that fish, the route of downstream passage at Rocky Reach was unknown. However, that fish subsequently migrated upstream of Rocky Reach Dam shortly after being detected in the tailrace, and ultimately entered the Entiat River. This fish was detected by USFWS personnel in Box Canyon (RK 47.2) on 9 September, and later near the mouth of the Entiat River on 31 October. Another fish, code 113, migrated upstream of Rocky Reach Dam after residing in the mainstem Columbia River between Rock Island Dam and the Wenatchee River confluence during the first half of 2009. After migrating upstream of Rocky Reach Dam, this fish entered the Entiat River and was last detected on 31 October by USFWS personnel as it migrated downstream into the Columbia River. This fish was located within the Mad River drainage prior to exodus of the Entiat River basin. The third fish, code 114, was in the process of migrating upstream of Rocky Reach Dam when the telemetry systems were shut-down on 19 June 2009. Therefore, detailed passage information for this fish is not available. However, USFWS personnel later detected this fish during one of their surveys within the Entiat basin on 29 October at Box Canyon.

For the five remaining bull trout that did not migrate upstream of a Chelan PUD project, four migrated into a tributary of the Columbia River in 2009. The fifth fish, code 167, was last detected within the mainstem Columbia River on 17 February during a boat survey. That was the last known location for this fish, and we believe that its transmitter may have failed prior to tributary entrance. Three bull trout (codes 118, 120, and 123) were all detected in Box Canyon within the Entiat River on 9 September by USFWS personnel. The fourth fish, code 102, entered the Methow River on 8 June, the Twisp

River on 20 June, and eventually migrated back into the mainstem Columbia River on 10 July.

For the 2005 to 2009 study period, the primary location of fall/winter residence was within the Entiat basin (Table 3). Of the 158 documented sites of fall/winter residence, 105 occurred within the Entiat basin, which includes the Mad River. Within the mainstem Entiat River, fish commonly resided upstream of Preston Creek, or more specifically, Box Canyon.

3.4 Migration Times at Rock Island and Rocky Reach Dams

The metrics used to assess bull trout migration past Chelan County PUDs projects are the same as those reported in the 2005, 2006, 2007, and 2008 annual reports (Stevenson et al. 2006, 2007, 2008, and 2009). Table 4 presents information on different components of bull trout migration time through Chelan County's hydroelectric projects. The four metrics used to describe migration times at the projects were tailrace residence time, fishway cycling time, fishway migration time, and project migration time. Incomplete detection histories for some tagged fish detected at the project precluded estimation of all four metrics. That is, for the metrics estimated if there was no detection in the tailrace or fishway entrance or exit, we could not estimate specific migration metrics. The four metrics used to describe movement through the project are defined as:

- **Tailrace Residence Time -** This metric is defined as the elapsed time between first detection by the aerial tailrace array and the first detection within any of the entrances to the fishway.

- **Fishway Cycling Time -** The metric is defined as the elapsed time between the first detection within any of the fishway entrances and the final detection as the fish enters the fishway.

- **Fishway Migration Time -** This metric is the elapsed time between the detection at the time of final entry into the fishway and the first detection as the fish exited the fishway.

- **Project Migration Time -** The sum of the travel time through the Tailrace, the Fishway Cycling Time, and the Fishway Migration Rate, which is also the elapsed time between the first detection by the tailrace array and the first detection as the fish exited the fishway.

Rocky Reach Project - Of the 86 bull trout tagged during the study period, 29 unique fish were detected as they migrated upstream of Rocky Reach Dam, with some bull trout being detected on more than one occasion (e.g., codes 24 and 151). There were 41

upstream passage events at Rocky Reach Dam; however, the number of metrics that could be estimated depended on the completeness of the detection history for each fish passing the project. For the 29 fish detected at the project, there were 34 unique tailrace detections at Rocky Reach Dam for which tailrace time could be estimated. For tagged bull trout, the majority (65%) resided in the tailrace for less than 1 day. For the entire study period, the median residence time for all tagged bull trout entering the Rocky Reach tailrace was 0.28 days (6.6 hrs) with a displayed range of 0.03 to 5.07 days (Table 4).

There were 38 unique fish detections at the fishway entrance at Rocky Reach Dam that were used to estimate fishway cycling time. Upon first detection at the fishway entrance, most fish (74%) spent at least one day traveling in and out of the fishway before resuming their movement upstream completely through the fishway (Table 4). The median fishway cycling time displayed at Rock Reach Dam was 2.48 days (59.5 hrs; Table 4). The range in fishway cycling time varied from 0.00 to 14.82 days.

There were 34 unique fish detections in the Rocky Reach fishway that were used to estimate fishway migration time. Upon last detection at the fishway entrance, most fish (97%) had ascended the fishway in less than 1 day. The median fishway migration time displayed at Rock Reach was 0.25 days (5.9 hrs; Table 4), and the range in fishway migration time varied from 0.12 to 2.07 days.

There were 32 unique fish detections at the Rocky Reach project that were used to estimate project migration time. From the time tagged bull trout were first detected in the tailrace until they exited the fishway, most bull trout (63%) passed the project in less than 5 days. The median project migration time displayed at Rock Reach was 3.84 days (92 hrs; Table 4). The range in project migration time displayed at Rocky Reach varied from 0.93 to 17.20 days.

Table 4. Migration time metrics for bull trout passing Rocky Reach Dam, 2005-2009.

		Migration Time (days)			
Year	**Code**	**Tailrace**	**Fishway Cycling**	**Fishway Migration**	**Project Migration**
2005	2	3.78	6.48	0.46	10.72
2005	3	0.29	6.68	0.21	7.18
2005	4	0.03	8.10	0.19	8.32
2006	19	3.69	13.30	0.21	17.20
2006	24	4.27	7.20	---	---
2006	24	5.07	1.17	0.38	6.63
2006	25	3.83	0.42	0.18	4.44
2006	25	1.26	3.23	0.13	4.62
2006	29	---	8.91	---	---
2006	35	0.32	0.00	0.73	1.05
2006	38	3.72	9.08	0.24	13.04
2006	38	0.29	1.61	0.17	2.06
2006	40	0.32	0.50	0.28	1.10
2006	40	---	0.16	0.23	---
2006	42	0.08	0.83	---	---
2006	45	0.06	1.49	0.25	1.80
2006	151	---	2.82	0.35	---
2006	153	1.17	0.11	0.20	1.48
2006	172	3.20	3.02	---	---
2007	40	---	0.40	0.74	---
2007	45	0.15	1.97	0.23	2.35
2007	151	0.05	2.08	0.29	2.41
2007	166	0.21	4.94	0.19	5.34
2007	173	0.04	1.86	0.16	2.06
2007	175	0.25	10.72	0.25	11.22
2007	178	0.04	4.06	0.26	4.36
2007	181	0.05	2.76	0.50	3.32
2007	184	0.03	2.91	0.12	3.05
2007	188	0.14	1.33	0.23	1.70
2007	190	0.26	1.14	0.20	1.60
2008	29	---	---	---	5.24
2008	102	0.17	0.10	0.66	0.93
2008	113	0.07	4.45	0.32	4.84
2008	114	0.05	0.10	2.07	2.22
2008	123	0.14	8.35	0.25	8.74
2008	151	1.89	0.00	0.24	2.13
2008	166	---	---	---	9.46
2008	174	1.20	5.71	0.24	7.15
2009	113	0.31	2.20	0.38	2.89
2009	114	1.64	---	---	---
2009	117	---	14.82	0.83	---
	Mean:	1.12	3.82	0.36	5.02
	Median:	0.28	2.48	0.25	3.84
	Minimum:	0.03	0.00	0.12	0.93
	Maximum:	5.07	14.82	2.07	17.20

