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Asotin Creek Salmonid Assessment

2013 Annual Report

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We extend our gratitude to the staff at the WDFW Ageing Laboratory for their dedication and expertise. They have consistently provided scale reading with quick turnaround times, and have answered our myriad questions relative to the diverse array of steelhead age and growth in the Lower Snake MPG.

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A. Fish Population Status Monitoring (RM&E)

The goal of this project is to assess the status and trends of the Asotin Creek steelhead population, which includes Asotin Creek and associated Snake River tributaries (Alpowa, Almota, Couse and Tenmile Creeks) as part of the Lower Snake River Steelhead Major Population Group (MPG). This research, monitoring and evaluation (RM&E) project provides estimates of abundance, productivity, survival rates, and temporal and spatial distribution of an ESA-listed species, summer steelhead *Oncorhynchus mykiss,* in accordance to FCRPS 2008 BiOp RPA 50.6. Incidentally, this project attempts to provide estimates of Snake River spring Chinook *O. tshawytscha* juvenile production and adult escapement.

Adult steelhead were captured and enumerated in Asotin and George Creek using floating, resistance board weirs. This marked the ninth consecutive trapping season in Asotin Creek and a total of 535 unique wild, prespawn steelhead were captured; resulting in a population estimate of 539 wild adult steelhead. Project staff captured an additional 29 hatchery origin adults at the weir, and all but one were removed prior to spawning upstream of the trap. In the fourth consecutive season of trapping in George Creek 205 wild adult steelhead were captured, effectively providing a census estimate of the spawning population. A total of 11 hatchery-origin steelhead were captured at the George Creek weir, and all but one was removed prior to spawning upstream of the trap. Adult steelhead picket weirs were also deployed and operated on Tenmile and Alpowa Creeks during the 2013 spawning season. Trapping operations on Alpowa Creek resulted in the capture of 98 unique wild steelhead, and an additional 40 hatchery origin steelhead were removed at the weir prior to spawning. Due to a lack of unmarked kelt captures, we consider 98 wild adult steelhead to be the minimum estimate of escapement. No fish of any species were caught or observed at the weir site on Tenmile Creek in 2013 presumably due to low river discharge.

Emigrating juvenile steelhead and Chinook salmon populations were estimated using a rotary screw trap. During the spring 2013 trapping season (2013 migration year) the steelhead emigrant population was estimated to be 35,280 and an additional 7,587 juvenile steelhead were estimated to have emigrated during the fall 2013 trapping season (2014 migration year). Project staff captured a total of 619 juvenile Chinook during the spring 2013 trapping season, resulting in an estimate of 3,080 juvenile Chinook emigrating from Asotin Creek. Not enough juvenile Chinook were captured during the fall 2013 trapping season to generate an emigrant estimate.

A summary of the nine years of adult data (2005-2013) and 10 years of juvenile steelhead data (2004-2013) are included in this report. These data continue to describe a substantial and persistent population of wild steelhead in the Asotin Creek basin. Although the population is variably affected by hatchery steelhead strays, it remains a sizable population for a subbasin of its size. The entire Asotin Creek steelhead population may be near or above Viable Salmonid Population (VSP) abundance thresholds; making Asotin Creek a valuable supplementation reference stream, in addition to monitoring the status and trends of the Lower Snake River steelhead MPG. The data collected by the project should continue to be used to inform habitat restoration, hatchery reform efforts and wild steelhead management.

2. Introduction

A. Fish Population Status Monitoring (RM&E)

All remaining populations of anadromous salmonids in the Snake River basin have been listed as threatened or endangered under the Endangered Species Act (ESA) by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), including steelhead *Oncorhynchus mykiss* and spring/summer Chinook salmon *O. tshawytscha*. Bull trout *Salvelinus confluentus* are listed as threatened by the U.S. Fish and Wildlife Service. Historically, Asotin Creek supported summer steelhead, spring Chinook salmon, bull trout, Pacific lamprey *Entosphenus tridentatus,* and possibly fall Chinook and coho *O. kisutch* salmon populations (ASP 2004). Substantial efforts have been made to assess the status of salmonid populations in the subbasin since the 1980's as part of the Lower Snake River Compensation Plan monitoring. The Washington Department of Fish and Wildlife (WDFW) designated the Asotin Creek subbasin a wild steelhead refuge in 1997, and no hatchery origin fish have been released into Asotin Creek since 1998. The Interior Columbia Technical Recovery Team (ICTRT) and WDFW considers the native population of spring Chinook salmon to be functionally extirpated in Asotin Creek. Data and field observations suggest that both spring and fall Chinook salmon can spawn successfully in Asotin Creek, but there are currently few adult spawners and their origin is generally unknown; although Blankenship and Mendel (2010) provided strong DNA evidence that many of the spring Chinook are likely from the Tucannon River. PIT tag detections of fall Chinook in 2013 indicate a mixture of stocks spawning in the lower mainstem of Asotin Creek. All PIT tag detections in Asotin Creek have been from hatchery origin fall Chinook released at sites upstream: Captain John Rapids, Pittsburgh Landing, and Grande Ronde River among others. Despite the functional extirpation of spring Chinook salmon, occasional spawning by fall Chinook and the depressed status of bull trout, there remains sufficient habitat to support a modest population of naturally producing steelhead in Asotin Creek.

Critical uncertainties must be answered if the status of ESA-listed salmonid populations are to be improved and subsequently removed from protection under the ESA. Such uncertainties include understanding the functional relationships between fish and habitat condition on survival and capacity, habitat restoration effectiveness, hatchery effectiveness and understanding the relationship between resident and anadromous *O. mykiss* life history strategies (SRSRB 2011). Specific critical uncertainties identified in the Asotin Creek Subbasin Plan include: 1) Is the natural population abundance high and stable enough to prevent extinction for the foreseeable future? 2) Is the steelhead population's progeny-to-parent ratio above replacement? 3) Can or should fisheries managers intervene to rebuild steelhead populations that may be at marginally successful productivity levels above eight Federal Columbia River Power System (FCRPS) dams (ASP 2004)? Whether a wild population above eight mainstem dams can persist or be recovered through habitat and mainstem actions without hatchery supplementation is a critical uncertainty that is relevant across the Columbia River basin. Moreover, measuring the effects of recovery actions on these populations is extremely difficult due to out-of-subbasin-effects on anadromous salmonids (e.g. hydrosystem operational changes, ocean survival, and among year environmental conditions).

In 2008, Asotin Creek was identified by the Washington State Governors' Salmon Recovery Office (GSRO) as an Intensively Monitored Watershed (IMW). The purpose of an IMW is to provide scientific documentation of the response of salmonid populations to habitat restoration activities, as a measure of effectiveness. The project specifically seeks to address the factors limiting juvenile salmonid survival and productivity. The IMW project entered its implementation phase in 2009. The Asotin Creek IMW primarily focuses on the effects of riparian habitat restoration on the dynamics of juvenile steelhead survival and productivity. The Asotin Creek project provides valuable data regarding the status and trends of the juvenile and adult steelhead response to habitat restoration efforts within the subbasin.

This project implements RPA 50.6 of the amended Federal Columbia River Power System's (FCRPS) 2008 Biological Opinion (NMFS 2008a). This RPA entails the monitoring of at least one population within each Major Population Group (MPG), and recommends the continued use and improvement of mark-recapture techniques to estimate pre-spawn mortality and adult escapement. In addition, the recent deployment of instream PIT tag interrogation systems, combined with continued redd counts, will allow for increased precision and accuracy of spawning escapement estimates to Asotin Creek and its tributaries.

This project is consistent with the Northwest Power and Conservation Council's 2010 Monitoring, Evaluation, Research, and Reporting (MERR) plan, in that it achieves the goals set forth by the MERR and addresses more than one of its nine management questions (NPCC 2010). Furthermore, the Asotin Creek Project is recommended for high intensity life-cycle monitoring in the Anadromous Salmonid Monitoring Strategy (ASMS 2010). This project assesses the status and trends of the abundance, productivity, and distribution of Asotin Creek steelhead, which are all criteria recommended as high priorities for monitoring in NOAA's Guidance Recovery document (Crawford and Rumsey 2011). The continued presence of steelhead within the Asotin Subbasin contributes to overall ecosystem health by virtue of supporting ecosystem functions. The data resulting from ongoing efforts of the project also serve a valuable role as a reference population for evaluation of hatchery steelhead supplementation effectiveness research across the Columbia River Basin. Furthermore, this project meets the prioritization criteria presented in the MERR. Data collected by this project will inform management and policy decisions concerning the lower Snake River steelhead MPG, and secondarily lower Snake River spring and fall Chinook salmon and Asotin Creek bull trout.

The genetic nature and diversity of naturally-produced (presumed wild origin) salmonids in the Snake River Basin is a concern under the ESA. This project provides the opportunity to contribute tissue samples to regional efforts to better describe steelhead and bull trout population structure, and to determine the origin of Chinook salmon that are spawning in Asotin Creek. Specifically, tissue samples collected from this project have been provided to the

IDFG Eagle Genetics Lab for inclusion in the Genetic Stock Index (GSI) baseline for steelhead (BPA #2010-026-00 and 2010-031-00) and for WDFW's genetic analyses of the sources of spring Chinook adults (Blankenship and Mendel 2010) and bull trout in Asotin Creek (Kassler and Mendel 2008).

The goals of this project are to determine the adult and juvenile abundance and productivity of the Asotin Creek steelhead population and to estimate life stage survival rates in the mainstem of Asotin Creek. The ICTRT, NOAA Fisheries and the Snake River Salmon Recovery Plan (SRSRB 2005, 2011) included George Creek and several other small adjacent Snake River tributaries (Tenmile, Couse, Almota and Alpowa Creeks) as part of the Asotin Creek steelhead population. As such, a full understanding of the abundance and productivity of steelhead in those tributaries is necessary to adequately understand the status of the Asotin Creek steelhead population. This project also implements the RM&E criteria specified in the Asotin Subbasin Plan (ASP 2004), the MERR, and the Anadromous Salmonid Monitoring Strategy (ASMS 2010), by establishing a baseline of the salmonid population in Asotin Creek upstream of the confluence with George Creek. In addition, this project will document the abundance of bull trout captured at the trapping locations. Future estimates of smolt-to-adult and adult-to-adult survival for the wild Asotin Creek steelhead will provide the data necessary to help determine if salmonid production in the subbasin is being limited by within- or out-of-basin factors.

3. Methods: Protocols, Study Designs, and Study Area

The project has developed operational protocols describing the work conducted and the analysis methods we utilize. Those protocols and methods can be found at the Pacific Northwest Aquatic Monitoring Partnership's (PNAMP) Monitoring Methods website. The titles and web addresses for those protocols are found below.

Asotin Adult Sampling and Analysis (2002-053-00)
    http://www.monitoringmethods.org/Protocol/Details/295
Asotin Main: Juvenile Sampling (2002-053-00)
    http://www.monitoringmethods.org/Protocol/Details/791

Description of Study Area

The Asotin Creek Subbasin is located in the southeast corner of Washington State and drains approximately 84,000 hectares (207,000 acres) of the northeast corner of the Blue Mountains. Asotin Creek is a third order tributary of the Snake River, joining it at the town of Asotin (Figure 1). Asotin Creek has two major watersheds: The mainstem and its upper tributaries, and George Creek. The mainstem (upstream of George Creek) drains about 48,000 hectares (118,000 acres) and is the primary area of focus for this project. Major tributaries of the mainstem include Charley Creek, North Fork, South Fork, and Lick Creek. George Creek, entering the mainstem near river kilometer (rkm) 4.4, drains about 36,000 hectares (89,000 acres).

Alpowa Creek is a first order tributary of the Snake River, and joins it about seven miles downstream of the town of Clarkston. It originates in the foothills of the Blue Mountains in the southeast corner of Washington State and drains approximately 26,550 hectares (~65,600 acres). The watershed is dominated by private ownership and farming and rangeland are the primarly land uses. Alpowa Creek differs from the other tributaries, in that the headwaters are not forested or wooded (B. Johnson, Asotin PUD, personal communication) and it is primarily spring fed, with less snow runoff to maintain flows during summer and early fall.

Tenmile Creek is also a first order tributary of the Snake River, joining roughly eight miles upstream of the town of Asotin. The watershed drains nearly 10,880 hectares (26,900 acres). The watershed is dominated by private ownership and currently land use is dominated by cattle range (Stewart 2007).

The WDFW is also conducting a monitoring project (BPA# 2010-028-00) downstream of Lower Granite Dam to assess the use of Almota Creek by steelhead, and small tributaries associated with the Tucannon River Steelhead population. Data collected by that project is not provided here, but is relevant to the Asotin Creek steelhead population and can be found in Trump et al. 2013.

Much of Asotin Creek and its tributaries have been straightened, channelized or relocated (ACCD 2004). Many habitat restoration projects have been completed or are on-going in the Asotin Creek watershed with state (Salmon Recovery Funding Board, Washington Conservation Commission) and federal (BPA & US Army Corps of Engineers) funding.

United States Geological Survey (USGS) records from 1929 to 1960 indicate a mean annual flow of 74 cfs above Headgate Dam (at rkm 14.5) in Asotin Creek. Normal low flow in late summer is from 15-30 cfs. Normal high flow in the spring and early summer (February to June) is from 200–400 cfs. Riparian conditions in the Asotin Creek Subbasin varied historically by location and land use. However, with the implementation of the Asotin Creek Model Watershed Plan beginning in 1995 (ACCD, 1995), and related riparian restoration projects undertaken by agencies and local landowners, most of the riparian zone above the trap site has been protected and is partially restored or recovering. The Washington Department of Ecology classifies Asotin Creek and its tributaries as Class A (excellent) surface waters. Waters within the National Forest in the subbasin are considered Class AA (extraordinary) surface waters.

