ANNUAL REPORT

STEELHEAD (*ONCORHYNCHUS MYKISS)* POPULATION AND HABITAT MONITORING IN LOWER YAKIMA RIVER TRIBUTARIES 2011 AND 2012

SEPTEMBER, 2011 THROUGH OCTOBER, 2012

YAKAMA RESERVATION WATERSHEDS PROJECT

BPA Project #1996-035-01-Contract 52386

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Abstract

To monitor the trends and status of the steelhead populations in Satus, Toppenish and Ahtanum Creeks we conducted spawning ground surveys including a redd count to index adult spawning escapement; snorkel surveys to monitor parr density in relation to minimum instream flows; and we operated four rotary screw traps. We also monitored water temperature, an important limiting factor for steelhead production in the Yakima River Basin. We attempted to obtain precise estimates of adult steelhead spawner abundance and juvenile out-migrant abundance. Census redd counts (three passes) were performed along all 76 miles of documented steelhead spawning habitat in Toppenish Creek and all 93 miles of habitat in the Satus Creek watershed. Two rotary screw traps were deployed on Toppenish Creek to estimate steelhead juvenile out-migration from Toppenish Creek spawning habitat and to evaluate survival to the mouth and downstream through the series of detection facilities on the Yakima and mainstem Columbia. An estimated 40,152 (SE 3790) steelhead juveniles migrated off the spawning and rearing grounds and past the rotary screw trap located at river mile 26.5 on Toppenish Creek. One rotary screw trap was deployed on Satus Creek where an estimated 11,200 (SE 2056) steelhead juveniles migrated past the trap zone. Part of the out-migration may have been missed because the trap could not be operated during a major flood; this was the most likely reason for a lower-than-expected estimate. In Ahtanum Creek no out-migration estimate could be obtained due to low capture rate—a total of 30 steelhead smolts were captured. During redd counts, we counted 152 redds on Satus Creek, 46 redds on Toppenish Creek and 7 redds in Marion and Harrah Drains. Snorkel surveys indicated a low density of age 0 steelhead parr in all three watersheds. Water temperature was monitored throughout the Satus, Toppenish, and Ahtanum watersheds.

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 all 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 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 cameras 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. 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, spawner 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.

In 2009, Toppenish Creek was identified as the watershed in the Yakima basin where "fish in/fish out" population monitoring should be prioritized. We strengthened our Toppenish Creek screw trapping program beginning in the 2010-2011 season to meet the objective of accurately quantifying "fish out" or the number of steelhead juveniles migrating out of the Toppenish creek spawning grounds with a data standard (CV, coefficient of variation < 30%) adhering to recommendations in Crawford and Rumsey (2009). Better equipment and more manpower obtained with additional BPA funding (1996-035-01 BIOP M&E Toppenish Creek) were required to meet this objective. We attempted to use census redd counts and develop expansions to obtain the adult abundance or “fish in” estimates. We attempted to obtain similar data and estimates from Satus and Ahtanum Creeks.

Estimates of juvenile steelhead abundance and adult spawner abundance are the primary objectives of this monitoring. Smolt-per-spawner and/or smolt-per-redd estimates will be provided in a future report along with estimates of downstream survival and smolt-to-adult returns (SAR). Information on life history characteristics such as migration timing and spawning behavior will also be provided by this study as will some abundance and life history information for non-target fish species.

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 mi^2) 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, 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.

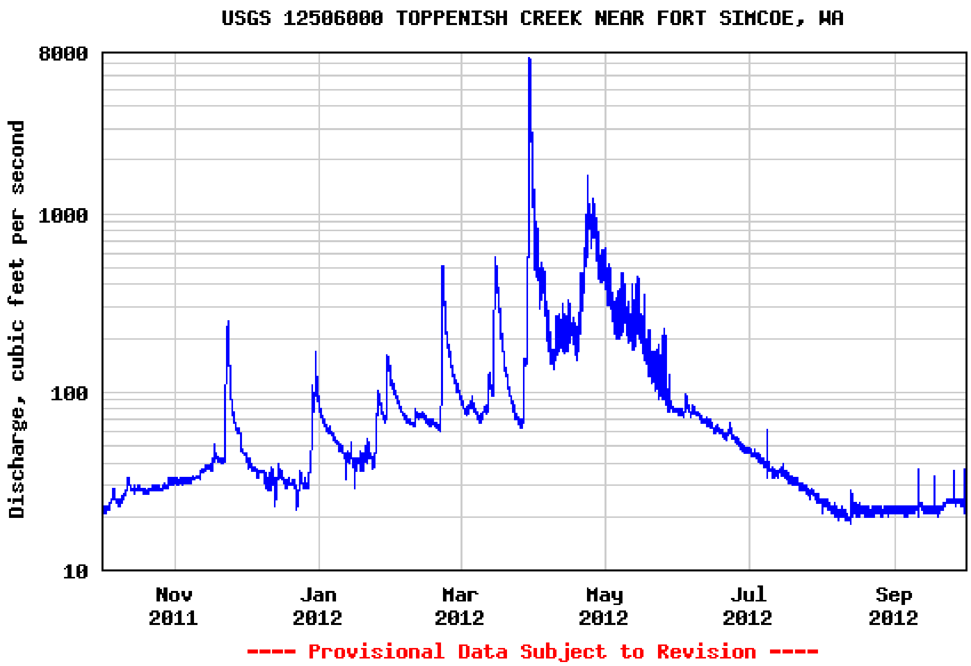

Figure 1. Hydrograph for Toppenish Creek at the USGS gage 12506000 at River Mile 44 for water year 2012 (these discharge data are preliminary).

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. 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.

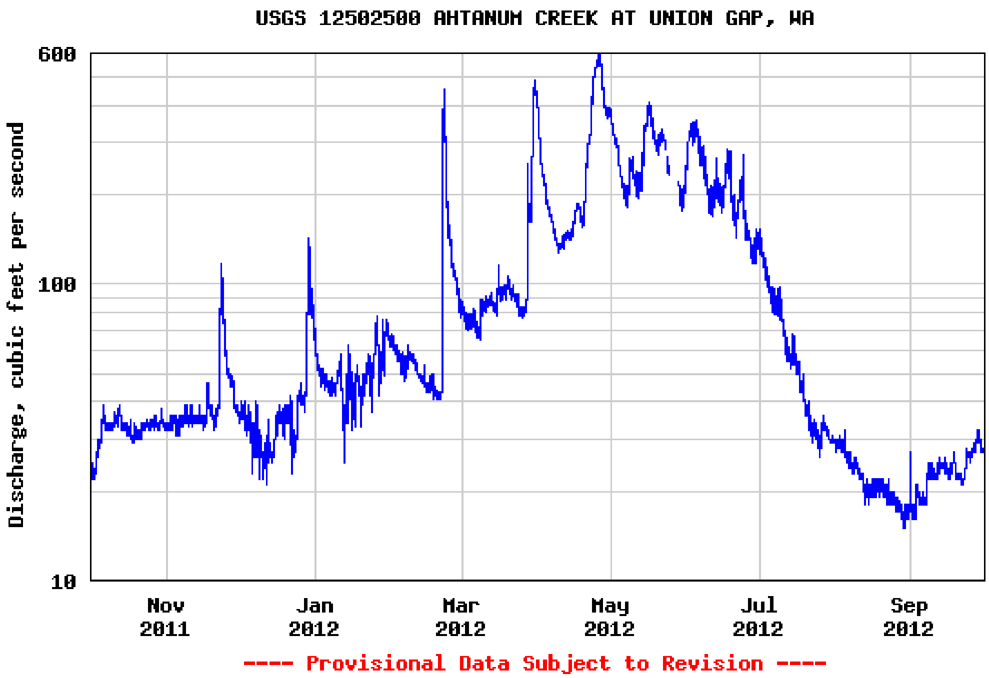

Figure 2. Hydrograph for the Ahtanum Creek watershed at the USGS gage 12502500 River Mile 0.5 for water year 2012 (these discharge data are preliminary).

Fish species that are known to reside in Toppenish Creek, Satus Creek, and Ahtanum Creek include: steelhead/rainbow trout (*Oncorhynchus mykiss*), Coho salmon (*O. kisutch*), chinook salmon (*O. tshawytscha*), westslope cutthroat trout (*O. clarki*), whitefish (*Prosopium williamsoni*), redside shiners (*Richardsonius balteatus*), speckled (*Rhinichthyus osculus*) and longnose dace (*R. cataractae*), chiselmouth (*Achrocheilus alutaceus*), northern pikeminnow (*Ptychocheilus oregonensis*), suckers (*Catostomus* spp.), sculpin (*Cottus* spp.), goldfish (*Carassius auratus*), carp (*Cyprinus carpio*), bluegill (*Lepomis macrochirus*), pumpkinseed (*L. gibbosus*), yellow Perch *(Perca flavescens),* largemouth bass *(Micropterus salmoides)*, black crappie *(Pomoxis nigromaculatus)* lamprey (*Entosphenus* spp.), black bulhead (*Ictalurus nebulosis*), threespine stickleback

(*Gasterosteus aculeatus*), bull trout (*Salvelinus confluentus*), and brook trout (*S. fontinalis*).

Although steelhead are the focus of the YRWP restoration project, many native fish and other aquatic species will likely benefit from stream restoration efforts in these watersheds.

Methods

Juvenile Out-migration

Steelhead outmigrants are partitioned into migratory years (MY) that begin on July 1st and end on June 30th of the following year (e.g. MY 12 began July 1, 2011 and ended June 30, 2012) because little or no migration occurs during the summer months.

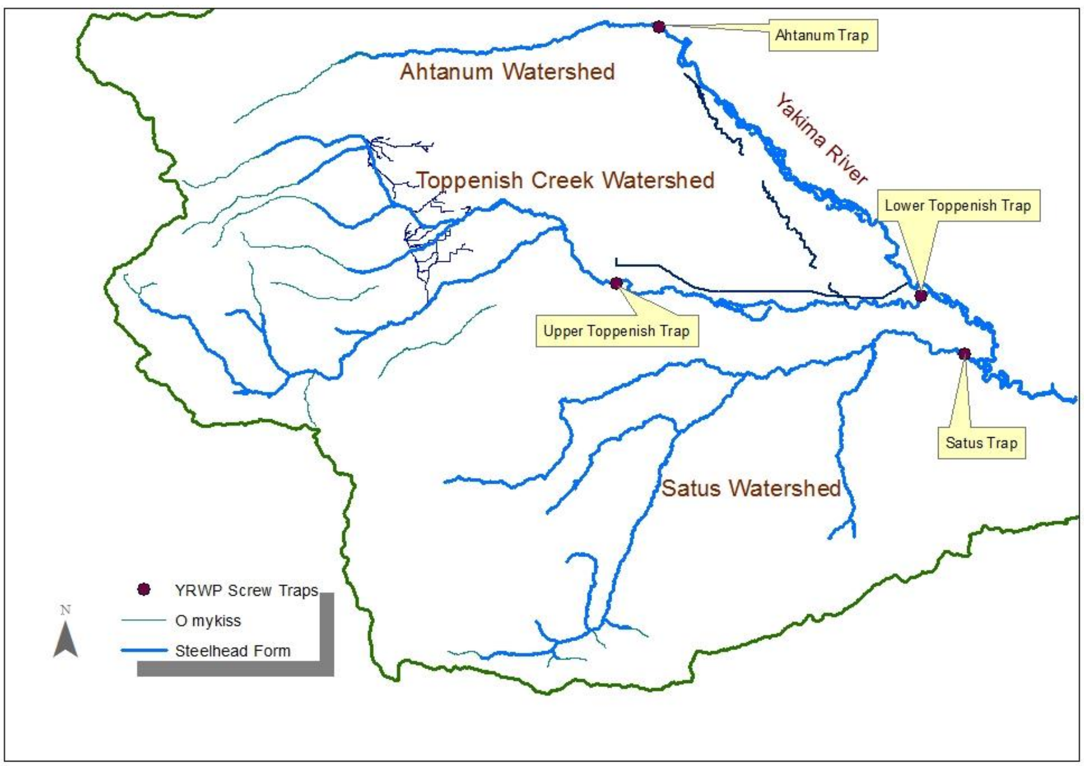

Figure 3. Location of rotary screw traps operated by YRWP in Satus, Toppenish, and Ahtanum Creeks on the lower Yakima River in 2011 and 2012.

Upper Toppenish Screw Trap

The upper Toppenish screw trap was deployed at the beginning of the outmigration season in late autumn and fished for the entire steelhead outmigration season ending in June.

We deployed and operated the 5-foot-diameter screw trap (designed and constructed by EG Solutions) located at river mile 26.5 below the Unit 2 diversion each year since 1999. This location was chosen because of its favorable site characteristics (stream morphology facilitating good trap efficiency and groundwater recharge allowing us to operate through the winter months) and its position several miles downstream from all recognized spawning and summer rearing habitat, which begins at about river mile 35.5 near Shaker Church Road on the mainstem Toppenish Creek, and above river mile 5.5 near Stephenson Road on Simcoe Creek. Mill Creek, which was identified as a minor spawning population in the Yakima Steelhead Recovery Plan (although there is no recent evidence of steelhead spawning activity), is located about 4.5 miles upstream from this site. No viable tributaries enter Toppenish Creek below the Mill Creek confluence and much of the runoff from the north is captured by Marion Drain, which parallels Toppenish Creek for 19 miles beginning at the upper trap site. Aerial, watercraft, and limited foot surveys below our trap site indicate that successful spawning activity in the reach below the upper screw trap is unlikely. Additional planned aerial spawning surveys and a three-year radio-tracking study begun in 2011 may lend additional support to our exclusion of this reach.

