STEELHEAD (ONCORHYNCHUS MYKISS) POPULATION AND HABITAT MONITORING IN LOWER YAKIMA RIVER TRIBUTARIES

2015

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1. Executive Summary

To monitor the trends and status of the steelhead populations in Toppenish, Satus and Ahtanum Creeks we conducted spawning ground surveys including a redd count to index adult spawning escapement. We operated rotary screw traps to monitor juvenile outmigration below the spawning and rearing habitat on these watersheds. We operated three passive Integrated Tag (PIT) Interrogation Systems (PTIS) in the Toppenish and Ahtanum Watersheds. We also monitored water temperature, an important limiting factor for steelhead production in the Yakima River Basin (Yakima Fish and Wildlife Recovery Board 2004, 2009)

Fish Population Monitoring

The number of steelhead redds (n=206) in 2015 decreased in Satus Creek compared with 223 redds observed the previous year and was the lowest since 2012 (Figure 12). Redd numbers (n=112) decreased in Toppenish Creek (Figure 13). An increase in steelhead counted at Prosser dam and good conditions for the identification of steelhead redds were present in both creek and played a role in the observed redd numbers. Spatial distribution of redds appeared to be typical in Satus (Figure 5) and Toppenish Creeks (Figure 6).

The estimated number (34,142 se 3266) of juvenile outmigrants from Toppenish Creek (Toppenish Creek screw trap) was slightly higher than the 10 year average (33,490; Figure 14). In lower Toppenish Creek, 55 Juvenile O. mykiss were captured. In Satus Creek, 91 steelhead smolts were captured in the rotary screw trap and no estimate was calculated for this site due to low recapture numbers. The number of smolts captured (N=80) at the Ahtanum screw trap in 2015, also continues to be too low to estimate juvenile outmigration from that watershed.

Tributary Habitat RME

High summer water temperature (into the mid to upper 20 degree Celsius range) appears to be a limiting factor for steelhead early life history stages in the lower reaches of Satus, Toppenish, Simcoe and Ahtanum Creeks (Tables 1-3).

2. Introduction

The Yakama Reservation Watersheds Project (YRWP; 1996-035-01) originated as several separate BPA-funded projects, the earliest of which began in Satus Creek in 1996. Projects in Toppenish and Ahtanum Creeks were added soon afterward in an attempt to address the declining steelhead populations in three steelhead-producing tributaries of the lower Yakima River. All three of these watersheds are located on the Yakama Reservation. In March 1999, the Middle Columbia River Steelhead Distinct Population Segment was listed as threatened under the Endangered Species Act (ESA). Four populations (Satus, Toppenish, Naches, and Upper Yakima) are recognized by NOAA's National Marine Fisheries Service for recovery purposes in the Yakima Basin and comprise the Yakima MPG (Major Population Group) (Yakima Fish and Wildlife Recovery Board 2009). Ahtanum Creek steelhead are grouped under the Naches population--although geographically removed it may function as a separate population.

Monitoring the steelhead populations in Toppenish, Satus and Ahtanum creeks has proved to be difficult in many years. Adult steelhead are counted as they migrate up the Yakima River at Prosser Dam in the town of Prosser Washington.

These counts using mostly video footage collected at the fish ladders (as well as a Denil fish ladder and trap for biological sampling) are believed to produce a fairly accurate adult migrant count for the Yakima MPG (http://ykfp.org/docsindex.htm). Another counting facility (Roza) is located on the Yakima River farther upstream above the Naches River confluence and provides a direct count of adult steelhead migrating upstream of the boundary delineating the Upper Yakima population. No counting facilities are present to enable delineation of the Naches, Toppenish, or Satus Creek populations. Instead, redd count surveys provide an index of adult escapement on these Yakima River tributaries. Spawner surveys including a redd count and similar methods to those used at present have been performed in Satus Creek since 1988, in Toppenish Creek since 1997, and in Ahtanum Creek beginning in 2001. The accuracy of these counts varies from year to year and is dependent on snowpack and stream conditions during the spawning season. The poor accessibility and spring flooding of the upper section of the Toppenish Creek watershed and much of the Ahtanum Creek watershed has been the greatest obstacle to completing a redd survey that captures the entire spawning season in those tributaries. Instream PIT tag antennas are being used to estimate the number of Adult steelhead returning to Satus, Toppenish, and Ahtanum Creek. This technology is also expanding into the Naches watershed as well.

Study Area

Satus Creek

Satus Creek is located in south-central Washington and drains the southeast portion of the Yakama Reservation with a watershed area of 710 mi² (Hubble 1992), more than 10 percent of the Yakima Basin area. It is the largest tributary of the Yakima River located on the Yakama Reservation. It is also the most downstream of the steelhead-producing tributaries in the Yakima basin and enters the Yakima River at river rile 69.6 (Columbia Basin Inter-Agency Committee 1964). Elevation ranges from 5800 feet near Potato Butte to 650 feet at the mouth. Logy Creek and Dry Creek are the largest tributaries of Satus Creek. Smaller tributaries include Mule-Dry Creek, Kusshi Creek, Shinando Creek, Bull Creek, and Wilson Charley Creek. A large section of Satus Creek located above Logy Creek becomes intermittent during the summer. Logy Creek itself drains a substantial area of the porous Simcoe Volcanic Field, and is perennial. Logy Creek provides summer stream flow for the lower portion of Satus Creek. Dry Creek, the largest tributary of Satus Creek, is intermittent in its lower 15 miles (below the "elbow") during the summer. However, the upper portion of this stream flows year round. Many of the smaller tributaries are also intermittent. Unlike the other lower tributaries of the Yakima River, irrigation withdrawals are limited to small pumps. The last irrigation dam (unused since 1981) was removed by YRWP in 2009. The watershed is also largely uninhabited with less than a dozen structures along its upper reaches, where grazing and logging are primary land uses. The lowest 10 miles of Satus Creek are within the Yakima River floodplain; here much of the land is farmed and irrigated with water withdrawn from the Yakima River near Parker Washington. Satus Creek has a particularly "flashy" hydrograph when compared to other streams in the Yakima basin due to its relatively low elevation and sparse vegetation. The highest recorded flows in Satus, Toppenish and Ahtanum creeks have been associated with midwinter rain-on-snow events.

Toppenish Creek

Toppenish Creek is located in south central Washington and the entire watershed is situated within the boundary of the Yakama Reservation. Toppenish Creek is also a major tributary of the Yakima River with nearly as large a watershed area (622 mi²) as Satus Creek. The headwaters of Toppenish Creek are located on Lost Horse Plateau at a maximum elevation of 5200 feet. Simcoe Creek, the main tributary of Toppenish Creek, joins at river mile 32 (about the halfway point). The forks of Simcoe Creek and its main tributaries Agency and Wahtum Creeks also arise from Lost Horse Plateau, but at a slightly lower elevation. Toppenish Creek enters the Yakima River about 7 miles south east of the town of Toppenish, Washington at river mile 80 at an elevation of 650 feet. Along its approximately 70-mile length, stream morphology and watershed topography changes substantially. Through nearly the upper third of its length, Toppenish Creek flows through a remote forested canyon. Most of the upper Toppenish Creek watershed is tribal trust land managed for timber production and cultural resources. The middle third of Toppenish Creek is dominated by an alluvial fan. This area is managed for multiple uses including livestock grazing and some agriculture. Irrigation withdrawals begin in this region of the watershed, at the head of the alluvial fan. The lower portion of Toppenish Creek is heavily influenced by agriculture with a variety of crops grown (e.g. corn, wheat, hops, mint, orchard fruit and grapes). Flows and water quality are altered drastically by irrigation withdrawals, spills and return flows in the lower portion of Toppenish Creek. Much of the land adjacent to the lower third of the creek is devoted to waterfowl production and hunting. The USFWS Toppenish Creek Wildlife Refuge, Yakama Nation wildlife areas, and a number of private duck clubs provide a substantial amount of off-channel wetland habitat (managed to attract waterfowl) on the lower 30 miles of Toppenish Creek.

The hydrograph of Toppenish Creek is similar to other streams on the east slopes of the Cascade Range. Peak flows typically occur in early to mid-spring resulting from snowmelt, although rain-on-snow events during winter can cause substantial floods—sometimes the peak flow for the season. Flows decrease rapidly during late spring and early summer as the snowpack is depleted. Flows (and closely-related water temperature) are probably the limiting factor for steelhead production in portions of the Toppenish and Simcoe watersheds. Irrigation spills and return flows in the lower portions of Toppenish Creek are substantially greater than natural flow and are believed to be detrimental to salmonids because of their temperature, suspended solids, and the potential homing issues raised by flows originating from outside the Toppenish Creek watershed.

Marion Drain and its tributary Harrah Drain carry irrigation drainage from the agricultural area north of Toppenish Creek eastward to the Yakima River. During the irrigation season, most of their flow is mixed with Toppenish Creek flow and diverted south of the creek to the Satus Area of the Wapato Irrigation Project. Steelhead can access Marion and Harrah drains via the Yakima River outlet or Toppenish Creek. Redds are counted in both drains every year, but survival of steelhead eggs and parr may be low enough to consider Marion and Harrah drain a population sink.

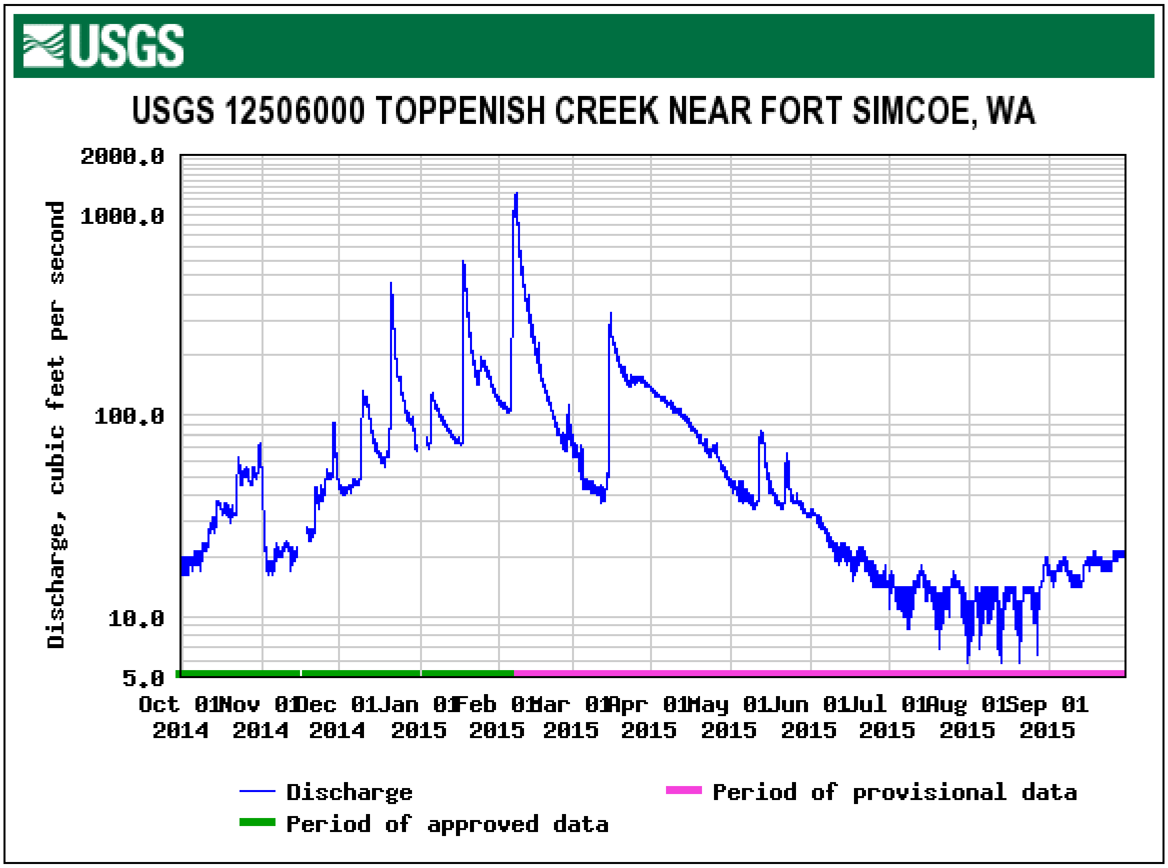

Figure 1. Hydrograph on Toppenish Creek at river mile 40 for Water Year 2015.