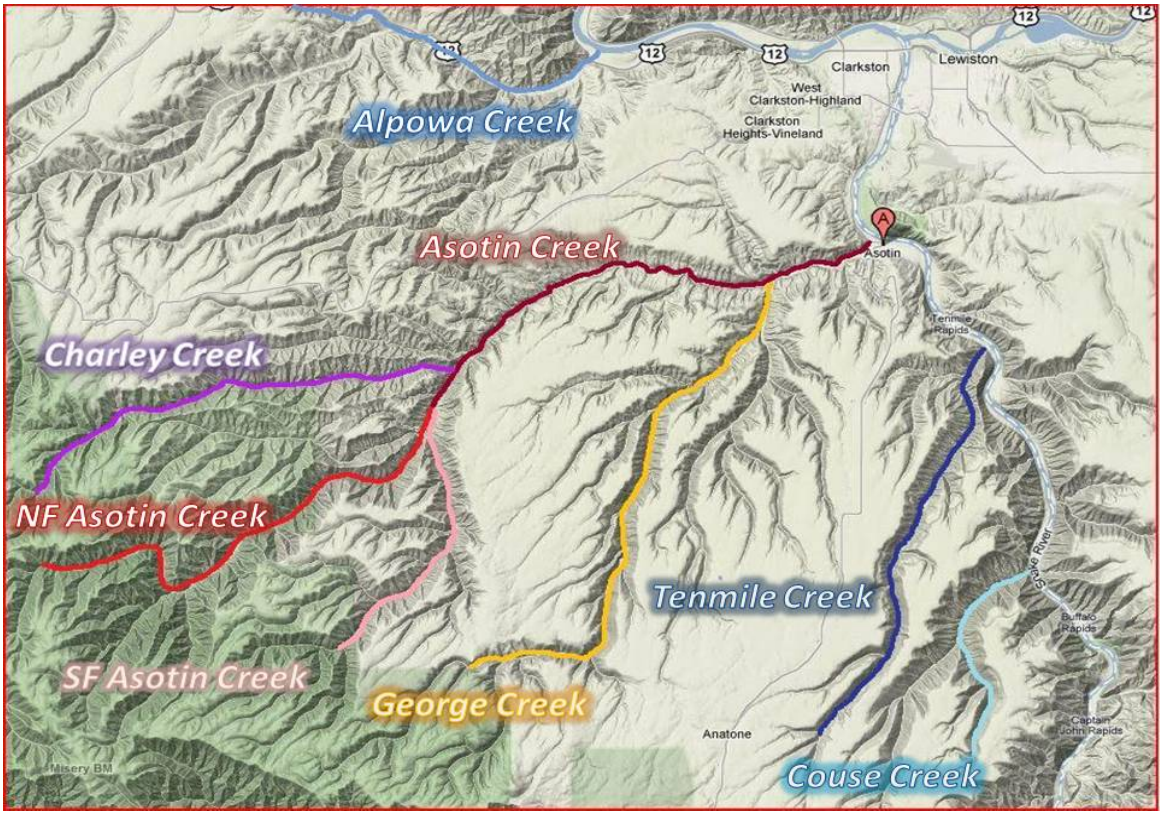

Figure 1. The Asotin Creek Subbasin and location of adjacent drainages (excluding Almota Cr.) included in the Asotin Creek steelhead population and monitored as part of this project.

Objectives

The objectives for the Asotin Creek Salmonid Assessment project are detailed below:

Objective 1: *Estimate escapement of wild and hatchery steelhead and Chinook salmon into the Asotin Creek watershed above George Creek, as well as in George, Alpowa, Tenmile and Couse creeks.*

A resistance board floating weir made of aluminum and polyvinyl chloride (PVC), with a 1.8 m x 1.2 m x 1.1 m aluminum adult salmonid trap was deployed in Asotin Creek to capture adult pre-spawners near rkm 4.5 (Table 1). Smaller weirs and adult fish traps were also deployed on Alpowa, George and Tenmile creeks. In those streams, picket weirs are installed across the stream channel and tied in with an approximately 1.8 m x1.2 m x 1.1 m aluminum trap box. The length and orientation of the weir changes with each iteration of the trap. Traps are installed to minimize unintended effects on fish behavior and to reduce the risk of mortality or injury.

Table 1. Adult weir and smolt trap locations for duration of Asotin Creek Project (2004-2013). All values listed are in river kilometers (rkm).

Asotin Creek	*2004*	*2005-2008*	*2009*	*2010*	*2011*	*2012*	*2013*
Adult Trap	n/a	7.0	4.5	4.7	4.7	4.5	4.5
Smolt Trap	Spring 13.2 Fall 7.0	7.0	7.0	Spring 7.0 Fall 3.0	3.0	3.0	3.0

Note: George Creek confluence with Asotin Creek is located near rkm 4.4.

The adult trapping season generally runs from early-January to early-June (see Results below). When not in use, the adult trap is dismantled and removed to allow unrestricted passage of fish upstream and downstream. When flow and stream temperature conditions allow, the trapping season may be is extended later into June.

The traps are operated 24-hours a day during the trapping season and are checked once or more daily, depending on stream flow, debris and/or number of fish present. Data collected from adult salmonids included: number, species, origin (hatchery or wild), sex, fork length, scales for determining age at spawning, and DNA samples. Wild origin adult steelhead captured at the Asotin Creek weir are tagged with PIT tags in the dorsal sinus. Adult steelhead captured at the Alpowa, George and Tenmile Creeks are marked with an operculum punch which also serves as a tissue sample for DNA samples. Trap efficiency is evaluated using mark-recapture techniques. The mark-recapture calculations used by the project are described below. These techniques were developed by M. Schuck and validated by K. Ryding, WDFW Statistician (WDFW Internal Memo, 7/2006).

Adult Population Estimate:
To provide the best estimate of available spawners above the weir, the population is first stratified by sex. The return rate for each sex is independently calculated as:

$$\hat{P}_R = \frac{R_M}{M}$$

Where,

$\hat{P}_R$ = The proportion of the population that returned to the weir,
R_M = The number of marked adults that returned to the weir,
M = The number of marked adults passed above the weir.

The number of unmarked adults above the weir is estimated as:

$$\hat{U} = \frac{R_{\hat{U}}}{\hat{P}_R}$$

Where,

$\hat{U}$= The number of unmarked adults above the weir,

$R_{\hat{U}}$= The number of unmarked adults that returned to the weir.

The estimated number for adults of each sex above the weir is then calculated as:

$$\hat{P} = \hat{U} + M$$

Where,

$\hat{P} =$ Population of available spawners above the weir.

Population estimates for each sex are added together to estimate the total number of potential spawners above the weir. Confidence intervals for the population estimates are calculated by first calculating 95% confidence intervals around estimates for $\hat{P}_{\mathrm{R}}$. Exact confidence intervals for $\hat{P}_{\mathrm{R}}$ are calculated using an online calculator (http://causascientia.org/math_stat/ProportionCI.html). Confidence intervals for $\hat{U}$ are then calculated as follows:

$$\hat{U}_{LCL}= \frac{R_{\hat{U}}}{P_{UCL}} \quad \text{and} \quad \hat{U}_{UCL}= \frac{R_{\hat{U}}}{P_{LCL}}$$

The upper and lower confidence limits for $\hat{U}$ are then added to M in order to construct 95% confidence intervals for $\hat{P}$.

Hatchery fish captured at the weir are identified by the presence of one or more of the following marks; adipose fin clip, ventral fin clips, visible implant elastomer tags (VIE) and coded wire tag (CWT). To check for CWT, a detector wand (Northwest Marine Technology) is used to assess the presence of a CWT in the snout of all fish sampled. If a fish is confirmed CWT positive, it is killed and the snout taken for tag extraction, reading and processing at the WDFW Snake River Laboratory. Processed CWTs were eventually sent to the WDFW CWT Lab in Olympia where they are verified and eventually uploaded to the Regional Mark Information System (RMIS) database.

All fish captured at the weirs are also sampled for the presence of passive integrated transponder (PIT) tags. Fish are scanned using a Destron Fearing Model FS-2001 ISO PIT tag transceiver and an attached handheld wand. At the Asotin Creek weir, all wild origin adult steelhead are implanted with PIT tags if scans do not indicate the presence of previously implanted PIT tags, in accordance to PIT tag best practices outlined in the PIT Tag Marking Procedures Manual (CBFWA &PTSC 1999). All adult PIT tag data are uploaded to the Pacific States Marine Fisheries Commission (PSMFC) PTAGIS web-based database.

Objective 2: *Estimate spawner abundance and adults per redd in Asotin Creek.*

When stream conditions allow, sight surveys for adults, carcasses and redds are conducted on index reaches covering at least 50% of the spawning areas above the adult trap between March and May. This is done to verify spawner abundance, assess trap efficiency, document spatial distribution and to estimate the number of adults per redd. Index area counts and redd visibility duration (redd life) are used to estimate total number of redds. Data from our trap are used to derive abundance estimates (#'s of male and female fish passed). (This work is conducted jointly with funds from this project and the LSRCP monitoring and evaluation effort for SE Washington).

Objective 3: *Document juvenile steelhead life history patterns, survival rates and estimate juvenile emigrant production in Asotin Creek.*

Smolt trapping procedures used in the Asotin Creek project are similar to those used on the Tucannon River (Gallinat et al. 2003; Bumgarner et al. 2000). Statistical procedures are conducted using software developed by the University of Idaho and Idaho Department of Fish and Game for estimating emigrants with a rotary smolt trap. The software uses a Bailey modified Lincoln-Petersen method to derive an estimate of the number of emigrants. Bootstrapping produces the confidence bounds around the estimate (Steinhorst and Kline 2006).

In early October 2010, we were asked by the landowner to remove our rotary trap from their property. We were able to quickly locate another suitable location for the fall 2010 trapping season, but at a location approximately four river kilometers downstream (Table 1). Therefore, results from the new trap site will not be directly comparable with previous years. Smolt production estimates from 2010 forward include production from the George Creek drainage.

A brief description of these methods is as follows: To estimate the number of emigrating juvenile salmonids, a 1.52 meter rotary screw (smolt) trap is placed in Asotin Creek near rkm 3.0 as in past years. The peak of the spring trapping season is typically from mid-March to mid-June. However, we attempt to trap emigrating juveniles whenever environmental and instream conditions allow. During operation, the trap ran 24-hours a day, 7-days a week, and is checked once or more daily, depending on conditions and fish numbers.

Data collected from juvenile salmonids included:
Number, species, length, weight, scales for age structure and age at migration. Body condition factor (K) is calculated to provide a measure of general health of migrants and is calculated as:

$$K = W/L^3 \times 100{,}000$$

A representative subsample of the entire out-migration of juvenile steelhead are tagged with 12 mm PIT tags. PIT tag data from Asotin Creek are uploaded to the PTAGIS database. Data generated by PIT tagging juveniles is useful in evaluating juvenile migration timing, patterns, and survival.

Scale samples are collected from emigrating juvenile steelhead captured, to estimate age composition. The goal is to collect a representative sample of approximately 20% of the emigrants, to provide an estimate of age at migration; which is necessary when calculating smolt to adult returns (SAR) and calculating recruits/spawner (see Productivity Estimates below.) Scale samples are collected according to WDFW protocols and age determinations are made by counting annuli, as described by Jearld (1983).

Juveniles are also categorized within a smoltification index as parr, transitional smolt, or smolt. The determination is made based on the sampler's assessment of each individual fish based on the following qualities: presence/absence of parr marks, coloration, tail banding and degree of scale shedding.

Trap capture efficiency testing is conducted as often as possible. Fish used for trap efficiency testing are tagged with a 12 mm PIT tag or fin clipped for identification. Test fish are allowed to regain equilibrium and begin swimming normally before being released back into the creek about 200 m above the trap in an area of quiet water. This location is close enough to minimize predation loss, but far enough away from the trap to allow the fish to distribute naturally in the creek following release. Recapture data are collected and capture (trap) efficiencies are calculated based on the following equation:

$$p = r/m;$$

Where,

p = the estimated trap efficiency (percent),

r = the number of marked fish recaptured, and

m = the total number of fish marked and released for the trap efficiency test.

Further details of the methods and equations used in deriving emigrant estimates can be found in Protocol #791, on PNAMP's Monitoring Methods website (http://www.monitoringmethods.org/Protocol/Details/791).

Juvenile survival rates are reported as a percent arrival to Lower Granite Dam (LGD) or other hydrosystem operations downstream of LGD. All juvenile PIT tag codes used for the duration of the project are uploaded to PTAGIS to be placed in "Monitor-Only" mode within the FCRPS Separation by Code system (SbyC). Placing PIT tag codes in monitor mode allows the tagged fish to be treated the same as the untagged run-of-the-river population. This means that at the four lower Snake River dams where transportation is an option, fish tagged at the Asotin Creek smolt trap are transported when those transport operations are occurring, whereas most other PIT tagged populations observed at those dams are allowed to continue their migration "in –

river". This SbyC request has been consistent and carried out for all years of the project to date.

As one of the primary objectives of this project is to address in-basin factors affecting survival, recruitment and productivity, it does little good from the project standpoint to generate hydrosystem survival estimates. Placing tags in "Monitor-only" mode limits our ability to use the suite of programs dedicated to estimating and assessing hydrosystem survival. Furthermore, the complex life histories observed in most summer steelhead populations further limits the utility of these programs. As the University of Washington Columbia Basin research group further refines these programs for use with monitor-only mode and summer steelhead populations, we expect the utility and usefulness of these programs to increase for assessing hydrosystem survival of the Asotin Creek steelhead population.

Spatial Structure

Spatial structure of the population within Asotin Creek, specifically the proportion of spawners above the weir, is analyzed using the PIT tag interrogation sites located at the mouths of the major tributaries (North Fork, South Fork and Charley Creek). This provides a reasonably accurate measure of the spawning distribution of adults in the tributaries and mainstem.

The method used is simple subtraction of the number of adult PIT tagged steelhead observed at the weir and at each array upstream of the weir. For example: for a fish to be assumed to have spawned in the South Fork of Asotin Creek in 2012, it would first have to be observed and tagged at the weir, followed by detections at the Cloverland Bridge Interrogation Site (*PTAGIS ID: ACB*) and subsequently detected at the Asotin Creek Forks Array (*PTAGIS ID: AFC*) on the South Fork coils. It should be noted however, that we have not made an attempt to quantify prespawning mortality upstream of the weir.

Certain assumptions are made given the convoluted migration history of some of the fish. These assumptions are:

1. Fish escaping above the weir will be spawning that year in Asotin Creek.
2. Fish undetected at any of the tributary arrays are presumed to be Mainstem Asotin spawners.
3. Fish detected at the Charley Creek Array (CCA), but at no other sites, are assumed Charley Creek spawners due to the distance from the mouth to the array.
4. Fish detected only at the South Fork (SF), and not at the North Fork (NF), are assumed to be South Fork spawners; and the inverse that fish detected at the NF and not the SF are assumed North Fork spawners
5. Fish with more complicated detection histories (detections at multiple tributary arrays) are then compared using detection timing and residence times. By defining conditional arguments that are tributary specific, fish which meet these requirements are assigned as escaped (presumed spawners) to that tributary.

6. Fish that meet none of the conditions defining tributary escapement are labeled Unknown.

Objective 4: *Collect DNA samples for future genetic characterization of focal species.*

DNA samples are collected from nearly all wild origin adult steelhead at the weir to genetically characterize naturally-producing steelhead and to determine if hatchery fish have significantly altered (or contributed to) the Asotin Creek stock. Metrics to be considered include heterozygosity, allele frequencies and similarities/differences to adjacent wild and regional hatchery stocks. Genetic samples are archived and sent to the WDFW genetics lab, or other regional labs, for future analysis. In late fall 2010, requests were made by the IDFG Single Nucleotide Polymorphism (SNP) Baseline project, for some of the tissues collected to date, to be used in establishing a SNP baseline for Snake River steelhead upstream of Lower Granite Dam. Such samples will also be helpful in establishing the genetic diversity of the Asotin Creek steelhead population and determine if the adjacent Snake River sub-populations (Alpowa, Tenmile and Couse, and Almota creeks) warrant inclusion in the Asotin Creek steelhead population group.

Objective 5: *Report and disseminate Asotin Creek salmonid assessment data.*

The Annual Report includes an abstract, introduction, description of project area, methods, results, discussion, summary and references, and is provided to the funding agency in electronic format.

