

# 2011

## Annual Report



### **Colville Confederated Tribes** **Fish & Wildlife Department**

**Okanogan Basin Monitoring & Evaluation Program**  
**BPA Project # 2003-022-00**

# **2011 Annual Report**

## **Okanogan Basin Monitoring & Evaluation Program**

### **Colville Confederated Tribes**

**Fish & Wildlife Department  
Anadromous Fish Division**

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## Summary

The Okanogan Basin Monitoring and Evaluation Program (OBMEP) monitors key components of the ecosystem related to anadromous salmonids including biological, physical habitat, and water quality parameters, plus serving to develop baseline research where data are currently unavailable. The program addresses questions specifically related to the Endangered Species Act for Upper Columbia River steelhead. Many of the program methods were influenced by existing strategies (ISAB, Action Agencies/NOAA Fisheries, and WSRFB) and by the Monitoring Strategy for the Upper Columbia Basin (Hillman 2006). In addition, the monitoring program was called for in the Upper Columbia Salmon Recovery Plan and in the Okanogan River Basin sub-basin plan. The collected data have greatly expanded the level of knowledge being used in planning efforts and for fisheries management in the Okanogan River basin. Information related to the status and trends for all salmon and steelhead within the Okanogan River basin requires long-term vision and commitment to provide answers about population level action effectiveness.

The year 2011 was another productive year with the completion of work elements related to collection of habitat, temperature, adult enumeration, spawning distribution, and juvenile abundance data. We catalogued, archived, analyzed, and reported on these data. Additional cooperative efforts resulted in redd and carcass data collection for summer/fall Chinook, real-time temperature and stream discharge data collection, and international coordination with agencies in Canada. Data and reports are available through the Okanogan Basin Monitoring and Evaluation Program website, located at:

<http://cctobmep.com/obmep.php>

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We would also like to extend our appreciation to the many private landowners who have provided land access and enabled us to collect data within the Okanogan Basin.

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## Introduction

Beginning in 2002, the Upper Columbia Regional Technical Team (RTT) attempted to standardize and improve monitoring in the upper Columbia River Basin by developing the Monitoring Strategy for the Upper Columbia Basin (Hillman 2006). A proposal for funding the Okanogan River portion of this strategy was submitted to the Northwest Power and Conservation Council (NPCC) and received a high priority rating from both the Columbia Basin Fish and Wildlife managers and the Independent Scientific Review Panel (ISRP). Funding for this project was approved in 2003. The Colville Tribes' Anadromous Fisheries Division began implementing this project in the spring of 2004 to provide essential information on habitat conditions and fish population viability. The collected data have already greatly expanded the level of knowledge being used in planning efforts and for fisheries management in the Okanogan basin. Information related to status and trends for all salmon and steelhead within the Okanogan River basin requires a long-term vision and commitment to provide answers about population level actions and effectiveness.

The Okanogan Basin Monitoring and Evaluation Program (OBMEP) draws from the existing strategies (ISAB, Action Agencies/NOAA Fisheries, Integrated Status and Effectiveness Monitoring Project (ISEMP), Pacific Northwest Aquatic Monitoring Partnership (PNAMP), and Columbia System-wide Monitoring and Evaluation Project (CSMEP)) and outlines an approach for addressing questions specifically related to anadromous fish management and recovery in the Upper Columbia and more specifically the Okanogan River basin. Therefore, OBMEP is specifically designed to monitor key components of the ecosystem including biological, physical habitat, and water quality parameters. This program also establishes baseline information where data are currently unavailable, thus allowing future status and trend analyses to occur.

The primary project goals of OBMEP include: (1) determining if there is a meaningful biological change at the population scale for steelhead in the Okanogan basin; (2) if meaningful change in selected physical habitat parameters are occurring over time; (3) if selected water quality parameters are changing in mainstem and tributary locations; (4) if change is occurring in Viable Salmonid Population (VSP) parameters from the cumulative habitat restoration actions occurring throughout the Okanogan basin; and (5) administering contracts and ensuring that this effort continues in a scientifically sound manner that is closely coordinated across the Okanogan River basin, geo-political boundaries, upper Columbia ESU, Columbia River basin, and Pacific Northwest region.

## Study Area

The Okanogan basin extends from its headwaters in southern British Columbia through north central Washington State, where it meets its confluence with the Columbia River (Figure 1). Shaped by receding glaciers, the Okanogan basin is comprised of diverse habitat, from high mountain forests to semi-arid lowlands. Often bordered by steep granite walls, water passes

from north to south through a series of large lakes which give way to a low gradient mainstem river before entering the Columbia River near the town of Brewster, WA.

The Okanogan River contains the furthest upstream and northern most extent of accessible anadromous habitat within the Columbia River system. The basin supports a stable population of summer-fall Chinook, a greatly expanding number of sockeye, a population of steelhead which are considered threatened, and rare observations of spring Chinook. During the late summer months, water temperatures in the Okanogan River frequently exceed 24°C, representing a harsh environment for salmonids, which may cause adjustments in juvenile rearing location and adult migration during that timeframe. A number of small cold water tributaries offer a more hospitable environment, but their access is often restricted by lack of discharge and the total extent is often limited by geographic and man-made barriers.

Within the Washington State portion of the basin, the vast majority of land along the river is owned by private landowners, requiring their cooperation for fisheries research activities to occur. Economy in the basin is centered around ranching, mining, timber harvest, agriculture, and fruit crops. In this relatively arid environment, a complex system of fisheries and water management requires the coordination of many local stakeholders, state agencies, federal agencies, and Tribes, spanning two countries.

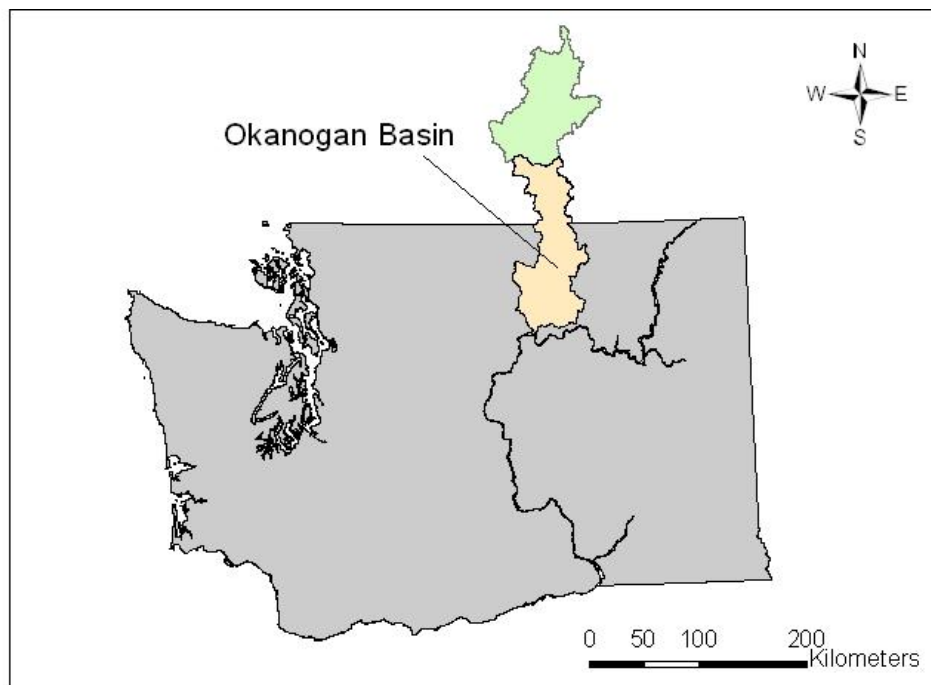


Figure 1. Study site - the Okanogan Basin in north-central Washington State and southern British Columbia.

## Program Methods

In order to collect data in a standardized, thorough, and scientific manner, the methods described in the Monitoring Strategy for the Upper Columbia Basin (Hillman 2006) were adapted for use in the OBMEP program. Snorkel surveys for fish, water quality monitoring, macroinvertebrate sampling, and physical habitat condition sampling were conducted at sites selected using a random, spatially balanced rotating panel design (EMAP sites). These EMAP sites were monitored throughout the Okanogan River sub-basin from March 2011 through February 2012. Migrating adult and emigrating juvenile fish were monitored at fixed sites, through adult weir traps, juvenile rotary screw traps, and underwater video systems. Steelhead redd surveys were conducted using a census approach.

Protocols were developed specifically for OBMEP. The current versions of these protocols can be viewed at the program's website. We are currently working towards uploading all methods and protocols to [monitoringmethods.org](http://monitoringmethods.org). This report provides a synopsis of all data collections and reporting efforts conducted under OBMEP for contract year 2011. Additional information relative to specific data collection activities, or links to previous year's reports can be found at:

[www.cctobmep.com](http://www.cctobmep.com)

## Project Objectives

### Work Element A: Produce Pisces Status Reports

All periodic status reports were completed on time.

### Work Element B: Produce (Annual) Progress Report

Each year, OBMEP produces an annual progress report. Several additional documents were completed as end-products for specific deliverables. Some of these reports and conclusions are included in this document under the specific work elements or as attachments to this document.

### Work Element C: Produce Environmental Compliance Documentation

Permit applications were developed and submitted primarily for operation and collection of fish at our rotary screw trap. All permits were procured before active trapping began. The permits obtained and issuing agencies are as follows:

<u>Title of Permit</u>	<u>Permit #</u>	<u>Issuing Agency</u>
NOAA Section 10 Permit	#16122	NOAA Fisheries
Hydraulic Project Approval (HPA)	#121497-1	WDFW
Scientific Collection Permit	#10-400	WDFW
Bridge Attachment Permit	#7687D	WSDOT
Shoreline Exemption	#1040	City of Okanogan
Floodplain Development Permit	#FDP 05-12	City of Okanogan

In addition to the above permits, OBMEP staff worked with BPA to develop compliance with the HIP-BiOp for all other activities.

## **Work Element D: Develop RM&E Methods and Designs – Revise Protocols**

OBMEP frequently updates protocols in order to reflect any additions, changes, or refinements to methodology. In 2011, the habitat data collection protocol was updated to include modifications and improvements to previous methods. Updated protocols, along with previous versions, are posted to the program's website. In following contract periods, all methods and protocols will be uploaded to [monitoringmethods.org](http://monitoringmethods.org).

## **Work Element E: Monitoring Changes in Standing Crop of Fish and Invertebrates at EMAP Sites**

### **Snorkel Surveys**

The Colville Tribes' Fish and Wildlife Department conducted snorkel surveys in established EMAP sites throughout the Okanogan basin as part of the Okanogan Basin Monitoring and Evaluation Program. In the US portion of the Okanogan, a total of 28 out of 34 sites were snorkeled. One site each on Tonasket and Wanacut Creeks was dewatered, one on Ninemile Creek was inaccessible due to poison ivy, and access was denied by the landowner of one site on Salmon Creek. On Tunk Creek, one site was not done because it was above the anadromous barrier and will be removed from future surveys, and the other site froze over before snorkeling could be completed. In the Canadian portion of the Okanogan all 16 sites were surveyed. Surveys were conducted from mid-August through November, later than in previous years, due to an extended runoff period in 2011.

Tributaries were snorkeled by the same observers as in 2010, and three out of the five snorkelers who snorkeled the mainstem Okanogan and Similkameen rivers in 2010 also snorkeled this year. All observers were trained in fish observation techniques and species identification prior to snorkeling. Time was spent before snorkeling to ensure estimates of size classes were consistent within and among observers.

Seventeen species of fish were observed among all EMAP sites in the US and Canada. All fish species had been observed previously in at least one of the last 5 years. The most abundant species of fish observed were three-spined stickleback (*Gasterosteus aculeatus*; N=35,179), which were observed among three sites on the Okanogan River. Steelhead (*Onchorhynchus mykiss*) were the next most abundant species (N=1,523), followed by northern pikeminnow (*Ptychocheilus oregonensis*; N=1,027). None of the sticklebacks, 1.1% of steelhead, and 0.4% of northern pikeminnow were greater than 300 mm in length.

Juvenile *O. mykiss* (<300mm) were observed in both the US and Canadian portions of the Okanogan and Similkameen basins. The highest densities observed at any single site on a creek was on Omak Creek (6,255 fish/ha), followed by Bonaparte Creek (3,647 fish/ha), and McLean Creek in Canada (3,419 fish/ha). Three sites were sampled on Salmon Creek, and densities among these sites ranged from 103 to 1,745 fish/ha. Two sites below the anadromous barrier on Omak Creek had densities of 3,560 and 6,255 fish/ha. In contrast, the density of juvenile *O. mykiss* at four sites above the anadromous barrier ranged from 223 to 912 fish/ha. No juvenile *O. mykiss* were observed in 13 out of 14 sites on the mainstem Okanogan in the US and 1 out of 3 sites in Canada, and none were observed in Ellis or Reed Creek in Canada. Total numbers and densities of juvenile *O. mykiss* for all streams and rivers are presented in Table 1 for the Washington State portion of the basin and Table 2 for the British Columbia region. Density of fish was calculated by dividing the number of observed fish within the snorkel site by the wetted area.

Table 1. Snorkel surveys conducted in the WA portion of the Okanogan basin in 2011.

WA Streams	Total Observed Juvenile <i>O. mykiss</i> (N)	Density (fish/Ha)
Aeneas Creek	not sampled	
Antoine Creek	49	1,942
Chiliwist Creek	not sampled	
Bonaparte Creek	94	3,647
Johnson Creek	not sampled	
Loup Loup Creek	48	1,267
Ninemile Creek	not sampled	
Okanogan River	30*	0.4†
Omak Creek	996*	1,982†
Salmon Creek	251*	830†
Similkameen River	33*	10.2†
Siwash Creek	not sampled	
Stapaloop Creek	not sampled	
Tonasket Creek	creek dry	
Tunk Creek	not sampled	
Wanacut Creek	not sampled	

\*sum of juvenile *O. mykiss* from multiple sites per creek.

†average density of juvenile *O. mykiss* from multiple sites per creek.

Table 2. Snorkel surveys conducted in the BC portion of the Okanogan basin in 2011.

BC Streams	Total Observed Juvenile <i>O. mykiss</i> (N)	Density (fish/Ha)
Ellis Creek	0	0
Haynes Creek	not sampled	
Inkaneep Creek	91*	806†
McLean Creek	175*	2,228†
Okanogan River	2*	0.5†
Park Rill Creek	2	1.3
Reed Creek	0	0
Shatford Creek	24	321
Shingle Creek	5*	80†
Shuttleworth Creek	60*	176†
Testalinden Creek	not sampled	
Vaseux Creek	227	839

\*sum of juvenile *O. mykiss* from multiple sites per creek.

†average density of juvenile *O. mykiss* from multiple sites per creek.

Figure 2 and Figure 13 provide a geographic reference for annual snorkel survey sites in the Okanogan basin. Trends of observed juvenile *O. mykiss* during snorkel surveys of tributaries to the Okanogan River are shown in Figures 3 – 12 and for mainstem locations in Figures 14 – 20. Data from 2008 were omitted in this analysis due to questions surrounding the quality of data during that year. Snorkel survey data are presented as density of *O. mykiss*/Ha, which was derived by dividing the observed number of fish in each site by the wetted surface area of the survey site. Wetted surface area was calculated by measuring 22 evenly spaced wetted width measurements within the site and multiplying the average width by the total survey reach length.

The highest densities of juvenile *O. mykiss* continued to be observed in the Okanogan basin tributaries, when compared with the mainstem Okanogan and Similkameen Rivers. In the mainstem Okanogan, warm water temperatures, commonly exceeding 24°C on most years, likely limit distribution of juvenile salmonids during that timeframe. However, quantity of water (i.e. dry creeks, as seen in the figures below) appears to limit distribution in small tributary locations. Tributaries that support adult steelhead spawning, but are most notably affected by low summer discharges, include Tonasket, Wild Horse Spring, Tunk, lower Salmon, and Loup Loup Creeks.



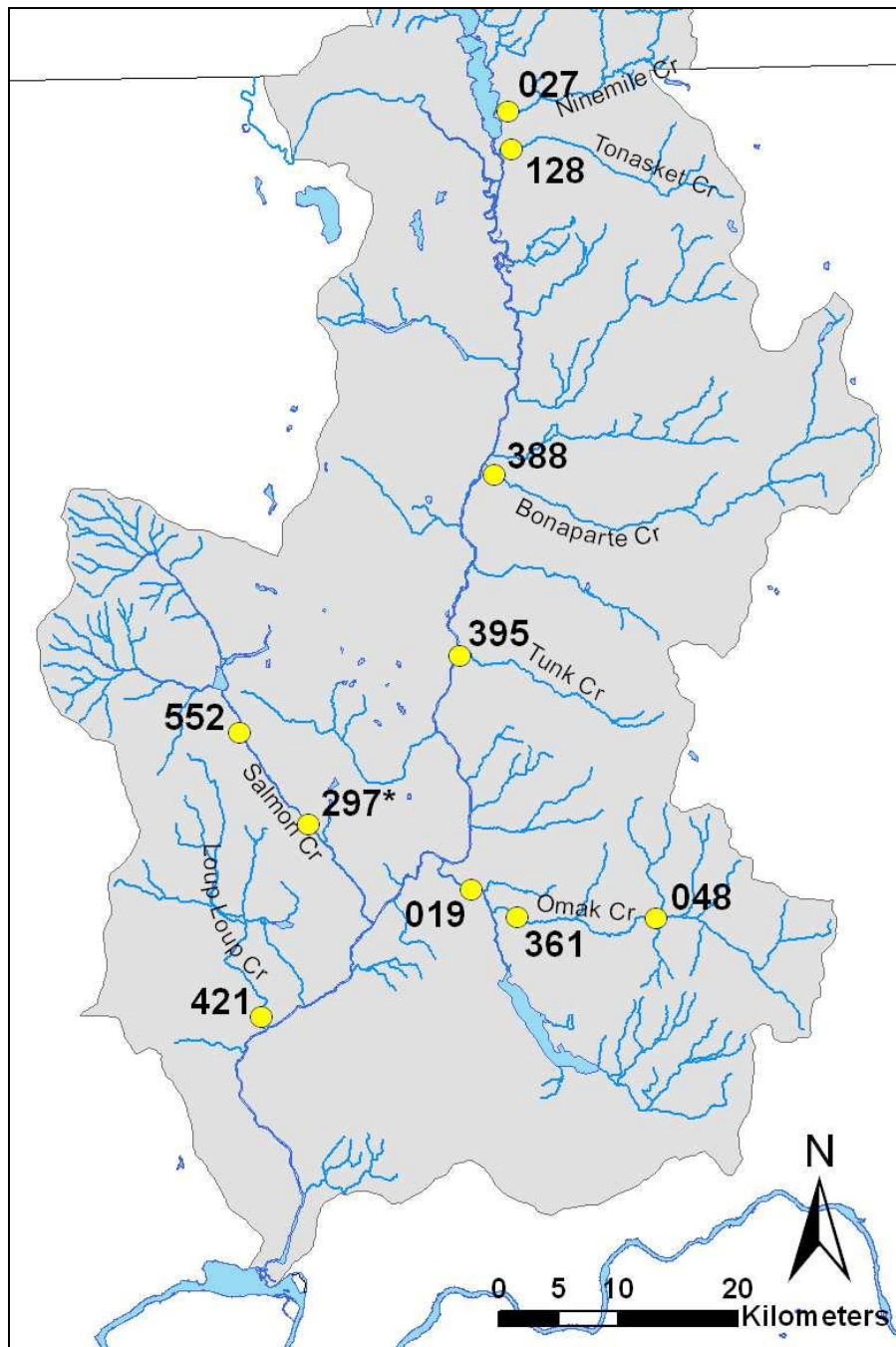


Figure 2. Location of 10 annual snorkel survey sites on tributaries to the Okanogan River. Rotating panel sites are not included in the below analysis due to fewer years of data available for each site.

\*Site 297 on Salmon Creek was changed from a previous annual site (360) in 2009.

### Ninemile Cr - 027

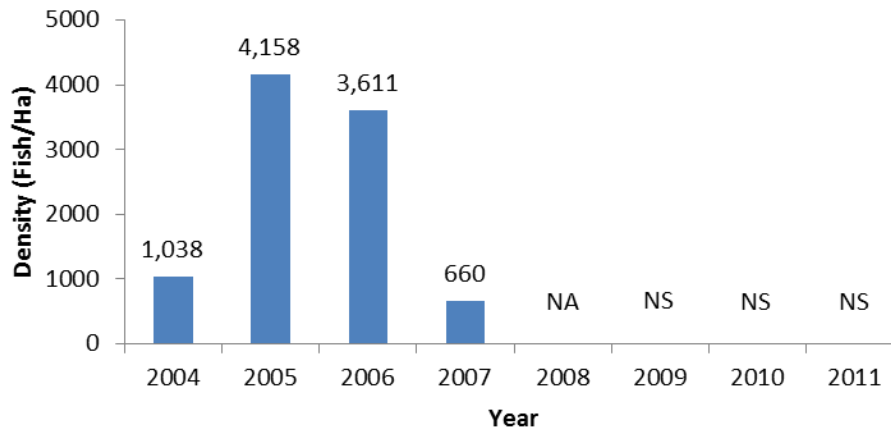


Figure 3. Observed densities of juvenile (<300mm) *O. mykiss* in Ninemile Creek. This site was not sampled from 2009-2011 due to complete poison ivy canopy closure. This site was subsequently moved for the 2012 sampling year.

### Tonasket Cr - 128

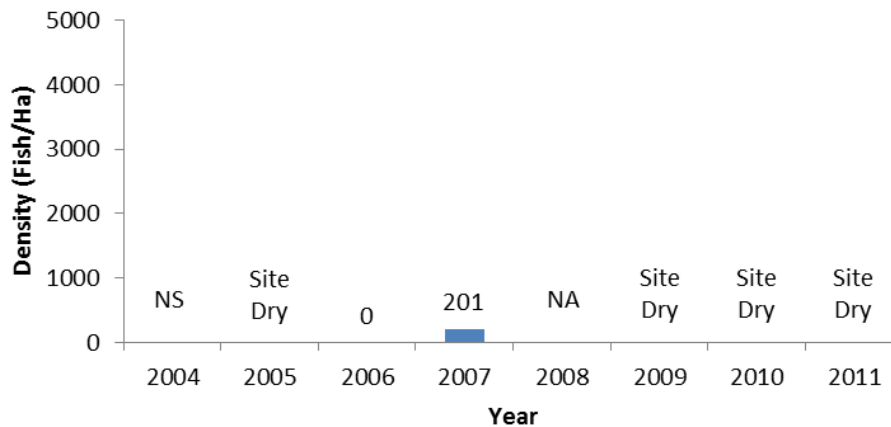


Figure 4. Observed densities of juvenile (<300mm) *O. mykiss* in Tonasket Creek.

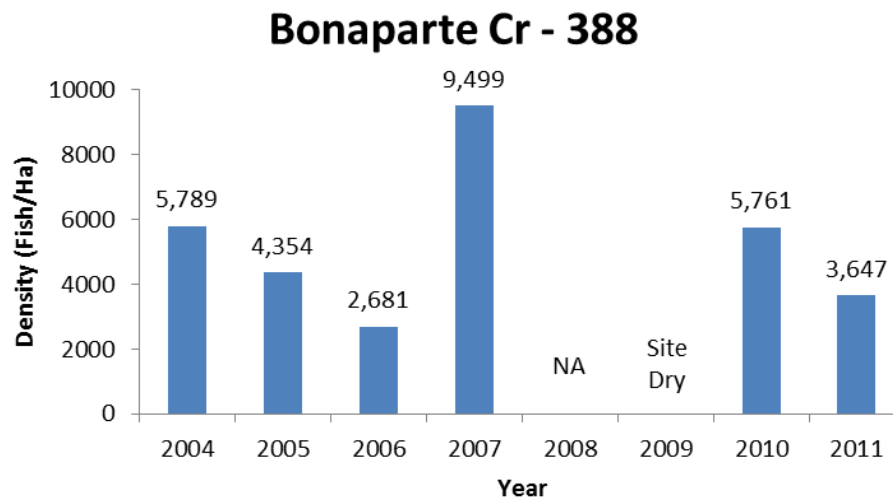


Figure 5. Observed densities of juvenile (<300mm) *O. mykiss* in Bonaparte Creek in the city of Tonasket, WA.

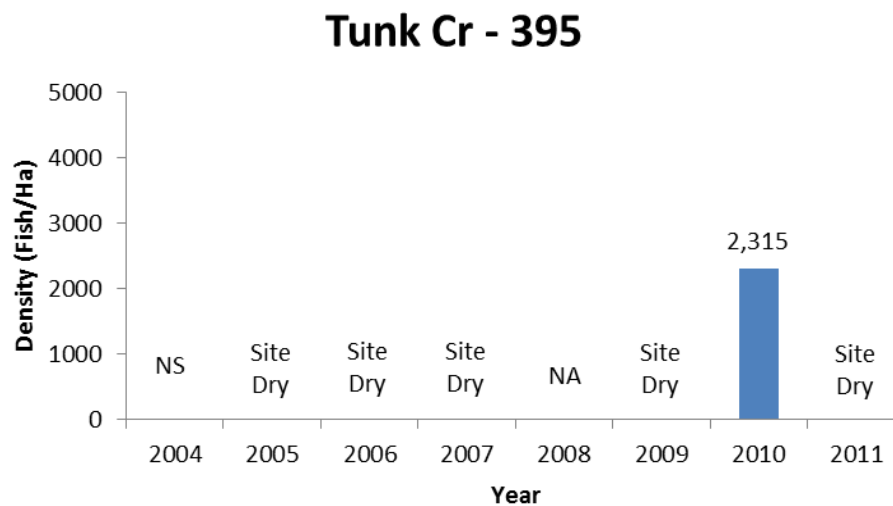


Figure 6. Observed densities of juvenile (<300mm) *O. mykiss* in the lower extent of Tunk Creek, below the anadromous barrier.

### Omak Cr - 048

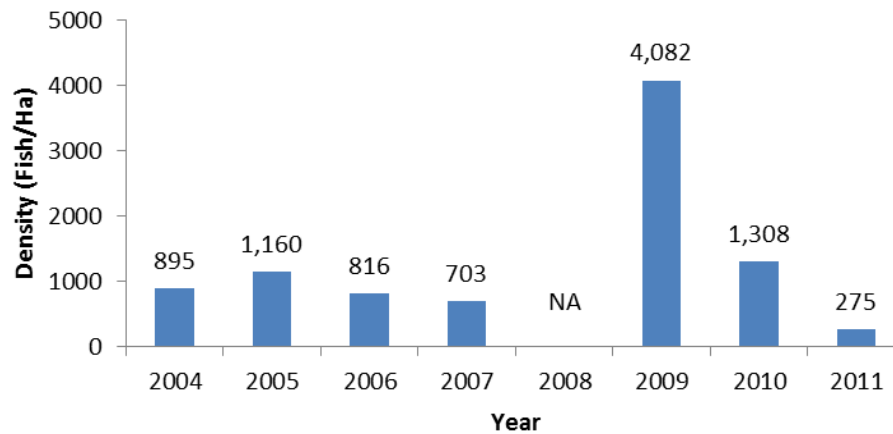


Figure 7. Observed densities of juvenile (<300mm) *O. mykiss* in Omak Creek, the upper most site in the Omak Creek watershed.

### Omak Cr - 361

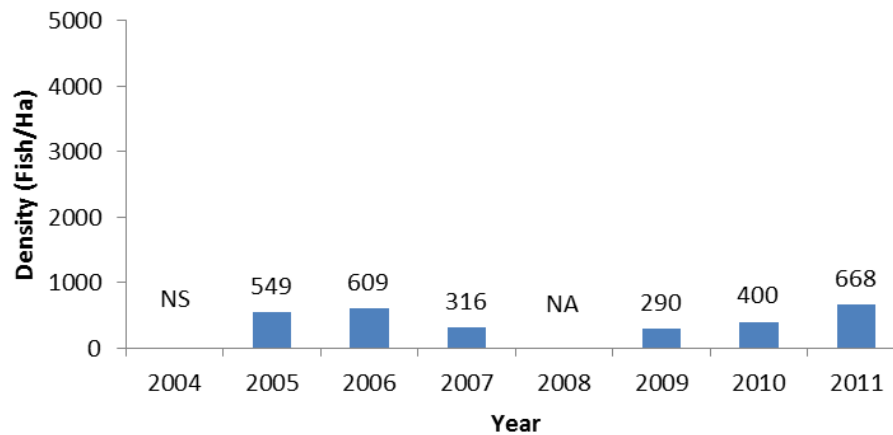


Figure 8. Observed densities of juvenile (<300mm) *O. mykiss* in Omak Creek, located in the middle portion of the watershed, but above Mission Falls (anadromous barrier).

