Integrated Status and Effectiveness Monitoring Program- Entiat River Intensively Monitored Watershed Study, 2010.

January 2010- January 2011

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Funded by

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
Portland, OR. 97208-3621

Project No. 2003-017-00
Contract No. 41045

January, 2011

Abstract

During 2010, the Mid-Columbia Fishery Resource Office operated two rotary screw traps, conducted a mark-recapture study, operated and maintained four stream-width Passive Integrated Transponder tag Interrogation Sites and conducted steelhead redd surveys on the Entiat River as part of the Integrated Status and Effectiveness Monitoring Program's Entiat River Intensively Monitored Watershed study. Screw trap operations were conducted between March and November and caught a total of 24,499 fish. The July through August mark-recapture study collected 9,462 juvenile fish species at 14 locations along the main stem Entiat and Mad rivers. In 2010, a total of 33,961 fish were captured and 17,757 wild salmonids were marked with Passive Integrated Transponder tags. Four Passive Integrated Transponder tag interrogation sites were operated throughout this reporting period resulting in a total of 2,115 unique detections. Steelhead redd surveys were conducted from February 9 to June 2, 2010. The first redd was observed on February 16th, and no new redds were seen after May 25th. A total of 189 redds were observed in the lower 45 km of the river.

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Introduction

The Integrated Status and Effectiveness Monitoring Program (ISEMP – BPA project #2003-0017) has been created as a cost effective means of developing protocols and new technologies, novel indicators, sample designs, analytical, data management and communication tools and skills, and restoration experiments. ISEMP activities support the development of region-wide Research, Monitoring and Evaluation (RME) programs to assess the status of anadromous salmonid populations, their tributary habitat and restoration and management actions.

The intent of the ISEMP project is to design monitoring programs that can efficiently collect information to address multiple management objectives over a broad range of scales. As well as status and trends monitoring, ISEMP is evaluating the benefits of habitat restoration actions to fish populations across the Columbia River Basin by implementing Intensively Monitored Watershed (IMW) studies. IMWs have been established in three pilot subbasins: Entiat River, WA; Bridge Creek, John Day River, OR; and Lemhi River, ID.

An IMW is a watershed-scale coordinated restoration effort with an associated effectiveness monitoring program (Bilby et al. 2004, PNAMP 2005) implemented in an experimental fashion to maximize the ability to detect fish responses to changes in their habitat (Bilby et al. 2005; Roni et al. 2005; Reeve et al. 2006). Such an approach seeks to maximize contrast and reduce noise to increase the ability to detect an effect. In addition, intensive monitoring is used to identify mechanisms by which habitat manipulations impact fish, so that these strategies can be extrapolated to other systems (Carpenter et al. 1995). As such, an IMW is a powerful approach to answer cause-and-effect questions at the scale relevant to management (i.e., at the watershed or population scale). IMWs are designed to address key questions in a disciplined scientific manner, reduce the complications associated with effectiveness monitoring, increase the comprehensiveness of monitoring and Increase efficiencies through shared responsibilities.

The restoration of the Entiat River subbasin under an IMW study design offers an opportunity to quantitatively evaluate the effectiveness of habitat restoration actions with regard to improving freshwater productivity. The Entiat River subbasin meets needed criteria, such as the feasibility of obtaining quantitative estimates of smolt production, the record of smolt monitoring, fish species present, and influence of hatchery-produced fish. In addition, the 2008 Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) identifies the Entiat River subbasin as an IMW (RPA 57.1) and the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007) calls for effectiveness monitoring coupled with adaptive management to assess the effects of habitat actions and recover these listed species in the Entiat River subbasin.

The work presented in this report is a component of the overall ISEMP, and while it stands alone as an important contribution to the management of anadromous salmonids and their habitat, it also plays a key role within ISEMP. Each component of work within ISEMP is reported on individually and in annual summary reports that present the overall project components in their programmatic context and shows how the data and tools developed can be applied to the development of regionally consistent, efficient and effective RME.

Juvenile outmigration study
The primary goal of this study is to provide long-term monitoring information and to detect changes due to habitat restoration actions on the juvenile life history characteristics and productivity of spring Chinook salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss gairdneri* in the Entiat River basin. The study uses rotary screw traps to capture juveniles in order to quantify abundance, measure physical characteristics, and tag individuals to assess migration timing and survival throughout the Entiat River and Columbia basin. This data is incorporated into a regional database that is utilized by area resource managers to compare attributes both within and between populations located in the Upper Columbia River basin. The ultimate goal of this study is to guide scientifically sound decisions regarding the future management of these species.

Entiat River IMW study
The primary goal of the Entiat IMW study is to identify and quantify the effects of habitat restoration upon response variables for ESA listed spring Chinook salmon and steelhead in the Entiat River basin. The measured response variables are productivity (emigrant per spawner), emigrant age structure, egg-to-parr survival, parr-to-emigrant survival, annual and seasonal growth of parr, and alterations in site specific fish density or observed movement of tagged individuals. The study uses mark-recapture methodologies to quantify and assess each response variable. The Entiat River IMW study is structured upon previous studies in the subbasin conducted by the U.S. Fish and Wildlife Service's Mid-Columbia River Fishery Resource Office (MCRFRO) which included snorkel surveys and remote fish capture and tagging at the watershed scale.

PIT Tag Interrogation Site monitoring
The primary goal of Passive Integrated Transponder (PIT) tag interrogation site monitoring is to increase the amount of quantifiable data on PIT tagged adult and juvenile species within the Entiat subbasin. This is facilitated through remote detections, or resightings at four independent interrogation sites within the Entiat subbasin. Interrogation site monitoring at these sites compliments a multitude of other projects occurring within the Upper Columbia basin as resighting data from these sites are made available to resource managers through a regional database. Interrogation data collected within the Entiat subbasin is of particular use in bolstering estimates of juvenile survival and abundance while providing unique opportunities to verify key assumptions associated with mark-recapture methodologies.

Steelhead redd surveys
The primary goal of redd surveys is to enumerate steelhead redds and map their distribution in the main Entiat River. A secondary goal is to determine if habitat restoration actions have any impact on numbers and distribution of steelhead redds.

Study Area

The Entiat River watershed originates from 11 glaciers and snowfields in the Cascade Mountains and flows southeast approximately 69 km to join the Columbia River at river

kilometer (rkm) 778 (CCCD 2004, Mullan et al. 1992). The Entiat watershed is bordered by the Entiat Mountains to the southwest and the Chelan Mountains to the northeast and drains approximately 1,085 km^2. The topography is steep with unstable erodible soils and vegetation types varying from semi-arid shrub steppe near the confluence with the Columbia River to temperate forests and alpine meadows in the headwaters.

Past glacial activity has shaped the Entiat River valley by creating a U-shaped valley upstream of terminal moraine at rkm 26.1 and V shaped valley downstream (Mullan et al. 1992). The present upstream limit to anadromy is at Entiat Falls (rkm 54.4) (Figure 1).

The Entiat River watershed supports eight salmonid species including spring and summer Chinook salmon *Oncorhynchus tshawytscha*, steelhead and resident rainbow trout *O. mykiss gairdneri,* sockeye salmon *O. nerka*, westslope cutthroat trout *O. clarki lewisi*, coho salmon *O. kisutch*, mountain whitefish *Prosopium williamsoni,* bull trout *Salvelinus confluentus,* and introduced eastern brook trout *S. fontinalis*. Other fish species include, chiselmouth *Acrocheilus alutaceus*, northern pikeminnow *Ptychocheilus oregonensis*, largescale sucker *Catostomus macrocheilus*, bridgelip sucker *C. columbianus*, speckled dace *Rhinichthys osculus*, longnose dace *R. cataractae*, redside shiner *Richardsonius balteatus*, sculpin *Cottus spp*., three-spined stickleback *Gasterosteus aculeatus* and Pacific lamprey *Entosphenus tridentatus*. (Mullan et al 1992, CCCD 2004, Wydoski and Whitney 2003).

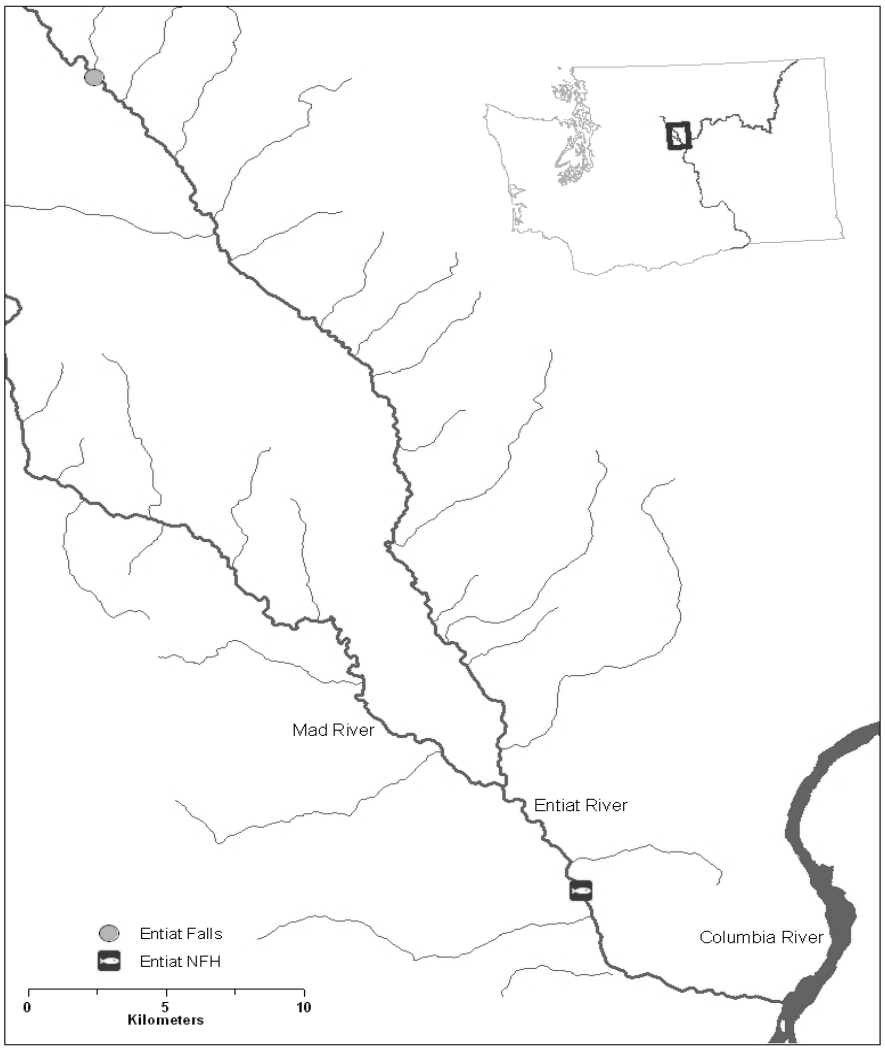

Figure 1. The Entiat River from its mouth to Entiat Falls at river kilometer 54.

Methods-Rotary Screw Trap

Rotary screw trap locations

MCRFRO has been operating a rotary screw trap in the Entiat River at rkm 11 near the Entiat National Fish Hatchery (ENFH) since 2003. Juvenile fish have been captured at other sites within the Entiat subbasin for PIT tagging since 2005. In addition to these legacy collection sites, MCRFRO added another rotary screw trap at rkm 2 during the 2007 field season (Figure 2).

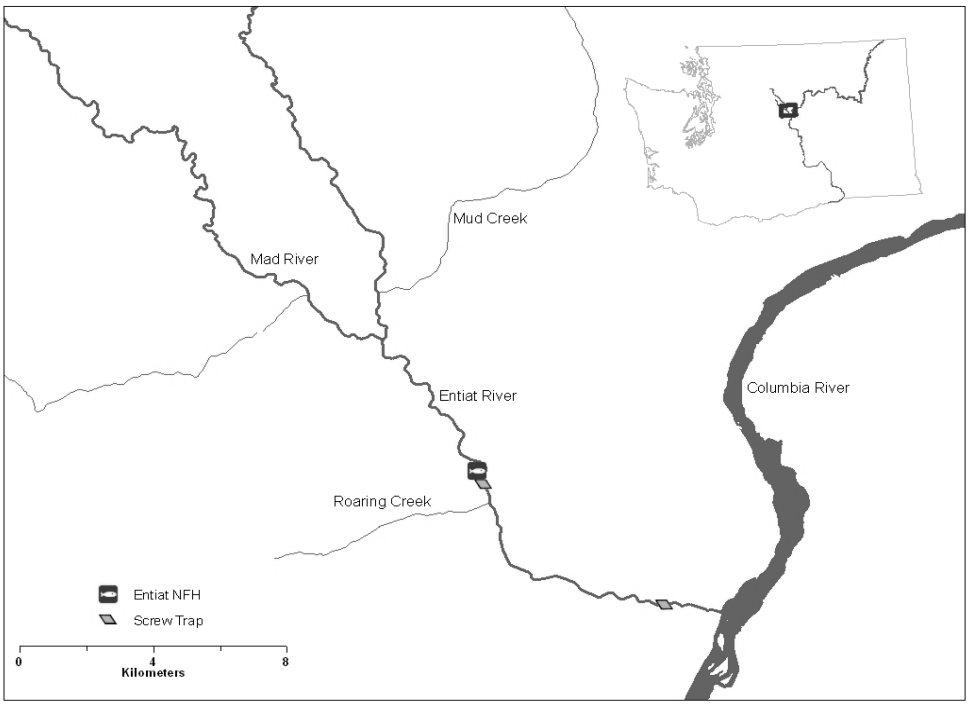

Figure 2. Study reach map of the Entiat River watershed with the juvenile rotary screw trap locations.

Rotary screw trap operation

Juvenile trapping methodologies are discussed annually by agencies conducting trapping programs in the upper Columbia River Basin. These discussions have resulted in the development of a basin-wide trapping protocol (Tussing, 2008).

Two modified 5 ft. diameter rotary screw traps (EG Solutions Inc.) were used to capture downstream migrating salmonids. The traps were retrofitted with pontoons from 8 ft. style screw traps to increase floatation and safety during higher flow. Traps were further modified to include an access door on the cone of each trap and a high pressure spray system to minimize algal accumulation upon the screen of the cone. Trap operations followed operational permit guidelines as per Chelan County Shoreline Management Act (file# SE 06-016 US Fish and Wildlife Service Fish Enhancement letter dated August 16, 2006), WDFW Temporary Use Permit (dated 11/27/07), and two Hydraulic Project Approvals (log#ST-F8213-01, upper trap dated 3/18/08 and control#112413-1, lower trap, dated 11/21/06). Assembled traps were lowered into the river via a boom truck and attached to ¼ inch aircraft cable that was anchored upstream to the bases of large cottonwood trees. A concrete road bridge at the upper trap site and a cross cable at the lower trap site suspended the anchor cable above the stream from the anchor point to the trap. A system of winches and pulleys was used to maintain the traps in fixed positions as flows changed throughout the trapping season. The traps were operated seven days a week from March through November with allowances for some events. If possible, traps were operated 24 hours a day; however, during spring high flows and increased debris loads the traps were operated from sunset to sunrise. Traps were removed from the river during periods of extreme flows to avoid damaging trapping equipment.

Fish handling
Fish handling procedures were conducted in accordance with WDFW Scientific Collection Permits #09-151, 155, 156, NOAA Permit 1119 and USFWS Subpermit No. MCRFO-12.

At least once a day, juvenile fish were transported from the live box of each trap into 5 gallon buckets for tagging and biological sampling. The buckets were equipped with aerators, and a light salt (NaCl) solution (1 tbs/gal.) was added to minimize stress during transport and holding. The fish were transported to ENFH, where a permanent fish handling/tagging station has been built.

Fish collected for biological sampling were anesthetized in a water bath with a measured amount of tricaine (MS-222) buffered with sodium bicarbonate (Summerfelt and Smith 1990). Small groups of fish were anesthetized at any one to reduce the chance of incidental mortality from anesthetic overdose. All fish were identified to species with the exception of sculpin, dace, and suckers. Juvenile Chinook salmon captured prior to the late summer capture nadir were initially identified as summer run and those captured after were identified as spring Chinook salmon. All salmonids were further ascribed a life history stage as either fry (<60 mm), parr (>60 mm and distinctive parr marks), transitional (>60 mm silver sheen, faint parr marks) or smolt (>60 mm silver sheen with absent parr marks with possible black tipped caudal).

Per trapping location, a daily minimum of 30 fish per species and life stage were measured to the nearest mm of fork length and weighed to the nearest tenth of a gram. After handling, all species were allowed to fully recover prior to release. Non-tagged individuals were released approximately 400 meters downstream from the trap of capture after a minimum one hour of recovery time.

PIT tagging of juvenile Chinook salmon, steelhead, and bull trout followed the procedures and file submission requirements outlined by Pacific State Marine Fisheries Commission PIT Tag Information System (PTAGIS). Wild juvenile Chinook salmon, coho salmon, steelhead, cutthroat trout and bull trout were tagged using a disinfected hollow needle to insert the PIT tag into the abdominal cavity. Individuals measuring between 50 and 60 mm in fork length were tagged with a 9 mm PIT tag (ISO tag model TX148511B operating at 134.2 kHz and weighing 0.065 g) and individuals greater than 60 mm were tagged with a 12.5 mm PIT tag (ISO tag model TX1411SST operating at 134.2 kHz and weighing 0.102 g). ISEMP supplied PIT tags for Chinook salmon and steelhead, Chelan County PUD provided tags for bull trout and USFWS supplied PIT tags for cutthroat trout and coho salmon. Any injuries or abnormalities were noted and juveniles were not PIT tagged if determined it had a recent or substantial injury that could be aggravated by tagging. PIT tagged juveniles were generally held 24 hrs at ENFH to monitor survival and tag retention. A maximum of 72 hours hold time was instituted on all tagged fish.

Data entry
All fish data were entered in the P3 program from PTAGIS. P3 is a data entry application program used to collect and submit information about marked or recaptured fish with a PIT tag in the Columbia River Basin. USFWS used this program to enter all fish information whether or not the fish was marked with a PIT tag. P3 serves as a Microsoft Access™ overlay which allows communication with peripheral devices. USFWS peripheral devices included a Destron Fearing FS2001-ISO transceiver/antenna for reading PIT tags, a GTCO Calcomp DrawSlate VI digitizing board and a GSE 350 electronic balance for automating data entry into a laptop computer. Data files generated from the P3 program were then parsed into two custom Access™ databases. The first database was constructed by MCRFRO staff for the purpose of preparing data for analytical use and various reports. The second database, known as the Automated Template Module (ATM) was designed by ISEMP (contact: Steve Rentmeester) and allowed for the data to be automatically parsed into a main ISEMP database. The original P3 file was left intact and subsequently uploaded to PTAGIS where it is available to researchers throughout the Columbia River Basin.

Genetic and scale sampling
Throughout the sampling period, a subset of captured bull trout, cutthroat, yearling and sub-yearling Chinook salmon and steelhead juveniles were sampled for genetic and age analysis (Hillman 2006). Genetic sampling involved taking a small clip of tissue from either the ventral fin (steelhead, cutthroat trout & spring Chinook salmon) or caudal fin (bull trout). Scales were collected from steelhead only and were cataloged and stored on site for future analysis. Tissue samples from Chinook salmon, cutthroat trout, steelhead and bull trout were sent to the Region 1 USFWS genetics lab for archiving and future analysis.