Ahtanum Creek

Ahtanum Creek is the next major Yakima River tributary located upstream from the Toppenish Creek watershed (Marion Drain). It forms the northern boundary of the Yakima Reservation and enters the Yakima River at river mile 106.9. Of the three steelhead- producing tributaries monitored by YRWP, Ahtanum Creek is the smallest with a watershed size of 173 mi^2, but its base flow is comparable to that in perennial sections of Satus and Toppenish creeks because of its relatively higher watershed elevation. Also, due to its higher watershed elevation, the winter freshets that are often seen in Satus and Toppenish Creek are absent or occur at a lesser magnitude (Figure 2). Elevations range from 6000 feet near Green Lake in the North Fork Ahtanum Creek watershed to 940 feet at the mouth. Flowing through the city of Union Gap and other small suburbs of the city of Yakima it is the most urban of the three watersheds and is where urbanization poses one of the greatest threats compared with other Yakima River tributaries. At one time irrigation withdrawals dewatered significant portions of the stream which is naturally perennial; however, regulated diversions now allow continuous flows. Irrigation withdrawals and returns still influence water quantity and quality.

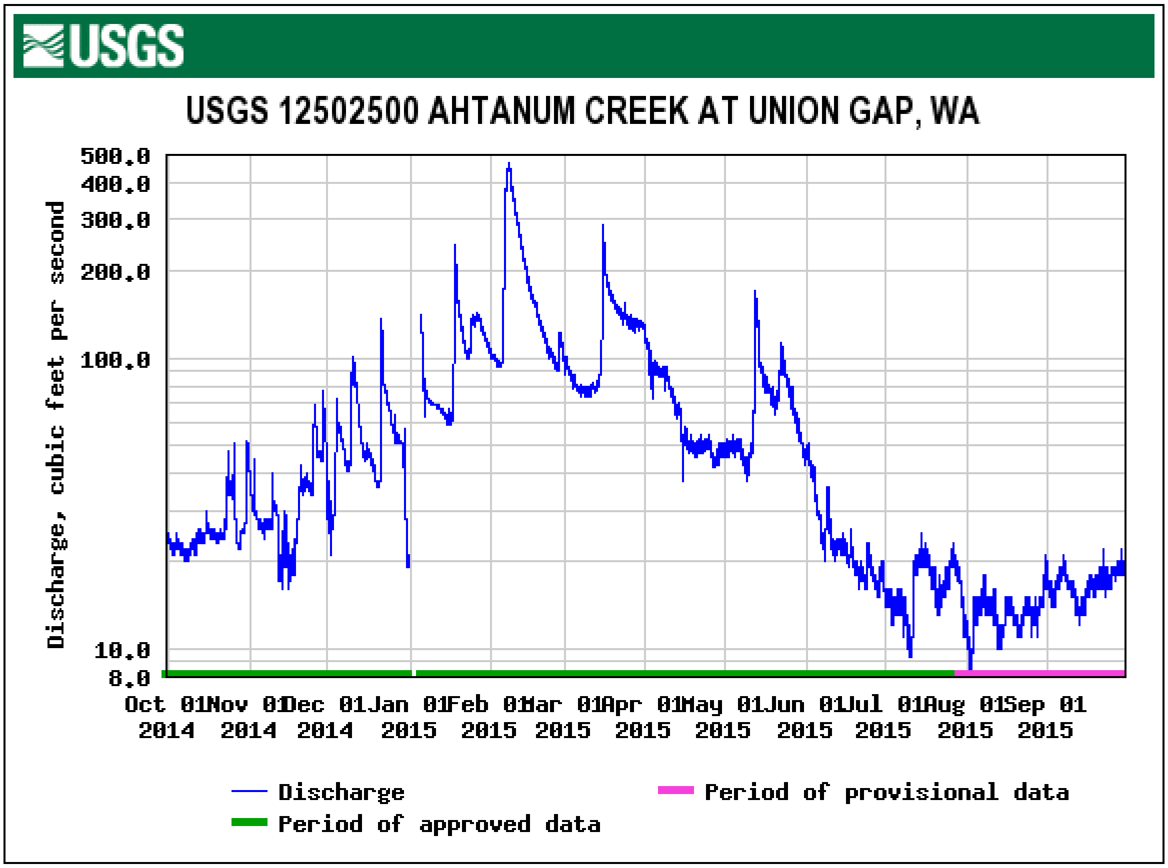

Figure 2. Hydrograph on Ahtanum Creek near the mouth for Water Year 2015.

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

Adult steelhead abundance and distribution

Protocol Title: YRWP Adult steelhead abundance (1996-035-01) v1.0

Protocol Link: http://www.monitoringmethods.org/Protocol/Details/110

Protocol Summary:

Steelhead redd counts are used as an index of adult spawner abundance on the tributary spawning grounds in Lower Yakima River tributaries (Satus, Toppenish and Ahtanum Creeks).

In each lower Yakima River tributary (Satus, Toppenish, and Ahtanum), we attempt to perform a census survey on all recognized spawning habitat in each tributary. Yakama Nation Fisheries has attempted various survey methods (ground, raft, aerial) in some areas outside of these recognized spawning reaches but have not documented any redds and cannot say with certainty that the documented lack of redds are due to a lack of spawning or the difficulty in observing steelhead redds in this environment, however the lower portions of these streams lacks the quality spawning gravel that is present in the upper surveyed reaches where steelhead redds are most abundant.

The procedure for conducting steelhead redd counts has not changed significantly during past 30 years that the Yakama Nation has performed them. A three pass census count using the following technique is used. Two surveyors typically cover each 2 to 6 miles survey reach, walking in a downstream direction. In some smaller streams only one surveyor conducts the survey. Surveyors wear polarized glasses to aid in spotting redds. Each identified redd is marked with a GPS with an accuracy of +/- 30 feet. Redds are marked with fluorescent flagging to prevent counting redds identified on previous passes. Each redd is measured and its location in relation to the stream bank and thawlweg are recorded. The presence or absence of direct cover is also noted on data sheets. It is unlikely that resident rainbow trout redds (or redds from other redd building species) are mistaken for anadromous steelhead redds because of the small size of all non-adult steelhead O. mykiss observed in these watersheds during population surveys (i.e. redd counts, snorkel surveys). The number of live steelhead adults and carcasses are also recorded. When possible, the sex of live steelhead and carcasses is noted. Surveyors will take care not to disturb spawning fish or possible staging pools when conducting spawner surveys. The survey begins after the sun breaks over the horizon to ensure that there is enough light to detect redds.

Redd Count Expansion

To translate our census count into an estimate of steelhead abundance we utilized the method outlined in Gallagher et al. (2007). The cumulative redd count was multiplied by the standard 2.5 fish per redd used for Washington streams for an estimate of spawning escapement. Other expansion coefficients were also considered.

Ahtanum Bull Trout surveys

The Yakama Nation has performed Bull trout surveys in the South Fork Ahtanum Creek annually since 2002. Each year they are conducted in the South Fork of Ahtanum Creek within an index reach from approximately RM 7.7 to RM 10.4. This section borders the Yakama Reservation and includes a small section of Tract C. upstream from Reservation Creek. Surveys are conducted as part of a program to track the status and trends of this species within the Yakima River watershed. Index reaches are situated in prime spawning reaches. In watersheds outside the South Fork Ahtanum, WDFW performs the surveys in cooperation with other agencies (e.g. USFWS, Joint Board, Yakama Nation, Yakima Basin Fish and Wildlife Recovery Board).

We perform these surveys using a protocol developed by WDFW (Eric Andersen; unpublished document-2011). In Summary, surveyor (s) walk upstream record, and flag redds during multiple passes. They are categorized as definite, probable, or possible. On the 3rd or last pass, GPS waypoints are collected. Live bull trout are documented during each pass as well. Only redds identified as probable or definite are included in the final count

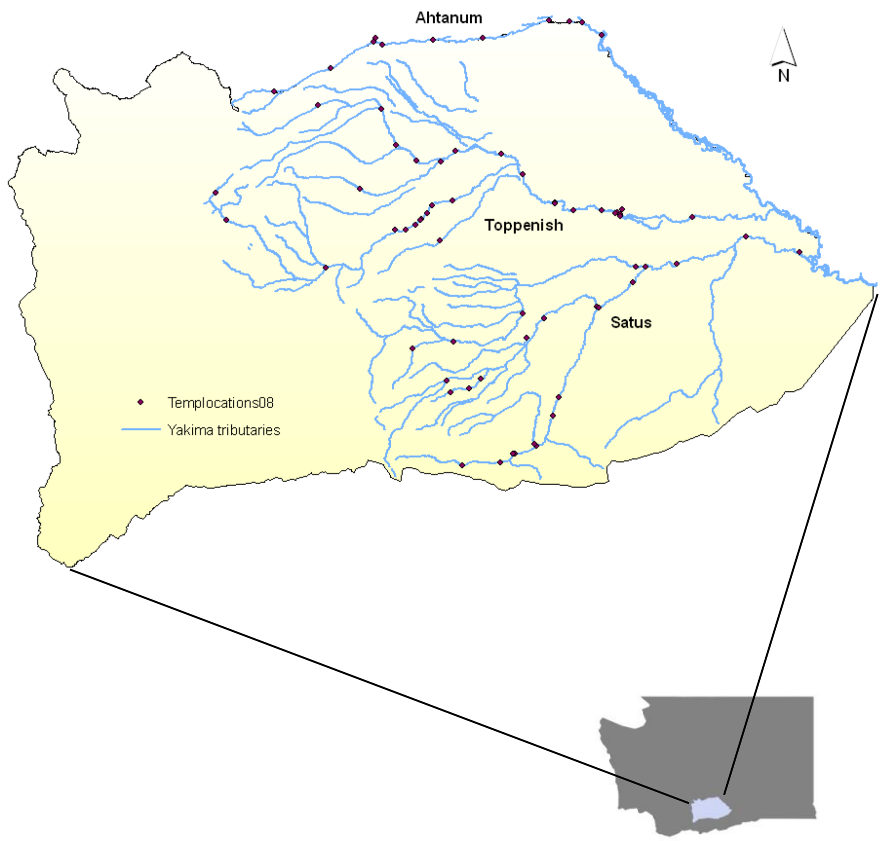

Figure 3. Locations of temperature monitoring stations established between 1997 and 2015 in Satus, Toppenish and Ahtanum Creeks on the Yakama Reservation. Some are no longer in use.

Juvenile steelhead out-migration

Protocol Title: YRWP Juvenile steelhead outmigration (1996-035-01) v1.0

Protocol Link: http://www.monitoringmethods.org/Protocol/Details/111

Protocol Summary:

Rotary screw traps are used on Satus, Toppenish, and Ahtanum to estimate juvenile steelhead outmigrant abundance, timing, and downstream survival.