### Omak Cr - 019

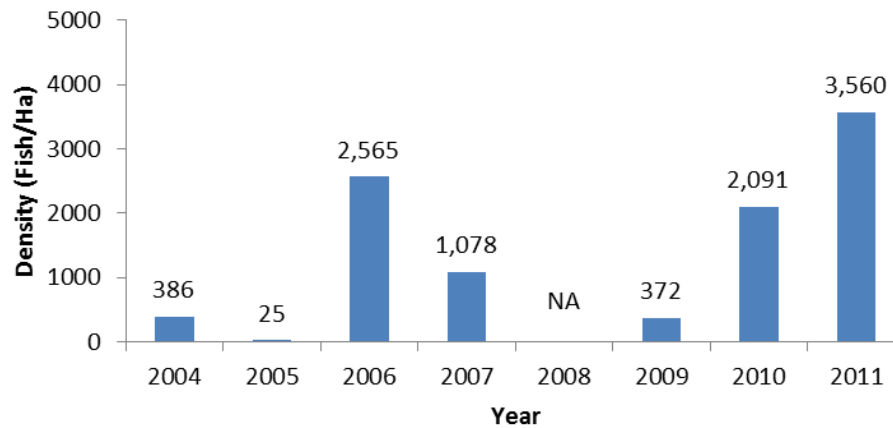


Figure 9. Observed densities of juvenile (<300mm) *O. mykiss* in Omak Creek, the lower most site on the creek, and the only annual site below Mission Falls.

### Salmon Cr - 552

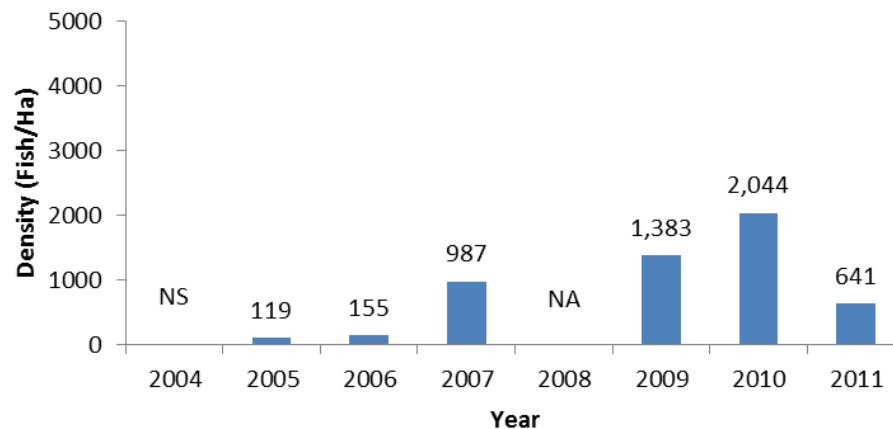


Figure 10. Observed densities of juvenile (<300mm) *O. mykiss* in Salmon Creek, the upper most annual site on the creek, near the historical townsite of Ruby.

### Salmon Cr - 297

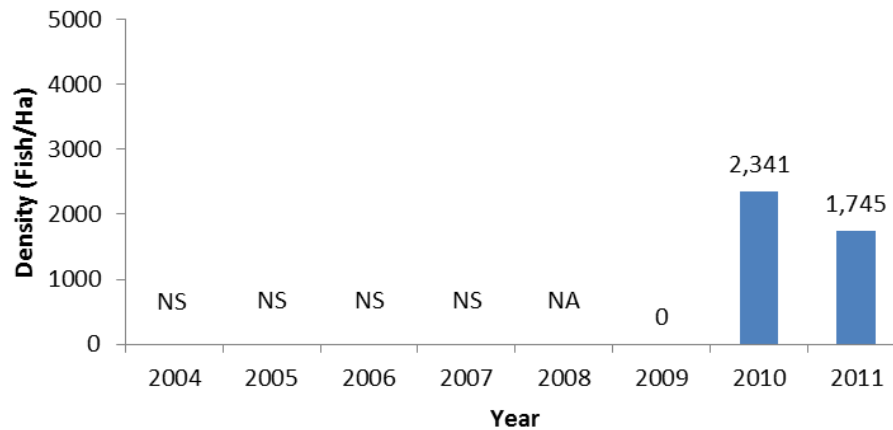


Figure 11. Observed densities of juvenile (<300mm) *O. mykiss* in Salmon Creek. This site was moved from a previous site (site 360) in 2009 due to access related issues. Therefore, fewer years of data exist for site 297.

### Loup Loup Cr - 421

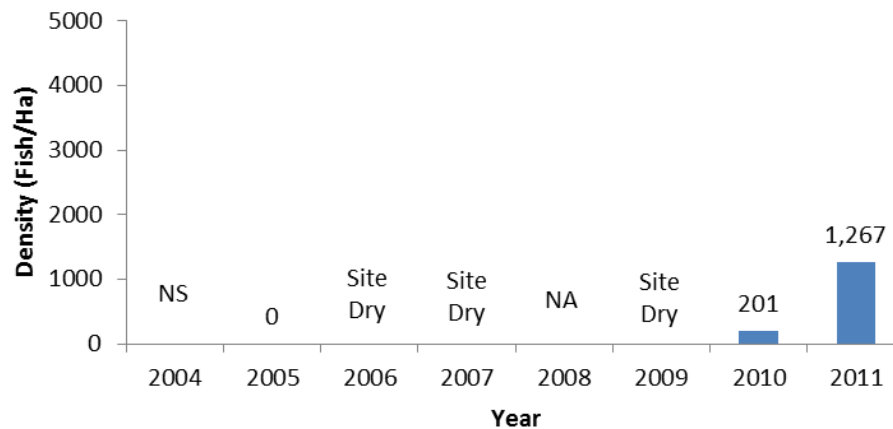


Figure 12. Observed densities of juvenile (<300mm) *O. mykiss* in Loup Loup Creek, in the town of Malott, WA.

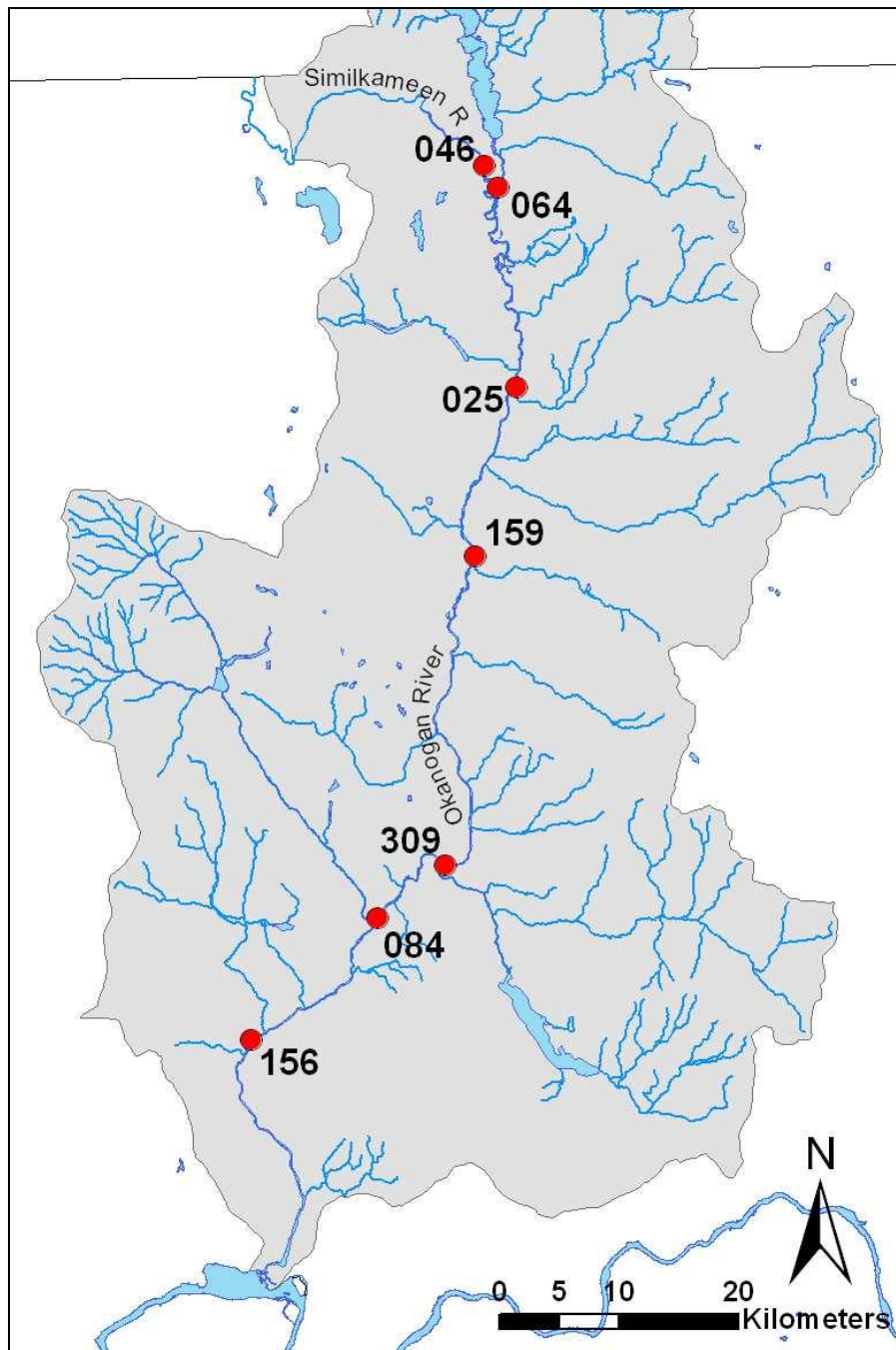


Figure 13. Location of 7 annual snorkel survey sites on the mainstem Okanogan River. Rotating panel sites are not included in the following analysis due to fewer years of data available for each site.

### Similkameen River - 046

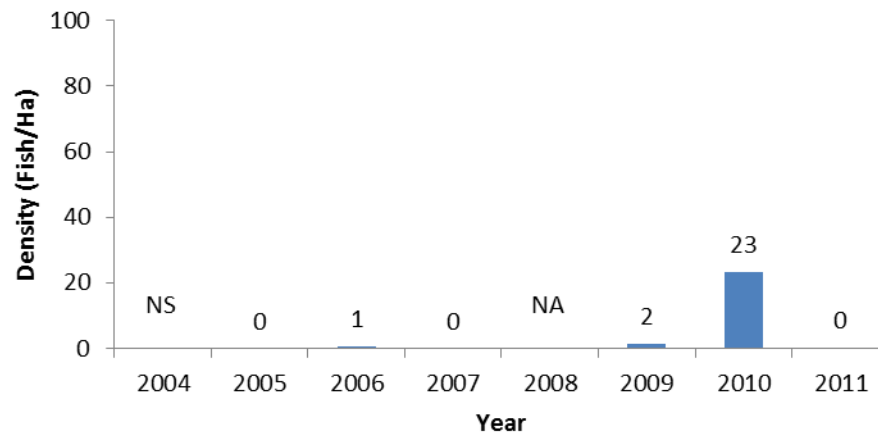


Figure 14. Observed densities of juvenile (<300mm) *O. mykiss* in the Similkameen River, near the city of Oroville, WA.

### Okanogan River - 064

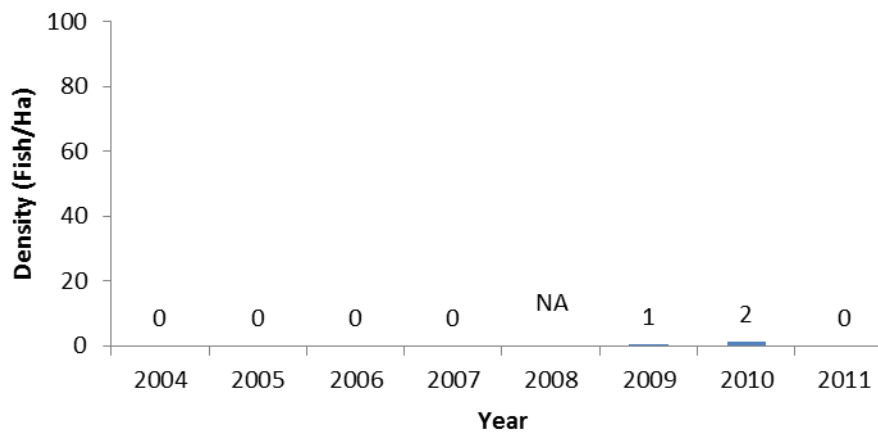


Figure 15. Observed densities of juvenile (<300mm) *O. mykiss* in the Okanogan River. Site 064 is located below Zosel Dam, in the east channel, adjacent to the cross-channel at the north end of Driscoll Island.



### Okanogan River - 025

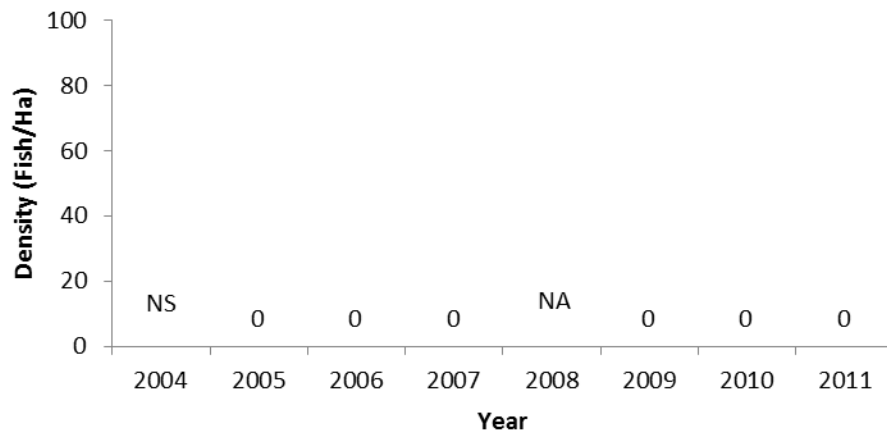


Figure 16. Observed densities of juvenile (<300mm) *O. mykiss* in the Okanogan River, upstream of the confluence with Antoine Creek.

### Okanogan River - 159

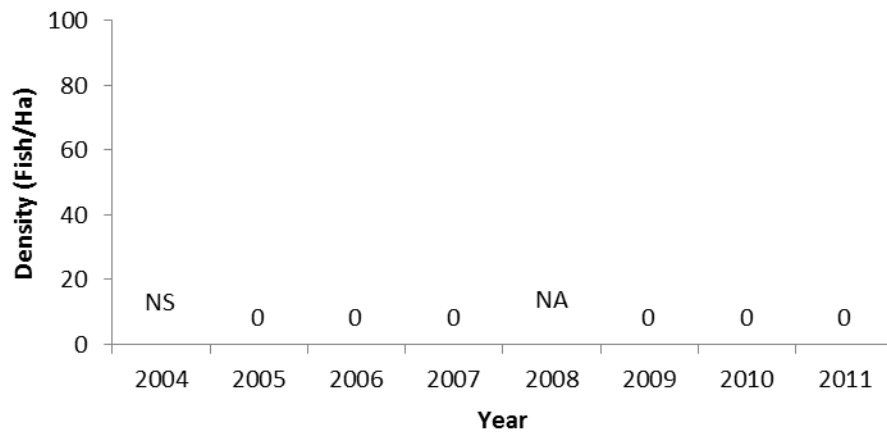


Figure 17. Observed densities of juvenile (<300mm) *O. mykiss* in the Okanogan River, south of Tonasket, WA, below Janis Bridge.

### Okanogan River - 309

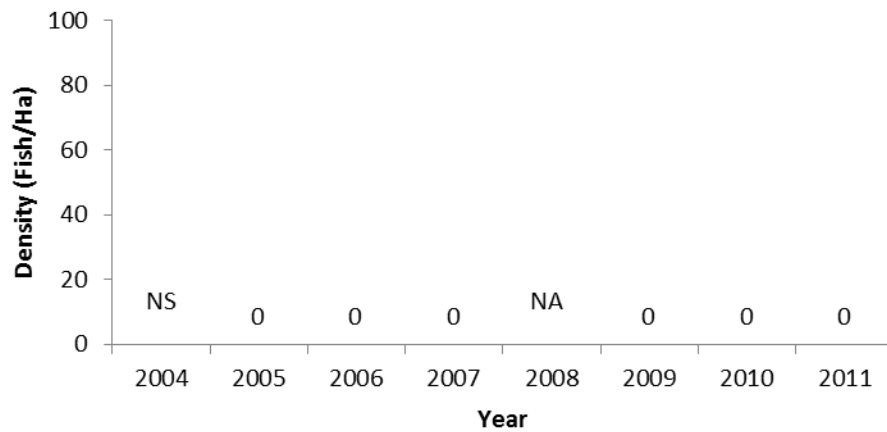


Figure 18. Observed densities of juvenile (<300mm) *O. mykiss* in the Okanogan River, directly upstream of the confluence with Omak Creek.

### Okanogan River - 084

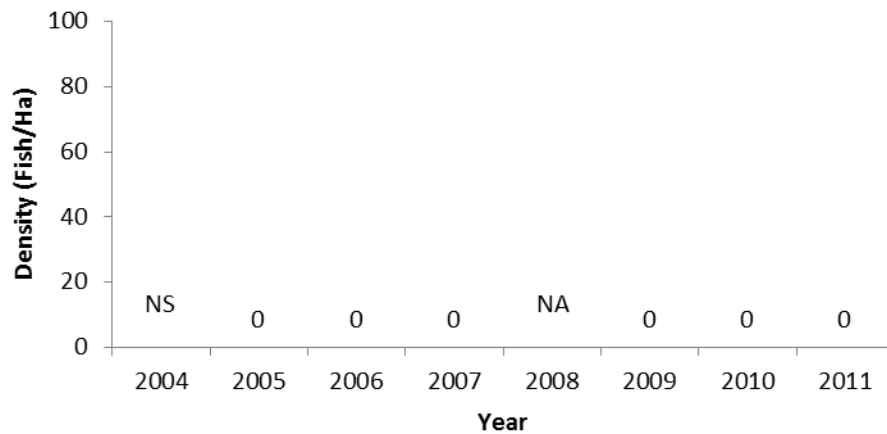


Figure 19. Observed densities of juvenile (<300mm) *O. mykiss* in the Okanogan River, upstream of the confluence with Salmon Creek.

## Okanogan River - 156

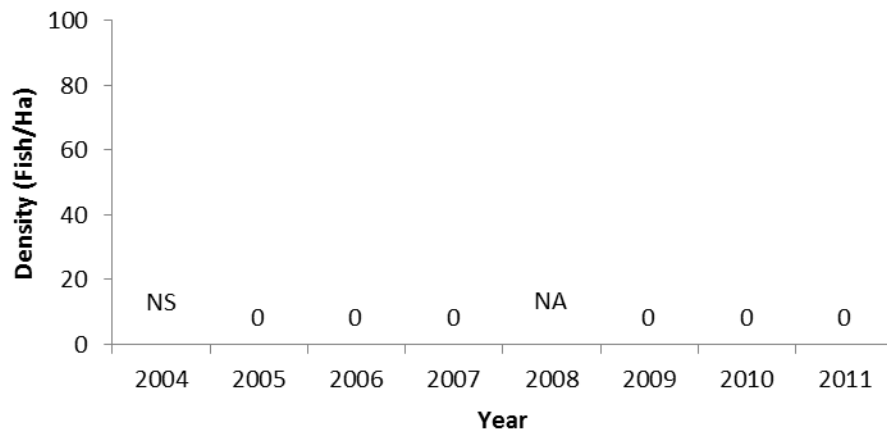


Figure 20. Observed densities of juvenile ( $<300\text{mm}$ ) *O. mykiss* in the Okanogan River, downstream of the confluence with Loup Loup Creek.

### Macroinvertebrate Sampling

In 2010 and 2011, aquatic macroinvertebrate sampling was expanded to cover all tributaries and the mainstem Okanogan, within both Washington and British Columbia. As additional years of data collection continue, macroinvertebrate composition will be compared to standing crop of fish, to help further describe population structures.

Macroinvertebrate data collected in 2011 from the Washington portion of the Okanogan Basin is presented in the Hilsenhoff Biotic Index (Hilsenhoff 1987), EPT Richness, and Taxa Richness. Laboratory work and species identification was performed by EcoAnalysts, INC. (Moscow, ID). Index keys are shown below in Table 3 and 4 for reference.

Table 3. Hilsenhoff Biotic Index key for data shown in Table 5 and Table 6.

Biotic Index	Water Quality	Degree of Organic Pollution
0.00 - 3.50	Excellent	No apparent organic pollution
3.51 - 4.50	Very good	Possible slight organic pollution
4.51 - 5.50	Good	Some organic pollution
5.51 - 6.50	Fair	Fairly significant organic pollution
6.51 - 7.50	Fairly poor	Significant organic pollution
7.51 - 8.50	Poor	Very significant organic pollution
8.51 - 10.00	Very poor	Severe organic pollution

Table 4. EPT and Taxa Richness key for data shown in Table 5 and Table 6.

Index	Excellent	Good	Fair	Poor
EPT Richness	>10	6-10	2-5	0-1
Taxa Richness	>30	21-30	11-20	0-10

Table 5. Summary of macroinvertebrate data from tributaries to the Okanogan River.

Stream	Date of collection	OBMEP site	Organisms (N)	HBI	EPT Richness	Taxa Richness
Omak Creek	7/25/2011	019	188	4.17	12	23
Omak Creek	7/27/2011	361	232	4.04	13	19
Omak Creek	8/4/2011	048	267	4.03	11	17
Omak Creek	7/21/2011	353	272	4.40	11	16
Omak Creek	8/3/2011	345	285	3.68	20	26
Omak Creek	8/18/2011	334	99	3.44	10	15
Bonaparte Creek	8/23/2011	388	33	4.30	7	10
Antoine Creek	8/23/2011	551	131	4.75	5	13
Salmon Creek	10/14/2011	552	145	3.70	11	15
Salmon Creek	10/28/2011	297	345	3.58	12	18
Salmon Creek	10/14/2011	316	449	4.05	11	25

Table 6. Summary of macroinvertebrate data from the mainstem river.

Stream	Date of collection	OBMEP site	Organisms (N)	HBI	EPT Richness	Taxa Richness
Okanogan River	8/30/2011	341	53	4.51	11	15
Okanogan River	9/14/2011	384	97	4.84	6	9
Okanogan River	9/21/2011	336	71	4.88	6	16
Okanogan River	9/30/2011	577	150	4.50	15	22
Okanogan River	10/4/2011	313	104	5.66	5	15
Okanogan River	10/19/2011	411	87	4.57	11	19
Okanogan River	8/25/2011	064	183	4.97	6	19
Okanogan River	9/19/2011	025	166	4.69	6	17
Okanogan River	9/19/2011	046	12	4.08	6	10
Okanogan River	9/22/2011	159	198	4.65	13	18
Okanogan River	9/30/2011	084	146	5.24	9	15
Okanogan River	9/30/2011	309	167	4.45	12	20
Okanogan River	10/23/2011	156	154	4.08	7	14

## Work Element F: Okanogan River Summer Chinook and Steelhead Smolt Trapping

The Colville Tribes' Fish and Wildlife Department continued enumerating juvenile salmonids using rotary screw traps in 2011. Anadromous forms of *Oncorhynchus* with verified natural production in the Okanogan basin were targeted for this study, including Chinook (*O. tshawytscha*), sockeye (*O. nerka*), and summer steelhead (*O. mykiss*). An 8-foot rotary screw trap was deployed on the Okanogan River from the Highway 20 Bridge in Okanogan, WA. The Trap was operated between April 1 and August 8, 2011. The 8-foot trap was used to sample the main channel of the river for the duration of the study.

### Chinook

Chinook salmon were the most abundant salmonid species trapped in 2011, followed by sockeye and steelhead. The naturally produced Chinook sub yearling catch totaled 13,935. Timing of outmigration is presented in Figure 21. Based on a higher than average spring runoff and the inability to perform quality sufficient mark-recapture efficiency tests (Figure 23), the Peterson population estimate was based on hatchery releases as a marked group for a pooled efficiency over the season. The release of hatchery summer/fall Chinook (N=676,356) were treated as a marked group. A total of 25,368 Chinook were captured in the rotary screw trap over the duration of the season, of which 11,433 were of hatchery origin. After removing hatchery fish from the population estimate, the Peterson formulated population estimate for naturally produced sub-yearling Chinook was 824,299.

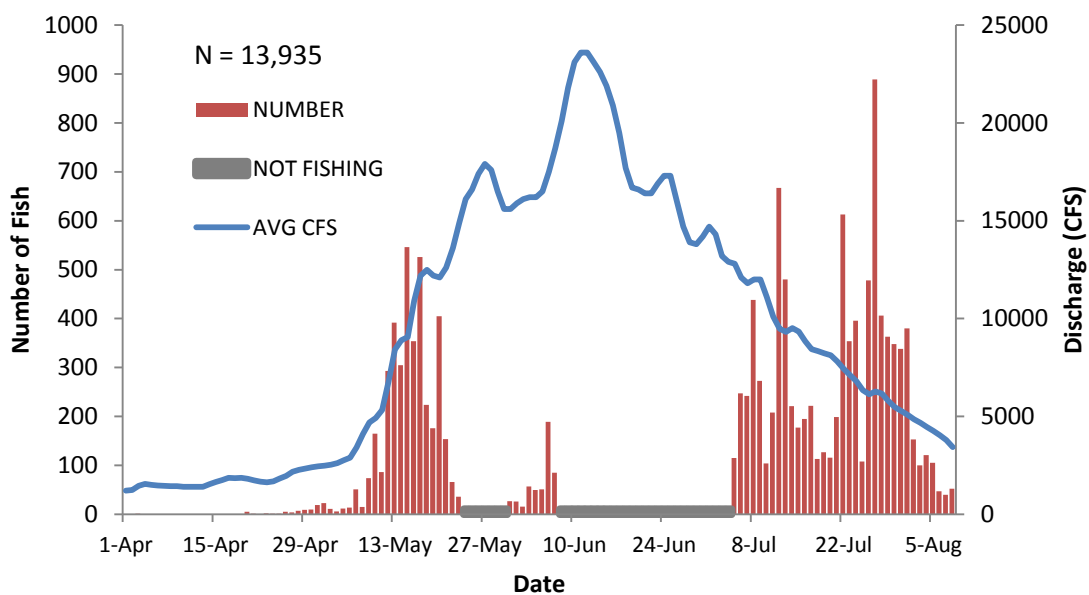


Figure 21. Sub yearling Chinook outmigration timing.

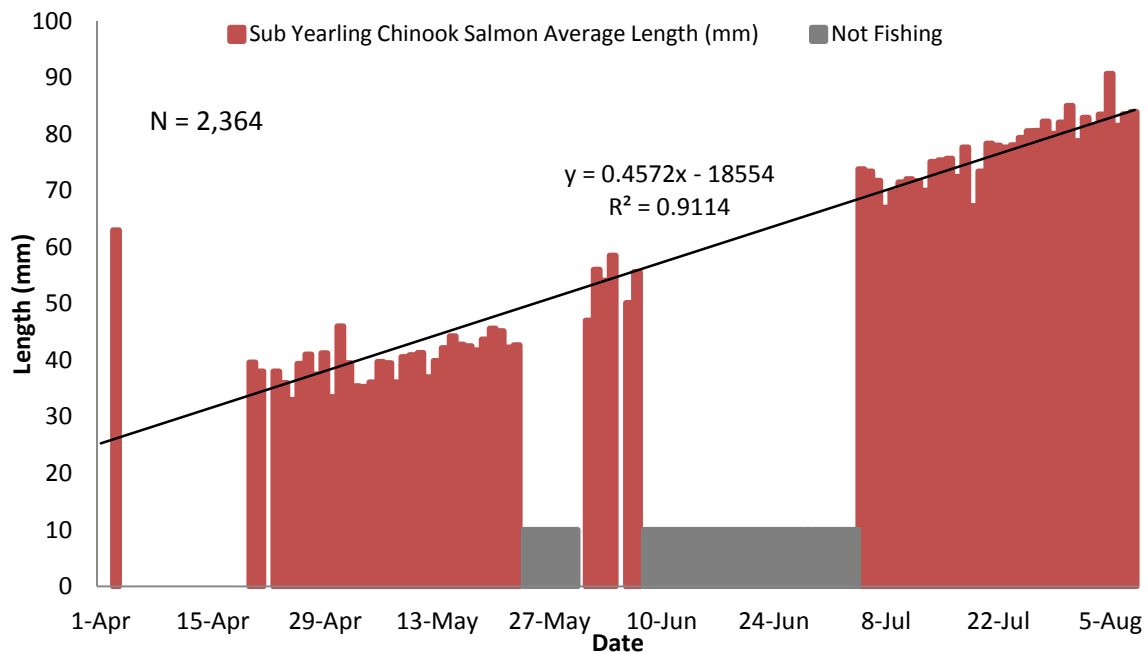


Figure 22. Sub yearling Chinook length distribution.