Lower Toppenish Screw Trap

We deployed a second screw trap on Toppenish Creek in beginning in 2010 to evaluate out-migration timing and survival of steelhead smolts in the lower part of Toppenish Creek. This portion of Toppenish Creek is situated on the historical Yakima River floodplain, which has been modified extensively for agricultural purposes and transportation over the last 150 years. There is a complex irrigation system of canals and drains (WIP, Wapato Irrigation Project) that significantly influences flow, temperature, and other hydrologic characteristics of the lower Toppenish Creek watershed. Another prominent feature of this part of the watershed are numerous controlled wetlands that were developed for producing, attracting and providing refuge to waterfowl species (and other migratory birds). It is unclear what role these wetlands play to migrating adult and juvenile steelhead. We hope to ascertain the impact of these wetlands through several ongoing studies including this PIT-tagging study for juveniles and also the radio tracking study for adults. Like the upper trap, the lower trap and its target organisms were protected by lifting the cone during periods of high flows and debris loading.

Trapping and Tagging Procedures

We have often been unable to obtain reliable out-migration estimates due to high flows that are common 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. During normal to high flow years between 1999 and 2009, we were forced to temporarily halt operation of the trap to avoid trap mortality numerous times throughout the season. This affected our study and estimates negatively because studies to obtain outmigration estimates require or at least benefit from continuous operation. In 2010, we found that we could operate the trap during high water events and minimize trapping mortality through multiple visits to the traps during a 24 hour period and, in some cases, camping at the trap site and cleaning it periodically throughout the night. Our study and out-migrant estimates have improved since we have combined continuous fishing with rigorous maintenance. The trap was operated continuously in all but the highest flows. Even during periods of low and moderate flow, the trap was checked every morning including holidays and weekends.

Our screw trapping protocol was similar at all four of the screw traps (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 and 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). On several occasions when large catches occurred (N > 300) only the first 100 were measured and weighed. We inserted PIT tags into the first 100 steelhead smolts we captured each day that were over 80 mm in length. PIT-tagged fish were released several hundred meters upstream from the trap to estimate trap efficiency from recapture rate. The upstream release site alternated between the right and left banks of the stream. These trap efficiency releases were made four times per week (Monday-Thursday), and the release numbers and recaptures for the week were pooled. Day and night releases were compared for several efficiency release groups. 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 reliable formula to achieve this. Despite adjusting the target number tagged per day several times during the season, we ended the season having tagged fewer fish than planned.

Scales were collected from 100 individuals from each stream of varying sizes (up to 10 per day) to use in conjunction with PIT tag data to assess survival by year class. We also collected fin clips from 100 Toppenish Creek steelhead smolts. DNA samples are analyzed by the Columbia River Inter-Tribal Fish Commission's part of a 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. Condition factor was calculated for each individual using the following: (W * 100000)/(L^3); W = weight (g), L = fork length (mm).

Juvenile out-migration estimate

Studies using capture-recapture methods have been used to obtain fairly precise estimates of smolt production of anadromous salmonid species including steelhead (Thedinga 1994, Calson et. al. 1998, Rawding and Cochran 2007). Several variations of the capture-recapture model exist and these models are used throughout the Columbia basin to estimate outmigrant abundance and are probably the most common method to obtain these estimates (Volkhardt et. al. 2007). We utilized 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 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 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.

Adult Abundance

Steelhead Census Redd Counts

Redd counts are often utilized to estimate or index spawning escapement for adult salmonids (Gallagher et. al. 2007, 2010a, 2010b; Susac and Jacobs 1999). 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 to use various survey methods (ground, raft, aerial) in areas outside of these recognized spawning reaches but have not documented any redds.
The procedure for conducting steelhead redd counts has not changed significantly during the 24 years that the Yakama Nation has performed them. A three-pass census is conducted as follows: Two surveyors, or a single surveyor on smaller streams, typically cover each 2-to-6-mile survey reach, walking downstream. Surveys do not start until the sun breaks over the horizon to ensure that there is enough light to detect redds, and 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 *O. mykiss* observed in these watersheds that are not adult steelhead during redd counts and 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 take care not to disturb spawning fish or possible staging pools when conducting spawner surveys.

Redd Count Expansion

The cumulative redd count was multiplied by 2.5 fish per redd, the standard used for Washington streams (Gallagher et al. 2007) for an estimate of spawning escapement. Other expansion coefficients were also considered.

Ahtanum Bull Trout surveys

The Yakama Nation has performed bull trout spawner surveys in the South Fork of Ahtanum Creek annually since 2002 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. Fish and Wildlife Service, Roza-Sunnyside Joint Board, Yakama Nation and the Yakima Basin Fish and Wildlife Recovery Board).

We perform these surveys using a protocol developed by Washington Department of Fish and Wildlife (Eric Anderson; unpublished document-2011). In summary, surveyor (s) walk upstream, record, and flag redds during multiple passes. Each observed redd is categorized as definite, probable, or possible. Live bull trout are documented during each pass as well. On the last pass, GPS waypoints are collected. Only redds identified as probable or definite are included in the final count.

<u>Parr Monitoring</u>

Snorkel surveys were utilized to monitor *O. mykiss* parr abundance on rearing habitat between swim up and outmigration, and generally followed procedures outlined in O'Neal (2007). Surveyors moved upstream through a survey segment. One person followed on foot behind two snorkelers to record data. For the past 8 years of monitoring steelhead parr in these tributaries, surveys have been performed by the same three snorkelers, providing some level of consistency in all years of this study. Enumerations were linked to a basic habitat type (pool or riffle). Steelhead/rainbow trout were placed into either an age 0 category; for individuals that hatched in the spring of that year, or an age 1+ category for those that likely hatched in previous years. Under most conditions, these two age classes of steelhead/rainbow trout were distinguishable through October, although size variation within age classes grew more pronounced as the season progressed. Age 1, 2, 3, etc. are probably not distinguishable from one another, so we lumped them into an age 1+ category. We cannot visually distinguish between anadromous steelhead and resident rainbows at these life stages.

We measured six widths at the beginning of the season at each site to calculate a surface area of the survey reach and obtain densities of rainbow/steelhead parr in number per 100 meters^2. Surveys were performed during the day after the sun appeared above the treetops, normally between 9:00 AM and 3:00 PM. We surveyed the parr monitoring sites near irrigation diversions every month during the low-flow season, and used the surveys completed in August to make comparisons between those sites and other sites where surveys are only conducted annually. Paired t tests were utilized to compare monthly survey visits to sites above and below diversions.

Satus Creek

We conduct snorkel surveys at six sites in the Satus Creek watershed, which has no major diversions or man-made barriers, to evaluate parr density and to compare with sites in Toppenish Creek and Ahtanum Creek where irrigation diversion and returns influence fish habitat. To obtain a general overview of steelhead par density and egg-to-parr survival, two sites on Satus Creek and its two largest tributaries (Logy and Dry creeks) were surveyed (Figure 4) .

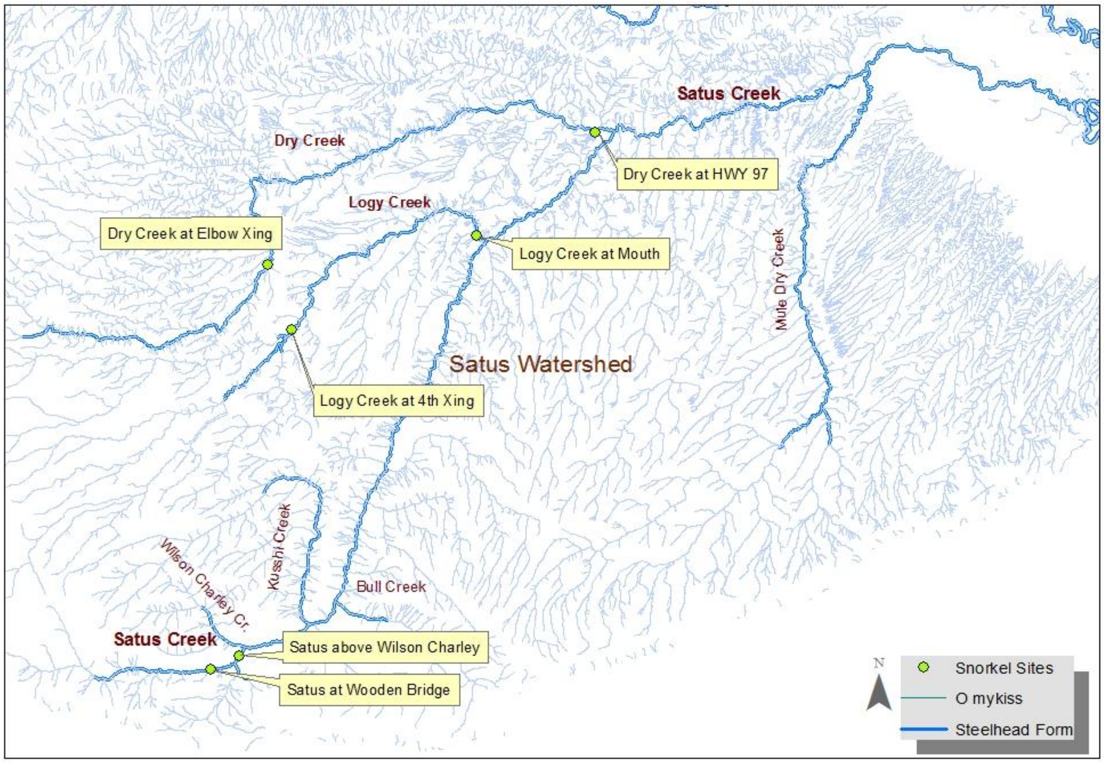

Figure 4. Snorkel site locations in the Satus Creek watershed surveyed in 2012.

Toppenish Creek

The uppermost diversion on Toppenish Creek is the Olney Diversion, which is located at river mile 44.3 and feeds the Toppenish Lateral Canal. Most of successful spawning and rearing of steelhead is believed to occur above the Olney Diversion. Before 2001, the reach below the diversion dam dewatered annually between July and September as result of irrigation withdrawals. Minimum instream flows for the summer months have restored about 2.5 miles of additional spawning and rearing habitat below the Olney diversion dam. Beyond about 2.5 miles, about 15 cfs of surface flow seeps into the Toppenish Creek alluvial fan during the summer months. Since 2007; there has been perennial flow of several cfs (2-8) through the formerly-dry reach on the alluvial fan, necessitating complete shutoff of the diversion in years with average or less-than-average summer streamflow. The resulting series of pools remain connected by a flowing corridor and are available to migrating steelhead parr to avoid stranding and desiccation. Stream temperature increases gradually through a 6.5-mile reach divided by the Toppenish Lateral diversion as indicated by dataloggers positioned at approximately 1-mile intervals through this reach. Between 2005 and 2012 our steelhead parr snorkel surveys were concentrated in this reach.

Another substantial point of diversion in the Toppenish Creek watershed is located on the North Fork of Simcoe Creek. Like the Olney Diversion on the mainstem of Toppenish Creek, prior to 2001 the entire North Fork Simcoe Creek was diverted during the summer into the Hoptowit Ditch creating a dry reach downstream from the diversion point for approximately one mile before the South Fork enters. Since 2001, enforced minimum instream flows have maintained flow in this reach. Snorkel surveys conducted in this reach have demonstrated rearing capacity in this formerly-dewatered reach similar to other portions of the watershed.

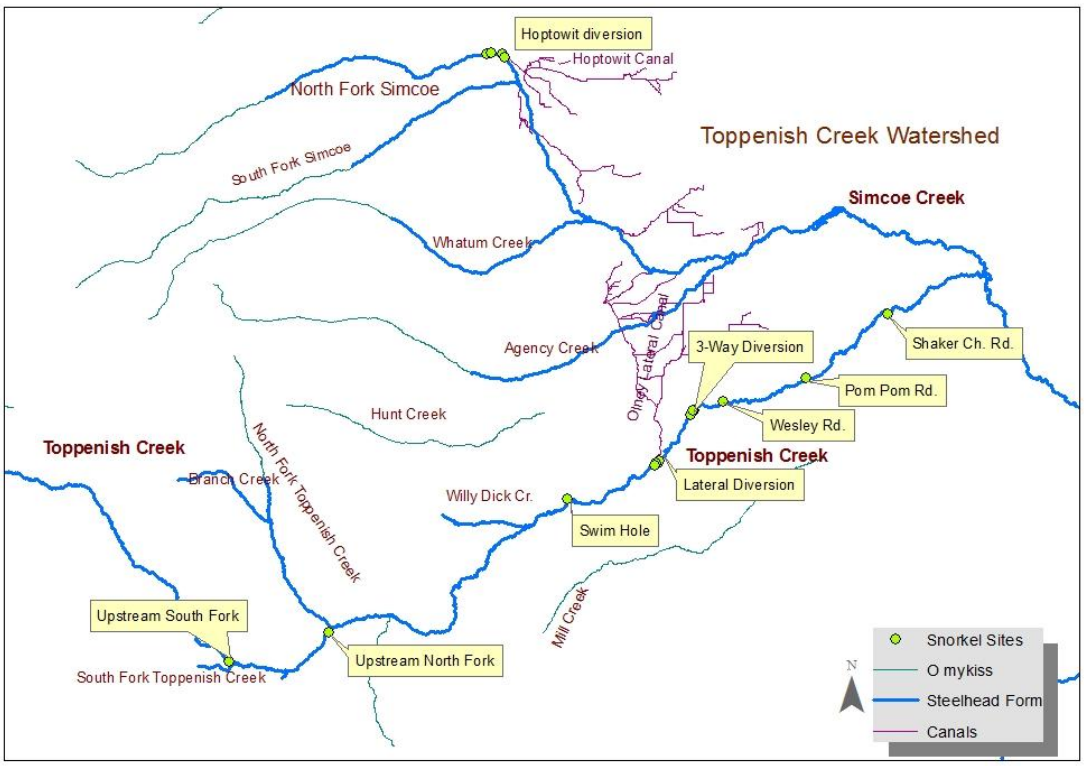

Figure 5. Snorkel site locations in the Toppenish Creek watershed in 2012.

