



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

2017

BPA Project # 1996-035-01

Report covers work performed under BPA contract #(s) 56662 REL 99, 56662 REL 113

Report was completed under BPA contract #(s) 56662 REL 127, 56662 REL139

1/1/2017 - 12/31/2017

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Report Created 3-2017

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

This report should be cited as follows: Resseguie, Tim. STEELHEAD (ONCORHYNCHUS MYKISS) POPULATION AND HABITAT MONITORING IN LOWER YAKIMA RIVER TRIBUTARIES, 1/1/2017- 12/31/2017 Annual Report, 1996-035-01

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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

In both Toppenish and Satus creek we observed the lowest number of steelhead redds on record (since 1997) with 23 redds recorded in the Satus Creek watershed and 6 redds recorded in the Toppenish Creek watershed. The steelhead adult count at Prosser dam was lower in autumn 2016 and spring 2017 partially accounting for this decrease. Higher spring runoff resulting from a heavy mid and lower elevation snowpack in Satus and Toppenish Creek also likely contributed. Spatial distribution of redds appeared to be typical in both Satus and Toppenish Creeks.

The estimated number (N = 10,464 SE 2133) of juvenile outmigrants from Toppenish Creek (Toppenish Creek screw trap) was the lowest since 2005 when this record began and well below the 10 year average (30,099; Figure 9). In Satus Creek, 43 steelhead smolts were captured in the rotary screw trap and no estimate was calculated for this site due to low recapture numbers.

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 mile 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 (Figure 1). 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.

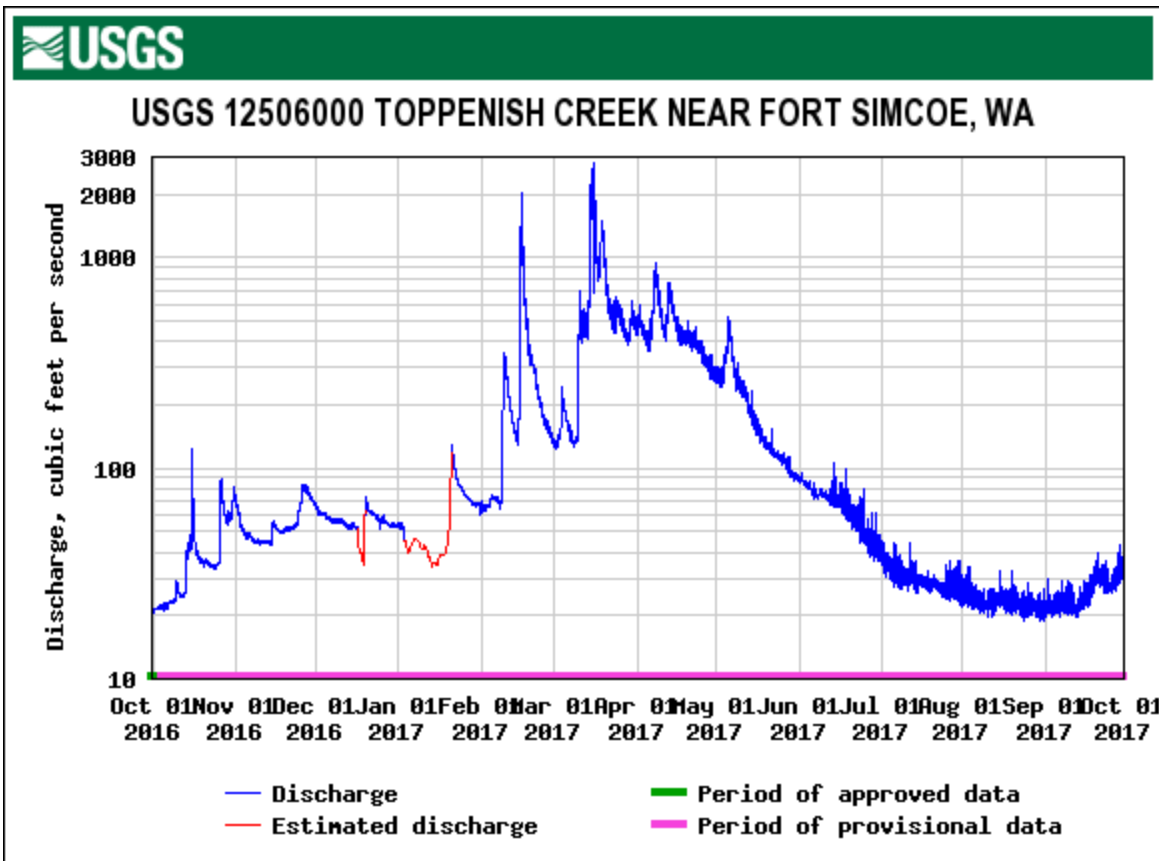


Figure 1. Hydrograph on Toppenish Creek at river mile 40 for Water Year 2017.

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 mi², 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 this 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.