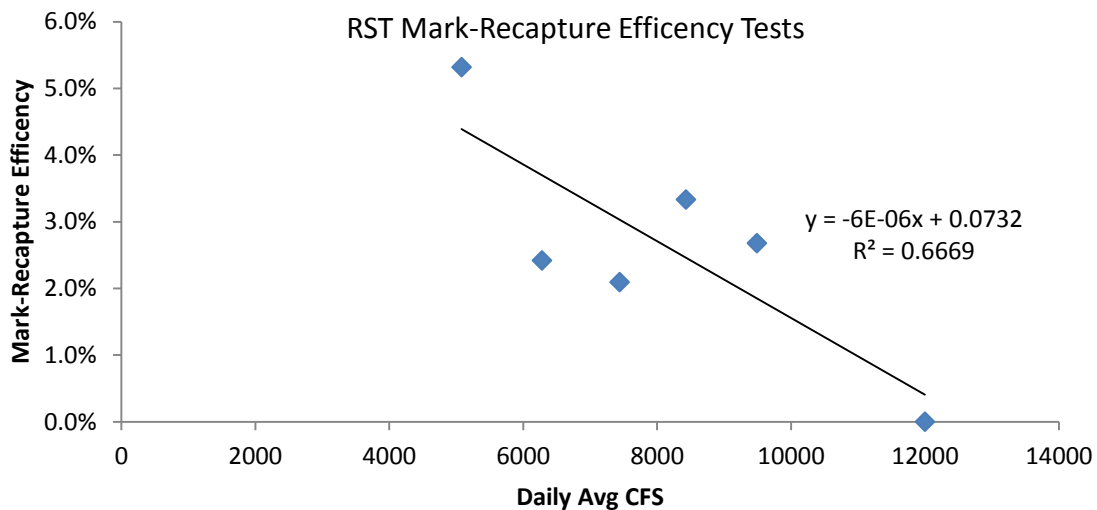


Figure 23. Sub yearling Chinook mark-recapture efficiency tests.

## Sockeye

Also caught were 3,720 juvenile sockeye. Due to the narrow window of timing in which sockeye out-migrate in the Okanogan, a population was not estimated. Data on sockeye emigration were forwarded to Chelan County PUD on a daily basis to help in spill timing at Rocky Reach Dam. Collection of these data were provided through Chelan PUD funding as a cost-share.

## Steelhead

A total of 1,295 hatchery steelhead were captured at the rotary screw trap in 2011. Hatchery releases in the Okanogan Basin totaled 159,929. Using the total hatchery releases as a marked group and 1,488 total summer steelhead captured in the rotary screw trap as the recapture group, a Peterson estimate of 23,816 naturally produced summer steelhead emigrated from the Okanogan River basin.

Due to continued infrequent encounters and low trapping efficiencies for naturally produced juvenile steelhead at this mainstem location, juvenile monitoring will be shifted from the mainstem to focus directly on tributaries to the Okanogan River. Within the Okanogan subbasin, natural production and total out-migrating population of natural origin anadromous steelhead (*Oncorhynchus mykiss*) remains largely unknown.

During annual redd surveys, the majority of adult steelhead have been documented spawning in the mainstem Okanogan and Similkameen Rivers (Miller et al. 2012). However, wild juvenile steelhead are scarcely observed in the mainstem during annual snorkel surveys (see results in Work Element E) due to high summer water temperatures. Anadromous *O. mykiss* commonly spend one to three years in freshwater before migrating out of their natal streams. Most cool tributaries may represent a more hospitable rearing environment for juvenile steelhead. Snorkel surveys conducted since 2004 have identified that the largest proportion of observed wild juvenile *O. mykiss* exist in the small tributaries of the Okanogan basin (Miller et al. 2011). We hypothesize that much of the successful wild steelhead production likely occurs in the small, cool water tributaries to the Okanogan River. Locating juvenile steelhead monitoring activities closer to these sources will allow us to describe individual systems at a finer scale, as well as estimate production from specific tributaries. However, the use of an RST may be unfeasible in small watersheds due to shallow water depths, narrow channels, large debris loads during spring runoff, highly variable water velocities, and considerable time expenditures involved in the operation and maintenance of each RST site.

In order to assess the utilization of tributaries by juvenile steelhead, we propose to use remote PIT tagging, a series of in-stream PIT tag antennas, and mark-recapture events to examine: 1) population estimates of juvenile *O. mykiss* in individual small streams, 2) the proportion that out-migrate from those systems, and 3) potential contribution to anadromy from resident populations found upstream of natural or manmade barriers. We will focus on tributaries that have known populations of adult spawning steelhead and evaluate production estimates.

Life histories strategies of juvenile *O. mykiss* are highly variable; consequently, interpretation of migrational movements (i.e. resident vs. anadromous) can be difficult. Through the use of remote PIT tagging, mark-recaptures, and in-stream PIT tag antennas, we propose to evaluate



population estimates and emigration of juvenile steelhead out of these spatially distinct systems.

In 2011, the Washington Department of Fish and Wildlife (WDFW) and the CCT installed a series of permanent and temporary PIT tag arrays near the mouth of all tributaries with known or potential for steelhead spawning to occur. These arrays were primarily put in place to monitor the movements of adult steelhead during the spring spawning period. This timeframe also overlaps with the spring out-migration timing of juvenile salmonids.

Future operations of the mainstem Okanogan River rotary screw trap will be lead by the Colville Tribe's Chief Joseph Hatchery Program with financial and resource support from OBMEP.

## **Work Element G: Enumerate Adult Returns to the Okanogan River Basin**

### **Underwater Video Monitoring**

OBMEP used underwater video to collect data on the run timing and abundance of adult salmonids. These data are used to determine basin-wide distributions, status and trends of adult returns, and origin. Year-round video systems located in the fish ways of Zosel Dam allow observation of salmonids passing into the British Columbia portion of the Okanogan River Basin. Three temporary video systems are installed on tributaries within the Okanogan Basin: Salmon, Antoine, and Ninemile Creeks.

### ***Sockeye Summary***

Zosel Dam is owned by the Department of Ecology and operated by the Oroville-Tonasket Irrigation District (OTID). The OTID adjusts the levels of the four spillway gates of the dam according to the International Joint Commission, which mandates the maintenance of Lake Osoyoos between 909 and 913 feet elevation. The spring freshet in the Okanogan River begins in April and can run until August. In order to maintain the lake level, the OTID may open the dam gates to levels exceeding 8 feet. We assume that any gate level greater than 1 foot is high enough for fish to pass through the open gate rather than through the fish ladders and video arrays. In 2011, the high snow pack and abundant spring rainfall caused the lake levels to become unusually high. The dam gates at Zosel Dam remained open at least 1 foot from May 7<sup>th</sup>, to August 7<sup>th</sup>, allowing the majority of the sockeye run to pass through the gates without being detected in the video arrays (Figure 24).

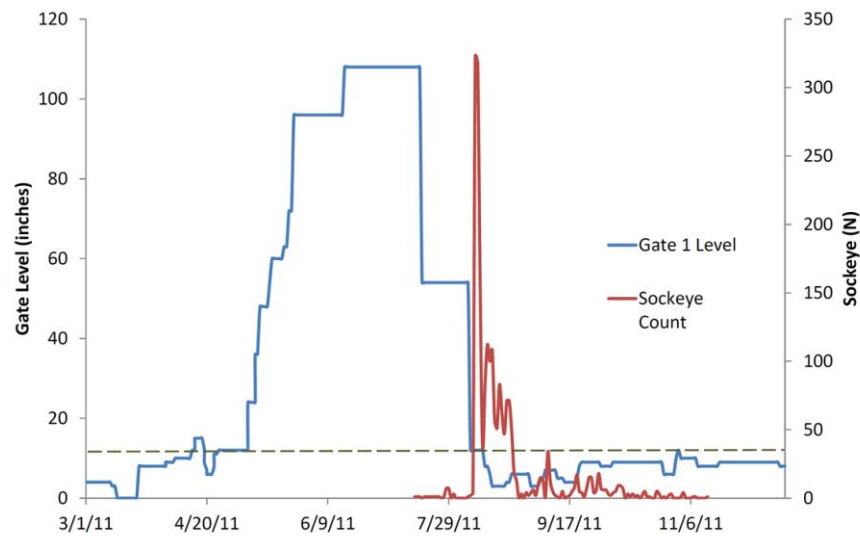


Figure 24. Red line is upstream migrating sockeye counted, a total of 2,002 fish. Blue line is Zosel Dam spillway gate heights; the dashed line represents Zosel Dam spillway gate height of 12 inches. The peak of the sockeye run passed through Zosel Dam open spillway gates between July 20<sup>th</sup> and August 7<sup>th</sup>, undetected by the video array.

The first sockeye observed at Wells Dam on the Columbia River was on June 16<sup>th</sup> and the peak was July 20<sup>th</sup> (7,328). Fish were able to move quickly through the system without being delayed by a high temperature barrier ( $\sim 21.0^{\circ}\text{C}$ ), which can form at the mouth of the Okanogan River (Hyatt et al. 2003). Assuming a minimum travel time of four days from Wells Dam to Zosel Dam, the peak of the sockeye run through Zosel Dam likely occurred between July 20<sup>th</sup> and August 7<sup>th</sup>, during the time that the Zosel Dam spillway gates were opened. The last fish was observed on December 18<sup>th</sup> (Figure 25).

The sockeye that were counted favored passing through the west bank ladder, which received 62.1% compared to 37.9% of fish passing through the east bank ladder (Figure 26). A large portion of passage occurred between the hours 00:00 and 07:00, with 58% of fish observed during these hours.

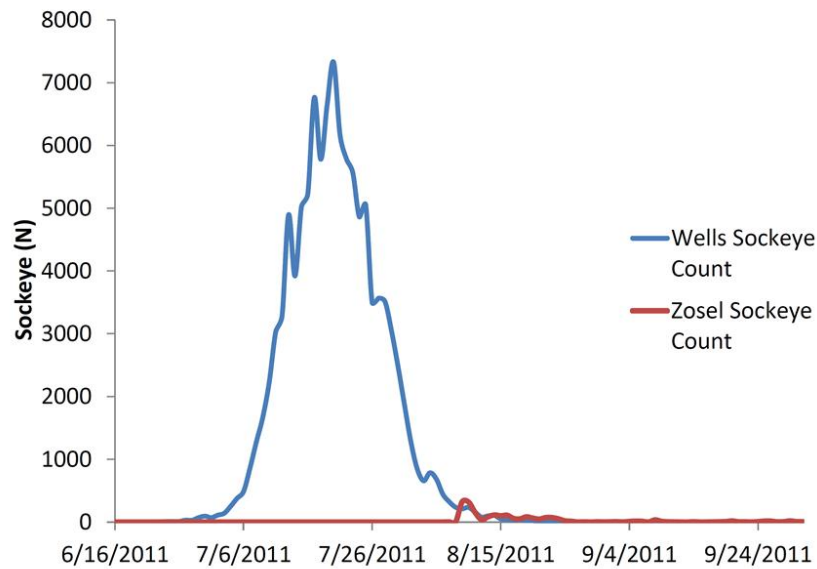


Figure 25. Daily sockeye counted passing through Zosel Dam video arrays (red line) in 2011. Blue line shows the sockeye run at Wells Dam for comparison.

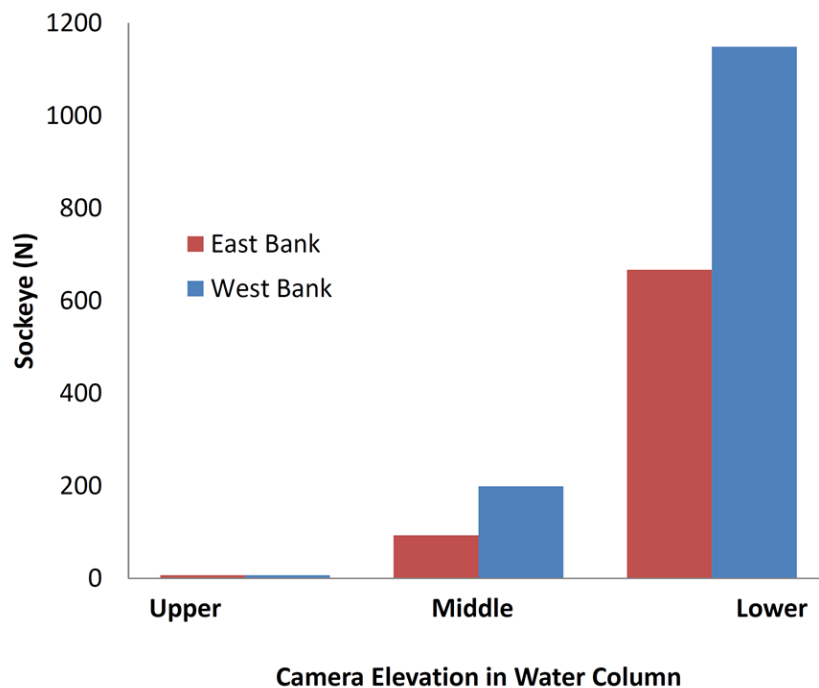


Figure 26. 2011 Sockeye preferred the cameras deployed at the lowest (deepest) part of the water column and preferred the right (west) bank camera array over the left (east) bank.

### ***Chinook Summary***

The first Chinook salmon to pass through the Zosel Dam video array was on August 13<sup>th</sup>, 6 days after the spillway gates were closed. All Chinook that pass Zosel Dam prior to July 24<sup>th</sup> are classified as spring Chinook. An unknown number of spring Chinook and early summer/fall Chinook may have passed through the open Zosel Dam spillway gates, but historically, numbers of Chinook passing prior to August 7<sup>th</sup> is low. A total of 1,415 Chinook salmon passed upstream through the Zosel Dam video array in 2011 (Table 7).

Table 7. Total Chinook counted at Zosel Dam video arrays in 2011, including totals for the adult, jack, hatchery and natural origin portions of the run.

Chinook	Adult	Jack	Total
Adipose Clipped	221	282	503
Adipose Present	702	210	912
Total	923	492	<b>1,415</b>

Hatchery Chinook, as identified by their clipped adipose fin, accounted for 35.5% of the run. Chinook jacks accounted for 34.8% of the run. Chinook were observed at Zosel Dam from August 13<sup>th</sup> through November 24<sup>th</sup> (Figure 27). The adult run peaked on October 5<sup>th</sup> with 113 adults passing that day. The peak of the adult run passing through Wells Dam was July 20<sup>th</sup>, indicating that Chinook spend the months of August and September utilizing habitat between Wells Dam and Zosel Dam before migrating north to Canadian waters. The number of Chinook that passed Zosel Dam is a relatively small proportion of the total run over Wells Dam (2.7%).

Chinook favored passing through the west bank ladder, which received 79.3% compared to 20.7% of fish passing through the east bank ladder (Figure 28). Chinook passage did not exhibit a diel pattern (Figure 29), migrating steadily during all hours of the day and night. Based on experienced video observers best determination of the sex of the fish, the 2011 Chinook run upstream migration into Canada was made up of 50.5% females, 48.5% males and 1% unknown sex.

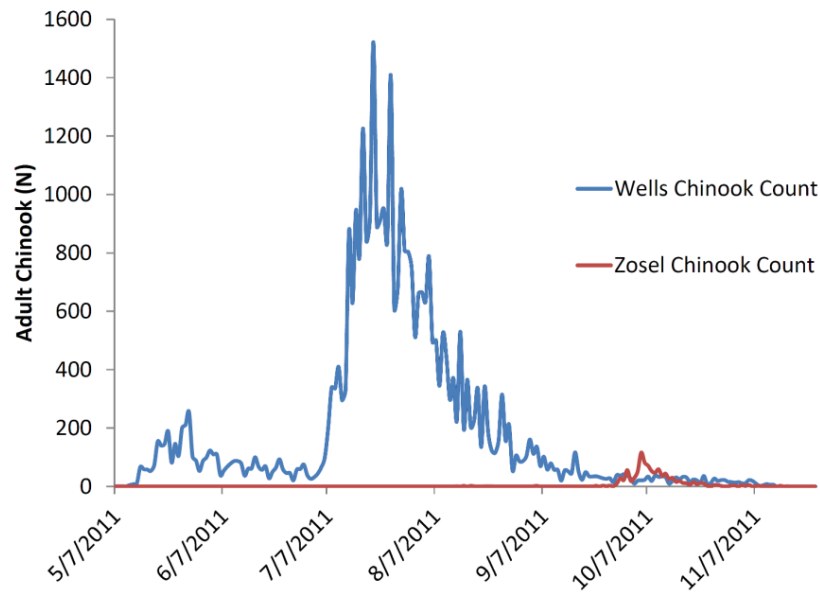


Figure 27. Daily adult Chinook counted passing through Zosel Dam video arrays (red line) in 2011. Blue line shows the adult Chinook run at Wells Dam for comparison.

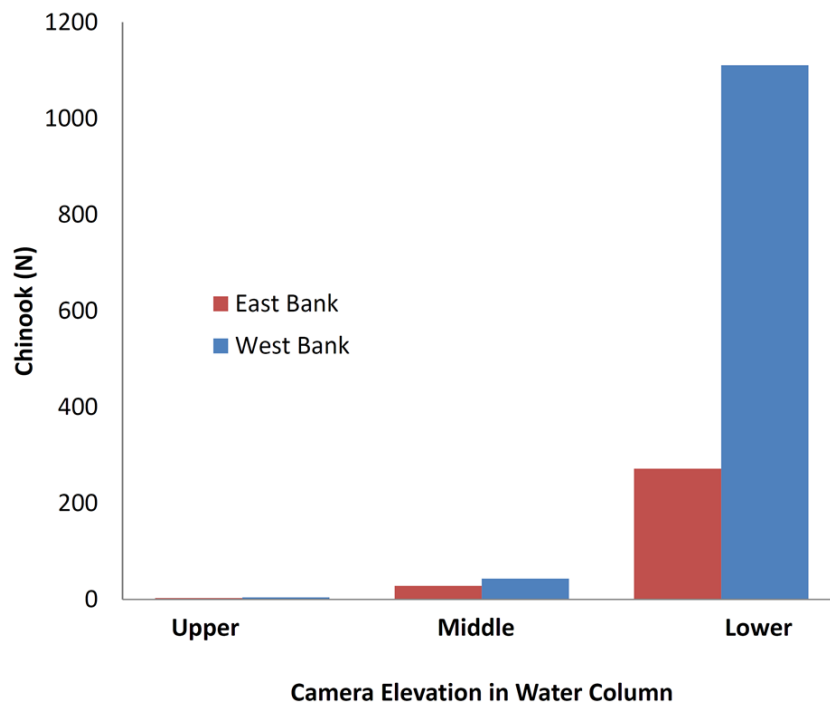


Figure 28. 2011 Chinook preferred the cameras deployed at the lowest (deepest) part of the water column and preferred the right (west) bank camera array over the left (east) bank.

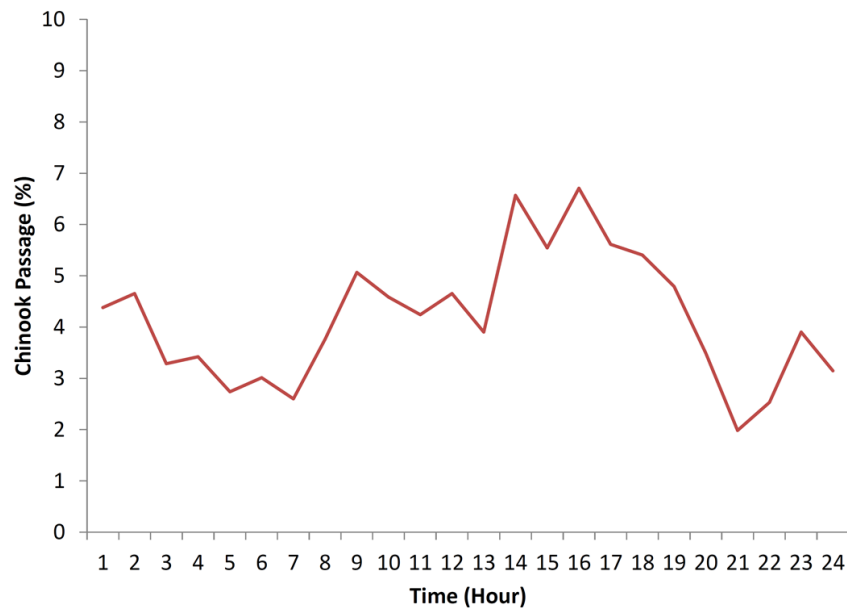


Figure 29. Hourly passage of Chinook at Zosel Dam in 2011.

A complete description of the apparatus and methodology for video sampling at Zosel Dam can be found at:

<http://cctobmep.com/media/files/VideoManual070312FinalMR.pdf>

Historic results from all years of operation are posted to the Columbia River DART website:

<http://www.cbr.washington.edu/dart/adult.html>

### Adult Steelhead Enumeration

Summer steelhead spawning distribution and abundance estimates were determined throughout the Okanogan subbasin in 2011 using redd surveys, adult weir traps, PIT tag detections, and underwater video enumeration. Within the Washington State portion of the basin, redd surveys were conducted across all available habitat up to anadromous barriers, weir traps, or underwater video sites. We estimated that between 1,479 and 1,687 summer steelhead spawned in the Okanogan River subbasin, and between 307 and 339 of those were of natural origin. Objectively determining wild origin was complicated by the unknown number of adipose-present hatchery steelhead released into the Okanogan River, the presence of adfluvial rainbow trout, and the inability to validate origin when observing steelhead on redds. In 2010 and 2011, fisheries regulations required the harvest of all steelhead with clipped adipose fins, which likely contributed to higher percentages of ad-present spawners than had been documented in previous years. The highest density of steelhead redds continue to be

documented in the lower extent of the Similkameen River and in the downstream vicinity of Zosel Dam on the Okanogan River.

Escapement into British Columbia was estimated at 174 steelhead and 38 of those likely had adipose fins. This value was calculated by counting the number of steelhead passing Zosel Dam and subtracting the estimated number of spawners in Tonasket and Ninemile Creeks. The spatial distribution of spawning in the Canadian portion of the Okanogan subbasin remains largely unknown.

Due to above-average runoff in 2011, tributaries to the Okanogan River were more readily accessible to adult steelhead. Approximately 38.9% of steelhead that spawned within the Washington State portion utilized tributary habitats, which was similar to 2010, and higher than previous years' surveys. The abundance of steelhead that spawned in tributary habitats may help to increase future years' returns of natural origin steelhead. Annual collection of steelhead spawning data continues to provide a comprehensive depiction of spawning distribution and minimum escapement trends within the Okanogan River subbasin.

The complete 2011 steelhead spawning report is attached as Appendix 1. This document can also be accessed at:

[http://www.cctobmep.com/media/files/2011\\_Okanogan\\_Sth\\_Redd\\_Surveys.pdf](http://www.cctobmep.com/media/files/2011_Okanogan_Sth_Redd_Surveys.pdf)

## **Work Element H: Monitor Threats to Salmonid Habitats at up to 50 Sites Annually**

Currently, the Colville Tribes are the only organization collecting comprehensive fish habitat data throughout the Okanogan basin, in both Washington and British Columbia. Cooperation includes the sharing of monitoring responsibilities between the Colville Tribes and the Okanogan Nation Alliance (ONA), adjusting or changing sampling methods to comport with standardized protocols, and adhering to robust statistical design criteria.

Physical habitat data are collected annually at 50 EMAP sites (25 panel, 25 rotating panel) consistent with protocols developed by the Colville Tribes. Thirty-four sites were located in the Washington State portion of the Okanogan Basin by the Colville Tribes and 16 sites were located in the British Columbia portion of the Okanogan Basin by the ONA. Of the 50 total EMAP sites, four were not sampled, due to either climatic or landowner restrictions.

Physical habitat data are collected in electronic format on Trimble GPS data loggers. The information collected pertains to: the presence and composition of large woody debris, riparian vegetation structure, canopy cover, human disturbance, substrate composition, stream channel habitat types (pool, riffle, glide, etc.), and channel morphology. All data are uploaded into the OBMEP SQL server database located at the Colville Tribes' Fish and Wildlife office in Omak, WA.

Specific information requests can be directed to the Colville Tribes' Fish and Wildlife Department, Anadromous Fish Division, 25B Mission Road, Omak, WA 98841, (509) 422-7424.

Past and present habitat data are being analyzed with the use of the Ecosystem Diagnosis and Treatment (EDT) model. The EDT approach integrates site specific information with larger spatial scales and broader ecological processes. Methods were developed by ICF International to examine the potential of habitat in the Okanogan River to support spring Chinook salmon and steelhead. The EDT model provides a framework for the evaluation of habitat data collected within the Okanogan River basin. The production version of EDT3 is due for release in 2012 and includes software and tools that will be used to conduct ecosystem status and trend analysis.

Reports related to habitat data can be downloaded at:

[http://cctobmep.com/obmep\\_publications.php](http://cctobmep.com/obmep_publications.php)

## **Work Element I: Fill Data Gaps Related to Water Quality and Quantity Needed to Evaluate Status and Trend**

### **Water Quality**

Water quality readings were collected at 24 locations within the Okanogan basin. Procedures were modeled after the Department of Ecology's water quality protocols. Specific metrics included conductivity, dissolved oxygen, pH, turbidity, ammonia, nitrates, and total dissolved gas. Data were collected once monthly, unless site conditions did not allow. During the winter months, many small streams and the Okanogan River were frequently iced over; therefore, no readings were taken during that timeframe. Additionally, water quality data were not collected if a streambed was dry. Specific water quality data requests can be directed to the Colville Tribes' Fish and Wildlife Department, Anadromous Fish Division, 25B Mission Rd., Omak, WA 98841, (509) 422-7424.

### **Water Temperature and Discharge**

Water temperature is largely accepted as the largest limiting factor for steelhead recovery in the Okanogan River. In order to monitor water temperatures, OBMEP began deploying Onset® temperature data loggers in streams at all annual and panel tributary sites in May of 2005. Data were again collected in 2011 at all EMAP sites located in the U.S. and Canadian portions of the Okanogan Basin. Temperature data are compiled on the OBMEP server located at the Colville Tribes, Fish and Wildlife office in Omak, WA. Specific information requests can be directed to the Colville Tribes' Fish and Wildlife Department, Anadromous Fish Division, 25B Mission Rd., Omak, WA 98841, (509) 422-7424. An online reporting tool, where interested parties can go to the OBMEP website and download temperature reports for specific location, is scheduled to be operable in December 2012.

Real time temperature data are collected at three sites on the Okanogan River in the United States at Malott, Tonasket, and Oroville by the US Geological Service under contract with the



Colville Tribes. An additional site is located on Ninemile Creek. Data have been assimilated into on-going data collection activities within the USGS web sites. These data are available on the internet to provide easy access to the public and other agencies. Data links for sites within the Okanogan Basin include:

Okanogan River at Malott: [http://waterdata.usgs.gov/nwis/uv?site\\_no=12447200](http://waterdata.usgs.gov/nwis/uv?site_no=12447200)

Okanogan River near Tonasket: [http://waterdata.usgs.gov/nwis/uv?site\\_no=12445000](http://waterdata.usgs.gov/nwis/uv?site_no=12445000)

Okanogan River at Oroville: [http://waterdata.usgs.gov/nwis/uv?site\\_no=12439500](http://waterdata.usgs.gov/nwis/uv?site_no=12439500)

Ninemile Creek: [http://waterdata.usgs.gov/wa/nwis/uv/?site\\_no=12438900](http://waterdata.usgs.gov/wa/nwis/uv/?site_no=12438900)

## **Work Element J: Manage Projects: Produce Necessary Documents, Estimates, and Contracts plus Direct Office Expenses**

Completed

## **Work Element L: Project Coordination/Public Outreach**

OBMEP biologists coordinated directly with other entities performing M&E related activities throughout the region to ensure compatibility with other regional M&E and salmon recovery efforts. On-going coordination with other monitoring practitioners is critical to the success of OBMEP's ability to collect useful data that can be easily assimilated to larger spatial scales.

We developed OBMEP under a regional M&E scheme involving coordination with multiple entities through both the Columbia System-wide Monitoring and Evaluation Project (CSMEP) and the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) to ensure that our project is compatible with efforts spanning the entire Pacific Northwest. Continued coordination with these entities will be necessary as region wide M&E efforts continue to evolve.

At the scale of the Upper Columbia ESU, OBMEP biologists regularly contributed to monthly meetings of the Upper Columbia Regional Technical Team (RTT) and monitoring and data management subcommittees. Data have been shared at these meetings along with field protocols and strategies for field sampling, data archiving, manipulation, and analysis. Ongoing coordination within the Upper Columbia Salmon Recovery Board process is essential to make sure data can be scaled up for ESU related recovery analysis to measure progress toward recovery of listed salmonid stocks.

Within the Okanogan River sub-basin, we have international coordination responsibilities with Canadian entities. To facilitate these relationships we have contracted with Okanogan Nation Alliance and host regular meetings. Additional meetings are occasionally attended with other agencies and groups that collect monitoring data or have a need or use for the data we are collecting. Regular updates are provided annually at the Bilateral Okanogan Basin Technical Working Group meeting and Lake Osoyoos Board of Control, Fisheries Advisory Group.

In addition to providing local groups and agencies with information and updates, many OBMEP survey sites fall within areas of private ownership. Therefore, landowners must be contacted (public outreach) and access granted before field crews can conduct surveys. Biologists and field staff working under OBMEP have made many contacts with landowners throughout the Okanogan basin to gain access to EMAP sampling sites, redd survey sites, and to keep the landowners updated. Most contacts have been positive and access to perform work under this contract would be impossible without cooperation from local landowners.

## **Work Element M: Support of OBMEP Website and Workshop/ Conference Attendance**

### **Workshop and Conference Attendance**

OBMEP staff are frequently involved in local and regional meetings, conferences, and workshops. In addition to attendance, data collected by the program are commonly requested to be presented at these events, which are used for both informative and management decisions.