Ahtanum Creek

We conducted snorkel surveys upstream and downstream from a complex of two major diversions on Ahtanum in August of 2012. At river mile 19 of Ahtanum Creek, the Wapato Irrigation Project (WIP) diversion and the Ahatnum Irrigation District (AID) diversions are less than a mile apart. We utilized the same survey method here that we used at diversions in the Toppenish Creek watershed. Snorkel surveys were conducted with three-person teams on 200-meter study sections upstream and downstream from this complex. Despite the use of two snorkelers, many "blind spots" obscured by rocks or exceedingly shallow areas probably contained fish that went unobserved and tallied. Due to these limitations, we believe that parr were consistently underestimated.

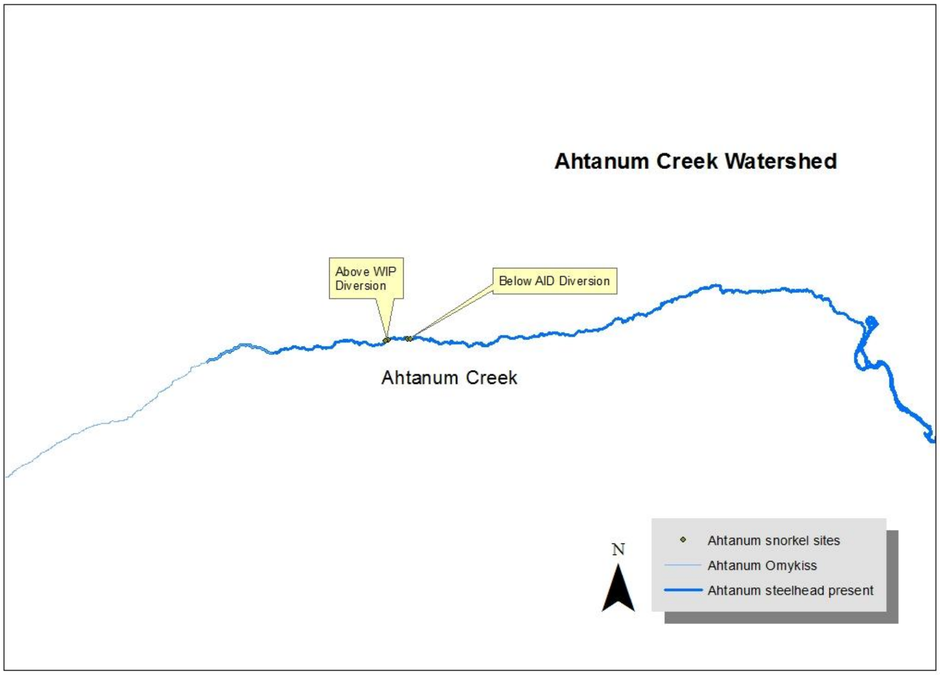

Figure 6. Location of snorkel survey sites in the Ahtanum Creek watershed in 2012.

Water Temperature monitoring

Data-loggers are used 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 (Figure 7). The Yakama Reservation Watersheds Project staff utilize these 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 (e.g. management of riparian timber harvest, water withdrawals, etc.).

We deployed a total of 49 devices in the three watersheds in 2012. Data-loggers (Onset Optic Stowaway and Onset Water Temp Pro v2) were launched in spring 2012 and were programmed to collect water temperatures at 40-minute intervals. The units were encased in protective PVC cages and secured to trees and roots using nylon-coated aircraft cable. They were generally placed in pool tailouts that were least likely to dewater during the summer. Although some data-loggers were deployed in early March in 2012, we only used data during the period between April 15th and October 15th to calculate descriptive statistics for evaluating 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).

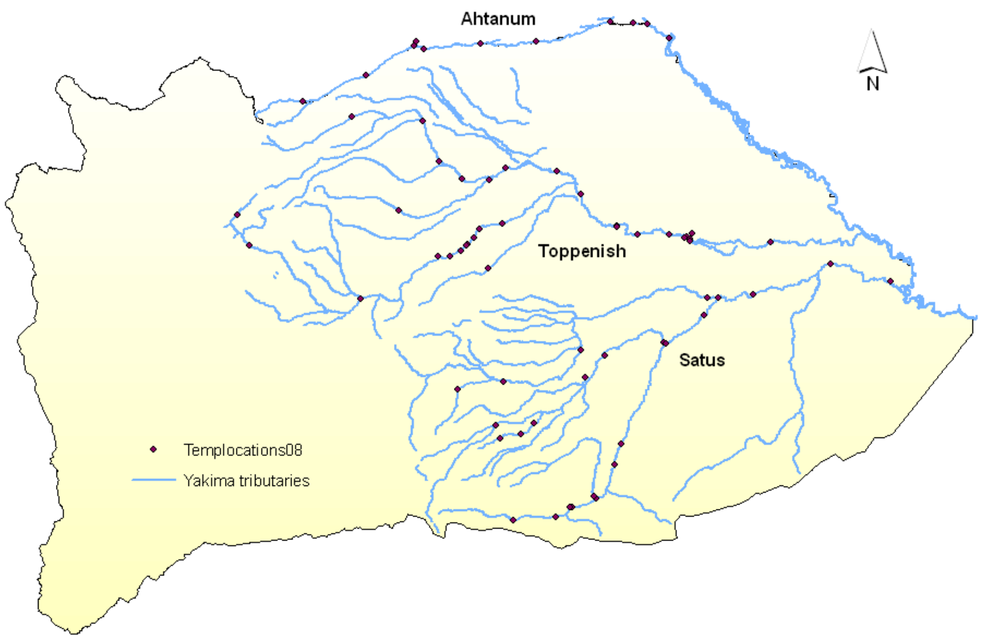

Figure 7. Locations of temperature monitoring stations established between 1997 and 2012 in the Yakima River watershed portion of the Yakama Reservation.

Results and Discussion

Juvenile Out-Migration

Water temperature and photoperiod may play a role, but stream discharge appears to be the primary factor influencing out migration in steelhead. In 2012, a wet spring with high precipitation and mountain snow-pack influenced both outmigration and screw trap operations.

Satus Creek

The Satus Creek screw trap is located within 1 mile from the mouth of the stream and is therefore in a position to intercept fish from all the spawning and rearing habitat in the Satus Creek watershed. The trap was deployed on October 20, 2011, and we caught the first steelhead juvenile on November 29, 2011. Catch rates remained low through

December before increasing sharply following the first major discharge peak in early January. The peak catch occurred on January 3, 2012 and the majority of the steelhead smolt catch occurred during January before catch rates began to decline steadily through February. Only 13.4 % of the total catch occurred during the spring months of March through June (Table 1). As in previous years these results indicate a pattern of downstream migration during late fall and early winter, and overwintering in the complex habitat of the Yakima River before resuming migration during the spring, although a potential spring peak in Satus Creek may have been missed in 2012, as discussed below.

A total of 589 steelhead juveniles were captured in the screw trap between November, 2011 and June 2012. Of these juveniles, we PIT-tagged 549 and released most of these as part of a mark-recapture study to obtain an outmigrant abundance estimate. Twenty-eight of these released fish were recaptured over the season producing an average (pooled) trap efficiency of 5.38%. The stratified estimator we used indicated an estimated 11,200 steelhead juveniles (SE = 2056; CV = 18.3%) migrated past the screw trap located near the mouth of Satus Creek. This is less than expected and only a quarter of the estimated Toppenish Creek outmigrants; however, we may have missed several critical periods. The largest of these occurred between March 30th and April 10th when a large flood event occurred. The trap could not be operated during this period and a significant number of steelhead smolts may have moved past during this 10-day period. Due to the timing and magnitude of this flow event we believe a peak in outmigration may have occurred during this period and would not be represented by such an estimate.

The average length of juveniles captured at the trap was 108 mm, and we did not observe a substantial increase in size as the season progressed (Table 1). Average condition factor was slightly lower than 1.0, which is not surprising because feeding and growth may slow over the winter when many fish are captured.

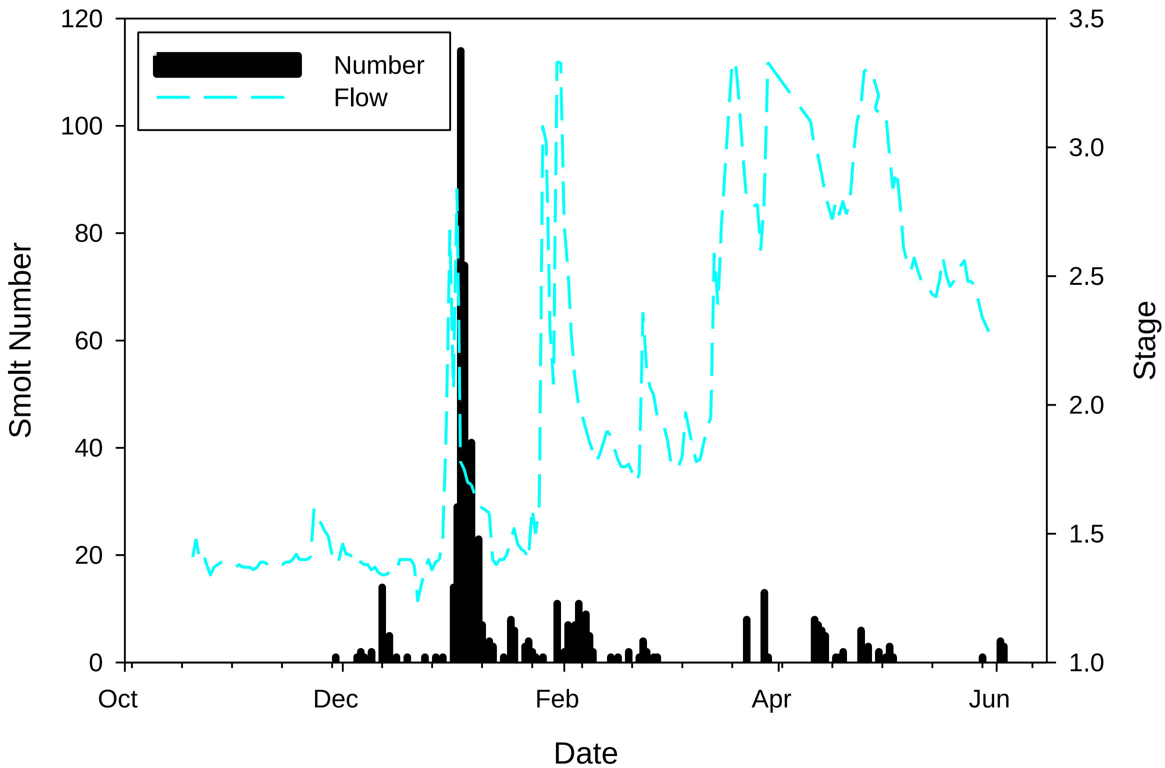

Figure 8. Number of steelhead juveniles captured per day (daily catch) compared with stream flow (represented by stage) at the Satus Creek screw trap in 2012.

Table 1. Monthly steelhead catch statistics for the rotary screw trap in upper Satus Creek (RM 1) for the 2012 season.