Rock Island Project - Of the 86 bull trout tagged during the study period, 4 unique fish were detected as they passed upstream of Rock Island Dam, with one bull trout being detected in two subsequent years (code 151). As discussed previously, there were no tagged bull trout detected passing Rock Island Dam in 2009. Of the 5 upstream passage events at Rock Island Dam, four fish detections at the project could be used to estimate tailrace residence time. The median residence time for tagged bull trout entering the Rock Island tailrace was 0.26 days (6.3 hrs), with a displayed range of 0.04 to 3.43 days (Table 5).

There were 3 unique fish detections at the Rock Island fishways that were used to estimate fishway cycling and fishway migration times. The median fishway cycling time displayed at Rock Island was 0.84 days (20.1 hrs; Table 5). The range in fishway cycling time varied from 0.02 to 18.40 days. The median fishway migration time displayed at Rock Island was 0.23 days (5.6 hrs; Table 5). The range in fishway migration time varied from 0.07 to 0.47 days.

There were 5 unique fish detections at the Rock Island project that were used to estimate project migration time. The median project migration time displayed at Rock Island was 1.38 days (92 hrs; Table 5). The range in project migration time displayed at Rock Island varied from 0.29 to 18.93 days.

Review of most project migration times at Rocky Reach and Rock Island dams suggest that most of the time spent ascending the projects occurred at or near the fishway entrance (fishway cycling time; Tables 4 and 5). In comparison, relatively little time was spent in the tailrace or within the fishway (fishway migration time) after last detection at the fishway entrance.

Table 5. Migration time metrics for bull trout passing Rock Island Dam, 2005 – 2009.

		Migration Time (days)			
Year	**Code**	**Tailrace Time**	**Fishway Cycling**	**Fishway Migration**	**Project Migration**
2006	42	3.43	---	---	5.04
2007	151	0.06	18.40	0.47	18.93
2007	188	0.46	0.84	0.07	1.38
2008	102	0.04	0.02	0.23	0.29
2008	151	---	---	---	0.56
	Mean:	1.00	6.42	0.26	5.24
	Median:	0.26	0.84	0.23	1.38
	Minimum:	0.04	0.02	0.07	0.29
	Maximum:	3.43	18.40	0.47	18.93

3.5 Inriver Upstream Migration

During the 2005 to 2009 study period, we monitored bull trout migration in the Columbia River from Rock Island and Rocky Reach dams to upstream tributaries or projects (Tables 6 and 7). For fish exiting the Rock Island fishways or released upstream of the dam, we calculated migration time to either the Wenatchee River fixed-telemetry site (RK 12.5), or Rocky Reach Dam (RK 762.3). Similarly, inriver migration times from Rocky Reach Dam were calculated to the Entiat River telemetry site (RK 4.8) or Wells Dam (RK 830.1).

The migration distance from Rock Island Dam to the Wenatchee River telemetry site, and from Rock Island to Rocky Reach Dam were 36.2 km and 32.7 km, respectively. The median migration time from Rock Island Dam to the Wenatchee River telemetry site was 6.87 days with a range of 2.4-15.4 days. Based on the median migration time the migration rate between Rock Island Dam to the Wenatchee River telemetry site was about 5.3 km/day. In comparison, the median migration time between Rock Island Dam to Rocky Reach Dam was 2.28 days with a range of 0.9 to 4.8 days. Based on the median migration time, the migration rate displayed by bull trout migrating up the Columbia River to Rocky Reach Dam was 14.3 km/day.

For fish exiting the Rocky Reach fishway, or released upstream of the dam, the migration distance to the Entiat River telemetry site was 19.9 km. For fish migrating upstream to Wells Dam, the distance was 67.8 km. The median migration time from Rocky Reach Dam to the Entiat River telemetry site was 6.87 days with a range of 2.4-15.4 days (Table 7). Based on the median migration time, the migration rate between Rocky Reach Dam to the Entiat River telemetry site was about 1.9 km/day. In comparison, the median migration time between Rocky Reach Dam to Wells Dam was 2.88 days with a range of 1.28 to 10.78 days (Table 7). Based on the median migration time, the migration rate displayed by bull trout migrating up the Columbia River to Wells Dam was 23.5 km/day.

Clearly, the migration rate within the Columbia River to the next upstream project is much faster when compared to migrations upstream to the Wenatchee and Entiat river telemetry sites. This may suggest that tagged bull trout entering these tributaries may stage within the Columbia River or within the lower Wenatchee and Entiat rivers prior to migrating upstream and being detected at the tributary telemetry sites. As discussed in previous reports (Stevenson et al. 2006, 2007, 2008, and 2009), the migration rate between the Rocky Reach fishway exit and the Entiat River site may seem slow, given other migration rates observed. However, on a number of occasions, mobile surveys conducted by Chelan PUD and the USFWS have identified tagged bull trout holding at the confluences of the Wenatchee and Entiat rivers, as well as in pools downstream of the fixed-telemetry tributary sites (Chelan PUD, unpublished data; Mark Nelson, USFWS, personal communication). The reason why bull trout tend to stage near or within the lower rivers is unknown.

Table 6. Migration time for bull trout from Rock Island Dam to the Wenatchee River telemetry site and the tailrace of Rocky Reach Dam, 2005-2009.