Some of the forums which OBMEP staff contributed to in 2011 included:

- Columbia Cascade Regional Fisheries Enhancement Group
- Upper Columbia Regional Technical Team
- Okanogan Irrigation District board meetings
- Enloe Dam relicensing meetings
- Regional Fisheries Enhancement Group Advisory Board and Coalition
- PNAMP Habitat Metric meetings
- HCP Hatchery Oversight Technical Team Conference
- Lake Osoyoos Board of Control Fisheries Advisory meeting
- PNAMP Steering Committee
- American Fisheries Society, 2011 National Conference, Seattle, WA
  - Okanogan Symposium
- Okanogan River Watershed Action Team meetings
- PNAMP Data Management Leadership Team
- Action Agencies Expert Panel
- Regional Coordinated Assessment Project
- Collaboration with WDFW on Okanogan PIT tag interrogation system

- PITAGIS Remote Array Subcommittee
- Presentations to local clubs, groups, and organizations

### Website

The primary purpose of the OBMEP website is to disseminate summary data and results in the form of reports. In 2010, Disuatel-Hege Communications was enlisted to redesign the OBMEP website and host it on one of their web servers. Their hosting services will ensure greater security for the website and more technical assistance for maintaining the site. Content from the old website was updated and new content was added to the new site. The new site has been streamlined making it very intuitive to use, with a modern look and feel consistent with the Colville Tribes' main website. The publications page is the primary location from which results and summary data within reports are disseminated. Publications have been simply organized by report type specific to a type of project or organization. A news feed has been added to the main page and will allow us to post updates on current projects or new work to be done under OBMEP. The program's URL is: [www.cctobmep.com](http://www.cctobmep.com)

### Work Element N: Manage, Maintain, and Expand the OBMEP Database

At the end of the 2006 contract year, OBMEP began using an Access® database developed by Summit Environmental Consultants Ltd. to archive and run basic queries on the data. They also developed protocols for transferring data collected on Trimble® handheld GPS units, hand-written data forms, and the Internet into the database. These methods have successfully enabled us to compile and interact with data at a basic level, but advances in technology and new software have brought a variety of more efficient and cost-effective ways to collect the data, process, store, and access it. Instead of interacting with the data in separate pieces, every instance of interaction from pre-collection to analysis of finalized data can be controlled and managed in one integrated system. An integrated data management system can greatly decrease time and cost on each instance of interaction with the data, and can greatly decrease various errors that can be introduced at each interaction.

Towards the end of 2011, we began implementing a plan to not just upgrade the database software, but to create a comprehensive data management system that includes tools for data storage, data collection, QA/QC the data, and analysis and reporting. With the desire among agencies in the Upper Columbia region and that of BPA to make our data more accessible and shareable, we also began the ground work for the website component of the data management system that would enable entities outside of the Colville Tribes' network to easily query and download portions of the data.

At the heart of the data management system is Microsoft SQL Server 2008 software, which is a database management system that not only stores the data, but easily integrates with a variety of other applications for interacting with and managing the data. SQL Server 2008 runs on Microsoft's ASP.NET framework, a programming model on which many applications running on Windows also utilize and, therefore, requires minimal coding. SQL Server 2008 is also much

more robust than Microsoft Access in that it can handle high-volume, multi-user environments especially on database-driven websites.

In 2011, we made several key infrastructure upgrades that are vital to the data management system. We purchased two HP® servers, one of which houses the database and the other which will be a front-end web server through which entities outside of the Colville Tribes' network can access certain data applications. On the database server, we installed Microsoft SQL Server 2008, and re-coded the database from Access to SQL Server. The Access interface was retained for now, which will enable us to continue running the basic queries and reports. However, a new interface with various tools is being built in the ASP.NET framework, which will eventually replace the Access interface.

In 2011, Summit Environmental Consultants Ltd. began building the habitat data collection template in ASP.NET, which will be implemented in the summer of 2012. The application will replace the current method of entering data into a Trimble® GeoXT data dictionary template, which then had to be post-processed through a series of translations in Microsoft Excel® before it could be uploaded in the database. The new template is synchronized with the database, and data that are entered into the application are directly uploaded upon establishing a connection with the database. Any QA/QC of the data is tracked within the data management system and becomes a part of the data.

The work plan that covers the 2011-2012 includes finishing the habitat data collection template, creating a dashboard interface application to replace the current Access interface, and creating a dynamic reporting tool. The dashboard will be a huge part of the management system because it will enable users to easily access frequently used data reports, navigate data collection templates, track when any user logs in to the database and what changes they make, mark data reliability (i.e. not yet reviewed, provisional, finalized, etc.), and access the dynamic reporting tool. The dynamic reporting tool will provide a user-friendly interface that managers can use to create custom queries, easily analyze some data types, and produce standardized graphs and reports.

## **Work Element O: Analyze Collected and Historical Data on Habitat, Biological, and Water Quality Parameters**

Conducted periodically throughout the contract period.

## Conclusions

The Okanogan Basin Monitoring and Evaluation Program completed another year of data collection, coordination, and reporting in 2011. All tasks were completed on time and within budget. Among the most requested data have been the annual spring spawning numbers; therefore, this report will continue to be produced on an annual basis. Data from other sampling events will be analyzed in a timely fashion and made available upon request from other agencies. Technical documents will continue to be posted on the OBMEP and BPA websites for public access. Access to OBMEP data will also be handled through the Upper Columbia Salmon Recovery Board data steward, Integrated Status and Effectiveness Monitoring Project (ISEMP) through the STEM Databank, the Columbia Basin Fish and Wildlife Authorities State of the Resource Report, Fish Passage Center, U.S. Geological Survey, and the Columbia River Data Access in Real Time (DART), Streamnet, or by contacting OBMEP staff directly.

Advances in technology and increased efficiencies in our equipment are enabling OBMEP to expand operations in previously un-monitored areas and help us collect better data at existing sites. Improvements to the video monitoring project's software and hardware have made collecting video data easier and faster. In late 2010, OBMEP worked in conjunction with WDFW to implement a basin-wide PIT tag detection project, which expanded our capabilities of monitoring steelhead in the mainstem Okanogan and tributaries. These PIT tag arrays are located in the lower extent of tributaries to the Okanogan River and provide detailed data on individual fish movements, population migration timing, and tributary spawning distribution. We are comparing data from the PIT tag antennas with redd survey, weir trap, and video data to help further refine steelhead spawning distribution estimates within the basin.

We are constantly working on improving our methods to collect and analyze habitat data, and are involved in standardizing our protocols with others being used in the upper Columbia, while maintaining consistency within our existing datasets. In order to holistically characterize the suitability of habitat within the Okanogan basin for steelhead utilization, our data are being analyzed with the EDT3 model. These new methods incorporate discrete habitat metrics, historically analyzed on an individual basis, into a comprehensive approach. As these efforts mature, the OBMEP staff hopes to continue delivering quality data for status and trend monitoring throughout the entire Columbia River basin and make our data available for use in more comprehensive, broad-scale analyses.

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# **Appendix 1**

Colville Tribes, Fish & Wildlife Department

# **2011 Okanogan Basin Steelhead Escapement and Spawning Distribution**



Brian F. Miller, Jennifer L. Panther, and John E. Arterburn



Prepared for the Bonneville Power Administration,  
Division of Fish and Wildlife, BPA Project # 200302200  
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# 2011 Okanogan Basin Steelhead Escapement and Spawning Distribution

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## Summary

Summer steelhead (*Oncorhynchus mykiss*) spawning distribution and abundance estimates were determined throughout the Okanogan subbasin in 2011 using redd surveys, adult weir traps, PIT tag detections, and underwater video enumeration. Within the Washington State portion of the basin, redd surveys were conducted across all available habitat up to anadromous barriers, weir traps, or underwater video sites. We estimated that between 1,479 and 1,687 summer steelhead spawned in the Okanogan River subbasin, and between 307 and 339 of those were of natural origin. Objectively determining wild origin was complicated by the unknown number of adipose-present hatchery steelhead released into the Okanogan River, the presence of adfluvial rainbow trout, and the inability to validate origin when observing steelhead on redds. In 2010 and 2011, fisheries regulations required the harvest of all steelhead with clipped adipose fins, which likely contributed to higher percentages of adipose-present spawners than had been documented in previous years. The highest density of steelhead redds continue to be documented in the lower extent of the Similkameen River and in the downstream vicinity of Zosel Dam on the Okanogan River.

Escapement into British Columbia was estimated at 174 steelhead and 38 of those likely had adipose fins. This value was calculated by counting the number of steelhead passing Zosel Dam and subtracting the estimated number of spawners in Tonasket and Ninemile Creeks. The spatial distribution of spawning in the Canadian portion of the Okanogan subbasin remains largely unknown.

Due to above-average runoff in 2011, tributaries to the Okanogan River were more readily accessible to adult steelhead. Approximately 38.9% of steelhead that spawned within the Washington State portion utilized tributary habitats, which was similar to 2010, and higher than previous years' surveys. The abundance of steelhead that spawned in tributary habitats may help to increase future years' returns of natural origin steelhead. Annual collection of steelhead spawning data continues to provide a comprehensive depiction of spawning distribution and minimum escapement trends within the Okanogan River subbasin.

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## **Introduction**

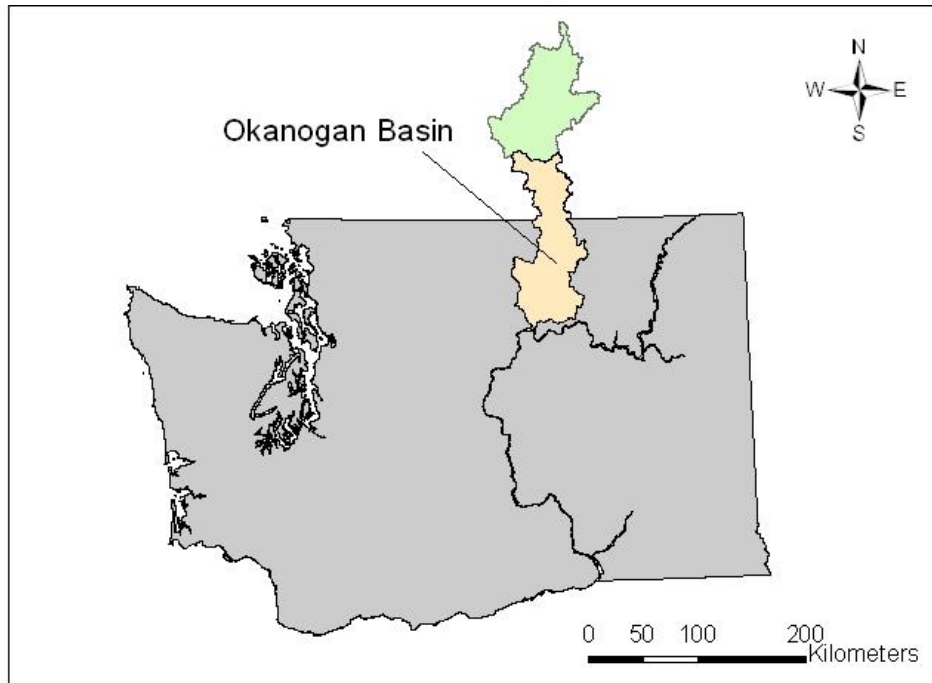
Summer steelhead are listed as threatened in the Upper Columbia Evolutionarily Significant Unit (ESU) under the Endangered Species Act (ESA). To recover this ESU requires that all four populations (Wenatchee, Methow, Entitat, and Okanogan) meet minimum adult abundance thresholds, have positive population growth rates, and each population must be widely distributed within respective basins (UCSRB 2007). Within the Okanogan River subbasin, the Okanogan Basin Monitoring and Evaluation Program (OBMEP) monitors adult abundance attributes. Since 2004, OBMEP developed protocols derived from the Upper Columbia Strategy (Hillman 2004) that called for a complete census of all spawning. Preliminary methodologies for implementing redd surveys were developed in 2005 (Arterburn et al. 2004) and these methods were later revised in 2007 (Arterburn et al. 2007c).

In addition to redd surveys, adult weir traps, PIT tag arrays, and underwater video counting were incorporated in order to improve escapement estimates, reduce project costs, and coordinate with other on-going data collection efforts. Weir traps have been operated on Omak Creek since 2001 and Bonaparte Creek since 2006. These weir traps provided supplemental biological data, such as length, weight, sex, mark/tags, origin, and age that are also used to evaluate adult steelhead returns. Underwater video enumeration has allowed adult steelhead to be counted at fixed locations, such as Zosel Dam since 2006, and Ninemile, Antoine, and Salmon Creek since 2008. In cooperation with the Washington Department of Fish and Wildlife (WDFW), we expanded the use of PIT tag arrays, which are primarily used to monitor adult summer steelhead use of small tributaries to the Okanogan River.

This document builds upon knowledge and information gained from preceding years' surveys. An extensive literature review of historic spawning information related to the Okanogan River subbasin can be found in Arterburn et al. (2005). Previous years' data and reports can be accessed at: [www.cctobmep.com](http://www.cctobmep.com). A census of all mainstem habitats was conducted within the U.S. in 2005 and identified several large areas that contained no redds due to unsuitable spawning habitat. Eliminating these areas from future surveys reduced program costs, and it is assumed there was minimal loss of relevant data. Recommendations from the 2005 surveys helped define the actual reaches that would be surveyed from 2006 through 2011.

## **Methods**

The Okanogan River subbasin flows from the northern headwaters near Vernon, BC to the confluence with the Columbia River near Brewster, WA (Figure 1). We conducted counts of all summer steelhead spawning downstream of anadromous fish migration barriers in the mainstem and all accessible tributaries of the Okanogan and Similkameen River drainages within the United States (Arterburn et al. 2007a, Walsh and Long 2006). Adult weir traps, PIT tag arrays, and underwater video enumeration were used at locations where habitat was extensive or difficult for surveys to be performed on foot. Redd surveys were used to cover all remaining spawning habitat.



**Figure 1.** The extent of historic and current habitat in the Okanogan River basin accessible to anadromous fish.

At weir traps, we used protocols developed for the collection of locally adapted broodstock (Dasher 2011). Weir traps were located at Omak Creek and Bonaparte Creek in 2011. The Omak Creek trap was located approximately 1.6 kilometers upstream of the confluence with the Okanogan River (Figure 2). This trap was a semi-permanent design that has remained operational under all discharges since 2005. The Bonaparte Creek temporary picket weir trap has been installed seasonally each year since 2006 (Figure 3). At each trap, fish species was identified, weight (g) and length (mm) recorded, sex determined, tags or marks identified, and biosamples taken as needed for DNA analysis and aging. Fish were either placed upstream of the weir, taken for broodstock, or relocated downstream.

Underwater video data were collected following procedures as described in Nash (2007). Video counting was conducted at Zosel Dam, where year around data (24 hours per day, 7 days per week) have been collected since 2006 (Figure 4). Seasonal video systems were installed in Ninemile and Antoine Creeks, near their confluence with the Okanogan River. A seasonal video monitoring station was also installed in Salmon Creek, at the Okanogan Irrigation District's diversion at river kilometer (RKM) 7.2. Above this point, most of the land is privately owned and access for a complete redd survey has been unattainable.





**Figure 2.** Semi-permanent floating weir trap located on Omak Creek, looking downstream.



**Figure 3.** Seasonal picket weir trap located on Bonaparte Creek, looking downstream.



**Figure 4.** Image of Zosel Dam west bank video chute array, prior to (left), and during deployment (right).

Summer steelhead were enumerated in all remaining spawning habitats following the OBMEP redd survey protocol (Arterburn et al. 2007C). Designated mainstem and tributary survey reaches are listed in Table 1. The area of the Okanogan River downstream from Chiliwist Creek is inundated by the Columbia River (Wells Pool/Lake Pateros). Consequently, this lower reach (~23 km) of the Okanogan River was excluded from surveys because it lacks appropriate velocity and substrate needed for summer steelhead to spawn.

The Okanogan River was divided into seven survey reaches based on access points. The Similkameen River was surveyed as two reaches. We used discharge data, air and water temperature, and local knowledge of fish movements collected from previous years to determine when to begin surveys on the mainstem. Mainstem surveys were conducted from rafts and on foot in a downstream progression. All island sections or other mainstem areas that could not be floated due to limited access and/or obstacles (e.g. wood debris, braided channels, and diversions) were surveyed on foot. Raft surveys were conducted by a minimum of two people using 10' Skookum® Steelheader model catarafts (Redman, Oregon). Small tributaries were surveyed on foot, walking in an upstream direction. Each reach within the mainstem Okanogan and Similkameen River was surveyed three times between March 28 and May 4, 2011. Tributaries were surveyed one to four times, between March 31 and July 5.

Geographic positions of redds were collected with a Trimble GeoExplorer XT GPS unit and downloaded into GPS Pathfinder® after each survey. The GIS data were reviewed and differentially corrected. To avoid recounting, redds were marked by flagging tied to bushes or trees adjacent to the area where they were observed. Individual flags were marked with the survey date, direction and distance from the redd(s), consecutive flag number, total number of redds represented by the flag, and surveyor initials. Incomplete redds or test pits were not flagged or counted. The color of the flagging was changed for each survey.



**Table 1.** Designated Okanogan River redd survey reaches used by OBMEP in 2011.

<b>Redd Survey Reaches</b>	<b>Location Description</b>	<b>Reach length(km)</b>
<b>Similkameen - S1/S2</b>	Similkameen/Okanogan Confluence (0) to Enloe Dam (14.6)	14.6
<b>Okanogan - O1</b>	Okanogan River south Loup Loup Creek (26.7) to Salmon Creek (41.4)	14.7
<b>Okanogan - O2</b>	Okanogan River at Salmon Creek (41.4) to the office (52.3)	10.9
<b>Okanogan - O3</b>	Okanogan River at the office (52.3) to Riverside (66.1)	13.8
<b>Okanogan - O4</b>	Okanogan River at Riverside (66.1) to Janis Bridge (84.6)	18.5
<b>Okanogan - O5</b>	Okanogan River at Janis Bridge (84.6) to Tonasket Park (91.4)	6.8
<b>Okanogan - O6</b>	Okanogan River at Horseshoe Lake (112.4) to confluence with Similkameen River (119.5)	7.1
<b>Okanogan - O7</b>	Okanogan River at confluence (119.5) to Zosel Dam (127.0)	7.5
<b>Tunk Creek</b>	Tunk Creek at Okanogan River confluence (0) to high water mark (0.2)	0.2
<b>Bonaparte Creek</b>	Bonaparte Creek/Okanogan River confluence (0) to Bonaparte Falls (1.6)	1.6
<b>Ninemile Creek</b>	Ninemile Creek from Okanogan River confluence (0) to video weir (0.7)	0.7
<b>Tonasket Creek</b>	Tonasket Creek/Okanogan River confluence (0) to Tonasket Falls (3.5)	3.5
<b>Antoine Creek</b>	Antoine Creek/Okanogan River confluence (0) to video weir (1.3)	1.3
<b>Loup Loup Creek</b>	Loup Loup Creek/Okanogan River confluence to Loup Loup Creek diversion (2.3)	2.3
<b>Wild Horse Sp Creek</b>	Wild Horse Spring Creek/Okanogan River Confluence to barrier (1.1)	1.1
<b>Omak Creek</b>	Omak Creek/Okanogan River Confluence (0) to Omak Creek trap site (2.0)	2.0
<b>Salmon Creek</b>	Salmon Creek confluence with the Okanogan (0) to OID diversion (7.2)	7.2

We employed the method currently used by Washington Department of Fish and Wildlife (WDFW) in the Upper Columbia Basin to extrapolate escapement estimates from redds using the sex ratio of broodstock collected randomly over the run at Wells Dam (Andrew Murdoch, WDFW, pers. comm.). For example, if the sex ratio of a random sample of the run was 1.5:1.0 male to female, the expansion factor for the run would be 2.5 fish per redd (FPR). All escapement calculations using sex ratio multipliers assume that each female will produce only one redd. This method is used for all supplemented stocks within the Upper Columbia River basin.

Sex ratio data were used to provide an estimate of total spawner escapement for the population, tributary, and mainstem reaches. Sex ratio was determined by counting and sexing a sample of adult steelhead at Wells Dam, as well as all fish collected at the Omak weir trap. The ratio of males to females was used representatively for the streams where fish were trapped. Values derived from Wells Dam data were applied to all mainstem survey reaches and the sex ratio from the Omak Creek trap was applied to tributaries to the Okanogan River. Total redd estimates, in combination with counts at video sites, were summed to estimate total escapement within sub-watersheds.

PIT tag arrays were installed on many of the tributaries to the Okanogan in 2011. Population estimates derived from PIT tag detections were calculated following Murdoch et al. 2011. A random representative sample of steelhead were tagged at Priest Rapids Dam, two days per week over the course of the run, from July through November. An approximate tag rate of 8.3431% wild steelhead and 8.3369% hatchery steelhead were tagged at Priest Rapids Dam. These values were used to expand the

number of detections into escapement estimates for tributaries with PIT tag arrays. For example, if two hatchery and one wild steelhead were detected at a given creek, the escapement estimate would be 24 hatchery and 12 wild steelhead, calculated from the tagging rates at Priest Rapids. Based on the relatively few numbers of detections at most locations, particularly for small tributaries, escapement estimates derived from PIT tag detections may be highly variable and should be considered a general estimate. In addition to fish tagged at Priest Rapids, steelhead were also PIT tagged at Wells Dam, however sampling was not consistent across the run. Therefore, any extrapolation from detections to an escapement estimate was derived only from the Priest Rapids tag group. Detections from fish tagged at Wells Dam may be mentioned anecdotally in this report.

## **Results and Discussion**

### **Sex Ratio**

A sample of 842 summer steelhead, including 300 males and 542 females, were sexed at Wells Dam in 2011 by Washington Department of Fish and Wildlife personnel (Charles Frady, WDFW, pers. comm.). Adjusted proportionally for the run, the WDFW calculated that the Wells Dam data resulted in a sex ratio of 0.55 males per female or 1.55 FPR. This value was used to expand redd counts on the mainstem Okanogan River into escapement estimates.

In 2011, 56 summer steelhead were enumerated at the Omak Creek trap. A ratio of 0.8 males for each female (25 males; 31 females) was observed, yielding 1.8 FPR. There was a failure of the Bonaparte Creek adult weir trap due to high discharges, and therefore, a reliable sex ratio was undetermined for this location. For tributaries to the Okanogan where sex ratio data were not available and reliable redd surveys occurred, the surrogate value was used from Omak Creek (1.8 FPR).

### **Percent-Wild**

The WDFW estimated the number of wild summer steelhead that escaped above Wells Dam was 1,698 or 15.2% of the total escapement in 2011. This value was based upon ad-present steelhead counts, PIT tags, coded wire tags, scale analysis, harvest, broodstock collection, and stray rates estimated for Wells Hatchery (Charles Frady, WDFW, pers. comm.). The proportion of wild fish assumed to be bound for the Okanogan River was 338, or 13.5% of the total escapement. This percentage was applied to all mainstem Okanogan River expanded redd counts in order to estimate the number of wild spawners at those locations.

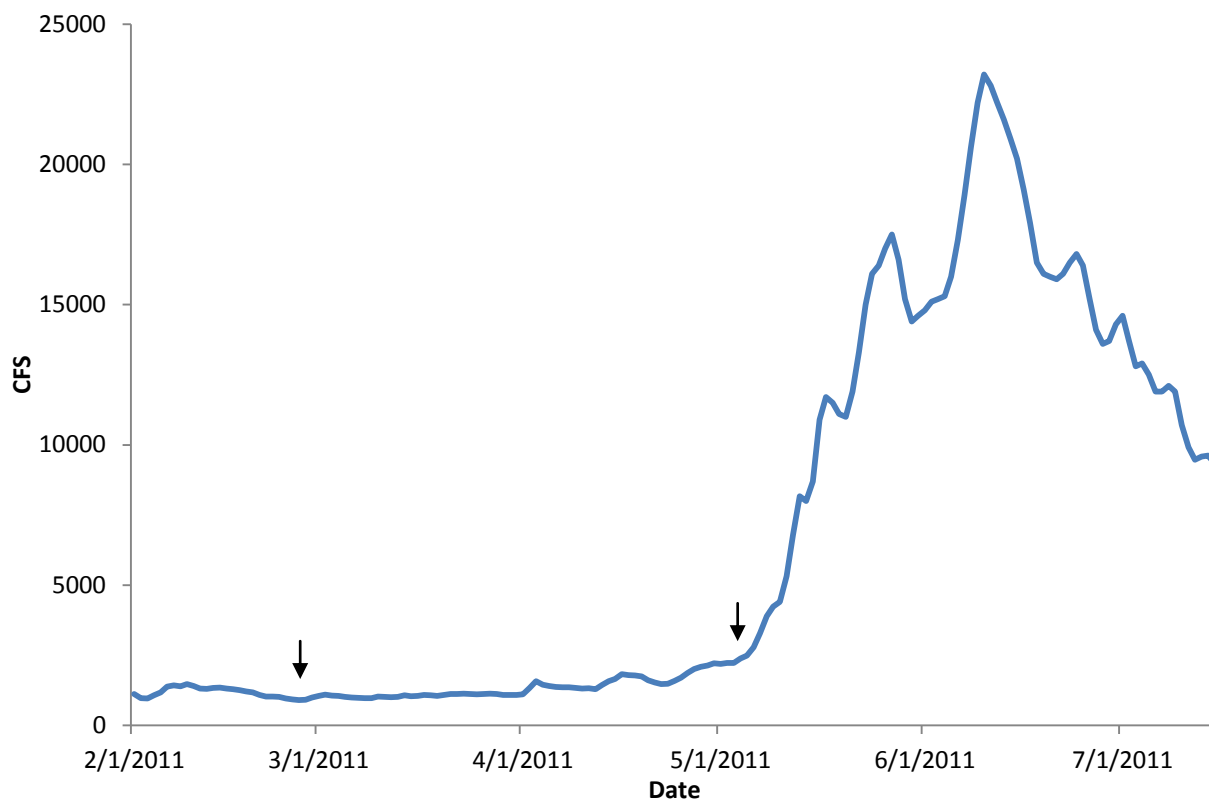
The percent of wild summer steelhead that returned to tributary weir traps was determined by the presence of an intact adipose fin, PIT tag, and coded wire tag information. The percent of natural origin steelhead returning to Omak Creek was 85.7% (48 out of 56 total fish). Four wild steelhead were captured in the Bonaparte Creek trap out of five total fish; therefore, 80.0% were considered wild.

Video weirs were also used on three tributaries and the mainstem Okanogan, which provided percent-wild estimates for those locations. On Salmon Creek, 10.6% of passing adult steelhead were documented as ad-present and 57.9% for Ninemile Creek. No adult steelhead were observed in the Antoine Creek video weir. At Zosel Dam, 62 out of 270 summer steelhead (23%) were documented

having intact adipose fins. A percent-wild value of 18% was used for Tunk Creek, derived from observations of hatchery and wild steelhead on redds during foot surveys. The most conservative percent wild estimate (13.5%) was used for Wild Horse Spring Creek and Tonasket Creek. Wild steelhead production has been rare in those systems based on a history of low or intermittent flows in the lower most reaches of those systems.

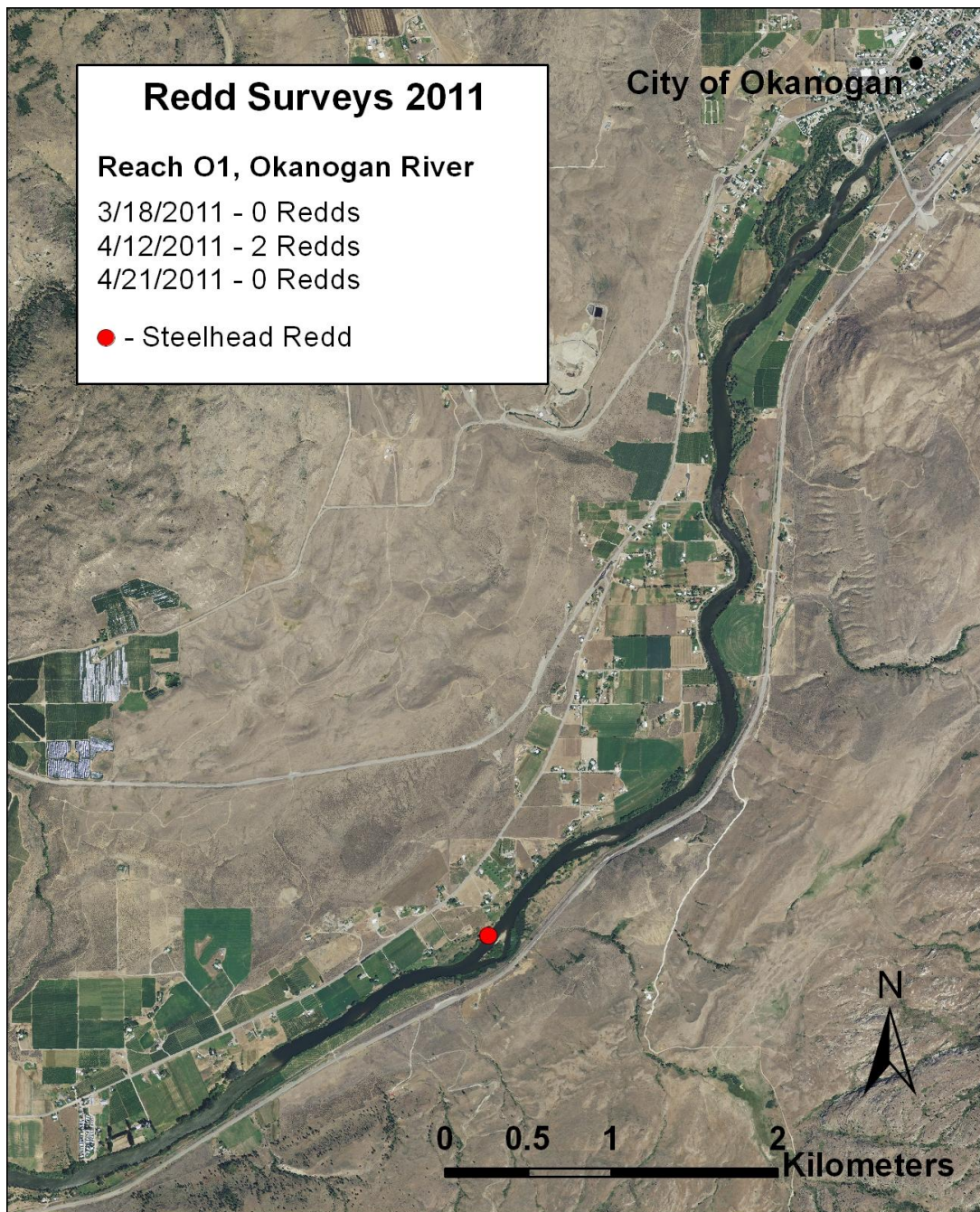
## Okanogan and Similkameen River Mainstem

Discharge and water clarity remained acceptable to conduct redd surveys on the mainstem surveys of the Okanogan and Similkameen Rivers in 2011 (Figure 5). Each reach within the mainstem Okanogan River and Similkameen River was surveyed three times between March 28 and May 4, 2011. The observed spawning activity of steelhead on the mainstem had concluded before early May and redd surveys were considered largely effective in documenting redds.