4. Results

A. Fish Population Status Monitoring (RM&E)

Asotin Creek

The 2013 adult trapping season began in Asotin Creek on 31 January, and was the ninth consecutive season of adult trapping for the project. The trapping location was maintained at rkm 4.5, as in 2012; the trapping site is approximately 200m upstream of the confluence with George Creek. The adult trapping season lasted approximately 17 weeks and ended on 31 May, due to declining streamflows and staffing levels. The stream flows in 2013 were relatively benign, and we experienced no breaks in trapping due environmental conditions for the duration of the adult trapping season. Over the course of the trapping season, project staff trapped and sampled 535 unique adult wild steelhead. An additional 29 hatchery-origin steelhead were captured and removed from the population prior to spawning. Scale samples were collected from 99.8% of the wild origin adult steelhead captured at the Asotin Creek weir (n=534).

Adult return timing to Asotin Creek was similar to previous years, and varied substantially between hatchery and wild origin fish, with hatchery fish coming in about three weeks later. We have documented adult steelhead moving into and out of Asotin Creek throughout the fall and winter months, however the PIT tag data suggests that the majority of these fish fallback to locations below the weir site prior to trap installation. Regardless, the timing of trap deployment is conducive to maximizing the capture of both wild and hatchery origin spawners returning to Asotin Creek (Figure 2), while decreasing our risk to the weir and our trapping equipment.

We estimated that 539 (95% CI= 538-540) wild origin steelhead migrated past the weir located at rkm 4.5 during the 2013 spawning season. We recaptured a total of 337 kelts returning to the weir, and handled a total of six unmarked kelts. As mentioned above, this trapping season presented relatively benign environmental conditions, allowing us to operate the weir with high efficiency, no downtime and therefore very tight confidence bounds, achieving a census estimate. This estimate is markedly lower than the previous three years' estimates, although it is about 80% of the nine year average of 671 (2004-2013).

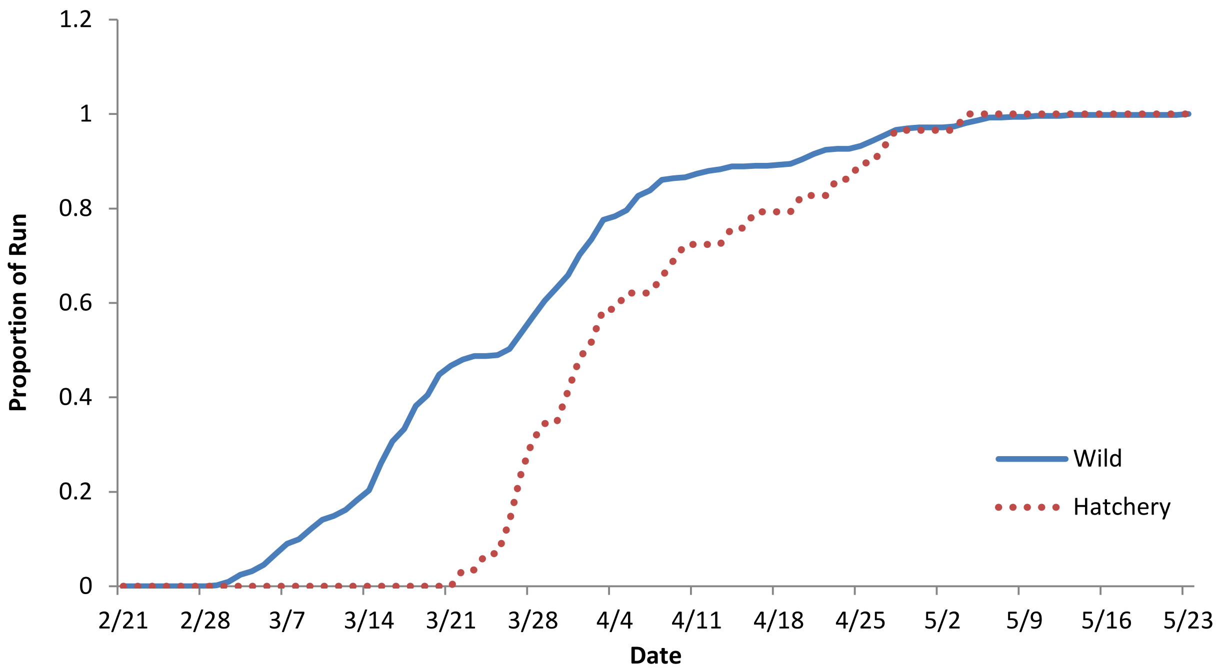

Figure 2. Daily catch of pre-spawn steelhead by origin at the Asotin Creek weir, 2013.

The majority of scale samples collected were readable in both freshwater and saltwater growth regions (87.85%; Table 2). The remaining scales were unable to be assigned to a freshwater age, due to regeneration in the freshwater growth annuli. These scales were included in length frequency analyses and statistical descriptions of ocean age, although we are unable to assign those samples to brood year.

In 2013, a large majority of both males and females captured at the Asotin Creek weir returned after spending two years maturing in saltwater (65% and 86%, respectively). Length at age was similar for fish spending one year at sea. However, males were on average approximately 40mm longer than females spending two years in the salt. It should be noted that the sample size of males in the Ocean Age 2 category is less than half of that of females (Table 3). Overall, females ranged from 500mm to 780mm, while males skewed slightly longer, ranging from 510mm to 840mm (Figure 3).

One male and two females (0.63% of the scales collected) were identified as repeat spawners according to scale pattern analysis (Table 2).

Table 2. Age composition by sex of wild adult steelhead captured at the Asotin Creek weir, 2013.

Age	**Female**		**Male**		**Total**	
(fresh.ocean)	***n***	**%**	***n***	**%**	***n***	**%**
1.1	2	0.65%	6	3.70%	8	1.70%
1.1s	1	0.32%	0	0.00%	1	0.21%
1.1s1	0	0.00%	1	0.62%	1	0.21%
1.2	167	54.22%	78	48.15%	245	52.13%
2.1	34	11.04%	46	28.40%	80	17.02%
2.1s	1	0.32%	0	0.00%	1	0.21%
2.2	62	20.13%	25	15.43%	87	18.51%
3.1	4	1.30%	3	1.85%	7	1.49%
3.2	35	11.36%	3	1.85%	38	8.09%
4.2	2	0.65%	0	0.00%	2	0.43%
r.1	6	1.79%	13	6.53%	19	3.55%
r.2	22	6.55%	24	12.06%	46	8.60%
Total Readable	308	91.67%	162	81.41%	470	87.85%
Regenerated	28	8.33%	37	18.59%	65	12.15%
Total n	336	100.00%	199	100.00%	535	100.00%

*Note: (“**s**” refers to a spawn check(Repeat Spawner), “**r**” indicates portions of scales unreadable due to regeneration).*

Table 3. Mean fork length of wild adult steelhead captured in Asotin Creek, 2013.

Ocean Age	**Statistic**	**Females**	**Males**
	n	46	68
1	Fork Length(mm)	576	572
	SD	32.34	40.66
	n	282	129
2	Fork Length(mm)	684	720
	SD	36.15	48.75

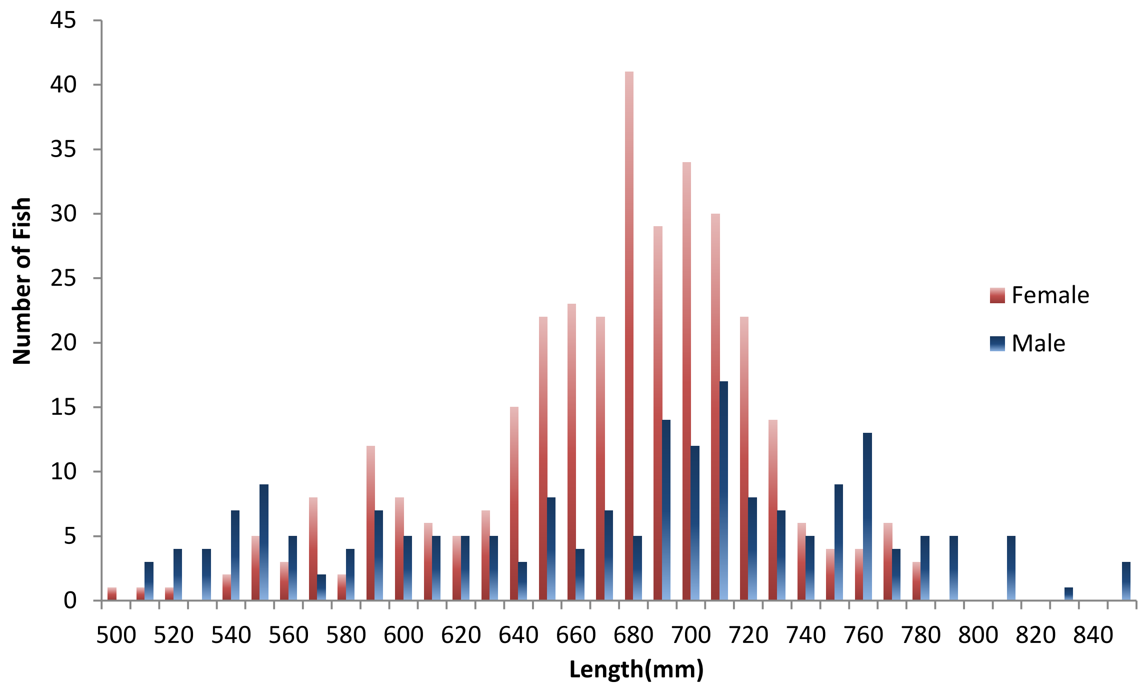

Figure 3. Length-frequency by sex of wild adult steelhead captured at Asotin Creek weir, 2013.

As mentioned in previous years' annual reports, it is difficult for us to establish or document the status and trend of hatchery origin steelhead escapement in Asotin Creek. Since 2009, we have been actively removing hatchery origin adults from the spawning population at the weir. During the 2013 trapping season, we captured and removed a total of 29 hatchery origin adult steelhead. We delivered 13 of the hatchery origin fish captured to the Asotin County Food Bank, and the remaining carcasses were used for nutrient enhancement downstream of the weir. The majority (*n*=21) of the hatchery origin spawners were identified through the presence of a coded-wire tag (CWT).

Spawning ground surveys were conducted across the spawning period in the mainstem of Asotin Creek and the tributaries by staff from this project and staff from the LSRCP funded WDFW Snake River Lab. Surveys were limited because of stream flows to the middle of March, late April and the middle of May; therefore we have some speculation on the accuracy and precision of the redd counts. Based on the redd expansion estimates from the index area, we estimate that there were 300 redds in Asotin Creek and its tributaries upstream of rkm 4.5. Using the weir escapement estimate for females, we estimate a female/redd ratio of 1.12.

George Creek

This year marked the fifth consecutive year of adult steelhead trapping on George Creek. The 2013 trapping season presented relatively benign streamflows and environmental conditions, much like the mainstem of Asotin Creek. The trap was installed on 8 February and operated continuously until the trap was removed on 8 May, due to declining flows and trap captures. This was our most successful adult trapping season on George Creek. A total of 205 unique wild adult steelhead were captured at the George Creek weir, and an additional 11 hatchery origin fish were captured at the weir, and the majority (*n*= 10) were removed from the population in prespawn condition.

We utilized the same mark-recapture techniques as Asotin Creek to estimate the number of adult steelhead spawning of the weir. However, due to the lower number of unmarked captures (*N*= 1), and the high number of marked recaptures(*N*=115), we can report a minimum estimate of 205 wild adult steelhead.

We collected scale samples from 100% (*n*=205) of the wild adult steelhead captured at the weir. An overwhelming majority of female steelhead returned to spawn in George Creek after spending 2 years in saltwater (~80%, Table 4). However, males were more evenly split between ocean ages, with a very slight majority (58%) returning to spawn after spending two years maturing in saltwater (Table 4).

Based on scale analysis, we identified five repeat spawners (2.63% of the scales collected) at the George Creek weir. Interestingly, none of the life histories are the same. Although, four out of the five fish returned after spending less than one year reconditioning in saltwater prior to returning to spawn (Table 4).

Table 4. Age composition by sex of wild adult steelhead captured at George Creek, 2013.

Age	Female		Male		Total	
(fresh.ocean)	*n*	%	*n*	%	*n*	%
1.1	1	0.81%	5	8.77%	6	3.31%
1.2	47	37.90%	20	35.09%	67	37.02%
2.1	20	16.13%	18	31.58%	38	20.99%
2.1s	1	0.81%	0	0.00%	1	0.55%
2.1s1	1	0.81%	0	0.00%	1	0.55%
2.2	41	33.06%	11	19.30%	52	28.73%
2.2s	1	0.81%	0	0.00%	1	0.55%
3.1	1	0.81%	1	1.75%	2	1.10%
3.2	11	8.87%	2	3.51%	13	7.18%
r	1	0.72%	0	0.00%	1	0.49%
r.1	3	2.17%	3	5.26%	6	2.93%
r.1s	0	0.00%	1	1.75%	1	0.49%
r.2	10	7.25%	6	10.53%	16	7.80%
r.2s	1	0.72%	0	0.00%	1	0.49%
Total Readable	124	89.21%	57	85.07%	181	87.86%
Unreadable	15	10.79%	10	14.93%	25	12.14%
Total n	139	100.00%	67	100.00%	206	100.00%

*Note: "**s**" refers to a spawn check (Repeat Spawner), "**r**" indicates portions of scales unreadable due to scale regeneration).*

Alpowa Creek

This year was the fifth consecutive year of adult trapping on Alpowa Creek. The trap was deployed on 29 January and operated without incident until removal on 25 May. In this time period we captured and sampled 98 wild origin adult steelhead.

Due to a low number of kelt captures at the weir and specifically, unmarked kelt (*N*= 0) returns to the weir, we are unable to generate a mark-recapture escapement estimate. We recaptured 14 marked kelts at the weir. The 98 unique wild adult steelhead is our best estimate of escapement, and should be considered a minimum estimate.

We trapped and removed an additional 40 hatchery origin steelhead prior to spawning. The majority (92.5%, *n*=37) of hatchery fish that we removed were taken to the Asotin County Food Bank in Clarkston, WA. The remaining three fish were in unsuitable condition for consumption and used as nutrient enhancement below the weir.

Project staff collected scales from 100% (*n*=98) of the wild origin adults sampled at the weir. The large majority (74.5%) of females sampled returned to spawn after spending two years in saltwater, whereas males were much more evenly distributed across ocean ages (44% Ocean Age 2, Table 5).

Table 5. Age composition of wild adult steelhead captured at Alpowa Creek weir, 2013.