		Exit Rock Island Dam	First Detection at:		Migration Time to: (days)	
Year	Code	Date/Time	Wenatchee River	Rocky Reach Dam	Wenatchee River	Rocky Reach Dam
2005	1	5/19 14:58	5/24 23:37	---	5.35	---
2005	2	5/26 15:33	---	5/27 15:09	---	0.98
2005	3	5/30 11:54	---	6/04 07:38	---	4.82
2005	4	6/02 11:24	---	6/05 07:00	---	2.82
2005	5	6/15 10:17	---	6/17 07:05	---	1.87
2005	6	6/16 18:37	6/19 05:10	---	2.44	
2005	7	6/20 17:48	---	6/23 09:29	---	2.65
2005	8	6/24 15:10	---	6/25 17:24	---	1.09
2006	151	5/18 10:20	---	5/21 09:27	---	2.96
2006	152	6/06 16:18	6/22 01:53	---	15.40	---
2006	153	6/13 11:36	6/18 06:25	---	4.78	---
2006	154	6/29 15:46	7/08 00:42	---	8.37	---
2007	101	5/30 12:49	6/11 01:25	---	11.53	---
2007	102	6/12 16:16	---	6/17 10:45	---	4.77
2007	103	6/13 10:16	6/20 07:09	---	6.87	---
2007	151	6/11 09:30	---	6/12 06:51	---	0.91
2007	188	6/08 15:49	---	6/10 04:45	---	1.54
2008	102	6/05 18:18	---	6/08 13:03	---	2.78
2008	151	5/20 22:42	---	5/22 20:34	---	1.91
				Mean:	7.82	2.43
				Median:	6.87	2.28
				Minimum:	2.44	0.91
				Maximum:	15.40	4.82

Table 7. The migration time of tagged bull trout passing Rocky Reach Dam to either the Entiat River telemetry site or the tailrace of Wells Dam, 2005 - 2009.

		Exit Rocky Reach Dam	First Detection at:		Migration Time to: (days)	
Year	Code	Date/Time	Entiat River	Wells Dam	Entiat River	Wells Dam
2005	2	6/07 08:21	6/10 21:17	---	3.54	---
2005	3	6/11 12:01		6/12 19:56	---	1.33
2005	4	6/13 14:41	6/19 22:35	---	6.33	---
2005	16	5/19 11:33	5/29 18:44	---	10.30	---
2005	17	5/20 17:12	5/30 22:09	---	10.21	---
2005	18	5/24 10:28	6/09 16:22	---	16.25	---
2005	19	5/24 12:30	5/30 02:31	---	5.58	---
2005	21	5/24 15:30	6/05 05:18	---	11.58	---
2005	22	5/24 16:30	---	---	---	---
2005	23	5/25 17:16	6/09 02:26	---	14.38	---
2005	24	5/26 08:40	6/06 04:23	---	10.82	---
2005	25	5/26 11:54	5/30 21:00	---	4.38	---
2005	26	5/26 12:48	5/29 11:35	---	2.95	---
2005	27	5/26 13:57	6/02 22:02	---	7.34	---
2005	28	5/27 11:10	6/05 23:18	---	9.51	---
2005	29	5/30 18:28	6/09 02:00	---	9.31	---
2005	30	5/31 15:36	---	6/11 10:25	---	10.78
2005	31	5/31 16:47	---	6/02 19:51	---	2.13
2005	32	6/01 15:53	6/12 02:12	---	10.43	---
2005	33	6/03 10:37	6/06 23:40	---	3.54	---
2005	34	6/06 17:28	---	6/11 01:10	---	4.32
2005	35	6/07 10:26	6/14 01:53	---	6.64	---
2005	36	6/07 12:12	---	6/11 18:32	---	4.26
2005	37	6/07 13:13	6/17 05:00	---	9.66	---
2005	38	6/07 16:32	6/15 01:11	---	7.36	---
2005	39	6/08 10:23	6/11 03:10	---	2.70	---
2005	40	6/16 13:29	6/17 23:36	---	1.42	---
2005	41	6/16 15:35	---	6/20 10:43	---	3.80
2005	42	6/16 16:33	---	6/26 02:59	---	9.43
2005	43	6/20 16:14	6/24 02:23	---	3.42	---
2005	44	6/27 15:51	---	6/29 10:25	---	1.77
2005	45	6/29 17:14	7/02 23:58	---	3.28	---
2005	46	6/30 10:39	---	7/01 17:16	---	1.28
2006	19	6/27 19:25	6/30 21:34	---	3.09	---
2006	24	6/08 18:48	6/19 13:02	---	10.76	---
2006	25	6/10 15:37	6/19 16:08	---	9.02	---
2006	35	5/30 06:12	6/21 20:08	---	22.58	---
2006	38	6/21 13:20	6/24 22:32	---	3.38	---
2006	40	7/01 17:19	7/03 22:01	---	2.20	---
2006	45	6/21 06:51	6/30 00:06	---	8.72	---
2006	151	5/24 14:09	6/20 18:36	---	27.19	---
2006	153	6/30 16:10	7/02 21:27	---	2.22	---
2006	166	5/17 10:22	5/31 21:39	---	14.47	---
2006	167	5/17 12:43	6/06 00:34	---	19.49	---

Year	Code	Exit Rocky Reach Dam Date/Time	First Detection at: Entiat River	First Detection at: Wells Dam	Migration Time to: (days) Entiat River	Migration Time to: (days) Wells Dam
2006	168	5/25 15:25	6/03 17:40	---	9.09	---
2006	169	5/25 15:26	6/22 16:39	---	28.05	---
2006	170	5/25 16:46	6/17 05:55	---	22.55	---
2006	171	5/25 16:47	---	5/27 10:12	---	1.73
2006	173	5/26 12:31	6/07 14:48	---	12.10	---
2006	174	5/26 13:49	---	5/29 13:18	---	2.98
2006	175	5/26 15:03	6/18 16:36	---	23.07	---
2006	176	5/29 14:46	6/11 18:17	---	13.15	---
2006	177	5/30 10:51	---	6/02 04:36	---	2.74
2006	178	5/30 13:36	6/21 19:58	---	22.27	---
2006	179	5/30 14:53	6/21 20:03	---	22.22	---
2006	180	5/31 16:50	---	6/03 04:52	---	2.50
2006	181	6/01 11:19	6/20 22:42	---	19.47	---
2006	182	6/02 15:36	---	6/12 08:06	---	9.69
2006	183	6/02 16:29	6/23 03:57	---	20.48	---
2006	184	6/05 14:15	---	6/10 20:07	---	5.24
2006	185	6/12 13:36	6/24 21:13	---	12.32	---
2006	186	6/14 15:16	---	6/19 07:08	---	4.66
2006	187	6/16 11:20	6/23 00:13	---	6.54	---
2006	188	6/22 15:19	---	6/26 06:24	---	3.63
2006	189	6/25 14:46	7/02 2:43	---	6.50	---
2006	190	6/29 14:05	---	7/02 11:13	---	2.88
2007	111	5/16 16:18	---	5/19 23:46	---	3.31
2007	112	5/17 15:56	---	5/19 18:59	---	2.13
2007	113	5/18 11:09	6/11 10:59	---	23.99	---
2007	114	5/21 17:17	6/11 11:10	---	20.75	---
2007	115	5/24 14:02	---	5/27 09:02	---	2.79
2007	116	5/29 13:02	---	6/02 19:57	---	4.29
2007	117	5/29 15:25	6/10 16:03	---	12.03	---
2007	118	6/01 09:31	6/19 02:13	---	17.70	---
2007	119	6/04 15:36	6/17 22:34	---	13.29	---
2007	120	6/04 18:29	6/16 11:45	---	11.72	---
2007	121	6/12 09:54	6/21 21:33	---	9.49	---
2007	122	6/12 11:32	6/21 22:49	---	9.47	---
2007	123	6/12 13:26	7/01 20:49	---	19.31	---
2007	124	6/13 12:55	6/21 11:57	---	7.96	---
2007	125	6/19 13:12	6/29 21:38	---	10.35	---
2007	126	6/19 15:27	6/27 22:04	---	8.28	---
2007	40	5/22 17:54	6/14 22:48	---	23.20	---
2007	45	6/23 00:35	6/26 22:55	---	3.93	---
2007	151	6/14 16:44	6/18 15:07	---	3.93	---
2007	166	5/17 16:56	5/22 14:45	---	4.91	---
2007	173	5/19 14:29	5/30 23:12	---	11.36	---
2007	175	6/13 12:47	6/17 13:43	---	4.04	---
2007	178	6/04 13:17	6/15 22:29	---	11.38	---
2007	181	5/24 18:06	6/12 19:31	---	19.06	---
2007	184	7/02 11:20	---	7/04 09:03	---	1.90
2007	188	6/11 21:40	---	6/14 16:20	---	2.78