**Figure 5.** Discharge of the Okanogan River as measured at Tonasket, WA for the period from February to July, 2011 ([http://waterdata.usgs.gov/nwis/uv?site\\_no=12445000](http://waterdata.usgs.gov/nwis/uv?site_no=12445000)). Beginning and end of mainstem redd surveys is marked by arrows.

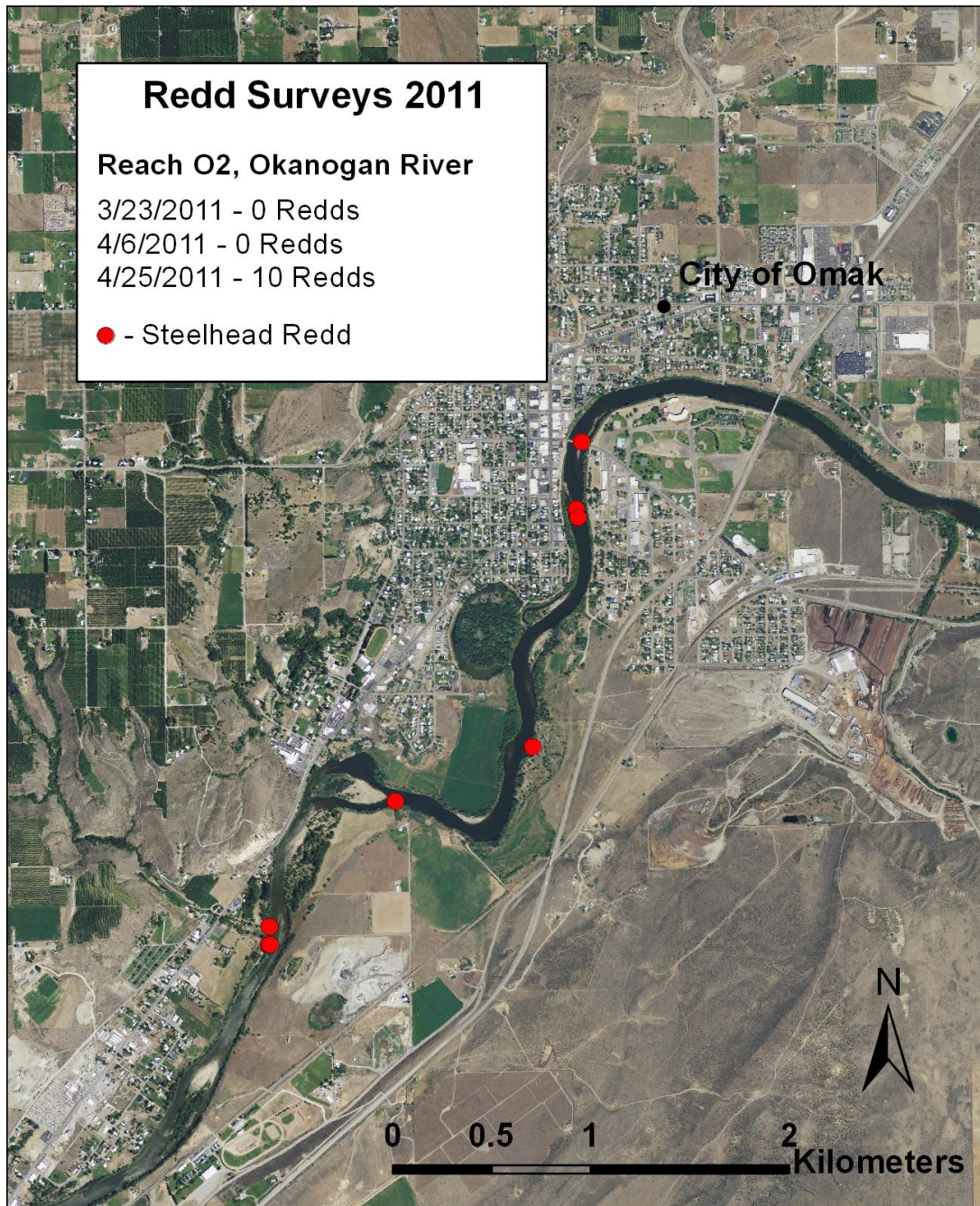
The lower-most reach on the Okanogan River (Reach O1) was surveyed March 18, April 12, and April 21 (Figure 6). A total of 2 steelhead redds were documented, both during the second round of surveys. Using the mainstem value of 1.55 FPR, 3 steelhead were estimated to be utilizing this reach. A 13.5% wild rate applied to this value would suggest that there were likely no spawners of natural origin. No redds were observed on the mid-channel bar downstream of the Malott bridge, which had been frequently utilized in previous years, but not in 2010 or 2011.



**Figure 6.** Redd distribution observed in 2011 for Okanogan River reach O1 from the confluence of Salmon Creek downstream to south of Loup Loup Creek.



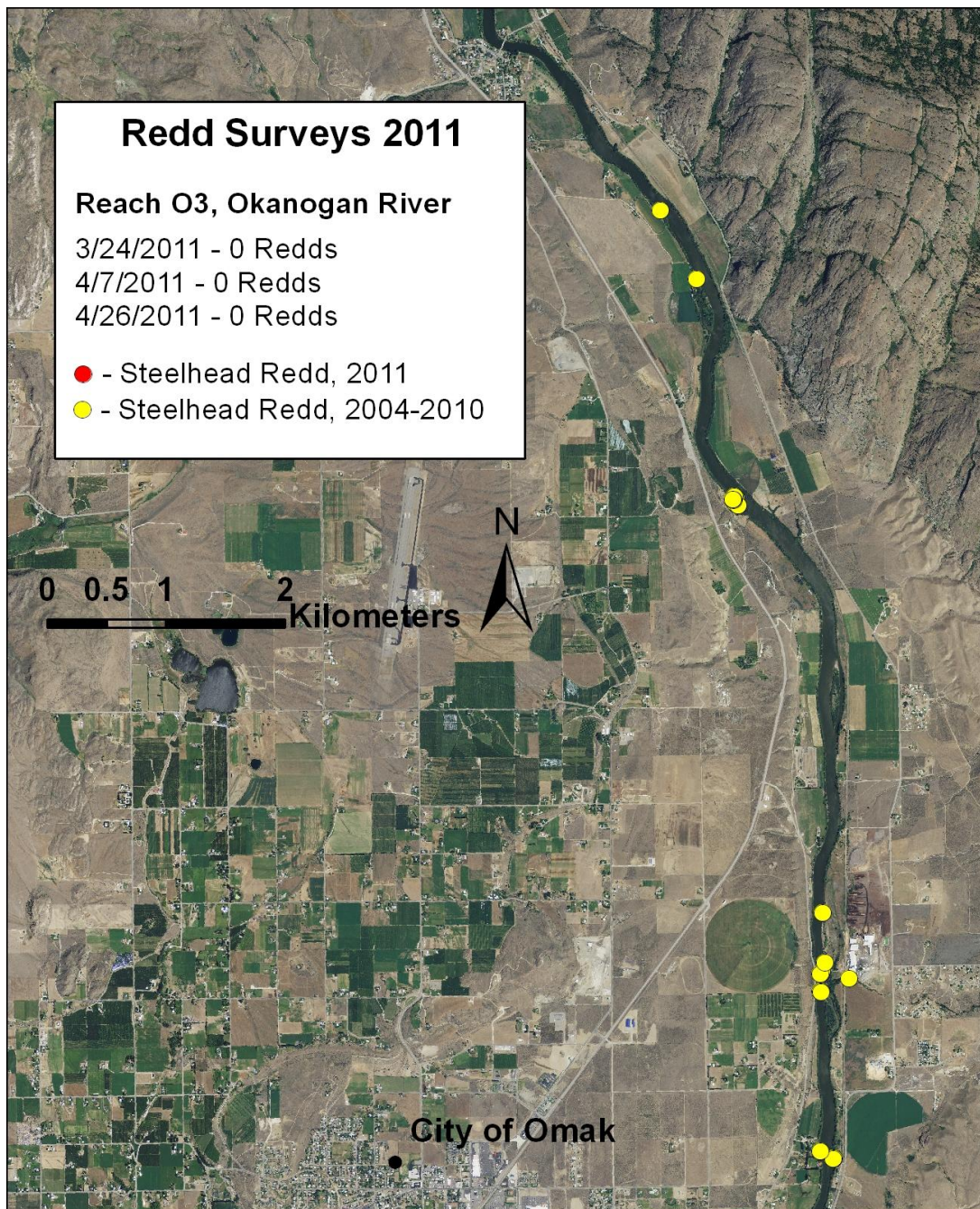
The first two surveys of Okanogan River reach O2 were conducted on March 23 and April 6, zero redds were observed (Figure 7). The third survey occurred on April 25 and 10 redds were documented. The value of 1.55 FPR rendered 16 steelhead that likely spawned in this reach, 2 of which may have been wild. Steelhead redds were documented in areas where spawning frequently occurred in previous years, including below the downtown Omak bridge and in the vicinity of the braided channel near Shellrock Point. However, no redds were observed at the mid-channel riffle immediately downstream of Omak Creek, where redds had been commonly observed in previous years.



**Figure 7.** Redd distribution observed in 2011 for Okanogan River reach O2 from the confluence of Omak Creek in Omak, WA downstream to the confluence of Salmon Creek.



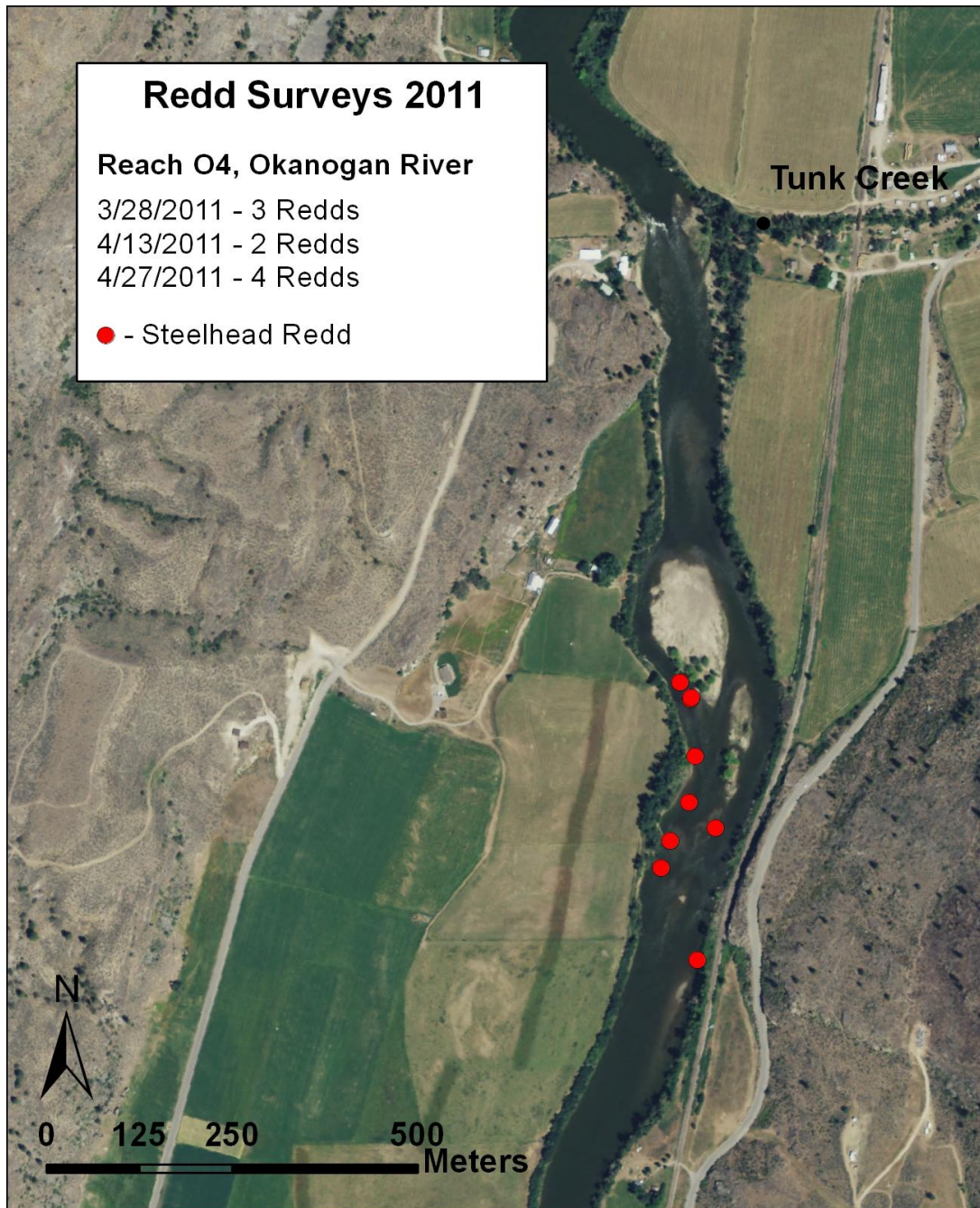
Okanogan River Reach O3 was surveyed on March 24, April 7, and April 26. No redds were observed in this reach in 2011 across all three surveys. Steelhead redds documented from 2004-2010 are shown in Figure 8 for reference of historical spawning locations. Availability of suitable spawning gravel is minimal within Reach O3. Fine sediments and low water velocities dominate much of this reach, which may account for the continued low abundance of spawning steelhead.



**Figure 8.** Redd distribution observed from 2004-2010 for Okanogan River reach O3 from the town of Riverside, WA downstream to the confluence with Omak Creek in Omak, WA. No redds were observed in 2011.



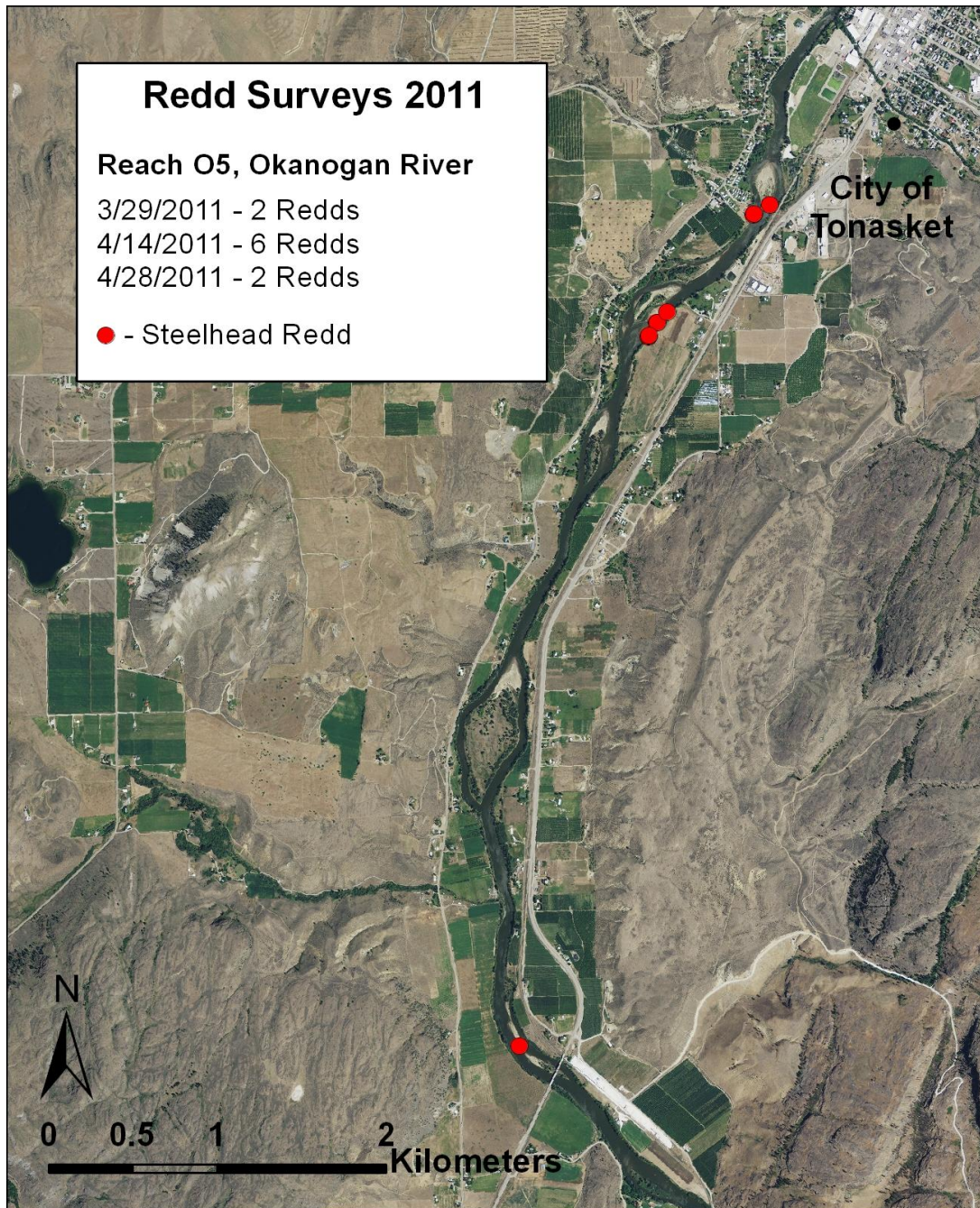
Okanogan River Reach O4 extends from Janis Bridge, south of Tonasket, WA, to the town of Riverside. Surveys of this reach occurred on March 28, April 13, and April 27 (Figure 9). A total of 9 redds were observed and all were located within the braided island complex just south of the confluence with Tunk Creek. These 9 redds likely represent a total of 14 adult steelhead, 2 of which may have been of wild origin. The number of redds observed in 2011 was the second lowest observed count within this reach (previous years range: 5-58 redds).



**Figure 9.** Redd distribution observed in 2011 for Okanogan River reach O4, from Janis Bridge downstream to the town of Riverside, WA.



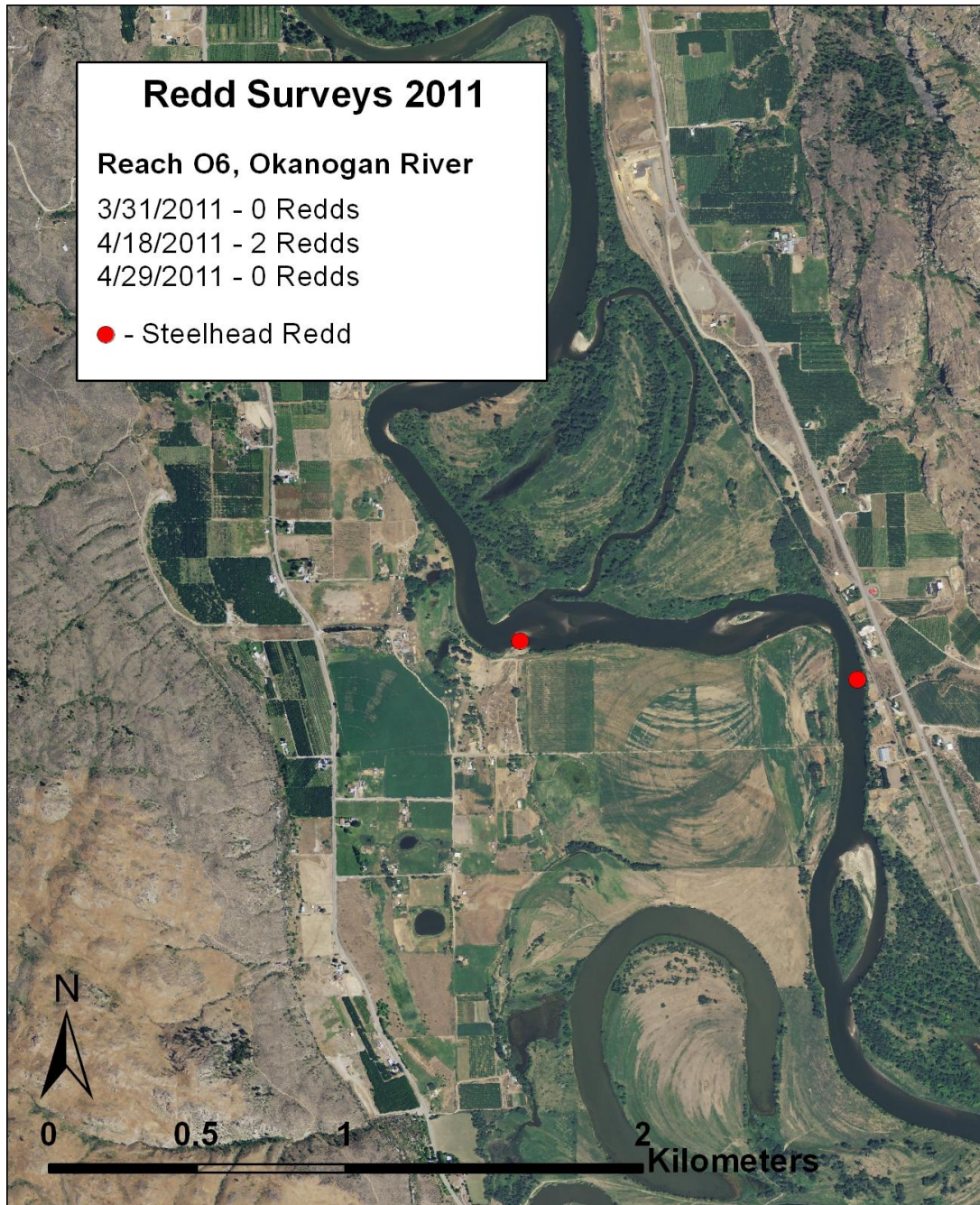
Okanogan River Reach O5 was surveyed on March 29, April 14, and April 28. A total of 10 redds were identified across three surveys (Figure 10). The majority of redds continued to be observed downstream of Tonasket, in sections of braided channel. An estimated 15 spawners used this reach, based on the value of 1.55 FPR. A 13.5% wild rate rendered 2 wild steelhead.



**Figure 10.** Okanogan River redd distribution observed in 2011 within reach O5 from the Chief Tonasket Park located in the town of Tonasket, WA downstream to the Highway 97 Bridge at Janis, WA.



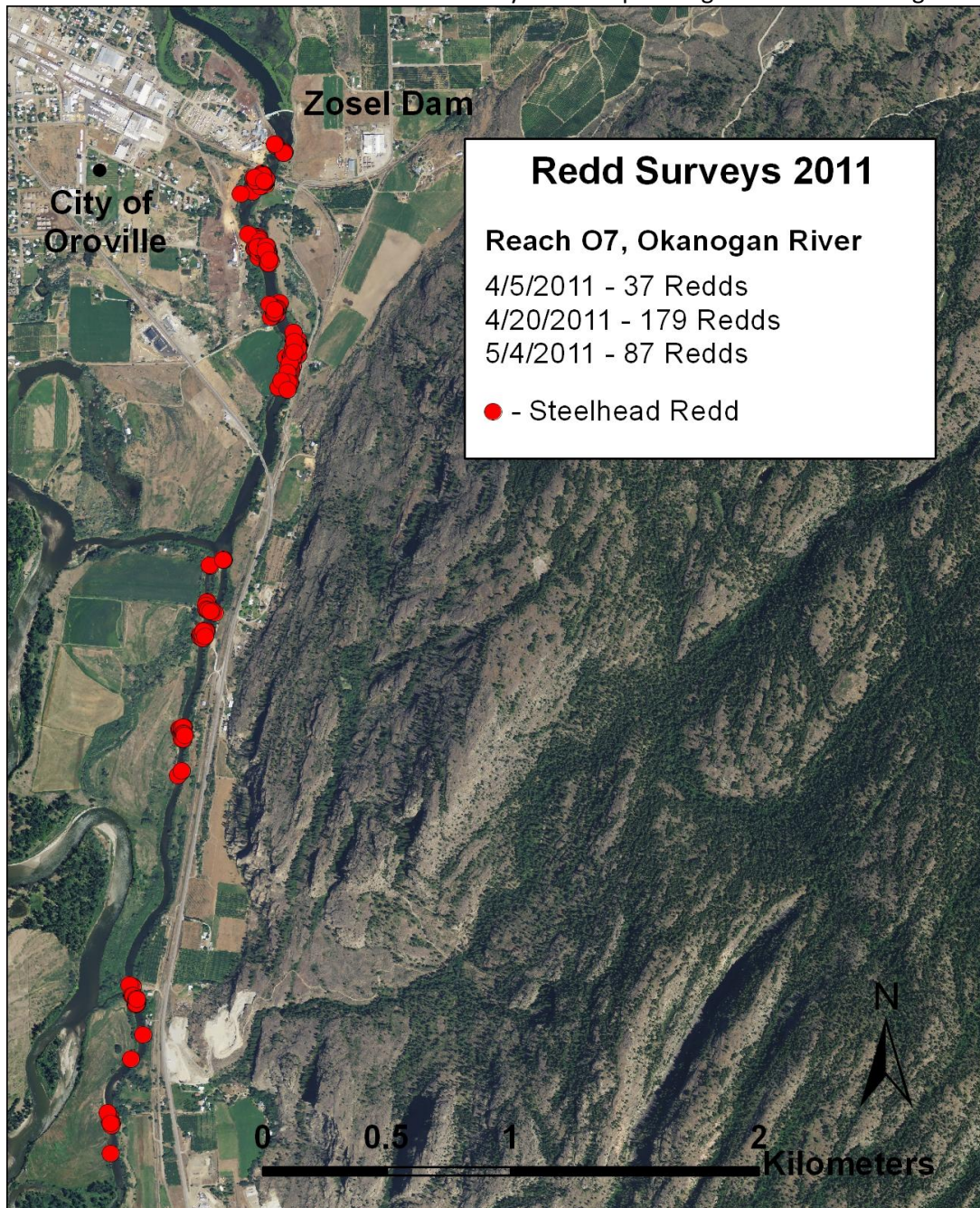
Surveys were conducted on Reach O6 on March 31, April 18, and April 29. Only two redds were observed during the second survey (Figure 11). A total of 3 steelhead spawners, zero wild, were attributed to the 2 redds. No redds were identified in this reach in both 2008 and 2009; however, 40 redds were observed in 2010. Redds had been previously documented at both of the locations where redds were found in previous years.



**Figure 11.** Redd distribution observed in 2011 within reach O6, from the confluence of the Okanogan and Similkameen Rivers to Horseshoe Lake.