Age	Female		Male		Total	
(fresh.ocean)	*n*	%	*n*	%	*n*	%
1.1	0	0.00%	6	16.67%	6	7.41%
1.2	25	55.56%	9	25.00%	34	41.98%
2.1	9	20.00%	14	38.89%	23	28.40%
2.2	6	13.33%	3	8.33%	9	11.11%
3.1	2	4.44%	3	8.33%	5	6.17%
3.2	3	6.67%	1	2.78%	4	4.94%
r.1	3	5.45%	3	6.98%	6	6.12%
r.2	7	12.73%	4	9.30%	11	11.22%
Total Readable	45	81.82%	36	83.72%	81	82.65%
Unreadable	10	18.18%	7	16.28%	17	17.35%
Total n	55	100.00%	43	100.00%	98	100.00%

Tenmile Creek

This season was the fourth consecutive trapping season on Tenmile Creek. The trap was installed on 23 February, and operated continuously until 1 May. We did not capture a single adult steelhead or any other species of fish at the Tenmile Creek weir site in 2013. Due to the dry late winter and spring in southeast Washington, flows on Tenmile Creek never exceeded 10cfs, and therefore were not conducive to fish passage or spawning.

We have no further data to report for Tenmile Creek for the 2013 trapping season.

Couse Creek

No trap was installed on Couse Creek in 2013 due to low flow conditions that prevented fish from migrating into Couse Creek.

Hatchery Fish Disposition

The stream specific summaries presented above document the capture of 80 hatchery origin steelhead at project weirs (Table 6). Of the 80 individuals captured, 78 (97.5%) were removed prespawn. The remaining two hatchery origin fish were recovered as unmarked kelts at Asotin and George Creek weirs. Alpowa Creek accounted for exactly half of the total number of hatchery origin steelhead captured at project weirs.

Table 6. Summary of hatchery-origin fish captured and disposition at project weirs in 2013.

Stream	*Total*	*Removed Prespawn*	*Prespawn Mortalities*	*Hatchery Origin Known Escapement*
Asotin	29	28	0	1
Alpowa	40	40	0	0
George	11	10	0	1
Tenmile	0	0	0	0

Technicians recovered coded wire tags from 47.5% (*n*=38) of the hatchery origin fish captured. The majority of these fish originated from the Tucannon River hatchery endemic stock (*N* = 30). Asotin Creek and George Creek had the highest proportions of CWT tagged fish (72% and 64% respectively), despite having lower numbers of hatchery origin fish overall (Table 7). The high proportions of CWT tagged fish in Asotin and George Creek also describes the hatchery of origin for the majority of stray hatchery fish captured in Asotin and all of the hatchery origin fish in George Creek: Tucannon River endemic stock (Table 8). Alternatively, Tucannon River endemic stock accounted for only half of the CWT recoveries from Alpowa Creek.

Table 7. Summary of coded-wire tags (CWT) collected at project weirs in 2013.

Stream	*n Recovered*	*Lyons Ferry On-Station*	*Lyons Ferry Touchet*	*Lyons Ferry Tucannon*	*Tucannon River Endemic*	*Wallowa River*	*Umatilla River*	*EFK Salmon*
Asotin	21	0%	5%	0%	85%	5%	5%	0%
Alpowa	10	20%	10%	10%	50%	0%	0%	10%
George	7	0%	0%	0%	100%	0%	0%	0%
Tenmile	0	0%	0%	0%	0%	0%	0%	0%
All	38	5%	5%	3%	79%	3%	3%	3%

Juvenile Trapping

Spring 2013

The spring 2013 juvenile steelhead trapping season began 4 February and ran until 7 June, and was operational for 93.8% (115 trap-nights) of that period. Trap deployment timing was delayed by low late-winter flows and similarly, the season ended earlier than planned due to lower than average early summer flows.

A total of 2,905 unique juvenile steelhead were captured emigrating past the smolt trap (Table 8). Using the mark recapture methodologies described above yielded an emigrant estimate of 34,951 (95% CI=30,411-41,518).

Of the 2,905 juvenile steelhead captured, 80.6% (N=2,788) were implanted with PIT tags. Assignments to smoltification index were also made for nearly all juvenile steelhead captured at the trap (n=2,924; 99.7%). The vast majority were classified as transitional smolts, accounting for 82.6% of those samples, followed by parr making up 16.1%; fully-smolted individuals accounted for 1.3% of the emigrants sampled (Table 9). The fork length of emigrants captured ranged from 65mm to 225mmm, with the mean length observed being 148mm (Table 10 and Figure 4). Other pertinent biological measurements can also be found in Table 10 and Figure 5.

Table 8. Summary of juvenile steelhead unique captures, tagging and scale sampling at the Asotin Creek smolt trap, 2013.

	2013 Juvenile Steelhead Summary				
	***N* captured**	***N* tagged**	**% tagged**	***N* scales**	**% scales**
Spring	2,905	2,788	95.97%	577	18.17%
Fall	767	536	69.88%	140	18.16%
Total	3,672	3,324	90.52%	673	18.17%

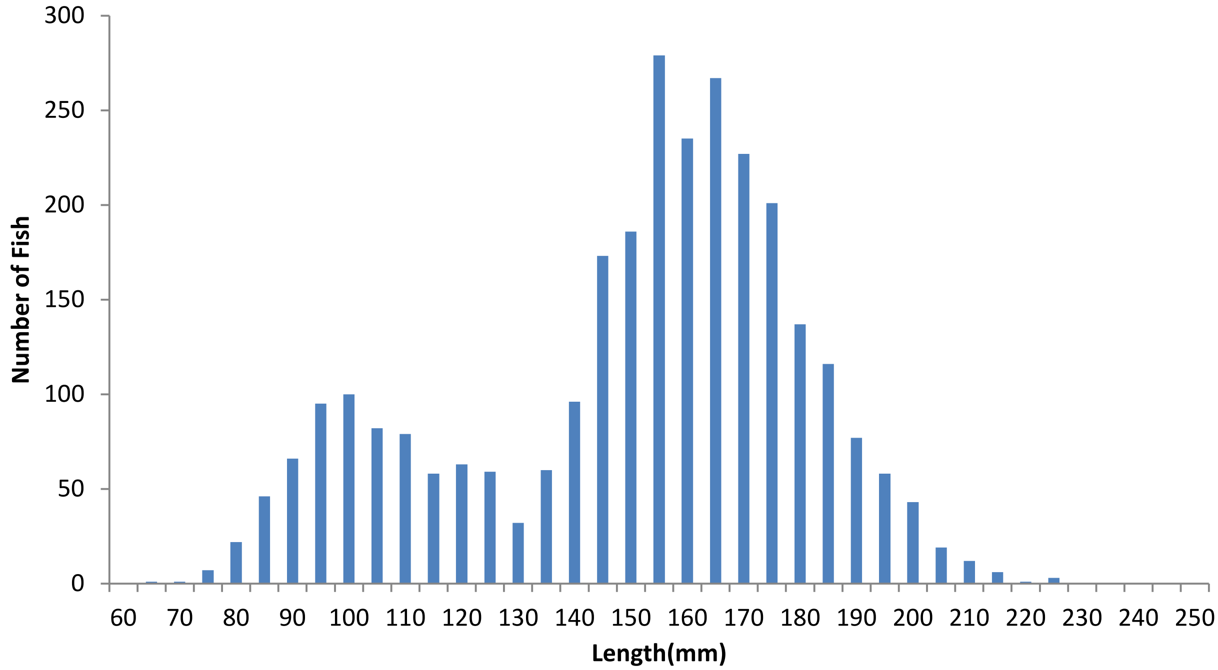

Figure 4. Length-frequency of emigrant steelhead captured (N=2,907), Spring 2013.

Emigration timing was only slightly later than observed in previous years (Figure 15). Fifty percent of the emigrants moved downstream of the trap site by 8 May; 75% by 13 May; and 90% by 19 May. This represents a rather truncated emigration period compared to previous years.

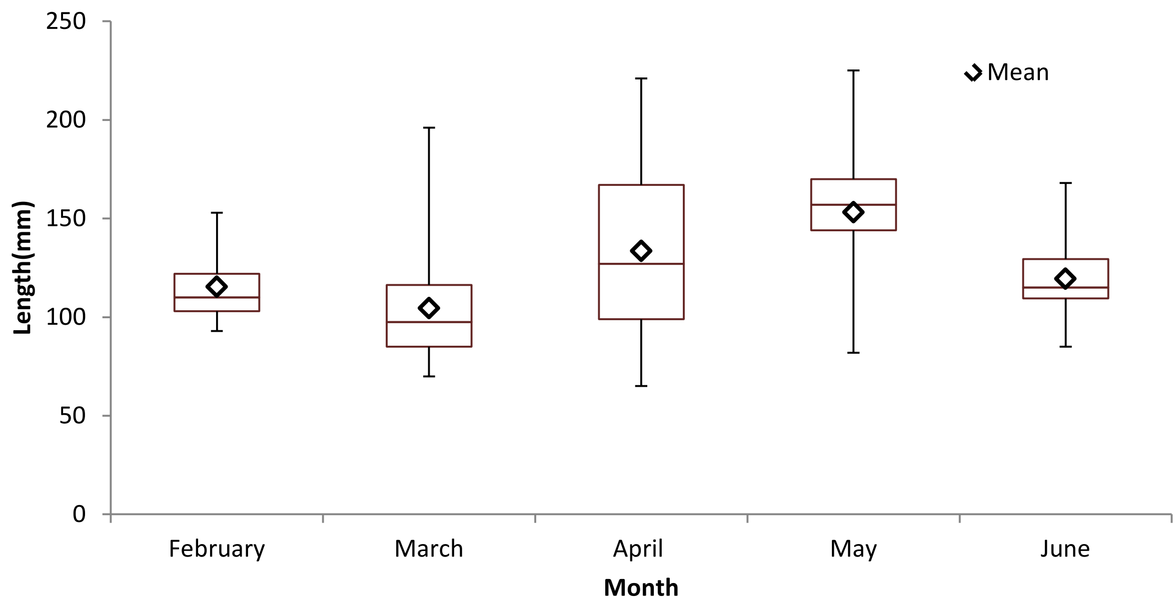

Figure 5. Mean, median, maximum and minimum lengths with 50% and 75% quartiles, of emigrants by month, Spring 2013.

Table 9. Summary of biological data collected from emigrating steelhead captured by smoltification index category, Spring 2013.

Smoltification Index	*N*	Mean Length(mm)	Mean Weight(g)	Condition Factor
Parr	471	99.1	11.21	1.10
Transitional	2,416	157.4	43.37	1.05
Smolt	37	186.4	71.25	1.06

Table 10. Summary of biological data collected from emigrating juvenile steelhead, Spring 2013.

Statistic	Length(mm)	Weight(g)	Condition Factor
Mean	148	38.9	1.06
Median	155	39.1	1.05
Min	65	4.3	0.61
Max	225	124.5	1.89
SD	30.4	19.9	0.097
N	2,933	2,674	2,674

Scale samples were collected from 18% (*n*=577) of the individuals captured, across all size ranges (Table 9). Of the samples collected, 87.1% (*n*=503) were readable. Age-2 emigrants made up slightly more than half of samples collected (50.3%), age-1 emigrants made up another 34.6% of those sampled. The remaining were accounted for as age-3 (14.5%) and to a much lesser extent age-4 (<1%) emigrants. Age breakdowns and comparisons across years are presented in Figure 12.

Efficiency trials were attempted daily when we had more than 10 marked fish to release upstream of the trap. Daily efficiency trials were compiled to give a weekly efficiency estimate. As a result, we had 17 completed weekly efficiency trials. We utilized the Akaike Information Criteria (AIC) programming within the Gauss software to further refine our efficiency trial strata. This resulted in collapsing the strata to 10 efficiency trials when the trap was operating similarly. Summaries of the weekly efficiency trials are provided in Table 11.

Table 11. Weekly trapping efficiencies for emigrating juvenile steelhead at Asotin Creek smolt trap, Spring 2013.

Week	*n* Captured	*n* Marked	*n* Recaptured	Weekly Average Efficiency
3/17-3/23	21	21	6	28.57%
3/24-3/30	13	13	2	15.38%
3/31-4/6	128	127	19	14.96%
4/7-4/13	173	172	24	13.95%
4/14-4/20	79	74	6	8.11%
4/21-4/27	127	124	4	3.23%
4/28-5/4	288	281	14	4.98%
5/5-5/11	1,035	783	86	10.98%
5/12-5/18	635	491	35	7.13%
5/19-5/25	288	282	16	5.67%
5/26-6/1	48	20	1	5.00%
Totals	***2,835***	***2,388***	***213***	**8.99%**

Fall 2013

The smolt trap was deployed from 14 October until 5 December (52 trap-nights). During the period the trap was deployed, the trap fished for a total of 41 nights. We did not experience cone stoppages due to debris or high flows, most of the trap outages were pre-emptive due to high wind (leaf loading), ice build-up and low water temperatures, low stream flows, and unsuitable for fish handling and tagging. Based on previous year's observations, and PIT array data, we suspect that fish movement was negligible during that period. The trap was pulled for the season on 5 December due to accumulating ice and low water temperatures.

We captured a total of 767 unique juvenile steelhead during the trapping period. The juveniles sampled ranged in size from 37mm to 240mm (Figure 6), with a mean of 99mm. Descriptive statistics for length, weight and condition factor are presented below in Table 12.

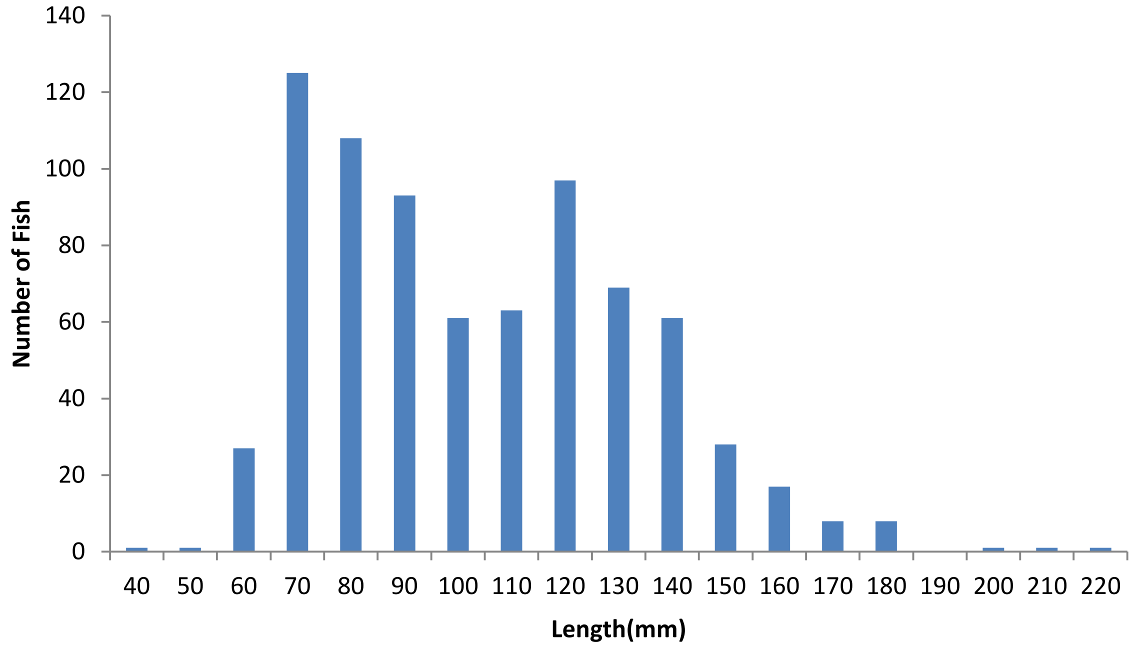

Figure 6. Length-frequency distribution of emigrating juvenile steelhead captured (N=767), Fall 2013.