Year	Code	Exit Rocky Reach Dam Date/Time	First Detection at: Entiat River	First Detection at: Wells Dam	Migration Time to: (days) Entiat River	Migration Time to: (days) Wells Dam
2007	190	6/08 14:46	---	6/10 17:31	---	2.11
2008	113	6/20 04:37	7/02 22:10	---	12.73	---
2008	114	6/02 12:55	6/08 18:25	---	6.23	---
2008	123	6/12 23:32	6/23 22:21	---	10.95	---
2008	151	5/27 19:05	6/07 23:17	---	11.17	---
2008	166	5/26 17:29	5/28 10:38	---	1.71	---
2009	113	5/31 02:12	6/10 22:57	---	10.86	---
2009	117	6/02 06:44	6/08 20:28	---	6.57	---
				Mean:	11.06	3.78
				Median:	10.25	2.88
				Minimum:	1.42	1.28
				Maximum:	28.05	10.78

3.6 Project Passage Events

During the 2005 to 2009 study period there were a total of 102 passage events at Rock Island and Rocky Reach dams combined. Table 8 presents a summary of the 102 passage events that occurred at the projects and are designated by the direction (upstream or downstream) in which the bull trout traveled. There were 14 passage events at Rock Island Dam and 88 passage events at Rocky Reach Dam. Details on upstream passage events and their associated passage indices are discussed in Section 3.4, and therefore, will not be repeated here. However, it should be noted that for the 46 upstream passage events documented at Rock Island and Rocky Reach dams during the period of 2005 to 2009, no instances of mortality was observed.

Table 8. Upstream and downstream bull trout passage events summarized for Rock Island and Rocky Reach dams, 2005 - 2009. Migration upstream through the projects usually occurred from April through July and downstream passage typically occurred from October through December.

Year	N	Rock Island Dam Downstream	Rock Island Dam Upstream	Rocky Reach Dam Downstream	Rocky Reach Dam Upstream
2005	14	2	0	9	3
2006	41	3	1	21	16
2007	30	4	2	13	11
2008	13	0	2	3	8
2009	4	0	0	1	3
Total:	102	9	5	47	41

In general, most downstream passage events occurred during the fall and winter, although some bull trout migrated downstream during the spring and summer in years following their initial tagging and release at the project. For Rock Island Dam, there were nine fish that accounted for the nine downstream passage events that occurred during the study period. No tagged bull trout passed downstream of Rock Island in 2008 or 2009 (Tables 8 and 9). Six tagged bull trout passed downstream of the project undetected by the telemetry systems, and therefore, location of passage is unknown. For three other bull trout, one migrated downstream of the project through the spillway, another through Powerhouse 2, and the third through one of the two powerhouses. None of the downstream passage events at Rock Island Dam occurred shortly after they were released or after they had ascended the fishway. For all nine bull trout, downstream migration followed residency upstream of the dam, either in the mainstem Columbia River or one of its tributaries for an extended period of time.

At Rocky Reach Dam there were 31 bull trout that accounted for the 47 downstream passage events (Tables 8 and 9). The route of downstream passage at Rocky Reach most often occurred through the powerhouse (35 passage events) followed by the spillway and surface collector (2 passage events each). For eight passage events, the route of passage could not be ascertained. For those eight events, passage through the project was confirmed by detection histories upstream and downstream of the project.

There was no downstream passage of tagged bull trout following ladder exodus during the 2007-2009 period, and only one event at Rocky Reach Dam in 2005. In 2005, a single fish (code 22) migrated downstream of the project after the fish was tagged and released. That fish was detected in the forebay of Rocky Reach Dam approximately 2.5 hours after release, and the next day in the tailrace of the dam. The fish passed downstream through the powerhouse, and was detected in the tailrace for approximately 4 days prior to entering the Wenatchee River where it resided for some time. The behavior of this fish may suggest that it overshot the Wenatchee River and simply migrated back downstream past Rocky Reach Dam to reach its intended destination.

In 2006, four bull trout (codes 24, 25, 38, and 40) migrated back downstream of Rocky Reach Dam after an initial ascent of the fishway, only to re-ascend a second time (Tables 4 and 9). For those four fish, the mean elapsed time between fishway exit and downstream passage at Rocky Reach Dam was 3.56 hours (range of 0.68 to 5.91 hours). A fifth bull trout (code 172), was released upstream of Rocky Reach Dam after being tagged, migrated downstream of the project, and ultimately re-ascended the fishway. For all five of these bull trout exhibiting this behavior, they re-ascended the Rocky Reach fishway and migrated upstream of the project. For the 56 downstream passage events observed at Rocky Reach and Rock Island dams, no confirmed mortalities of tagged bull trout was observed.

Table 9. Downstream bull trout passage events at Rock Island and Rocky Reach dams, 2005 - 2009.