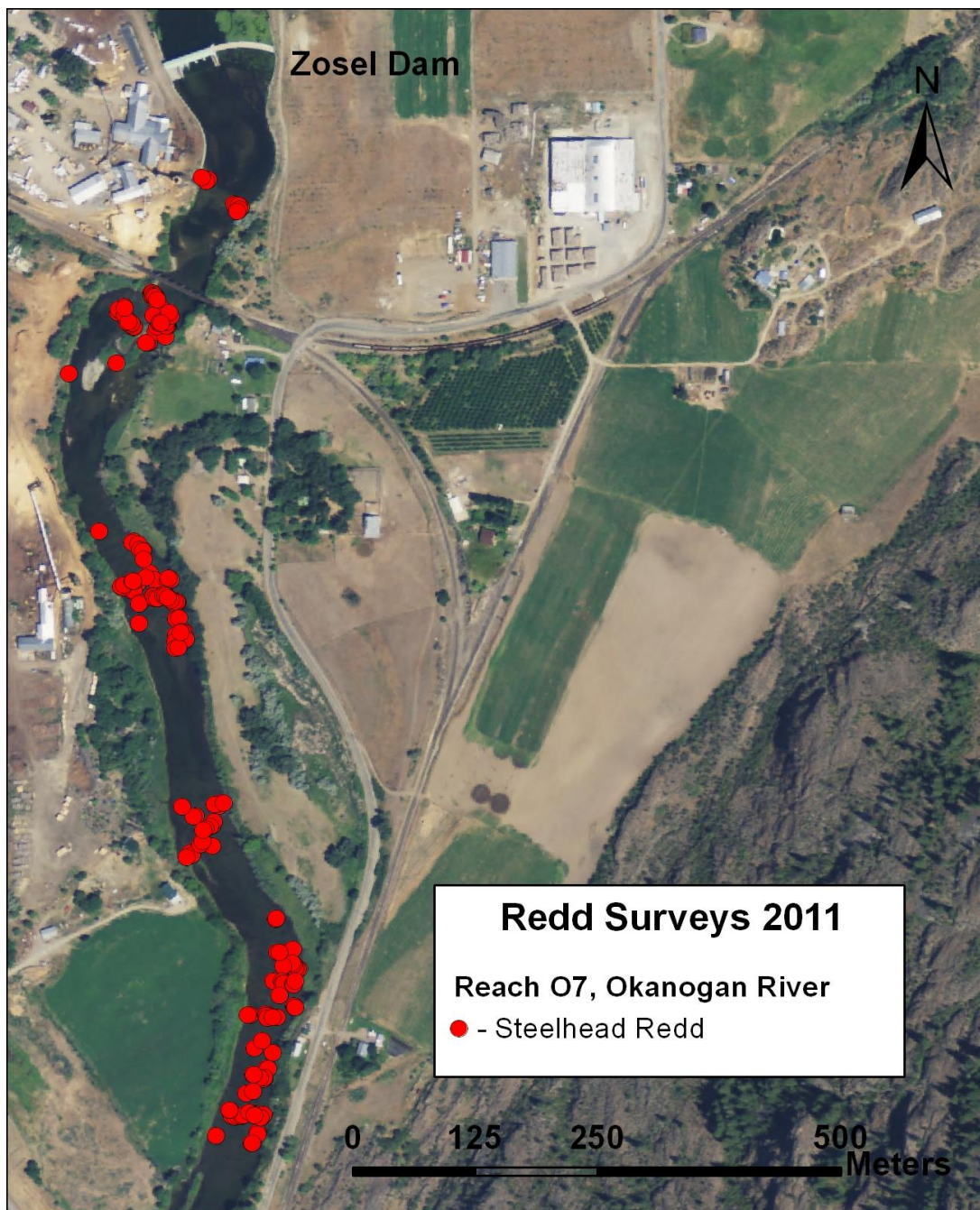


Okanogan River Reach O7 was surveyed three times in 2011 and a total of 304 summer steelhead redds were identified. Thirty-seven redds were documented on April 5, 179 redds on April 20, and 87 redds on May 4. Additionally, one redd was previously observed on March 31, during a survey of a different reach. The majority of redds were observed downstream of Zosel Dam, but above Driscoll Island (Figure 12 and 13). As in previous years, much of the spawning activity was focused on ridges of gravel created by summer/fall Chinook. The value of 1.55 FPR provided a total estimate of 471 steelhead spawning within this reach. The mainstem value of 13.5% wild represented 64 of those fish as ad-present spawners. Reach O7 continues to be the most densely utilized spawning area in the Okanogan basin.



**Figure 12.** Redd distribution observed in 2010 for Okanogan River reach O7 which extends from Zosel Dam downstream to the confluence with the Similkameen River.

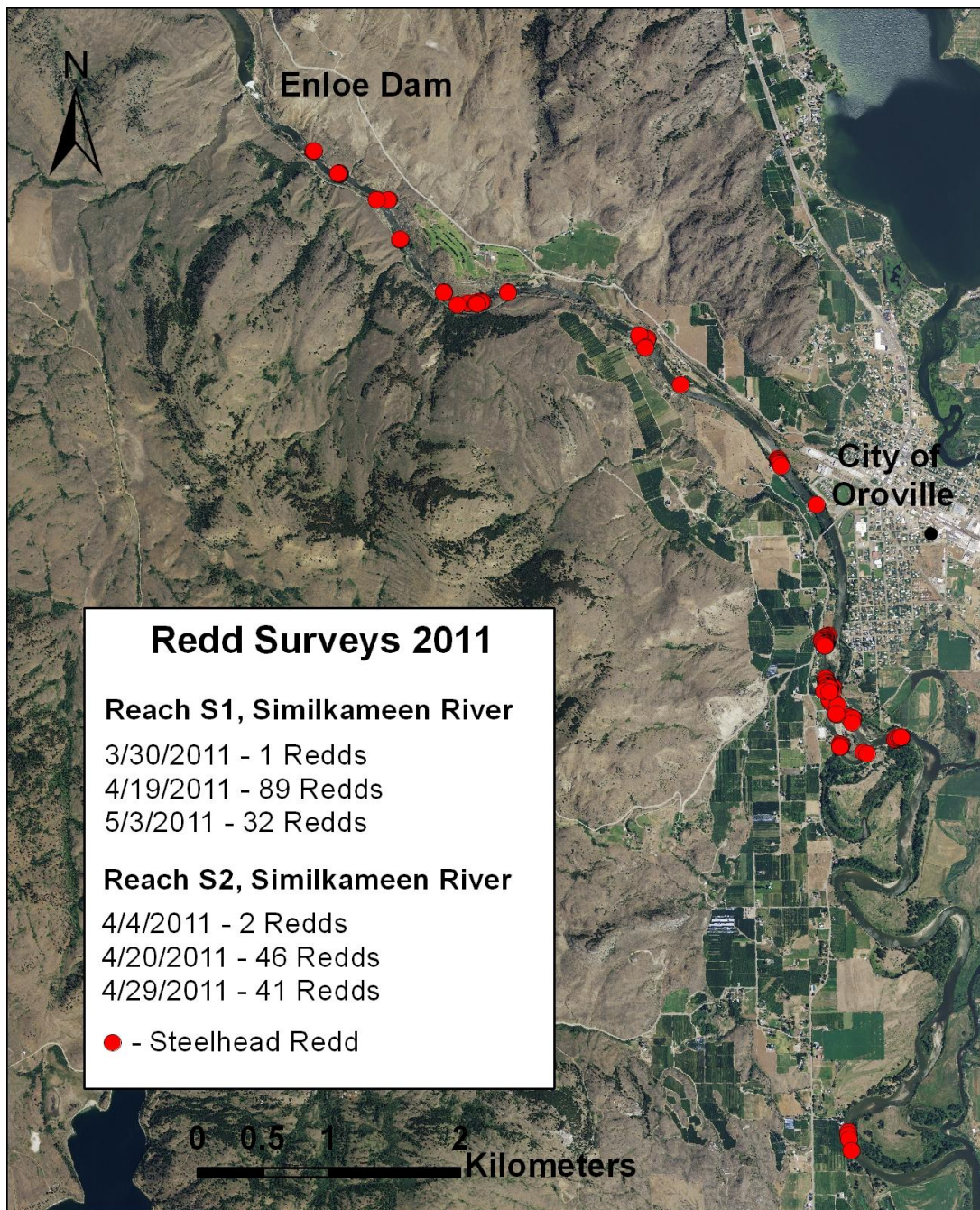




**Figure 13.** Map showing closer detail of redd distribution in the most extensively used spawning area on the Okanogan River, Reach O7.

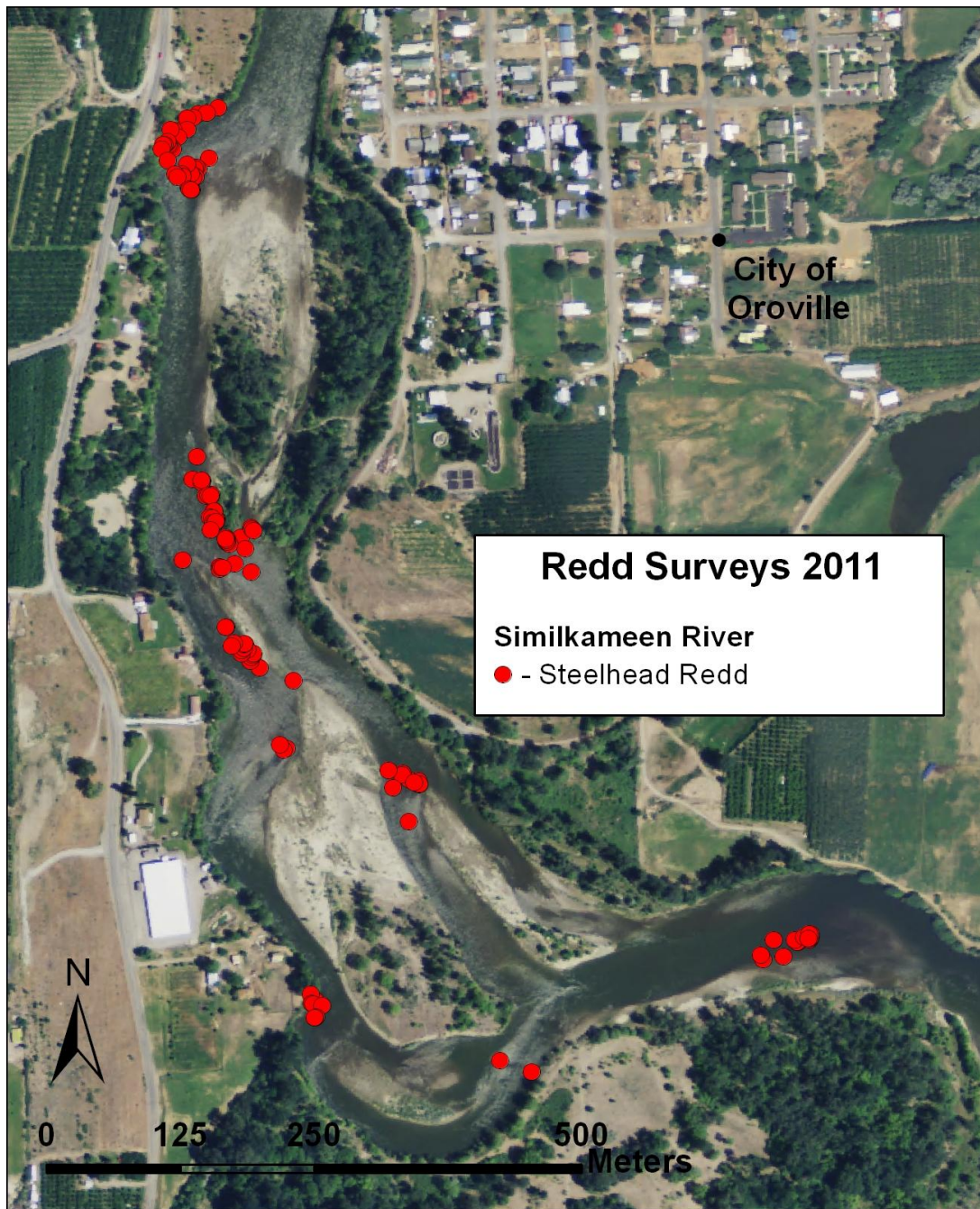


Observers were able to survey the Similkameen River Reach S1 and Reach S2 three times each in 2011 due to favorable water clarity. A total of 122 redds were documented in Reach S1 which likely represented 189 steelhead spawners. In Reach S2, 138 spawners were extrapolated from 89 redds (Figure 14). From the mainstem 13.5% wild rate, 26 and 19 wild steelhead likely spawned in Reach S1 and S2, respectively. A large proportion of redds within this reach were observed near the city of Oroville, adjacent to the water treatment plant (Figure 15).



**Figure 14.** Redd distribution observed in 2011 for Similkameen River Reach S1 and S2. Reach S1 extends from the base of Enloe Dam downstream to the water treatment plant in Oroville, WA. Reach S2 encompasses the section between Oroville and the lower confluence with the Okanogan River.





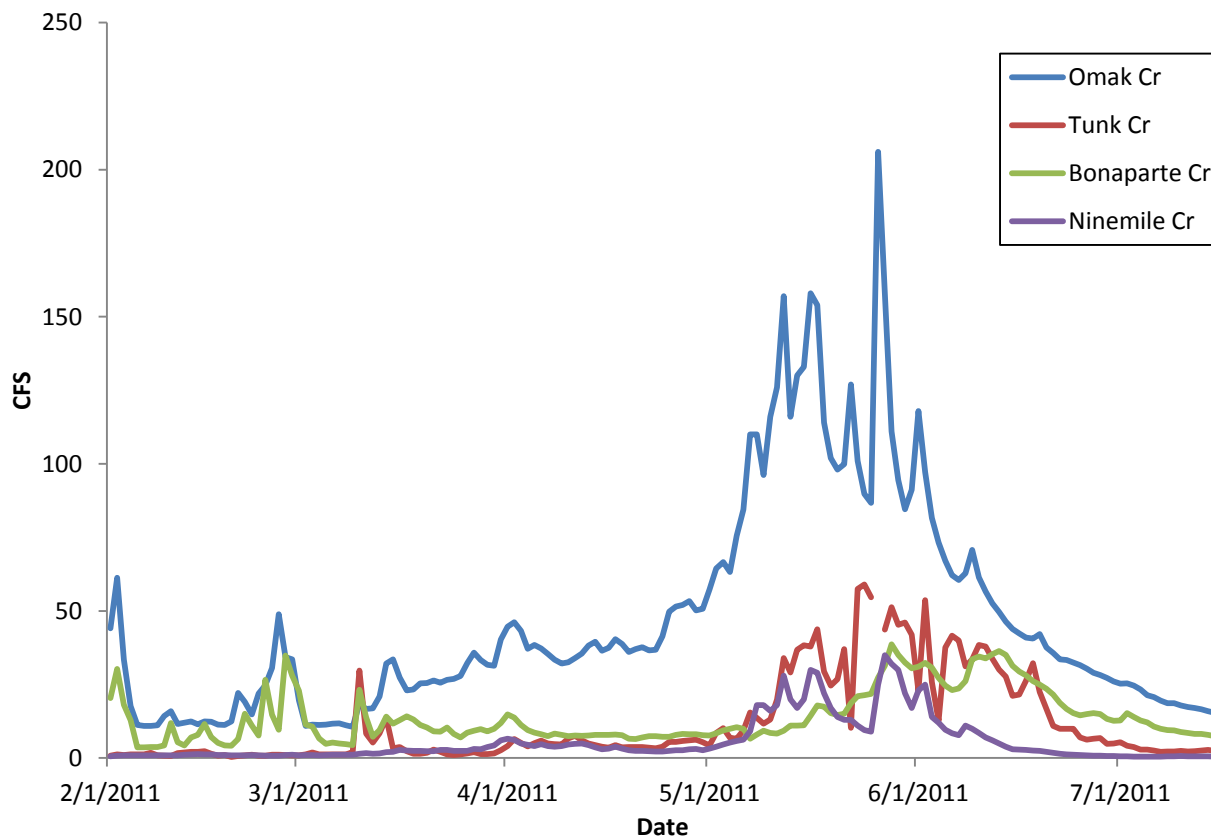
**Figure 15.** Map showing closer detail of redd distribution in the most extensively used spawning area on the Similkameen River.

## Tributary redd surveys in the Okanogan River subbasin

Tributary surveys began as soon as water clarity allowed or landowner access was granted. Steelhead redd surveys within tributary habitats were conducted from March 31 through July 5. The upstream extent of each survey was limited by either a natural fish passage barrier or access to private land, as described in Arterburn et al. (2007a). Above-normal precipitation (Table 2) and discharge (Figure 16) in 2011 allowed adult steelhead to access many of the tributaries, including those which are frequently inaccessible due to low flows or dry creek beds. However, increased flows frequently resulted in reduced water clarity, which limited the effectiveness of redd surveys on many small tributaries.

**Table 2.** Precipitation totals measured by the National Weather Service at the Omak airport for March, April, and May 2011. <http://www.crh.noaa.gov/>

Month	2011	2010	2009	2008	2007	2006	Avg Precip (1981-2010)
March	2.72	0.52	0.93	0.73	0.08	0.81	0.89
April	0.23	1.21	0.19	0.19	0.06	0.89	0.91
May	2.96	3.05	1.23	0.18	0.74	1.35	1.18
Total	5.91	4.78	2.35	1.10	0.88	3.05	2.98



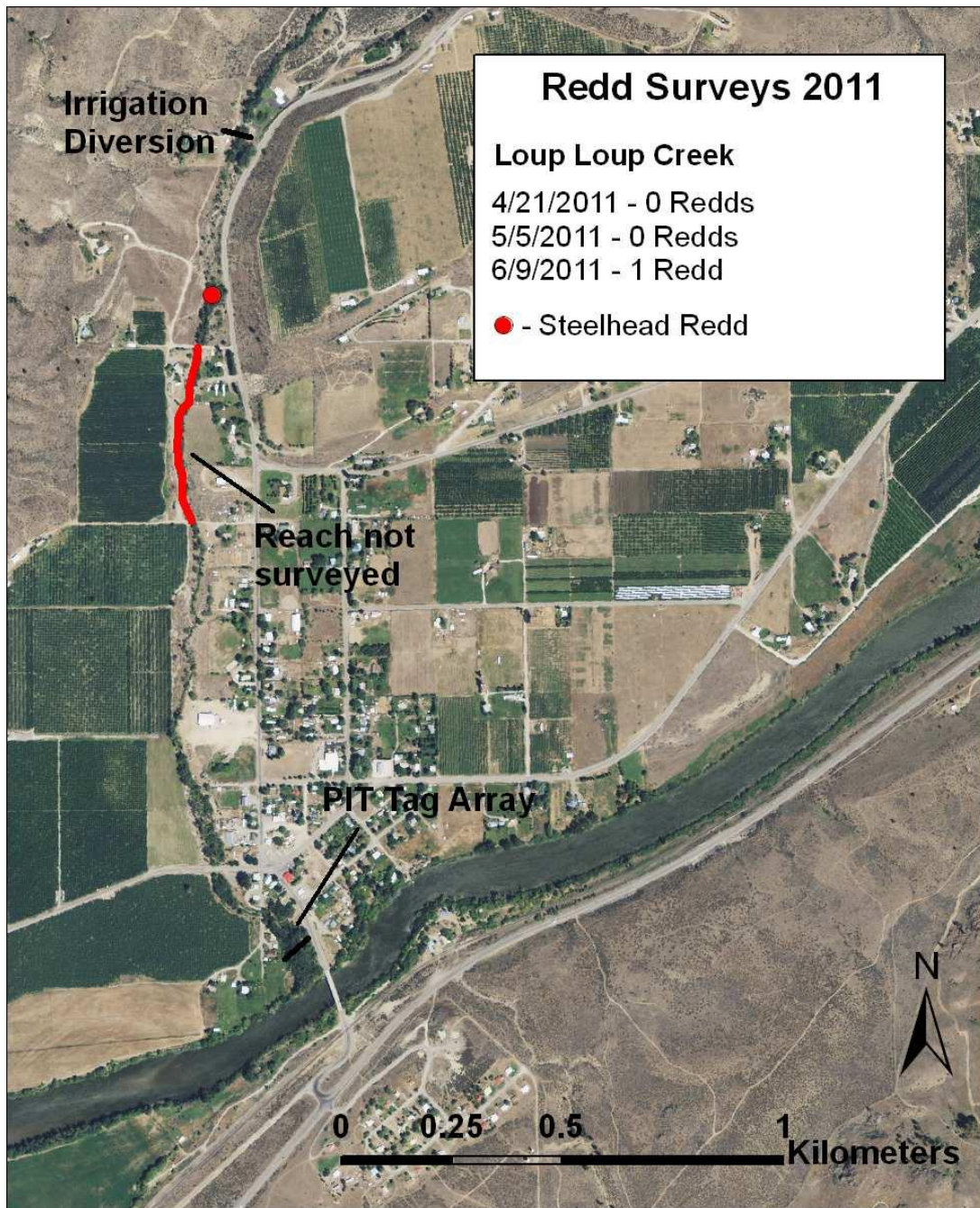
**Figure 16.** Discharge from February through June of 2011 for four tributary streams known to produce summer steelhead in the Okanogan basin. Data were obtained from the USGS and WA Dept of Ecology.

### *Loup Loup Creek*

A history of low stream flows on Loup Loup Creek restricted anadromous fish access in the previous years, primarily due to an impediment (culvert) located at RKM 0.1. However, adequate flows allowed steelhead access into Loup Loup Creek and passage above the culvert in 2010 and 2011. Well above average discharge in 2011 limited redd survey effectiveness due to limited water visibility. Only one redd was documented on June 9, after visibility improved (Figure 17). A section of Loup Loup Creek was not surveyed due to access related issues and is marked in the figure below.

Due to the inability of redd surveys to comprehensively document spawning activity on Loup Loup Creek, PIT tag data were used to develop a local escapement estimate. One PIT tagged hatchery steelhead was detected at the seasonal PIT tag array located at the mouth of Loup Loup Creek. Based on the Priest Rapids Dam hatchery steelhead release tag rate of 8.3369%, twelve hatchery steelhead were expanded from this detection. It is likely that the escapement estimate calculated from PIT tag detections, rather than the one documented redd, more likely represented the actual number of steelhead using Loup Loup Creek in 2011.





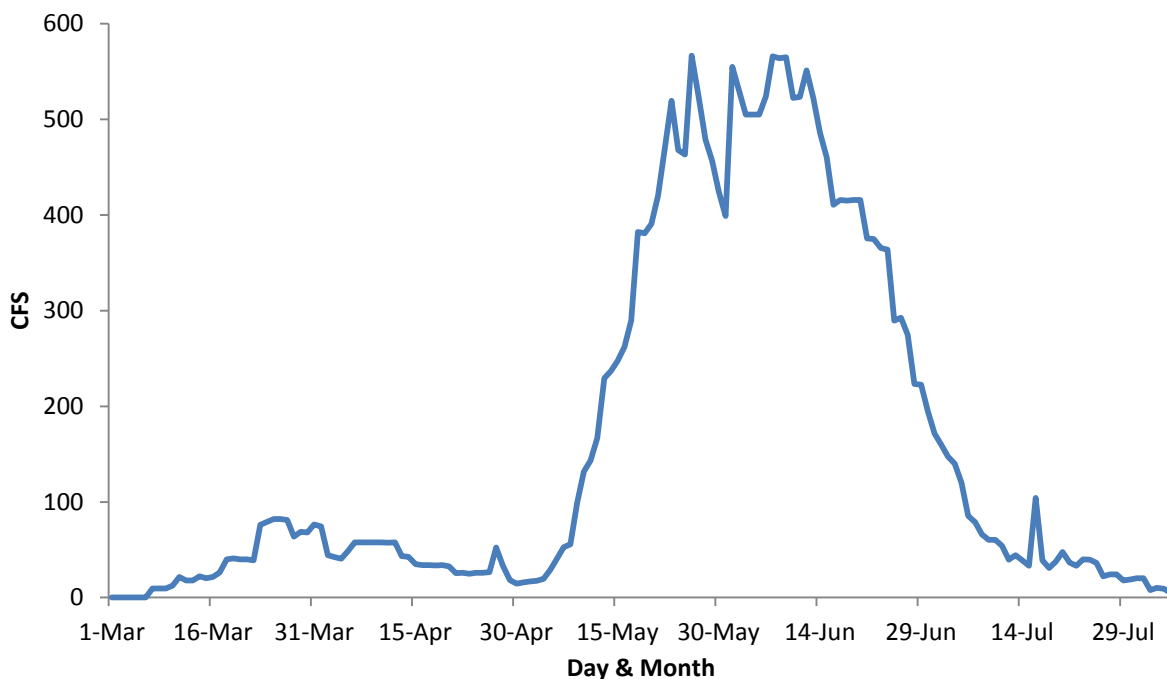
**Figure 17.** Map of summer steelhead redds observed in Loup Loup Creek, from the confluence with the Okanogan River to the irrigation diversion (barrier), during the spring of 2011. One section of the creek was not surveyed due to access related issues.



## Salmon Creek

Since the early 1900's, the majority of water from Salmon Creek has been diverted for irrigation usage. The resulting dry stream channel extended from the Okanogan Irrigation District (OID) diversion dam (7.2 km) to the confluence with the Okanogan River. Occasionally, uncontrolled spills occurred downstream of the OID diversion dam on high water years. These spills typically occur in mid-May to June, which is after summer steelhead have already moved into tributaries to spawn. In order to provide sufficient water during the migration window of spring-spawning steelhead, the Tribes purchased water from the OID and allowed it to flow down the channel to the Okanogan River. After several years of successful evaluations of steelhead passage, the Tribes negotiated a long term water lease agreement with the OID in order to provide water for returning adults and out-migrating juveniles.

In 2011, water was again provided for a migration window, primarily for summer steelhead (Chris Fisher, Colville Tribes, pers. comm.). The potential for adult steelhead to access Salmon Creek from the mainstem Okanogan began the first week of March. Additionally, above average spring rainfall in 2011 significantly increased the amount of runoff that came down Salmon Creek in May and June (Figure 18). It is unknown to what extent scour events could have negatively impacted steelhead redds.



**Figure 18.** Release of water from Salmon Creek to allow steelhead passage and subsequent high water runoff occurring in 2011.

A specialized underwater video apparatus was installed into the fish ladder of the OID diversion dam in 2011. A total of 66 adult steelhead were observed passing upstream through the video chamber and 7 of those had intact adipose fins. The first steelhead was seen on April 3 and the final fish was counted on May 8. Due to the sustained high discharge rates occurring in 2011, water spilled over the concrete fish-ways at the diversion site. It is possible that an unknown number steelhead passed upstream of the diversion without passing through the video array during two separate high water events, March 22 - March 31 and May 20 - July 7.

The lower reach of Salmon Creek was surveyed for redds on May 2 and the upper reach was surveyed on May 5. A total of 45 steelhead redds were documented in the lower 7.2 km of Salmon Creek (Figure 19). Surveys could not be conducted after this date due to sustained high discharge rates until July. At that date, any previously constructed redds were unidentifiable. Using a FPR value of 1.8 (from Omak Creek) rendered 81 documented spawners below the diversion. Ad-present fish made up 10.6% of the fish observed in the video weir. This rate was applied to the redd count downstream of the video weir, which rendered 9 ad-present steelhead spawning between the confluence with the Okanogan River and the diversion site. The combined estimate of 147 spawners, from redd surveys and video observations, should be considered a minimum escapement estimate, due to high water and incomplete surveys in 2011.

Sixteen hatchery and one wild steelhead from the Priest Rapids release group were detected at the PIT tag array on Salmon Creek. The calculated escapement estimate from those detections were 192 hatchery and 12 wild steelhead. In addition to the tag detections, three redds were constructed downstream of the array, which added 5 more hatchery steelhead. The total spawning estimate for Salmon Creek based on tag detections and 3 downstream redds was 209 steelhead, 12 of which were likely wild (Table 3).

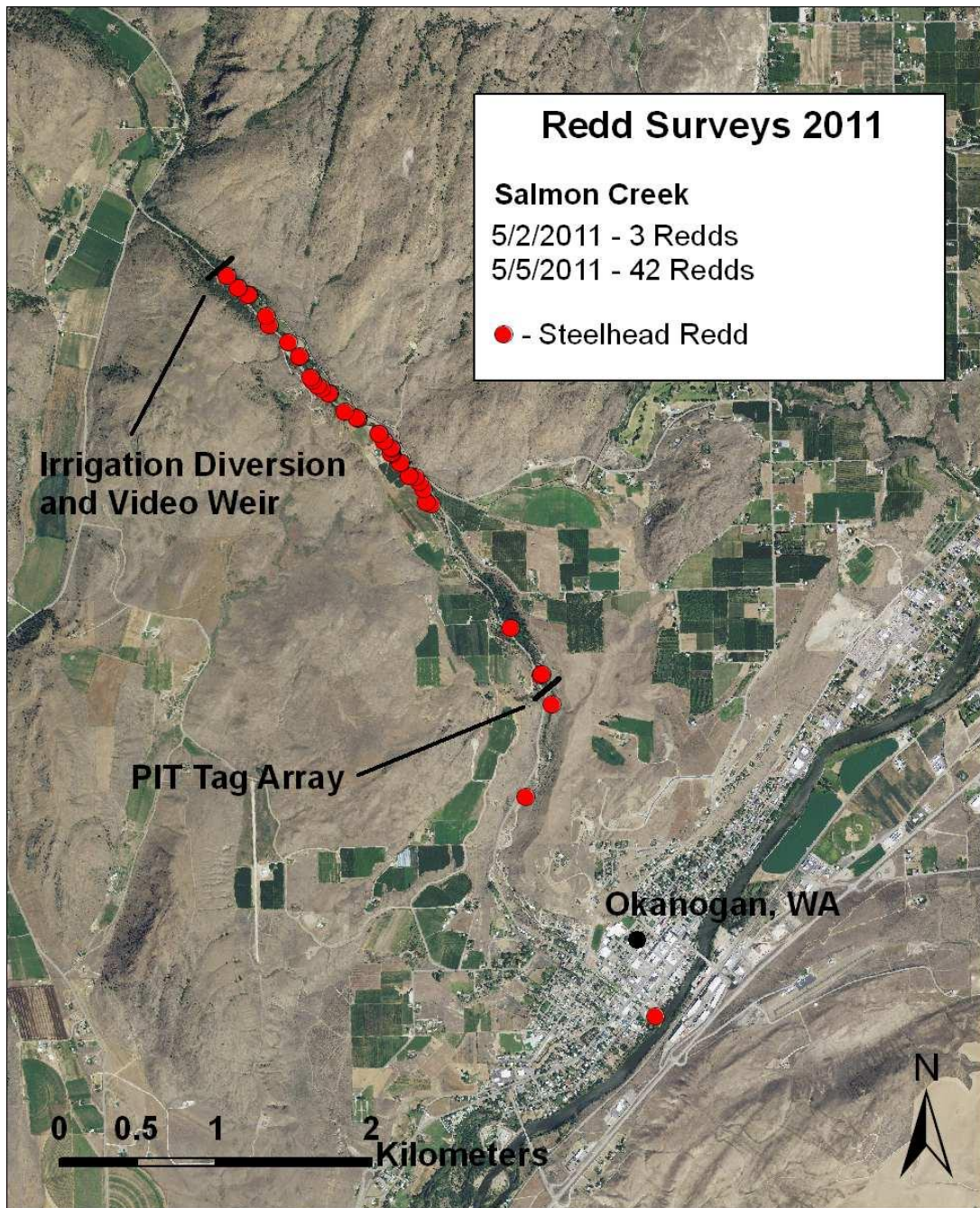
**Table 3.** Two methods for calculating escapement estimates in Salmon Creek. (A) Video counts at the OID diversion and redd surveys conducted below the diversion and (B) expansion based on PIT tag detections.