Table 12. Summary of biological data collected from emigrating juvenile steelhead captured, Fall 2013. (Mean values for length, weight and condition factor are also provided.)

Season	Statistic	Length(mm)	Weight(g)	Condition Factor
Fall	Mean	99	12.1	1.02
	Median	95	9.3	1.00
	Min	37	1.0	0.55
	Max	240	103.4	2.17
	SD	29.7	11.3	0.13
	n	771	677	677

Scale samples were collected from 17.8% (n=140) of the juvenile steelhead captured. The majority (89.2%) of the scales were readable. Age-1 emigrants made up the majority of the fall emigrants, and accounted for 65.6% of the readable scales. Age-0 emigrants made up slightly over a quarter (27.2%) of the readable samples, and the remaining proportion was composed entirely of age 2 emigrants (7.2%). No age 3 emigrants were identified in the scale samples.

A total of seven trap efficiency trials were completed using 710steelhead. However, only one of those weekly trials produced enough recaptures to be considered statistically valid (Table 13). However, due to low flow conditions, we find it reasonable to assume that trap efficiency did not differ greatly over the first six trap efficiency trials, and that the trap was performing similarly over those periods. Therefore, we collapsed the first six efficiency trials into two strata, and counted the last week of operation as one stratum. This provided an estimate of 7,653 (95%CI=5,270 -12,274) juvenile steelhead emigrants.

Table 13. Weekly trapping efficiencies for emigrating juvenile steelhead captured at Asotin Creek smolt trap, Fall 2013.

Week	*n* Captured	*n* Marked	*n* Recaptured	Weekly Average Efficiency
10/20-10/26	64	50	2	4.00%
10/27-11/2	49	44	1	2.27%
11/3-11/9	89	72	4	5.56%
11/10-11/16	38	28	6	21.43%
11/17-11/23	33	20	0	0.00%
11/24-11/30	0	Trap out due to ice and low stream flows		
12/1-12/7*	476	309	44	14.24%
Totals	***749***	***523***	***57***	9.50%

** Efficiency trial for the week of 12/1-12/7 is incomplete, as the trapping season ended on 12/3.*

Other juvenile species of interest

Spring and Fall 2013

During the spring 2013 trapping season, project staff captured 619 juvenile Chinook salmon. An increase from 105 captured during the 2012 trapping season. Chinook salmon captured were representative of both yearling and subyearling age classes and both spring-run and fall-run life history types.

Due to the higher capture numbers, we successfully completed efficiency trials for emigrating Chinook salmon in spring 2013. We conducted a total of nine trap efficiency trials over the course of the season. Mark-recapture methods generated an estimate of 3,080 (95% CI=2,483-3,928) emigrating Chinook salmon during the spring of 2013.

Emigrants captured during the spring trapping season ranged in length from 33mm to 148mm with a median fork length of 94.8mm (Table 14). The median weight of spring emigrants was 10.6 (range: 1.0-33.2); the median condition factor observed was 1.2 (range: 0.4-1.90) (Table 14).

The fall emigrants captured were representative of both yearling and subyearling age classes and spring and fall-run life history types. Median fork length of those sampled ranged from 64mm to 102mm, with a median fork length of 80mm observed (Table 14). The median weight of emigrants was 5.4 grams (range: 3.1-12.5g) and the median condition factor observed was 1.11 (range: 0.80-1.75) (Table 14).

Table 14. Summary of length, weight and condition factor of emigrating juvenile Chinook captured at the Asotin Creek smolt trap, Spring and Fall 2013.

Season	Statistic	Length(mm)	Weight(g)	Condition Factor
Spring	Mean	94.8	10.5	1.20
	Median	96	10.6	1.20
	Min	33	1	0.40
	Max	148	33.2	1.90
	SD	12.47	3.72	0.17
	n	621	537	537
Fall	Mean	80.5	5.9	1.11
	Median	80	5.4	1.11
	Min	64	3.1	0.80
	Max	102	12.5	1.75
	SD	8.36	1.93	0.12
	n	119	114	114

We captured 119 unique Chinook salmon emigrants during the fall 2013 trapping season. Several efficiency trials were attempted over the course of the trapping season. Due to the low number of daily captures and subsequent number of recaptures within efficiency trials, we were unable to generate an emigrant estimate.

5. Synthesis of Findings: Discussion

A. Fish Population Status Monitoring (RM&E)

Adult Abundance

As mentioned above, we estimate that 539 adult natural origin steelhead escaped above the Asotin Creek weir in 2013, approximately 80% of the project average (*n*=671; range: 284 - 1,411). However, this estimate remains above the Interior Columbia Technical Review Team's, and the Snake River Salmon Recovery Plan, goal of 500 adult spawners for the entire Asotin population (ICTRT 2007).

No fish of any species were captured at Tenmile Creek in 2013. In most years, we typically capture a handful (range: 5-20) of Bridgelip and Largescale Suckers (*Castostomus* spp.) at Tenmile Creek. No adult fish of any species were observed above or below the weir in 2013 (though there is not much holding water below the weir). Spring flows typically reach 30 to 80cfs in late March or early April (WA Department of Ecology, unpublished data, Site ID: 35J050). However, spring flows in 2013 never exceeded 10 cfs for the duration of the trapping season. The same low flow conditions that provided a successful trapping season at the other traps appears to be the reason behind the lack of fish captures at Tenmile Creek. Flow conditions in the independent tributaries may have important implications on the spawning distribution of the Asotin Creek population as a whole.

Where adult steelhead destined for Tenmile Creek actually spawned is unknown. This highlights an important aspect of steelhead ecology: How are wild steelhead populations subsidized by other adjacent populations? This question has important implications to the productivity of populations. We know from PIT tag recaptures, that in some years the escapement of wild origin Tucannon adult steelhead can be as high as 10% in Asotin Creek (SY 2010, Crawford et al 2011). However, PIT tag estimates may be biased low due to assumptions related to tag effects and tag loss. Knudsen et al (2009) reported PIT tag loss in returning hatchery origin spring Chinook in the Yakima River basin averaged 18.4% between 6 months and 4 years after being tagged as juveniles.

In Asotin Creek, the first prespawn adult capture was markedly later in 2013 than we have observed in previous years (Figure 7). Stream flow and temperatures were near average for February and March 2013. PIT tag data from the Asotin Creek mouth (ACM) PIT tag interrogation array suggests no significant movement of PIT tagged adults until mid to late March, coinciding with first capture dates of pre-spawn adults. Snake River flows were lower than the 55 year median at the gaging station near Anatone, WA (USGS Site ID: 13334300). It is possible, as we have observed in Tenmile Creek (Crawford et al 2011), that low flows in the Snake River could have reduced or completely prevented adult salmonid access into the mouth of smaller tributaries. High flows in 2012 moved bedload and debris, effectively building a delta at the mouth of Asotin Creek (Crawford et al 2013). Alpowa Creek would be unaffected by this phenomenon, as it flows into Lower Granite Reservoir. It may be necessary to adjust spring flows from upstream dams to meet elevations of creek mouths. Moreover, these delta formations may increase susceptibility to predation and angling pressure in areas adjacent to blocked or otherwise inaccessible creek mouths where fish tend to hold prior to moving into the tributaries to spawn as water temperatures rise.

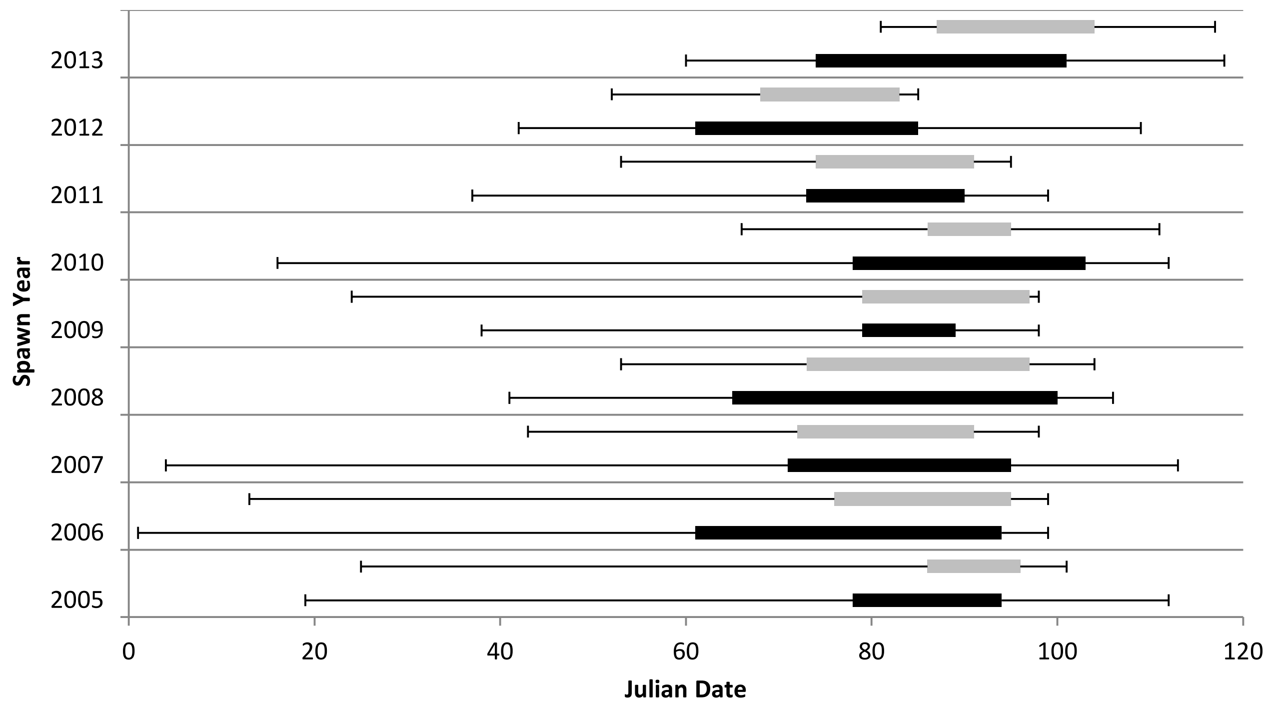

Figure 7. Run timing of wild and hatchery origin fish captured at Asotin Creek weir for spawn years 2005-2013. Black bars represent wild origin adults; grey bars represent hatchery origin adults. (*Thick bars represent middle 50% of run, negative error bars extend to first capture. Positive error bars extend to 90% capture date*).

Due in part to the benign flows in 2013, project staff were successful in limiting hatchery spawner escapement above project weirs. No hatchery origin fish were known to have spawned above the weir location in Alpowa Creek, and only one each in Asotin (Table 16) and George Creeks. Implementation of adult management at the Asotin Creek weir since 2008 has been successful in limiting the number of hatchery fish on the spawning grounds (Table 16).

Table 15. Total number of adult steelhead captured, percent (%) hatchery-origin fish captured at Asotin Creek weir, and wild population estimate for 2005-2013 in Asotin Creek above the weir.

Year	*n Captured*	*n Hatchery Captured*	*% Hatchery Captured*	*Wild Estimate (95%CI)*	*Hatchery Estimate*	*% Hatchery Spawners*	*% Wild Spawners*
2005	513	35	6.82%	611(568-669)	41	6.29%	93.71%
2006	477	41	8.60%	509(479-524)	46	8.29%	91.71%
2007	292	49	16.78%	284(277-294)	60	17.49%	82.51%
2008	350	64	18.29%	300*	20	6.25%	93.75%
2009	393	37	9.41%	363*	12	3.20%	96.80%
2010	1,180	98	7.88%	1,411(1,335-1,463)	7	0.49%	99.51%
2011	1,010	51	5.05%	1,128(1,095-1,182)	4	0.35%	99.65%
2012	391	44	11.25%	915(701-1,273)	15	1.60%	98.40%
2013	565	29	5.13%	539(538-540)	1	0.19%	99.81%
Average	***575***	***49***	***9.91%***	***673***	***23***	***4.91%***	***95.09%***

*Values marked with * are considered minimum estimates.*

Of the hatchery origin fish captured many have been marked with a fin clip (Adipose, Left Ventral, etc.). However, we continue to capture a high proportion of fish with no fin clips or other externally identifiable marks distinguishing them as hatchery origin fish (Table 17). In these cases we have come to rely heavily on the presence of internal marks such as VIE and PIT tags, and more importantly Coded Wire Tags. Maintaining high mark rates, both internal and external, is critical to our success in removing hatchery origin spawners straying into the Asotin Creek subbasin.

Over the course of the project, we have recovered CWTs from slightly over 150 fish in Asotin Creek (Table 18). Of those recoveries, Tucannon endemic stock has made up the highest proportion of wire recoveries on an annual basis, ranging from 33% to 90% of the CWT samples (Table 18).

Table 16. Summarized disposition of hatchery fish captured at Asotin Creek weir, 2005-2013.

	Hatchery Fish Captured						*Removal*	
Year	**AD Only**	**AD+CWT**	**ADLV**	**ADRV**	**AD Intact**	**Total**	**Removed Prespawn**	**Prespawn Mortalities**
2005	19	3	4	1	11	**38**	0	0
2006	16	1	1	0	23	**41**	4	0
2007	28	0	7	1	17	**53**	5	1
2008	42	0	2	0	20	**64**	42	0
2009	21	0	5	1	10	**37**	26	0
2010	29	9	4	0	51	**93**	86	0
2011	16	1	2	0	32	**51**	47	0
2012	20	0	8	0	16	**44**	28	1
2013	8	0	1	1	19	**29**	28	0

**Fish with intact adipose fins were determined to be of hatchery origin based on the presence of one or more tags; PIT, CWT or VIE).*

As we have documented in previous annual reports, we can only speculate on the reasons driving the variation in the proportion of hatchery fish captured at project weirs and the difference among them. Variations in hydrosystem operation may cause increased numbers of hatchery smolts released at sites downstream of Lower Granite Dam (LGR) to migrate upstream as returning adults, especially in years when water temperatures and discharge are abnormally high or low. Extremely cool temperatures and higher than average discharge in the Snake River upstream of Lower Granite Dam may lure more adult fish to LGD during the late summer and fall. On the contrary, higher water temperatures have been known to create a thermal barrier downstream in the Snake River (Caudill et al 2013) that substantially delays upstream migration and may effectively reduce the numbers of stray hatchery fish migrating above LGR.

Table 16. Summary of CWT tag recoveries at Asotin Creek weir, 2005-2013.