Year	Code	Date	Location	Dam
2005	1	10/22/05	Unknown	RIS
2005	6	6/19/05 - 10/23/05	Unknown	RIS
2006	42	5/19/06 - 5/21/06	Unknown	RIS
2006	152	10/21/06 - 10/26/06	Powerhouse 1 or Powerhouse 2	RIS
2006	188	12/09/06 07:47:40	Powerhouse 2; Turbine 7 or Turbine 8	RIS
2007	23	7/25/07 02:41:00	Spillbay 1	RIS
2007	31	7/11/07 - 7/14/07	Unknown	RIS
2007	102	7/27/07 - 12/17/07	Unknown	RIS
2007	151	11/28/07 - 11/29/07	Unknown	RIS
2005	16	12/26/05 09:36:54	Turbine 5	RRH
2005	22	5/24/05 19:01:38	Turbine 11	RRH
2005	24	10/20/05 10:38:58	Turbine 1	RRH
2005	26	10/04/05 16:32:22	Turbine 1	RRH
2005	27	10/15/05 16:43:11	Turbine 1	RRH
2005	34	10/19/05 - 11/11/05	Unknown	RRH
2005	38	10/31/05 22:15:45	Turbine 1	RRH
2005	41	11/13/05	Powerhouse	RRH
2005	42	8/27/05	Unknown	RRH
2006	24	6/02/06 03:26:24	Turbine 2	RRH
2006	25	5/05/06 - 6/01/06	Unknown	RRH
2006	25	6/05/06 23:15:29	Turbine 4	RRH
2006	29	3/07/06 12:36:38	Turbine 5	RRH
2006	31	7/04/06 22:32:38	Juvenile Bypass System	RRH
2006	35	3/04/06 15:59:30	Turbine 1	RRH
2006	38	6/12/06 20:12:00	Spillbay 3	RRH
2006	40	5/16/06 - 6/30/06	Unknown	RRH
2006	40	7/01/06	Unknown	RRH
2006	40	11/09/06 - 11/10/06	Powerhouse	RRH
2006	42	10/18/06	Powerhouse	RRH
2006	45	5/25/06 08:20:55	Turbine 3	RRH
2006	151	8/25/06 - 8/26/06	Powerhouse	RRH
2006	166	11/02/06 - 11/11/06	Powerhouse	RRH
2006	170	10/09/06 18:02:34	Turbine 2	RRH
2006	172	5/26/06 02:56:12	Turbine 11	RRH
2006	175	11/11/06 - 11/15/06	Powerhouse	RRH
2006	178	11/09/06 12:21:36	Powerhouse	RRH
2006	181	11/12/06	Powerhouse	RRH
2006	182	8/10/06 - 8/12/06	Unknown	RRH
2006	188	11/23/06 17:21:30	Turbine 1	RRH
2007	23	7/21/07 15:48:56	Spillbay 6	RRH
2007	25	5/13/07 07:24:04	Turbine 1	RRH
2007	45	6/04/07 12:24:39	Juvenile Bypass System	RRH
2007	112	10/02/07 15:23:03	Turbine 8	RRH
2007	113	12/09/07 19:09:05	Turbine 3	RRH
2007	114	10/05/07 07:50:41	Turbine 10	RRH
2007	123	11/30/07 - 12/05/07	Unknown	RRH

Year	Code	Date	Location	Dam
2007	126	11/04/07 18:09:40	Turbine 10	RRH
2007	151	11/28/07	Powerhouse	RRH
2007	166	11/15/07	Powerhouse	RRH
2007	175	10/23/07	Powerhouse	RRH
2007	181	12/03/07 10:28:18	Turbine 3	RRH
2007	190	3/29/07 09:16:31	Turbine 7	RRH
2008	113	12/03/08 21:41:14	Turbine 4	RRH
2008	114	11/06/08 18:16:55	Turbine 3	RRH
2008	151	11/25/08 - 11/26/08	Powerhouse	RRH
2009	117	2/17/09 - 4/26/09	Unknown	RRH

3.7 Transmitter Recovery

A total of 86 bull trout were tagged during the period of 2005-2007. Of those, 30 tagged bull trout (34.9%) have either perished or shed their transmitters (Table 10). That percentage is similar to observations made by other researchers. For example, of the 20 bull trout tagged and released from Wells Dam during 2006-2007 by Douglas PUD, seven transmitters (35.0%) were recovered (unpublished data, USFWS). During the 2001-2002 bull trout study funded by the Mid-Columbia PUDs, 35.0% of the transmitters (14 of 40 bull trout tagged in 2002) were recovered following initial release into the mainstem Columbia River. Most (78.6%) were found in tributaries. Of those recoveries, only one carcass was found (BioAnalysts 2004).

Table 10 summarizes all documented transmitter and carcass recoveries for bull trout tagged from 2005-2007. There were seven transmitters recovered in 2005, four recovered in 2006, eleven recovered in 2007, and eight recovered in 2008. No transmitters were recovered in 2009. Nine transmitters were recovered with a carcass, 19 without a carcass and two were inconclusive. Twenty percent of the transmitters were located in the mainstem Columbia River and 80% in tributaries of the Columbia River. Six transmitters were recovered in the Columbia River, four within the Wenatchee River basin, four within the Methow River basin, and sixteen were recovered in the Entiat River basin (Table 10). Appendix A provides a more comprehensive summary of transmitter recovery locations for each year.

It is important to note that potential fish mortality based on transmitter recovery may not accurately represent the true fate of the fish. In radiotelemetry research, estimates of mortality are based on transmitter recovery. That is, the recovery of a transmitter is based on the ability of the researcher to locate and recover the transmitter as well as assign a fate to that particular tagged fish. Simply put, if a transmitter is shed or the fish dies in deep water where the transmitter cannot be detected or recovered, the fate of the fish cannot be assigned. Conversely, if a transmitter is recovered without a carcass the fate of the fish is still unknown.

Table 10. Summary of all documented transmitter and carcass recoveries, 2005 - 2009.