USGS 12502500 AHTANUM CREEK AT UNION GAP, WA

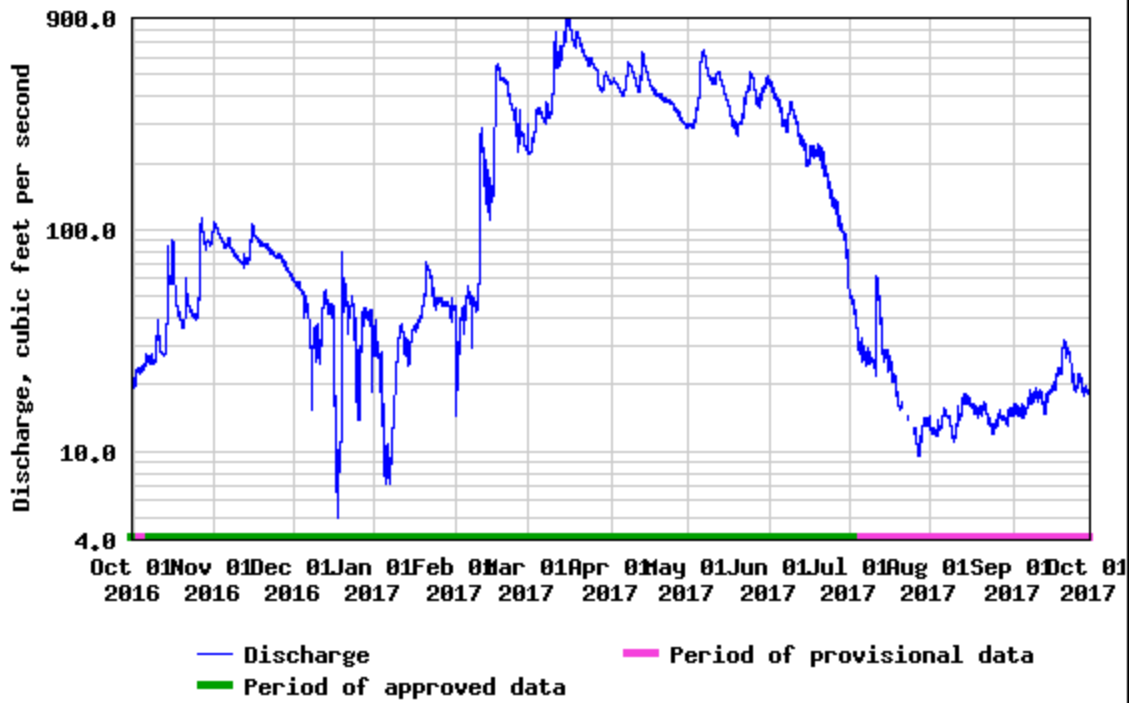


Figure 2. Hydrograph on Ahtanum Creek near the mouth for Water Year 2017.

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 thalweg 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 2017 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.

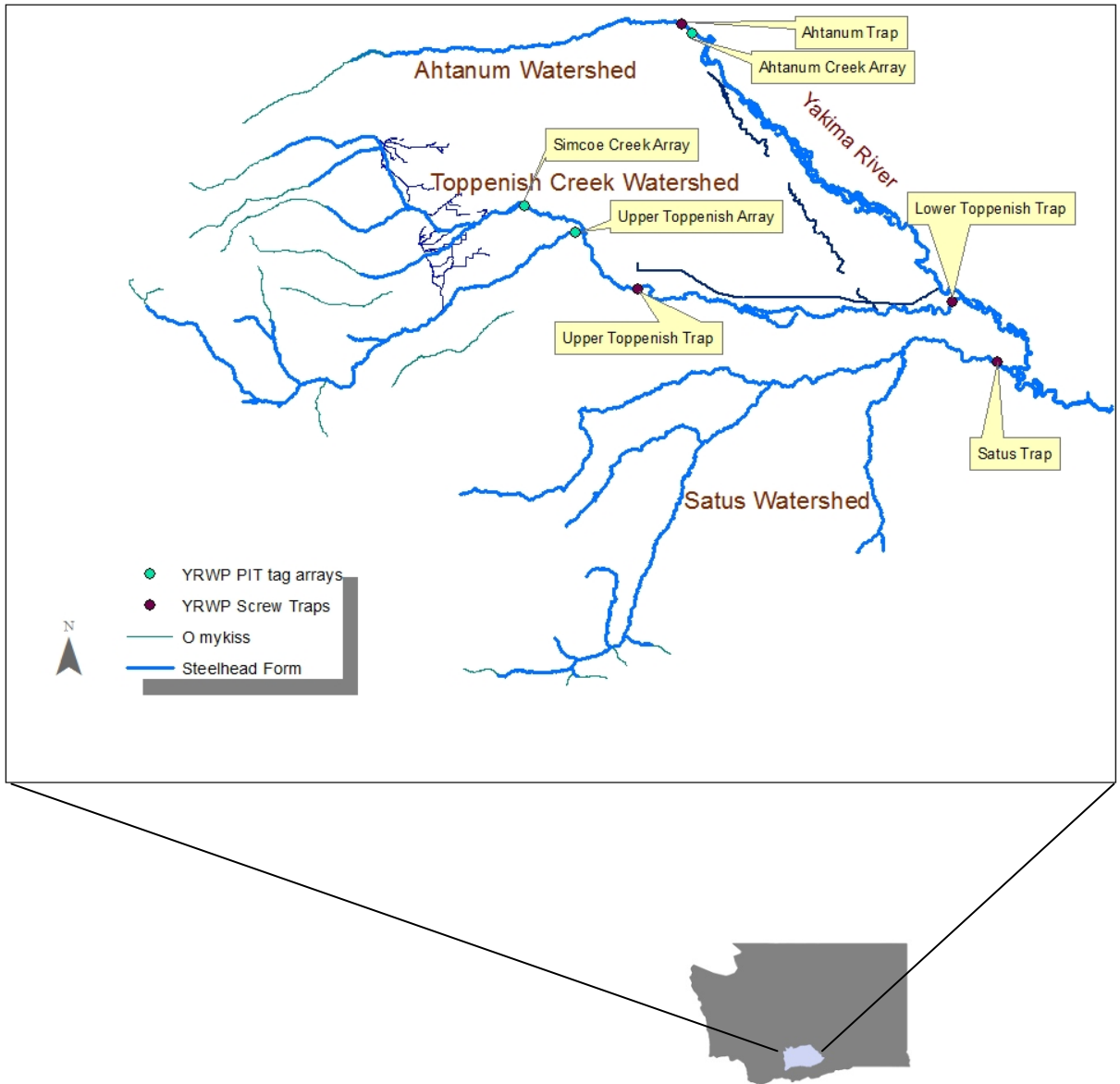


Figure 4. Location of rotary screw traps and PIT tag antenna arrays operated by YRWP in Satus, Toppenish, and Ahtanum Creeks on the lower Yakima River.