Stat	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Overall
Monthly Catch		1	33	403	65	22	43	6	7	580
% of total		0.2%	5.7%	69.5%	11.21%	3.8%	7.4%	1.0%	1.2%	100.0%
Max Fork Length		164	185	180	154	150	180	160	164	185
Min Fork Length		164	78	52	68	75	65	86	104	52
Mean Fork Length		164.00	123.67	106.10	98.70	117.50	125.42	137.33	131.71	108.25
Max Weight		40.5	67.1	58.2	33.07	36.1	55.4	38.2	42.0	67.1
Min Weight		40.5	9.0	1.5	2.22	4.8	3.4	7.2	11.1	1.5
Mean Weight		40.50	22.64	12.94	10.43	11.86	23.54	28.27	24.17	14.07
Mean Cond. Factor		0.918	1.006	0.977	0.98	1.086	1.069	1.029	0.998	0.985
Number tagged		1	21	385	60	19	39	6	7	549.000
%		100.0%	63.6%	95.5%	92.3%	86.4%	90.7%	100.0%	100.0%	94.7%

monthly catch tagged										
%of total		0.2%	3.8%	70.1%	10.9%	3.5%	7.1%	1.1%	1.3%	100.0%

Toppenish Creek

The upper Toppenish Creek trap was deployed during the first week of September, 2011 and remained in until early June, 2012. Juvenile *O. mykiss* were captured throughout this period, but catch rates were low at the beginning and end of the season indicating that little of the outmigration season was missed. Above-normal precipitation and snowpack in 2012 resulted in several runoff events that were beyond those seen in previous years of screw trap operation. As a result, the trap was removed on three occasions for short periods of several hours to several days due to movement of large debris jams and the possibility of stranding operators at the screw trap site. However, during most of the frequent high water events during 2012, we managed to keep the trap operating. During periods of high flow and high catches, staff would stay onsite at the upper Toppenish screw trap in a small travel trailer, check the trap every two hours throughout the night and clean any debris from the cone or live-box. In 2012, YRWP personnel had to stay on-site overnight at the upper Toppenish trap for a total of 4 to 5 weeks mostly between the end of December and mid-April. This practice improved trap efficiency and reduced mortality. Overall (average) trap efficiency for the 2012 outmigration season was 13.7% and juvenile *O.mykiss* mortality for the season was 1.35%. Despite this success, the frequency and magnitude of flood events during the season resulted in lower average efficiency and a higher mortality rate for the MY (migratory year) 2012 season compared with the MY 2011 season.

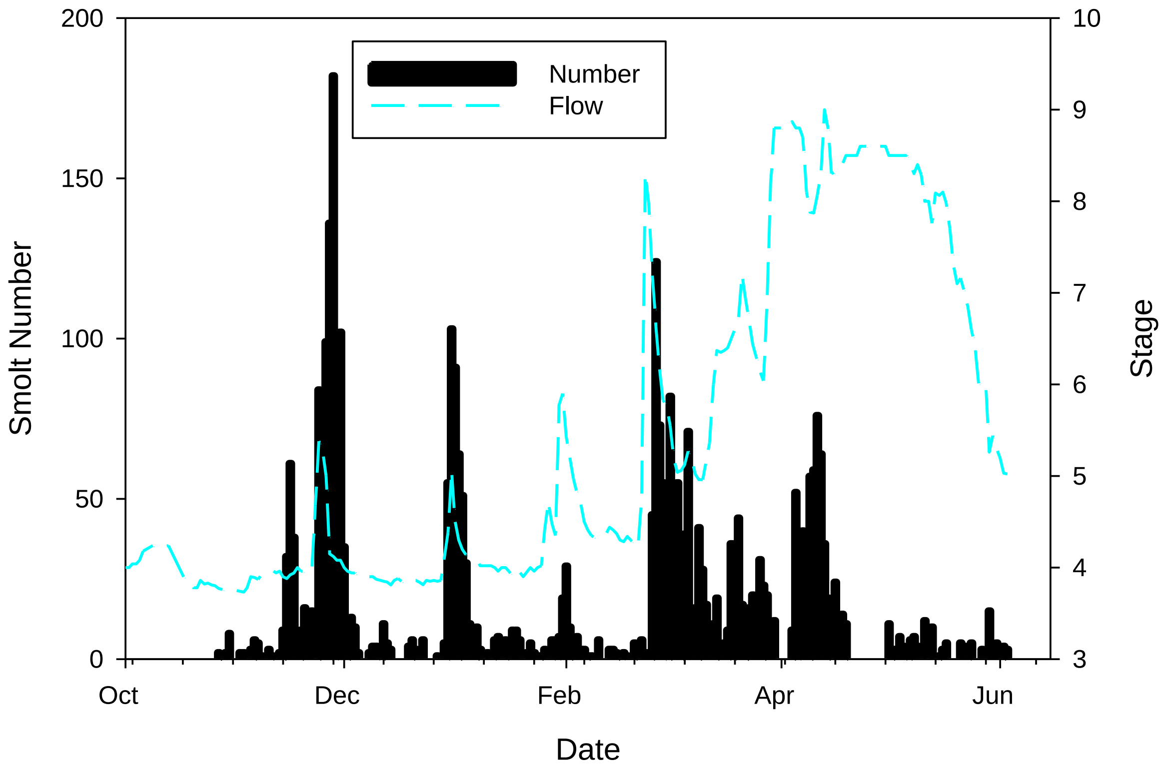

Figure 9. Number of steelhead juveniles captured per day (daily catch) compared with stream flow at the Upper Toppenish Creek screw trap in 2012.

Table 2. Monthly steelhead catch statistics for the rotary screw trap in upper Toppenish Creek (RM 26.5) for the 2012 season.

Stat	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Overall
Monthly Catch	12	944	281	364	439	765	540	119	7	3471
% of total	0.3%	27.2%	8.1%	10.5%	12.6%	22.0%	15.6%	3.4%	0.2%	100.0%
Max Fork Length	183	246	270	343	198	195	190	190	164	343
Min Fork Length	104	68	72	65	50	60	57	71	104	12
Mean Fork Length	131.71	120.59	117.91	116.19	111.24	111.55	100.57	121.08	131.71	113.66
Max Weight	42	145.3	169.89	197.31	73.13	75.11	66	62.2	42	197.31
Min Weight	11.1	3	1.2	1.3	1.7	2.32	1.8	2	11.1	1.2
Mean Weight	24.17	19.42	18.66	16.14	15.55	16.92	13.55	22.12	24.17	17.29
Mean Cond.Factor	0.998	0.975	0.991	0.942	0.984	1.048	1.103	1.067	0.998	1.299
Number tagged	7.0	585.0	145.0	305.0	386.0	502.0	376.0	75.0	7.0	2393.0
% monthly catch tagged	58.33%	61.97 %	51.60 %	83.79 %	87.93 %	65.62 %	69.63 %	63.03 %	100.00 %	68.94%
%of total	0.20%	24.45 %	6.06%	12.75 %	16.13 %	20.98 %	15.71 %	3.13%	0.29%	100.00 %

The first juvenile steelhead of the season were captured on October 27th, 2011--nearly 2 months after the screw trap was first deployed. Little movement by steelhead smolts was shown to occur during the month of June during prior screw trapping seasons. This indicates that little outmigration occurs during the warmer periods of the year. It also may suggest that few residents are present in this reach of Toppenish Creek.

In MY 2012, the peak in screw trap catch occurred at the end of November--earlier than normal. Migratory behavior appeared to be triggered by a minor spike in discharge (Figure 1). 27.5 % of the MY 2012 juveniles were captured before December 1st, when typically only a few juveniles were captured during this period in previous years.

During MY 2011, monthly catches decreased later in the season with less than 7% of the annual catch occurring during the spring period (March-June). However, at the nearest PIT tag detection site on the Yakima River at Prosser dam (RM 48), migrants typically are detected from the end of April through May. In MY 2012, we observed a different pattern. More spring migration was apparent at the screw trap with 41% of the catch occurring from March through June, in contrast with the typical year in which the majority of steelhead juveniles appear to pass the trap from November through January. Surprisingly, the 2012 out-migration pattern most closely resembled that of 2005, but 2005 was one of the drier years on record.

The total catch for the 2012 season was 3471 steelhead and of these, 2393 were PIT tagged. Catches and numbers tagged decreased from MY 2011 due to higher flows that decreased the efficiency of the trap.

Our primary goal in operating the screw trap is to estimate of the number of steelhead juveniles migrating out of the spawning and rearing habitat of upper Toppenish Creek and into the over-wintering habitat on lower Toppenish Creek and the Yakima River (outmigration estimate). In 2012, our estimate of total outmigrating juveniles was 40,152 (SE=3790; CV=9.4%). The trap operation had to be halted for several short periods due to above-normal peak flows that washed out the access road to the trap. Catches were interpolated during these high flow dates from catches three dates before and after trapping was halted. For the purpose of monitoring trends in juvenile out-migration, using the estimate of all juveniles captured at the trap is probably prudent assuming that no substantial differences in age composition or migratory behavior exist between years.

Although these estimates do not differentiate between residents and anadromous steelhead smolts, we have concluded that the number of residents moving through this portion of Toppenish creek is small and possibly discountable. That assumption is based on documentation of very few recaptured *O.mykiss* that were not previously released upstream as part of an efficiency test and recaptured within a few days. With a more robust resident population we would expect periodic recaptures of residents that were PIT-tagged earlier in the season or in prior years. These non-efficiency recaptures are more commonplace in watersheds where resident populations are present at the trapping location. Another indicator of resident *O.mykiss* absence is the rarity of individuals larger than 200 mm in the catch. Such larger individuals are however, sometimes seen miles upstream during summer snorkel surveys. High summer temperatures may prevent the resident population from establishing themselves lower in the watershed where the traps are located. In our similar screw trap on Ahtanum Creek, we frequently catch *O. mykiss* larger than 200 mm, despite the slower rotation rate of the trap cone. This suggests that trap avoidance by larger fish is not the reason for their absence in the Toppenish Creek catch. Large *O.mykiss* are also rare in the Satus Creek screw trap catch.

Lower Toppenish Screw Trap

In 2012, we operated a second screw trap at a new location near the mouth. Just 14 juvenile steelhead were captured at this site indicating that the trap location and site stream morphology was less than ideal. However, we could not locate a better site near the mouth of Toppenish Creek. Like our other sites on the Yakima River floodplain, morphology and low gradient make screw trapping a challenge. It is impossible to obtain estimates of outmigration with such a low sample size. Timing is also unclear for the same reason; however, outmigration through this location appears to occur throughout the season (December through June). Most PIT-tagged juveniles appear at the first detection facility at Prosser Dam from late April through mid-May.

We recaptured two steelhead juveniles tagged at the upper screw trap site and both appeared to exhibit overwinter growth.   This is consistent with a previous trapping study conducted on lower Toppenish Creek at the USFWS Toppenish Refuge where over winter growth of PIT tagged juveniles was also observed (Jezerek and Petersen 2005). In addition to steelhead juveniles, we captured 1106 chinook smolts--mostly smaller specimens that were likely fall chinook--but also some larger possible spring chinook juveniles earlier in the season. Three coho juveniles were captured in the spring as well.

We hope to increase the efficiency of this trap in future years by using weir panels to direct more flow and fish into the screw trap. The trap data supplement detections at an instream PIT tag antenna operating at the same location since December, 2011. We hope to continue operation of the screw trap through 2013 to test efficiency of these antennas in detecting outmigrating smolts and to recapture juveniles tagged upstream to collect information on winter growth. If the antenna continues to operate at a high-enough efficiency allowing us to calculate survival rate through the lower reach, we may relocate the lower screw trap to Marion Drain to obtain an out-migrant estimate for that part of the Toppenish Creek watershed.

Table 3. Monthly steelhead catch statistics for the rotary screw trap in upper Toppenish Creek (RM 1) for the 2012 season.

Stat	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Overall
Monthly Catch	0	0	1	1	4	4	3	1	0	14
% of total	0.0%	0.0%	7.1%	7.1%	28.6%	28.6%	21.4%	7.1%	0.0%	100.0%
Max Fork Length		.	200	110	154	164	180		.	200
Min Fork		.	200	110	97	80	80		.	80

Length										
Mean Fork Length		.	200.00	110.00	125.25	130.75	145.67		.	136.23
Max Weight		.	73.13	13.9	154	44.5	56.7		.	73.13
Min Weight		.	73.13	13.9	97	19.3	4.9		.	4.9
Mean Weight		.	73.13	13.90	125.25	33.47	37.17		.	31.68
Mean Cond.Factor		.	0.914	1.044	0.928	1.009	0.943		.	0.967
Number tagged		.	1.0	1.0	4.0	1.0	3.0		.	10.0
% monthly catch tagged		.	100.00%	104.43%	100.00%	25.00%	100.00%		.	71.43%
%of total		.	10.00%	10.44%	40.00%	10.00%	30.00%		.	100.00%

Ahtanum Creek

In 2012, we captured 30 fish in between the months of December and June. Over half of these juveniles were captured in May. The sample size is too low to draw many conclusions from these data. However, several years of data indicate later migration timing than in the Toppenish or Satus watersheds.

Table 4. Monthly steelhead catch statistics for the rotary screw trap in upper Ahtanum Creek (RM 3) for the 2012 season.

Stat	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Overall
Monthly Catch			5	6	1	1	1	16	0	30
% of total			16.67%	20.00%	3.33%	3.33%	3.33%	53.33%	0.00%	100.00%
Max Fork Length			208	210	133	150	194	217	0	217
Min Fork Length			107.0	140.0	133.0	150.0	194.0	158.0	0.0	107.0
Mean Fork Length			170.8	173.6	133.0	150.0	194.0	181.7	0.0	176.1
Max Weight			80.7	210.0	24.6	36.0	83.0	102.8	0.0	102.8
Min Weight			11.5	140.0	24.6	36.0	83.0	40.2	0.0	11.5
Mean Weight			54.3	173.6	24.6	36.0	83.0	65.9	0.0	59.8
Mean Cond.Factor			0.97	0.97	1.04	1.07	1.14	1.08	0.00	1.04
Number tagged			5	6	1	1	1	16	0	30
% monthly catch tagged			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%	100.0%

<u>Adult Abundance</u>

A total of 6359 adult steelhead were enumerated at Prosser Dam between July 1, 2011 and June 30, 2012, the second highest return since counting at Prosser Dam started in 1983. The highest return occurred recently in MY 2010 (n= 6796) and the third highest in 2011 (n=6196). With the three highest counts at Prosser occurring over the last three years, an increasing trend in steelhead spawning escapement is apparent. However, 2012 redd counts in the Satus, Toppenish and Ahtanum watersheds did not correspond with the trend seen at Prosser. Low redd counts were seen in both Toppenish and Satus Creeks, but instead of low spawning escapement, this probably reflects a low success rate in identifying redds due to high water throughout most of the season. Radio tracking of Prosser-tagged adults in these reaches throughout the 2012 spawning season indicated higher escapement than that suggested by redd counts. Nevertheless, snorkel surveys conducted throughout the summer of 2012 indicate low parr densities in Satus, Toppenish and Ahtanum during this period, as discussed in a later section. Extensive scouring of steelhead redds during floods was the most likely cause.