Code	Date of Recovery	Basin	Location	Carcass Recovered
5	10/04/2005	Wenatchee River	Snow Creek	No
2	10/06/2005	Entiat River	Mad River	No
4	10/06/2005	Entiat River	Mad River	Yes
33	10/24/2005	Entiat River	Upper Entiat River	No
18	10/25/2005	Entiat River	Mad River	Yes
36	10/28/2005	Entiat River	Upper Entiat River	No
37	10/28/2005	Entiat River	Upper Entiat River	Yes
6	9/06/2006	Columbia River	Columbia River	No
154	9/19/2006	Wenatchee River	Icicle Creek	No
39	9/21/2006	Entiat River	Upper Entiat River	No
172	10/18/2006	Entiat River	Entiat River	Yes
186	1/10/2007	Columbia River	Columbia River	No
153	2/20/2007	Entiat River	Entiat River	No
44	4/04/2007	Entiat River	Entiat River	Yes
189	4/04/2007	Columbia River	Columbia River	Inconclusive
26	5/09/2007	Columbia River	Columbia River	Yes
101	8/14/2007	Wenatchee River	Peshastin Creek	No
31	9/11/2007	Columbia River	Columbia River	No
177	9/12/2007	Methow River	Foggy Dew Creek	Yes
185	10/02/2007	Entiat River	Mad River	No
190	11/01/2007	Methow River	Twisp River	Yes
171	11/08/2007	Methow River	Methow River	Yes
119	3/05/2008	Columbia River	Columbia River	Inconclusive
103	3/31/2008	Wenatchee River	Peshastin Creek	No
168	4/23/2008	Entiat River	Upper Entiat River	No
169	4/23/2008	Entiat River	Upper Entiat River	No
111	10/03/2008	Methow River	Methow River	No
178	12/02/2008	Entiat River	Upper Entiat River	No
179	12/02/2008	Entiat River	Upper Entiat River	No
183	12/02/2008	Entiat River	Upper Entiat River	No

Note: For the code 189 transmitter, remains of a fish were uncovered at the time of the search. However, due to zero visibility, it was impossible to say positively that the remains were associated with the transmitter. Furthermore, it was not possible to identify the fish species.

3.8 Conclusions and Observations

Based on the data collected during the period 16 May 2005 through 19 June 2009, we offer the following conclusions and observations:

1. During the 2009 study period, a total of 17 active transmitters were detected at some time. Of those, we believe that 9 tagged bull trout were alive and active, and that the other 8 tagged trout had either perished or shed their transmitters.

2. Based on detection histories of the 9 bull trout in 2009, we observed no passage at Rock Island Dam, and three total passage events at Rocky Reach Dam. At Rocky Reach, one tagged trout was observed migrating downstream of the project through an unknown route; that fish and two others were observed migrating upstream through the Rocky Reach fishway.

3. For the nine tagged bull trout detected in 2009, seven migrated into the Entiat basin, another into the Methow basin, and another was last detected in the mainstem Columbia River. For that fish, we believe its transmitter failed prior to tributary entry.

4. During the 2005 to 2009 study period, telemetry systems at Rocky Reach and Rock Island dams, as well as tributary sites on the Wenatchee and Entiat rivers operated continuously for 1,496 days with minor exceptions due to system outages or fishway maintenance. Furthermore, during the study period, a total of 35 aerial, 39 boat, and 2 truck mobile surveys were conducted.

5. During the 2005 to 2009 study period, a total of 41 upstream passage events occurred at Rocky Reach Dam. For those events, the median Tailrace Residence, Fishway Cycling, Fishway Migration, and Project Migration times were 0.28, 2.48, 0.25, and 3.84 days, respectively.

6. During the 2005 to 2009 study period, a total of 5 upstream passage events occurred at Rock Island Dam. For those events, the median Tailrace Residence, Fishway Cycling, Fishway Migration, and Project Migration times were 0.26, 0.84, 0.23, and 1.38 days, respectively.

7. Based on Conclusions 4 and 5, it is clear that bull trout spend the majority of the time at either Rock Island or Rocky Reach dams moving in and out of the fishways prior to final fishway passage.

8. The in-river migration rate for tagged fish from Rock Island Dam to the Wenatchee River telemetry site, and to Rocky Reach Dam were 5.3 km/day and 14.3 km/day, respectively. At Rocky Reach Dam, the in-river migration rates to either the Entiat River telemetry site or Wells Dam were 1.9 km/day and 23.5 km/day, respectively. These observations, in conjunction with mobile survey data suggest that bull trout stage at the confluences and within the lower reaches of major Columbia River tributaries prior to upstream movement within those tributaries.

9. During the 2005 to 2009 study period there were a total of 56 downstream passage events at Rock Island and Rocky Reach dams combined, with 9 downstream passage events at Rock Island Dam and 47 passage events at Rocky Reach Dam.

10. Of the 9 passage events documented at Rock Island Dam, 2 were through one of the two powerhouses, one through the spillway; and 6 through an unknown route. At Rocky Reach Dam, a total of 35 downstream passage events occurred at the powerhouse, 2 through the spillway, 2 through the Juvenile Bypass System, and 8 through unknown routes.

11. For the 56 passage events observed over the entire study period at either Rock Island or Rocky Reach dams, no documented mortality associated with downstream passage was observed.

12. During the entire study period, four bull trout migrated back downstream of Rocky Reach Dam after an initial ascent of the fishway, only to re-ascend a second time. For those four fish, the mean elapsed time between fishway exit and downstream passage at Rocky Reach Dam was 3.56 hours. A fifth bull trout, was released upstream of Rocky Reach Dam after being tagged, migrated downstream of the project, and ultimately re-ascended the fishway. For all five of these bull trout exhibiting this behavior, after re-ascending the Rocky Reach fishway they migrated upstream of the project.

13. Collectively, of the 30 transmitters recovered since tagging began in 2005, six have been recovered in the Columbia River, 12 in the Entiat River, four in the Mad River, two in each of the Methow River and Peshastin Creek, and one in each of the Twisp River, Foggy Dew Creek, Snow Creek, and Icicle Creek. Therefore, 20% of tag recoveries have been in the mainstem Columbia River and 80% in tributaries of the Columbia River.

14. Bull trout appear to have adequate time to find spawning tributaries after passing Rocky Reach or Rock Island dams, and appear to reach spawning grounds in those tributaries in a timely manner (BioAnalysts 2004).

4.0 Acknowledgements

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Appendix A. A summary of detection histories for fish that may have perished or shed their transmitters during the period of 16 May, 2005 and 19 June, 2009.

2005

Two fish that migrated upstream of Rocky Reach Dam and entered the Entiat River may have died during tributary residence. For one fish, code 4, its remains were recovered in the Mad River by USFWS personnel. It was found 6 October on shore near a pool, which was approximately 10m downstream of a log-jam. A portion of its belly and head had been consumed, which indicated predation or scavenging (Mark Nelson, USFWS, personal communication). The fate of a second fish, code 2, was not as obvious. Its transmitter was recovered by USFWS personnel on 6 October, also in the Mad River, but without an accompanying carcass.