Screw trap efficiency
A portion of the collected Chinook salmon and steelhead were used to estimate trap capture efficiency. Fish from several collection events were pooled and held for up-to 72 hours before release upstream of the capture location. All fish used for efficiency trials were either PIT tagged (>50 mm FL) or dye marked (<50 mm FL) with Bismark brown. Marked fish were placed in a live box located at ENFH for holding (<72 hrs) prior to release. Marked fish were transported to release sites using 5 gallon buckets with aerators to minimize stress. Juvenile fish used for efficiency trials were released after twilight upstream of each trap. The release location for the upper trap was located at rkm 18 (Mad River road bridge) and rkm 2.3 (Keystone Ranch private bridge) for the lower trap site. PIT tagged recaptured fish were subsequently re-measured, released and not included in subsequent efficiency testing.

Calculating production estimates
Estimates of natural juvenile salmon production from the Entiat watershed were derived for wild yearling spring Chinook, wild subyearling spring Chinook and wild steelhead. Production estimates were calculated using two steps. First, daily trap efficiency was determined based on regression analysis of the relationship between trap efficiency

(dependent variable) and flow (independent variable). The resulting regression formula was then used to estimate daily trap efficiency and juvenile production.

Trap efficiency was calculated using the following formula:

$$\text{Trap efficiency, } E_i = \frac{R_i}{M_i}$$

where E_i is the trap efficiency during time period i; M_i is the number of marked fish released during time period i; and R_i is the number of marked fish recaptured during time period i.

The number of fish captured was expanded by the estimated daily trap efficiency (e) to estimate the daily number of fish migrating past the trap (Ni) using the following formula:

$$\text{Estimated daily migration} = N_i = \frac{C_i}{e_i}$$

where N_i is the estimated number of fish passing the trap during time period i; C_i is the number of unmarked fish captured during time period i; and e_i is the estimated trap efficiency for time period i based on the regression equation.

The variance for the total daily number of fish migrating past the trap was calculated using the following formulas:

$$\text{Variance of daily migration estimate} = \text{var}\ N_i = N_i^2 \frac{\text{MSE}\ \ 1 + \frac{1}{n} + \frac{X_i - \overline{X}}{n-1\ s_x^2}^2}{e_i^2}$$

where X_i is the flow for time period i, and n is the sample size. If a relationship between flow and trap efficiency was not present (i.e. $P < 0.05$; r^2 0.5) a pooled trap efficiency was used to estimate daily emigration:

$$\text{Pooled trap efficiency} = E_p = \frac{R}{M}$$

The daily emigration estimate was calculated using the formula:

$$\text{Daily emigration estimate} = N_i = \frac{C_i}{E_p}$$

The variance for the daily emigration estimates using the pooled trap efficiency was calculated using the following formula:

Variance for daily emigration estimate = var N_i $= N_i^2 \frac{E_p \ 1-E_p \ / \ M}{E_p^2}$

The total emigration estimate and confidence interval was calculated using the following formulas:

$$\text{Total emigration estimate} = N_i$$

$$95\% \text{ confidence interval} = 1.96 \times \overline{\text{var}} \ N_i$$

Water temperature and flow
Water temperatures were measured daily at each trap location. Flow was monitored by USGS station number 12452990, located at rkm 2.3.

Results-Rotary Screw Trap

Trap operation period
The trapping sites were unchanged from 2009 with the lower and upper sites located at river kilometers 2 and 11, respectively. Rotary screw trap operation began on February 28th, 2010 at both trapping locations. The upper trap was run intermittently and primarily during periods of low emigration in order to supplement the number of tagged individuals available for efficiency modeling at the lower trap location. The lower trap was operated on a seven day per week schedule through November 19th, 2010. Of the 265 trapping days available within the season the lower trap operated 176 (66.42%) complete days (uninterrupted sampling from sunset to sunrise), 25 (9.43%) incomplete days (interrupted sampling from sunset to sunrise), and was not operated for 64 days (24.15%). Total daily capture numbers for Chinook and steelhead are presented in Figures 3 through 6. Detailed operational summaries are included as Appendix Table 1 and 2.

Rotary screw trap target species capture summary
In 2010 a total of 24,499 fish were captured by the rotary screw traps (Table 1). Total juvenile fish capture consisted of 9,683 spring Chinook salmon (39.52%), 5,283 summer Chinook salmon (21.59%), 3,582 steelhead trout (14.62%), 166 coho salmon (0.68%), 13 cutthroat trout (0.05%), 82 bull trout (0.33%), and 5,690 non-target species (including adult salmonids) (23.32%). A total of 15,146 wild salmonids were implanted with PIT tags. Detailed capture summaries including adult species and total mortality are included as Appendix Table 3.

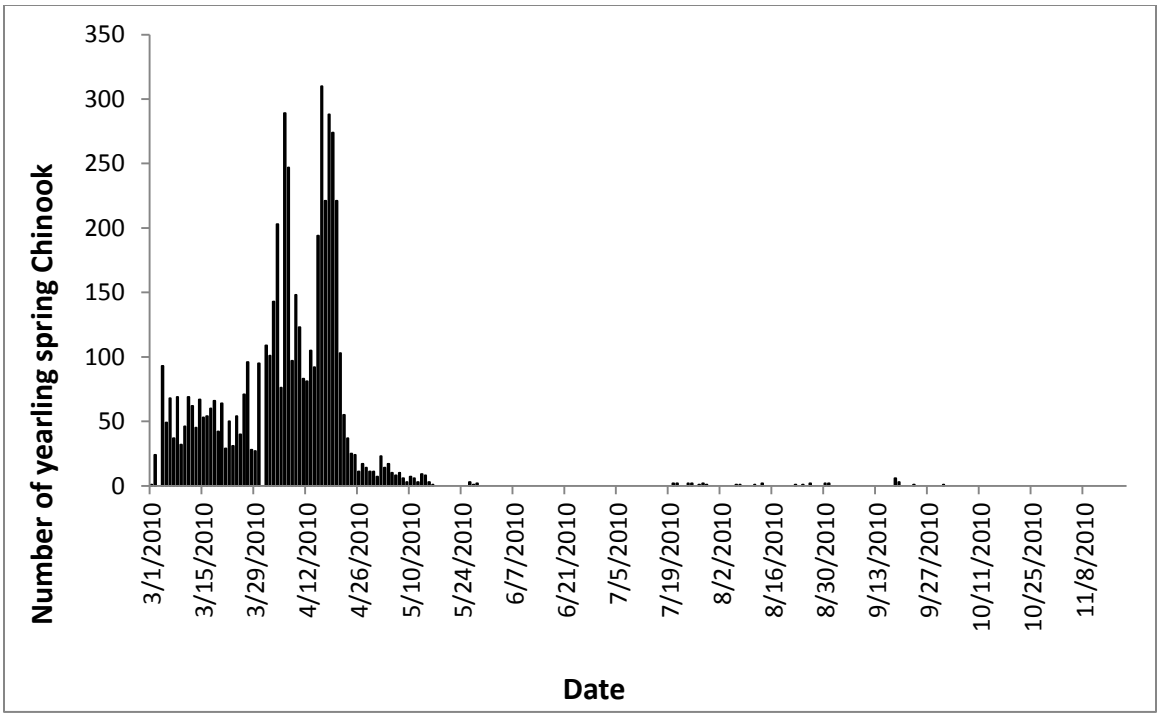

Figure 3. Total daily captures of yearling spring Chinook salmon for both trapping locations in 2010.

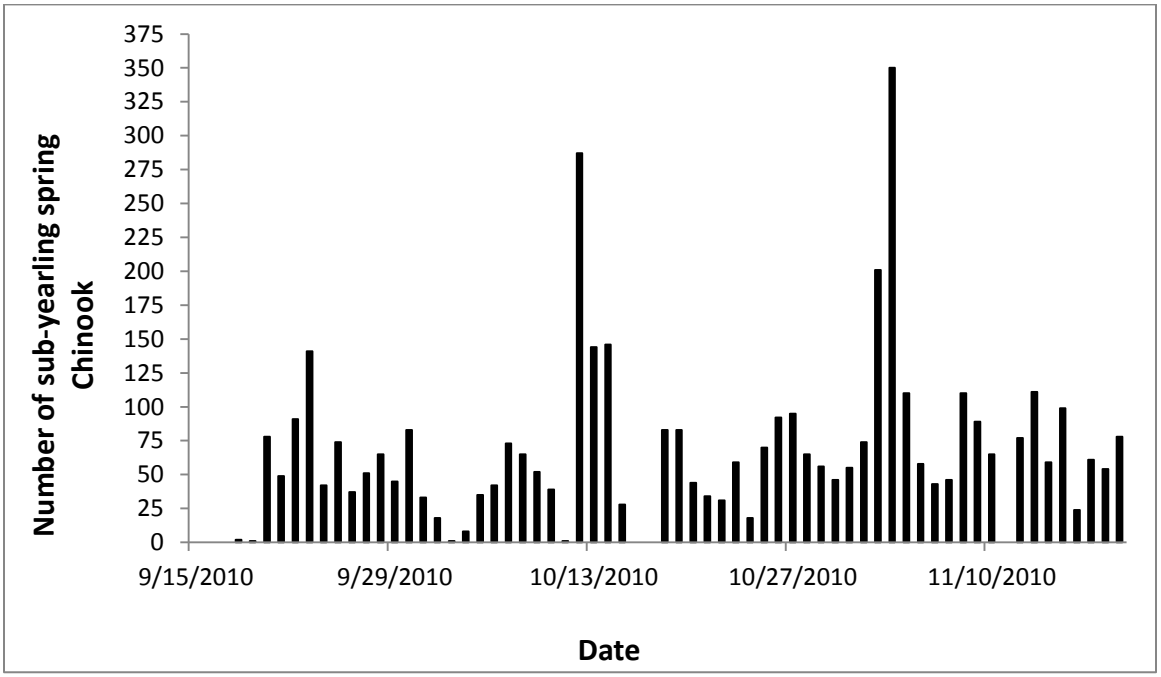

Figure 4. Total daily captures of sub-yearling spring Chinook salmon for both trapping locations in 2010.

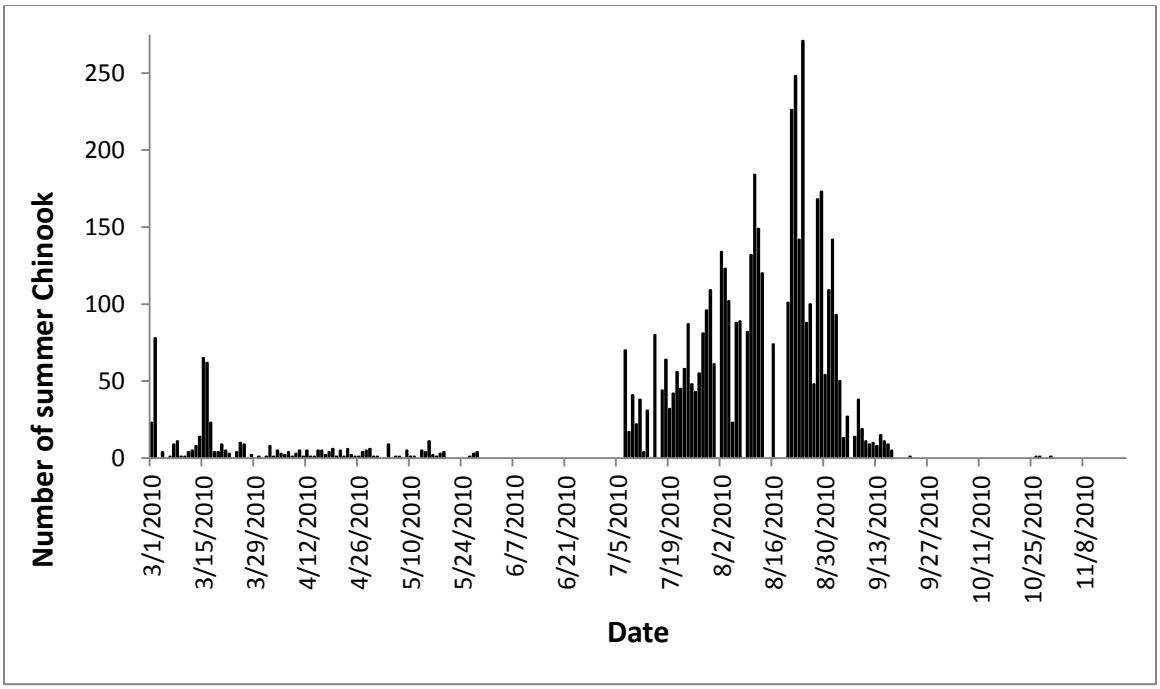

Figure 5. Total daily captures of summer Chinook salmon for both trapping locations in 2010.

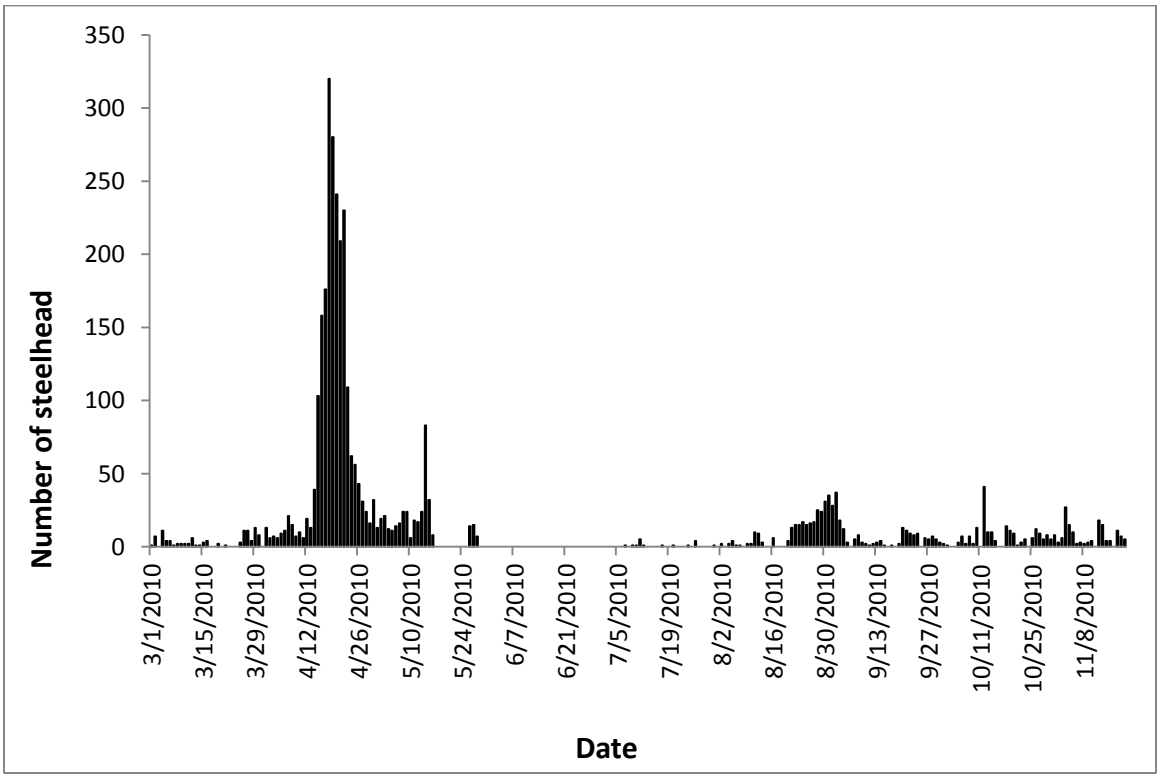

Figure 6. Total daily captures of steelhead for both trapping locations in 2010.

Trap efficiencies

At the lower Entiat River rotary screw trap, 16 viable efficiency trials were conducted for yearling spring Chinook salmon, 10 trials were conducted for subyearling spring Chinook salmon, 5 trials were conducted for summer Chinook salmon, and 15 trials were conducted for steelhead. Yearling spring Chinook salmon efficiency averaged 22.4% (Table 2), subyearling spring Chinook 33.2% (Table 3), summer Chinook 18.3% (Table 4) and steelhead 13.2% (Table 5). No efficiency trials were conducted at the upper rotary screw trap due to its intermittent operation.

Production estimates

The lower Entiat River production estimate for wild spring Chinook yearling and subyearling was 15,230 (95% C.I. = 713) and 13,021 (95% C.I. = 166) respectively (Appendix Table 4 and 5). Wild summer steelhead were estimated at 29,595 (95% C.I. = 31,738) (Appendix Table 6). Due to the limited operational period, production estimates were not calculated for the upper Entiat trapping location. Age analysis for wild steelhead juveniles was not conducted due to the cost of this analysis; therefore, production estimates for juvenile steelhead are not bracketed within emigrant age classes.

Data dissemination

All data was uploaded into the PTAGIS database and the MCRFRO database on a weekly basis. Data was entered into the ATM beginning in the fall following the completion of all fish capture efforts. All data entry was completed on December 17th, 2010.

Table 1. Number of fish captured and PIT tagged from the upper rotary screw trap (rkm 11) and the lower rotary screw trap (rkm 2) on the Entiat River.

Sampling Location	Species and Life Stage	Total number of fish caught	Total PIT tagged
Upper Rotary Screw Trap	Wild sub-yearling spring Chinook salmon	0	0
	Wild yearling spring Chinook salmon	1,593	1294
	Wild summer Chinook salmon	27	2
	Wild coho salmon	9	3
	Wild steelhead	108	97
	Bull trout	1	1
	Wild cutthroat trout	0	0
	Non-target species	392	0
	Total	**2,130**	**1,397**
Lower Rotary Screw Trap	Wild sub-yearling spring Chinook salmon	4,271	3,639
	Wild yearling spring Chinook salmon	3,819	2,900
	Wild summer Chinook salmon	5,257	3883
	Wild coho salmon	157	139
	Wild steelhead	3,474	3,106
	Bull trout	81	70
	Wild cutthroat trout	13	12
	Non-target species	5298	0
	Total	**22,369**	**13,749**

Table 2. Estimated capture efficiency of yearling spring Chinook salmon at the lower Entiat River rotary screw trap (rkm 2.0) with average (sunrise to sunset) flow from the USGS Entiat gauging station.

Trial Date	Flow (m^3/s)	Release Size (n)	Efficiency
03/06/2010	5.2	85	23.5%
03/08/2010	5.1	100	25.0%
03/11/2010	4.8	91	29.7%
03/14/2010	4.5	131	19.1%
03/17/2010	4.5	71	22.5%
04/01/2010	5.4	81	25.9%
04/16/2010	5.9	185	32.8%
04/17/2010	6.5	240	25.8%
04/18/2010	6.4	154	21.4%
04/19/2010	9.3	248	23.0%
04/20/2010	11.1	204	20.6%
04/23/2010	21.1	51	15.7%
04/25/2010	19.0	53	17.0%
04/27/2010	17.6	24	20.8%
04/30/2010	18.4	35	11.4%
05/04/2010	18.0	43	23.3%

Table 3. Estimated capture efficiency of subyearling spring Chinook salmon at the lower Entiat River rotary screw trap (rkm 2.0) with average (sunrise to sunset) flow from the USGS Entiat gauging station.

Trial Date	Flow (m^3/s)	Release Size (n)	Efficiency
09/23/2010	6.5	213	42.7%
09/30/2010	5.8	151	23.8%
10/15/2010	6.0	144	33.3%
10/23/2010	5.0	106	41.5%
10/26/2010	5.5	70	22.9%
10/27/2010	5.3	74	36.5%
11/3/2010	7.0	192	26.5%
11/9/2010	6.6	106	36.8%
11/13/2010	6.1	77	37.7%
11/18/2010	7.1	59	30.5%

Table 4. Estimated capture efficiency of subyearling summer Chinook salmon at the lower Entiat River rotary screw trap (rkm 2.0) with average (sunrise to sunset) flow from the USGS Entiat gauging station.