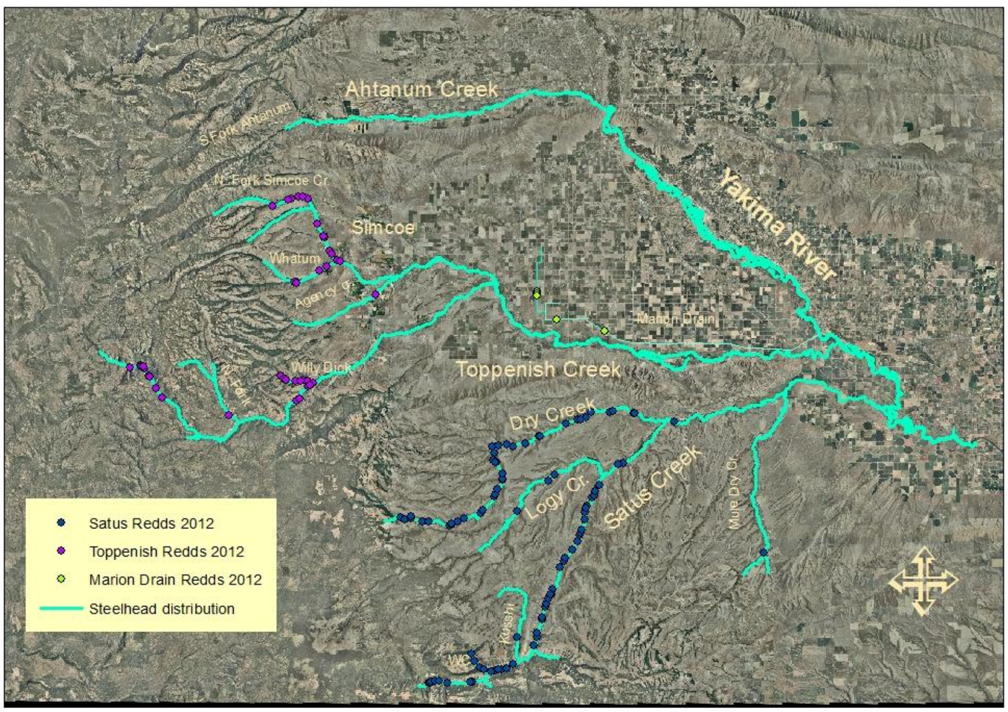

Figure 10. Location of steelhead redds in Satus Creek, Toppenish Creek, and Marion Drain 2012.

Satus Creek

On March 30, 2012 a substantial rainfall (4 to 7 inches) event took place in the Satus Creek basin resulting in a large flood. A preliminary discharge of 6100 cfs was estimated (Ladd 2012a). Local residents reported that they had not seen water this high since the 1970’s. This event occurred around the typical peak in steelhead spawning (from the end of March to the beginning of April). As a result steelhead redds were likely scoured, escaping detection and failing to produce viable offspring.

Fewer redds were identified in 2012 (N=152) than in 2011 (N=293) or 2010 (N=465). Most redds were identified in the mainstem Satus Creek (N=69) and Dry Creek (N=71). Only four redds were identified in Logy Creek in 2012; this probably reflects the high streamflow rather than low spawning escapement. Logy Creek drains a relatively high-elevation plateau that received significant rainfall at the end of March on top of heavy snowpack. Flows were too high to perform surveys between the end of March and the beginning of May. Only one pass could be performed in May after flows receded. By this time many of the redds constructed earlier had likely been obliterated by flooding.

Redds were identified in some of the smaller tributaries of Satus Creek and numbers ranged from zero in Shinando Creek to six in Wilson Charley Creek.

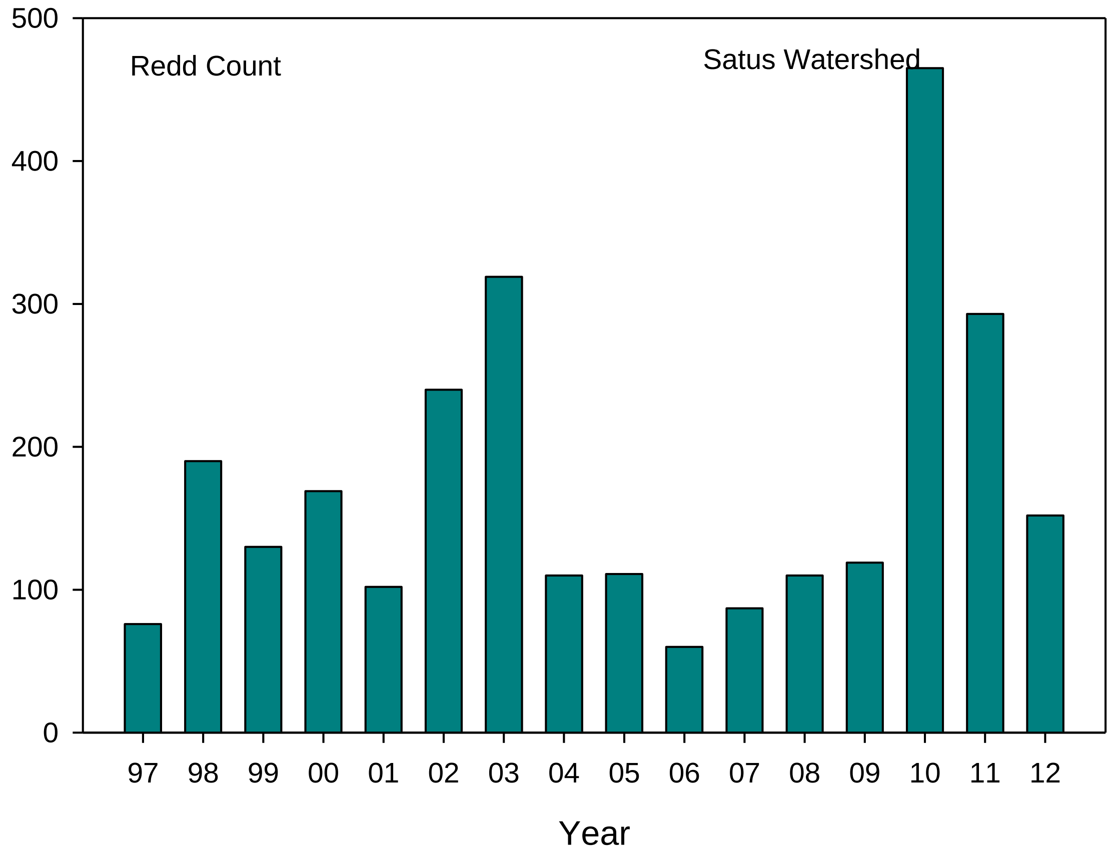

Figure 11. Number of steelhead redds per year in the Satus Creek watershed.

Table 5. Number of steelhead trout redds per reach in the Satus Creek watershed in 2012. 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	**22**
(3 passes)	Wood Bridge (40.8)	County Line (36.4)	4.4	**7**

	County Line (36.4)	High Bridge (32.4)	4	**12**
	High Bridge (32.4)	Holwegner(28.4)	4.8	**7**
	Holwegner (28.4)	2nd X-ing (23.7)	3.9	**17**
	2nd X-ing (23.7)	1st Xing (20.2)	3.5	**3**
	1st X-ing (20.2)	Gage (17.4)	2.8	**1**
	Gage (17.4)	Rd 23 (13.1)	4.3	**0**
Total			**31.9**	**69**
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	**4**
	3rd Xing (3.5)	Mouth (0.0)	3.5	**0**
Total			**14**	**4**
DRY	South Fk. (27.8)	Saddle (24)	3.6	**10**
(3 passes)	Saddle (24)	Elbow Xing (18.25)	5.75	**33**
	Elbow Xing (18.25)	Seattle Cr (14)	4.25	**11**
	Seattle Cr (14)	Rd 75 bend (8.75)	5.25	**6**
	Rd 75 bend (8.75)	Power Line Ford (2.5)	6.25	**8**
	Power Line Ford (2.5)	Mouth (0.0)	2.75	**3**
Total			**27.85**	**71**
W. CHARLEY	Forks (1.9)	Mouth (0.0)	**1.9**	**6**
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**	**1**
TOTAL			**92.05**	**152**

Toppenish Creek

In 2012, only 46 redds were identified in the Toppenish Creek watershed. This is substantially fewer than expected and certainly reflects the poor surveying conditions discussed above, rather than low spawning escapement in the Toppenish Creek *w*atershed. This is the lowest number of redds identified since 2006.

Of the Toppenish Creek sub-watersheds, the planned three passes could only be completed in the Simcoe Creek watershed. Fourteen redds were identified in the Simcoe Creek watershed. High flows are typically less of a barrier to completing spawning surveys in Simcoe Creek.

In the mainstem of Toppenish Creek, only one pass could be completed after the flows subsided in late May. Surveys of two reaches comprising the center of steelhead spawning in the mainstem were completed on March 27th, 2012. Rain and rising waters on March 28th prevented us from finishing the survey of the mainstem as planned. Heavier rain (4 to 7 inches) over the following days in the region produced a flood not seen in the watershed since the late 1990's (Ladd 2012a, b). At elevations above 4000 feet, substantial snow pack was added during this event. Preliminary discharge readings at the Toppenish Creek gage at river mile 44 peaked at over 7000 cfs, and this site does not include discharge from Simcoe Creek which enters at river mile 32.7. As discharge from the precipitation subsided in mid-April, warmer temperatures triggered snowmelt in the higher elevations of the Toppenish Creek watershed where snow pack was 152% of normal on April 1, 2012st (Ladd 2012a). These events created conditions where wading surveys were impossible between March 28th and May 20th—most of the steelhead spawning season. These conditions resulted in a redd count totaling only 18 for the mainstem Toppenish Creek. Most of these (N=10) were documented in the uppermost reach where water temperature is cooler and spawning appeared to occur after most of the scouring flows receded. No redds were identified below the Willy Dick Creek confluence (river mile 48.5) where spawning habitat is typically productive. In addition, fewer redds than normal were identified in Willy Dick Creek and the North Fork Toppenish Creek (Table 6).

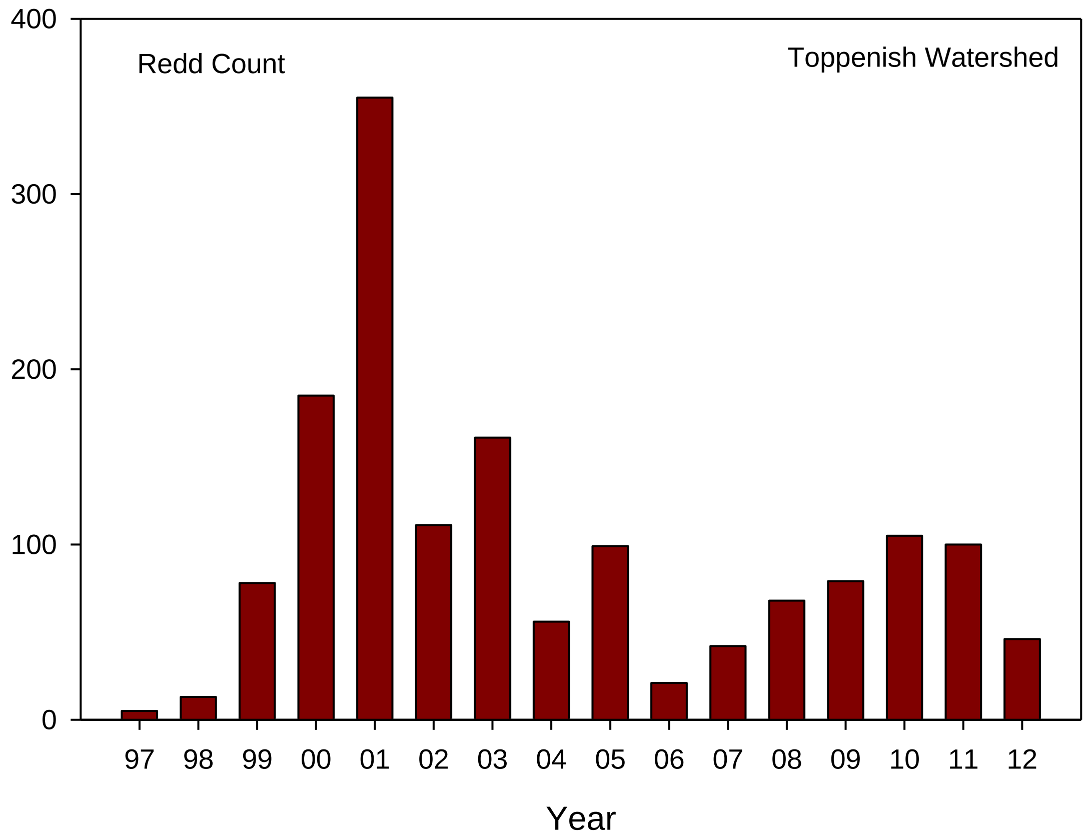

Figure 12. Number of steelhead redds per year in the Toppenish Creek watershed.