A. Redd surveys and video count, Salmon Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Below Diversion (Redd surveys)	45	81	9
Above Diversion (Video monitoring)	Surveys not conducted	66	7
Total	n/a	147	16

B. PIT Tag detection estimation, Salmon Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Total	n/a	204	12



**Figure 19.** Map of summer steelhead redds observed below the Salmon Creek trap during the spring of 2011. The lower reach, below the PIT tag array, was surveyed on May 2 and the upper reach was surveyed on May 5.

### *Omak Creek*

The highest proportion of wild steelhead was recorded at the weir trap in 2011, since data were first collected in 2001, with 85.7% of all steelhead being of natural origin (Table 4). Twenty-five male and 31 female steelhead were sexed at the trap, rendering a sex ratio of 0.8 M:F (1.8 FPR), which was applied to redd surveys occurring downstream of the trap. The run timing at the Omak Creek weir appeared to be the second earliest since 2005 (Figure 21).

Redd surveys identified 29 redds below the Omak Creek weir trap (Figure 22). Only one redd survey was conducted in 2011 because discharge levels were not conducive to survey spawning activity until July, after all spawning activity had ceased. Using the FPR value of 1.8 from the Omak Creek weir trap, an estimated 52 steelhead likely spawned between the mouth of Omak Creek and the trap. Thirteen redds were constructed immediately downstream of the weir trap, possibly suggesting trap avoidance behavior. However, trap avoidance continued to be less prevalent than in prior years, based on trap modifications made in 2009 (Rhonda Dasher, Colville Tribes Biologist, pers. comm.). Based on combined redd surveys and weir counts, we estimated that a total of 108 adult steelhead spawned in Omak Creek in 2011 (Figure 20).

**Table 4.** Proportions and totals of male, female, and wild summer steelhead passed above the Omak Creek trap in 2011.

Omak Creek Adult Weir Trap, 2011	Total (N)	Wild (N)	Percent-Wild (%)
Total	56	48	85.7%
Males	25	20	80.0%
Females	31	28	90.3%

A permanent PIT tag array was located on Omak Creek, just upstream from the confluence with the Okanogan River, but below the adult weir trap. Eight wild and 3 hatchery steelhead from the Priest Rapids release group were detected at this location in the spring of 2011. A total of 96 wild and 36 hatchery steelhead were calculated from those PIT tag detections. No steelhead redds were observed below the PIT tag array. Therefore, it is probable that a minimum of 108, but more likely 132 steelhead spawned in Omak Creek in 2011 (Table 5).

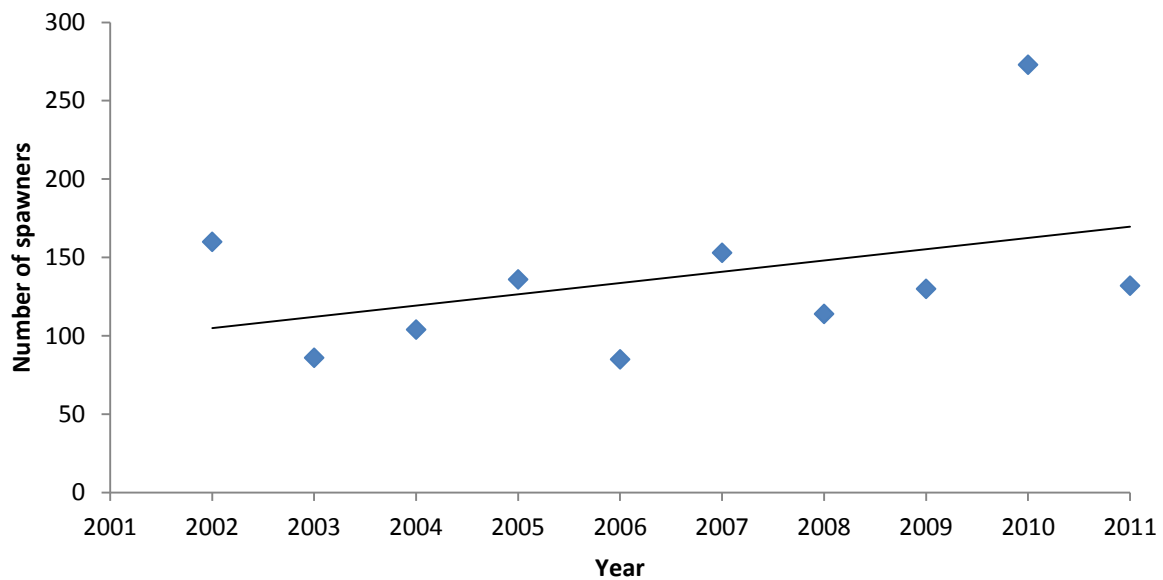
**Table 5.** Two methods for calculating escapement estimates in Omak Creek. (A) Weir counts and redd surveys below the weir and (B) expansion based on PIT tag detections.

A. Redd survey and adult weir count, Omak Creek

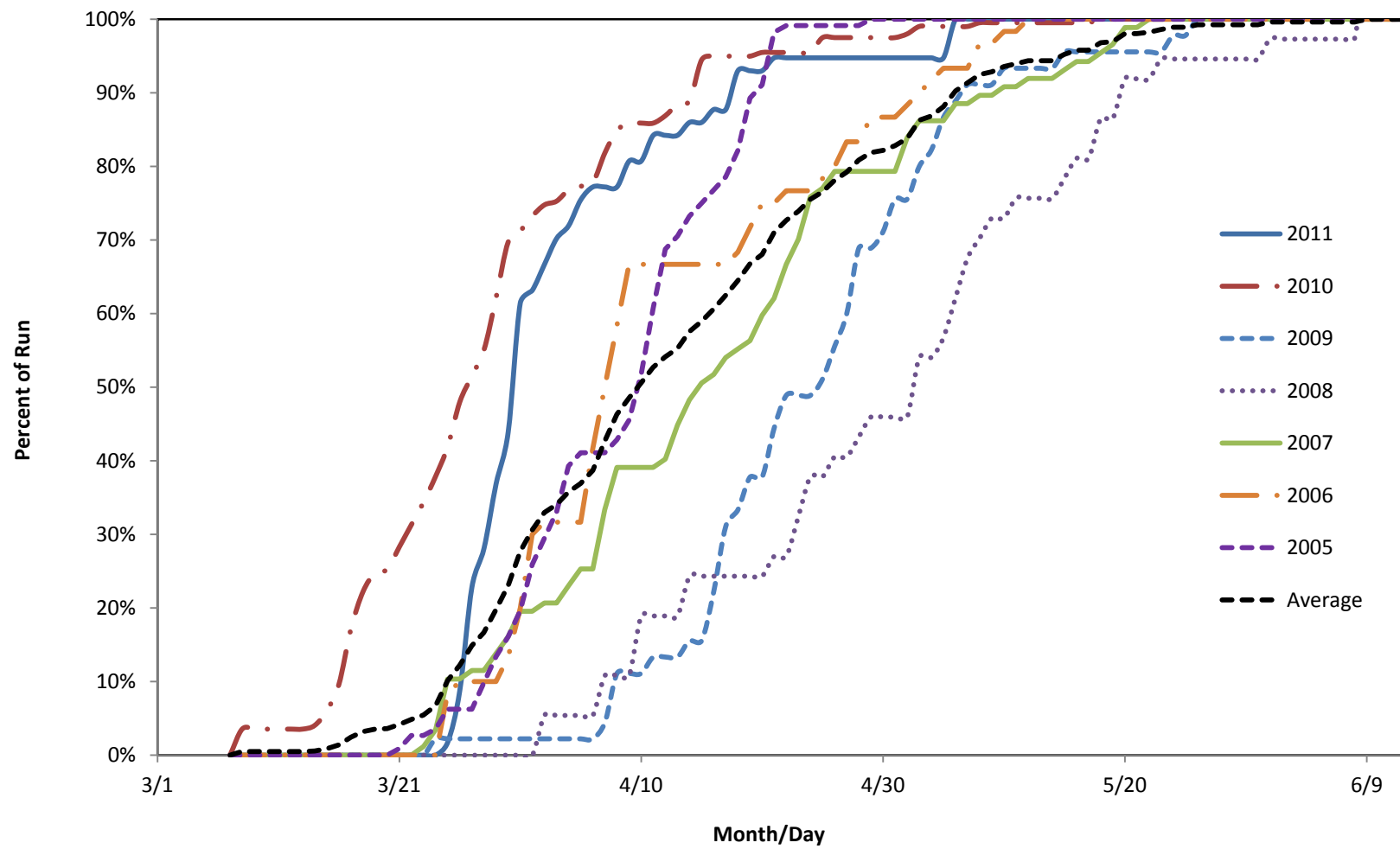
	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Below Weir (Redd surveys)	29	52	45
Above Adult Weir	Surveys not conducted	56	48
Total	n/a	108	93

B. PIT Tag detection estimation, Omak Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Total	n/a	132	96

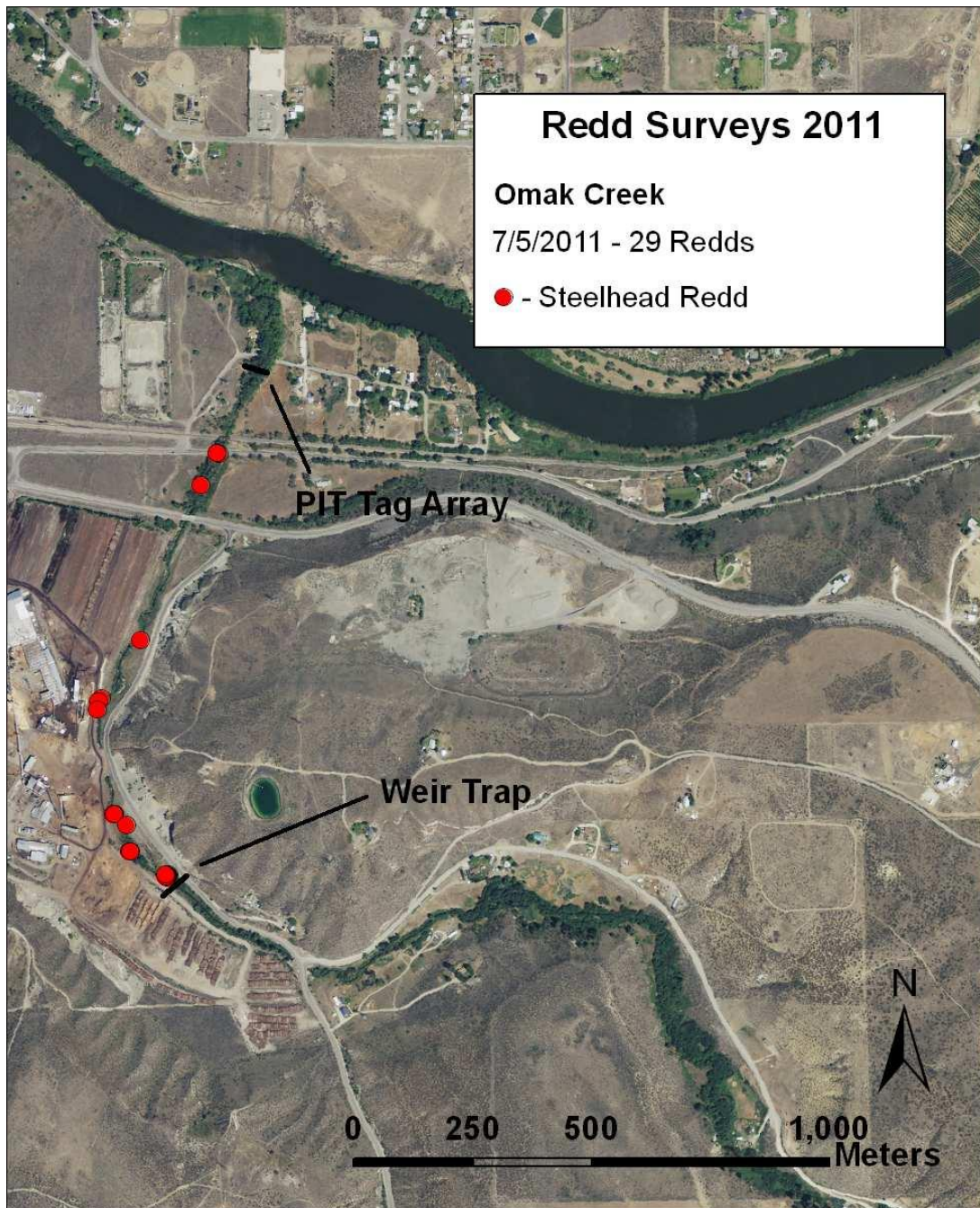


**Figure 20.** Total number of summer steelhead estimated to have spawned in Omak Creek, 2002 to 2011.



**Figure 21.** Run timing of summer steelhead captured at the Omak Creek weir trap, 2005-2011.





**Figure 22.** Map of summer steelhead redds observed below the Omak Creek trap during the spring of 2011.

### *Wanacut Creek*

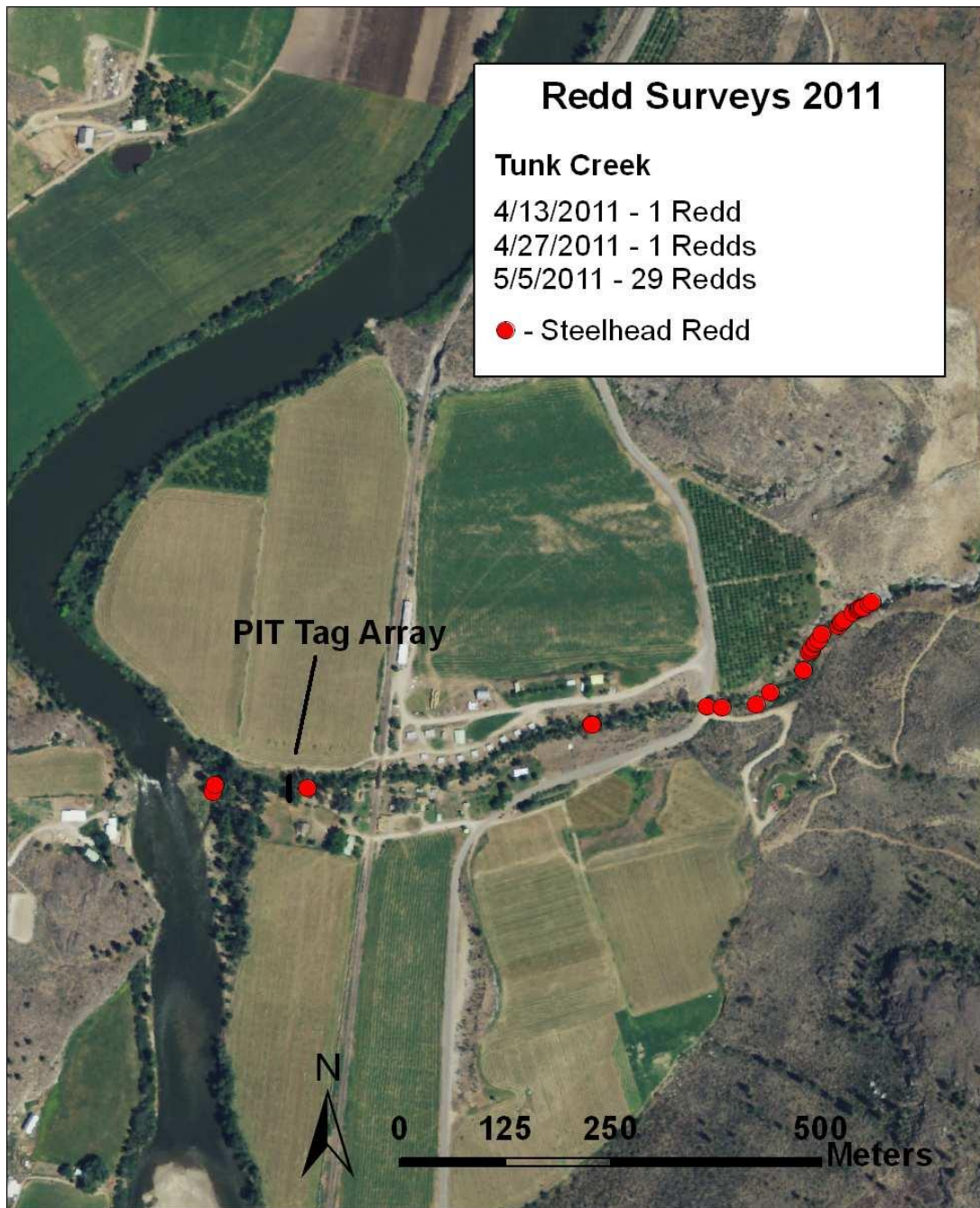
Although sufficient flows existed to allow water to reach the Okanogan River, no adult steelhead or redds were observed in Wanacut Creek in 2011. No steelhead were detected on the seasonal PIT tag array, which was located just upstream of the confluence with the Okanogan. A seasonal PIT tag array will again be installed in 2012 to help further examine the potential benefits of stream restoration activities on returning adult steelhead in Wanacut Creek.

### *Tunk Creek*

On April 13, one redd was identified immediately upstream of the Tunk Creek confluence with the Okanogan River. One additional redd was documented on April 27 and 30 identified on May 5 (Figure 23). Using a value of 1.8 FPR derived from the Omak Creek weir trap, provided an estimate of 56 steelhead that spawned in Tunk Creek. On May 5, 11 steelhead were observed on redds in Tunk Creek, with two of these being ad-present and nine being marked hatchery fish. Extrapolating this percent wild-rate (18%) to the total of 56 steelhead, represented 10 wild spawners. Tunk Creek was only surveyed completely up to the barrier in the two years prior to 2011; escapement estimates were 10 steelhead in 2009 and 109 in 2010.

A seasonal PIT tag array was installed near the mouth of Tunk Creek in the spring of 2011. One wild and 4 hatchery steelhead were detected at this location. Based on the Priest Rapids release group, the calculated spawning escapement was 12 wild and 48 hatchery fish. Both methods used appeared to validate one another (the redd survey expansion estimated 56 total, 10 wild steelhead and the PIT tag detection estimated 60 total, 12 wild steelhead).





**Figure 23.** The distribution of redds observed in Tunk Creek during 2011, from the confluence with the Okanogan River upstream to Tunk Falls (anadromous barrier).

### *Bonaparte Creek*

An adult weir trap was installed on Bonaparte Creek in 2011. A total of four wild steelhead and one hatchery steelhead were collected at the Bonaparte Creek weir (Table 6). Difficulties with high discharge rates, paired with damage to the weir trap, may have led to an undetermined number to steelhead passing by the trap without being counted. Redd surveys were conducted downstream of the Bonaparte Creek trap on April 14 and April 28. A total of 4 steelhead redds were observed (Figure 24). Based upon the value of 1.8 FPR generated from adult steelhead collected at the Omak Creek weir trap, an estimated 7 summer steelhead spawned downstream. The percent-wild value, calculated at the trap site and applied to downstream redds, provided an estimate of 6 wild fish that spawned downstream of the weir. When the redd survey estimate and weir count were summed, the result was 12 total spawners in Bonaparte Creek, 10 of them likely wild.

Although preliminary plans existed to construct a permanent PIT tag array in Bonaparte Creek in early 2011, installation did not occur due to complications with providing power to the site and noise issues. Therefore, a secondary escapement estimate could not be determined from tag detections. Due to high water events and the subsequent difficulties surrounding the weir trap, the final number of steelhead in Bonaparte Creek should be considered a minimum estimate.

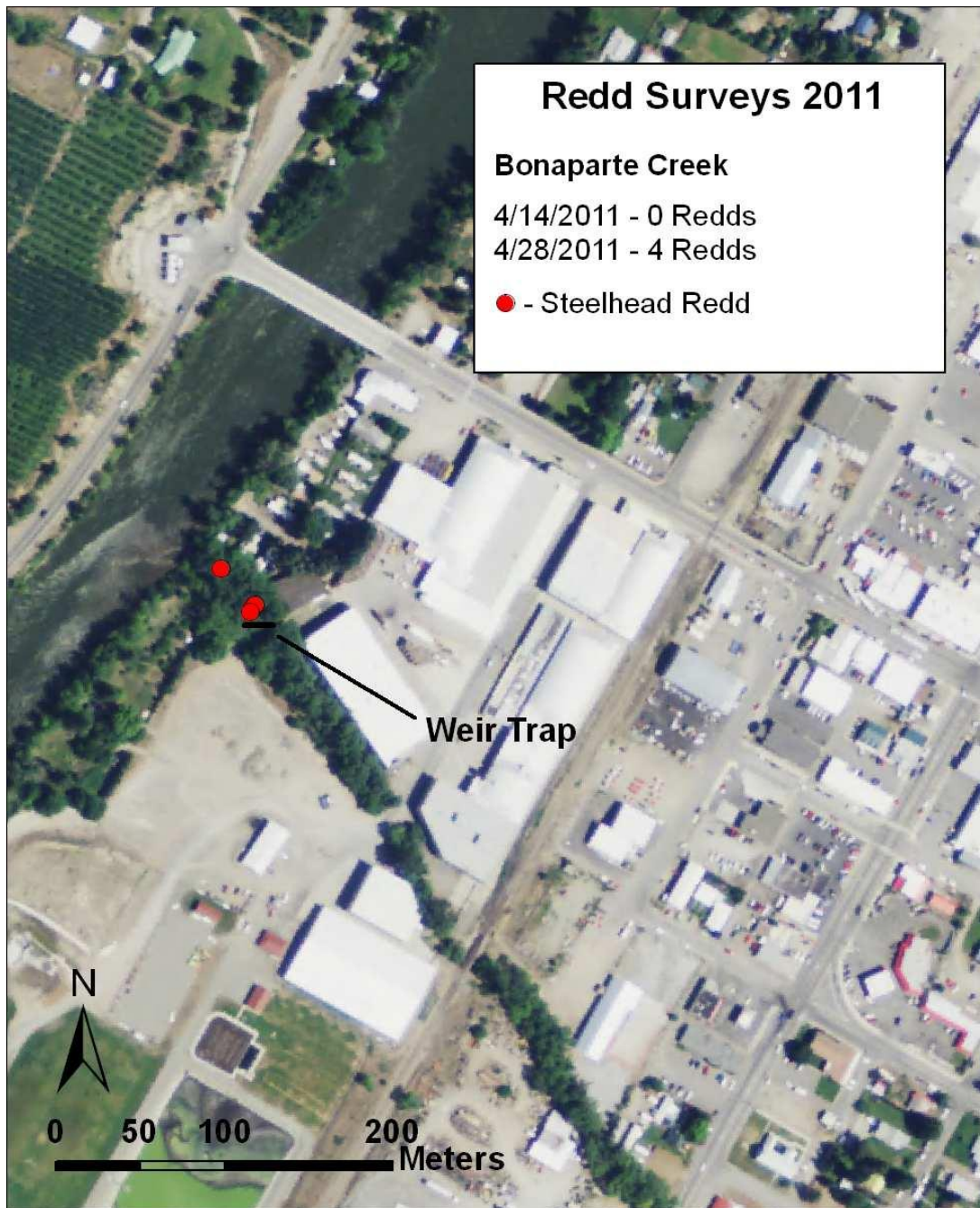
**Table 6.** Proportions and totals of male, female, and wild summer steelhead at the Bonaparte Creek weir trap in 2011.

Bonaparte Creek Adult Weir Trap, 2011	Total (N)	Wild (N)	Percent-Wild (%)
Total	5	4	80%

### *Antoine Creek*

Antoine Creek flows perennially; however, minimal discharge across an alluvial fan at the mouth of the creek may have deterred access of adult steelhead throughout much of the 2011 spawning season. When the stream was surveyed on May 9, one summer steelhead redd was observed between the confluence with the Okanogan River to the video weir/PIT tag array (Figure 25). No adult steelhead were documented passing through the video weir in 2011, which operated from March 20 – May 17. However, one hatchery steelhead was documented on the PIT tag array (two antennas downstream of the video system and two antennas upstream) during a short timeframe when turbid water obscured video observation. Due to the fact that the steelhead was tagged at Wells Dam and not from the representative random mark group at Priest Rapids, an expanded escapement estimate was not calculated from that detection.

Although escapement was zero in 2008, 2009, and 2010, and only two steelhead in 2011, snorkel surveys have identified multiple year-classes of both brook trout and *O. mykiss*, indicating that rearing conditions exist (Kistler et al. 2006, Kistler and Arterburn 2007). To accelerate the reestablishment of summer steelhead in Antoine Creek, approximately 3,000 juvenile steelhead were released during April of 2008 (Fisher 2008). However, the relatively large delta at the confluence of Antoine Creek makes access difficult for returning adult steelhead. Consideration should be given to increasing flow and improving adult steelhead access during typical flow conditions.



**Figure 24.** Distribution of redds observed in Bonaparte Creek during 2011, from the confluence with the Okanogan River upstream to the Bonaparte weir trap.





**Figure 25.** Redd distribution observed in 2011 for Antoine Creek from the confluence with the Okanogan River upstream to the video array.

### *Wild Horse Spring Creek*

Wild Horse Spring Creek was surveyed March 31, April 18, April 29, and June 9, 2011. A total of 21 redds were documented (Figure 26). Thirty-three steelhead, five of those considered of natural-origin, were estimated to have spawned in this creek in 2011 based on 1.55 FPR and a 13.5% wild rate. The majority of redds on Wild Horse Spring Creek were documented for a second year in a row in a recently rehabilitated section of creek, immediately upstream (east) of Hwy 97. The stream channel rehabilitation created more habitat complexity, added spawning substrate, reestablished stream channel, and stabilized banks through riparian shrub plantings along approximately 300 meters of creek. Between April 29 and June 9 surveys, turbid water prevented observation of redds and an unknown number of redds may have been not counted.

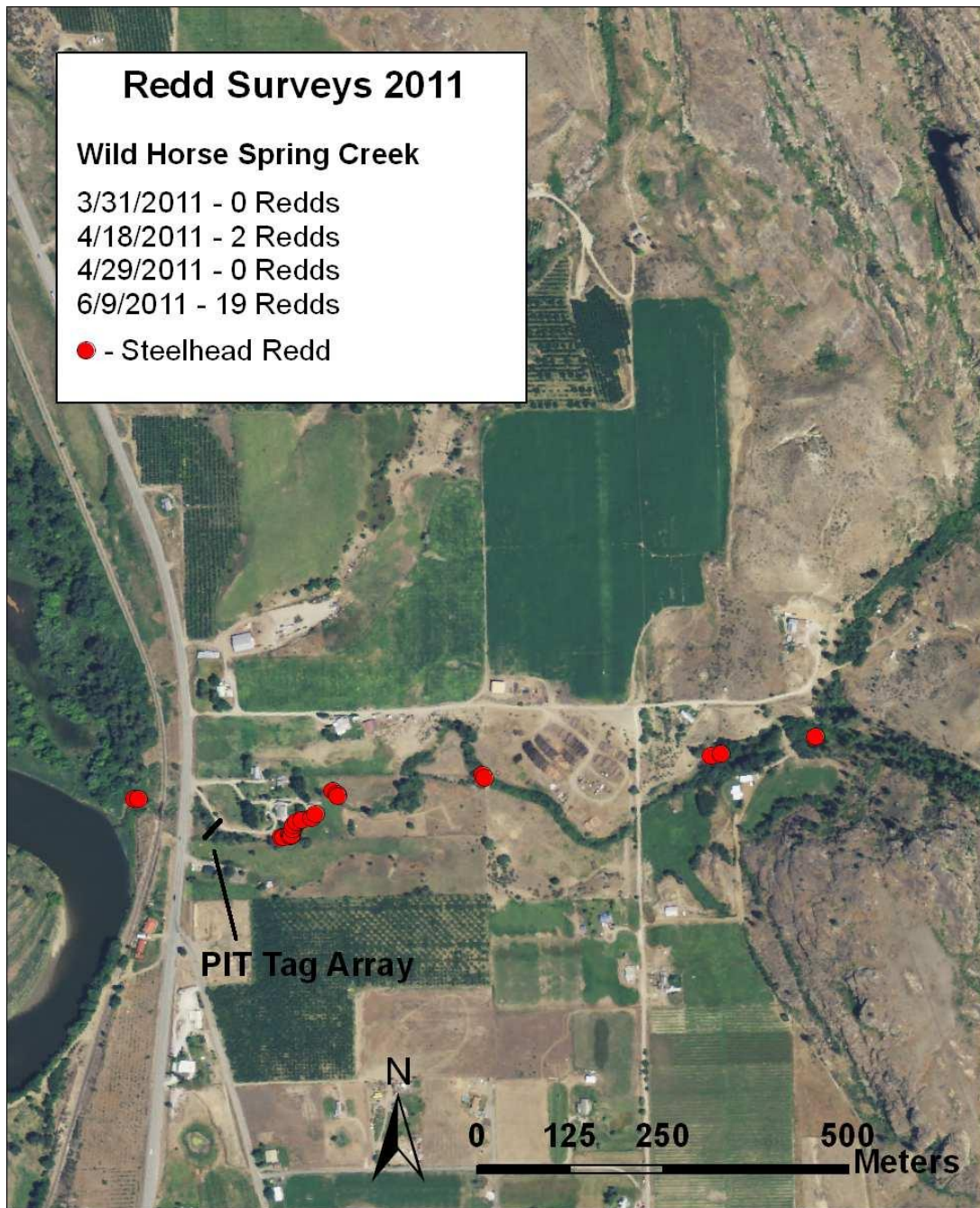
A PIT tag array located near the mouth of Wild Horse Spring Creek documented a total of 2 wild and 9 hatchery steelhead during the spring of 2011. Expanding those detections with the tag rate of steelhead at Priest Rapids Dam rendered 24 wild and 108 hatchery steelhead. It is likely that the actual escapement value is closer to the PIT tag derived estimate of 132 steelhead, rather than the 33 that was estimated by redd surveys, due to peak spawning being missed during high run off.