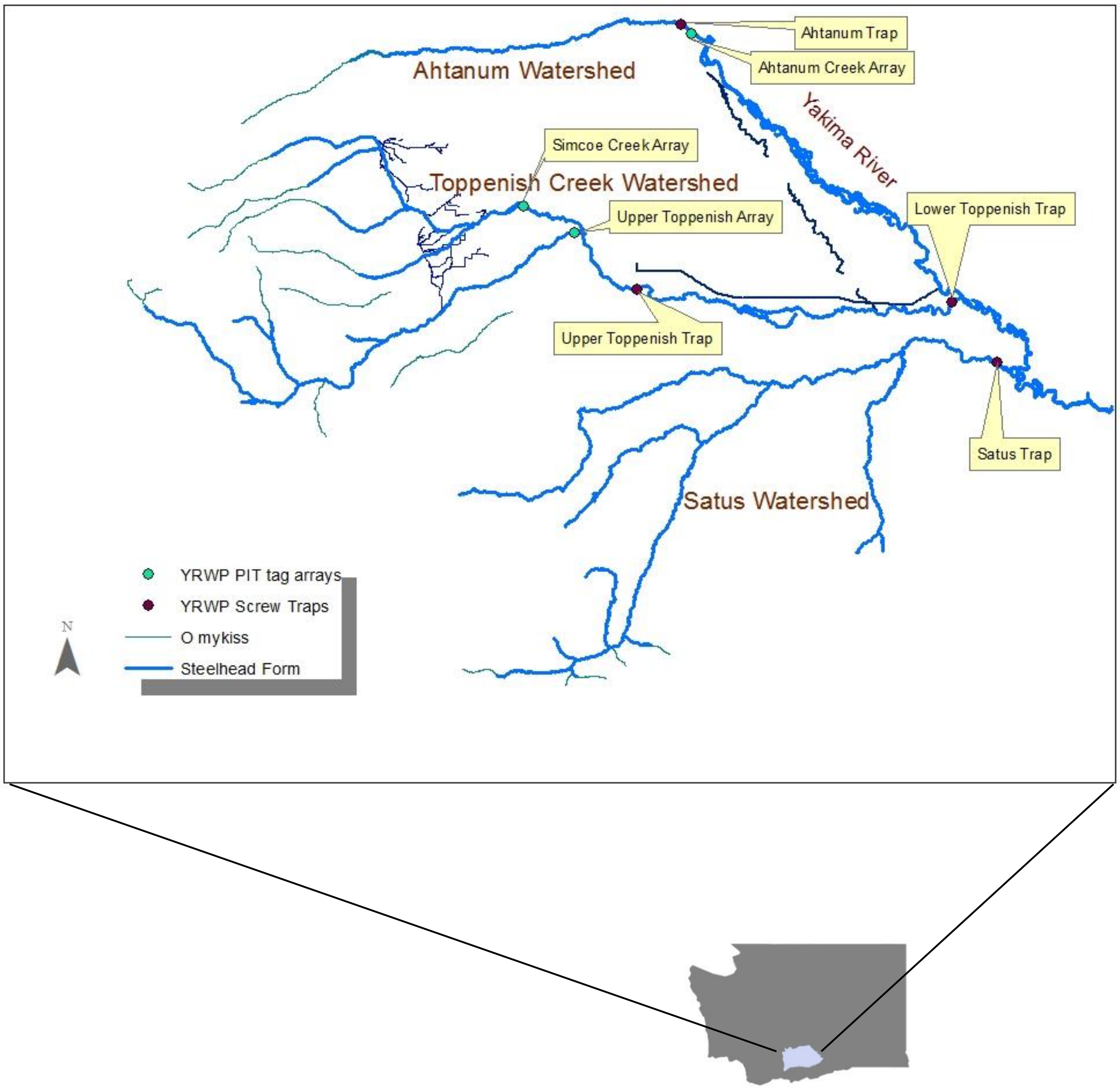

Figure 4. Location of rotary screw traps and PIT tag antenna arrays operated by YRWP in Satus, Toppenish, and Ahtanum Creeks on the lower Yakima River.

Trapping and tagging Procedures

In many years we have not been able to obtain reliable estimates due to high flows that often occur in winter and spring. The heavy debris loads associated with these high-flow events have the potential to clog the screw trap cone and impinge and kill out-migrating juvenile fish. To avoid fish kills, the alternatives were to either discontinue operation of the trap during these periods or monitor the trap continuously until flows recede. Our screw trapping protocol was similar at all four of the screw traps that we operate (upper Toppenish, lower Toppenish, Ahtanum, and Satus). Each trap was visited at least once a day usually between 6:30 AM and 11:00 AM. Fish were netted out, identified and target fish were held in 5-gallon buckets. Aeration using battery operated pumps was applied if needed. All juvenile steelhead were anesthetized in MS-222 before being handled. They were then enumerated, measured (mm), and weighed (g). Scales were collected on 100 individuals per season and location (up to 10 per day). We also collected fin clips from 100 individuals from Toppenish Creek. These samples were sent to CRITFC for DNA analysis to be used in several ongoing studies. On several occasions when large catches occurred (N > 300) only a random sub-sample (first 100) were measured and weighed. We inserted PIT tags into a subsample (first 100) of captured steelhead smolts over 80 mm in length. PIT tagged fish were released several hundred meters upstream from the trap to estimate trap efficiency (i.e. mark-recapture). The upstream release site alternated between the right and left banks of the stream. Efficiency releases were made 4 times per week (Monday-Thursday) and release numbers and recaptures for the week were pooled. We set a target of 4000 steelhead juveniles to PIT tag and attempted to space our tagging effort throughout the season so the total out-migration was represented appropriately. Due to variable seasonal catches, there is no clear formula to achieve this and the target number tagged per day had to be adjusted several times during the season; however, we still ended the season short on PIT tagged fish.

Scales were collected from 100 individuals from each stream. We collected fin clips from 100 steelhead smolts for use in DNA studies as well. DNA samples are analyzed by CRITFC for their steelhead kelt reconditioning study. After handling we released steelhead juveniles, along with all recaptures and undersized fish 100 meters downstream. Physical data (water temperature, air temperature, and percent cloud cover) were recorded. The trap rotation rate (seconds per revolution) was recorded to evaluate operating efficiency.

Juvenile out-migration estimate

We utilized a Petersen's stratified capture-recapture model to estimate juvenile steelhead outmigrant abundance.

The assumptions of this model are:

1) The population is closed;
2) All fish have an equal probability of capture in the first period;
3) Marking does not affect catchability;
4) The fish do not lose their marks; and
5) All recovered marks are reported (Volkhardt et al. 2007)

Due to changes in factors shown to affect trap efficiency (i.e. stream flow, temperature, increasing smolt size) that occur as out-migration season progresses, we stratified our estimate temporally by week. Darr 2.02 software for R statistical software utilizing Darroch's (1961) maximum likelihood estimator for stratified data was used to obtain an estimate and its associated variance (Bjorkstedt 2005 and 2009). A one-trap study design was used. Since at least 5 recaptures are typically necessary to converge, Darr 2.02 incorporates an algorithm that automatically pools adjacent strata as needed. We enabled this algorithm because many weekly strata outside the peak migration period had fewer than five recaptures.

During periods of high flow when operation of the trap was not possible and trapping was suspended for several days, we interpolated daily catches by calculating the average of the three days before and the three days after the missed period.

In Stream PIT Tag Interrogation Systems

We operated three Instream PIT tag antenna arrays in the Ahtanum and Toppenish. Two were located in Toppenish Creek watershed at the confluence with Simcoe Creek--The largest tributary of Toppenish Creek. One of these two was located about 0.5 miles upstream of the confluence on Toppenish Creek and the other was located and the other was installed 6 miles upstream of the confluence on Simcoe Creek. These systems will be used to determine the proportion of adult steelhead migrating into the mainstem Toppenish watershed and the Simcoe Creek watershed.

We installed one PIT tag antenna system at the mouth of Ahtanum Creek as well to determine the number of adult steelhead entering that stream. In Ahtanum Creek, Juveniles PIT tagged at the rotary screw trap located upstream and hatchery produced coho that are tagged and released upstream are also expected to be interrogated at this site.

All systems utilize to pass-by antenna arrays that span the stream channel during most flows. They use IS1001 data loggers that are powered with thermo-electric generators.

Water temperature monitoring

Protocol Title: YRWP continuous temperature monitoring (1996-035-01) v1.0

Protocol Link: http://www.monitoringmethods.org/Protocol/Details/695

Protocol Summary:

High summer water temperature limits steelhead production in many reaches of the lower Yakima River tributaries (Toppenish, Satus, and Ahtanum)

We deployed data-loggers in the Ahtanum, Toppenish, and Satus watersheds to monitor water temperatures continuously during the warmer seasons when water temperatures can be a limiting factor for salmonid survival and growth. The Yakama Reservation Watersheds Project utilize this data to identify reaches where restoration projects would be most beneficial to salmonid populations and also to aid in management decisions that may affect water temperatures (i.e. management of irrigation diversions, riparian harvest, water withdrawals, etc.).

We deployed a total of forty nine devices in the three watersheds. Data-loggers (Onset Optic Stowaways and Onset Water Temp Pro v2) were launched in spring of 2015 and were programmed to collect water temperatures at 1 hour intervals. The units were encased in protective cages and secured to trees and roots using nylon coated aircraft cable. They were generally placed in pool tailouts that were less likely to dewater during the summer. Although some data-loggers were deployed beginning in April 2015, we only used data during the period between April 15th and October 15th to calculate descriptive statistics to evaluate in-stream conditions for salmonids. Several data-loggers were left in place year round to monitor water temperatures during the peak migration and spawning periods for steelhead (i.e. winter and spring).

4. Results

a. Fish Population Status Monitoring (RM&E)

Adult abundance and distribution

The results discussed in this report are best viewed in the context of the overall steelhead abundance trends for the Yakima River basin. 5212 adult steelhead were enumerated at the Prosser Dam facility between July 1, 2014 and June 30, 2015. Lower than the peak Prosser Dam count of 2010 (6793); however, still above the 10-year average (http://ykfp.org/).

Satus Creek

206 Steelhead redds were identified during three passes on Satus Creek between March and June of 2015. The largest number of redds were identified in the main stem Satus (n=98) followed by Dry Creek (n=66) then Logy Creek (n=39) (Figure 5). Also, redds were identified in some of the smaller tributaries of Satus Creek and numbers ranged from zero in Shinando Creek and Mule Dry Creek to 2 in Kusshi Creek. More redds (n=32) were identified in the upper portion of Satus Creek where a fire burned in late summer 2013 this year following a low redd count (n=10) in this area in 2014.

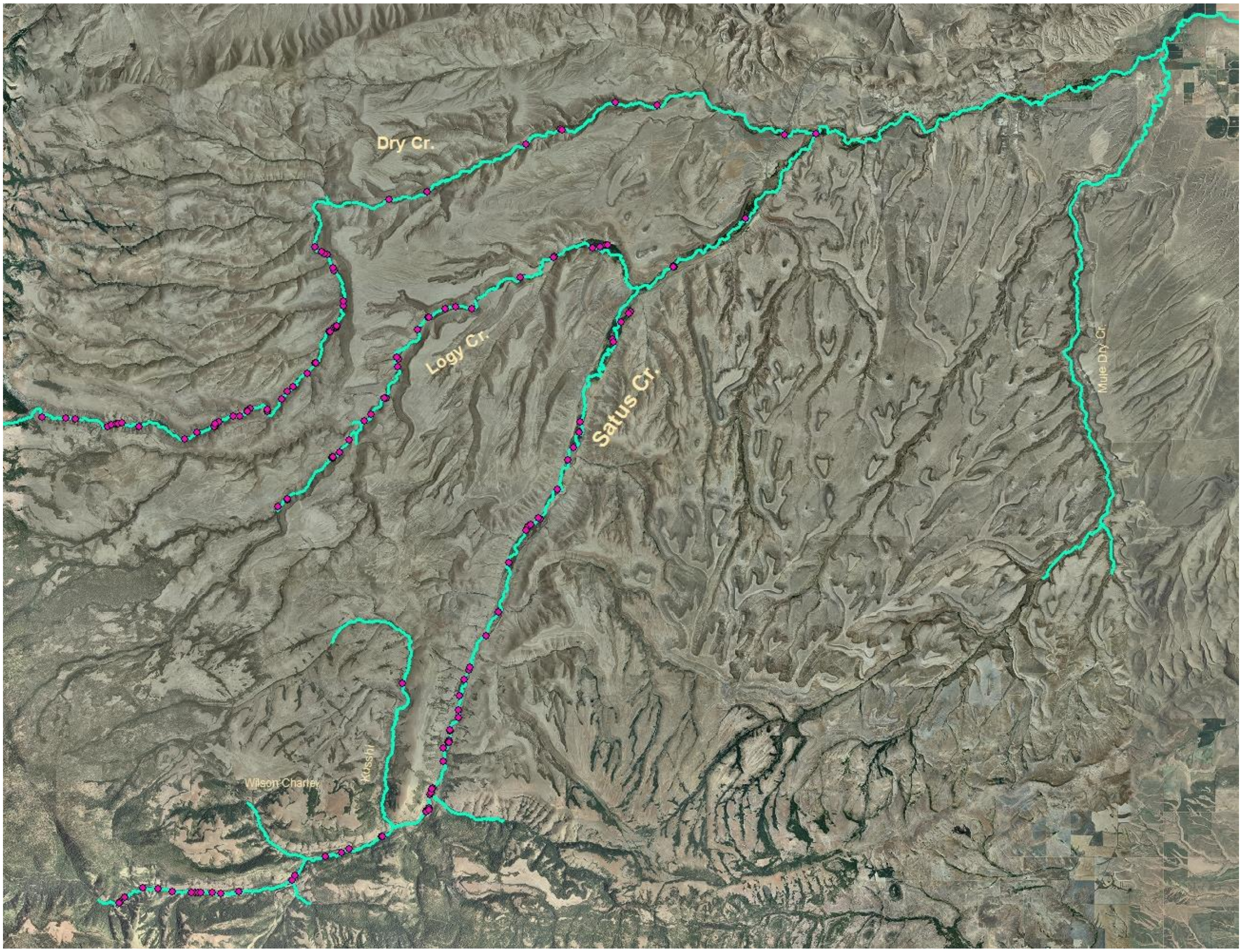

Figure 5. Locations of steelhead redds in the Satus Creek watershed 2015.