Table. 6 Number of steelhead redds in the Toppenish Creek watershed in 2012.

	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	**10**
	"East Bank" (61.1)	NF confluence (55.4)	5.7	**2**

	North Fork (55.4)	Washout (50.9)	4.5	**0**
	Washout (50.9)	Willy Dick Cr (48.5)	2.5	**5**
	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	**0**
Total			**29.9**	**18**
N. Fork Toppenish	NF Falls (4)	NF confluence (0)	**4**	**1**
Willy Dick	old logging site (4)	Confluence (0)	**4**	**8**
		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	**6**
	Simcoe Creek Rd. (15.3)	Wesley Rd. (10.1)	5.2	**2**
	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	**0**
Total			**25.7**	**14**
Agency	Falls (8.9)	Lateral Canal (4.4)	4.5	**0**
	Lateral Canal (4.4)	Confluence (0)	4.4	**1**
Total			**8.9**	**1**
Wahtum	Yesmowit Rd. (3.6)	Confluence (0)	**3.6**	**5**
Total			76.1	**46**

Marion Drain and South Satus Drain.

Seven redds were identified during a survey of Marion and Harrah drains on March 5th, 2012. A survey of the South Satus drain that empties into the Yakima River several hundred meters downstream from Satus Creek did not reveal any redds or adult steelhead despite the presence of riffles that could be used for spawning by steelhead.

Ahtanum Creek

In 2012, no steelhead redd counts could be completed due to higher-than-normal water following heavy rainfall throughout the region on March 30, 2012. Three bull trout surveys were completed in the South fork of Ahtanum Creek on Sept 12, Sept 25, and Oct 4, 2012. We found a total of 2 redds during the first 2 passes. No live bull trout were documented in 2012.

Redd Count Expansion

The cumulative redd count was multiplied by 2.5 fish per redd for a spawning escapement estimate of 115 adult steelhead for the Toppenish Creek watershed. The 2.5 fish per redd expansion used for our estimate (Gallagher et al. 2007) 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). A backup method of estimating abundance is to disaggregate the total adult steelhead count at Prosser by the proportion of radio-tagged steelhead (from Prosser) returning to the Toppenish Creek watershed (11%) during a radio-telemetry study that spanned 1989-1992 (Hockersmith 1995). With 6359 adult steelhead counted at Prosser between July 1, 2010 and June 30, 2011, we can use this 20-year-old proportion to estimate a return of 699 Toppenish steelhead.

In Marion Drain and Harrah Drain, we documented 7 redds. Multiplied by the standard 2.5 fish per redd an escapement estimate of 17 adult steelhead is obtained. The proportion of steelhead spawning in the Marion Drain system was 2% in the Hockersmith (1995) study explained above. A disaggregation of the Prosser count using this figure produces an escapement estimate of 127 adult steelhead. Redd counts are typically incomplete in Marion Drain and only capture activity by the earliest spawners. After irrigation commences in early April, flow increases substantially along with turbidity making redd identification nearly impossible.

For Satus Creek the cumulative number of redds for the season was 152, which when multiplied by the standard 2.5 fish per redd produces an estimate of 380 adult spawners. This is considerably fewer than the number calculated using the Satus Creek proportion developed in the Hockersmith (1995) radio-tagging study. During the course of the Hockersmith study (1989-1992), 48% of steelhead adults tracked after tagging at Prosser entered the Satus Creek watershed to spawn. Expanding the overall Prosser count in 2012 (6359) produces an estimate of 3052 spawners in Satus Creek, suggesting that we should have identified over 1500 redds if there was a 1:1 male:female ratio and 100% survival to the spawning habitat by adult steelhead. If this Prosser expansion method is accurate, only 10% of the redds were identified in 2012. In reality more females than male likely returned and migration survival from the mouth to redd construction was probably lower.

A 3-year radio-telemetry study began in 2011, which should provide further insight into tributary escapement. Although at this point it provides only one year of data. About 15% of steelhead tagged at the Prosser Dam facility for the 2011/2012 migration period that were tracked to a likely spawning location returned to Toppenish Creek (including Marion Drain), a slightly increased proportion from the early 1990s (Chris Frederiksen (YN); personal communication). Using this Prosser Count Disaggregation method coupled with the 2012 radiotracking data and adjusting for tagging effects (tag mortality and tag regurgitation) an estimate of 812 +/- 153 to the mouth of Toppenish Creek was obtained. Preliminary results of the 2012 radiotracking data indicate a lower proportion (42 %) of the steelhead adults spawning in Satus Creek compared with 20 years ago (48 %). This isn't surprising since significant gains in stream habitat restoration and instream flow management have been made in steelhead producing portions of the other watersheds (i.e. Toppenish, Naches, Upper Yakima). Satus Creek which is unregulated and not impacted by irrigation has required and been subjected to less restoration activity. After adjusting for tagging effects, an escapement estimate of 2176 +/- 217 to the mouth of Satus Creek was obtained (Chris Frederiksen (YN) personal communication).

These two tagging studies suggest the redd count expansion method likely underestimates steelhead spawning escapement due to poor visibility or scouring of redds during high water events between surveys.

Steelhead Parr Monitoring

Satus Creek

The two index sites on Satus Creek (Table 6) are located in a reach that provides high-quality spawning and rearing habitat with favorable water temperatures. There are channelized portions of this reach that, if addressed through removing dikes and relocating a road, could provide more complex habitat and more production.

Age 0 parr density was lower at these two sites in 2012 compared with 2010 and 2011. Significant flooding during the peak spawning period was probably the reason for this apparent decrease.

Table 6. Number and density of steelhead parr at sites in upper Satus Creek above the Wilson Charley Creek confluence in 2012.

	Age 0 Satus above Wilson Charley Cr.	Age 0 Satus at Wooden Br.	Age 1 + Satus above Wilson Charley Cr.	Age 1 + Satus at Wooden Br.
		2010		
Number	145	323	98	105
Density (per 100 m²)	9.73	23.30	6.58	7.57
		2011		
Number	133	90	22	66
Density (per 100 m²)	8.92	6.49	1.48	4.76
		2012		
Number	84	76	40	13
Density (per 100 m²)	5.64	5.48	2.68	0.94

As in much of the lower Yakima watershed, age-0 steelhead juvenile density was lower in 2012 than in 2011 at the two Dry Creek sites. The highest densities of age-0 *O. mykiss* were recorded at the Dry Creek snorkel index sites in 2010. Densities were slightly higher in 2011 than in other years in Logy Creek (Table 5). The strength of this year class made 2011 the best year for densities of age-1 juveniles at all sites in both tributaries.

Among all sites in 2012, Dry Creek at the Elbow crossing had the highest density of both age 0 and age-1+ juvenile *O. mykiss* (Table 7). The perennial portion of Dry Creek typically has higher parr densities than Logy Creek. In 4 of the 6 years that surveys have been completed in these tributaries of Satus Creek, the highest parr density has been observed at the Elbow crossing site.

Table 7. Number age 0 and Age 1 steelhead observed during snorkel surveys of Dry Creek and Logy Creek in 2012

	Age 0	Age 0	Age 0	Age 0	Age 1 +	Age 1 +	Age 1 +	Age 1 +
	Dry Creek at the Elbow Crossing (200m)	Dry Creek below HWY 97 (200m)	Logy Creek at upper crossing (200m)	Logy above HWY 97 (200m)	Dry Creek at the Elbow Crossing (200m)	Dry Creek below HWY 97 (200m)	Logy Creek at upper crossing (200m)	Logy above HWY 97 (200m)
2007								
Number	129	121	45	.	49	30	15	.
Density	11.84	9.92	2.62	.	4.50	2.46	0.87	.
2008								
Number	151	71	49	32	131	48	10	59
Density	13.86	5.82	2.86	2.24	12.02	3.94	0.58	4.14
2009								
Number	25	159	34	22	62	12	34	4
Density	2.29	13.04	1.98	1.54	5.69	0.98	1.98	0.28
2010								
Number	521	692	47	32	148	47	9	14
Density	47.81	56.76	2.74	2.24	13.58	3.82	0.52	0.98
2011								
Number	313	97	54	47	234	145	52	23
Density	28.72	7.96	3.79	2.74	21.47	11.89	3.65	1.34
2012								
Number	83	10	28	26	33	17	24	2
Density	7.62	.82	1.96	1.52	3.03	1.39	1.68	0.12

Toppenish Creek

In 2012, storms resulted in substantial rainfall on the middle and lower elevations of the Toppenish Creek watershed. The upper mainstem Toppenish was most affected by significant flooding that occurred near the peak of spawning activity for steelhead. As a likely result, the *O. mykiss* densities were the lowest seen since surveys began in 2005 (Table 8). August densities ranged from 0 fish/ 100 m² at Pom Pom Road (RM 38.9) to 10.5 fish/ 100 m² at a new site on the North Fork Toppenish Creek near the mouth (where a restoration project is planned for 2014). These results followed adult returns in 2012 that were estimated to be the 2nd highest (after 2010) in a nearly thirty-year record of anadromous fish enumeration at Prosser Dam. Parr densities in 2012 were, considerably lower than those observed in 2010 following another large adult steelhead return. These snorkel surveys confirmed our observations of extensive redd scouring to demonstrate that the timing and magnitude of 2012 flood events were detrimental to egg to parr survival for steelhead in the Toppenish Creek watershed. The MY 2013 outmigrant abundance estimate at the Toppenish screw trap may further validate this conclusion.

In Toppenish Creek, snorkel surveys have become a critical part of our instream flow implementation strategy. Below the Toppenish Lateral Canal, the farthest upstream diversion on Toppenish Creek, minimum instream flows are set each year by the Yakama Nation Tribal Council Fish, Wildlife, and Law and Order Committee, based on recommendations by the Yakama Nation Fisheries Resource Program and other tribal programs. Snorkel survey data aid in making these recommendations and evaluating the effectiveness of instream flow mandates in maintaining fish rearing habitat in reaches that can be (and have been in the recent past) dewatered by irrigation withdrawals. In prior years, a 4.85-mile reach typically went dry on Toppenish Creek in between Olney diversion site on river mile 44 to above Pom Pom Road at RM 39. A minimum instream flow of 10 cfs was established below the Olney Lateral diversion in 2001. Minimum instream flows have increased incrementally each year since 2006. Perennial flow has been present in this reach since 2008 as a result. We have extrapolated the average densities observed during snorkel surveys (years 2005 to 2012) within the previously dry reach to provide rough estimates of the number of age 0 *O.mykiss* parr rearing in this previously dry or intermittent reach. Estimates of rearing par in the 4.85 mile reach ranged from 1138 in 2012 to 14,259 in 2010. Since we believe that parr densities are underestimated due to difficult counting conditions in the shallow water areas of the survey sites, true numbers of parr were likely higher. Although survival rates between the summer /early fall rearing stage and outmigration is unknown, this seems to suggest that a significant portion of the outmigrating smolts rear in this reach in some years based on screw trap mark-recapture point estimates which ranged from 31,830 to 45,849 during this period (excludes years (2006-2009) with partial screw trap estimates).

Table 8. A comparison of density (fish/100m²) of Age 0 and Age 1+ steelhead juveniles at the Olney-Lateral Diversion (RM 44) snorkel survey study site in 2005-2012.