### *Tonasket Creek*

During most years, Tonasket Creek flows intermittently during the spring and completely dries up by mid-summer in the lower-most 3 km. However, above average flows existed in 2011 and allowed for steelhead passage. Steelhead redd surveys were conducted on Tonasket Creek only on June 23 and were constrained on previous dates by limited water visibility. A total of three redds were identified (Figure 27). The mainstem value of 1.55 FPR and 13.5% wild rate was applied to those redds, based on the fact that access to steelhead has been limited and few observations of spawning have been documented in previous years. Expanded redd counts represented five spawners, one of which may have been ad-present. Based on the delayed redd surveys, which could not be conducted until the end of June, this number should represent a minimum number of spawners.

A PIT tag array located near the mouth of Tonasket Creek documented one wild and 4 hatchery steelhead (Priest Rapids mark group), which were expanded to 12 wild and 48 hatchery steelhead. This escapement estimate likely better represented the actual number of steelhead that spawned in Tonasket Creek in 2011.





**Figure 26.** Redd distribution observed in 2011 for Wild Horse Spring Creek from the confluence with the Okanogan River upstream to the anadromous barrier.



**Figure 27.** Redd distribution observed in 2011 for Tonasket Creek, from the confluence with the Okanogan River upstream to the anadromous barrier.



### *Ninemile Creek*

The lower 0.7 km of Ninemile Creek was surveyed on June 9 and no redds were observed. Discharge and water clarity during the month of May prevented redd surveys from occurring prior to this date. Significant stream bed movement occurred and deposition of substrate up to two feet deep was noted in many areas. It is likely that an unknown number of redds were constructed in Ninemile Creek, but were unidentifiable by June. For spatial reference, redds documented from previous years surveys from 2004 to 2010 are shown in Figure 28. A video counting array at RKM 0.7 documented 8 hatchery and 11 ad-present adult steelhead that passed above this point. The digital video recorder was disabled from April 1 through April 6 and the first steelhead were observed passing the video array on April 7, as soon as repairs were made. Significant sediment deposition buried and disabled the video system on May 4 through the end of the spring runoff period. Therefore, the 19 steelhead observed passing the video system should be considered a minimum escapement estimate.

A permanent PIT tag array was in place throughout 2011 at the same location as the underwater video system. Based on the tag rate of the Priest Rapids release group, two hatchery and one wild detection were expanded to 24 and 12 fish, respectively (Table 7).

**Table 7.** Two methods for calculating escapement estimates for Ninemile Creek. (A) Video count and redd survey conducted below the video station and (B) expansion based on PIT tag detections.

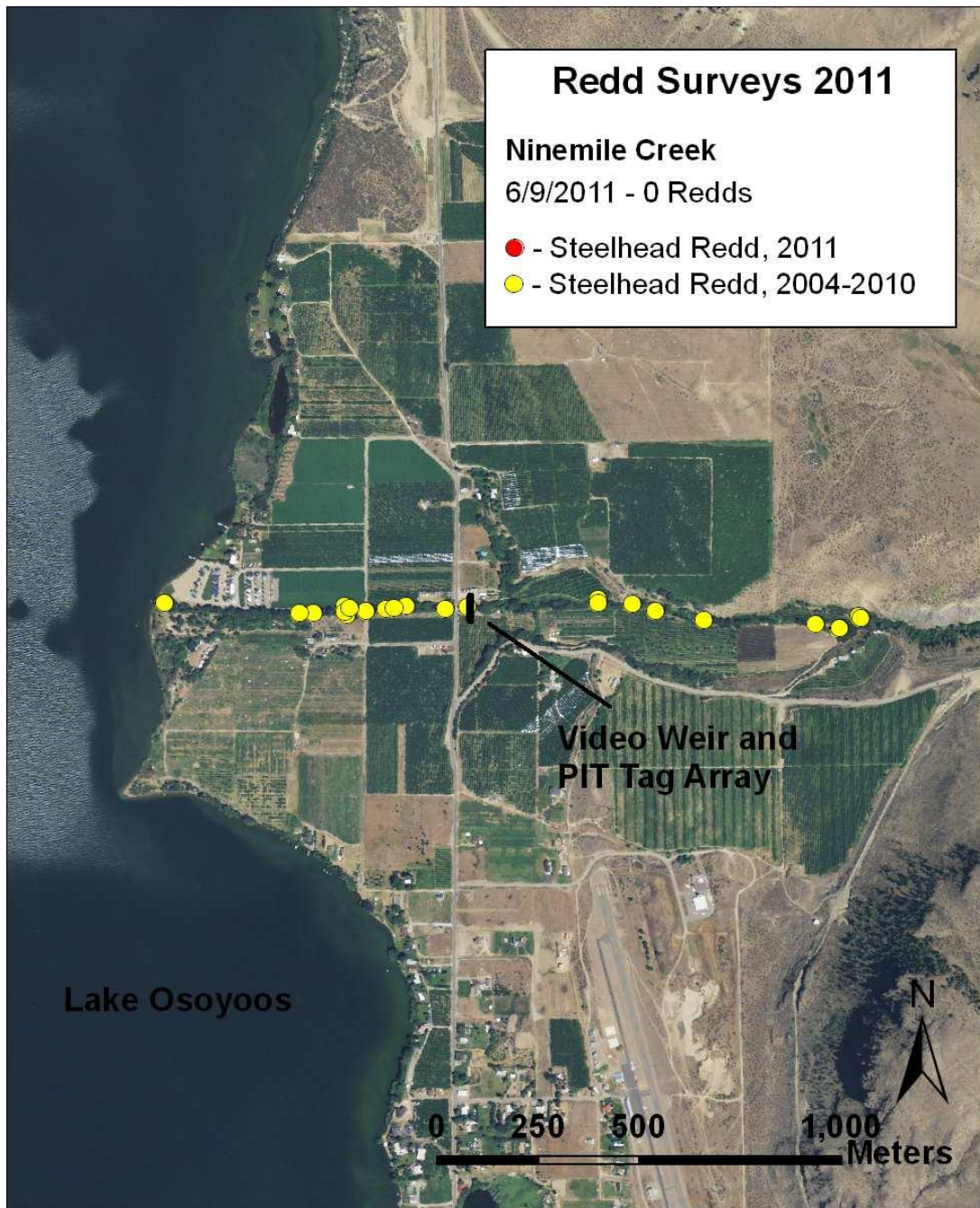
#### A. Redd survey and video count, Ninemile Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Below Video Weir (Redd surveys)	0	0	0
Above Video Weir	Surveys not conducted	19	11
Total	n/a	19	11

#### B. PIT Tag detection estimation, Ninemile Creek

	Documented # of Redds	Estimated Total # Spawners	Estimated # Wild
Total	n/a	36	12





**Figure 28.** Redd distribution from 2004-2010 for Ninemile Creek. No redds were observed in 2011 below the video weir at RKM 0.7 due to high water runoff.

## Escapement into British Columbia

From July 2010 through June 2011, 270 summer steelhead were counted on underwater video passing Zosel Dam through the fishways (Table 8). In order to determine the number of steelhead unaccounted for in Lake Osoyoos, the estimated number of spawners that entered Ninemile (36 steelhead) and Tonasket (60 steelhead) Creeks were subtracted from the total number counted at Zosel Dam. These two creeks are located upriver (north) of Zosel Dam, but south of the international border. Therefore, 174 summer steelhead may have passed into habitats beyond Lake Osoyoos.

A total of 62 ad-present summer steelhead were observed at the Zosel Dam video station. The estimated number entering Ninemile (12 ad-present steelhead) and Tonasket (12 ad-present steelhead) Creeks were subtracted from the total, resulting in an estimate of 38 ad-present summer steelhead. Of the total number of summer steelhead unaccounted for in Lake Osoyoos, 21.8% were likely ad-present.

**Table 8.** The number of adult summer steelhead that passed Zosel Dam by month for the 2011 spawner cohort, July 2010 to June 2011.

<b>Zosel Dam Video Counts</b>			
Month	Ad-Clipped	Ad-Present	Total
July, 2010	0	0	0
August	0	0	0
September	1	0	1
October	0	0	0
November	0	0	0
December	0	0	0
January, 2011	0	0	0
February	0	0	0
March	13	10	23
April	174	37	211
May	20	15	35
June	0	0	0
<b>Total</b>	<b>208</b>	<b>62</b>	<b>270</b>

## PIT Tag Detections at VDS-3

Two PIT tagged adult wild steelhead from the Priest Rapids release group were detected at the PIT tag array located at VDS-3, in the mainstem Okanogan River, just north of Osoyoos Lake. Based on those detections, an estimated 24 wild steelhead passed above this point. In addition to the steelhead tagged at Priest Rapids, one additional wild steelhead and three hatchery steelhead were detected at this location. However, those fish were not part of the Priest Rapids release group, and therefore, not expanded into the total escapement estimate.

## Bringing it all together

In the United States, summer steelhead are currently listed as “threatened” under the Endangered Species Act in the Upper Columbia River Evolutionary Significant Unit. Detailed percent-wild information for 2011 is provided in this document and every attempt has been made to ensure that these estimates are as accurate as possible. However, these data should be used with caution, as it is difficult to define natal origin through visual observation alone (i.e. intact adipose fin). Values presented in this document represent our best scientific estimate from available information, but the variability surrounding our point estimates is unknown. Thus, high and low estimates are also provided to represent a full range of potential scenarios. A summary of the best available counts and estimates for each reach or sub-watershed throughout the Okanogan River basin are presented in Table 9.

The total escapement estimate for Okanogan River summer steelhead spawners in 2011, based on redd surveys, weir traps, PIT tags, and video data, was likely between 1,479 and 1,687 (Table 10). Since 2005, the number of spawning summer steelhead in the Okanogan River has been growing at a rate of 258 per year (Figure 29). For 2011, the WDFW estimated maximum spawner escapement into the Okanogan River basin at 2,497 summer steelhead (Charles Frady, WDFW, pers. comm.). The WDFW estimate was derived from Wells Dam passage counts, modified by harvest information, and divided into individual subbasins (Methow and Okanogan) through the use of radio telemetry data (English et al. 2001, 2003).

The WDFW escapement estimate for wild steelhead in the Okanogan basin was 338; OBMEP estimated that between 307 and 339 ad-present steelhead likely spawned within the Okanogan River basin in 2011 (Table 11). The range in our estimate of wild steelhead was directly linked to uncertainty in the actual origin of ad-present steelhead. Additionally, inconsistent percentages of ad-present steelhead that utilized individual tributaries (i.e. 85.7% wild for Omak Creek vs. 10.6% for Salmon Creek) complicated percent-wild calculations from redd counts where we had no means of determining local counts. Since 2005, the Okanogan River population of wild steelhead has been increasing by approximately 62 steelhead per year (Figure 30).

**Table 9.** Estimated number of total and wild spawning steelhead for each sub-watershed or counting location in 2011. The grand total for the entire Okanogan River population is presented with subtotals for tributary and mainstem habitat types in Washington and British Columbia.

<b>Distribution of Steelhead Spawning in the Okanogan Basin, 2011</b>			
<b>Category</b>	<b>Description/location</b>	<b>Estimated Total # Spawners</b>	<b>Estimated Total # Wild</b>
WA Mainstem	Reach O1	3	0
WA Mainstem	Reach O2	16	2
WA Mainstem	Reach O3	0	0
WA Mainstem	Reach O4	14	2
WA Mainstem	Reach O5	15	2
WA Mainstem	Reach O6	3	0
WA Mainstem	Reach O7	471	64
WA Mainstem	Reach S1	189	26
WA Mainstem	Reach S2	138	19
WA Tributary	Loup Loup Creek	12 <sup>a</sup>	0
WA Tributary	Salmon Creek	209 <sup>a</sup>	12 <sup>a</sup>
WA Tributary	Omak Creek	132 <sup>a</sup>	96 <sup>a</sup>
WA Tributary	Wanacut Creek	0	0
WA Tributary	Tunk Creek	56	10
WA Tributary	Bonaparte Creek	12	10
WA Tributary	Antoine Creek	2	0
WA Tributary	Wild Horse Spring Creek	132 <sup>a</sup>	24 <sup>a</sup>
Zosel Dam	<b>Observed Passing Zosel Dam</b>	270	62
WA Tributary	Tonasket Creek	60 <sup>a</sup>	12 <sup>a</sup>
WA Tributary	Ninemile Creek	36 <sup>a</sup>	12 <sup>a</sup>
<b>Subtotals</b>	<b>Adult escapement into WA mainstem</b>	<b>849</b>	<b>115</b>
<b>Subtotals</b>	<b>Adult escapement into WA tributaries</b>	<b>651</b>	<b>176</b>
<b>Subtotals</b>	<b>Adult escapement into BC</b>	<b>174</b>	<b>38</b>
<b>Grand total</b>		<b>1,674</b>	<b>329</b>

<sup>a</sup> Total is based on expanded PIT tag detections.

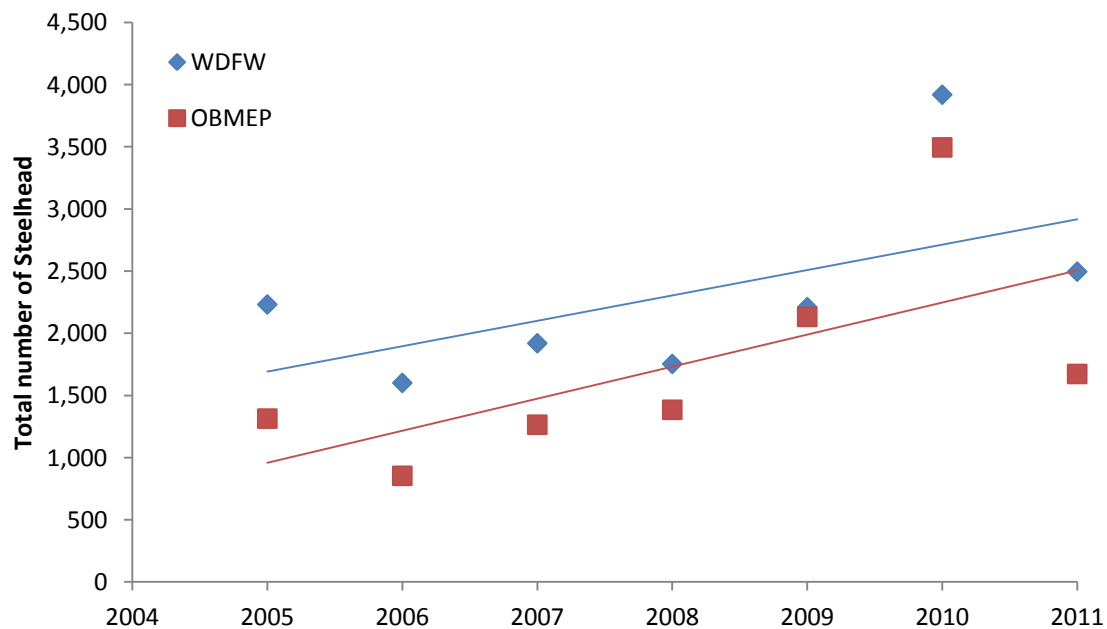
**Table 10.** Total escapement of summer steelhead for the Okanogan River, since 2005, including combined hatchery and natural-origin summer steelhead estimates.

Okanogan River summer steelhead spawner population trend data				
Year	WDFW escapement estimate <sup>b</sup>	OBMEP spawner survey estimate		
		Low	Estimate	High
2005	2,233	1,147	1,315 <sup>c</sup>	1,482
2006	1,602	779	855 <sup>c</sup>	930
2007	1,921	1,234 <sup>d</sup>	1,266 <sup>d</sup>	1,280 <sup>d</sup>
2008	1,755	1,341	1,386	1,436
2009	2,211	2,020	2,133	2,198
2010	3,920	3,236	3,496	3,596
2011	2,497	1,479	1,674	1,687

<sup>b</sup> WDFW restated previous escapement estimates from previous years in 2010.

<sup>c</sup> Estimated mainstem reach data rather than empirical data, as in other years.

<sup>d</sup> Only a low and high value was reported, so a simple arithmetic mean was computed.



**Figure 29.** Trend in Okanogan River steelhead spawners, 2005-2011.



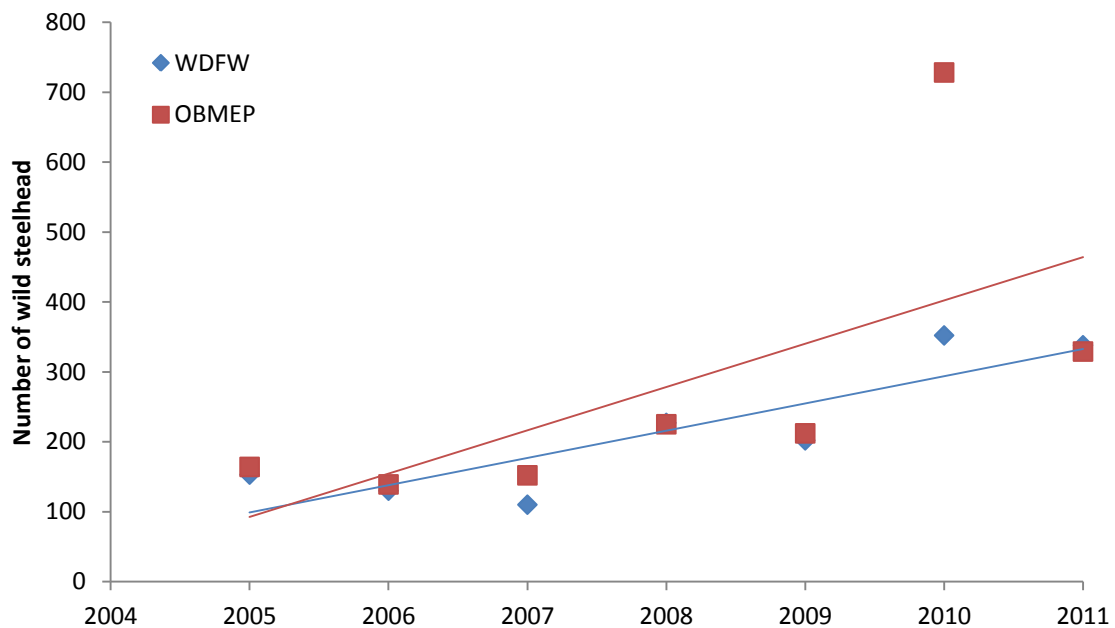
**Table 11.** Natural origin summer steelhead estimates for the Okanogan River, since 2005.

Okanogan River wild summer steelhead spawner population trend data				
Year	WDFW escapement estimate <sup>e</sup>	OBMEP spawner survey estimate		
		Low	Estimate	High
2005	153	143	164 <sup>f</sup>	185
2006	130	127	139 <sup>f</sup>	151
2007	110	148 <sup>g</sup>	152 <sup>g</sup>	155 <sup>g</sup>
2008	227	213	225	266
2009	202	178	212	241
2010	352	630	728	853
2011	338	307	329	339

<sup>e</sup> WDFW has restated escapement estimates from previous years in 2010.

<sup>f</sup> The Okanogan mainstem percent wild was applied across all reaches.

<sup>g</sup> Only a low and high value was reported, so a simple arithmetic mean was computed.



**Figure 30.** Trend in Okanogan River ad-present steelhead spawners, 2005-2011.

## Conclusions

Results from steelhead adult enumeration efforts in the Okanogan basin indicate that the number of spawning steelhead in the Okanogan River continued to increase since the program began collecting data in 2005. Spawning was common throughout the mainstem Okanogan River, although narrowly focused to distinct areas that contained suitable spawning substrates and water velocities. Steelhead spawning was most heavily concentrated below Zosel Dam on the Okanogan River and in braided island sections of the lower Similkameen River. It is likely that distribution of spawning is largely influenced by stocking location because juvenile hatchery steelhead were scatter-planted in Omak Creek, Salmon Creek, and the Similkameen River acclimation site. Steelhead redds were commonly observed near these stocking locations, as well as near Chinook redd mounds and mid-channel islands.

Annual variations of environmental factors can profoundly impact redd distributions in small tributaries to Okanogan River. Changes in spawner distribution within tributaries appear to be driven by the following four factors:

- 1) Discharge and elevation of the Okanogan River
- 2) Discharge of the tributary streams
- 3) Timing of runoff that alters the shape of the hydrograph
- 4) Stocking location of hatchery smolts

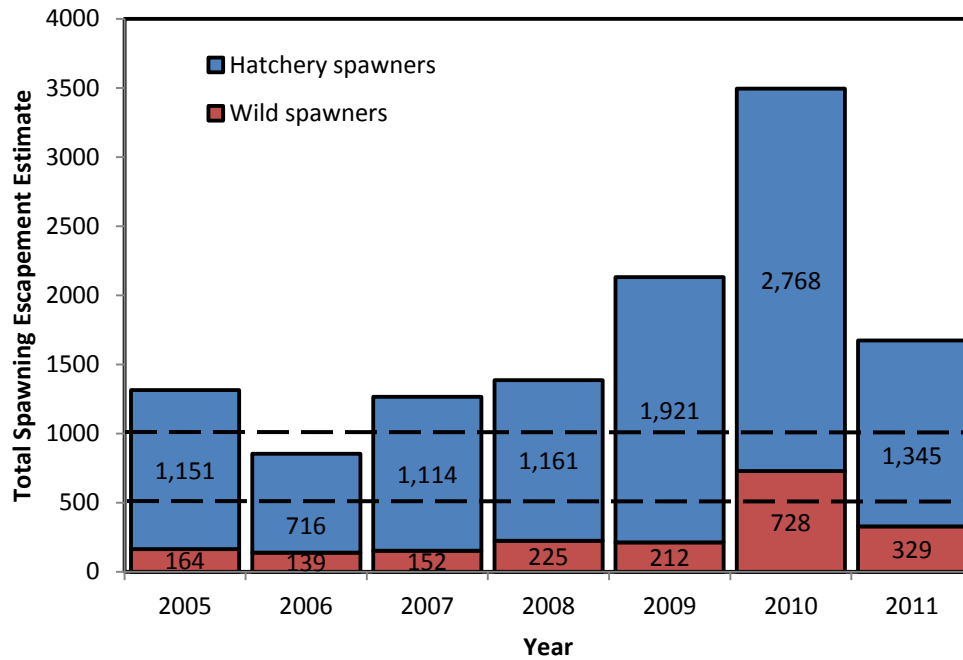
The first three factors are largely based upon natural environmental conditions, which can be altered dramatically by such things as water releases from dams, irrigation withdrawals, and climate change. Years such as 2006, 2008, and 2009 clearly show how low tributary discharge can dramatically alter spawning location and reduce the available tributary habitat for steelhead to utilize. Habitat alterations at the mouths of key spawning tributaries can improve access, provided that sufficient discharge is available. In 2010 and 2011, water availability in the Okanogan River basin was above normal and subsequently, a much larger proportion of steelhead spawned in tributaries than was documented in previous years. Approximately 37% and 38.9% of steelhead were estimated to have spawned in tributaries to the Okanogan in 2010 and 2011, respectively. Summer steelhead that spawn in tributary habitats of the Okanogan River basin are more likely to find suitable environmental conditions and rearing habitats than those spawning in mainstem habitats.

Spring spawner data provides a reasonable depiction of steelhead spawning distribution and an estimate of minimum spawner abundance; however, determining the origin of returning adults is less objective. Although the abundance of ad-present spawners appears to be increasing in the Okanogan subbasin, the current numbers remain well below recovery goals, as outlined by the Upper Columbia recovery plan (UCSRB 2007) (Figure 31). Accurate and reliable determination of origin is critical for tracking recovery of Upper Columbia summer steelhead within the Okanogan River basin. However, hatchery activities that do not mark all fish in an easily identifiable way complicate origin determinations. It is difficult to conclude if increasing trends in wild fish are a result of more natural production or fewer summer steelhead being marked with an adipose fin clip. In 2010 and 2011, new angling regulations required the retention of all steelhead caught with a clipped adipose fin. The benefits of these regulations may be reduced when not all hatchery fish are properly marked. Evaluation of natural production would be improved in the future by ensuring that all hatchery summer steelhead are marked by the removal of the adipose fin.

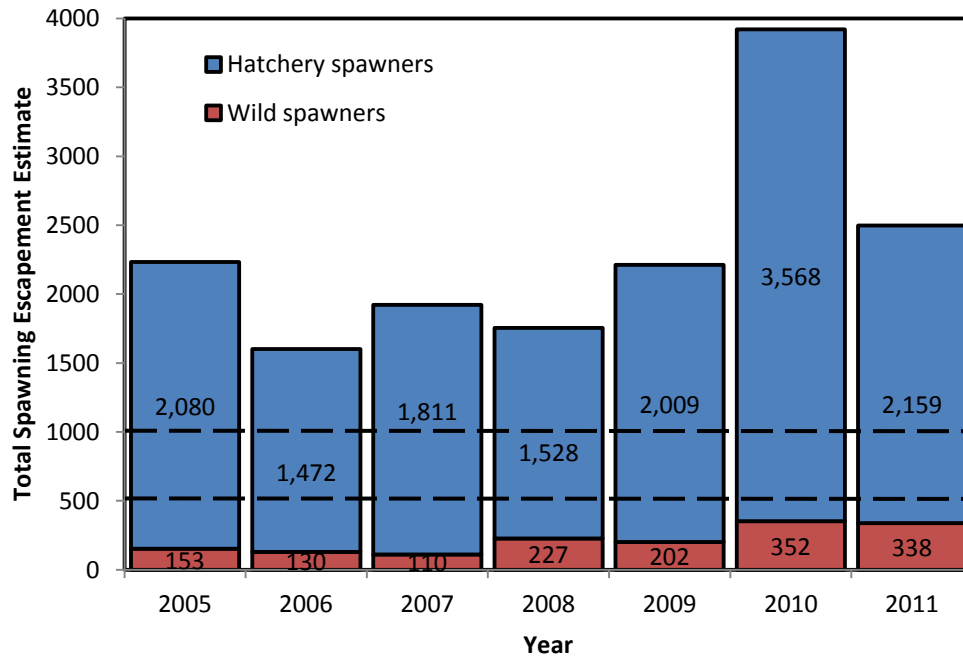
PIT tag arrays will be installed again in 2012 at the downstream extent of most tributaries throughout the Okanogan River system. Additionally, returning adults will continue to be implanted with PIT tags at mid-Columbia PUD facilities. Once the basin-wide PIT tag arrays are in place, interrogations of PIT tagged adult steelhead will allow further examination of age, sex, and origin within each sub-watershed. The increasing frequency of PIT tag detections also help to validate redd survey observations, provide an escapement estimate when redd surveys could not be conducted, and further improve our ability to describe habitats used by summer steelhead in the Okanogan subbasin.



### A. OBMEP



### B. WDFW



**Figure 31.** Escapement estimates determined by OBMEP (A) and WDFW (B) compared with steelhead recovery goals, as outlined in the Upper Columbia Spring Chinook and Steelhead Recovery Plan (UCSRB 2007). The Interior Columbia Basin Technical Recovery Team (ICBTRT) determined that 500 naturally produced steelhead adults would meet the minimum abundance recovery criteria within the U.S. portion of the Okanogan subbasin. If the Canadian portion of the subbasin was included, minimum abundance recovery criteria would be 1,000 naturally produced adults (UCSRB 2007).

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