Trial Date	Flow (m^3/s)	Release Size (n)	Efficiency
07/21/2010	18.8	103	6.8%
07/24/2010	16.6	118	8.5%
07/29/2010	14.0	161	12.4%
08/11/2010	8.8	204	20.6%
08/24/2010	5.3	374	36.1%

Table 5. Estimated capture efficiency of steelhead at the lower Entiat River rotary screw trap (rkm 2.0) with average (sunrise to sunset) flow from the USGS Entiat gauging station.

Trial Date	Flow (m^3/s)	Release Size (n)	Efficiency
04/16/2010	5.9	102	21.6%
04/17/2010	6.5	133	15.0%
04/18/2010	6.4	152	16.5%
04/19/2010	9.3	286	14.0%
04/20/2010	11.1	233	13.3%
04/23/2010	21.1	228	4.8%
04/25/2010	19.0	151	8.6%
04/27/2010	17.6	85	7.1%
04/30/2010	18.4	62	12.9%
05/04/2010	18.0	52	7.7%
05/09/2010	14.4	53	13.2%
08/24/2010	5.3	30	13.3%
09/23/2010	6.5	30	10.0%
09/30/2010	5.8	16	12.5%
11/13/2010	6.1	18	27.8%

Discussion- Rotary Screw Trap

Rotary screw trap operation

The day to day operation of rotary screw traps can prove time consuming and difficult. Seasonal high river flow and/or weather events often increase the amount of debris present within the river leading to higher frequencies of missed trapping periods due to trap failure. These periods require an increased staffing demand to maintain the traps in an operational condition. This can create a hazardous work environment for the crew, increase the trap related mortality of captured fish, and cause damage to traps and capture-related equipment. To alleviate these potential hazards, traps were pulled when deemed necessary. During this study period the majority of days missed from sampling

were due to high spring flow events and fall wind events in late October and November, which inundated the traps with leaves and other debris. The staffing demands of the mark-recapture study, scheduled holidays, and training events accounted for the remainder of days the trap did not operate.

Summer vs. spring Chinook salmon

Both spring and summer Chinook salmon spawn in the Entiat basin. Early in the season, distinct morphological differences between summer sub-yearlings and spring Chinook salmon yearlings make identification easy. During this period spring Chinook salmon yearlings are much larger in size (75-100 mm) in comparison to newly emergent summer Chinook fry (32-45 mm). Identification becomes much more difficult during summer and early fall as both spring and summer Chinook sub-yearlings are of similar lengths and condition. Currently there is no definitive method to apportion these two runs of sub-yearlings. In order to determine if the difference in migration timing could be used to assign the proper run, total catch was monitored and plotted by day. When catch decreased and a relative nadir was reached in early September, all Chinook salmon captured onward were assigned a run based on any detectable break in fork length distributions. Undoubtedly, the run of some Chinook salmon was improperly assigned using this method. This was illustrated after the installation of stream-width PIT tag interrogation sites in the Entiat basin. Utilizing the data from these interrogation sites and the emigration timing of PIT tagged Chinook salmon it became clear that delineation of the two runs of sub-yearling Chinook salmon used in previous years was inadequate. In 2010, the USFWS began PIT tagging all Chinook species regardless of run designation. Through the continued monitoring of adult Chinook returns to the Entiat River a better understanding of the accuracy and precision of the nadir based identification method will be obtained.

Production estimates

Calculations used in production estimates using rotary screw traps are standardized between monitoring agencies within the Upper Columbia basin to increase the consistency and usefulness of these annual estimates. Because rotary screw traps cannot be operated throughout the entire spring emigration period due to high flows, expansions must be used which can bias estimates. This bias increases the probability of under or overestimating annual production and the associated variance. We are currently reviewing the statistical calculations used to achieve these estimates in order to limit bias within future estimates.

The high confidence limits associated with the steelhead production estimate is of concern and is likely attributed to not bracketing estimates by age class. As juvenile steelhead of varying ages (size) are expected to exhibit different capture probabilities a more precise estimate may be obtained by stratifying efficiency testing by age class. Furthermore, capture probabilities also vary by season with higher trap efficiencies resulting during spring emigration as opposed to late summer and fall. In the future, trap efficiency testing methods will be adjusted in attempt to account for these issues.

Project goals
Project goals were met during the 2010 field season. Continued out-migrant monitoring is required both at the rotary screw traps and within the basin in order to evaluate the success of wild steelhead and spring Chinook salmon. This is especially relevant in order to monitor the effects of the discontinuation of the spring Chinook salmon program at the ENFH.

Methods- Mark-Recapture Sampling

Sample site selection
Sample sites for the Mark-recapture study were systematically selected within geomorphic reaches. Start locations were randomly drawn then the resulting sites were generated systematically based on the number of sites needed per reach. If a site was unavailable to be sampled, the next most upstream site was then selected (Figure 7).

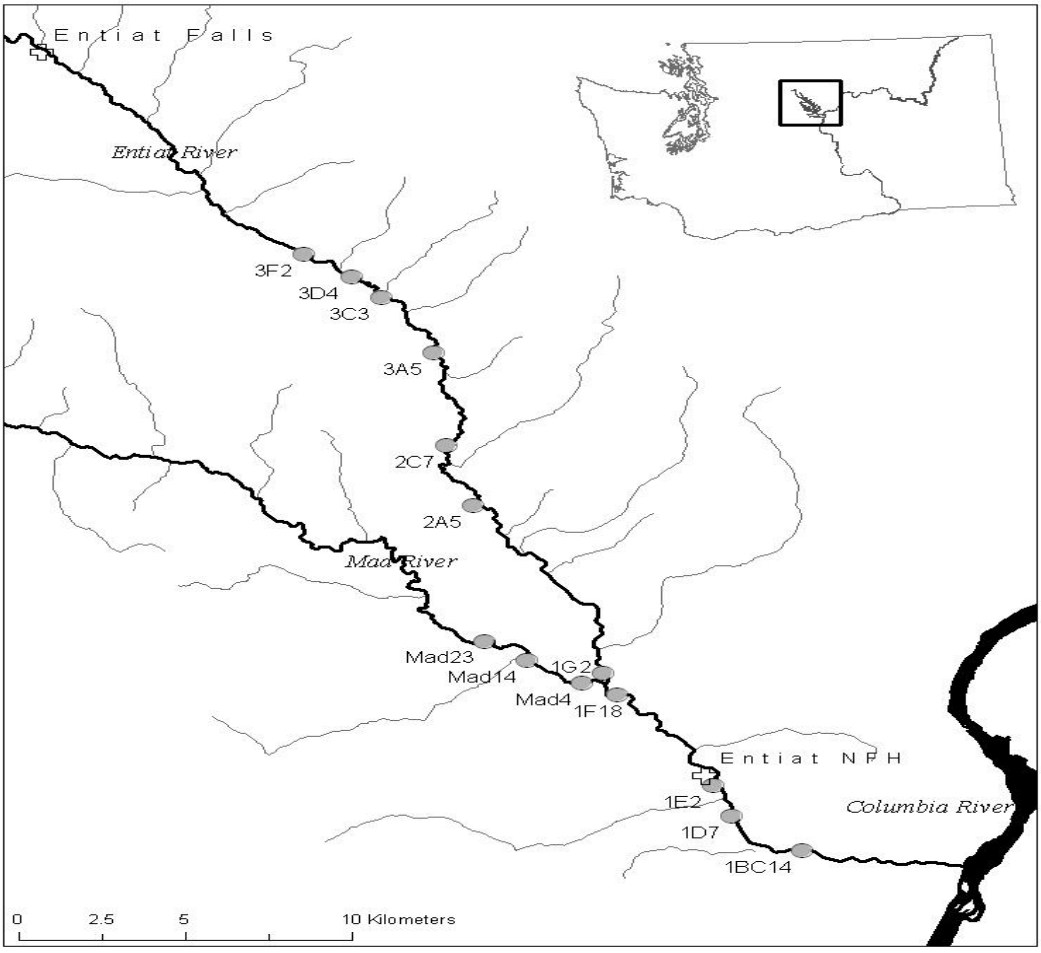

Figure 7. Map of the Entiat River watershed defining locations of the mark-recapture sample sites.

Sample period
Fish sampling was conducted within the Entiat and Mad rivers during July and August of 2010 when river flow fell below 11.3m^3/s.

Fish collection
Mark-recapture fish collection methods (backpack electrofishing, snorkel-herding, hand-netting, and beach seining) were used to estimate capture probability and population size for Chinook salmon and steelhead at discrete sites within the Entiat subbasin. Sampling methods were based upon specific sampling conditions within each site and were often used in combination. All methods relied on the assumption that a population within a site can be treated as effectively closed and that immigration, emigration, or mortality during the sampling period was zero or negligible.

Fish sampling was conducted at each site over a period of two consecutive days. In order to avoid high afternoon water temperatures all sampling began no later than 7:00 am and usually was complete by 2:00 pm. Three capture crews consisting of a minimum of six personnel sampled independently of one another. Within each crew, four personnel were assigned fish capture responsibilities and the remaining two to fish handling and PIT tagging. Prior to the sampling period, all sites were surveyed to determine a primary sampling method. Pre-sampling surveys included recording visual observations of available habitats and incorporated snorkeling observations at sites where age and species composition was unknown. A primary sampling method of either backpack electrofishing or snorkel-seining was chosen based upon site specific conditions such as water depth, expected flow at time of sampling, the expected age and species composition and the overall complexity of habitat types present. All sampling was conducted in an upstream direction with crews beginning at the lowermost point and methodically working upstream until the site was completely sampled. In some cases the site or specific habitat was sampled a second time using an alternative method if it was deemed more suitable to the specific conditions. Electrofishing was conducted with either a Smith-Root model 12 or LR-24 backpack electrofisher. Electrofisher operation followed the guidelines of the manufacturer and the National Marine Fisheries Service (NOAA 2000).

Fish handling
Fish were handled in accordance with WDFW Scientific Collection Permits #09-151, 155, 156, NOAA Permit 1119 and USFWS Subpermit No. MCRFO-12.

Fish were transported within 5 gallon aerated buckets from the point of capture to 25 gallon plastic live boxes located on the river margins within the site. Water temperatures and fish condition were closely monitored during transportation and holding in order to minimize stress and mortality. All individuals that exhibited signs of injury or excessive stress were interrogated for a pre-existing PIT tag and released. Fish were periodically transported from live boxes to a stationary fish handling and tagging station.

Collected species were anesthetized in a water bath with a measured amount of tricaine (MS-222) buffered with sodium bicarbonate (Summerfelt and Smith 1990). Small groups of fish were anesthetized at any one time during daily handling to reduce the chance of

incidental mortality from anesthetic overdose. All fish were identified to species with the exception of Chinook salmon, sculpin, dace, and suckers. Chinook salmon run designation was classified as unknown due to the inability to distinguish between spring and summer run characteristics during the time sampling occurred. All salmonids were ascribed to a life history stage as either fry (<60 mm), parr (>60mm and distinctive parr marks), transitional (>60 mm silver sheen, faint parr marks) or smolt (>60 mm silver sheen with absent parr marks with possible black tipped caudal).

All Chinook salmon, steelhead, bull trout, cutthroat trout and a minimum 30 each of the remaining species were measured to the nearest millimeter of fork length and weighed to the nearest tenth of a gram. After handling, all individuals were allowed full recovery prior to release. Non-marked individuals were released within the site in close proximity to their point of capture.

PIT tagging of juvenile Chinook salmon, steelhead, and bull trout followed the procedures and file submission requirements outlined by PTAGIS. Wild juvenile Chinook salmon, coho salmon, steelhead, cutthroat trout and bull trout were tagged using a disinfected hollow needle to insert the PIT tag into the abdominal cavity. Individuals measuring between 50 and 60 mm in fork length were tagged with a 9 mm PIT tag (ISO tag model TX148511B operating at 134.2 kHz and weighing 0.065 g) and individuals greater than 60 mm were tagged with a 12.5 mm PIT tag (ISO tag model TX1411SST operating at 134.2 kHz and weighing 0.102 g). ISEMP supplied PIT tags for Chinook salmon and steelhead, Chelan County PUD provided tags for bull trout and USFWS supplied PIT tags for cutthroat trout and coho salmon. Any injuries or abnormalities were noted and juveniles were not PIT tagged if determined it had a recent or substantial injury that could be aggravated by tagging. Marked juveniles were held for a minimum of one hour to ensure full recovery prior to being released in close proximity to their capture origin.

Data entry

All individual fish data entry utilized the P3 program from PTAGIS. Data files generated from the P3 program were then parsed into a MCRFRO. Data files were provided to ISEMP and the original P3 file uploaded to PTAGIS where it is available to researchers throughout the Columbia River Basin.

Scale sampling

Throughout the sampling period, scales were taken from a subset of juvenile steelhead and archived for future age analysis.

Results – Mark-Recapture Sampling

Sampling period

Fish sampling began on July 28th, 2010 when river flow was expected to fall below the 11.33m^3/s target within 24 hours. A series of unexpected rain storms occurring between August 1st and 4th increased river flow and turbidity levels making sampling impossible.

Sampling resumed on August 11th when flow had fallen to 8.50m^3/s and turbidity levels returned to normal. All sampling activities were completed on August 19th. Daily mean flow (m^3/s) during the sampling period is summarized in Figure 3. Because sampling was delayed a number of sites could not be sampled completely due to either water temperatures exceeding 18˚ C or the presence of adult endangered spring Chinook salmon within the site. Detailed locations and sampling notes are presented as Appendix Table 7.

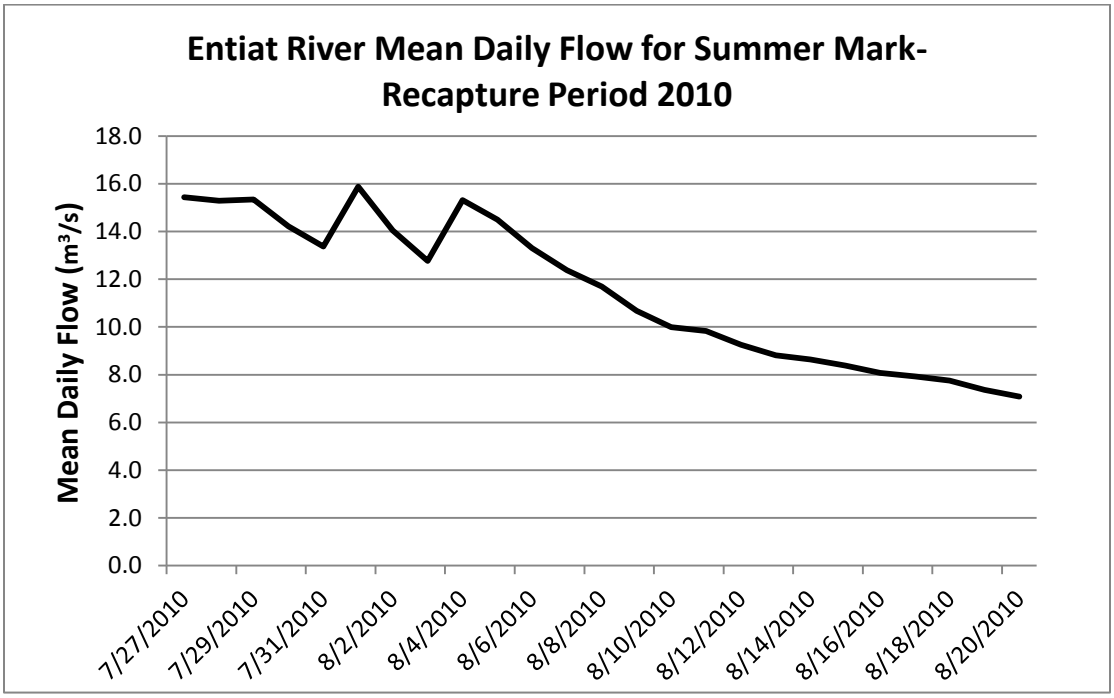

Figure 8. Entiat River mean daily flow during mark-recapture sampling in 2010 (USGS station number 12452990, located at rkm 2.3).

Fish capture summary

A total of 9,381 fish were captured at 14 sites throughout the Entiat and Mad rivers in 2010. Total capture species composition included 1,541 Chinook salmon (16.4%), 1,852 steelhead (19.7%), 32 coho salmon (0.3%), 11 bull trout (0.1%) and 5,945 non-target species (63.4%). A total of 2,690 wild salmonids (83.6%) were implanted with PIT tags. Detailed capture summaries including those from training events are included as Appendix Table 8. Mortality rates were tracked for Chinook salmon and steelhead throughout the study and categorized as either instantaneous or delayed. Instantaneous mortality was the result of capture, handling or PIT tagging while delayed mortality was assumed to be due to PIT tagging alone. In 2010, instantaneous mortality was attributed to a total of 36 Chinook salmon (2.3%) and 30 steelhead (1.6%). Capture related mortality accounted for 25 Chinook salmon and 21 steelhead (69.4% and 70.0% of total instantaneous capture mortality respectively) while tagging related mortality accounted for 11 Chinook salmon and 9 steelhead (30.7% and 30.0% of total instantaneous tagging mortality respectively). Delayed mortality and tag shed rates were assessed at a subset of sites by holding newly PIT tagged fish overnight following day two recapture sampling. A total of 286 wild Chinook salmon and 387 steelhead were retained from a total of 6

sample sites throughout the Entiat and Mad rivers for assessing post tagging mortality and shed rates. In total, 9 Chinook salmon (3.2%) and 4 steelhead (1.0%) were attributed to post tagging mortality. Shed tag recoveries were limited to one steelhead (0.3%).

Site level point estimates

Point estimates of abundance and 95% confidence intervals were generated for wild Chinook and steelhead at each of the 14 sites sampled (Table 6). Estimates were generated using the Chapman modification of the Peterson equation following the formulas presented in Van Den Avyle and Hayward (1999). All estimates were further tested and considered valid when the data met the validity test conditions proposed by Robson and Regier (1964).

Table 6. Point estimates of abundance for Chinook salmon and steelhead captured at IMW sites in 2010. Estimates that did not pass validity criteria are identified by INV.