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. The Ahtanum array will have a mixture of pass through and pass by antennas in the future. They all use IS1001 data loggers that are powered with thermo-electric generators. All have a multiplexer (IS1001 MC).

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 thirty three devices in the three watersheds. Data-loggers (Onset Water Temp Pro v2) were launched in spring of 2017 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 2017, we only used data during the period between April 15th and October 15th to calculate descriptive statistics to evaluate in-stream conditions for salmonids.

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. 1617 adult steelhead were enumerated at the Prosser Dam facility managed by YKFP between July 1, 2016 and June 30, 2017 (<http://ykfp.org/>). Thirteen of these were identified as hatchery strays.

Satus Creek

23 steelhead redds were identified during two passes on Satus Creek between March and June of 2017. The largest number of redds were identified in Dry Creek (N=18). Only two redds were observed in the mainstem Satus Creek and only one in Logy Creek. One steelhead redd was documented in both Kusshi Creek and Wilson Charley Creeks.

Toppenish Creek

For the 2017 spawning season lasting from March through June a total of six steelhead redds were identified in the Toppenish Creek watershed during a season when conditions for counting redds were difficult due to a robust snowpack and prolonged spring snowmelt. Only one pass of the upper 3 reaches of Toppenish Creek was completed.

Two of the 6 redds were observed in Wahtum Creek in the Simcoe Creek subwatershed and the other 4 were recorded in the mainstem Toppenish Creek. Typically, One third of the steelhead redds in the Toppenish Watershed are found in the Simcoe Creek sub-watershed.

Ahtanum Creek

In 2017, no steelhead redd counts could be completed due to high flows above 300 cfs that persisted throughout the spring and steelhead spawning season in Ahtanum Creek. Ahtanum Creek is typically not wadeable above 150 cfs.

Bull trout were surveyed in late summer and autumn 2017 in the South Fork Ahtanum watershed which forms the northern boundary of the Yakama Reservation. No redds or adult bull trout were observed during surveys.

Redd Count Expansion

The cumulative redd count was multiplied by 2.5 fish per redd for an estimate of spawning escapement of 57 adult steelhead for the Satus watershed and 15 for the Toppenish watershed for the 2016 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.

The screw trap in Satus Creek was deployed on October 18th 2016 and fished until July 14th 2017. During this period, 43 steelhead juveniles were captured and 41 were PIT tagged. The PIT tagged fish were released as part of a mark-recapture study; however, none were recaptured so no estimate of outmigrants could be obtained.

Upper Toppenish Creek Screw Trap

We operated a rotary screw trap on Toppenish creek from October 6, 2016 through July 30, 2017, a period which encompasses most if not all of the outmigration period. We captured a total of 659 steelhead parr/smolts and PIT tagged 605. The daily catch of steelhead juveniles peaked in December (Figure 5) 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 10,464 SE 2133 juvenile steelhead outmigrants was obtained for the 2016-2017 season using this method. The mean length for all measured outmigrants was 122 mm (fork length) with length frequency distribution similar to previous years. We also captured 15 lamprey juvenile at this site during the season. The juveniles that have been captured at this site were taken to YN lamprey biologist for identification before being released on site.