Five other transmitters, along with two carcasses were also recovered. All of which, were recovered by USFWS personnel during mobile surveys. Of those five recoveries, the transmitter of one was recovered in Snow Creek (code 5) on 4 October, approximately 50m upstream of the confluence with Icicle Creek (a tributary to the Wenatchee River, near the town of Leavenworth). For this fish, no carcass was recovered (Mark Nelson, USFWS, personal communication). For three other fish (codes 33, 36, and 37), their transmitters were recovered in the upper Entiat River between the dates of 24-28 October, with the carcass of one being recovered without any apparent signs to indicate the cause of mortality. Finally, one other fish, with its transmitter still in place was recovered in the Mad River. The remains clearly indicated predation, but by what could not be determined (Mark Nelson, USFWS, personal communication). It should be noted that this fish, code 18, had previously been captured by the USFWS and moved downstream of a pool in which it was trapped in an effort to rescue the fish. Within the pool in which it had been captured, the USFWS personnel found two dead bull trout, and one other untagged live bull trout. The code 18 fish, along with the other live untagged fish were moved downstream in an effort to save them, but as noted by the USFWS personnel "…it still has several debris jams to navigate through, so the rescue may have only been temporary".

For the seven fish presumed to have died in the tributaries, the cause of their mortality is unclear. For the fish where carcasses were recovered, it appears that predation may have played a role. For the others, it is impossible to speculate as to their fate. What can be concluded, however, is that the transmitters of all seven fish were found well upstream within the Wenatchee and Entiat basins, and that they were recovered well after they were tagged and released upstream of Rocky Reach and Rock Island dams.

2006

The transmitter for code 6 fish was recovered in 2006 without the carcass. It was recovered by Grant County PUD personnel on 6 September 2006 downstream of Wanapum Dam in about 2.5 m of water. This fish was first detected downstream of Rock Island Dam on 23 October 2005 and first detected downstream of Wanapum Dam on 8 February 2006 during an aerial survey. The time of passage at Wanapum Dam is unknown as that project was not monitored.

A second fish (code 1), which is not reported in Table 10, is presumed to have died or shed its transmitter. Grant County PUD personnel detected the transmitter downstream of Priest Rapids Dam during a boat survey between Vernita Bar and Vernita Bridge. Because the transmitter was in deep water, they did not attempt to recover it. On 9 February 2007, despite being downstream of our study area, we attempted to recover the transmitter using SCUBA to evaluate any physical marks on the transmitter. The fish/transmitter was presumed to be in about 9.0 m of water with a flow velocity of about 1 m/second. One dive was made, but no bull trout or transmitter was found. A second dive was attempted, but flows were too high to firmly anchor the boat and the search was aborted. Since no recovery was made, this fish has not been classified as a shed or mortality. Rather its fate is currently classified as unknown.

Of the other five fish listed in Table 10 (codes 39, 153, 154, 172 and 186), only two had migrated either upstream or downstream of a Chelan PUD dam in 2006 (codes 153 and 172). The fate of codes 39, 154, and 186 was unrelated to the operations of the projects (supported by the length of time between release and recovery, and the extent of upstream travel) and therefore will not be discussed here. Instead, we focus our discussion on the fate of the two fish that migrated through the projects.

The code 153 fish was captured and tagged at Rock Island Dam in 2006. It migrated upstream and passed Rocky Reach Dam via the fishway. About 2 days after exiting the Rocky Reach fishway, the fish was detected at the Entiat River fixed site (R.K. 4.8). Subsequently, it was detected downstream of the Mad River confluence on four occasions before its transmitter was recovered on 20 February 2007. The transmitter was recovered without a carcass in the location where it had been detected during the four surveys. There were no distinguishing marks on the transmitter to aid in determining the fate of the fish.

The code 172 fish was released about 2.3 km upstream of Rocky Reach Dam. It migrated downstream through the project 10.5 hours after release. It then re-ascended the fishway and entered the Entiat River on 7 June 2006. This fish was detected on two occasions after entering the Entiat River (29 June and 26 July). Based on the distance between detections (16.7 km), the fish was probably alive until at least the beginning of August. Because the fish was not detected between 26 July and 18 October, when the fish and transmitter were recovered, it is not possible to estimate when the fish died. Personnel

from the USFWS recovered the carcass and concluded that the fish was either depredated or scavenged based on the condition of the carcass (Mark Nelson, USFWS, personal communication).

2007

Columbia River Mainstem Tag Recoveries

The transmitter and carcass of the code 26 fish was recovered 9 May 2007 in the Columbia River, about 0.8 km downstream of the George Seller Bridge in Wenatchee. The carcass and transmitter were recovered on shore below the high water mark of the river. Due to the extent of deterioration of the carcass, the cause of mortality could not be determined. This fish did not pass any hydro project in 2007.

The code 31 fish was tagged at Rocky Reach Dam on 31 May 2005. It migrated upstream through Wells Dam and entered the Methow River on 27 June 2005. It was then detected on the spawning grounds by USFWS personnel in Wolf Creek. This fish overwintered in Wolf Creek during 2005-2006. On 30 May 2006 the fish exited the Methow River and migrated downstream through Rocky Reach on 4 July 2006 and entered the Wenatchee River on 30 August 2006. It exited the Wenatchee River on 4 November 2006 and was detected during an aerial survey on 11 January 2007 in the Rock Island Reservoir. It again entered the Wenatchee River and remained there for eight days between 3 July and 11 July 2007. This fish then migrated downstream through Rock Island Dam where it was detected in the tailrace for four days. The tag was detected during an aerial flight on 5 September, and the transmitter was recovered six days later in some rocks on shore, but below the high water mark. Due to the high velocities at the location of detection and subsequently the location of recovery of the transmitter, we do not suspect that this fish perished as a result of passing Rock Island Dam. Had it died or been injured during dam passage, we believe the fish would probably have ended up further downstream. Regardless, due to the fact that no carcass was recovered, it is not possible to determine the fate of this fish.

Using SCUBA, the transmitter of the code 189 fish was recovered in the Columbia River on 4 April, just downstream of the Entiat River confluence. Remains of a fish were found at the time of the recovery. However, because of very poor visibility at the recovery site, it was not possible to say that the remains were associated with the transmitter or that the remains were that of a bull trout. Unfortunately, the carcass was lost during the recovery effort, and could not be retrieved. This fish was tagged on 25 June 2006, and resided within the Entiat basin during the fall of 2006 upstream of Preston Creek. This fish did not pass any hydro project between the time of tagging and recovery.

Entiat River Basin Recoveries

The code 44 fish was tagged on 6 June 2005 at Rocky Reach Dam. It was detected at Wells Dam on 30 June 2005 and overwintered in the Columbia River. On 25 May 2006 it entered the Methow River and then exited on 10 November 2006. This fish migrated downstream through Wells Dam on 17 November 2006 and entered the Entiat River. Four aerial surveys conducted between 20 December 2006 and 3 April 2007 detected the code 44 fish in the Entiat River (RK 0.8). The transmitter was recovered near RK 0.8 on 4 April, 2007. A carcass was also recovered; however, the fate of the fish could not be determined because of the extensive deterioration of the carcass.