Site	Species	New Cptrs	Total Marked	Total Recaps	Recap prob.	Pop. Est.	Lower 95% C.I.	Upper 95% C.I.	Stdrd Error
1BC14	Wild Chinook	67	43	4	0.09	597	163	1,031	221.4
	Wild steelhead	134	101	9	0.09	1,376	623	2,120	379.4
1D7	Wild Chinook	60	53	5	0.09	548	184	912	185.8
	Wild steelhead	210	120	19	0.16	1,276	801	1,750	242.1
1E2	Wild Chinook	90	70	17	0.24	358	233	483	63.7
	Wild steelhead	87	76	6	0.08	967	353	1,581	313.1
1F18	Wild Chinook	126	61	15	0.25	491	303	680	96.1
	Wild steelhead	30	47	4	0.09	297	90	503	105.3
1G2	Wild Chinook	56	47	9	0.19	273	142	403	66.7
	Wild steelhead	51	36	4	0.11	384	112	656	138.9
2A5	Wild Chinook	19	23	0	0.00	INV	--	--	--
	Wild steelhead	4	1	0	0.00	INV	--	--	--
2C7	Wild Chinook	90	16	1	0.06	INV	--	--	--
	Wild steelhead	48	7	2	0.29	INV	--	--	--
3A5	Wild Chinook	176	41	9	0.22	742	370	1,115	190.0
	Wild steelhead	9	1	0	0.00	INV	--	--	--
3C3	Wild Chinook	53	36	4	0.11	399	115	682	144.5
	Wild steelhead	13	3	1	0.33	INV	--	--	--
3D4	Wild Chinook	10	9	1	0.11	INV	--	--	--
	Wild steelhead	13	2	0	0.00	INV	--	--	--
3F2	Wild Chinook	121	57	13	0.23	504	295	714	106.9
	Wild steelhead	21	4	0	0.00	INV	--	--	--
M04	Wild Chinook	30	26	13	0.50	59	43	74	7.9
	Wild steelhead	117	105	23	0.22	520	360	681	81.8
M14	Wild Chinook	16	8	4	0.50	30	16	43	7.0
	Wild steelhead	110	74	18	0.24	437	286	588	77.1
M23	Wild Chinook	25	11	4	0.36	61	27	96	17.5
	Wild steelhead	123	93	33	0.35	342	265	419	39.4

Data dissemination
All data was uploaded into the PTAGIS database and the MCRFRO database on a weekly basis. Due to programming issues, data was not entered into an ATM but instead was transferred to the Upper Columbia Data Steward on January 11th, 2011.

Discussion- Mark-Recapture Sampling

Fish sampling
In 2010, the first year of the Entiat River IMW study, fish capture efforts were expanded substantially to include areas where information on the distribution and frequency of juvenile salmonids was relatively unknown. This posed a number of challenges in determining an adequate study design that would produce a level of precision and accuracy suitable for long term study goals. Although sampling under the Entiat IMW design has demonstrated that mark-recapture sampling is a feasible method of obtaining distribution and abundance information, it is also important to periodically revisit key assumptions and methodology in order to improve future data collection and analysis.

In 2010, a maximum flow of 11.3m^3/s was targeted for the onset of fish sampling during the summer mark-recapture period. The target flow was based on a 10 year average flow that would allow for sampling to begin in late July. This time period is preferable in order to avoid late afternoon water temperatures that are known to exceed the maximum sampling threshold of 18˚ C in mid to late August. As sampling began at flows close to 11.3m^3/s, low capture and recapture rates were observed at a number of sites within the main stem Entiat River. These low capture and recapture rates were most likely due to the difficulties posed by maintaining the capture equipment within the river at higher flows and consequently greater water depths. Furthermore, low rates may be attributed to behavioral differences of fish observed at a number of sample sites during higher flow. At these sites, fish oriented more frequently in habitats that were inaccessible to sampling crews (i.e., deep undercut banks and complex wood structure). Given these difficulties, a maximum flow of 9.2m^3/s will be targeted for the onset of fish sampling activities during future summer sampling periods and sites containing complex habitats will be delayed until flows further decline.

Electrofishing and snorkel-seining served to produce sufficient capture numbers of Chinook salmon and steelhead at most sites. Capture related mortality was observed to be higher for electrofishing than for other methods utilized. This difference is most likely due to low conductivity within the Entiat watershed requiring higher electrofisher settings to be used. Low conductivity serves to diminish the size of the electrical field produced when electrofishing and requires higher voltage settings in order to better facilitate fish capture. The resulting mortality was observed predominantly when smaller juveniles were encountered (< 60mm fork-length). To better control mortality rates in future sampling periods, snorkel-seining will be used prior to electrofishing at sites where either method is possible.

Length-frequency analysis appears to support a size bias toward the capture of smaller steelhead within the main stem Entiat River. Snorkel observations at a number of sites support the apparent size bias as a sufficient number of larger steelhead were observed but were not represented within the total capture. As the Entiat IMW study design seeks to bracket steelhead abundance within multiple age classes it is imperative that these larger steelhead be represented in future sampling efforts. Past sampling conducted by MCRFRO in the Entiat watershed suggests that angling is biased toward larger, older age class juvenile steelhead and may be suitable for limited use to target these larger steelhead during mark-recapture sampling at main stem Entiat River sampling locations.

Summer vs. spring Chinook salmon

The Entiat watershed supports populations of both spring and summer run Chinook salmon. Late summer identification of juvenile Chinook salmon at fixed rotary screw trap locations is hindered by the inability to visually distinguish between spring and summer run Chinook. A relative nadir (based on catch frequency) has been used at RST locations to differentiate between Chinook run types. The summer sampling period for the Entiat IMW currently lacks such a method to differentiate between run types of Chinook and as a result all Chinook were classified as 'wild Chinook (unknown run).' Through continued monitoring of the emigration timing of juvenile PIT tagged Chinook we hope to detect trends that will enable real-time classification of run type at time of capture. USFWS collects and archives genetic samples from juvenile Chinook salmon throughout their emigration period. Eventually funding may be available to analyze a subset of these samples to determine if a break between the run types can be established.

Site level point estimates

Estimates of site level abundance were calculated for all sample sites using the Chapman modification of the Petersen estimate. Several assumptions were made concerning the validity of these estimates: 1) the sample population remained closed to immigration and emigration during the study or rates were negligible; 2) marked and unmarked fish had the same mortality rates; 3) marked and unmarked fish were equally available for capture; 4) all marks were retained during the sample period and all marks on recaptured fish were recognized; 5) marked fish randomly mixed with the unmarked population following release.

Of the 28 abundance estimates generated, all but 9 were determined to be valid estimates. According to Robson and Regier (1964), bias in abundance estimates produced by the Chapman modification of the Petersen estimate are negligible (less than 2%) when the product of marked fish (M) and the total number of fish examined for marks (C) exceeds the population size (N) by a factor of 4 ($M \times C > N \times 4$). Further analysis indicated that all of the 9 invalid estimates are biased by greater than 5%. The bias within these estimates is most likely attributed to low fish densities leading to insufficient numbers of marked fish available for recapture.

Given the physical river conditions within the Entiat River IMW sampling design, block netting was not utilized during the first sampling season. To be effective within larger rivers such as the Entiat, block netting requires periodic inspection and maintenance

between marking and recapture periods. Given the additional staffing requirements that this would require, block netting was not achievable. By leaving the sample population physically open to immigration and emigration during the study period, we were unable to meet the assumption of a closed population, nor did we have the means to determine if these rates were substantial enough to introduce bias to the abundance estimates. ISEMP has experimented with the use of portable antennas in place of block netting to monitor the movements of PIT tagged fish from study sites in other areas. The use of portable antennas at Entiat River IMW sampling sites would allow the rate of emigration of marked fish from the study site to be calculated. Although the rate of immigration of marked or unmarked fish could not be determined, data on how many marked individuals moved into a study site would be beneficial. Since the use of these portable antenna systems would require a substantial staffing requirement it is doubtful that all sample sites could be monitored; however, if a subset of sites were monitored that data could then be applied to the project as a whole.

The effects of PIT tagging, specific to tag related mortality and shed rates, have recently been brought to question in a publication by Knudsen et. al. (2009). The authors suggest that delayed mortality and shed rates for hatchery reared spring Chinook in the upper Yakima River can exceed previous expectations. Assuming that these finding are applicable to wild populations of Chinook and steelhead in the Entiat watershed a number of problems arise in consideration to the goals set forth by the Entiat River IMW study (estimating juvenile survival, smolt to adult recruitment, etc.). We will continue to monitor rates of mortality and mark retention in order to limit bias in juvenile abundance estimates; however, we are currently unable to account for long-term tag related mortality and retention rates that could bias estimates of seasonal survival and adult recruitment.

Project goals

Project goals were met during for 2010. The first year of fish sampling under the Entiat IMW study design has provided estimates of abundance for juvenile Chinook salmon and steelhead at most sites. This season provided valuable information that will serve to improve future abundance and survival estimates. Fish sampling through the Entiat IMW study provides additional data on non-target species and this information is valuable for the long-term monitoring of species native to the Entiat watershed.

Methods- PIT Tag Interrogation Site Monitoring

Interrogation site locations

There are currently four PIT tag interrogation sites operating within the Entiat watershed. The lower Entiat River interrogation site (ENL) has been operational since 2007 and is located at rkm 2. The middle Entiat River interrogation site (ENM) has been operational since 2008 and is located below the McKenzie diversion dam at rkm 26. The Entiat River Forest Service boundary (ENF) site became operational in 2010 and is located at rkm 40.6. Finally, the Mad River (MAD) site has been operational since 2008 and is located on the Mad River at rkm 1. Although not yet operational, a fifth site was installed within

the Entiat River in 2010 near Stormy Creek at rkm 35.7. Locations of current and future interrogation sites within the Entiat watershed are shown in Figure 9.

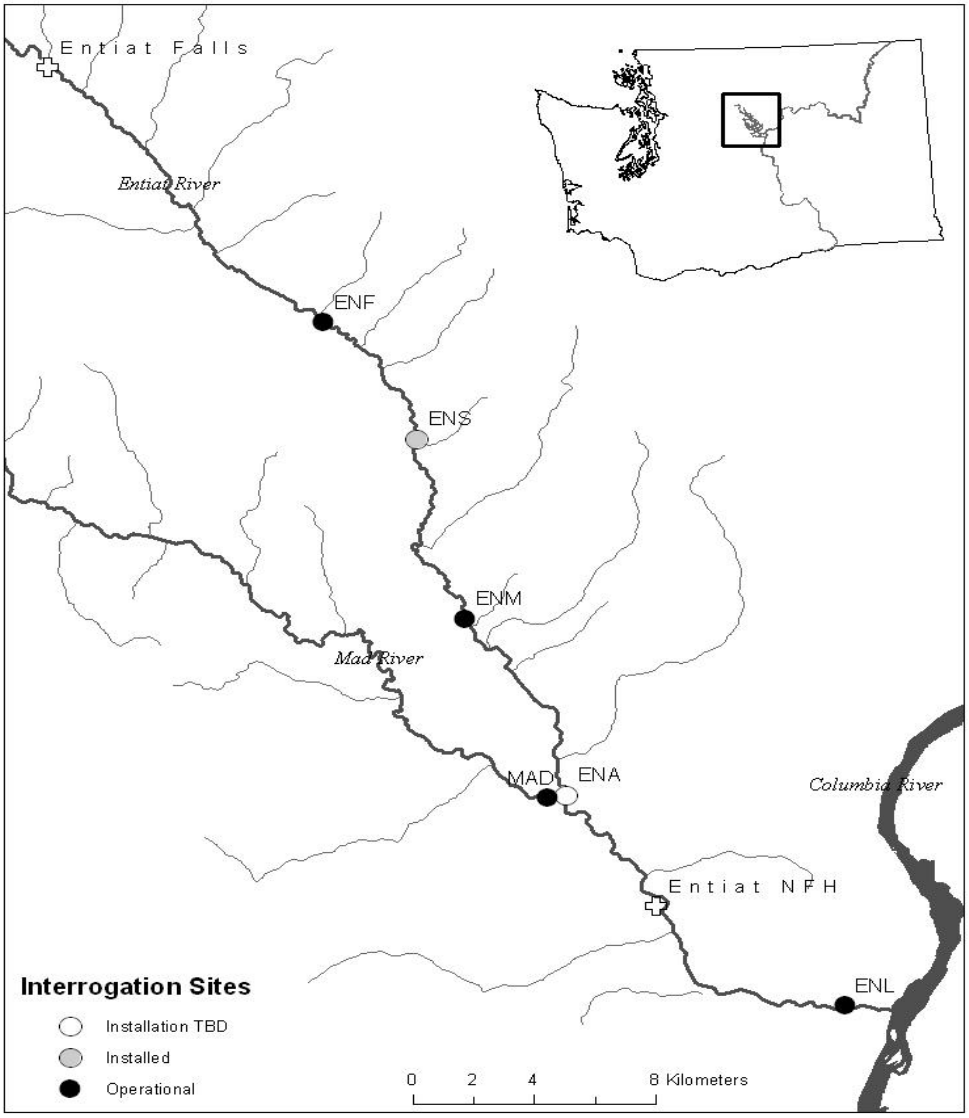

Figure 9. Study reach map of the Entiat River watershed with the locations of current and future PIT tag interrogation sites.

Interrogation site operation

Each interrogation site is equipped with a multiplexing transceiver (Destron-Fearing Digital Angel® model # FS1001M) capable of reading full duplex PIT tags (134.2 kHz). Six antennas of various sizes (10-20 foot each) span the width of the river at each site. Antennas power and communication is provided by a coax cable connected to the transceiver. External AC power is used to charge DC batteries in a weatherproof housing.

Antenna size is dependent upon the width of the river and thus varies between sites. Antennas are configured within the river in rows in order to determine direction of movement and increase site efficiency through redundancy. At main stem Entiat River sites (ENL, ENM and EFS) antennas are configured as two rows of three while at the Mad River site (MAD) three rows of two antennas are used. All antennas are anchored to the substrate in the flat plate, or pass-over configuration, meaning they are anchored on both the upstream and the downstream sides.

Interrogation sites are operated continuously throughout the year with exception to brief periods of equipment failure. All sites are downloaded weekly or as necessary based on river conditions or expected periods of high fish movement. Records of operational status are taken during each site visit. Transceiver data files are either transmitted via a cellular modem located at the site or by manually downloading the file onto a laptop computer. Site operational status and data files are uploaded to the PTAGIS website on a weekly basis.

Interrogation site maintenance
Routine maintenance is conducted by the MCRFRO on an as-needed basis and includes cable reconnection, replacement of anchor straps, debris removal, and antenna tuning. Interrogation sites within the Entiat watershed are largely affected by fluctuating river flows and the associated debris, thus it is generally expected that some antennas will require repair especially during or after spring run-off events. In the event that equipment failure is beyond the scope of work previously outlined, the Upper Columbia ISEMP coordinator and subsequently Washington Department of Fish and Wildlife (WDFW) staff are contacted in order to schedule needed repairs.

Results- PIT Tag Interrogation Site Monitoring

Monitoring periods
During the 365 day monitoring period, the ENL interrogation site operated 278 days (76.2%), ENM 306 days (83.8%) and the MAD site operated throughout the entire monitoring period (100%). The ENF site began operation on August 10th and operated a total of 140 days of the remaining 142 (98.6%) in the monitoring period. The majority of monitoring days lost were due to high flows during May and June. Specific details pertaining to site inactivity or failure are outlined in Appendices 9, 10, 11 and 12.

Detection summary
In 2010, a combined total of 2,115 unique detections were recorded between all sites (Table 7). Unique detections were determined by pooling detections from all sites during the monitoring period and removing any duplicate values. Juvenile fish accounted for a total of 1,805 (85.3%) of all unique detections while adult detections accounted for 310 (14.7%).

Table 7. Combined unique detections from all interrogation sites during the 2010 monitoring period. PTAGIS naming convention used to indicate run and rear type.

Species (indicating rear and run type)	Total Juvenile	Total Adult	Total Detected
Hatchery spring Chinook salmon	2	3	5
Wild spring Chinook salmon	856	60	916
Hatchery summer Chinook salmon	11	1	12
Summer Chinook salmon (unknown rear type)	0	1	1
Wild summer Chinook salmon	157	2	159
Fall Chinook salmon (unknown rear type)	0	2	2
Hatchery Chinook Salmon (unknown run)	0	1	1
Chinook salmon (unknown run and rear type)	0	11	11
Wild Chinook salmon (unknown run)	164	2	166
Hatchery coho salmon	2	0	2
Wild coho salmon	12	0	12
Hatchery summer steelhead	3	41	44
Summer steelhead (unknown rear type)	0	69	69
Wild summer steelhead	583	82	665
Steelhead (unknown run and rear type)	0	2	2
Wild resident rainbow trout	1	0	1
Hatchery sockeye salmon (unknown run)	0	13	13
Sockeye salmon (unknown run and rear type)	0	3	3
Wild sockeye salmon (unknown run)	0	2	2
Bull trout	11	14	25
Wild resident cutthroat trout	3	1	4
Total	1,805	310	2,115

Unique detections were further determined for each interrogation site. The ENL site had a total of 1,586 unique detections (Table 8), ENM totaled 273 (Table 9), ENF 78 (Table 10) and the MAD interrogation site had 401 detections (Table 11).

Table 8. Summary of unique detection from the lower Entiat River (ENL) site during the 2010 monitoring period. PTAGIS naming convention used to indicate run and rear type.

Species (indicating rear and run type)	Total Juvenile	Total Adult	Total Detected
Hatchery spring Chinook salmon	1	0	1
Wild spring Chinook salmon	726	24	750
Hatchery summer Chinook salmon	11	1	12
Summer Chinook salmon (unknown rear type)	0	1	1
Wild summer Chinook salmon	155	1	156
Fall Chinook salmon (unknown rear type)	0	2	2
Hatchery Chinook Salmon (unknown run)	0	1	1
Chinook salmon (unknown run and rear type)	0	7	7
Wild Chinook salmon (unknown run)	56	0	56
Hatchery coho salmon	1	0	1
Wild coho salmon	12	0	12
Hatchery summer steelhead	3	37	39
Summer steelhead (unknown rear type)	0	63	63
Wild summer steelhead	390	68	458
Wild resident rainbow trout	1	0	1
Hatchery sockeye salmon (unknown run)	0	1	1
Sockeye salmon (unknown run and rear type)	0	3	3
Wild sockeye salmon (unknown run)	0	1	1
Bull trout	10	8	18
Wild resident cutthroat trout	0	2	2
Total	1,366	220	1,586

Table 9. Summary of unique detection from the middle Entiat River (ENM) site during the 2010 monitoring period. PTAGIS naming convention used to indicate run and rear type.

Species (indicating rear and run type)	Total Juvenile	Total Adult	Total Detected
Hatchery spring Chinook salmon	2	1	3
Wild spring Chinook salmon	96	37	133
Hatchery summer Chinook salmon	1	0	1
Wild summer Chinook salmon	0	2	2
Chinook salmon (unknown run and rear type)	0	3	3
Wild Chinook salmon (unknown run)	39	2	41
Hatchery summer steelhead	0	3	3
Summer steelhead (unknown rear type)	0	19	19
Wild summer steelhead	22	22	44
Hatchery sockeye salmon (unknown run)	0	11	11
Sockeye salmon (unknown run and rear type)	0	1	1
Wild sockeye salmon (unknown run)	0	2	2
Bull trout	1	7	7
Wild resident cutthroat trout	1	1	1
Total	162	111	273

Table 10. Summary of unique detection from the middle Entiat River Forest Service boundary (ENF) site during the 2010 monitoring period. PTAGIS naming convention used to indicate run and rear type.

Species (indicating rear and run type)	Total Juvenile	Total Adult	Total Detected
Hatchery spring Chinook salmon	0	1	1
Wild spring Chinook salmon	1	30	31
Chinook salmon (unknown run and rear type)	0	2	2
Wild Chinook salmon (unknown run)	31	2	33
Wild summer steelhead	3	0	3
Hatchery sockeye salmon (unknown run)	0	1	1
Bull trout	0	6	6
Wild resident cutthroat trout	0	1	1
Total	35	43	78

Table 11. Summary of unique detection from the Mad River (MAD) site during the 2010 monitoring period. PTAGIS naming convention used to indicate run and rear type

Species (indicating rear and run type)	Total Juvenile	Total Adult	Total Detected
Hatchery spring Chinook salmon	0	1	1
Wild spring Chinook salmon	68	7	75
Wild summer Chinook salmon	2	0	0
Wild Chinook salmon (unknown run)	55	0	55
Hatchery coho salmon	1	0	1
Hatchery summer steelhead	0	5	5
Summer steelhead (unknown rear type)	0	26	26
Wild summer steelhead	193	33	226
Steelhead (unknown run and rear type)	0	2	2
Wild resident rainbow trout	1	0	1
Hatchery sockeye salmon (unknown run)	0	2	2
Bull trout	1	4	5
Total	321	80	401

Data dissemination

All data files and operational status information collected from interrogation sites were uploaded to the PTAGIS database with few exceptions. The uploading of data files occurred weekly or when data became available.