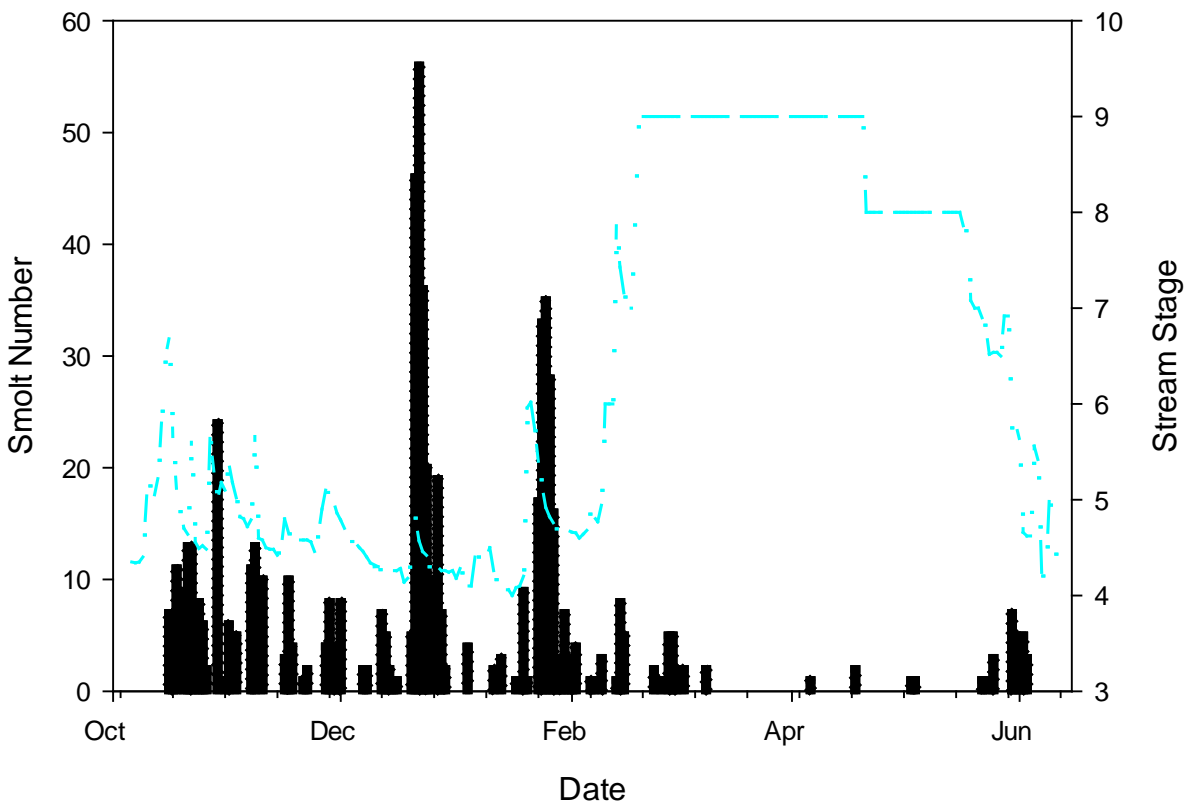


Figure 5. Steelhead juvenile outmigration timing. Daily catch at the Upper Toppenish Creek trap compared with stream stage for the 2017 Season.

Ahtanum Creek

We could not deploy a screw trap at the mouth of Ahtanum Creek due to high water in 2017. Flows were above 300 cfs from mid-February through June when most juveniles outmigrate.

PIT tag Interrogation Systems

The upper Toppenish PIT tag site was destroyed by flooding once again in March 2017 and only detected four steelhead before going down for the season. The other sites on Simcoe Creek and Ahtanum Creek were operational for the adult migration period. The Simcoe site did not detect any steelhead, but did detect 5 lamprey. The Ahtanum site operated continuously from November through June in 2016 and 2017. Six steelhead that were tagged at Prosser for adult steelhead estimation were detected. In addition, 145 juvenile coho, 1 adult coho, 1 hatchery adult chinook, 1 juvenile chinook, 65 O mykiss (previously tagged as juveniles in Ahtanum and other locations in the Yakima watershed), Two adult steelhead tagged as Juveniles, 3 steelhead kelts (from the kelt reconditioning study), 5 adult steelhead tagged in the Columbia, and 9 lamprey (released from the lamprey reintroduction study) were detected during the season of operation.

b. Tributary Habitat RM&E

Water Temperature Monitoring

Satus Creek

Mean daily averages in the main stem Satus Creek ranged from 15.1°C at 1st Crossing to 15.5 °C below Dry Creek (Table 1) in 2017. The greatest instantaneous maximum recorded for the Satus Creek watershed was 25.7°C located below the Dry Creek Confluence (RM 18.7) and the highest maximum 7-day maximum water temperature (25.1°C) was also recorded at this location (Table 1).

Table 1. Descriptive statistics for water temperature for 2017 for the period between April 15th and October 15th at 7 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)
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Above Logy Creek (23.6)	24.5	5.0	17.8	15.3	13.0	20.6	23.5	20.3
Satus 1 st crossing	24.1	5.4	17.0	15.1	13.2	21.7	23.6	21.2
Below Dry Creek (18.7)	25.7	5.6	18.1	15.5	13.2	22.4	25.1	21.8
Logy at Falls(12.5)	17.3	1.7	13.0	11.4	9.6	15.5	16.6	14.9
Logy at Fourth Crossing (8.8)	18.9	2.7	13.1	11.7	10.2	17.2	18.0	16.6
Dry Creek at Elbow Crossing (18.5)	23.2	7.9	17.3	15.3	14.1	18.2	22.1	17.8
Section corner source (4.6)	8.9	7.1	8.5	8.0	7.6	8.2	8.9	8.2

Toppenish Creek

In 2017, mean daily average temperatures in the mainstem Toppenish Creek ranged from 12.6°C below the swim hole (RM 45.9) to 19.7°C below the Highway 97. The highest instantaneous maximum of 26.6°C occurred at Indian Church Road. The highest Maximum Weekly Maximum occurred at the site below Highway 97. By most standards the summer water temperatures in 2017 in the lower portion of Toppenish Creek (below the Unit 2 diversion) were higher than most salmonids can tolerate (Table 2). In Simcoe Creek, the highest instantaneous maximum water temperature occurred at Barkes Road while the highest MWMT occurred at Simcoe Creek Road.

Table 2. Descriptive statistics for water temperatures at 21 locations in the Toppenish Creek watershed for 2017 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
1 mile below swim hole (45.9)	18.3	4.5	13.5	12.6	11.7	17.3	18.1	17.0
1 mile above lateral (45.1)	20.9	4.5	15.0	13.5	12.2	19.3	20.5	18.9
Topp. above lateral (44.2)	21.2	6.8	17.3	15.8	14.6	19.6	20.8	19.1
At three way (43.1)	21.6	5.4	15.7	14.2	12.9	19.9	21.1	19.5
Topp. At Cleparty	22.3	7.0	17.8	16.0	14.5	20.2	21.7	19.7
Topp. At Marion Drain	23.7	8.6	19.4	17.0	14.8	21.6	22.7	19.4