Toppenish Creek

For the 2015 spawning season lasting from March 2015 through June 2015 a total of 112 steelhead redds were identified in the Toppenish Creek watershed during a season when conditions for counting redds was good due to low flows. Only two passes of the upper 3 reaches of Toppenish Creek could be due to low staffing and few volunteers.

27 percent of these redds were found in the Simcoe Creek watershed the largest tributary and the remaining 73 percent were found in the main stem and smaller tributaries such as the North Fork Toppenish Creek and Willy Dick Creek. Typically, One third of the steelhead redds in the Toppenish Watershed are found in the Simcoe Creek sub-watershed (Figure 6).

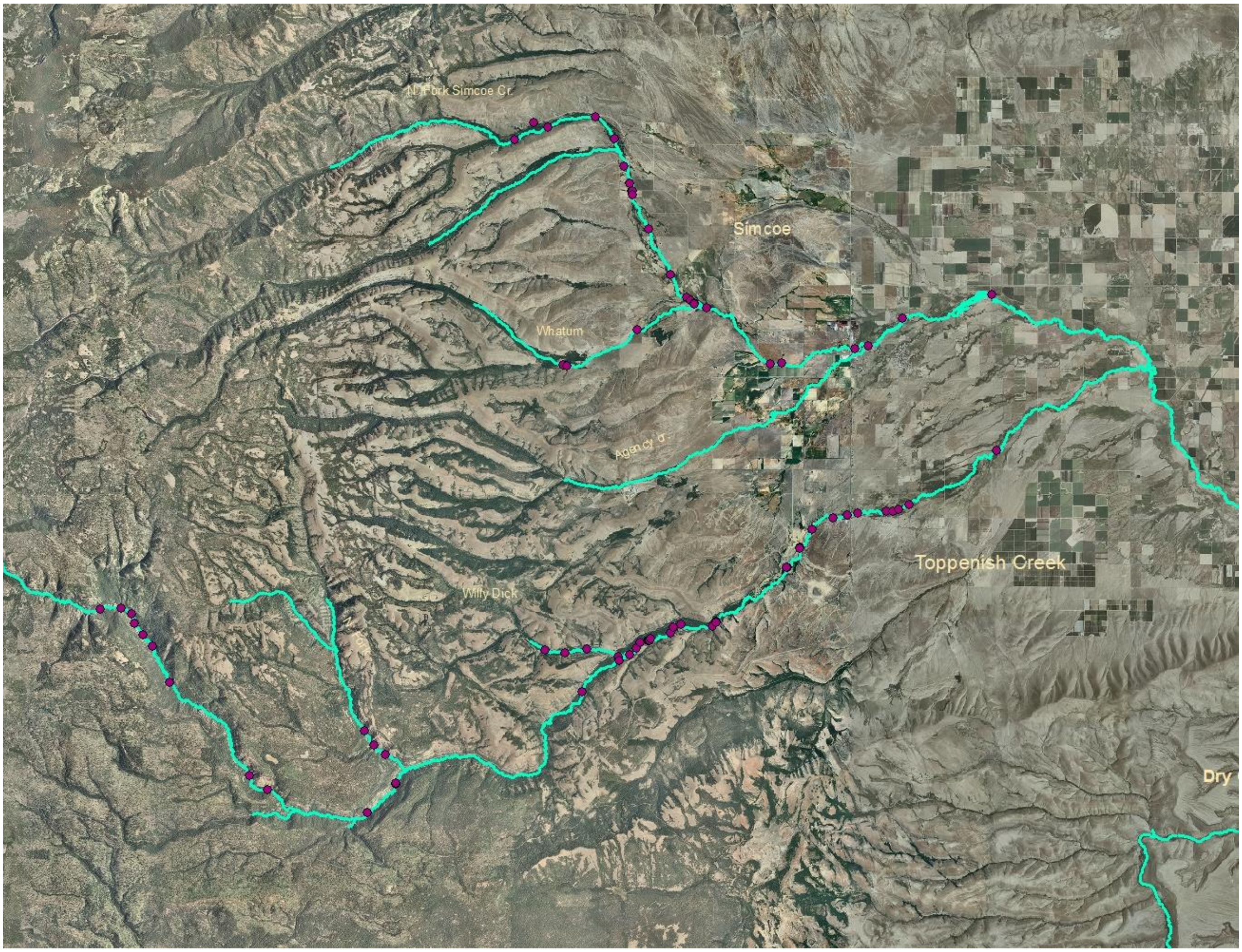

Figure 6. The Location of steelhead redds in the Toppenish Creek watershed in 2015.

Ahtanum Creek

In 2015, no steelhead redd counts could be completed due to the unavailability of staff during a short period in early April when redd counts were possible.

Bull trout were surveyed in late summer and autumn 2015 in the South Fork Ahtanum watershed which forms the northern boundary of the Yakama Reservation. During our 2015 bull trout surveys, we completed individual passes on Sept-10, Sept-17, and Oct- 8. No Redds or bull trout were observed in 2015

Redd Count Expansion

The cumulative redd count was multiplied by 2.5 fish per redd for an estimate of spawning escapement of 515 adult steelhead for the Satus watershed and 280 for the Toppenish watershed for the 2015 season. The 2.5 fish per redd expansion used for our estimate is similar to those obtained through studies of other Middle-Columbia steelhead populations in Oregon ranging from 2.1 to 2.6 fish per redd (Poxon et. al 2011). Better methods of enumerating adult steelhead utilizing PIT tagged adults and antenna arrays are currently under development.

Juvenile Out-migration

Satus Creek

The Satus Creek screw trap is located within 1 mile from the mouth of the stream and is located in a position to intercept fish from all the spawning and rearing habitat.

Although the trap was deployed on October 22, 2014 for the 2015 migratory season, we did not catch the first steelhead juvenile until November 10. The peak catch occurred at the end of February when 54 steelhead juveniles were captured although another spike in outmigration occurred in April and May (Figure 7). A total of 91 steelhead juveniles were captured in the screw trap between November, 2014 and June 2015. Of these juveniles, we PIT tagged 89 and released most of them as part of a mark-recapture study to obtain an outmigrant abundance estimate. Two of these released fish were recaptured over the season producing an average (pooled) trap efficiency of 2.27%. The average length (120 mm) was similar to other years.

In addition to steelhead juveniles, we captured 2 lamprey in the Satus Creek trap.

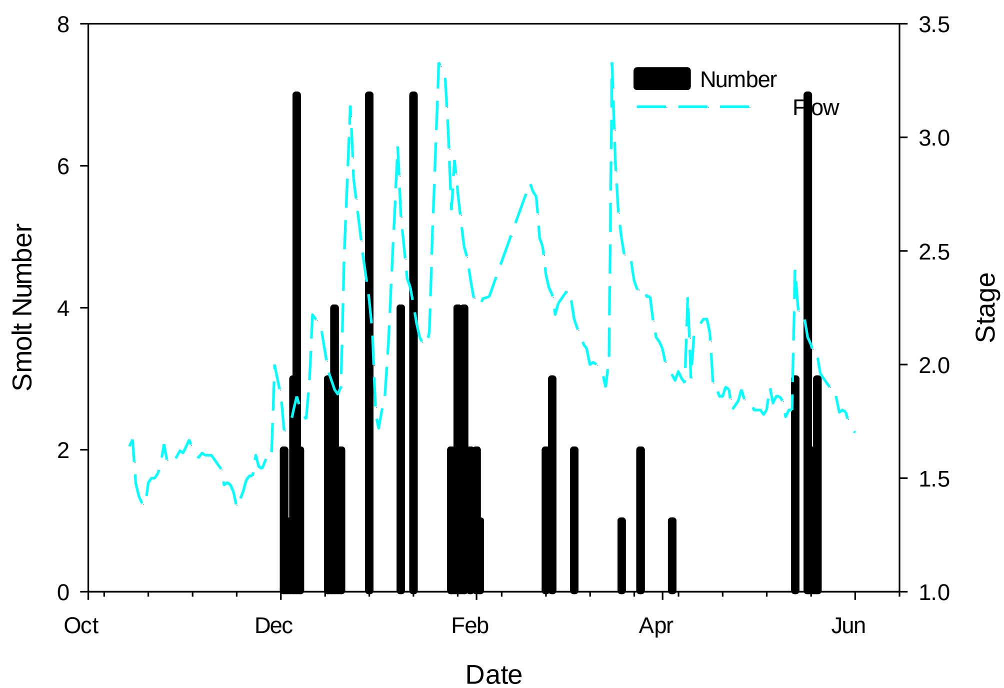

Figure 7. Number of steelhead juveniles captured per day compared with steam stage at the Satus Creek screw trap in 2014 and 2015.

Upper Toppenish Creek Screw Trap

We operated a rotary screw trap on Toppenish creek from October 2014 through June 2015, a period which encompasses most of the outmigration period. We captured a total of 3989 steelhead parr/smolts and PIT tagged 3269. The daily catch of steelhead juveniles peaked in early December (Figure 8) as typically observed. Most of the PIT tagged steelhead juveniles were released several hundred meters above the screw trap as part of a mark- recapture study. An estimate of 34,142 SE 3267 juvenile steelhead outmigrants was obtained for the 2015 season using this method. The mean length for all measured outmigrants was just over 134 mm (fork length) with a frequency distribution similar to previous years with the majority (81%) of captured steelhead falling in the range between 100 and 200 mm. We also captured 2 chinook juveniles and 38 lamprey juveniles at this site during the season. The number of lamprey caught increased from only 3 captured last year.

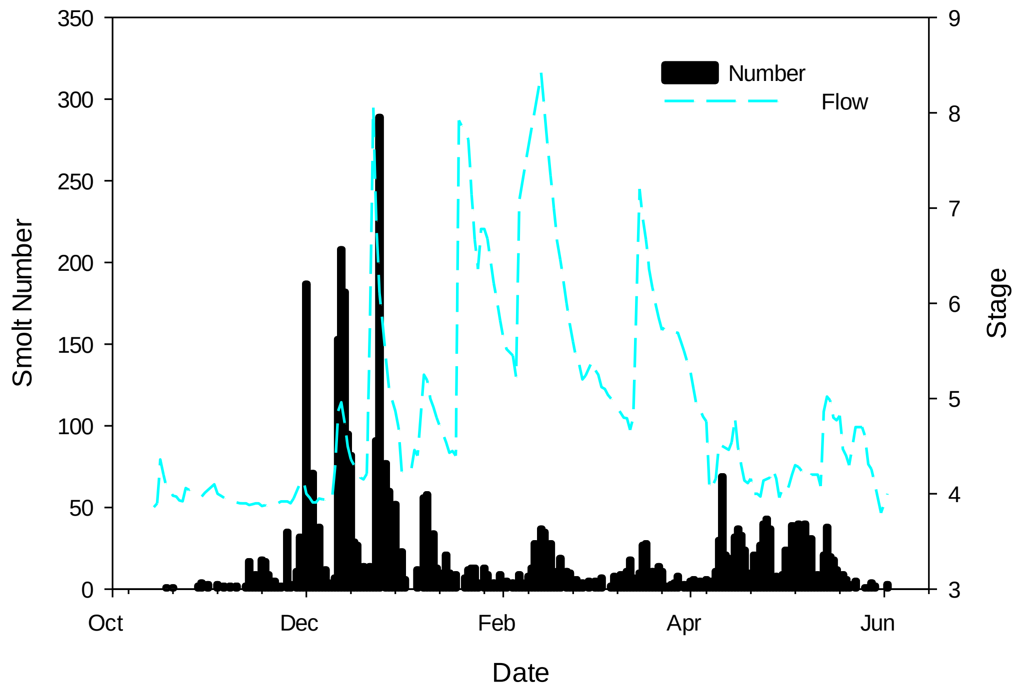

Figure 8. Steelhead juvenile outmigration timing. Daily catch at the Upper Toppenish Creek trap compared with stream stage for the 2015 season.