Discussion- PIT Tag Interrogation Site Monitoring

Operating periods

Stream-width interrogation sites are often subjected to a multitude of harsh conditions that can result in equipment loss or damage. As this loss or damage typically occurs

during high water events and spring freshets, there are periods of time in which they cannot be safely accessed for repair. This occurs most frequently at the lower Entiat site due to its location within the drainage and the higher flow associated with it. In 2010, repairs to both ENL and ENM sites were further delayed due to the prolonged peak of spring river discharge.

Project goals
ISEMP will be installing an additional interrogation site within the Entiat River in 2011. This site will be located on the main stem Entiat at rkm 17.1. The interrogation site at Stormy Creek has been installed but will remain inoperable until AC power can be provided. It is anticipated that this power issue will be resolved within the 2011 monitoring period.

Currently, data from the ENF site cannot be uploaded to the PTAGIS website due to a lack of site recognition within the PTAGIS database. This issue is being addressed and we anticipate that all data collected from the ENF site will be uploaded to PTAGIS within the 2011 monitoring period.

Methods- Steelhead Redd Surveys

Redd surveys for steelhead were conducted on the Entiat River during the spring of 2010. Redd surveys were conducted and data were recorded using methods described in Nelle and Moberg (2008). Turbidity samples and a Secchi disk reading were also taken during each survey to aid in defining water clarity. Water clarity was defined as (1) good, (2) adequate, or (3) poor. The area surveyed encompassed the entire main stem river from Fox Creek campground at rkm 45 to the Entiat city limits at rkm 1.1 (Figure 10). The survey area was divided into four reaches based on river access points and distances that could be surveyed in one work day. Reach A extended from the Entiat city limits (rkm 1.1) to the Entiat National Fish Hatchery (ENFH) (rkm 10.6). Reach B, covered the river from ENFH (rkm 10.6) to the McKenzie diversion dam (rkm 25.9). Reach C went from the McKenzie diversion dam (rkm 25.9) to a private bridge upstream of Brief (rkm 37.7). Reach D began at the Brief bridge (rkm 37.7) and ended at Fox Creek campground (rkm 45). Conditions permitting, all four reaches were surveyed once each week. Surveys were conducted in a downstream direction using two 10 foot personal catarafts and walking when areas were inaccessible or too dangerous for rafts.

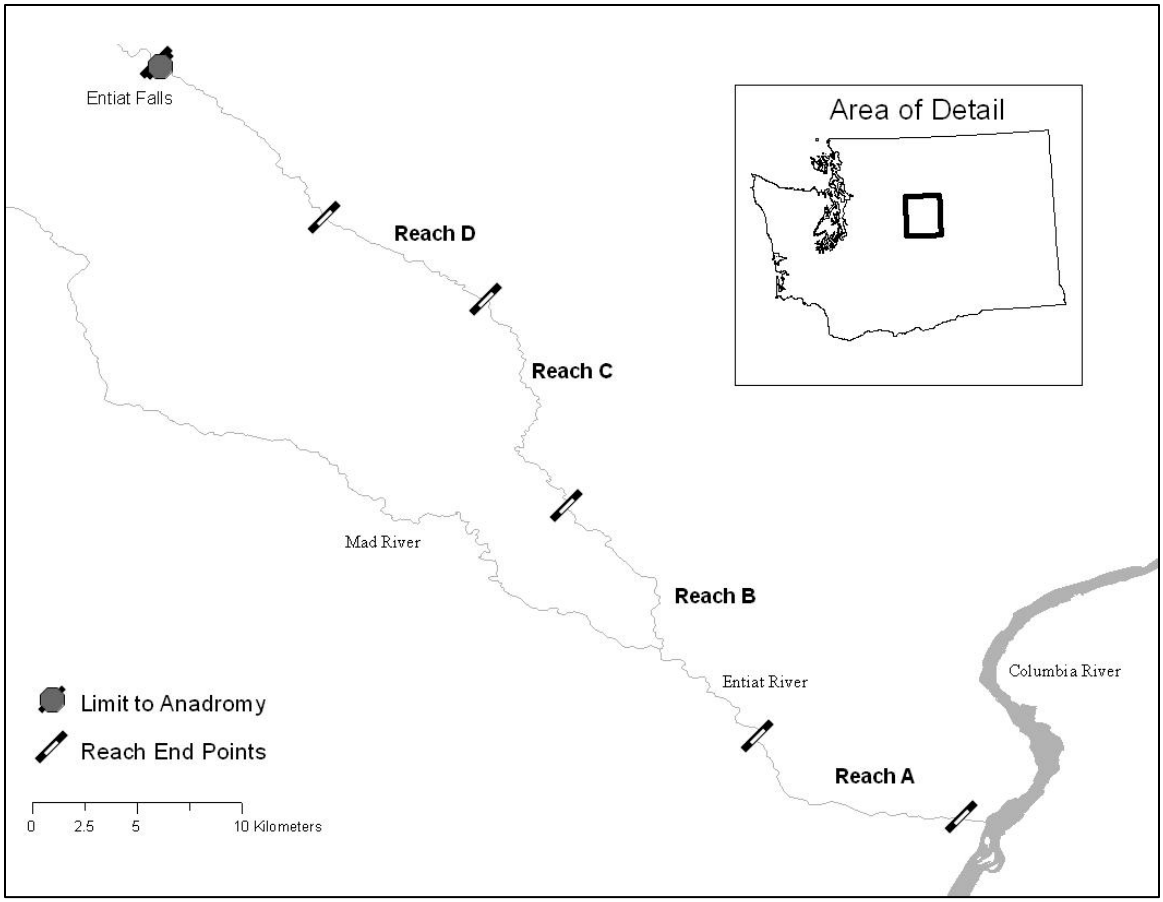

Figure 10. The four reaches of steelhead redd surveys on the Entiat River, 2010.

Results- Steelhead Redd Surveys

Steelhead redd surveys began on February 9, 2010 and were completed on June 2, 2010. High flows prevented surveys during the rest of June. Water temperatures ranged from 1.5 to 10.5° C, with averages of 6.1, 5.6, 5.3, and 4.9° C for reaches A, B, C, and D respectively. Turbidity averaged 0.62 Nephelometric Turbidity Units (NTU) and Secchi disk readings averaged 1.5 meters over all reaches. Water clarity averaged 1. Turbidity was greater in the lower sections of the river; however, there was minimal difference in Secchi disk readings based on location alone (Table 12). A total of 189 redds were observed throughout the reaches. No redds were observed during the first survey for each reach. The first redd was observed on February 16 in reach A and the last new redd was observed on May 25 in reach C. After February 16, new redds were observed consistently during each remaining survey with exception to periods in which high river flow prevented surveys from occurring (Table 13). With a total of 98, the month of April had the highest observation of new redds for 2010. As in previous years, the majority of new redds (81%) were observed during the months of April and May (Fig 11).

Table 12. The average Temperature (°C), Secchi disk reading, turbidity (NTU), and water clarity of the Entiat River during steelhead redd surveys, 2010.

	Average			
Reach	**Temp °C**	**Secchi Disk (m)**	**Turbidity (NTU)**	**Water Clarity**
A	6.1	1.5	0.91	1
B	5.6	1.4	0.60	1
C	5.3	1.5	0.42	1
D	4.9	1.5	0.56	1
All Reaches	5.5	1.5	0.62	1

Table 13. The numbers of new redds by week for each of the steelhead redd survey reaches on the Entiat River, 2010.

Survey Week	**Midweek Date**	**A**		**B**		**C**		**D**		**All Reaches**	
		New	**Total**	**New**	**Total**	**New**	**Total**	**New**	**Total**	**New**	**Total**
1	02/10/10	0	0							0	0
2	02/17/10	1	1	0	0					1	1
3	02/24/10	0	1	0	0	0	0			0	1
4	03/03/10	2	3	0	0	0	0			2	3
5	03/10/10	1	4	0	0	-	-			1	4
6	03/17/10	4	8	2	2	1	1			7	11
7	03/24/10	2	10	5	7	1	2	0	0	8	19
8	03/31/10	9	19	4	11	3	5	0	0	16	35
9	04/07/10	8	27	4	15	10	15	-	-	22	57
10	04/14/10	26	53	7	22	8	23	7	7	48	105
11	04/21/10	-	53	0	22	3	26	1	8	4	109
12	04/28/10	13	66	2	24	7	33	2	10	24	133
13	05/05/10	10	76	7	31	15	48	6	16	38	171
14	05/12/10	11	87	2	33	1	49	1	17	15	186
15	05/19/10	-	87	-	33	-	49	-	17	-	186
16	05/26/10	0	87	0	33	3	52	0	17	3	189
17	06/02/10	-	87	-	33	0	52	0	17	0	189

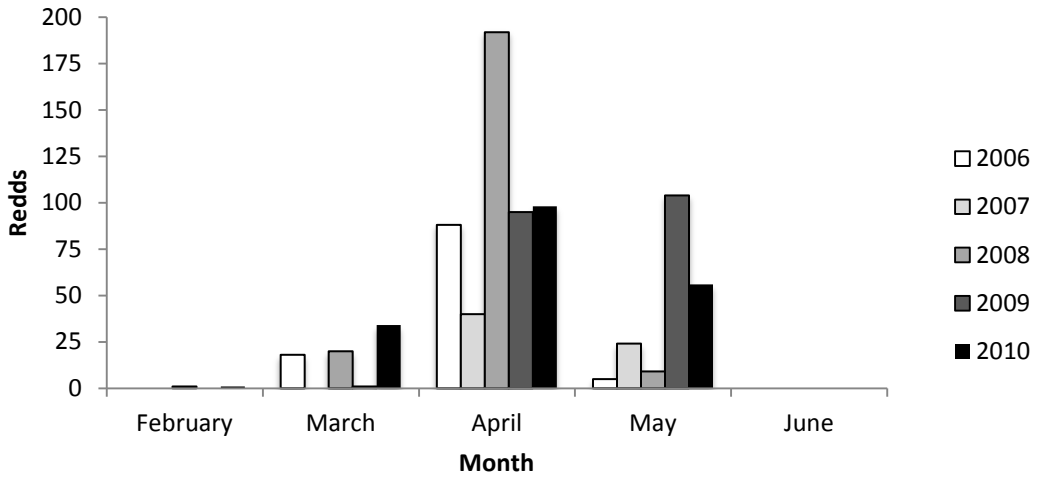

Figure 11. The numbers of steelhead redds observed by month in the Entiat River from 2006 to 2010.

Eighty-seven (46%) redds were found downstream of the ENFH in reach A (Fig 12). Reach B contained 33 (17%) of the observed redds (Fig 13). In reach C 52 (28%) redds were observed (Fig 14). Reach D had 17 (9%) redds observed (Fig 15). This distribution is similar to previous years' surveys in which more redds were found lower in the river system (Table 14).

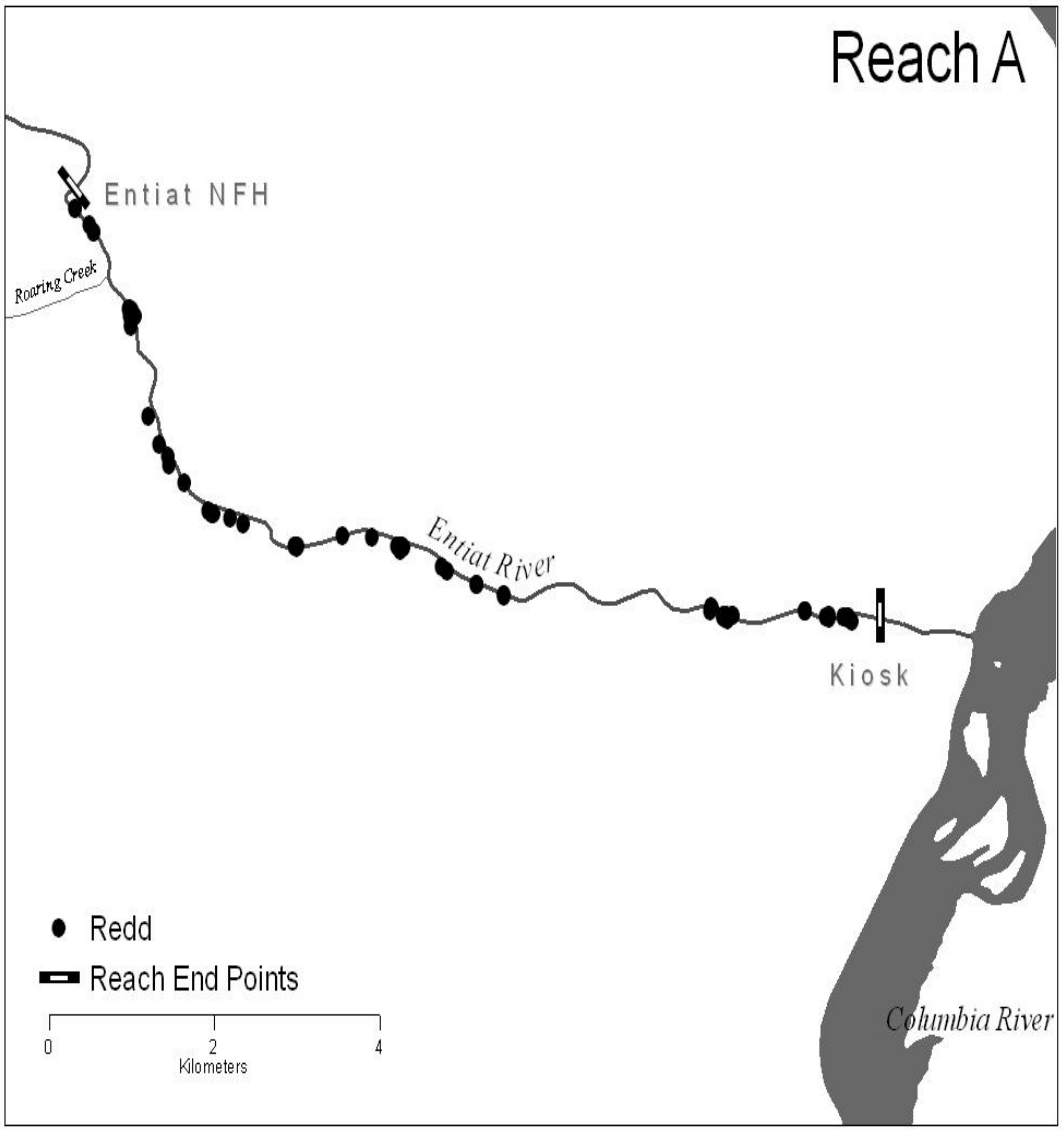

Figure 12. Reach A and the locations of redds during steelhead redd surveys on the Entiat River, 2010.

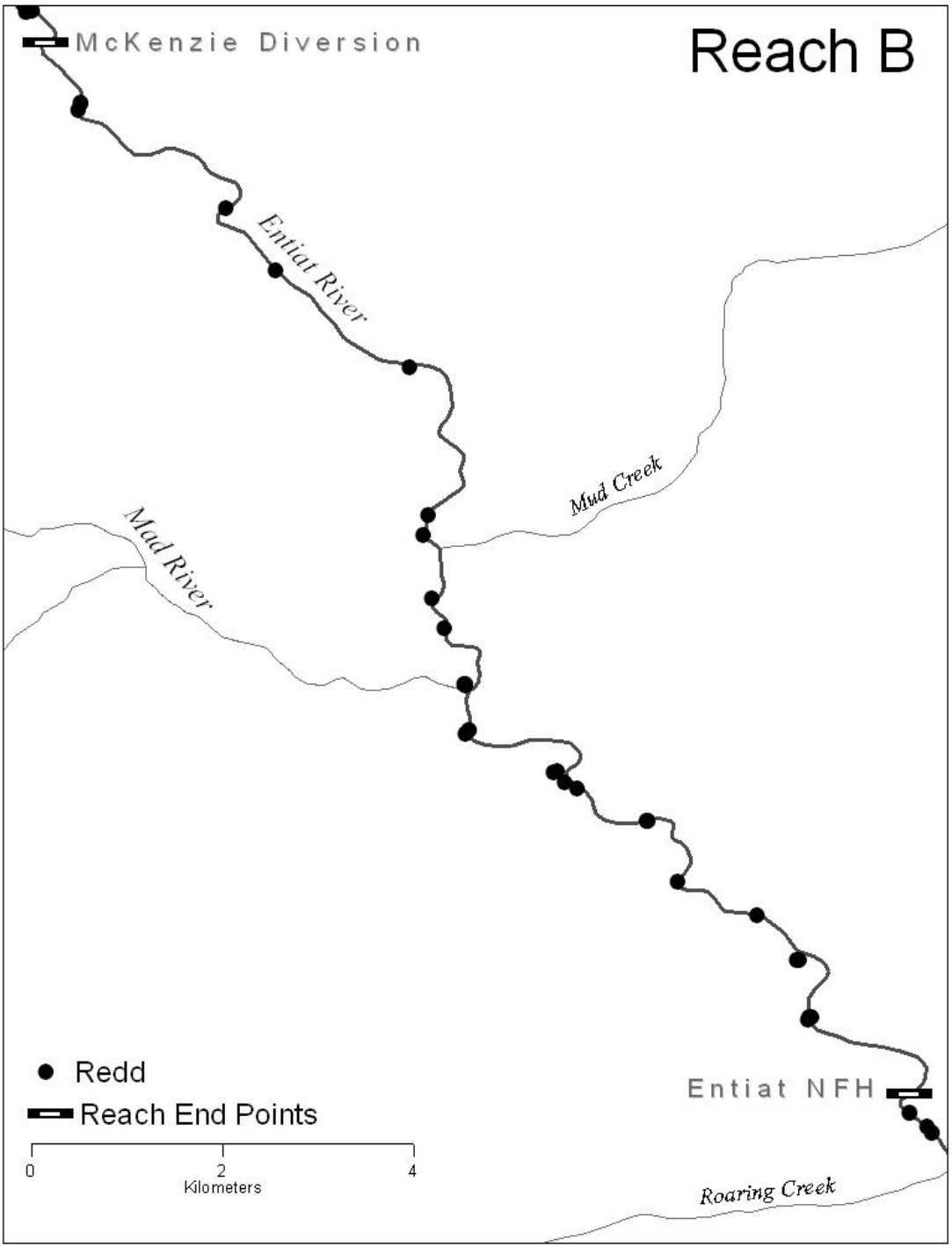

Figure 13. Reach B and the locations of redds during steelhead redd surveys on the Entiat River, 2010.