Year	***CWT Recoveries***		***Smolt Release Site***							
	Collected	***Recovered***	***LF Tuc***	***LF***	***Tuc. End.***	***LF TOU***	***Grande Ronde***	***Wallowa R.***	***LF Walla Walla***	***Umatilla River***
2005	13	12	0.5	0.17	0.33	0	0	0	0	0
2006	8	8	0.33	0.23	0.44	0	0	0	0	0
2007	17	17	0.35	0	0.53	0.06	0.06	0	0	0
2008	4	4	0	0	0.75	0.25	0	0	0	0
2009	2	2	0	0.5	0	0.5	0	0	0	0
2010	47	39	0.1	0.03	0.82	0.05	0	0	0	0
2011	30	30	0.03	0	0.9	0.03	0	0.03	0	0
2012	24	24	0.25	0	0.67	0.04	0	0	0.04	0
2013	21	21	0	0	0.86	0.047	0	0.047	0	0.047

We continue to capture the highest proportion of hatchery origin fish in Alpowa Creek (Table 19). As noted above in the stream specific results, Tucannon Endemic stock make up the highest proportion of hatchery origin fish captured. Hatchery fish captured at Alpowa Creek are also representative of a broader array of various hatcheries and release sites near and far, both historically and during the 2013 spawn year.

Over the course of the project, slightly over 41% of the prespawn steelhead captured have been of hatchery origin (Table 19). It should be noted that even though hatchery origin fish have made up a high proportion of the fish captured, we have been somewhat successful at keeping hatchery fish off the spawning grounds, averaging nearly 25% hatchery spawners and effectively keeping the proportion of hatchery spawners below 3% for the last three years (Table 19).

Table 17. Number of adult steelhead captured, percent (%) hatchery fish captured at Alpowa Creek weir, and population estimates above the weir, 2008-2013.

Year	*n* Total Captured	*n* Hatchery Captured	% Hatchery Captured	% Hatchery Spawners	% Wild Spawners	Wild Estimate	Hatchery Estimate
2008	170	95	55.88%	53.99%	46.01%	75*	88*
2009	408	263	64.46%	64.02%	35.98%	145*	258*
2010	505	198	39.20%	25.85%	74.15%	307*	107*
2011	182	41	22.52%	0.00%	100.0%	141*	0*
2012	287	126	43.90%	2.51%	97.49%	194	5*
2013	138	40	28.98%	0.00%	100.0%	98*	0*
Average	***281***	***127***	***41.32%***	***24.39%***	***75.61%***	***160***	***76***

Values marked with an asterisk (*) are simply a count of fish captured at the weir. Not enough recaptures were caught to facilitate a Mark-Recapture population estimate for those years.

The intensity of angling pressure and subsequent angler success may also account for variations in the number of hatchery fish escaping to spawning tributaries. Data from WDFW steelhead catch record cards shows a relationship between the number of hatchery fish captured at Asotin and Alpowa Creek weirs and the number of hatchery fish harvested in adjacent sections of the Snake River open to hatchery steelhead harvest (Figure 8). The data is subject to bias in the accuracy of the harvest reporting, as not all anglers return their cards at the end of the fishing season, and because of that an adjustment is made statewide which could bias individual river section estimates. The number of hatchery origin fish captured in Asotin and Alpowa (except 2009) creeks are highly correlated with hatchery origin steelhead harvest (Figure 9).

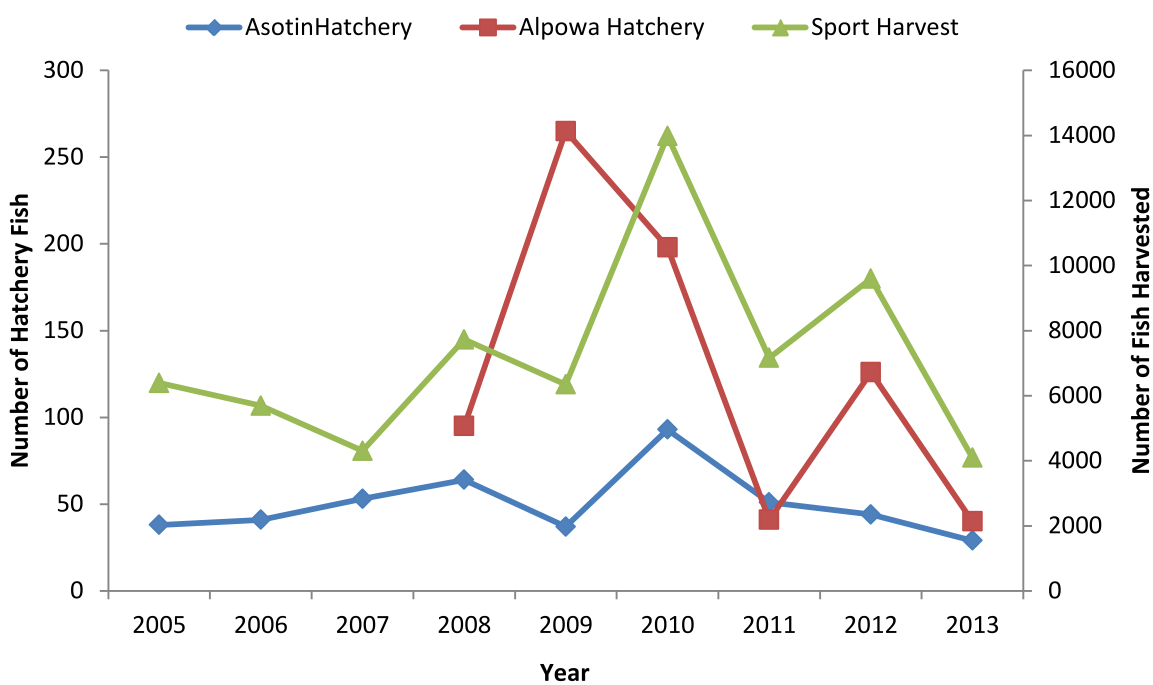

Figure 8. Hatchery-origin steelhead weir captures and sport harvest in adjacent Snake River sections (648 & 650), 2005-2013. *Plotted by fall and spring fisheries occurring immediately prior to spawn year.*

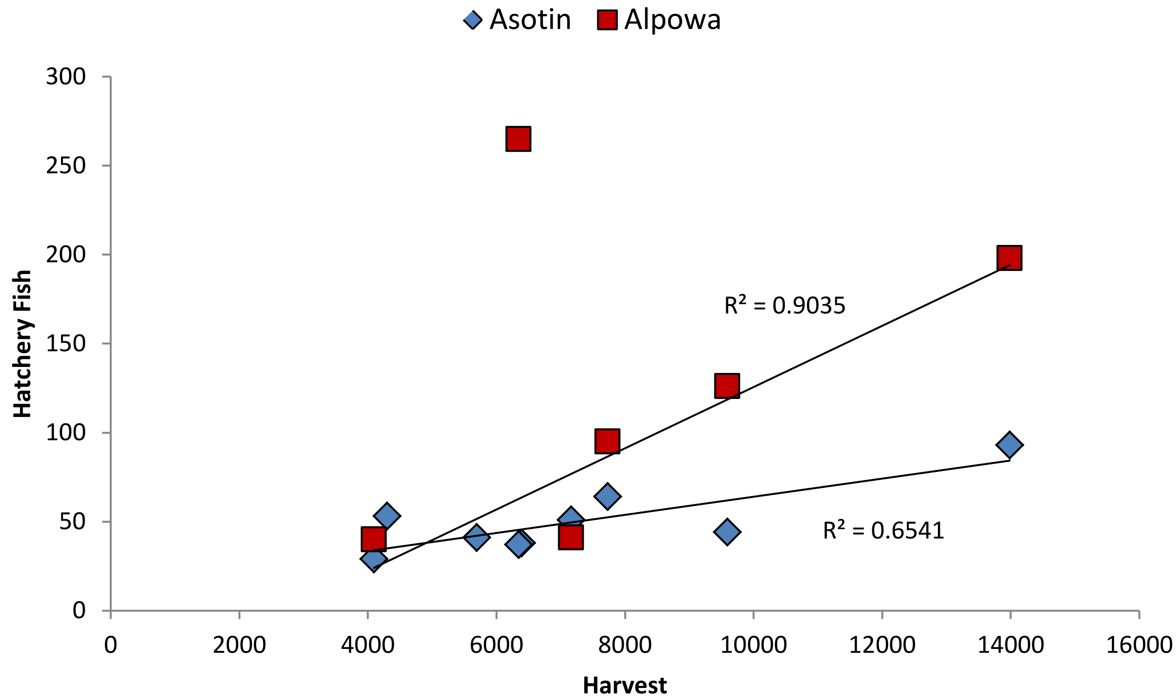

Figure 9. Relationship between numbers of hatchery fish captured at Asotin and Alpowa Creek weirs and hatchery steelhead harvest in Snake River sections 648 and 650.

Age at return of adult spawners has been similar most years in Asotin Creek (Figure 8). However, in 2013 we observed a very high proportion of age 1.2 spawners. This age class would be representative of the 2009 brood year, for which we have observed high juvenile production (Crawford et al 2013).

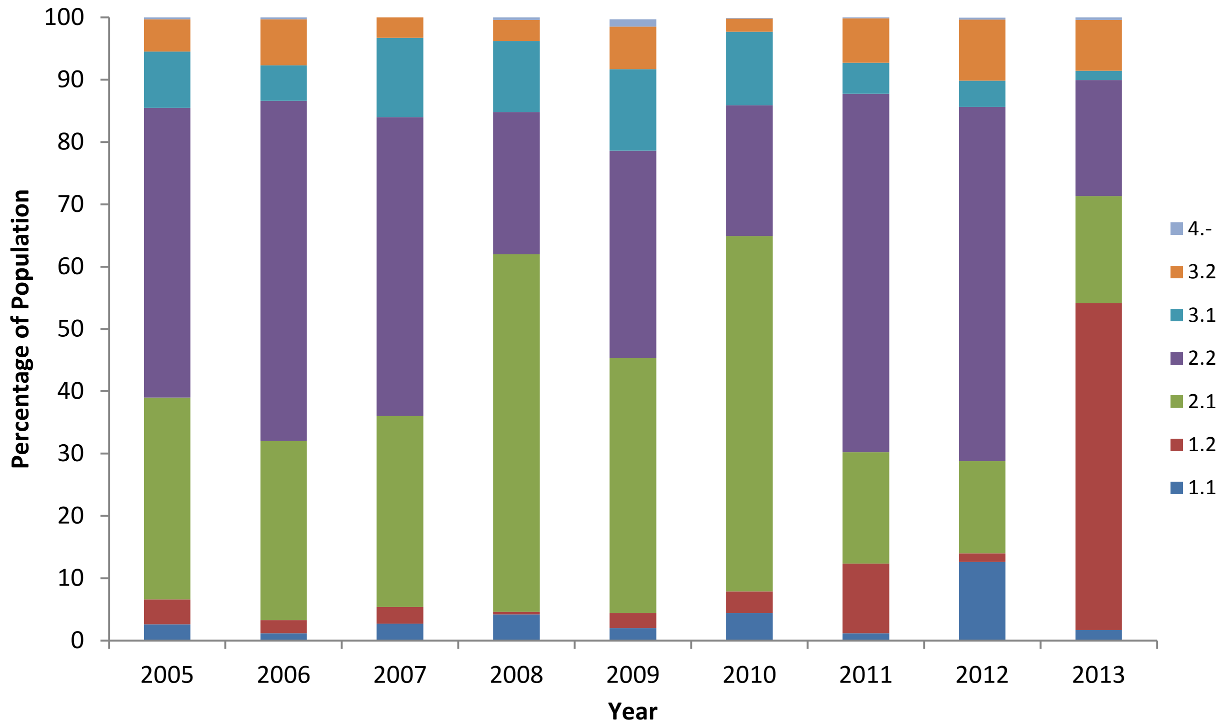

Figure 10. Comparison of total ages of wild adult steelhead captured at Asotin Creek weir, 2005-2013.

The high proportion of age 1.2 spawners also occurred at similar magnitude in George and Alpowa Creeks (Figure 10). This would suggest a variable larger than (or outside of) the basin scale led to high production for the 2009 brood year across these watersheds, or conditions in the hydrosystem or ocean were such that survival of that age class was better than previous years. The age at return for each spawn year appears to be related to the brood year success of the brood years making up each return. Although, data collected from the Touchet River in 2013 suggests a similar increase in the proportion of 1.2 spawners.

Sex ratios of adult spawners have remained similar across years (Figure 9 and Figure 11) at Asotin Creek and the other project weirs.

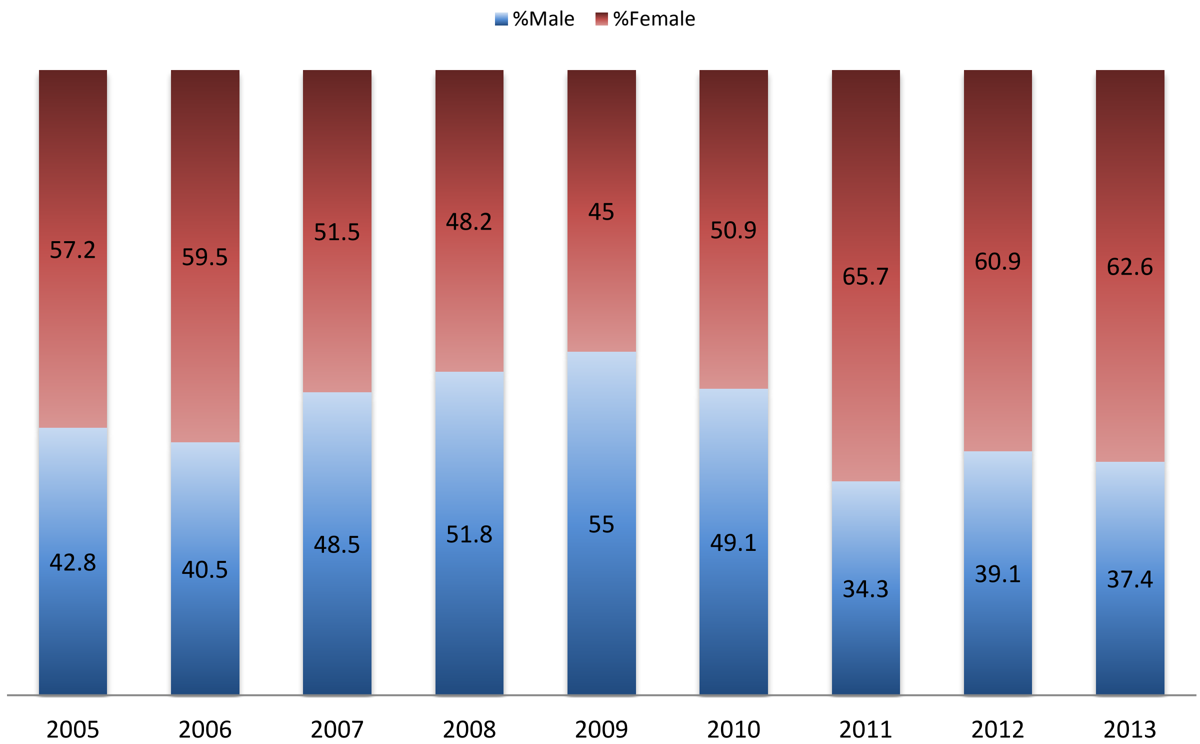

Figure 11. Comparison of sex ratios of wild adult steelhead captured at Asotin Creek weir, 2005-2013.