<u>Lower Toppenish Creek Screw Trap</u>

We operated a second rotary screw trap near the mouth of Toppenish Creek at a location that has been in use since 2011. This trap was deployed in mid-October 2014 and retrieved in June 2015. We captured 56 steelhead juveniles and 172 chinook juveniles. No coho salmon or lamprey were captured in this trap. Unlike the screw trap located upstream at river mile 30 on Toppenish Creek where outmigration typically peaks in late fall or early winter, most juvenile steelhead were captured at the lower screw trap during the spring. This pattern, similar to previous years, indicates that significant overwintering in the lower reaches of Toppenish Creek between the traps (Figure 9).

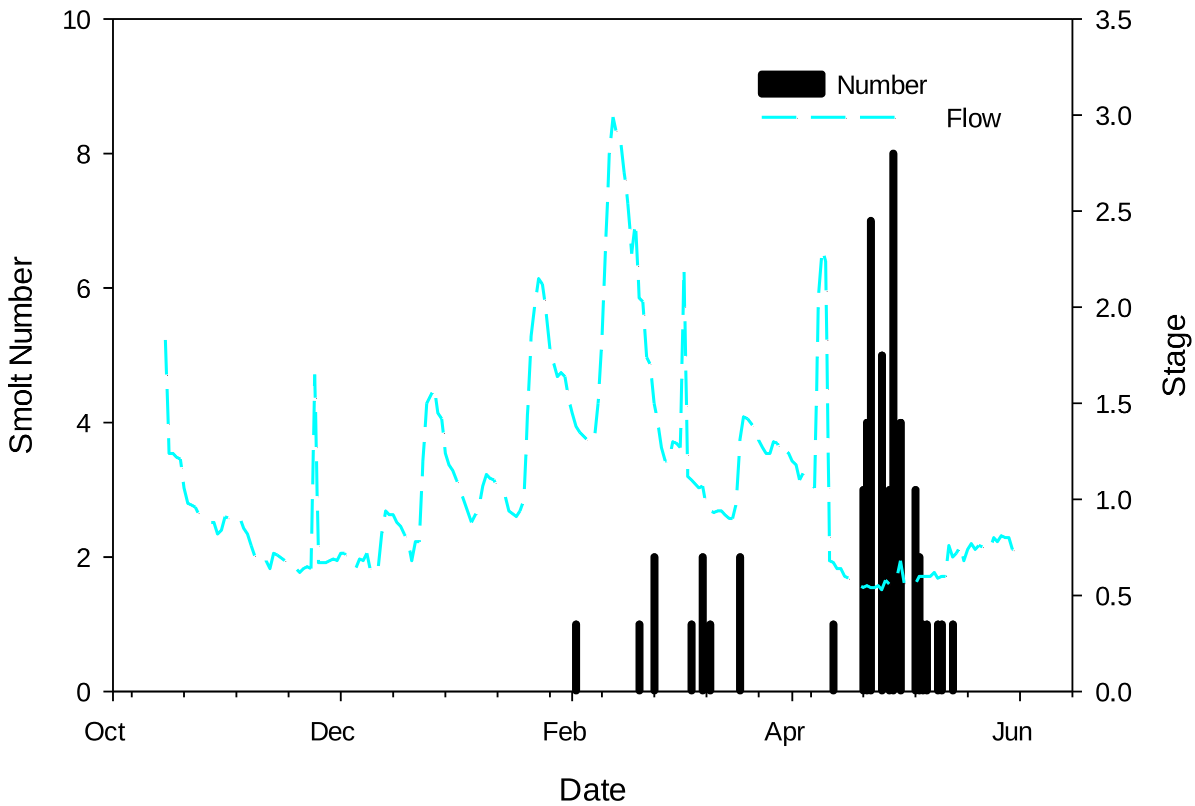

Figure 9. Steelhead juvenile outmigration timing. Daily catch at the Lower Toppenish Creek trap compared with stream stage for the 2015 season.

Ahtanum Creek

In 2015, we captured 80 juvenile *O.mykis*s in between the months of November and June and tagged 72. Sample size is too low to obtain an estimate or draw many conclusions from these data. Peak catches typically occur during the late spring like in 2015 (Figure 10). In addition to *O.mykis*s, we captured 3 chinook, 5 coho, and 2 lamprey juveniles in the Ahtanum Creek screw trap.

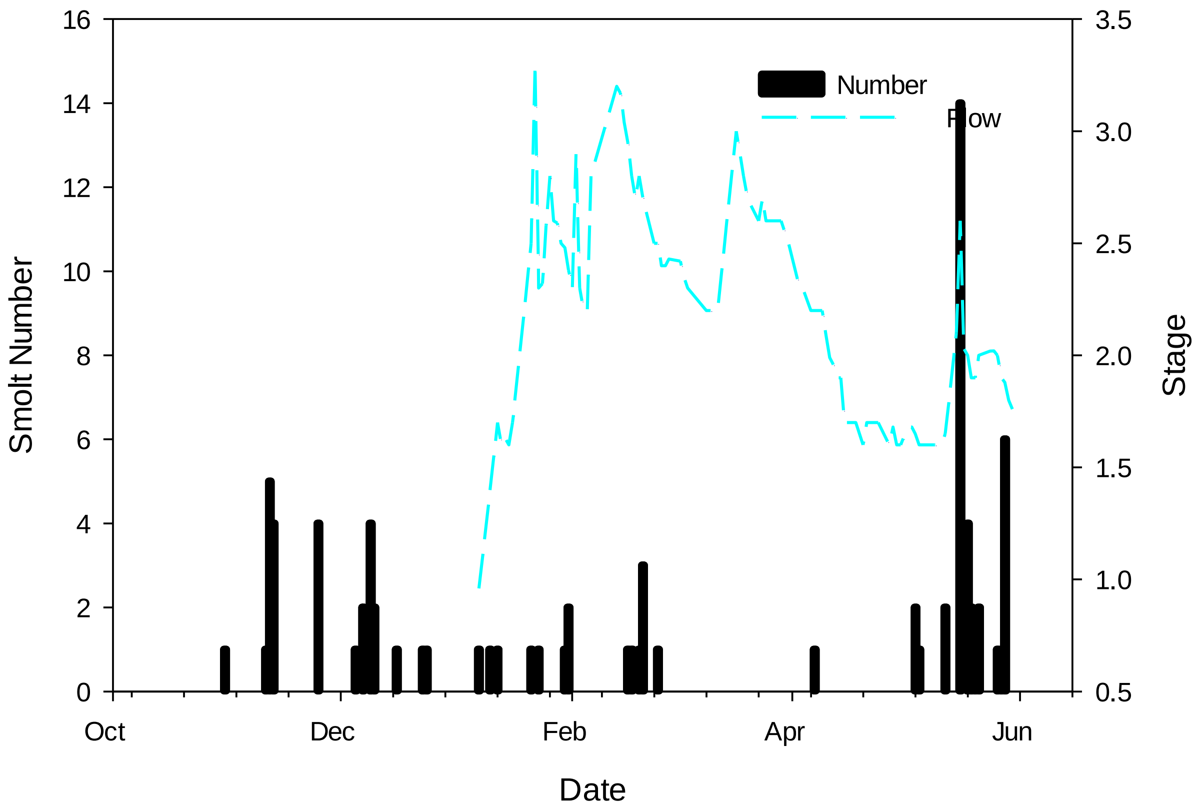

Figure 10. Steelhead juvenile outmigration timing. Daily catch at the Ahtanum Creek trap compared with stream stage for the 2015 season.

<u>PIT tag Interrogation Systems</u>

The upper Toppenish Creek system was installed and activated first on December 01, 2014. It operated for about 3 weeks before the Can Bus cables were chewed through by a resident beaver. There were no detections at this site and we were unable to replace the cables for the 2015 season.

The site on Simcoe Creek operated from February 2015 through June 2015 when it was shut down for the summer due to fire danger. Eighteen adult steelhead were detected at this site.

The site at Ahtanum was also established in December 2014 and operated through June 2015 when it shut down due to fire danger. We missed a period in May when a bad connection from the generator to the propane tank resulted in the propane leaking out the tank. Power to the antenna system was disrupted and it shut down for a week. We detected 57 adult steelhead at this site.

b. Tributary Habitat RM&E

Water Temperature Monitoring

Satus Creek

Mean daily averages in the main stem Satus Creek ranged from 11.0ºC downstream from the falls to 17.6 ºC below Dry Creek (Table 1) in 2015. The greatest instantaneous maximum recorded for the Satus Creek watershed was 28.9ºC below the Dry Creek Confluence (RM 18.7) and the highest maximum 7-day maximum water temperature (28.4ºC) was also recorded at this location. This was the 2 degrees higher than in 2014. (Table 1).

Table 1. Descriptive statistics for water temperature for 2015 for the period between April 15th and October 15th at 14 locations in the Satus Creek watershed. Maximum weekly average temperature are in bold text.

Location (river mile in parenthesis)	Instantaneous Maximum (°C)	Instantaneous Minimum (°C)	Mean Daily Maximum (°C)	Mean Daily Average (°C)	Mean Daily Minimum (°C)	Maximum Daily Average (°C)	**Maximum 7-Day Maximum** (°C)	Maximum 7-Day Average (°C)
Falls (44)	19.3	2.1	12.9	11.0	9.3	16.4	**18.9**	16
Satus at Wilson Charley (39.5)	25.2	2.8	17.4	14.0	11.6	20.4	**24.7**	20.2
Satus below Kusshi	26.2	4.0	18.2	15.0	12.3	21.9	**25.7**	21.6
4th Crossing (34.1)	25.3	3.6	18.2	15.9	13.8	22.6	**24.9**	22.3
High Bridge (32.4)	27.2	4.1	19.3	16.6	14.3	23.3	**26.6**	23.0
Above Logy Creek (23.6)	26.8	6.3	21.1	17.3	13.9	23.2	**26.4**	23.0
Below Dry Creek (18.7)	28.9	6.7	20.2	17.6	15.2	24.6	**28.4**	24.4
Logy at Falls(12.5)	19.5	2.9	13.9	12.2	10.2	17.7	**19.1**	17.3
Logy at Fourth Crossing (8.8)	22.1	3.8	15.4	13.6	12.0	19.9	**21.8**	19.5
Logy Mouth (0.5)	25.7	5.1	18.1	16.3	14.3	23.5	**25.2**	23.0
Dry Creek at Falls (25.7)	16.3	3.4	12.3	10.2	8.1	14.1	**15.9**	13.5
Dry Creek at Elbow Crossing (18.5)	20.8	5.4	16.1	14.4	13.1	18.6	**20.6**	18.3
Section corner source (4.6)	9.0	7.1	8.5	7.9	7.6	8.2	**9.0**	8.2
Section corner lower ford (2)	14.9	4.1	12.0	9.8	7.8	12.1	**11.9**	5.1

Toppenish Creek

In 2015, mean daily average temperatures in the mainstem Toppenish Creek ranged from 8.0ºC on Panther Creek in the head waters of Toppenish Creek (RM 65.7) to 20.6ºC above the Snake Creek inlet. The highest instantaneous maximum of 30.5ºC as well as the highest MWMT (30.2ºC) occurred at the Snake Creek inlet. By most standards the summer water temperature in 2015 in the lower portion of Toppenish Creek (below the Unit 2 diversion) was higher than most salmonids can tolerate (Table 2). In Simcoe Creek, the highest instantaneous maximum water temperature occurred higher up in the watershed at Simcoe Creek road; however, this unit was placed in a shallow area outside of the main current of the stream which likely affected the measurements during the low flows of August.

Table 2. Descriptive statistics for water temperatures at 16 locations in the Toppenish Creek watershed for 2015 during the period from April 15th to October 15th. Maximum Weekly Maximum Temperature in bold text.