	Age 0	Age 0	Age 0	Age 1 +	Age 1 +	Age 1 +

	Above Diversion	Below Diversion	Above Three way	Above Diversion	Below Diversion	Above Three way
2005						
June	9.54	20.05	13.37	5.04	1.48	0.00
July	11.58	11.93	22.98	0.68	0.86	0.28
August	18.53	26.08	32.54	6.40	4.80	1.42
September	9.54	13.65	22.41	3.13	7.26	5.40
October	10.22	6.03	17.06	5.18	12.55	5.57
2006						
June	0.00	0.80	5.92	1.77	2.28	0.11
July	2.45	6.46	14.16	0.27	0.62	0.80
August	6.40	15.81	26.85	2.18	0.80	0.51
September	5.31	14.82	27.02	0.95	3.38	1.54
October	7.49	9.78	15.19	2.04	2.83	3.47
2007						
June	8.11	11.24	3.58	1.91	1.19	0.00
July	12.89	2.62	0.26	0.36	0.95	0.00
August	11.93	8.56	6.20	3.58	1.84	0.63
September	12.17	9.51	8.25	4.18	2.14	1.58
October	8.23	12.13	14.56	2.63	2.79	3.15
2008						
June	1.97	3.27	2.73	8.41	5.65	0.53
July	6.44	6.96	5.31	4.65	2.02	0.63
August	8.05	9.45	9.20	9.43	6.48	3.68
September	11.28	9.93	10.41	8.00	4.70	2.94
October	na	na	na	na	na	na
2009						
June	na	Na	na	na	na	na
July	4.24	10.11	7.20	3.58	1.72	1.16
August	10.68	14.27	12.83	5.49	2.62	2.68
September	6.21	5.83	3.21	8.00	6.12	5.73
October	1.61	3.75	4.94	8.00	2.68	3.73
2010						
June	na	na	na	na	na	na
July	2.68	15.04	8.83	10.56	4.52	1.42
August	15.99	14.27	21.29	11.22	8.09	4.73
September	9.84	8.98	8.94	7.76	5.89	3.21
October	6.38	8.15	17.09	6.32	8.50	6.41
2011						
June	na	na	na	na	na	Na
July	8.77	6.78	0.79	6.44	2.56	0.05
August	6.03	2.91	2.05	2.45	1.07	1.16
September	5.85	4.93	1.79	4.12	3.03	1.21
October	5.13	5.83	1.58	1.19	0.42	1.10
2012						
June	na	na	na	na	na	na
July	2.92	2.08	0.58	1.55	2.14	0.63
August	1.31	4.76	0.21	0.12	0.18	0.00
September	3.52	6.54	1.63	3.76	6.30	1.10
October	3.22	4.82	0.84	1.49	1.66	0.74

The density of age 0 *O. mykiss* was greater downstream from the Olney Lateral diversion compared to the upstream site. However, this difference was not significant (T=-187;

p=0.16). Density is higher at the downstream site in many years probably due to more complex habitat below the diversion. Another factor likely causing this higher density is juveniles congregating below the fish screen bypass pipe outlet. The Three-Way snorkel site is located at an abandoned diversion site about one mile downstream from the Olney-Lateral diversion. Relatively low densities of age-0 juvenile *O. mykiss* were observed in 2012 like 2011. In prior years (2005 to 2010), higher densities were observed at this site. This decrease could be attributed to flooding in 2011 and 2012 causing habitat simplification of this reach. Channel straightening and dike construction in the mid-1970s and late 1990s limit the channel migration and woody debris recruitment that allow the formation of pools and other complex features in this reach. Most of this reach now has a plane-bed channel type.

Table 9. *O. mykiss* age 0 number and density (fish/100m²) at Toppenish Creek watershed sites during August 2012.

Site	RM(river mile)	*O. mykiss* Age 0 Number	Age 0 Density	Age 1+ Number	Age 1+ Density
Toppenish Shaker Church Rd.	35.9	5	0.44	16	1.42
Toppenish Pom Pom Rd.	38.9	0	0	10	0.89
Toppenish Wesley Rd.	41.4	86	4.03	1	0.05
Toppenish 3-Way diversion	41.9	4	0.21	0	0.00
Toppenish Olney diversion Downstream	44.2	80	4.76	3	0.18
Toppenish Olney diversion Upstream	44.2	22	1.31	2	0.12
Toppenish Swim Hole	46.6	59	2.93	29	1.44
Toppenish Above N. Fork	55.4	11	0.70	3	0.19
Toppenish S. Fork Upstream	58.2	41	4.10	5	0.50
N.F. Simcoe	32.7--18.9--	35	4.86	27	3.75

Hoptowit Downstream	0.7				
N.F. Simcoe Hoptowit Upstream	32.7--18.9--0.8	30	3.28	34	3.72
North Fork Toppenish Cr	58.2—0.5	107	10.52	28	2.75

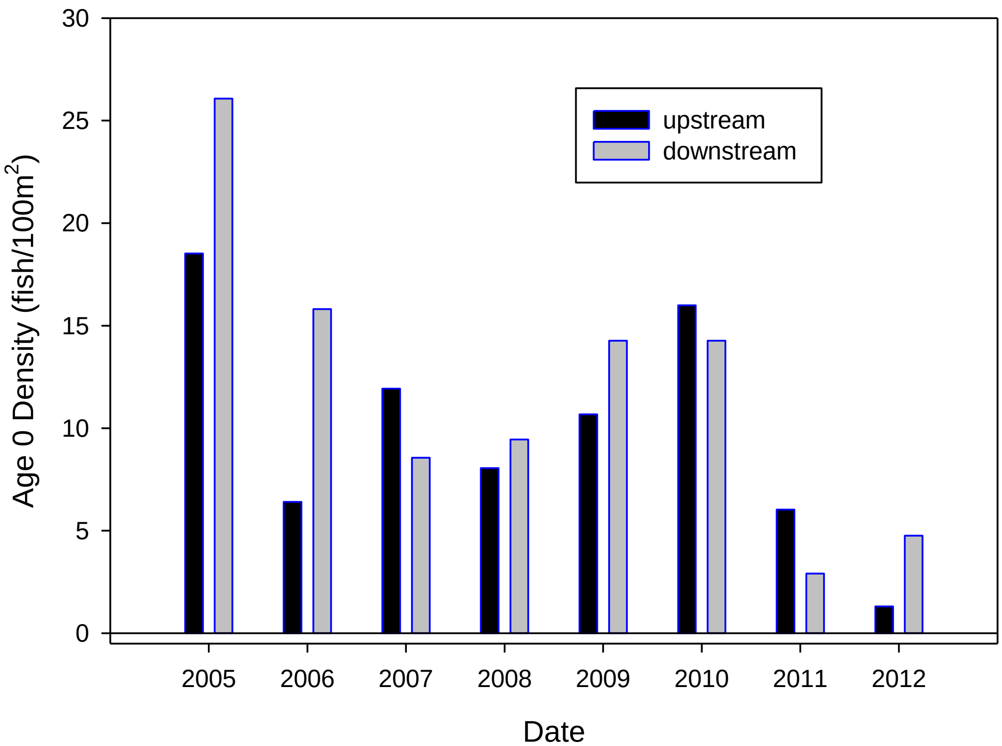

Figure 13. A comparison of steelhead age 0 juvenile densities at locations upstream and downstream from the Olney-Lateral diversion in Toppenish Creek between 2005 and 2012.

Another major point of diversion in the Toppenish Creek watershed is located on the North Fork of Simcoe Creek. Like the Olney Diversion on the mainstem of Toppenish Creek, prior to 2001 the entire North Fork Simcoe Creek was diverted into the Hoptowit Diversion creating a dry reach downstream from the diversion point for approximately one mile before the South Fork enters during the summer. Since 2001, diversion regulation has maintained flow in this reach. Snorkel surveys conducted in this reach have demonstrated rearing capacity in this reach similar to other portions of the watershed. As in the mainstem of Toppenish Creek, relatively lower densities of age-0 steelhead parr were observed in 2012. They were not the lowest densities observed between 2005 and 2012 because in the drought year 2005 no age-0 steelhead were seen in this reach of the North Fork Simcoe Creek. Low parr densities were also seen in 2008 and 2009 (Figure 14).

Table 10. Number and density of steelhead parr upstream and downstream from the Hoptowit diversion on the North Fork of Simcoe Creek in 2012.

	Age 0 Below Hoptowit	Age 0 Above Hoptowit	Age 1 + Below Hoptowit	Age 1 + Above Hoptowit
June				
July	4	18	35	21
August	35	30	27	34
September	11	25	29	32
October	1	14	23	13
Densities (per 100 m²)				
June				
July	0.56	1.97	4.86	2.30
August	4.86	3.28	3.75	3.72
September	1.53	2.74	4.03	3.50
October	0.14	1.53	3.19	1.42

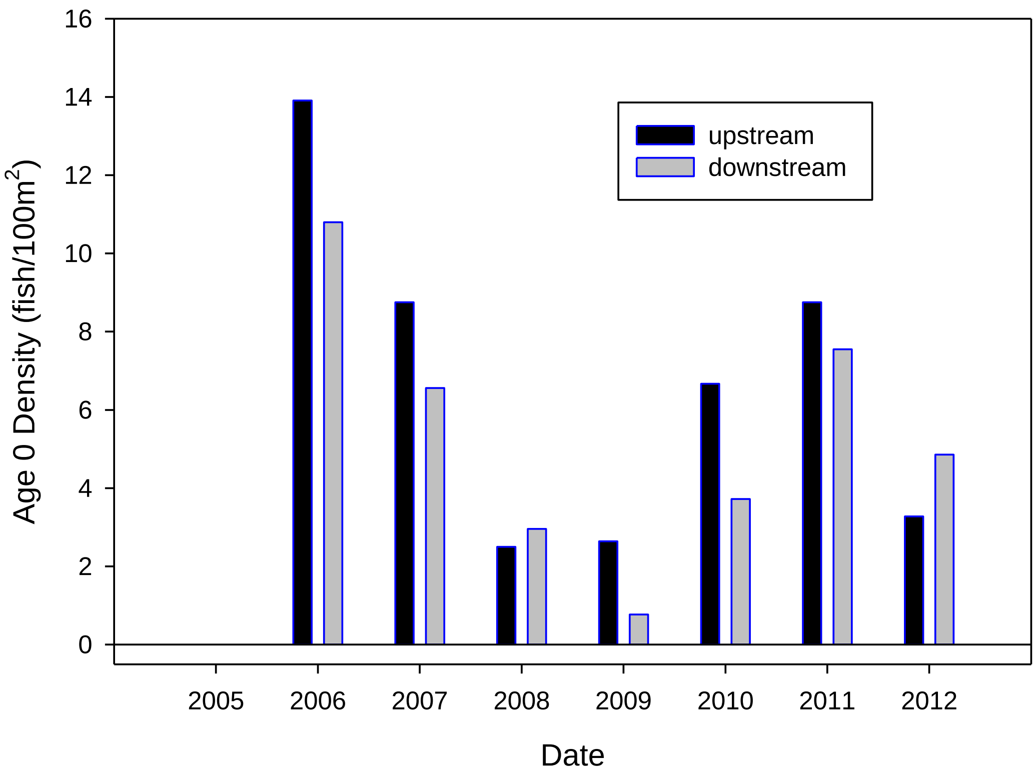

Figure 14. A comparison of steelhead Age 0 juveniles at locations upstream and downstream from the Hoptowit diversion in the North Fork Simcoe Creek between 2005 and 2011 (No age 0 *O. mykiss* were captured in 2005).

Ahtanum Creek

As in the other tributaries of the lower Yakima River, densities of *O. mykiss* were lower in 2012 than in other years on record (Figure 15). This is likely due to significant flooding during the peak spawning period. More age-0 and older juveniles were observed downstream from the diversion complex than upstream (Table 11). This pattern has been observed each year since 2008 and is probably due to increasing channel simplification and coarse gravel deposition that is occurring upstream from the upper (WIP) diversion and increasing channel complexity observed downstream from the lower (AID) diversion after a decade of mandated instream flow.

Table 11. snorkel survey rainbow/steelhead (*O. Mykiss*) numbers and densities at irrigation diversions in Ahtanum Creek 2012.

	Age 0 *O. mykiss*	Age 0 *O. mykiss*	Age 1+ *O. mykiss*	Age 1+ *O. mykiss*
Numbers	Above diversions	Below diversions	Above diversions	Below diversions

August	4	12	9	37
Densities (per 100 m²)				
August	0.19	0.52	0.43	2.04

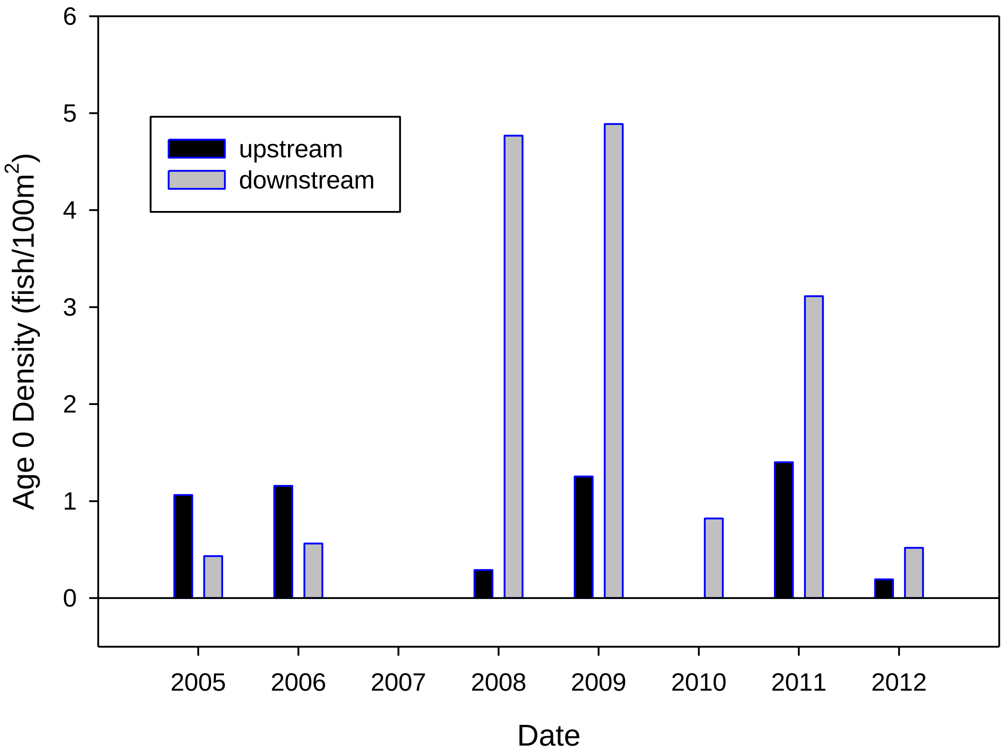

Figure 15. A comparison of steelhead Age 0 juveniles at locations upstream and downstream from the WIP/AID diversion complex in Ahtanum Creek between 2005 and 2012 (no survey was completed in 2007).