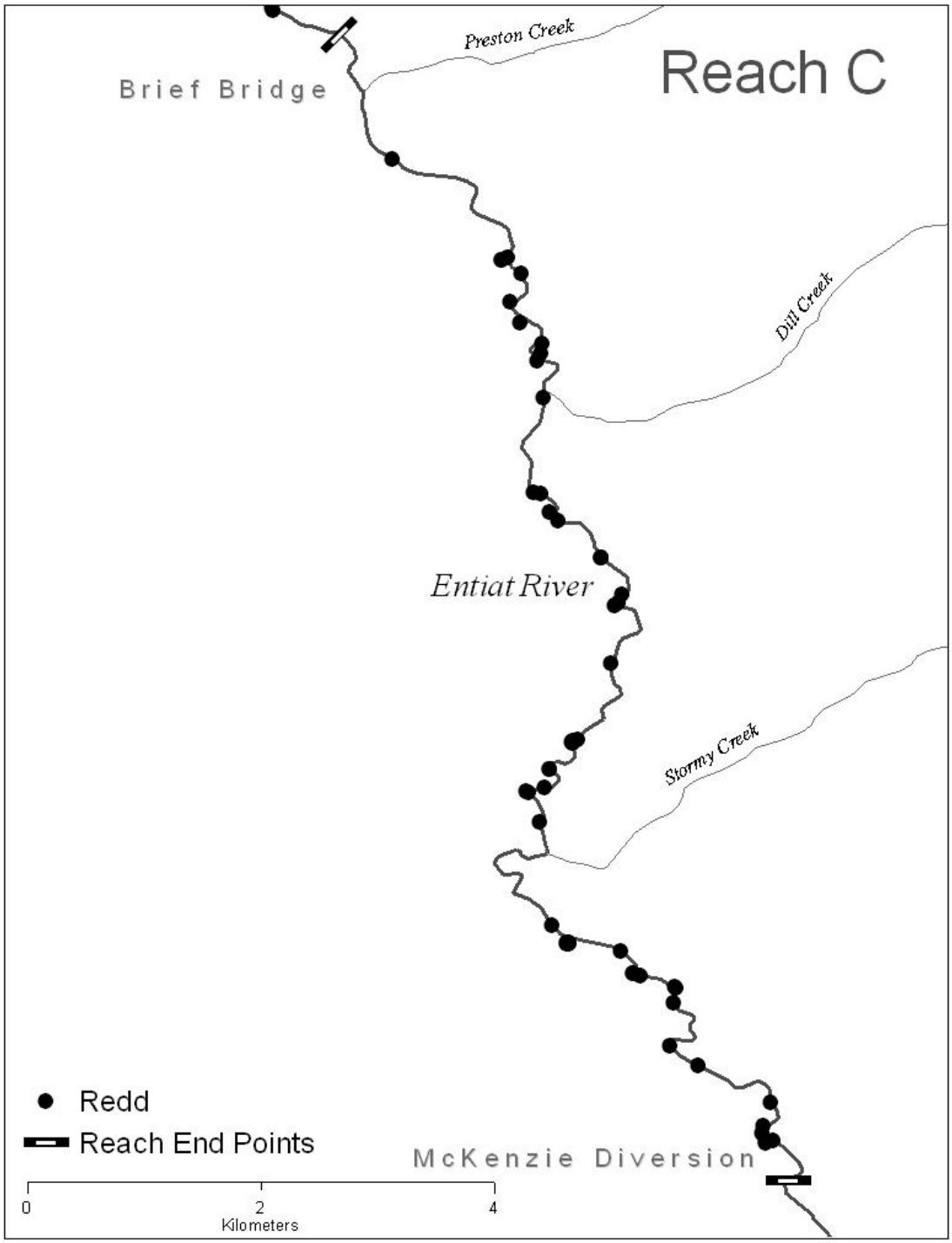

Figure 14. Reach C and the locations of redds during steelhead redd surveys on the Entiat River, 2010.

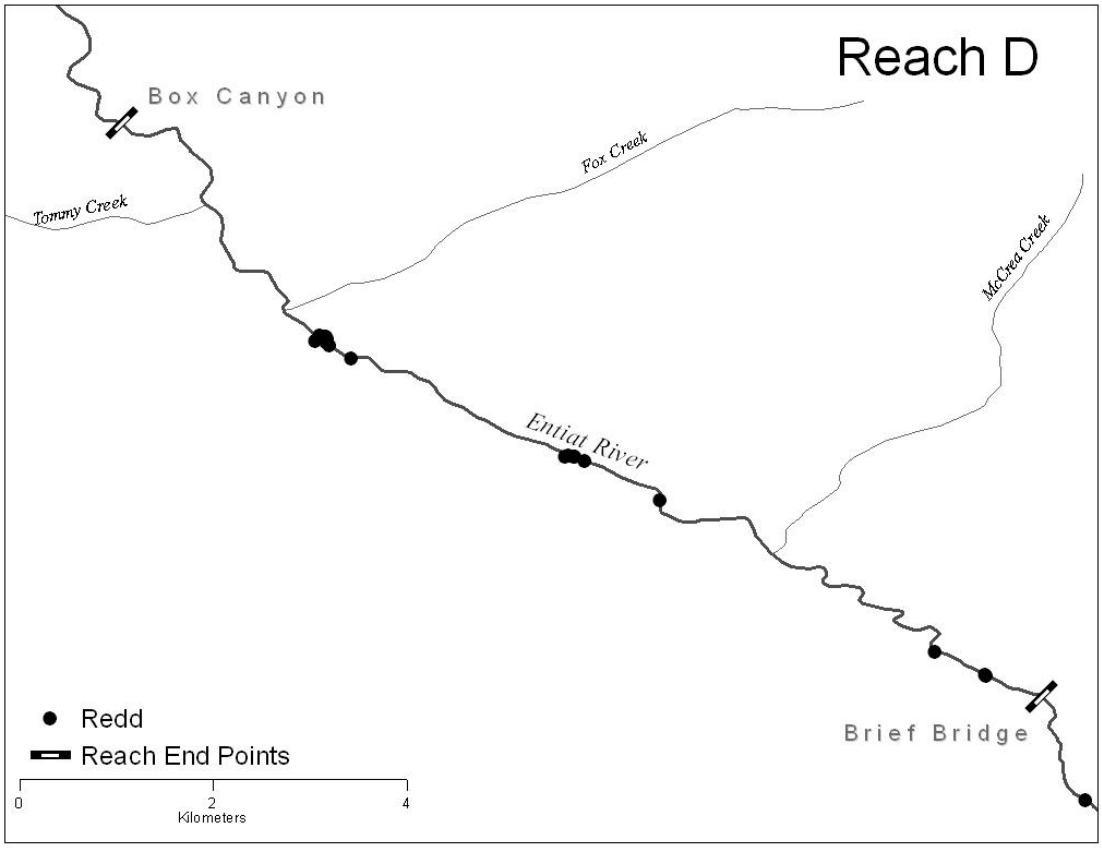

Figure 15. Reach D and the locations of redds during steelhead redd surveys on the Entiat River, 2010.

Table 14. The total number of steelhead redds by reach on the Entiat River from 2006 to 2010.

	Reach				
Year	**A**	**B**	**C**	**D**	**Total**
2006	38	26	34	13	111
2007	40	7	14	3	64
2008	93	84	31	14	222
2009	128	37	27	8	200
2010	87	33	53	17	189

Thirty-four of the 87 redds (39%) found below the ENFH (reach A) were associated with restoration sites. This is up from last year's (24%) but less than in 2008 when 48% were within restoration sites. As in previous years' surveys, established sites had fewer associated redds than those that were recently constructed. A new restoration site below the Keystone bridge (rkm 1.4) established in 2009 had eleven redds associated with it. Six were observed in this area during 2009 and only one in the years prior (Table 15).

Table 15. The redds observed within the Entiat River from 2006 to 2010 that were in close proximity to restoration sites.

Survey Year	**2010**	**2009**	**2008**	**2007**	**2006**
Total Redds Observed	189	200	222	64	111
Redds above Hatchery	102	72	129	24	73
Redds below Hatchery	87	128	93	40	38
Hatchery to Dinkelman Cyn Rd.					
John Small Barb	0	0	0	0	0
Hanan/Detwiler Cross Vane (2007)	1	5	9	9	2
Rest of the Section	23	32	31	18	5
Total Redds	24	37	40	27	7
Dinkelman Cyn Rd. to Fire Station					
Dinkelman Cyn. Rd. Cross Vane (2001)	1	2	3	0	0
PUD Irrigation Ditch	6	2	4	0	7
Whitehall Cross Vane (2006)	7	1	4	0	1
Rest of the Section	10	15	6	0	6
Total Redds	24	22	17	0	14
Fire Station to U.S.G.S.					
Fire Station Cross Vanes (2001)	2	6	1	0	0
Milne Irrigation Diversion (2007)	6	15	24	3	4
Rest of the Section	0	10	2	4	2
Total Redds	8	30	27	7	6
U.S.G.S. to Columbia River Confluence					
Keystone (2009)	11	6	0	0	1
Rest of the Section	20	33	9	6	10
Total Redds	31	39	9	6	11

Discussion- Steelhead Redd Surveys

Steelhead redd surveys on the Entiat River were conducted on time and within the given time frame for 2010. A total of 189 redds were found in the lower 45 km of the river during the months of February to May. Surveys began earlier in 2010 based upon previous years' data that suggested redd construction beginning in February. Beginning surveys earlier combined with mild winter weather conditions allowed establishing zero counts within each reach and better explained when spawning began.

The Hanan-Detwiler irrigation diversion (rkm 5) was not opened this year. This prevented steelhead from utilizing it for spawning. This diversion channel has supported numerous redds in the past.

The new restoration site downstream of the Keystone Bridge will provide a new area of spawning that was previously used little by spawning steelhead. This will allow further studying of the length of time in which these sites provide suitable spawning gravels.

Acknowledgements

MCRFRO staff diligently spent many long hours collecting accurate data for these ISEMP programs. Thanks to all who assisted with juvenile fish capture operations and steelhead redd surveys: Caleb Barnes, Andy Bohl, Matt Cooper, Kyle Fronte, Chris Jones, Armin Halston, Josh Pierrat, Fredy Quezada, Ryan Santo, Jonah Terrel-Lewis, Heather Trainer, Cal Yonce. We would further like to acknowledge the dedicated staff provided by the Yakama Nation and Terraqua for their valuable assistance in mark-recapture sampling: Josh Adams, Rick Alford, Matt Collins, Kevin Creager, Syria DiMonica, Joe Ezell, Jason Hickman, Barry Hodges, Bryan Ishida, Jeremy Moberg, Kraig Mott, Steve Tussing, Mike Ward, Keith Watson and Eric Wittenbach. Last but not least, the success of these projects would have been limited if not for the support from Craig Chisam, Jason Reeves and John Reier, the exceptional staff of Entiat National Fish Hatchery.

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Appendix

Appendix Table 1. Rotary screw trap operational summary for the Entiat River lower trap location, 2010. Day's not trapped, trapped but incomplete, river flow and the causes of trapping status.

Date	Status	Flow (m^3/s)	Comments
3 /1 /2010	Incomplete	4.0	Cone clogged low RPM.
3 /2 /2010	Incomplete	4.1	Cone clogged low RPM.
3 /3 /2010	Not operated	4.3	Pulled for training.
3 /31/2010	Not operated	5.6	Pulled for training.
4 /20/2010	Incomplete	11.1	Trap stopped due to debris.
4 /21/2010	Incomplete	15.0	Trap stopped due to debris.
4 /22/2010	Incomplete	20.6	Trap stopped due to debris.
4 /23/2010	Incomplete	21.1	Trap stopped due to debris.
5 /14/2010	Incomplete	21.6	Trap stopped due to debris.
5 /15/2010	Incomplete	27.2	Trap stopped due to debris
5 /16/2010	Incomplete	35.8	Trap stopped due to debris
5 /17/2010	Not operated	46.2	Pulled due to high flow.
5 /18/2010	Not operated	57.6	Pulled due to high flow.
5 /19/2010	Not operated	63.6	Pulled due to high flow.
5 /20/2010	Not operated	60.4	Pulled due to high flow.
5 /21/2010	Not operated	52.2	Pulled due to high flow.
5 /22/2010	Not operated	45.5	Pulled due to high flow.
5 /23/2010	Not operated	39.9	Pulled due to high flow.
5 /24/2010	Not operated	35.8	Pulled due to high flow.
5 /25/2010	Not operated	31.8	Pulled due to high flow.
5 /29/2010	Not operated	35.9	Pulled due to high flow.
5 /30/2010	Not operated	37.7	Pulled for Holiday.
5 /31/2010	Not operated	39.9	Pulled due to high flow.
6 /1 /2010	Not operated	44.1	Incomplete due to high flow.
6 /2 /2010	Not operated	47.2	Pulled due to high flow.
6 /3 /2010	Not operated	58.1	Pulled due to high flow.
6 /4 /2010	Not operated	63.5	Pulled due to high flow.
6 /5 /2010	Not operated	57.4	Pulled due to high flow.
6 /6 /2010	Not operated	53.7	Pulled due to high flow.
6 /7 /2010	Not operated	52.1	Pulled due to high flow.
6 /8 /2010	Not operated	53.1	Pulled due to high flow.
6 /9 /2010	Not operated	54.7	Pulled due to high flow.
6 /10/2010	Not operated	57.8	Pulled due to high flow.
6 /11/2010	Not operated	56.7	Pulled due to high flow.
6 /12/2010	Not operated	54.1	Pulled due to high flow.

Appendix Table 1. Continued

Date	Status	Flow (m^3/s)	Comments
6 /13/2010	Not operated	57.1	Pulled due to high flow.
6 /14/2010	Not operated	67.2	Pulled due to high flow.
6 /15/2010	Not operated	69.4	Pulled due to high flow.
6 /16/2010	Not operated	57.5	Pulled due to high flow.
6 /17/2010	Not operated	50.1	Pulled due to high flow.
6 /18/2010	Not operated	44.3	Pulled due to high flow.
6 /19/2010	Not operated	41.8	Pulled due to high flow.
6 /20/2010	Not operated	41.6	Pulled due to high flow.
6 /21/2010	Not operated	48.5	Pulled due to high flow.
6 /22/2010	Not operated	54.5	Pulled due to high flow.
6 /23/2010	Not operated	58.0	Pulled due to high flow.
6 /24/2010	Not operated	61.4	Pulled due to high flow.
6 /25/2010	Not operated	62.8	Pulled due to high flow.
6 /26/2010	Not operated	60.1	Pulled due to high flow.
6 /27/2010	Not operated	55.5	Pulled due to high flow.
6 /28/2010	Not operated	52.6	Pulled due to high flow.
6 /29/2010	Not operated	53.0	Pulled due to high flow.
6 /30/2010	Not operated	50.4	Pulled due to high flow.
7 /1 /2010	Not operated	43.1	Pulled due to high flow.
7 /1 /2010	Not operated	43.1	Pulled due to high flow.
7 /2 /2010	Not operated	37.7	Pulled due to high flow.
7 /3 /2010	Not operated	33.1	Pulled due to high flow.
7 /4 /2010	Not operated	30.3	Pulled due to high flow.
7 /5 /2010	Not operated	29.7	Pulled due to high flow.
7 /6 /2010	Not operated	28.9	Pulled due to high flow.
7 /12/2010	Incomplete	39.4	Cone clogged with Styrofoam.
7 /13/2010	Incomplete	34.9	Cone clogged debris.
7 /14/2010	Not operated	27.8	Trap pulled for IMW training.
7 /16/2010	Not operated	23.3	Trap pulled for IMW training.
7 /28/2010	Incomplete	13.7	Cone clogged with a rubber tube.
7 /31/2010	Incomplete	12.2	Cone clogged with woody debris.
8 /1 /2010	Not operated	13.1	Trap pulled for IMW sampling.
8 /5 /2010	Incomplete	14.2	Cone clogged with debris.
8 /7 /2010	Incomplete	11.4	Cone clogged with debris.
8 /8 /2010	Not operated	10.8	Trap pulled for IMW sampling.
8 /14/2010	Not operated	7.8	Trap pulled for IMW sampling.
8 /15/2010	Not operated	7.5	Trap pulled for IMW sampling.
8 /17/2010	Not operated	7.1	Trap pulled for IMW sampling.
8 /18/2010	Not operated	6.9	Trap pulled for IMW sampling.
8 /19/2010	Not operated	6.7	Trap pulled for IMW sampling.
9 /1 /2010	Incomplete	5.4	Cone partially clogged.

Appendix Table 1. continued

Date	Status	Flow (m^3/s)	Comments
9 /6 /2010	Not operated	4.9	Trap pulled for Holiday.
9 /19/2010	Incomplete	6.3	Cone clogged with debris.
9 /21/2010	Incomplete	7.4	Cone clogged with debris.
10/3 /2010	Incomplete	5.2	Cone clogged with debris.
10/11/2010	Incomplete	9.3	Cone clogged with debris.
10/15/2010	Incomplete	6.0	Cone clogged with debris.
10/16/2010	Not operated	5.8	Trap pulled to transition to nights.
10/17/2010	Not operated	5.6	Trap pulled to transition to nights.
11/2 /2010	Incomplete	6.0	Cone clogged with debris.
11/3 /2010	Incomplete	7.0	Trap stopped due to debris.
11/8 /2010	Incomplete	7.0	Trap stopped due to debris.
11/11/2010	Not operated	6.4	Pulled for Holiday
11/16/2010	Incomplete	6.6	Pulled due to high debris.

Appendix Table 2. Rotary screw trap operational summary for the Entiat River upper trap location, 2010. Days not trapped, trapped but incomplete, river flow and the causes of trapping status.

Date	Status	Flow (m^3/s)	Comments
3 /3 /2010	Not operated	4.3	Trap pulled for training.
3 /9 /2010	Not operated	5.0	Trap pulled for training.
3 /30/2010	Incomplete	5.7	Trap stopped due to debris.
3 /31/2010	Not operated	5.6	Trap pulled for training.
4 /5 /2010	Not operated	5.1	Trap not ran.
4 /8 /2010	Not operated	5.2	Trap not ran.
4 /9 /2010	Not operated	5.2	Trap not ran.
4 /10/2010	Not operated	5.0	Trap not ran.
4 /11/2010	Not operated	5.0	Trap not ran.
4 /12/2010	Not operated	5.0	Trap not ran.
4 /13/2010	Not operated	5.0	Trap not ran.
4 /14/2010	Not operated	5.2	Trap not ran.
4 /15/2010	Not operated	5.5	Trap not ran.
4 /16/2010	Not operated	5.9	Trap not ran.
4 /17/2010	Not operated	6.4	Trap not ran.
4 /18/2010	Not operated	7.8	Trap not ran.
4 /19/2010	Not operated	9.3	Trap not ran.
4 /20/2010	Not operated	11.1	Trap not ran.
4 /21/2010	Not operated	15.0	Trap not ran.
4 /22/2010	Not operated	20.6	Trap not ran.
4 /23/2010	Not operated	21.1	Trap not ran.
4 /24/2010	Not operated	20.3	Trap not ran.
4 /25/2010	Not operated	19.0	Trap not ran.
4 /27/2010	Not operated	17.6	Trap not ran.
4 /28/2010	Not operated	19.8	Trap not ran.
4 /29/2010	Not operated	18.9	Trap not ran.
4 /30/2010	Not operated	18.3	Trap not ran.
5 /1 /2010	Not operated	17.9	Trap not ran.
5 /4 /2010	Not operated	17.9	Trap not ran.
5 /5 /2010	Not operated	16.7	Trap not ran.
5 /9 /2010	Not operated	14.3	Trap not ran.
5 /10/2010	Not operated	14.1	Trap not ran.
5 /11/2010	Not operated	14.3	Trap not ran.
5 /12/2010	Not operated	14.8	Trap not ran.
5 /13/2010	Not operated	17.2	Trap not ran.
5 /15/2010	Not operated	27.2	Pulled due to high flow.
5 /16/2010	Not operated	35.7	Pulled due to high flow.