Location (river mile in parenthesis)	Instantaneous Maximum	Instantaneous Minimum	Mean Daily Maximum	Mean Daily Average	Mean Daily Minimum	Maximum Daily Average	Maximum 7-Day Maximum	Maximum 7-Day Average
Panther Creek	15.1	0.7	9.9	8.0	6.2	13.3	**14.7**	12.8
Topp. at N. Fork confluence (55.9)	20.5	4.7	14.8	12.6	10.9	17.4	**20.2**	17.1
1 mile below swim hole (45.9)	24.2	5.6	17.4	15.3	13.6	21.2	**23.8**	21.0
1 mile above lateral (45.1)	23.3	5.4	17.0	15.5	14.1	21.2	**23.0**	21.1
Topp. above lateral (44.2)	23.3	5.5	17.1	15.5	14.2	21.3	**23.1**	21.1
At three way (43.1)	24.1	5.8	17.8	16.0	14.4	21.7	**23.8**	21.4
Topp. At Cleparty Diversion (36.1)	25.6	5.8	18.7	16.3	14.3	22.2	**25.3**	22.0
Topp. At Shaker Church Rd. (36.1)	24.9	6.7	18.9	16.5	14.3	21.7	**24.4**	21.3
Topp. at Unit 2 (26.5)	26.0	9.3	19.5	18.6	17.6	15.2	**25.8**	25.0
Topp at Zimmerman's	29.9	8.4	21.4	19.7	18.1	27.4	**29.6**	27.2
Topp at Snake Cr	30.5	9.5	21.9	20.6	19.4	29.3	**30.2**	28.9
Topp below HWY97	26.0	9.7	19.5	18.3	17.2	24.5	**25.7**	24.3
Simcoe below Forks (18.9)	20.8	3.5	14.9	13.6	12.2	19.4	**20.4**	19.1

Simcoe at Simcoe Cr. Rd. (15.3)	27.5	4.2	19.4	15.6	12.6	22.9	**26.9**	22.3
Simcoe below Stephensen Rd. (8.1)	23.7	7.2	18.5	16.2	14.2	22.1	**23.0**	20.8
Simcoe below Barkes Rd (2.7)	20.5	4.7	14.8	12.6	10.9	17.4	**20.2**	17.1

Ahtanum Creek

Mean daily averages ranged from 13.2 C in the South Fork of Ahtanum Creek one mile above the confluences to 17.8ºC at LaSalle High School about 2 miles upstream from the mouth of Ahtanum Creek (Table 3). The highest instantaneous maximum of 27.5 C was also recorded at the AID diversion location at River Mile 18.9. The highest maximum 7-day maximum was recorded at this location as well. Further downstream at the LaSalle site at River mile 2, the instantaneous maximum and the 7-day maximum were only slightly lower and could have resulted from differences at the immediate site such as shading, depth, etc. The location at the mouth of ahtanum Creek recorded lower water temperatures.

Table 3. . Descriptive statistics for water temperatures at 5 locations in the Ahtanum Creek watershed for 2015. Maximum Weekly Maximum Temperature in bold text.

Location (river mile in parenthesis)	Instantaneous Maximum (C)	Instantaneous Minimum (C)	Mean Daily Maximum (C)	Mean Daily Average (C)	Mean Daily Minimum (C)	Maximum Daily Average(C)	**Maximum 7-Day Maximum (C)**	Maximum 7-Day Average (C)
South Fork Ahtanum at Mouth(1.0)	20.5	2.2	14.6	13.2	11.9	18.9	**20.0**	18.6
AID Diversion (18.9)	27.5	3.0	19.2	15.5	12.2	22.8	**26.8**	22.3
At American fruit rd.	27.4	4.9	19.0	16.1	13.4	22.8	**26.8**	22.6
At LaSalle HS	27.2	7.3	18.8	17.8	17.0	25.4	**26.4**	25.1
At USGS Gauge (0.5)	25.7	7.9	19.1	17.4	15.7	23.6	**25.5**	23.3

5. Synthesis of Findings: Discussion/Conclusions

a. Fish Population Status Monitoring (RM&E)

Information on Adult Steelhead Abundance and Juvenile out-migrant abundance is valuable in evaluating restoration efforts, managing natural resources (fish, water, etc.) and in determining if recovery goals for this species are being met.

As adult steelhead spawner abundance has increased through the Yakima River basin over the last 20 years (Figure 11), abundance has likely increased in Satus (Figure 12), Toppenish (Figure 13) and Ahtanum Creeks, although this trend is less clear in the redd count record for reasons explained below.

In 2012, Redd count surveys were obstructed by substantial flooding, probably causing a substantial underestimation of spawning activity. Although conditions improved in 2013 and 2014, and were relatively good in 2015 due to low spring flows; we have concluded that redd counts are not the best method to monitor adult steelhead spawner abundance because of the variability between years of conditions for detecting redds (i.e. drought vs. flood years). We do however intend to continue redd count surveys because they provide useful information on spawning distribution and they provide an opportunity for reconnaissance of critical steelhead spawning and rearing habitat. Spatial information (GPS coordinates) collected during redd count surveys using the same protocol over multiple years have been used to identify reaches where spawning habitat should be protected or restored. Alternative methods to using PIT tagged adult steelhead and instream antenna arrays to determine spawner abundance and fish per redd are under development with PIT tag antenna arrays that were installed in 2011 and 2014 in the Satus, Toppenish and Ahtanum watersheds.

A slight increase in steelhead juvenile outmigrant abundance seems to have occurred over the last 10 years (Figure 14).

Our screw trap in the upper Toppenish Creek and the method of operation that we have employed for the last four years appears to provide relatively precise estimates (CV, coefficient of variation ranging from 6.78% to 16.71%) for the number of steelhead migrating from the spawning and rearing areas. However, the other three screw traps do not produce adequate estimates of outmigrant abundance, although some useful information have been collected on timing, growth, and survival of smolts captured and PIT tagged at these traps. One change proposed for the future is to discontinue trapping at the lower Toppenish site and move that trap to Marion Drain to determine if this constructed tributary to Toppenish Creek is producing steelhead juveniles. An absence of captured smolts, as we expect, would support our efforts to isolate this drain (where adult steelhead are observed spawning each year) from Toppenish Creek.

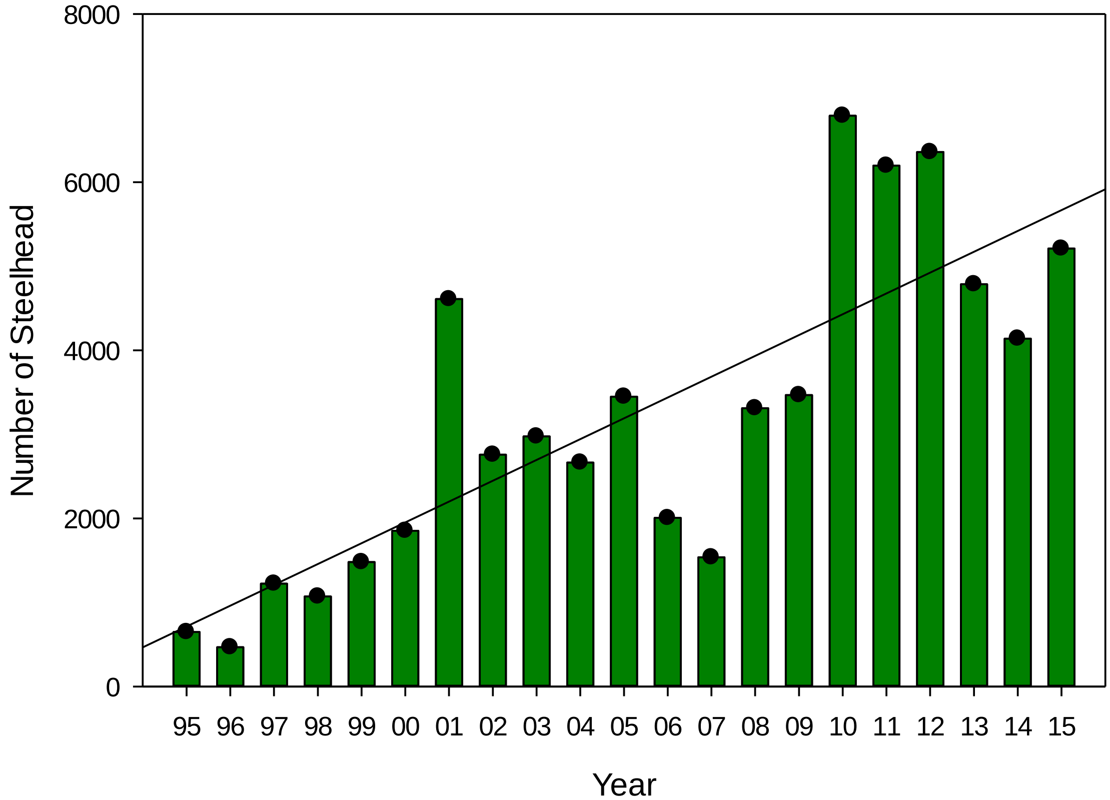

Figure 11. Number of adult steelhead detected passing over Prosser dam between the dates of July 1 and June 30 of the following year for 1995 through 2015 (http://ykfp.org/docsindex.htm).

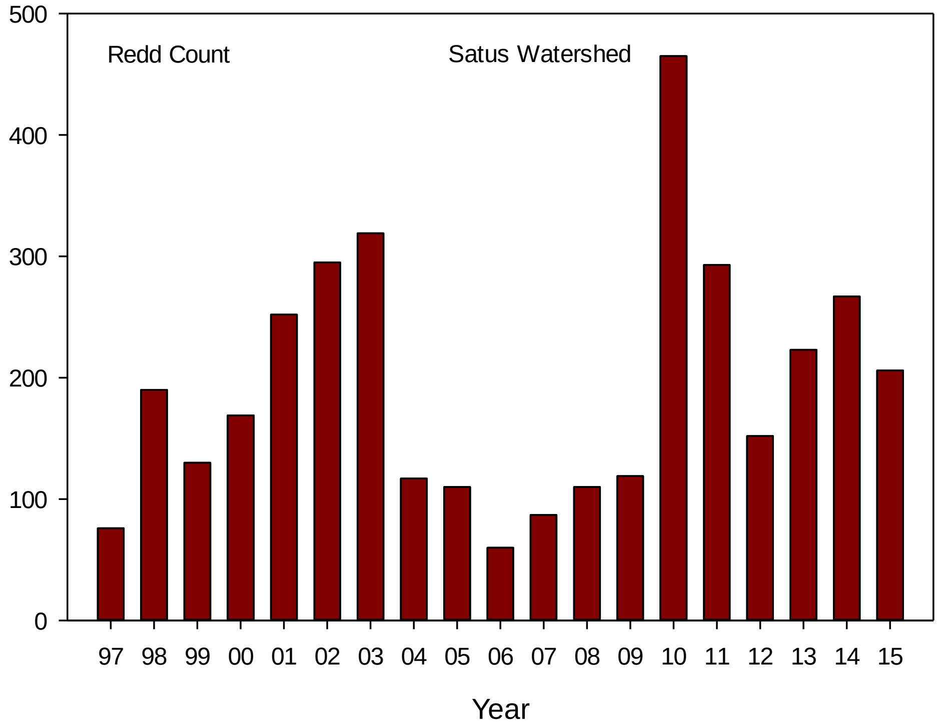

Figure 12. Number of steelhead redds in the Satus Creek watershed 1997 to 2015.

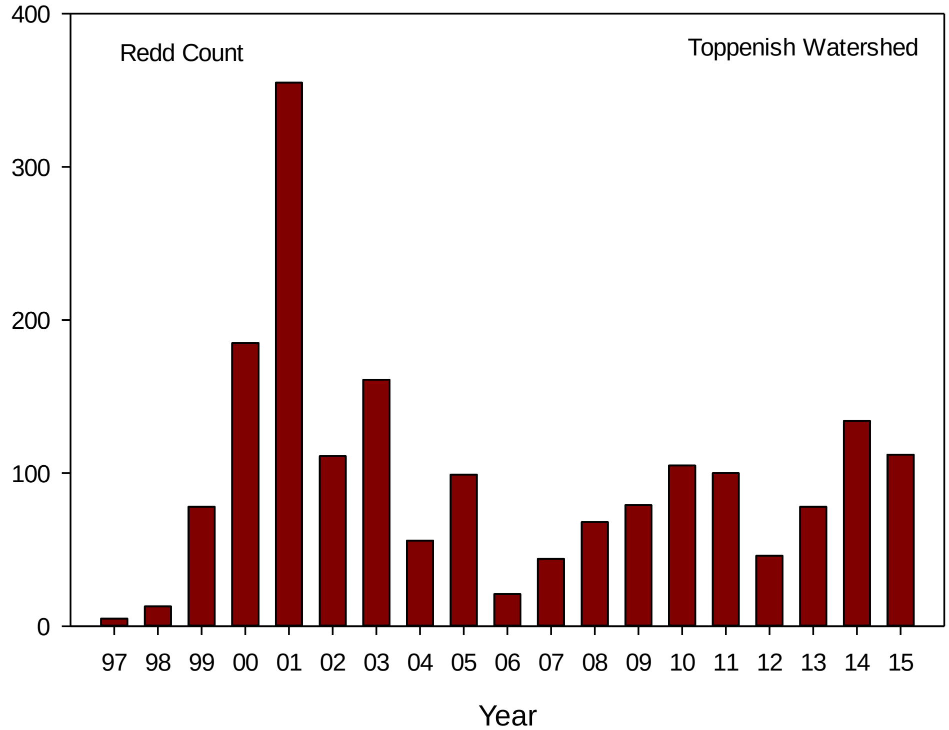

Figure 13. Number of steelhead redds per year in the Toppenish Creek watershed from 1997 to 2015.