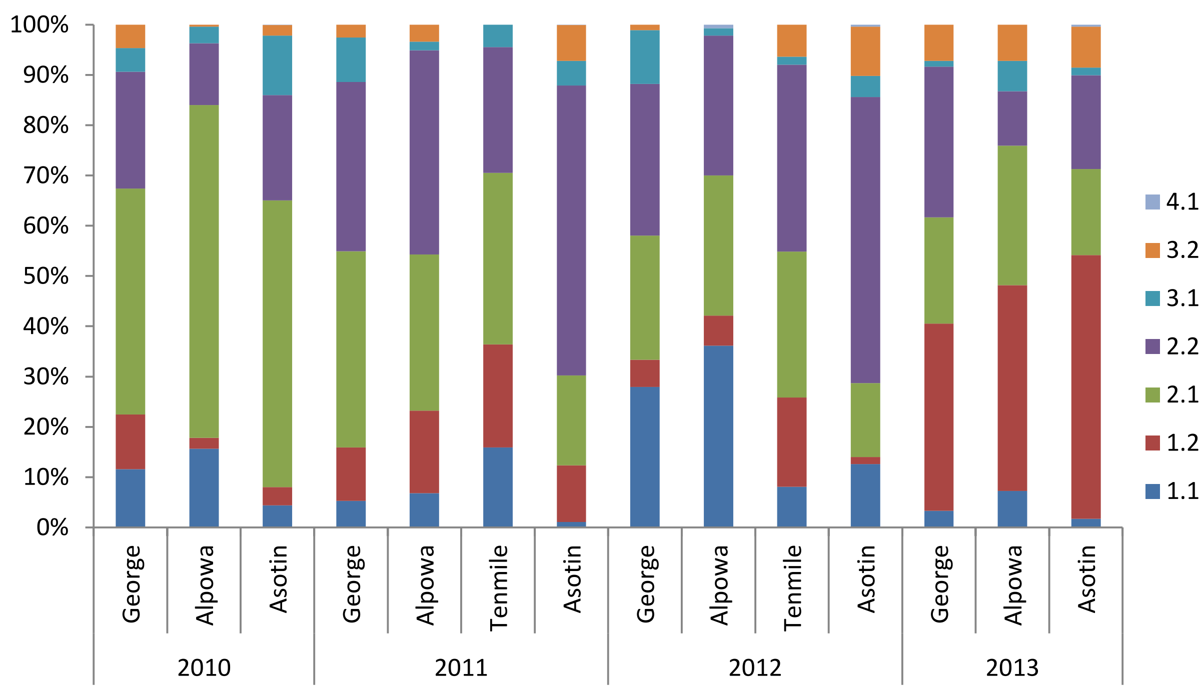

Figure 12. Comparison of age at return for adults captured at all project weirs, 2010-2013.

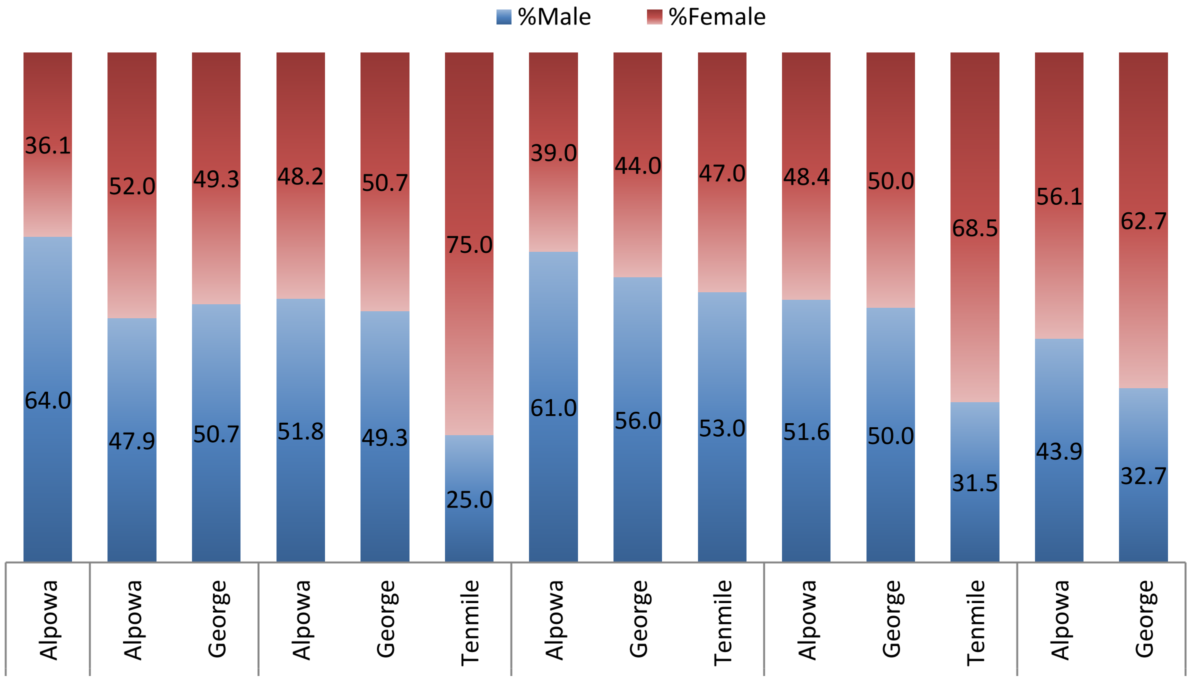

Figure 13. Comparison of sex ratios of wild adult steelhead captured at Alpowa, George and Tenmile Creek weirs, 2008-2013.

Adult escapement (based on PIT Tag detections) into the IMW study tributaries has remained similar over the years of the project (Table 20). We have yet to detect any significant changes to the use of these tributaries by spawning adult steelhead. On average, slightly more than 50% of the spawners escaping above the weir site are never detected in the tributaries. The North Fork of Asotin Creek typically makes up around 20% of the total spawners upstream of the weir. The numbers of spawners in the tributaries seems to relate closely to overall drainage area of each tributary (Table 20).

We continue to observe a proportion of the spawners at multiple tributaries, causing us to maintain roughly 5% of unknown spawning tributary assignment. Not surprisingly, males account for a higher number of the unknown spawners. Males of most salmonid species are generally promiscuous and tend to search out mates until they are spawned-out. This is supported by increased residence times for males above arrays in the tributaries. The roaming behavior of the males in the tributaries may affect the productivity estimates our IMW collaborators are calculating.

Table 18. PIT tag based tributary escapement of adult steelhead for 2010-2013.

Year	Sex	Mainstem		North Fork		South Fork		Charley Creek		Unknown		# PIT Tags
		N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	
	F	253	*26.5*	124	*13.0*	42	*4.4*	37	*3.9*	12	*1.3*	
2010	M	221	*23.2*	134	*14.1*	50	*5.2*	31	*3.3*	49	*5.1*	**953**
	Total	**474**	***49.7***	**258**	***27.1***	**92**	***9.7***	**68**	***7.1***	**61**	***6.4***	
	F	321	*34.8*	135	*14.6*	78	*8.5*	57	*6.2*	14	*1.5*	
2011	M	156	*16.9*	54	*5.9*	51	*5.5*	32	*3.5*	25	*2.7*	**923**
	Total	**477**	***51.7***	**189**	***20.5***	**129**	***14.0***	**89**	***9.6***	**39**	***4.2***	
	F	101	*37.7*	24	*9.0*	12	*4.5*	18	*6.7*	4	*1.5*	
2012	M	52	*19.4*	22	*8.2*	11	*4.1*	14	*5.2*	10	*3.7*	**268**
	Total	**153**	***57.1***	**46**	***17.2***	**23**	***8.6***	**32**	***11.9***	**14**	***5.2***	
	F	220	*41.3*	67	*12.6*	25	*4.7*	15	*2.8*	8	*1.5*	
2013	M	104	*19.5*	37	*6.9*	19	*3.6*	11	*2.1*	27	*5.1*	**533**
	Total	**324**	***60.8***	**104**	***19.5***	**44**	***8.3***	**26**	***4.9***	**35**	***6.6***	
Average:		***54.8%***		***21.1%***		***10.1%***		***8.4%***		***5.6%***		**669**
DrainageArea (Ha):		***50,900***		***16,500***		***10,400***		***5,800***				

Juvenile Emigration

The total number of juvenile steelhead capture and juvenile emigrant population estimates for all years sampled are provided below in (Table 21 and Table 22). The estimates do vary across years, however the number of emigrating juveniles captured and the overall estimates remain substantial for a subbasin the size of Asotin Creek.

It should be noted that migratory year (MY) estimates are not provided here. Through our ongoing analysis of PIT tag and travel time through the hydrosystem, we have learned that some fish are not migrating to the ocean immediately after leaving Asotin Creek. We intend to refine our estimates of smolt emigrants and hope to present revised estimates of smolt and parr emigrations in future reports. It is our hope that we can quantify the numbers of juvenile of smolts emigrating immediately or at least within that migratory year and the numbers of parr leaving Asotin Creek, or remaining below the smolt trap, and emigrating from the Snake River basin in subsequent years.

During the 2013 spring and fall juvenile trapping seasons we experienced the lowest trap efficiencies observed over the course of the project. Some of this is likely due to the low flows observed throughout the year, and some of it may be due to nuanced changes at the smolt trap site. We hope to install some removable wings to direct more water and fish into the cone. Due to the low efficiency the confidence bounds in our 2013 estimates are quite wide.

Table 19. Total number of emigrant steelhead captured and population estimates during Spring out-migrations from Asotin Creek, 2004–2013.

Year	Mean Trap Efficiency	*n* Steelhead Captured	*n* Tagged	Emigrant Pop. Estimate	95% CI
2004	20.50%	8,028	0	43,457	37,972 - 48,942
2005	30.00%	6,606	2,290	24,422	17,005 - 33,441
2006	20.20%	4,170	1,553	25,741	21,771 - 30,584
2007	23.80%	5,727	1,853	22,848	19,211 - 27,755
2008	21.20%	4,351	1,524	32,824	25,986 – 42,836
2009	18.70%	2,505	576	16,870	13,879 - 21,419
2010	16.30%	3,935	2,083	23,261	18,175 - 23,661
2011	13.70%	4,205	3,353	34,997	32,127 - 38,564
2012	15.30%	5,402	4081	36,194	33,506 - 39,716
2013	8.99%	2,905	2,788	34,951	29,882 - 42,014
AVERAGE	***18.87%***	***4,784***	***2,233***	***29,313***	

The age composition of spring emigrants is provided below in Figure 12 and for fall emigrants in Figure 14. In 2013, the proportion of ages observed during both the spring and fall trapping seasons were similar to previous years, and near the average for all age classes.

We continue to track age composition closely. We have not provided productivity estimates in this report for the same reasons mentioned above. Over the course of 2014 we plan to populate our models and provide revised estimates of smolt and parr production as well as revised adult productivity metrics.

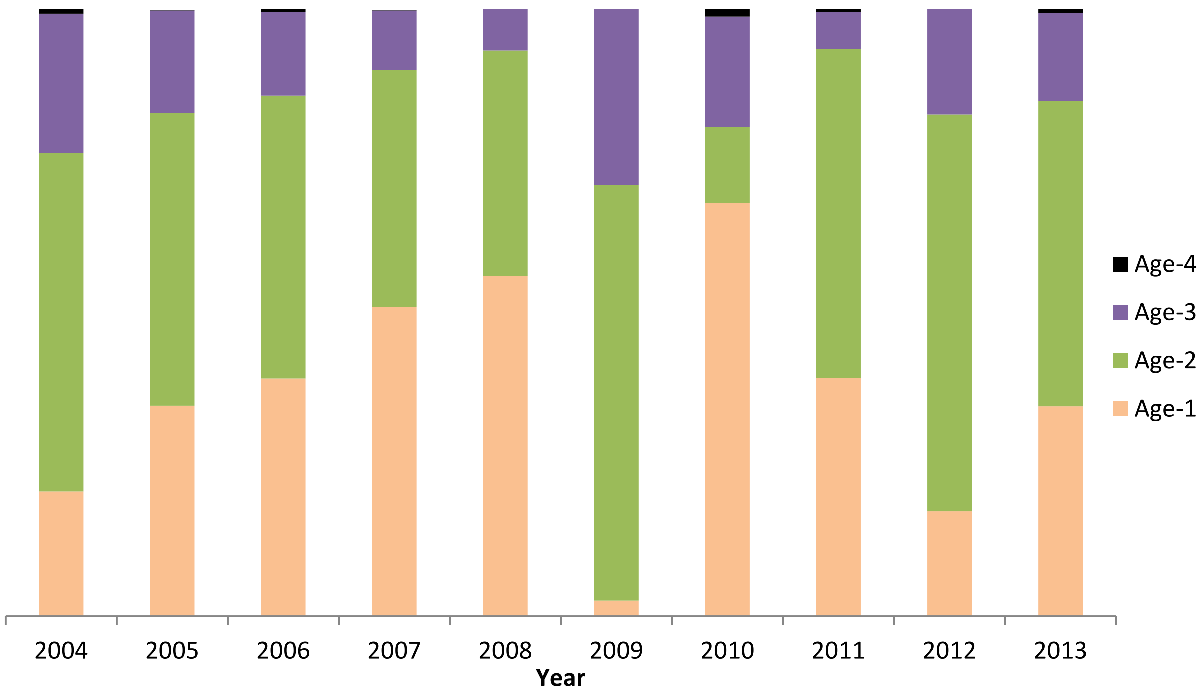

Figure 14. Age structure of emigrants sampled during spring out-migrations, 2004-2013.

We continue to observe variation in the length at age of age-1 spring emigrants (Figure 13). In 2013, we observed a median length of 134mm, above the project median of 106mm. This increase to a length similar to what we observed in 2009 and 2010 may be indicative of lower brood year production from 2012, and may be suggestive of a density dependent population response.