Topp. At Shaker Church	23.1	8.2	18.8	16.8	14.8	20.1	21.9	19.4
Topp. at Unit 2 (26.5)	23.6	6.5	17.3	16.5	15.6	22.8	23.0	22.3
Toppenish below H97	26.1	8.4	20.9	19.7	18.6	24.9	25.6	24.3
Toppenish at Indian Church	26.6	10.3	20.8	19.1	17.5	23.1	24.8	22.5
Simcoe below Forks (18.9)	18.9	4.2	13.3	12.1	11.0	18.0	18.6	17.6
Simcoe at Simcoe RD.	23.2	4.9	18.8	15.6	13.1	19.7	22.9	19.2
Simcoe at Towtnuk Rd.	22.7	5.2	17.7	16.0	14.1	20.7	21.8	19.9
Simcoe at Wesley Rd.	20.3	8.0	14.1	12.2	11.0	16.8	19.8	16.4
Simcoe below Unit 1 spill	18.7	6.4	15.8	14.0	12.1	16.7	18.3	16.0
Simcoe below Barkes Rd. (2.7)	23.2	6.9	18.4	16.9	15.4	21.7	22.2	20.8
Mission Springs at Barkes Rd.	22.1	5.1	17.6	15.7	13.4	20.1	21.1	19.1
Rodeo Springs at Stephenson Rd.	24.5	6.8	19.2	18.1	17.1	23.2	23.8	22.5
Wheeler spring at N White Swan Rd.	14.7	8.3	12.8	12.3	11.9	13.6	14.5	13.3
Olney Flat Drain	23.8	8.5	19.4	18.4	17.3	22.8	23.3	22.3
Mud Lake Drain	25.1	7.4	19.9	18.6	17.2	23.0	24.3	22.4

Ahtanum Creek

Mean daily averages ranged from 12.0 C in the South Fork of Ahtanum Creek one mile above the confluences to 17.2°C at the USGS gage at the mouth (Table 3). The highest instantaneous maximum of 24.2 C was also recorded at the USGS gage at the mouth. The highest maximum 7-day maximum was recorded at this location as well.

Table 3. Descriptive statistics for water temperatures at 2 locations in the Ahtanum Creek watershed for 2017. 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)	19.4	2.2	14.5	12.0	9.8	16.5	19.1	16.2
At USGS Gauge (0.5)	24.2	7.2	18.7	17.2	15.6	22.0	23.3	21.3

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.

We 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 steelhead redd counts 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.

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 20.38%) for the number of steelhead migrating from the spawning and rearing areas. At this point our other screw traps located on Satus and Ahtanum Creeks are not providing adequate outmigration estimates for those streams.

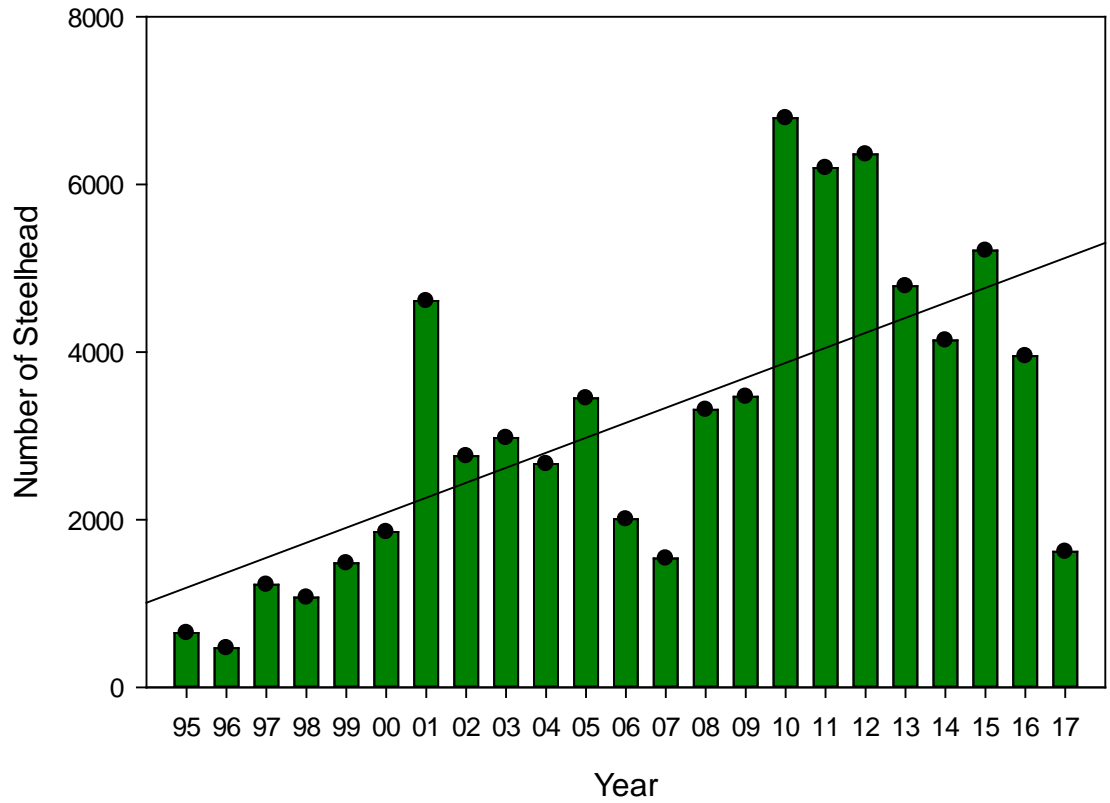


Figure 6. Number of adult steelhead detected passing over Prosser dam between the dates of July 1 and June 30 of the following year for 1995 through 2017 (<http://ykfp.org/docsindex.htm>).