Appendix Table 2. Continued

Date	Status	Flow (m^3/s)	Comments
5 /17/2010	Not operated	46.1	Pulled due to high flow.
5 /18/2010	Not operated	66.0	Pulled due to high flow.
5 /19/2010	Not operated	63.6	Pulled due to high flow.
5 /20/2010	Not operated	60.4	Pulled due to high flow.
5 /21/2010	Not operated	52.1	Pulled due to high flow.
5 /22/2010	Not operated	45.5	Pulled due to high flow.
5 /23/2010	Not operated	39.9	Pulled due to high flow.
5 /24/2010	Not operated	35.8	Pulled due to high flow.
5 /25/2010	Not operated	31.8	Pulled due to high flow.
5 /26/2010	Not operated	29.5	Pulled due to high flow.
5 /27/2010	Not operated	34.6	Pulled due to high flow.
5 /28/2010	Not operated	32.9	Pulled due to high flow.
5 /29/2010	Not operated	35.9	Pulled due to high flow.
5 /30/2010	Not operated	37.7	Pulled due to high flow.
5 /31/2010	Not operated	39.8	Trap pulled for holiday.
6 /1 /2010	Incomplete	44.0	Incomplete due to high flow.
6 /2 /2010	Not operated	47.2	Pulled due to high flow.
6 /3 /2010	Not operated	58.0	Pulled due to high flow.
6 /4 /2010	Not operated	63.5	Pulled due to high flow.
6 /5 /2010	Not operated	57.4	Pulled due to high flow.
6 /6 /2010	Not operated	53.7	Pulled due to high flow.
6 /7 /2010	Not operated	52.0	Pulled due to high flow.
6 /8 /2010	Not operated	53.0	Pulled due to high flow.
6 /9 /2010	Not operated	54.7	Pulled due to high flow.
6 /10/2010	Not operated	57.7	Pulled due to high flow.
6 /11/2010	Not operated	56.6	Pulled due to high flow.
6 /12/2010	Not operated	54.1	Pulled due to high flow.
6 /13/2010	Not operated	57.0	Pulled due to high flow.
6 /14/2010	Not operated	67.1	Pulled due to high flow.
6 /15/2010	Not operated	69.4	Pulled due to high flow.
6 /16/2010	Not operated	57.4	Pulled due to high flow.
6 /17/2010	Not operated	50.0	Pulled due to high flow.
6 /18/2010	Not operated	44.3	Pulled due to high flow.
6 /19/2010	Not operated	41.8	Pulled due to high flow.
6 /20/2010	Not operated	41.6	Pulled due to high flow.
6 /21/2010	Not operated	48.4	Pulled due to high flow.
6 /22/2010	Not operated	54.5	Pulled due to high flow.
6 /23/2010	Not operated	58.0	Pulled due to high flow.
6 /24/2010	Not operated	61.4	Pulled due to high flow.
6 /25/2010	Not operated	62.7	Pulled due to high flow.
6 /26/2010	Not operated	60.0	Pulled due to high flow.
6 /27/2010	Not operated	55.5	Pulled due to high flow.

Appendix Table 2. continued

Date	Status	Flow (m^3/s)	Comments
6 /28/2010	Not operated	52.6	Pulled due to high flow.
6 /29/2010	Not operated	52.9	Pulled due to high flow.
6 /30/2010	Not operated	50.3	Pulled due to high flow.
7 /2 /2010	Not operated	37.7	Pulled due to high flow.
7 /3 /2010	Not operated	33.1	Pulled due to high flow.
7 /4 /2010	Not operated	30.3	Pulled due to high flow.
7 /5 /2010	Not operated	29.7	Pulled due to high flow.
7 /6 /2010	Not operated	28.9	Pulled due to high flow.
7 /8 /2010	Not operated	31.1	Trap pulled for season.

Appendix Table 3. Detailed Rotary Screw Trap capture summary for the Entiat River, 2010.

Species and Life Stage	Total Capture	Capture Mortality
Spring Chinook (unknown r/t) adult	0	0
Hatchery spring Chinook salmon adult	2	0
Wild spring Chinook salmon juvenile	9,683	171
Hatchery summer Chinook salmon adult	1	0
Hatchery summer Chinook salmon jack	4	0
Summer Chinook (unknown r/t)adult	2	0
Summer Chinook (unknown r/t) jack	1	0
Wild summer Chinook salmon adult	4	0
Wild summer Chinook salmon precocial	52	0
Wild summer Chinook salmon juvenile	5,231	84
Wild coho salmon juvenile	166	0
Hatchery summer steelhead adult	1	0
Wild summer steelhead adult	1	0
Wild steelhead juvenile	3,582	23
Bull trout adult	9	0
Bull trout juvenile	73	2
Wild cutthroat trout juvenile	13	0
Wild sockeye (unknown run) salmon juvenile	179	1
Pacific lamprey ammocete	3,690	8
Pacific lamprey transformer	51	0
Northern pikeminnow juvenile	171	0
Mountain whitefish juvenile	822	31
Unknown sucker juvenile	227	4
Unknown dace juvenile	193	5
Chiselmouth juvenile	50	1
Unknown sculpin	75	9
Peamouth	1	0
Red side shiner	112	0
Three-spine stickleback	103	5
Total	**24,499**	**344**

Appendix Table 4. Actual daily and estimated captures and emigration estimates for wild yearling spring Chinook salmon at the lower Entiat River rotary screw trap 2010.

Date	Average Trapping Flow (m^3/s)	Daily Catch		Yearling spring Chinook Migration Estimate
		Actual	Estimated	
3/1/2010	4.0	--	0	2
3/2/2010	4.1	13	--	51
3/3/2010	4.3	--	21	82
3/4/2010	5.5	48	--	193
3/5/2010	5.4	22	--	88
3/6/2010	5.2	28	--	112
3/7/2010	5.0	11	--	44
3/8/2010	5.1	25	--	100
3/9/2010	5.0	32	--	128
3/10/2010	4.9	24	--	95
3/11/2010	4.8	31	--	123
3/12/2010	4.7	20	--	79
3/13/2010	4.8	21	--	83
3/14/2010	4.5	25	--	99
3/15/2010	4.4	18	--	71
3/16/2010	4.5	11	--	43
3/17/2010	4.5	19	--	75
3/18/2010	4.6	17	--	67
3/19/2010	4.6	15	--	59
3/20/2010	4.5	13	--	51
3/21/2010	4.5	13	--	51
3/22/2010	4.6	16	--	63
3/23/2010	4.7	13	--	52
3/24/2010	4.9	13	--	52
3/25/2010	5.0	22	--	88
3/26/2010	5.2	33	--	132
3/27/2010	5.2	37	--	148
3/28/2010	5.2	8	--	32
3/29/2010	5.4	23	--	92
3/30/2010	5.7	40	--	161
3/31/2010	5.6	--	35	141
4/1/2010	5.4	45	--	181
4/2/2010	5.2	32	--	128
4/3/2010	5.5	55	--	221
4/4/2010	5.2	60	--	240
4/5/2010	5.1	76	--	303
4/6/2010	5.5	105	--	422
4/7/2010	5.2	67	--	268
4/8/2010	5.2	97	--	387

Appendix Table 4. continued.

Date	Average Trapping Flow (m^3/s)	Daily Catch		Yearling spring Chinook Migration Estimate
		Actual	Estimated	
4/9/2010	5.2	147	--	588
4/10/2010	5.1	123	--	490
4/11/2010	5.0	83	--	330
4/12/2010	5.0	81	--	322
4/13/2010	5.0	105	--	418
4/14/2010	5.2	92	--	367
4/15/2010	5.5	190	--	763
4/16/2010	5.9	248	--	1004
4/17/2010	6.5	157	--	643
4/18/2010	7.8	258	--	1086
4/19/2010	9.3	214	--	928
4/20/2010	11.1	178	--	801
4/21/2010	15.0	75	--	529
4/22/2010	20.6	51	--	455
4/23/2010	21.1	29	--	324
4/24/2010	20.3	25	--	138
4/25/2010	19.0	15	--	81
4/26/2010	17.6	8	--	42
4/27/2010	17.6	12	--	62
4/28/2010	19.9	14	--	77
4/29/2010	19.0	11	--	59
4/30/2010	18.4	7	--	37
5/1/2010	17.9	7	--	37
5/2/2010	17.8	13	--	68
5/3/2010	17.7	9	--	47
5/4/2010	18.0	10	--	52
5/5/2010	16.7	10	--	51
5/6/2010	16.0	6	--	30
5/7/2010	15.0	8	--	39
5/8/2010	14.7	5	--	24
5/9/2010	14.36	2	--	10
5/10/2010	14.1	7	--	34
5/11/2010	14.4	6	--	29
5/12/2010	14.8	3	--	15
5/13/2010	17.2	9	--	46
5/14/2010	21.6	4	--	23
5/15/2010	27.2	3	--	24
5/16/2010	35.8	1	--	17
5/17/2010	46.2	--	3	16
5/18/2010	57.6	--	2	14
5/19/2010	63.6	--	2	13

Appendix Table 4. continued

Date	Average Trapping Flow (m^3/s)	Daily Catch		Yearling spring Chinook
		Actual	Estimated	Migration Estimate
5/20/2010	60.4	--	2	12
5/21/2010	52.2	--	2	12
5/22/2010	45.5	--	2	12
5/23/2010	39.9	--	2	12
5/24/2010	35.8	--	2	11
5/25/2010	31.8	--	2	11
5/26/2010	29.5	3	--	17
5/27/2010	34.7	1	--	6
5/28/2010	32.9	2	--	11
5/29/2010	35.9	--	1	4
5/30/2010	37.7	--	1	4
5/31/2010	39.9	--	0	2
6/1/2010	44.1	--	0	1
6/2/2010	47.2	--	0	1
6/3/2010	58.1	--	0	1
6/4/2010	63.5	--	0	0
6/5/2010	57.4	--	0	0
6/6/2010	53.7	--	0	0
6/7/2010	52.1	--	0	0
6/8/2010	53.1	--	0	0
6/9/2010	54.7	--	0	0
6/10/2010	57.8	--	0	0
6/11/2010	56.7	--	0	0
6/12/2010	54.1	--	0	0
6/13/2010	57.1	--	0	0
6/14/2010	67.2	--	0	0
6/15/2010	69.4	--	0	0
6/16/2010	57.5	--	0	0
6/17/2010	50.1	--	0	0
6/18/2010	44.3	--	0	0
6/19/2010	41.8	--	0	0
6/20/2010	41.6	--	0	0
6/21/2010	48.5	--	0	0
6/22/2010	54.5	--	0	0
6/23/2010	58.0	--	0	0
6/24/2010	61.4	--	0	0
6/25/2010	62.8	--	0	0
6/26/2010	60.1	--	0	0
6/27/2010	55.5	--	0	0
6/28/2010	52.6	--	0	0

Appendix Table 4. continued

Date	Average Trapping Flow (m^3/s)	Daily Catch		Yearling spring Chinook Migration Estimate
		Actual	Estimated	
6/29/2010	53.0	--	0	0
6/30/2010	50.4	--	0	0
7/1/2010	43.1	--	0	0
7/2/2010	37.7	--	0	0
7/3/2010	33.1	--	0	0
7/4/2010	30.3	--	0	0
7/5/2010	29.7	--	0	0
7/6/2010	28.9	--	0	0
7/7/2010	29.0	0	--	0
7/8/2010	31.1	0	--	0
7/9/2010	34.8	0	--	0
7/10/2010	38.1	0	--	0
7/11/2010	39.8	0	--	0
7/12/2010	39.4	--	0	0
7/13/2010	34.9	--	0	0
7/14/2010	27.8	--	0	0
7/15/2010	24.2	--	0	0
7/16/2010	23.3	--	0	0
7/17/2010	23.0	0	--	0
7/18/2010	22.0	0	--	0
7/19/2010	21.1	0	--	0
7/20/2010	19.6	2	--	11
7/21/2010	18.8	2	--	11
7/22/2010	17.6	0	--	0
7/23/2010	17.6	0	--	0
7/24/2010	16.6	2	--	10
7/25/2010	15.6	2	--	10
7/26/2010	15.0	0	--	0
7/27/2010	14.2	1	--	5
7/28/2010	13.7	2	--	10
7/29/2010	14.0	0	--	0
7/30/2010	13.2	0	--	0
7/31/2010	12.2	--	0	0
8/1/2010	13.1	--	0	0
8/2/2010	13.5	0	--	0
8/3/2010	11.8	0	--	0
8/4/2010	11.7	0	--	0
8/5/2010	14.2	--	1	2
8/6/2010	12.2	1	--	5
8/7/2010	11.4	1	--	5
8/8/2010	10.8	--	1	2

Appendix Table 4. continued

Date	Average Trapping Flow (m^3/s)	Daily Catch		Yearling spring Chinook Migration Estimate
		Actual	Estimated	
8/9/2010	10.0	0	--	0
8/10/2010	9.1	0	--	0
8/11/2010	8.9	1	--	4
8/12/2010	8.5	0	--	0
8/13/2010	8.0	2	--	8
8/14/2010	7.8	--	1	2
8/15/2010	7.5	--	1	3
8/16/2010	7.3	0	--	0
8/17/2010	7.1	--	0	1
8/18/2010	6.9	--	0	0
8/19/2010	6.7	--	0	0
8/20/2010	6.4	0	--	0
8/21/2010	6.1	0	--	0
8/22/2010	5.9	1	--	4
8/23/2010	5.6	0	--	0
8/24/2010	5.3	1	--	4
8/25/2010	5.1	0	--	0
8/26/2010	4.9	2	--	8
8/27/2010	4.9	0	--	0
8/28/2010	4.9	0	--	0
8/29/2010	4.8	0	--	0
8/30/2010	4.9	2	--	8
8/31/2010	5.1	2	--	8
9/1/2010	5.4	--	1	4
9/2/2010	5.1	0	--	0
9/3/2010	4.8	0	--	0
9/4/2010	5.0	0	--	0
9/5/2010	4.9	0	--	0
9/6/2010	4.9	--	0	0
9/7/2010	5.0	0	--	0
9/8/2010	6.2	0	--	0
9/9/2010	6.1	0	--	0
9/10/2010	5.9	0	--	0
9/11/2010	5.3	0	--	0
9/12/2010	5.1	0	--	0
9/13/2010	5.0	0	--	0
9/14/2010	4.9	0	--	0
9/15/2010	4.9	0	--	0
9/16/2010	4.8	0	--	0
9/17/2010	4.9	0	--	0
9/18/2010	5.4	6	--	24

Appendix Table 4. continued

Date	Average Trapping Flow (m^3/s)	Daily Catch		Yearling spring Chinook Migration Estimate
		Actual	Estimated	
9/19/2010	6.3	3	--	12
9/20/2010	8.5	0	--	0
9/21/2010	7.4	--	1	4
9/22/2010	6.9	0	--	0
9/23/2010	6.5	1	--	4
9/24/2010	6.2	0	--	0
9/25/2010	6.2	0	--	0
9/26/2010	5.9	0	--	0
9/27/2010	5.7	0	--	0
9/28/2010	5.7	0	--	0
9/29/2010	5.8	0	--	0
9/30/2010	5.8	0	--	0
10/1/2010	5.6	1	--	4

Appendix Table 5. Actual daily and estimated captures and emigration estimates for wild subyearling spring Chinook salmon at the lower Entiat River rotary screw trap 2010.

Date	Average Trapping Flow (m^3/s)	Daily Catch		Subyearling spring Chinook Migration Estimate
		Actual	Estimated	
9/20/2010	8.5	77	--	232
9/21/2010	7.4	46	--	156
9/22/2010	6.9	85	--	256
9/23/2010	6.5	45	--	135
9/24/2010	6.2	41	--	123
9/25/2010	6.2	73	--	220
9/26/2010	5.9	36	--	108
9/27/2010	5.7	49	--	147
9/28/2010	5.7	62	--	187
9/29/2010	5.8	43	--	129
9/30/2010	5.8	46	--	138
10/1/2010	5.6	32	--	96
10/2/2010	5.4	18	--	54
10/3/2010	5.2	1	--	3
10/4/2010	5.1	8	--	24
10/5/2010	4.9	35	--	105
10/6/2010	4.9	42	--	126
10/7/2010	4.8	43	--	129
10/8/2010	4.8	62	--	187
10/9/2010	4.7	51	--	153
10/10/2010	5.2	38	--	114
10/11/2010	9.3	1	--	390
10/12/2010	7.1	286	--	861
10/13/2010	6.4	143	--	430
10/14/2010	6.1	98	--	295
10/15/2010	6.0	27	--	305
10/16/2010	5.8	--	91	274
10/17/2010	5.6	--	89	269
10/18/2010	5.5	83	--	250
10/19/2010	5.4	82	--	247
10/20/2010	5.3	44	--	132
10/21/2010	5.2	34	--	102
10/22/2010	5.2	30	--	90
10/23/2010	5.0	15	--	45
10/24/2010	5.1	18	--	54
10/25/2010	5.9	70	--	211
10/26/2010	5.5	76	--	229
10/27/2010	5.3	68	--	205
10/28/2010	5.0	64	--	193
10/29/2010	5.2	56	--	169

Appendix Table 5. continued.