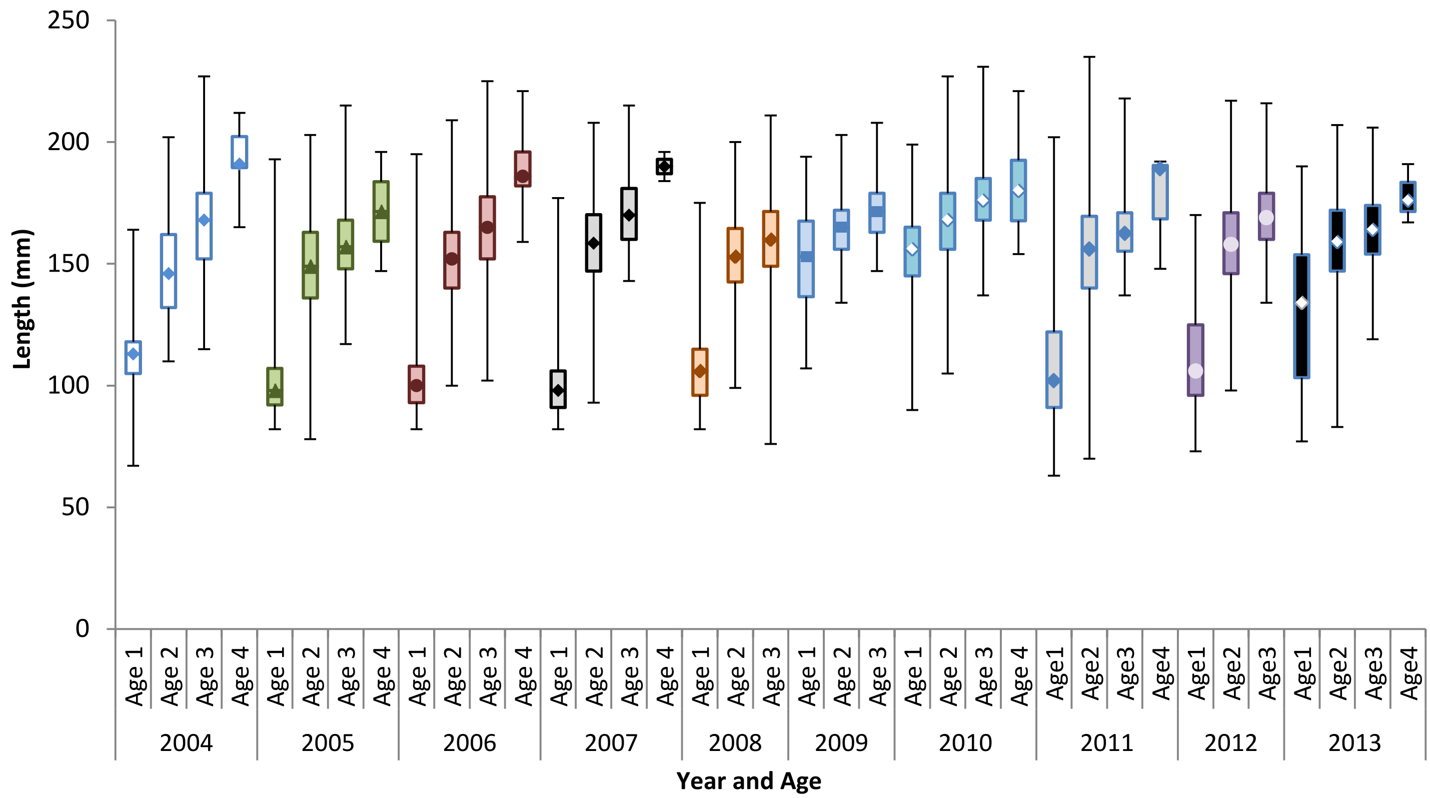

Figure 15. Length-at-age distribution (with maximum, minimum and median values) of juvenile steelhead captured in Asotin Creek during the spring out-migrations, 2004-2013 (n=10,901). (Median length values are represented by shapes in each box).

Table 20. Number of emigrant steelhead captured, in Asotin Creek, and population estimates during fall out-migrations, 2004–2013.

Year	Mean Trap Efficiency	*N* Steelhead Captured	*N* Tagged	Emigrant Pop. Estimate	95% CI
2004	35.10%	484	0	2,287	1,771 - 2,805
2005	31.00%	608	172	2,865	1,772 - 4,347
2006	30.40%	1,659	0	10,827	9,051 - 12,852
2007	33.50%	6,639	0	27,527	24,306 -31,534
2008	25.10%	941	341	3,942	3,185 - 5,166
2009	27.70%	1,578	371	8,596	6,781 - 11,064
2010	23.20%	690	523	2,432	1,934 - 3,126
2011	16.10%	716	649	5,869	4,208 - 7,192
2012	9.97%	838	598	7,182	5,877 - 8,896
2013	9.50%	767	536	7,653	5,269 - 12,376
AVERAGE	***24.16%***	***1,492***	***319***	***7,918***	

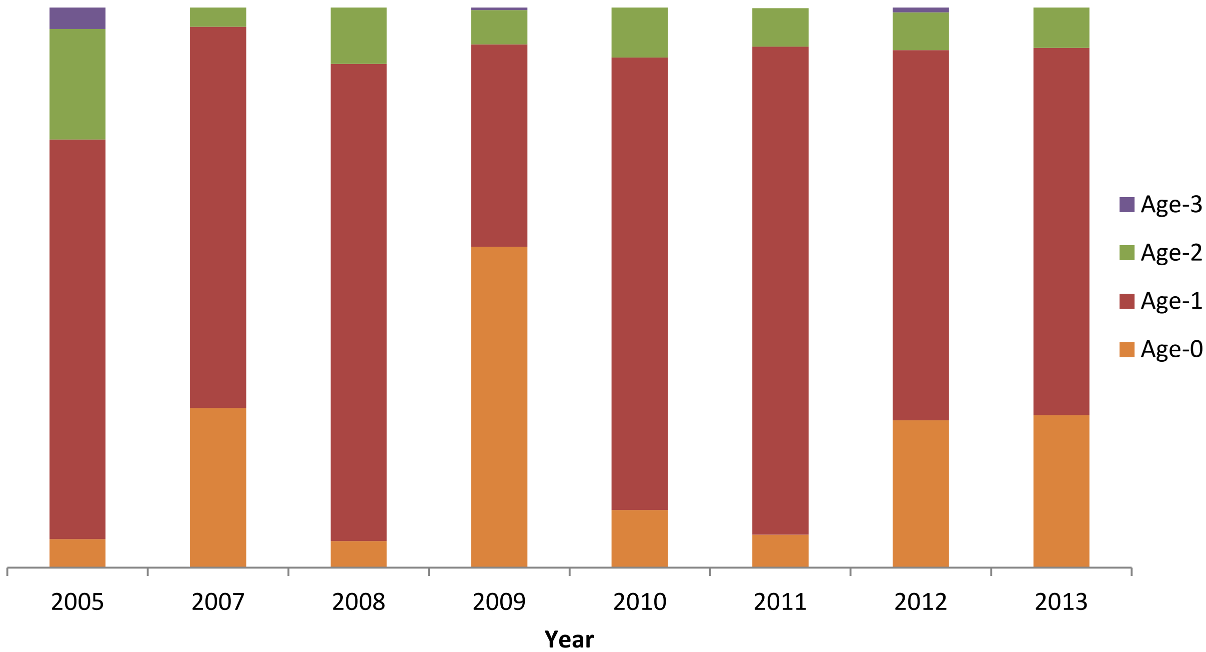

Figure 16. Age structure of emigrants sampled during fall out-migrations from Asotin Creek, 2005, 2007-2013.

The timing of the spring emigration was similar to previous years in Asotin Creek (Figure 15). The start of the emigration appeared to be slightly later than in previous years. As mentioned above, we experienced low flows throughout early February and March, and cold stream temperatures. Very little juvenile movement was detected at the smolt trap through January and February as well as at our PIT tag interrogation sites. We observed no interrogation events in January and February 2013, and in previous years we have recorded between 5 and 50 unique tag detections each month from IMW or previously tagged fish at the smolt trap.

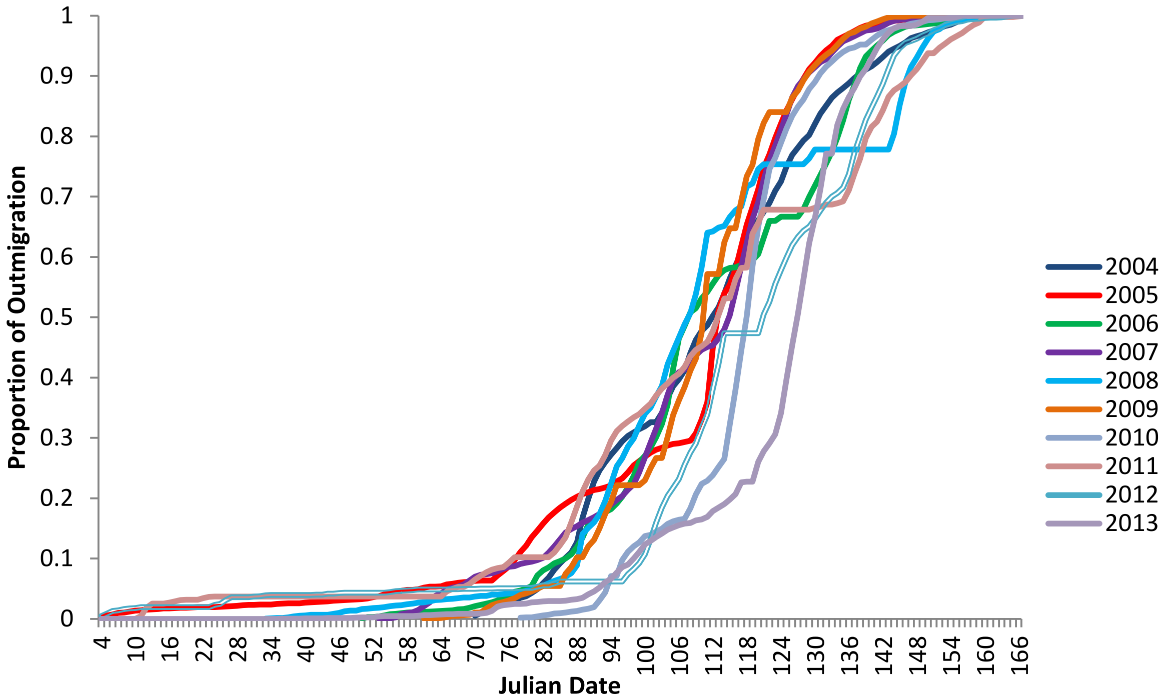

Figure 17. Emigration timing of juvenile steelhead from Asotin Creek, Spring 2004-2013.

Conclusions

The 2013 field season was a successful one for the project. Benign flow conditions allowed for near census estimates at project weirs. The low flow also allowed project staff to collect higher numbers of kelts captured in good condition. We also improved our kelt trapping techniques, and hope to further refine our passive capture kelt trap during the 2014 field season.

Stream flows may have a big impact on the ecology of the Asotin Creek steelhead population, and this project continues to look for the correlation between productivity and seasonal or annual discharge. Maintaining the long term data from the Department of Ecology Flow Monitoring gages should be a priority for that agency, especially in basins when money is being spent on habitat restoration and monitoring and fisheries monitoring. Having detailed flow and temperature records is imperative for understanding the effects of drought and high water events on these stream systems. In the face of a changing climate, understanding the role of the climate on population dynamics is of paramount importance to the long term recovery of this population.

We have also been working on an ongoing analysis of the juveniles PIT tagged at the Asotin Creek smolt trap, and have learned that not all fish leaving Asotin, are actually leaving the Snake River Basin, and actually emigrate as smolts. Though this is not surprising, we recognize that it presents problems in comparing productivity estimates across populations. We intend to utilize different models (Hierarchical Bayesian Models) for estimating the emigration, and will break that down by smolts (+transitional) and parr. We intend to complete this both retrospectively and going forward. This will allow for more realistic smolt to adult ratios, and estimates of productivity. The change in emigrant estimators will standardize our approach with other WDFW steelhead monitoring programs in the Columbia Basin. We expect to present those revisions and adjustments in the 2014 Annual Report. This effort will also provide data critical to NOAA Fisheries upcoming stock status review in 2015. In previous reviews there has not been sufficient data to inform the TRT as to the status of the Asotin Creek steelhead population; however we have collected an additional five years' worth of juvenile and adult data.

We believe that there is a need to look further into the relationship between hatchery origin steelhead sport harvest and returns to project weirs. From this brief analysis, we have raised several additional questions: In years where a high return of hatchery fish is forecasted, do more anglers participate in fisheries? Do anglers invest more time during fishing seasons targeting a forecasted high return? What is the impact of increased angling pressure and angling success on wild returns and conversion rates to spawning tributaries? Do sales of recreational fishing licenses at vendors near these fisheries increase in these return years? Though this seems to be on the verge of this projects scope, we believe that there is more room for adaptive management of the fishing season and bag limits to reduce the number of stray hatchery steelhead spawning in the wild. It would certainly be worthwhile for fisheries managers to take a hard look at the relationships between fisheries forecasts, harvest and angler participation. With the ongoing fight among wild fish advocates and hatchery fish proponents, being able to answer these questions accurately is paramount to resolving conflict, achieving management goals and ultimately, steelhead recovery.

The Fish Passage Center will be providing cost sharing for fiscal year 2014 through a PIT tag purchase. The FPC's Comparative Survival Study (CSS) is providing an additional 1,500 PIT tags to be applied to emigrating juvenile steelhead. The CSS is a large scale study designed to provide basin-wide monitoring of Chinook, steelhead and sockeye survival through the hyrdrosystem. Additionally, the CSS provides demographic data (e.g. SAR's) on Snake River wild and hatchery salmon and steelhead populations (FPC 2013). The additional PIT tags will increase the sample size of CSS's Snake River wild steelhead component and provide this project with a tag group that will allow us to better estimate survival through the hydrosystem, and, eventually could lead to a comparison of juvenile to adult survival related to each tag group's hydrosystem migration history.

We continue to emphasize that there is much value in understanding the ecology and interactions of the small stream tributaries of the Snake River. However, as we have noted in previous annual reports operating adult fish traps in these tributaries has proven difficult. In 2013, we had great success operating and maintaining the trap on Tenmile Creek, though we did not capture any fish. The lack of captures at the Tenmile Creek weir may have implications to the management of the hydrosystem upstream of Hells Canyon. Tenmile Creek shares many similarities with many of the small Snake River tributaries upstream. Annual escapement in these tributaries may depend on the discharge of the mainstem Snake River more so than the tributaries themselves. However, the lack of water in these steep tributaries may also be indicative of the potential for habitat restoration opportunities. Much like George Creek, Tenmile and Couse Creeks run dry for significant stretches of the late summer and fall in some years. These streams may benefit from projects addressing floodplain connectivity and efforts to increase or maintain flow and connectivity year round.

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Appendix A: Use of Data & Products

Data collected by this project is stored in electronic databases housed at the project office in Clarkston, WA. The data and associated databases are a backed up to an external hard drive that is stored off site. Additionally, the databases and all project data are also backed up on WDFW Corporate databases on a weekly basis. Derived data from the project is backed up on a monthly schedule, or as needed when changes occur. Since 2010, the project has been working on developing a standardized MS Access database for all project data. We are happy to report that the database is fully populated with all years of project data collected to date.

Requests for data and or summaries can be made by contacting the authors of this report. It is important that any data users contact the authors in advance so that they can be informed of the caveats inherent in the data and informed of the guidelines for use.

Some kelts recovered at the Asotin Creek and George Creek weirs in 2013 (*n*=50) were provided to staff from the Pacific Northwest National Laboratory for their ongoing kelt hydroacoustic tracking through the FCRPS. Data generated by that project is available in their "Steelhead Kelt Passage Distributions and Federal Columbia River Power System Survival for Fish Tagged Above and at Lower Granite Dam" (Colotelo et al 2013.) We plan on continuing to assist with kelt passage efforts into the future.