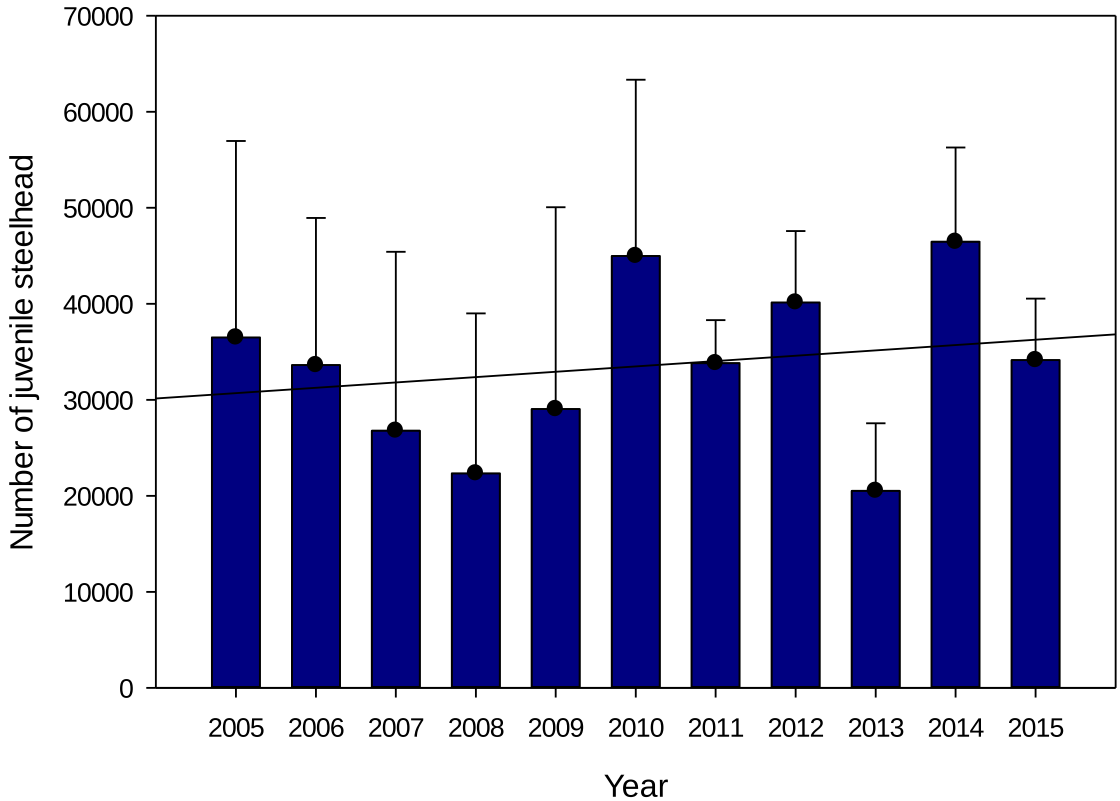

Figure 14. Estimated number of steelhead juveniles outmigrating from spawning and rearing habitat on Toppenish Creek. Error bars represent 95% CI

a. Tributary Habitat (RM&E)

With Maximum 7 day average water temperatures consistently above 23 degrees C, water temperature appears to be a limiting in the lower portions of Toppenish, Simcoe, Ahtanum and Satus Creeks.

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Appendix A: Use of Data & Products

Steelhead redd count, juvenile outmigrant abundance, and juvenile outmigrant survival data for Toppenish Creek are located at:

http://ykfp.org/docsindex.htm

Appendix B: Detailed Results

Table B-1. Number of steelhead trout redds per reach in the Satus Creek watershed in 2015. River miles are in parentheses.

Stream	Start location, RM	End location, RM	Distance (miles)	# of Redds
SATUS	Falls (44.1)	Wood Bridge (40.8)	4.2	**15**
(3 passes)	Wood Bridge (40.8)	County Line (36.4)	4.4	**17**
	County Line (36.4)	High Bridge (32.4)	4	**31**
	High Bridge (32.4)	Holwegner(28.4)	4.8	**18**
	Holwegner (28.4)	2nd X-ing (23.7)	3.9	**13**
	2nd X-ing (23.7)	1st Xing (20.2)	3.5	**4**
	1st X-ing (20.2)	Gage (17.4)	2.8	**0**
	Gage (17.4)	Rd 23 (13.1)	4.3	**0**
Total			**31.9**	**98**
LOGY	Falls (14)	Spring Cr (11)	3	**10**
(3 passes)	Spring Cr (11)	S. C. Ford (9.5)	1.5	**4**
	S. C. Ford (9.5)	3rd Xing (3.5)	6	**18**
	3rd Xing (3.5)	Mouth (0.0)	3.5	**7**
Total			**14**	**39**
DRY	South Fk. (27.8)	Saddle (24)	3.6	**12**
(3 passes)	Saddle (24)	Elbow Xing (18.25)	5.75	**16**
	Elbow Xing (18.25)	Seattle Cr (14)	4.25	**16**
	Seattle Cr (14)	Rd 75 bend (8.75)	5.25	**2**
	Rd 75 bend (8.75)	Power Line Ford (2.5)	6.25	**5**
	Power Line Ford (2.5)	Mouth (0.0)	2.75	**3**
Total			**27.85**	**66**
W. CHARLEY	Forks (1.9)	Mouth (0.0)	**1.9**	**1**
KUSSHI	Top (11th) Xing (4.5)	Mouth (0.0)	**4.5**	**2**
SHINANDO	Ford (0.5)	Mouth (0.0)	**0.5**	**0**
MULE DRY	Yakima Chief Rd. (15.4)	Rd. 39 (4)	**11.4**	**0**

TOTAL	**92.05**	**206**

Table B2. Number of steelhead redds in the Toppenish Creek watershed in 2015.

	Upper Toppenish Creek watershed (River Miles at Confluence in Parentheses)		Distance miles	Number of Redds
Toppenish	O Connor Cr (65.7)	"East Bank" (61.1)	4.6	**14**
	"East Bank" (61.1)	NF confluence (55.4)	5.7	**9**
	North Fork (55.4)	Washout (50.9)	4.5	**9**
	Washout (50.9)	Willy Dick Cr (48.5)	2.5	**5**
	Willy Dick Cr (48.5)	Olney Lateral (44.2)	4.3	**17**
	Olney Lateral (44.2)	Pom Pom Rd. (38.9)	5.3	**15**
	Pom Pom Rd. (38.9)	Shaker Church Rd. (35.9)	3	**6**
Total			**29.9**	**78**
N. Fork Toppenish	NF Falls (4)	NF confluence (0)	**4**	**3**
Willy Dick	old logging site (4)	Confluence (0)	**4**	**4**
	Simcoe Creek Watershed			
Simcoe	NF at 2nd crossing (6.5)	Diamond Dick Cr (3.4)	3.1	**0**
	NF at Diamond Dick Cr (3.4)	NF/SF confluence (0)	3.4	**4**
	SF 6 mi above confluence (6.2)	SF 3 mi above confluence (3)	3.2	**0**
	SF 3 mi above confluence (3)	NF/SF confluence (0)	3	**0**
	NF/SF confluence (18.9)	Simcoe Creek Rd. (15.3)	3.6	**12**

	Simcoe Creek Rd. (15.3)	Wesley Rd. (10.1)	5.2	**7**
	Wesley Rd. (10.1)	N. White Swan Rd. (8.1)	2.0	**3**
	N. White Swan Rd. (8.1)	Stephenson Rd. (5.9)	2.2	**0**
Total			**25.7**	**27**
Agency	Falls (8.9)	Lateral Canal (4.4)	4.5	**0**
	Lateral Canal (4.4)	Confluence (0)	4.4	**0**
Total			**8.9**	**0**
Wahtum	Yesmowit Rd. (3.6)	Confluence (0)	**3.6**	**3**
Total			**76.1**	**112**

Table B3. Steelhead juvenile catch and mark-recapture data stratified weekly for the upper Toppenish creek screw trap for the MY 2015 season. Recaptures for each week are adjusted using PIT tag codes to exclude fish tagged in previous seasons and to assign fish to appropriate release group (e.g. fish in the trap recapture week *i* +1 column were recaptured the week following the week they were released above the trap)

Statistical Week (*i*.)	Dates	Number Captured (week *i*)	Number Released Upstream (week *i*)	Number Recaptured (week *i*)	Number Recaptured Week (week *i*+1)+
Week 1	10/13-10/19	1	1	0	0
Week 2	10/20-10/26	1	0	0	0
Week 3	10/27-11/02	9	6	0	0
Week 4	11/3-11/09	9	2	0	1
Week 5	11/10-11/16	39	16	2	0
Week 6	11/17-11/23	58	50	14	0
Week 7	11/24-11/30	87	36	0	1
Week 8	12/01-12/07	402	344	93	1
Week 9	12/08-12/14	652	129	35	0
Week 10	12/15-12/21	188	167	44	0

Week 11*	12/22-12/28	643	161	11	0
Week 12	12/29-01/04	98	86	15	0
Week 13	01/05-01/11	215	121	10	0
Week 14	01/12-1/18	60	49	15	0
Week 15	01/19-1/25	49	43	2	0
Week 16	01/26-02/01	42	20	3	0
Week 17	02/02-02/08	27	21	1	0
Week 18	02/09-02/15	166	106	2	0
Week 19	02/16-02/22	81	50	2	0
Week 20	02/23-03/01	20	15	0	0
Week 21	03/02-03/08	26	16	0	0
Week 22	03/09-03/15	64	53	9	0
Week 23	03/16-03/22	111	74	0	0
Week 24	03/23-03/29	29	28	2	0
Week 25	03/30-04/05	27	19	2	0
Week 26	04/06-04/12	147	51	12	0
Week 27	04/13-04/19	172	136	11	1
Week 28	04/20-04/26	192	71	10	1
Week 29	04/27-5/03	112	29	5	0
Week 30	05/04-05/10	186	144	15	0
Week 31	05/11-05/17	126	105	11	4
Week 32	05/18-05/24	31	22	5	0
Week 33	05/25-05/31	8	1	1	0
Week 34	06/01-06/07	3	0	0	0
Total	**10/13-06/07**	**4081**	**2172**	**332**	**9**

*number captured during this week includes some dates when the trap was not operated and numbers were interpolated using an average of the catch 3 days before and after the period of inoperability. Two juvenile steelhead were recaptured more than 1 week after its release. One fish was tagged the previous year and was excluded.