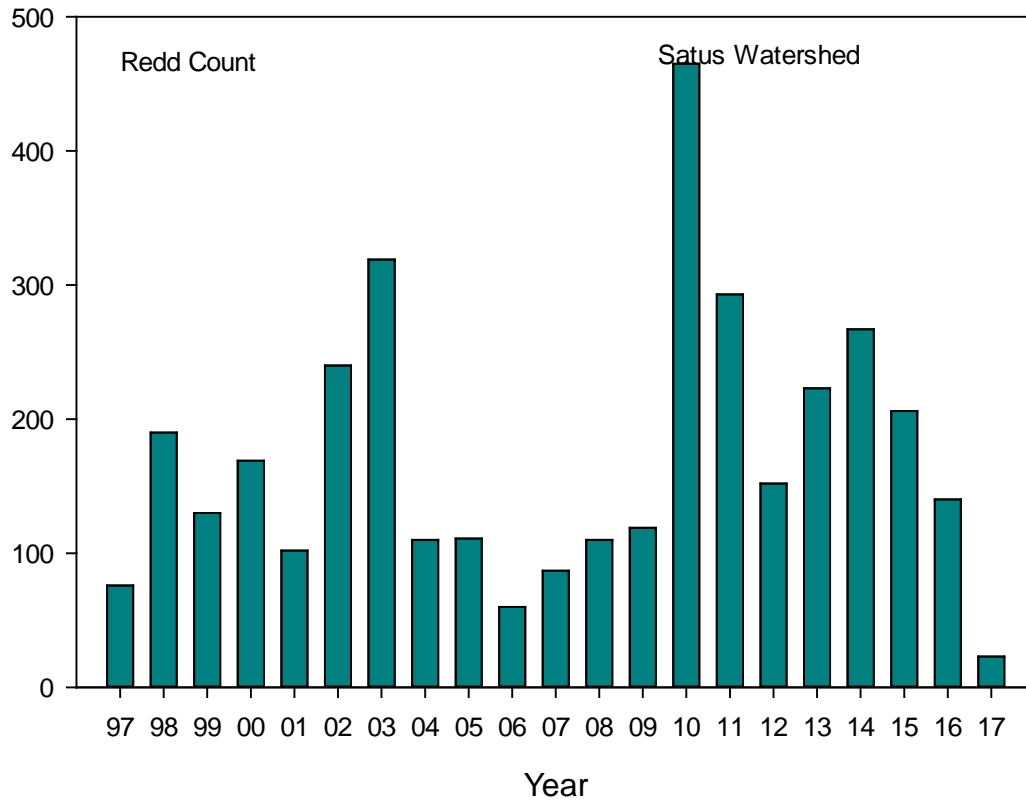


Figure 7. Number of steelhead redds in the Satus Creek watershed 1997 to 2017.

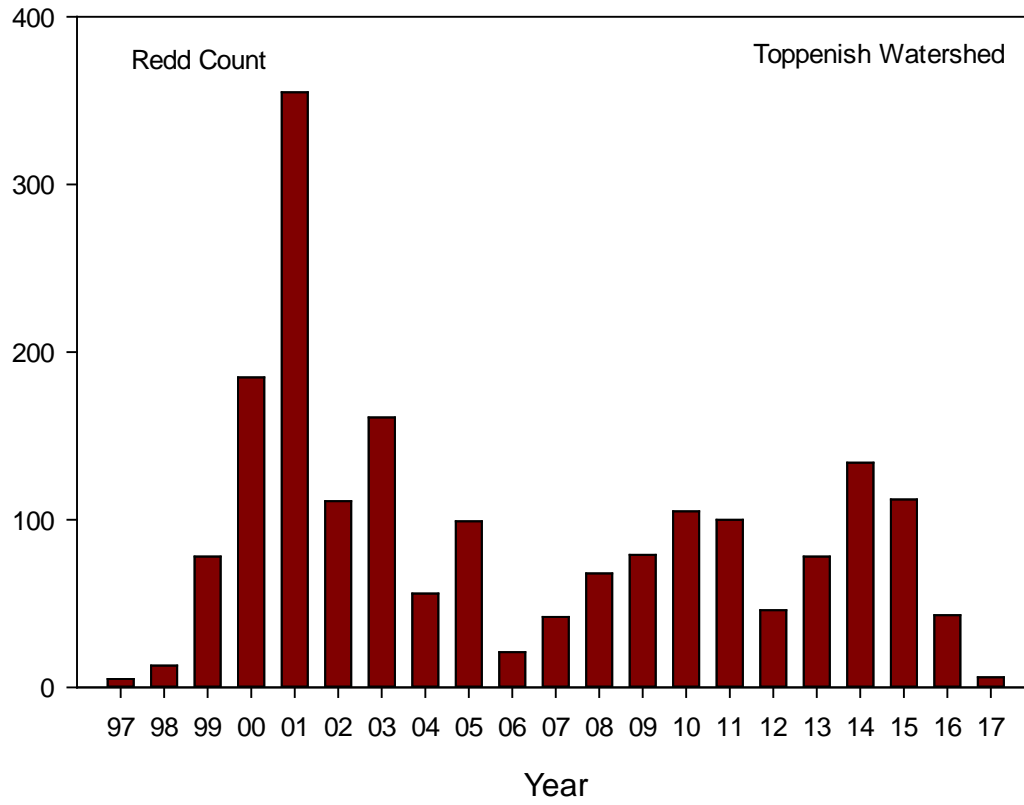


Figure 8. Number of steelhead redds per year in the Toppenish Creek watershed from 1997 to 2017.