Date	Average Trapping Flow (m^3/s)	Daily Catch		Subyearling spring Chinook Migration Estimate
		Actual	Estimated	
10/30/2010	4.6	46	--	138
10/31/2010	4.5	54	--	163
11/1/2010	4.7	73	--	220
11/2/2010	6.0	201	--	605
11/3/2010	7.0	299	--	900
11/4/2010	5.9	110	--	331
11/5/2010	5.7	57	--	172
11/6/2010	5.7	43	--	129
11/7/2010	6.0	45	--	135
11/8/2010	7.0	110	--	331
11/9/2010	6.6	50	--	150
11/10/2010	6.4	65	--	196
11/11/2010	6.4	--	69	208
11/12/2010	6.1	77	--	232
11/13/2010	6.1	84	--	253
11/14/2010	6.0	57	--	172
11/15/2010	6.3	99	--	298
11/16/2010	6.6	23	--	190
11/17/2010	7.6	61	--	184
11/18/2010	7.1	36	--	108
11/19/2010	6.7	78	--	235

Appendix Table 6. Actual daily and estimated captures and emigration estimates for wild summer steelhead at the lower Entiat River rotary screw trap 2010

		Daily Catch		Summer steelhead
Date	**Average Trapping Flow (m^3/s)**	**Actual**	**Estimated**	**Migration Estimate**
3/1/2010	4.0	--	3	15
3/2/2010	4.1	6	--	33
3/3/2010	4.3	-	5	27
3/4/2010	5.5	10	--	55
3/5/2010	5.4	4	--	22
3/6/2010	5.2	3	--	16
3/7/2010	5.0	1	--	5
3/8/2010	5.1	2	--	11
3/9/2010	5.0	2	--	11
3/10/2010	4.9	2	--	11
3/11/2010	4.8	1	--	5
3/12/2010	4.7	2	--	11
3/13/2010	4.8	1	--	5
3/14/2010	4.5	0	--	0
3/15/2010	4.4	1	--	5
3/16/2010	4.5	2	--	11
3/17/2010	4.5	0	--	0
3/18/2010	4.6	0	--	0
3/19/2010	4.6	1	--	5
3/20/2010	4.5	0	--	0
3/21/2010	4.5	1	--	5
3/22/2010	4.6	0	--	0
3/23/2010	4.7	0	--	0
3/24/2010	4.9	0	--	0
3/25/2010	5.0	2	--	11
3/26/2010	5.2	9	--	49
3/27/2010	5.2	11	--	60
3/28/2010	5.2	4	--	22
3/29/2010	5.4	13	--	71
3/30/2010	5.7	8	--	44
3/31/2010	5.6	--	8	45
4/1/2010	5.4	7	--	38
4/2/2010	5.2	5	--	27
4/3/2010	5.5	4	--	22
4/4/2010	5.2	4	--	22
4/5/2010	5.1	9	--	49
4/6/2010	5.5	8	--	44
4/7/2010	5.2	17	--	93
4/8/2010	5.2	15	--	82
4/9/2010	5.2	7	--	38

Appendix Table 6. continued

Date	Average Trapping Flow (m^3/s)	Daily Catch		Summer steelhead Migration Estimate
		Actual	Estimated	
4/10/2010	5.0	10	--	55
4/11/2010	5.0	6	--	33
4/12/2010	4.98	19	--	104
4/13/2010	5.0	13	--	71
4/14/2010	5.2	39	--	213
4/15/2010	5.5	103	--	562
4/16/2010	5.9	136	--	742
4/17/2010	6.5	156	--	875
4/18/2010	7.8	296	--	1781
4/19/2010	9.3	240	--	1563
4/20/2010	11.1	209	--	1504
4/21/2010	15.0	186	--	1710
4/22/2010	20.6	230	--	3223
4/23/2010	21.1	97	--	1903
4/24/2010	20.3	62	--	843
4/25/2010	19.0	43	--	528
4/26/2010	17.6	31	--	342
4/27/2010	17.6	25	--	276
4/28/2010	19.9	24	--	315
4/29/2010	19.0	16	--	196
4/30/2010	18.4	24	--	280
5/1/2010	17.9	13	--	146
5/2/2010	17.8	8	--	89
5/3/2010	17.7	14	--	156
5/4/2010	18.0	9	--	102
5/5/2010	16.7	11	--	114
5/6/2010	16.0	10	--	98
5/7/2010	15.0	9	--	83
5/8/2010	14.7	17	--	153
5/9/2010	14.4	16	--	141
5/10/2010	14.1	6	--	52
5/11/2010	14.4	18	--	159
5/12/2010	14.8	17	--	154
5/13/2010	17.2	24	--	257
5/14/2010	21.6	51	--	745
5/15/2010	27.2	31	--	453
5/16/2010	35.8	8	--	405
5/17/2010	46.2	--	22	320
5/18/2010	57.6	--	20	287

Appendix Table 6. continued

Date	Average Trapping Flow (m^3/s)	Daily Catch		Summer steelhead Migration Estimate
		Actual	Estimated	
5/19/2010	63.6	--	18	258
5/20/2010	60.4	--	17	242
5/21/2010	52.2	--	16	231
5/22/2010	45.5	--	15	224
5/23/2010	39.9	--	15	220
5/24/2010	35.8	--	15	217
5/25/2010	31.8	--	15	215
5/26/2010	29.5	14	--	205
5/27/2010	34.7	15	--	219
5/28/2010	32.9	7	--	102
5/29/2010	35.9	--	6	80
5/30/2010	37.7	--	3	46
5/31/2010	39.9	--	2	32
6/1/2010	44.1	--	1	19
6/2/2010	47.2	--	1	13
6/3/2010	58.1	--	1	8
6/4/2010	63.5	--	0	5
6/5/2010	57.4	--	0	3
6/6/2010	53.7	--	0	2
6/7/2010	52.1	--	0	1
6/8/2010	53.1	--	0	1
6/9/2010	54.7	--	0	1
6/10/2010	57.8	--	0	0
6/11/2010	56.7	--	0	0
6/12/2010	54.1	--	0	0
6/13/2010	57.1	--	0	0
6/14/2010	67.2	--	0	0
6/15/2010	69.4	--	0	0
6/16/2010	57.5	--	0	0
6/17/2010	50.1	--	0	0
6/18/2010	44.3	--	0	0
6/19/2010	41.8	--	0	0
6/20/2010	41.6	--	0	0
6/21/2010	48.5	--	0	0
6/22/2010	54.5	--	0	0
6/23/2010	58.0	--	0	0
6/24/2010	61.4	--	0	0
6/25/2010	62.8	--	0	0
6/26/2010	60.1	--	0	0
6/27/2010	55.5	--	0	0
6/28/2010	52.6	--	0	0

Appendix Table 6. continued

Date	Average Trapping Flow (m^3/s)	Daily Catch		Summer steelhead Migration Estimate
		Actual	Estimated	
6/29/2010	53.0	--	0	0
6/30/2010	50.4	--	0	0
7/1/2010	43.1	--	0	1
7/2/2010	37.7	--	0	1
7/3/2010	33.1	--	0	2
7/4/2010	30.3	--	0	2
7/5/2010	29.7	--	0	5
7/6/2010	28.9	--	0	4
7/7/2010	29.0	1	--	15
7/8/2010	31.1	0	--	0
7/9/2010	34.8	0	--	0
7/10/2010	38.1	1	--	15
7/11/2010	39.8	5	--	73
7/12/2010	39.4	1	--	22
7/13/2010	34.9	--	2	24
7/14/2010	27.8	--	1	11
7/15/2010	24.2	0	--	0
7/16/2010	23.3	--	0	3
7/17/2010	23.0	0	--	0
7/18/2010	22.0	0	--	0
7/19/2010	21.1	0	--	0
7/20/2010	19.6	1	--	13
7/21/2010	18.8	0	--	0
7/22/2010	17.6	0	--	0
7/23/2010	17.6	0	--	0
7/24/2010	16.6	1	--	10
7/25/2010	15.6	0	--	0
7/26/2010	15.0	3	--	28
7/27/2010	14.2	0	--	0
7/28/2010	13.7	--	1	6
7/29/2010	14.0	0	--	0
7/30/2010	13.2	0	--	0
7/31/2010	12.2	1	--	8
8/1/2010	13.1	--	1	6
8/2/2010	13.5	2	--	17
8/3/2010	11.8	0	--	0
8/4/2010	11.7	1	--	7
8/5/2010	14.2	3	--	26
8/6/2010	12.2	1	--	8
8/7/2010	11.4	1	--	7

Appendix Table 6. continued

Date	Average Trapping Flow (m^3/s)	Daily Catch		Summer steelhead Migration Estimate
		Actual	Estimated	
8/8/2010	10.8	--	2	11
8/9/2010	10.0	2	--	14
8/10/2010	9.1	2	--	13
8/11/2010	8.9	8	--	51
8/12/2010	8.6	9	--	56
8/13/2010	8.0	3	--	18
8/14/2010	7.8	--	5	32
8/15/2010	7.5	--	4	26
8/16/2010	7.3	5	--	29
8/17/2010	7.1	--	7	38
8/18/2010	6.9	--	7	41
8/19/2010	6.7	--	8	44
8/20/2010	6.4	4	--	22
8/21/2010	6.1	13	--	72
8/22/2010	5.9	15	--	82
8/23/2010	5.6	15	--	82
8/24/2010	5.3	13	--	71
8/25/2010	5.1	15	--	82
8/26/2010	4.9	16	--	87
8/27/2010	4.8	17	--	93
8/28/2010	4.9	25	--	136
8/29/2010	4.8	24	--	131
8/30/2010	4.9	31	--	169
8/31/2010	5.1	35	--	191
9/1/2010	5.4	25	--	165
9/2/2010	5.1	37	--	202
9/3/2010	4.8	18	--	98
9/4/2010	5.0	12	--	65
9/5/2010	4.9	3	--	16
9/6/2010	4.9	--	7	38
9/7/2010	5.0	5	--	27
9/8/2010	6.2	8	--	44
9/9/2010	6.1	3	--	16
9/10/2010	5.9	2	--	11
9/11/2010	5.3	1	--	5
9/12/2010	5.1	1	--	5
9/13/2010	5.0	3	--	16
9/14/2010	4.9	4	--	22
9/15/2010	4.9	1	--	5
9/16/2010	4.8	0	--	0
9/17/2010	4.9	0	--	0

Appendix Table 6. continued

Date	Average Trapping Flow (m^3/s)	Daily Catch		Summer steelhead Migration Estimate
		Actual	Estimated	
9/18/2010	5.4	0	--	0
9/19/2010	6.3	2	--	32
9/20/2010	8.5	12	--	75
9/21/2010	7.4	11	--	65
9/22/2010	6.9	9	--	52
9/23/2010	6.5	5	--	28
9/24/2010	6.2	9	--	50
9/25/2010	6.2	0	--	0
9/26/2010	5.9	6	--	33
9/27/2010	5.7	5	--	27
9/28/2010	5.7	7	--	38
9/29/2010	5.8	4	--	22
9/30/2010	5.8	1	--	5
10/1/2010	5.6	2	--	11
10/2/2010	5.4	1	--	5
10/3/2010	5.2	--	2	8
10/4/2010	5.1	0	--	0
10/5/2010	4.9	3	--	16
10/6/2010	4.9	7	--	38
10/7/2010	4.8	1	--	5
10/8/2010	4.8	6	--	33
10/9/2010	4.7	2	--	11
10/10/2010	5.2	13	--	71
10/11/2010	9.3	--	17	107
10/12/2010	7.1	41	--	237
10/13/2010	6.4	10	--	56
10/14/2010	6.1	9	--	50
10/15/2010	6.0	4	--	60
10/16/2010	5.8	--	11	61
10/17/2010	5.6	--	12	64
10/18/2010	5.5	14	--	76
10/19/2010	5.4	11	--	60
10/20/2010	5.3	9	--	49
10/21/2010	5.2	1	--	5
10/22/2010	5.2	3	--	16
10/23/2010	5.0	3	--	16
10/24/2010	5.1	0	--	0
10/25/2010	5.9	6	--	33
10/26/2010	5.5	9	--	49
10/27/2010	5.3	9	--	49
10/28/2010	5.0	5	--	27

Appendix Table 6. continued

Date	Average Trapping Flow (m^3/s)	Daily Catch Actual	Daily Catch Estimated	Summer steelhead Migration Estimate
10/29/2010	5.2	8	--	44
10/30/2010	4.6	4	--	22
10/31/2010	4.5	8	--	44
11/1/2010	4.7	3	--	16
11/2/2010	6.0	5	--	71
11/3/2010	7.0	26	--	150
11/4/2010	6.0	15	--	82
11/5/2010	5.7	10	--	54
11/6/2010	5.7	2	--	11
11/7/2010	6.0	3	--	16
11/8/2010	7.0	2	--	17
11/9/2010	6.6	3	--	17
11/10/2010	6.4	4	--	22
11/11/2010	6.4	--	9	48
11/12/2010	6.1	18	--	99
11/13/2010	6.1	9	--	50
11/14/2010	6.0	4	--	22
11/15/2010	6.3	3	--	17
11/16/2010	6.6	--	6	34
11/17/2010	7.6	11	--	65
11/18/2010	7.1	6	--	35
11/19/2010	6.9	5	--	29

Appendix Table 7. Mark-recapture site locations, dates sampled, average flow, maximum water temperature and sampling notes during the summer 2010 sampling period.

Site Code	River	Site Length (m)	RKM	Avg. (m^3/s)	Mark Date	Recap Date	Max Water Temp (˚C)	Sample Comments
1BC14	Entiat	330	5.19	7.7	8/13	8/14	17.5	Completely sampled.
1D7	Entiat	330	8.42	6.7	8/18	8/19	18.0	Did not sample final 45m on river left due to high temperatures.
1E2	Entiat	330	9.93	7.1	8/16	8/17	17.5	Completely sampled.
1F18	Entiat	330	16.31	7.1	8/16	8/17	16.5	Completely sampled.
1G2	Entiat	330	17.84	6.7	8/18	8/19	16.5	First 33 meters of site not sampled due to swift deep run. Final 33 meters not sampled due to excessive depth.
2A5	Entiat	330	28.12	12.2	8/2	8/3	13.0	Site fully sampled. High flow and turbidity. Fish observed in undercut bank at 5 foot depth.
2C7	Entiat	330	32.55	8.5	8/11	8/12	15.5	Adult Chinook observed within site. Did not sample between 230 and 260 meters from start of site.
3A5	Entiat	330	37.35	8.5	8/11	8/12	14.0	Completely sampled.
3C3	Entiat	315	40.89	7.7	8/13	8/14	14.0	First 100 m of river right not sampled due to depth and adult Chinook presence. Last 100 m of river left not sampled due to depth and flow. Last 50 m of river right not sampled due to Chinook redd presence.

Appendix Table 7. continued

Site Code	River	Site Length (m)	RKM	Avg. (m^3/s)	Mark Date	Recap Date	Max Water Temp (˚C)	Sample Comments
3D4	Entiat	330	42.41	7.7	8/13	8/14	11.3	Sampled first 200 m completely. Did not sample upper portion of site due to the presence of multiple Chinook redds.
3F2	Entiat	315	44.59	6.7	8/18	8/19	13.0	Completely sampled.
M04	Mad	220	0.65	7.1	8/16	8/17	15.5	Completely sampled.
M14	Mad	220	2.85	14.0	7/28	7/29	15.0	Last 5 meters of site not sampled due to adult Chinook presence.
M23	Mad	220	4.83	12.2	8/2	8/3	16.0	Completely sampled.

Appendix Table 8. Number of fish captured and mortalities during the summer 2010 mark recapture study in the Entiat and Mad rivers.

Species and Life Stage	Total Capture	Capture Mortality
Wild Chinook (unknown run) salmon juvenile	1,586	49
Wild Chinook (unknown run) salmon precocial	3	0
Wild coho salmon juvenile	37	0
Wild steelhead juvenile	1,295	36
Bull trout juvenile	11	0
Pacific lamprey ammocete	66	0
Mountain whitefish juvenile	270	0
Unknown sucker juvenile	94	0
Unknown dace juvenile	1,704	0
Unknown sculpin juvenile	3,819	0
Total	**9,462**	**85**

Appendix Table 9. Site operational summary for the lower Entiat River interrogation site (ENL) during the 2010 monitoring period. Site event logs as submitted to the PTAGIS website.

Date	Operational Comments
05/02/2010	Elevated river flow resulted in the loss of operation to antenna #23. The site operated continually from January 1st until this point.
05/16/2010	Elevated river flow resulted in loss of operation to antenna #22.
05/31/2010	Elevated river flow resulted in loss of operation to antenna #21.
06/05/2010	Elevated river flow resulted in loss of operation to antenna #25.
06/08/2010	Elevated river flow resulted in loss of operation to antenna #24.
06/13/2010	Elevated river flow resulted in loss of operation to antenna #26.
07/28/2010	Antennas # 21,22,23,24 and 25 reinstalled and operational. High noise on antenna # 23. Antenna #26 to be installed after anchoring. Can be reset at a later date.
08/10/2010	Cable replaced on antenna # 23. Noise now 'normal' (20-30%). Antenna #26 still not installed but all other antenna fully operational.
09/22/2010	Antenna #26 operational as of first detection at 17:04:52.
10/08/2010	Antennas all operating well
11/09/2010	Antennas #3 and #5 show intermittent high noise levels
12/13/2010	Site visually checked, no alarms, low noise

Appendix Table 10. Site operational summary for the middle Entiat River interrogation site (ENM) during the 2010 monitoring period. Site event logs as submitted to the PTAGIS website.

Date	Operational Comments
6/14/2010	Site ran consistently and continually through spring until current. Elevated noise level on antenna #3 (>70%).
6/15/2010	Antenna #54 inoperable with no current. Will repair when flows drop. Antenna #51, 52, 53, 55, and 56 all operational
7/18/2010	Antenna #53 logging high noise (93%) and low current.
7/22/2010	Antenna #53 inoperable with no current. Will repair when flows drop. Antenna #51, 52, 55, and 56 all operable.
7/26/2010	Debris built up on antenna #52. Will remove when water levels drop.
8/6/2010	Cellular modem downloading error. Reset modem but problem persists. Will resume manual download until problem fixed.
08/12/2010	Antenna #54 replaced at 10:30 now and operational. All antennas now functioning properly. Antenna #54 replaced and functional. All antennas with exception to #53 are functional.
8/26/2010	All antennas are operating properly.
09/03/2010	Debris removed from antenna #51 and high noise logged on antenna #52.
9/14/2010	Site operating properly.
9/23/2010	All antennas operating normal. Unplugged modem cable from MUX; Will continue retrieving and sending data manually; downloaded 1153 records and erased buffer.
10/1/2010	All antennas operating. Noise levels all <20%. Downloaded 1006 records.
10/8/2010	All operational, low noise
10/13/2010	Noise level on #1 very high ~50%, downloaded and erased buffer
10/29/2010	All antenna show low noise, download and erased buffer
11/5/2010	Noise on #3 and 4 about 25%. Transceiver time was incorrect and was changed from 10:37 to 10:27
11/9/2010	All antenna operating well with low noise, time was reset 1 hour back due to DST ending
12/1/2010	Antennas #1, 3 have elevated noise
12/13/2010	Site visually checked, everything operating with little noise
12/29/2010	Antenna #1 has 83% noise, all others good; 3186 records downloaded

Appendix Table 11. Site operational summary for the Entiat River Forest Service boundary interrogation site (ENF) during the 2010 monitoring period. Site event logs as submitted to the PTAGIS website.

Date	Operational Comments
9/23/2010	All antennas – Noise levels increased, 382 records downloaded. Antenna #4 – high noise, power currently being connected to underground line, was previously an external power cord
10/1/2010	All antennas have high noise, >30%, trench for underground power supply has been backfilled, downloaded 265 records
10/8/2010	Entire array down, no power to MUX
10/10/2010	Antennas operational
10/29/2010	All running great; downloaded 980 records
11/5/2010	All antennas operating well with low noise, time on MUX changed from 09:59 to 10:10
11/9/2010	All antennas operating with little noise, DST over and clock was changed- discover it was not supposed to be on DST at any time
11/17/2010	All antennas operational, low noise
12/1/2010	Antennas #2, 3, 5, and 6 completely covered with ice but is not affecting detections or creating noise
12/13/2010	MUX checked for operating alarms, no downloads occurred
12/29/2010	All operating well, low noise

Appendix Table 12. Site operational summary for the Mad River interrogation site (MAD) during the 2010 monitoring period. Site event logs as submitted to the PTAGIS website.

Date	Operational Comments
6/14/2010	Site ran consistently and continually through spring until current. Elevated noise levels on antenna #3 (>70%).
6/29/2010	Antenna #33 noise level still elevated (63%). All other antenna operating fine.
7/18/2010	Antenna #33 noise level currently at 34% and is still higher than normal (approximately 5-10%).
7/26/2010	All antenna noise levels at normal.
8/9/2010	Removed debris that had built up on antenna #33. Site operating as expected.
8/26/2010	Site inspected. All antenna operating as expected. Spring Chinook redd present just above antenna #31. One adult is PIT tagged. Reset time stamp on Mux. Was about 12 minutes fast.
10/1/2010	All antenna have high noise >50%. Downloaded 529 records. 09/14/2010 - Site inspected. All antennas operating as expected.
10/13/2010	Antenna #5 showing high noise, download complete and buffer erased
10/29/2010	All antenna showing low noise, Summer Chinook building red above antennas #1 and #2, not reading tag code, assume no PIT tag
11/5/2010	All antenna operating well with low noise, downloaded and erased buffer
11/9/2010	All antenna operating with low noise, transceiver time was set 1 hour back due to DST ending
12/1/2010	All antennas completely covered with ice; site configured with cellular modem today
12/13/2010	Site checked, antennas operating well with low noise, no alarms, modem not transmitting data; will continue to manually download
12/29/2010	All antennas operating, little noise, downloaded 2997 records