Water Temperature Monitoring

Satus Creek

In 2012, we deployed 20 Onset Stowaway and Hobo Temp Pro v2 data loggers in the Satus Creek watershed to assess the suitability of water temperature for salmonids including ESA-listed steelhead and other cold water biota. Yakama Nation Fisheries staff have monitored water temperature in the Satus Creek basin since 1996. We intend to use these long-term data to evaluate changes within the watershed that may affect water temperature (i.e., restoration projects, grazing practices, and timber harvest).

We began deploying the data-loggers in February 2012 at sites in Satus Creek located between RM 1.2 and RM 44 (downstream from the falls that form the upper limit of the steelhead distribution in Satus Creek). We also deployed data-loggers at three locations in Dry Creek, and Logy Creek from the falls downstream on each stream, which defines the upper extent of steelhead spawning and rearing habitat to their confluence with Satus Creek. Additionally, we deployed several data-loggers at headwater sites beyond the upper extent of steelhead spawning habitat. The units were in place and periodically recording water temperatures at 40-minute intervals until we retrieved them at the end of October. This deployment provided a six-month record of stream temperatures spanning the warmest part of the year and allows us to evaluate summer peak temperatures which a likely limiting factor to steelhead production in many parts of the watershed.

Mean daily averages (the mean of all daily average temperatures over the entire deployment period for each station) in the mainstem of Satus Creek ranged from 10.5ºC at the uppermost functioning site (Wooden Bridge at RM 41.4) to 17.6ºC below Plank Road (RM 7.4; Table 12). The greatest instantaneous maximum for the Satus Creek watershed was 26.3ºC below the Dry Creek confluence (RM 18.7). The maximum 7-day average of the daily maximum (MWMT) and average (MWAT) water temperature were used as an index to evaluate suitability for salmonids and other cold water biota along the course of the stream. MWAT in the mainstem ranged from 15.2ºC at the uppermost functioning site to 23.3ºC at the lowermost functioning site (Table 12). MWMT ranged from 18.7ºC to 25.0ºC.

Table 12. Descriptive statistics for water temperature for 2012 at 19 locations in the Satus Creek watershed. Maximum weekly average 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)
Falls (44)	lost							
Wooden bridge (41.4)	19.3	3.6	12.6	10.5	8.8	16.1	18.7	15.2
Satus at Wilson Charley (39.5)	dewatered							
Satus bellow Kusshi Cr.(37.1)	21.6	4.7	15	12.5	10.4	18.6	20.5	17.6
4th Crossing (34.1)	22.8	5.1	16	13.8	11.7	20.2	21.7	19.2
High Bridge (32.4)	24.8	5.6	17.1	14.4	12.3	21.0	23.7	20.0
Above Logy Creek (23.6)	24.8	8.7	19.6	16.8	14.2	21.7	23.9	20.7
1st Crossing (20.2)	24.9	1.2	17.7	15.5	13.5	21.9	23.5	20.7
Below Dry Creek (18.7)	26.3	7.9	19.1	16.3	13.9	22.7	25.0	21.4
Plank Rd. (7.4)	26.1	7.1	18.9	17.6	16.4	24.4	24.7	23.3
N. Satus Rd. (1.2)	Dewatered							
Logy at Falls(12.5)	lost							

Logy at Fourth Crossing (8.8)	lost							
Logy Mouth (0.5)	lost							
Dry Creek at Falls (25.7)	lost							
Dry Creek at Elbow Crossing (18.5)	19.8	5.9	14.9	13.3	12.2	17.9	19.5	17.4
Dry Creek at Mouth (1.2)	19.5	6.4	15.6	14.2	13.0	18.3	18.1	17
Section corner source (4.6)	8.8	7.0	8.4	7.8	7.5	8.1	8.8	8
Section corner mid crossing (2.7)	12.0	4.8	10.2	8.5	7.2	10.1	11.6	9.6
Section corner lower crossing (1.2)	13.4	3.7	10.9	9.0	7.4	11.4	13	10.7

Toppenish Creek

We deployed 16 data-loggers in the mainstem of Toppenish Creek during spring 2012 at sites located between RM (river mile) 2.4 and 66. We also deployed five data-loggers in Simcoe Creek and two in Agency Creek. The units were in place and continuously recording water temperatures at 40-minute intervals until we retrieved them in mid-October 2012. Some units failed to record temperatures due to battery failure; were lost due to high flows, beaver activity, or theft; or dewatered for an extended period, but 15 data-loggers recorded temperatures for the entire period.

Mean daily average temperatures in the mainstem Toppenish Creek ranged from 9.4ºC below O'Connor Creek (RM 65.7) to 18.3ºC at the middle channel of Toppenish Creek at Campbell Road (RM 18.6). The highest instantaneous maximum of 27.0ºC also occurred at the Campbell Road location as well as the highest MWMT (26.2ºC). By most standards the summer water temperature in 2012 in the lower portion of Toppenish Creek (below the Unit 2 diversion) was higher than most salmonids can tolerate (Table 13).

Table 13. Descriptive statistics for water temperature for 2012 at 19 locations in the Satus Creek watershed. Maximum weekly average 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)
Topp. above O'Connor Cr (65.7)	13.7	3.6	10.5	9.4	8.5	12.4	13.1	11.8
Topp. at N. Fork confluence (55.9)	18.1	4.4	13.1	11.1	9.6	15.3	17.2	14.4
Topp. at swim hole (47.2)	dewatered							
1 mile below swim hole (45.9)	21.3	6.7	15.7	14.1	12.7	19.0	20.3	18.2

1 mile above lateral (45.1)	21.1	6.2	15.6	14.1	12.9	19.1	20.2	18.4
Topp. above lateral (44.2)	21.4	4.6	14.5	13.0	11.6	19.4	20.5	18.6
At three way (43.1)	22.7	7.6	16.6	14.7	13.2	20.1	219	19.2
At Cleparty (42.1)	23.8	7.1	17.2	14.9	13.2	20.6	22.8	19.8
Topp. At Shaker Church Rd. (36.1)	lost							
At Old Graves Property (33.9)	malfunction							
Topp. below Mud Lake Drain (31.4)	22.5	9.2	17.4	16.1	15.2	21.2	22.2	20.6
Topp. at Unit 2 (26.5)	23.6	10.0	18.1	17.1	16.3	22.8	23.0	22.0
Topp at Lat A Rd. (21.2)	26.2	8.6	19.5	17.8	16.4	23.9	24.7	23.2
Topp at Campbell Rd. (18.6)	27.0	8.6	20	18.3	16.8	25	26.2	24.3
Topp. Above Snake Creek(16)	25.9	8.9	18.7	17.6	16.6	24.8	25.4	24.2
Topp. below Hwy97 (10.7)	dewatered							
Topp. at Indian Church Rd. (2.4)	24.1	9.8	18.1	16.8	15.6	21.8	23.6	21.4
N. Fork Simcoe (24.9)	15.4	3.9	11.5	10.2	8.9	14.2	14.9	13.5
Simcoe below Forks (18.9)	18.8	6.0	13.8	12.6	11.3	17.6	17.9	16.7
Simcoe at Simcoe Cr. Rd. (15.3)	lost							
Above N White Swan Rd. (8.1)	lost							
Barkes Rd (2.7)	23.4	9	17.2	16.2	14.6	21.4	22	20.2
Agency Creek Below Woodchoppers (8.9)	19.7	6.7	14.6	13.2	11.5	17.8	18	16.2
Agency Creek at Wesley (0.5)	15.6	6.1	13.2	11.4	9.9	13.5	15	12.7

Ahtanum Creek

We deployed four data-loggers in February and March 2012 at sites located between river mile (RM) 0.5 (at the USGS gage) and RM 18.9 (Downstream from the Ahtanum Irrigation District (AID) Diversion). We also deployed two data-loggers in the South Fork and one in the North Fork of Ahtanum Creek near their confluence. The units were in place and continuously recording water temperatures at 40-minute intervals until we retrieved them in mid-October. Several units in the Ahtanum Creek watershed were lost during high discharge, malfunctioned, or were stolen. Four data-loggers recorded temperatures for the entire period (Table 14).

Mean daily averages ranged from 6.6ºC in the South Fork of Ahtanum Creek 11 miles above the confluences to 14.9ºC at 42nd Ave. in Union Gap (Table 14). The highest instantaneous maximum of 24.6ºC was also recorded at 42nd Ave. (RM 14.0) in 2012.

The MWMT were lowest (10.3 ºC) at the upper site on the South Fork of the Ahtanum Creek as expected because they are farthest upstream and at the highest elevation. The site at 42nd Ave (RM 7) displayed the highest MWMT (23.3 ºC) as well as the highest instantaneous maximum. Recharge and shading along the lowest reach of Ahtanum Creek typically decrease water temperature slightly as seen at the USGS gage near the mouth.

Table14. Descriptive statistics for water temperatures at 8 locations in the Ahtanum Creek watershed for 2012. 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 the DNR gate(11.4)	10.7	2.8	7.8	6.6	5.5	9.3	10.3	8.9
South Fork Ahtnaum at campground (8.7)	lost							
South Fork Ahtanum at Mouth(1.0)	malfunction							
North Fork Ahtanum at Mouth (1.3)	malfunction							
AID Diversion (18.9)	22.7	5.1	16.3	13.2	10.7	19.2	22.3	18.4
American Fruit Rd. (14.0)	lost							
At 42nd Ave. (7.0)	24.6	5.8	17.0	14.9	12.4	21.7	23.3	20.5
At USGS Gauge (0.5)	23.3	6.8	16.0	14.6	13.2	21.5	22.1	20.2

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APPENDIX A. ADDITIONAL TABLES AND FIGURES

Table A-1. Steelhead juvenile catch and mark-recapture data stratified weekly for the upper Toppenish creek screw trap for the MY 2012 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	10/24-10/30	12	0	0	
Week 2	10/31-11/06	13	0	0	
Week 3	11/07-11/13	12	0	0	
Week 4	11/14-11/20	167	124	17	2
Week 5	11/21-11/27	373	112	14	7
Week 6	11/28-12/04	446	291	64	1
Week 7	12/05-12/11	12	9	1	
Week 8	12/12-12/18	19	19	4	1
Week 9	12/19-12/25	19	19	1	
Week 10	12/26-01/01	255	143	7	36
Week 11+	01/02-01/08	176	156	52	
Week 12	01/09-01/15	21	7	0	
Week 13	01/16-01-22	31	23	3	
Week 14	01/23-01/29	19	5	0	
Week 15	01/30-02/05	78	65	9	
Week 16	02/06-02/12	11	3	2	
Week 17	02/13-02/19	11	11	3	
Week 18	02/20-02/26	184	162	5	14
Week 19	02/27-03/04	388	308	19	
Week 20	03/05-03/11	217	159	13	1
Week 21	03/12-03/18	88	36	3	
Week 22	03/19-03/25	158	103	8	
Week 23*	03/26-04/01	143	66	1	
Week 24*	04/02-04/08	224	106	2	1
Week 25	04/09-04/15	311	225	11	
Week 26	04/16-04/22	53	44	1	
Week 27*	04/23-04/29	21	0	0	
Week 28	04/30-05/06	33	15	1	
Week 29	05/07-05/13	39	16	1	
Week 30	05/14-05/20	9	8	0	
Week 31	05/21-05/27	19	15	0	
Week 32	05/28-06/03	29	19	2	
Total	**10/24-06/03**	**3591**	**2269**	**244**	**63**

*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.

+ One individual in week 11 was recaptured 6 weeks after it was released upstream of the trap.

Table A-2. Steelhead juvenile catch and mark-recapture data stratified weekly for the Satus Creek screw trap for the MY 2012 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

Statistical week (*i*)	Dates	Number captured (week *i*)*	Number released (week *i*)	Number recaptured (week *i*)
Week 1	11/28-12/04	1	0	0
Week 2	12/05-12/11	6	3	0
Week 3	12/12-12/18	23	23	1
Week 4	12/19-12/25	2	2	1
Week 5	12/26-01/01	16	15	0
Week 6	01/02-01/08	338	327	17
Week 7	01/09-01/15	15	12	1
Week 8	01/16-01/22	21	13	1
Week 9	01/23-01/29	4	3	0
Week 10	01/30-02/05	41	28	2
Week 11	02/06-02/12	22	19	3
Week 12	02/13-02/19	4	4	0
Week 13	02/20-02/26	8	7	1
Week 14	02/27-03/04	1	1	0
Week 15	03/05-03/11	0	0	0
Week 16	03/12-03/18	2	0	0
Week 17*	03/19-03/25	22	8	0
Week 18*	03/26-04/01	18	10	0
Week 19*	04/02-04/08	14	0	0
Week 20*	04/09-04/15	26	23	0
Week 21	04/16-04/22	4	3	1
Week 22	04/23-04/29	13	13	0
Week 23	04/30-05/06	5	5	0
Week 24	5/07-05/13	0	0	0
Week 25	05/14-05/20	0	0	0
Week 26	05/21-05/27	0	0	0
Week 27	05/28-06/03	1	1	0
Total	**11/28-06/03**	**607**	**520**	**28**

*number captured includes 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 A-1. Photograph of the 5-foot rotary screw trap at the upper Toppenish location (RM 26.5) including modifications.