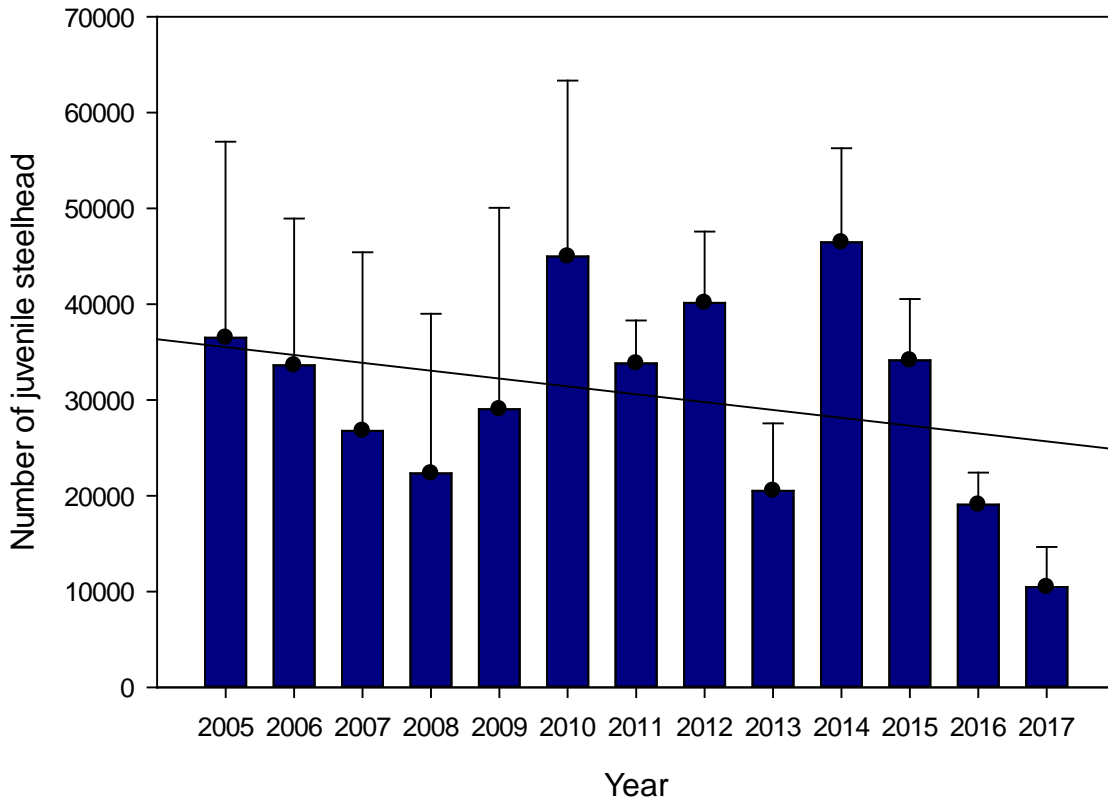


Figure 9. Estimated number of steelhead juveniles outmigrating from spawning and rearing habitat on Toppenish Creek for years 2005-2017. Error bars represent 95% CI

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 2017. 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	1
(3 passes)	Wood Bridge (40.8)	County Line (36.4)	4.4	0
	County Line (36.4)	High Bridge (32.4)	4	0
	High Bridge (32.4)	Holwegner(28.4)	4.8	0
	Holwegner (28.4)	2nd X-ing (23.7)	3.9	1
	2nd X-ing (23.7)	1st Xing (20.2)	3.5	0
	1st X-ing (20.2)	Gage (17.4)	2.8	0
	Gage (17.4)	Rd 23 (13.1)	4.3	0
Total			31.9	2
LOGY	Falls (14)	Spring Cr (11)	3	0
(3 passes)	Spring Cr (11)	S. C. Ford (9.5)	1.5	0
	S. C. Ford (9.5)	3rd Xing (3.5)	6	0
	3 rd Xing (3.5)	Mouth (0.0)	3.5	1
Total			14	1
DRY	South Fk. (27.8)	Saddle (24)	3.6	0
(3 passes)	Saddle (24)	Elbow Xing (18.25)	5.75	7
	Elbow Xing (18.25)	Seattle Cr (14)	4.25	6
	Seattle Cr (14)	Rd 75 bend (8.75)	5.25	0
	Rd 75 bend (8.75)	Power Line Ford (2.5)	6.25	2
	Power Line Ford (2.5)	Mouth (0.0)	2.75	1
Total			27.85	18
W. CHARLEY	Forks (1.9)	Mouth (0.0)	1.9	1
KUSSHI	Top (11th) Xing (4.5)	Mouth (0.0)	4.5	1
SHINANDO	Ford (0.5)	Mouth (0.0)	0.5	0
MULE DRY	Yakima Chief Rd. (15.4)	Rd. 39 (4)	11.4	0

Bull	Falls(1)	Mouth (0.0)	1	0
TOTAL			92.05	23

Table B2. Number of steelhead redds in the Toppenish Creek watershed in 2017. River miles are in parentheses.				
Upper Toppenish Creek watershed			Distance miles	Number of Redds
(River Miles at Confluence in Parentheses)				
Toppenish	O Connor Cr (65.7)	“East Bank” (61.1)	4.6	2
	“East Bank” (61.1)	NF confluence (55.4)	5.7	0
	North Fork (55.4)	Washout (50.9)	4.5	0
	Washout (50.9)	Willy Dick Cr (48.5)	2.5	0
	Willy Dick Cr (48.5)	Olney Lateral (44.2)	4.3	0
	Olney Lateral (44.2)	Pom Pom Rd. (38.9)	5.3	0
	Pom Pom Rd. (38.9)	Shaker Church Rd. (35.9)	3	2
Total			29.9	4
N. Fork Toppenish	NF Falls (4)	NF confluence (0)	4	0
Willy Dick	old logging site (4)	Confluence (0)	4	0
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	0
	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	0
	Simcoe Creek Rd. (15.3)	Wesley Rd. (10.1)	5.2	0
	Wesley Rd. (10.1)	N. White Swan Rd. (8.1)	2.0	0
	N. White Swan Rd. (8.1)	Stephenson Rd. (5.9)	2.2	
Total			25.7	0
Agency	Falls (8.9)	Lateral Canal (4.4)	4.5	0
	Lateral Canal (4.4)	Confluence (0)	4.4	0
Total			8.9	0
Wahnum	Yesmowit Rd. (3.6)	Confluence (0)	3.6	2
Total			76.1	6