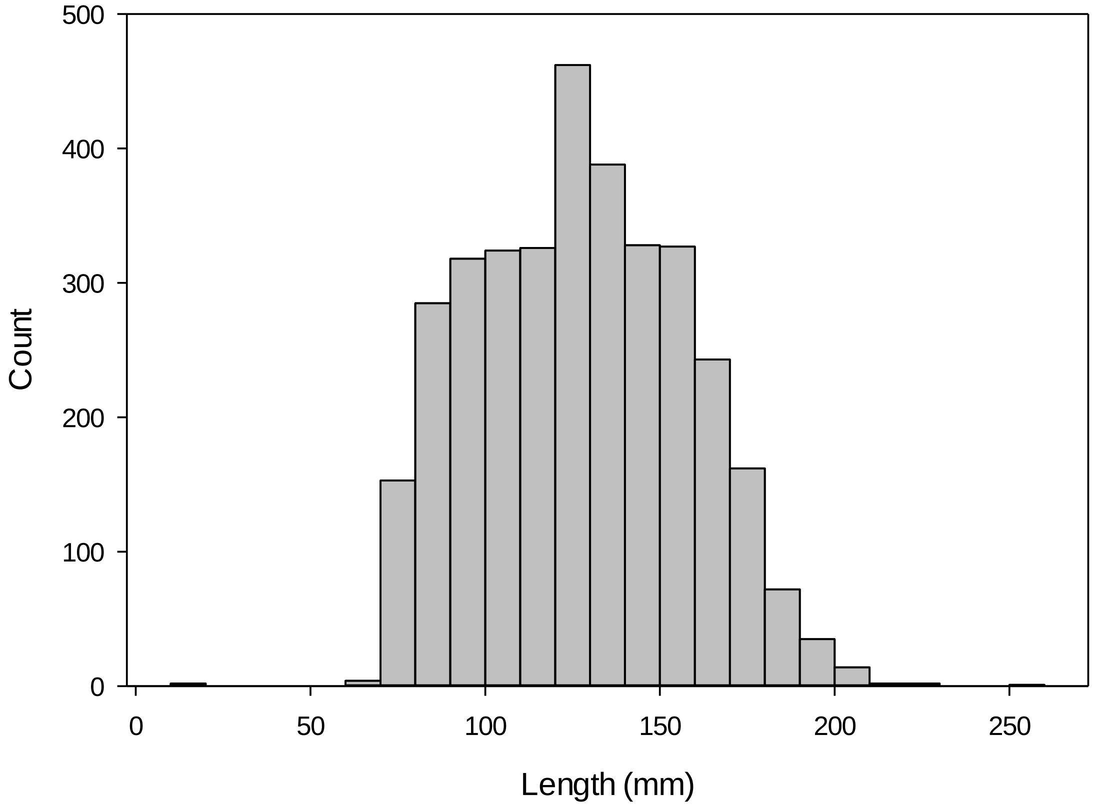

Figure B1. Length frequency distribution of steelhead juveniles captured in the upper Toppenish rotary screw trap between October 2014 and June 2015.

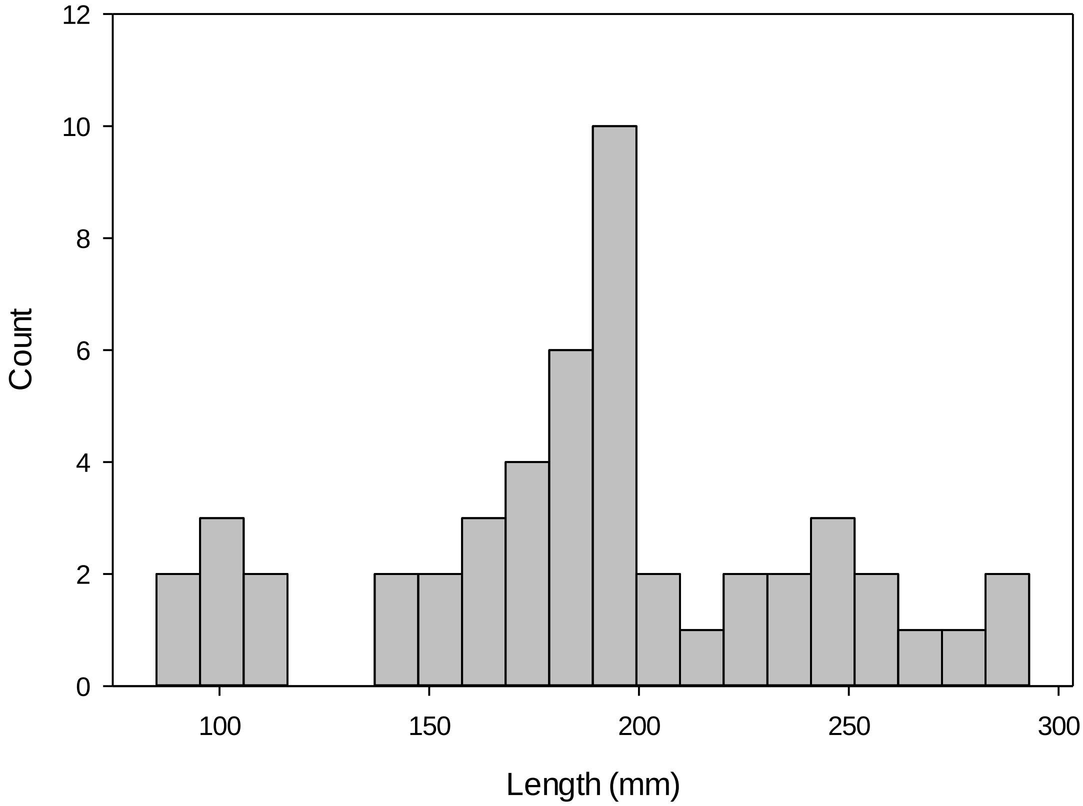

Figure B2. Length frequency distribution of steelhead juveniles captured in the lower Toppenish rotary screw trap between October 2014 and June 2015.

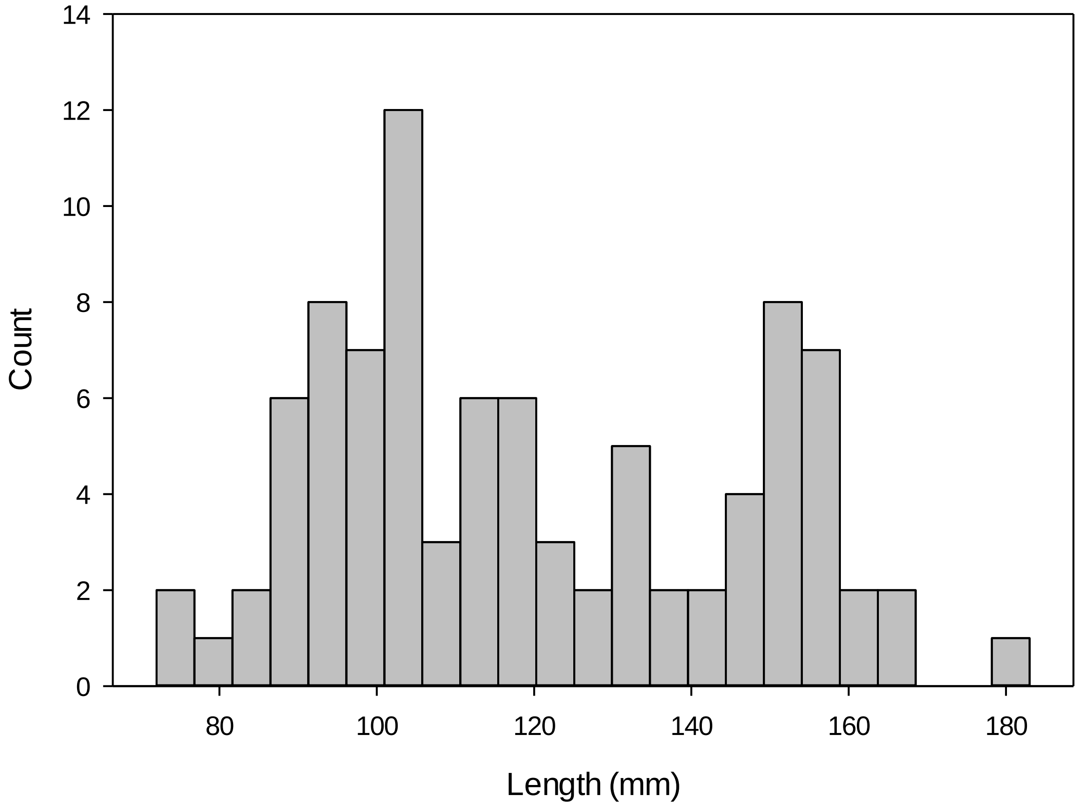

Figure B3. Length frequency distribution of steelhead juveniles captured in the Satus Creek rotary screw trap between October 1st 2014 and June 10th 2015.

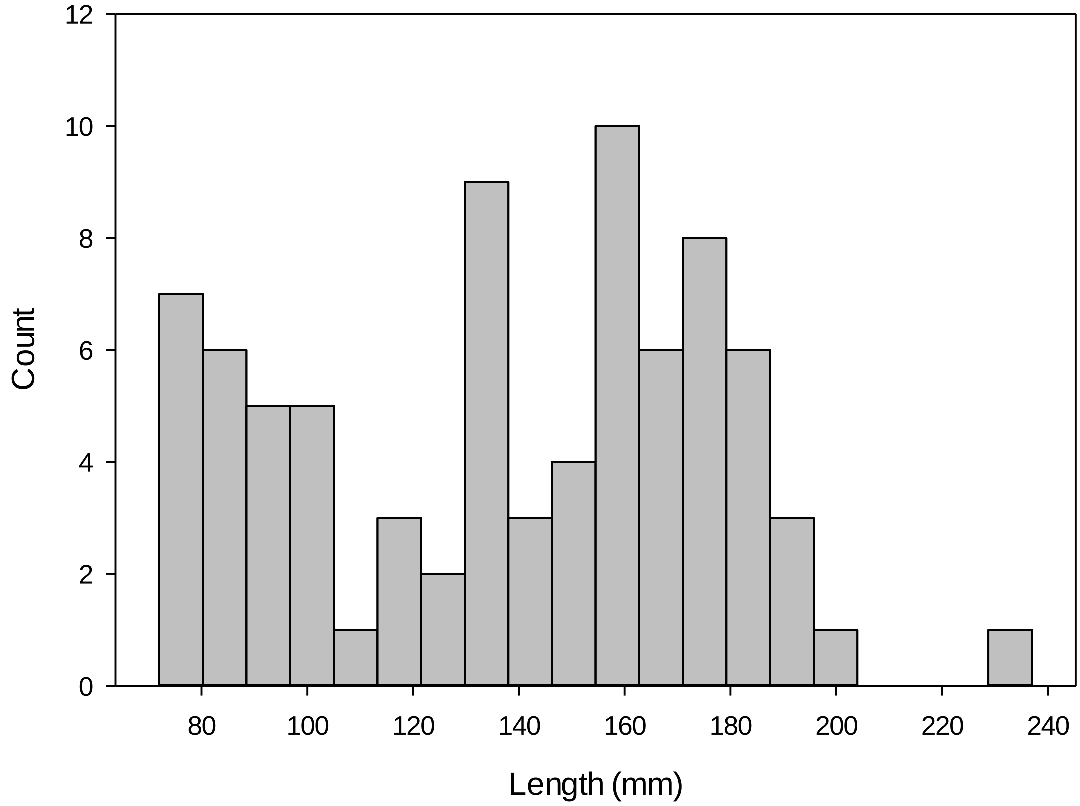

Figure B4. Length frequency distribution of steelhead juveniles captured in the Ahtanum Creek rotary screw trap between October 1st, 2014 and June 10th, 2015.

Appendix C: List of Metrics and Indicators

Category	Subcategory	Subcategory Focus 1	Subcategory Focus 2	Specific Metric Title
Fish	Abundance of Fish	Fish Life Stage: Adult - Outmigrant	Fish Origin: Natural	Estimate of juvenile steelhead outmigrant abundance
Fish	Abundance of Fish	Fish Life Stage: Juvenile - Migrant	Fish Origin: Natural	Rotary screw trap juvenile steelhead daily catch
Fish	Abundance of Fish	Fish Life Stage: Adult - Spawner	Fish Origin: Natural	Steelhead redd count (an index of adult spawner abundance)
Fish	Abundance of Fish	Fish Life Stage: Juvenile - Fry/Parr	Fish Origin: Natural	Steelhead parr density: Steelhead parr / 100m^2

Landscape Form & Geomorphology	Abundance of Habitat Types	Habitat Type: Channels		Stream habitat type composition
Landscape Form & Geomorphology	Abundance of Instream Wood Structures			Large Woody Debris
Landscape Form & Geomorphology	Cover	Habitat Type: Riparian Zone		Canopy Cover
Sediment/Substrate/Soils	Composition: Substrate/Soil-Dominant Size			Wolman Pebble Count
Water Quality	Water Temperature			Continuous water temperature
Water Quality	Water Temperature			Maximum Weekly Maximum Water Temperature
Hydrology/Water Quantity	Flow			Stream discharge
Hydrology/Water Quantity	Ground Water Level Change			Ground water lever