The code 185 fish was tagged on 12 June 2006 at Rocky Reach Dam. It entered the Entiat River on 24 June 2006. Subsequent aerial surveys conducted in April, July and September of 2007 detected this fish in the Mad River. The transmitter for this fish was recovered in the Mad River at RK 16.9 on a dry stream bank within a logjam. No carcass was recovered with the transmitter.

Wenatchee River Basin Recoveries

The transmitter for the code 101 fish was recovered in Peshastin Creek at RK 3.2, a tributary to the Wenatchee River. This fish entered the Wenatchee River on 11 June and was detected during an aerial survey conducted 3 July off the mouth of Peshastin Creek in the Wenatchee River. The transmitter was recovered on 14 August by USFWS personnel. The transmitter was found on the bank in heavy vegetation with no carcass present.

Methow River Basin Recoveries

The code 171 fish was tagged at Rocky Reach Dam on 25 May 2006. After release, it overwintered in the Methow basin and then resided within the mainstem Columbia River downstream of Wells Dam both years following release. In 2007, USFWS personnel detected the fish in Early Winters Creek on 14 September and in the Methow River upstream of Mazama on 24 October. The transmitter was recovered in the Methow River (RK 107.9) by USFWS personnel on 8 November 2007. The carcass was recovered on the bank with evidence of scavenging.

The code 177 fish was tagged on 30 May 2006. After release, it was first detected at Wells Dam on 8 June 2006. USFWS personnel detected it in the Methow River (near Gold Creek) on 6 June 2006. An aerial survey on 5 September 2007 located the transmitter at RK 7.2 on Foggy Dew Creek (a tributary to Gold Creek). A deteriorated carcass along the waterline was recovered on 12 September 2007 along with the transmitter.

The code 190 fish was tagged on 29 June 2006 at Rocky Reach Dam. After a winter residence in the Columbia River, it migrated downstream of Rocky Reach on 29 March 2007. On 8 June 2007, it exited the Rocky Reach fishway and arrived at Wells Dam on 10 June 2007. It was then detected in the Methow River on 16 June 2007. The transmitter for code 190 was recovered upstream of a dry reach in the Twisp River (RK 45.0) on 1 November 2007 by USFWS personnel. The transmitter and one bone were recovered on the bank with evidence of scavenging and/or predation. This location was within 50 meters of an unknown mammal den.

2008

Columbia River Mainstem Tag Recoveries

The transmitter of the Code 119 fish was recovered on 5 March 2008 in the Columbia River about 15 m from the east shore, near the town of Orondo, Washington. The transmitter was recovered in about 2 m of water. The head and backbone of a fish was also recovered in the vicinity of the transmitter. However, because of extensive deterioration of the carcass, it was not possible to determine conclusively that the carcass belonged to Code 119 or was even a bull trout. This fish left the Entiat River on 9 November 2007, was detected near the Entiat River confluence on 17 December 2007, and resided within the Columbia River until the transmitter was recovered on 5 March 2008.

Entiat River Basin Recoveries

The transmitter of the Code 168 fish was recovered on 23 April 2008 in the Entiat River just downstream of Box Canyon (RK 47.2). This fish was tagged and released on 18 May 2006 at Rocky Reach Dam. On 3 June 2006 this fish entered the Entiat River and was detected in the Upper Entiat River at RK 46.7 in the Box Canyon region. The transmitter of this fish was detected during several aerial surveys since December 2006, with no detection history indicating that the fish ever left the area. At the time the transmitter was recovered, no carcass was found. The transmitter was recovered in about 1 m of water and was wedged between two rocks. Based on the detection history of the transmitter, we believe that this fish had died or the transmitter was shed several months before the transmitter was recovered. The recovered transmitter showed scuff marks indicating that it may have tumbled some distance down the river.

The code 169 transmitter was recovered on 23 April 2008 in the Entiat River at RK 46.9 near the Lake Creek Campground, about 200 m downstream of the foot bridge. This fish was tagged and released on 25 May 2006 at Rocky Reach Dam and entered the Entiat River on 22 June 2006. After entering the Entiat River, this fish was detected near Box Canyon on September 2006. The transmitter was recovered on the left bank wedged between two rocks. No carcass was present. As with the Code 168 transmitter, this

transmitter was also scuffed indicating that it had tumbled down the river during higher flows.

The transmitter of the Code 178 fish was recovered by USFWS personnel on 2 December 2008 in the Entiat River at RK 43.6. This fish was tagged and released at Rocky Reach Dam on 30 May 2006 and entered the Entiat River on 21 June 2006. Later this fish migrated out of the Entiat basin and moved downstream of Rocky Reach Dam, where it resided within the Rock Island reservoir in early 2007. The fish migrated upstream of Rocky Reach Dam (exiting the fishway on 4 June, 2007), and subsequently entered the Entiat River on 15 June 2007. Aerial surveys indicate that this fish was in the upper Entiat since January 2008. At the time of recovery, the transmitter antenna was missing and there was a hole in the transmitter casing (Mark Nelson, USFWS, personal communication). The transmitter was recovered without a carcass and was buried beneath about 20 cm of gravel.

The transmitter of the Code 179 fish was recovered 2 December 2008 in the Entiat River at RK 46.7. The fish was tagged and released at Rocky Reach Dam on 30 May 2006. After release, the fish was detected at the Entiat River fixed-telemetry site on 21 June 2006 and was subsequently detected within the Upper Entiat River during six mobile surveys. We detected no movement of the tag during a 23 April 2008 recovery effort, suggesting that the fish had died or shed the tag. Although we were unable to retrieve the transmitter at that time, it appeared to be lodged under a boulder downstream of Box Canyon. When the transmitter was finally recovered by USFWS personnel, it was located further downstream, suggesting that it had been dislodged by high flows during spring run-off.

The transmitter of the Code 183 fish was recovered in Box Canyon on the Entiat River on 2 December 2008, where it had resided since entering the Entiat River on 2 June 2006. The transmitter was found buried under about 15 cm of gravel by USFWS personnel. No carcass was recovered.

Wenatchee River Basin Recoveries

The transmitter of the Code 103 fish was recovered in Peshastin Creek (RK 8.6), a tributary to the Wenatchee River. The fish was tagged and released on 13 June 2007 at Rock Island Dam and entered the Wenatchee River on 20 June 2007. The transmitter was found on the right bank within the high water mark about 3 m from the main channel. No carcass was present at the time of recovery.

Methow River Basin Recoveries

The transmitter of the Code 111 fish was recovered in the Lower Methow River at RK 4.8 on 3 October 2008. The fish was tagged and released at Rocky Reach Dam on 16 May 2007. Following release, the fish migrated upstream of Wells Dam and later entered

the Methow River on 3 June 2007. The transmitter was recovered by USFWS personnel in the lower Methow River buried beneath about 15 cm of gravel. No carcass was present.