Table B3. Steelhead juvenile catch and mark-recapture data stratified weekly for the upper Toppenish creek screw trap for the MY 2017 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	10/10-10/16	7	7	0	0
Week 2	10/17-10/23	56	52	0	0
Week 3	10/24-10/30	40	38	2	0
Week 4	10/31-11/6	12	11	0	0
Week 5	11/7-11/13	34	28	1	0
Week 6	11/14-11/20	17	17	0	0
Week 7	11/21-11/27	7	7	0	0
Week 8	11/28-12/4	22	13	0	0

Week 9	12/5-12/11	4	4	0	1
Week 10	12/12-12/18	16	15	4	0
Week 11	12/19-12/25	173	172	19	0
Week 12	12/26-1/1	28	25	1	0
Week 13	1/2 – 1/8	7	3	0	0
Week 14	1/9-1/15	5	2	0	0
Week 15	1/16-1/22	11	10	1	0
Week 16	1/23-1/29	133	129	13	1
Week 17	1/30-2/5	16	8	2	0
Week 18	2/6-2/12	5	5	0	0
Week 19	2/13-2/19	14	14	0	0
Week 20	2/20-2/26	3	3	0	0
Week 21	2/27-3/5	14	13	0	0
Week 22	3/6-3/12	2	2	0	0
Week 23	3/13-3/19	0	0	0	0
Week 24	3/20-3/26	0	0	0	0
Week 25	3/27-4/2	0	0	0	0
Week 26	4/3-4/9	1	1	0	0
Week 27	4/10-4/16	0	0	0	0
Week 28	4/17-4/23	2	2	0	0
Week 29	4/24-4/30	0	0	0	0
Week 30	5/1-5/7	2	2	0	0
Week 31	5/8-5/14	0	0	0	0
Week 32	5/15-5/21	0	0	0	0
Week 33	5/22-5/28	5	5	0	0
Week 34	5/29-6/4	23	16	1	0

*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.

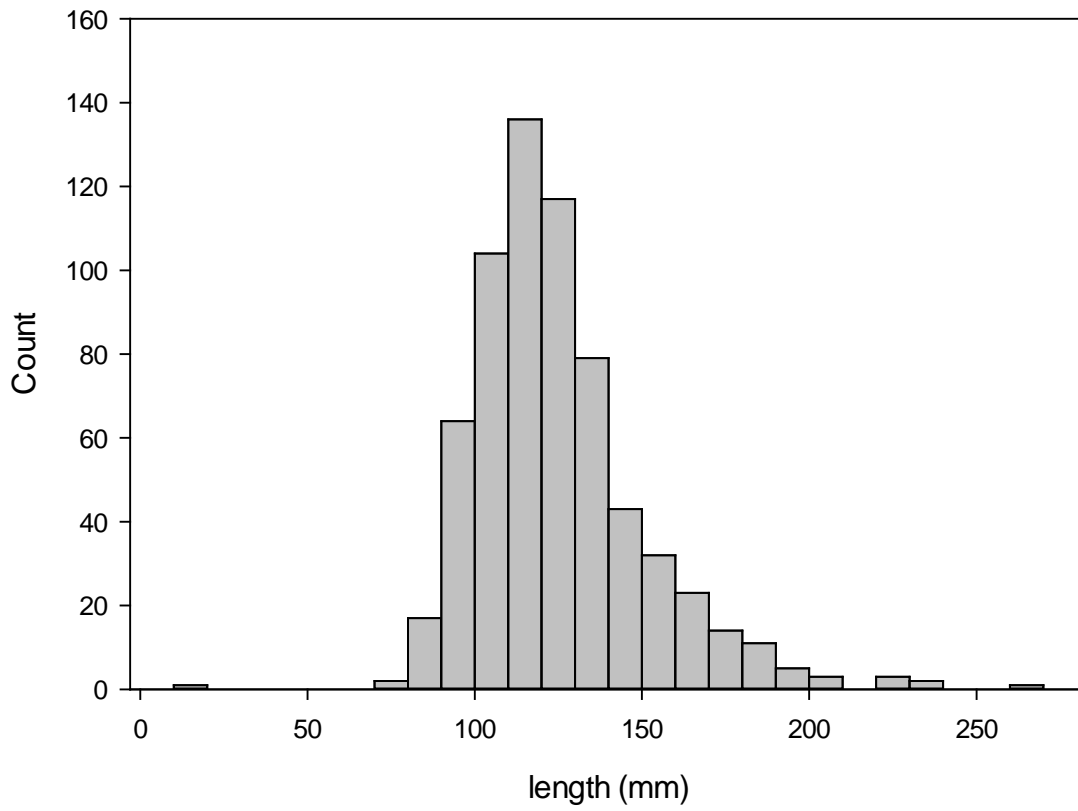


Figure B1. Length frequency distribution of steelhead juveniles captured in the upper Toppenish rotary screw trap between October 2016 and June 2017.