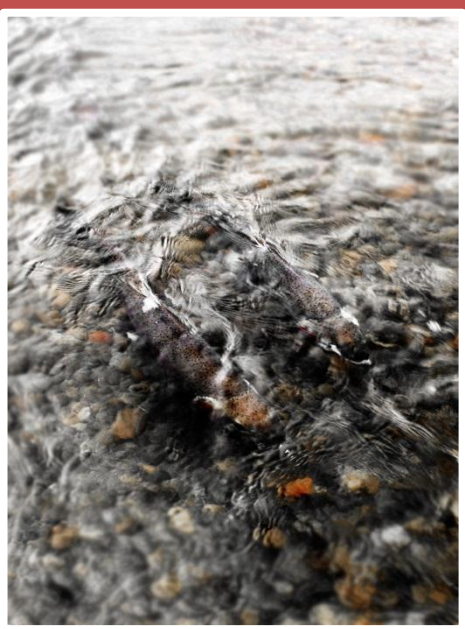
2012

Annual Report



Colville Confederated Tribes

Fish & Wildlife Department

Okanogan Basin Monitoring & Evaluation Program

BPA Project # 2003-022-00

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I. Executive Project Summary

The Okanogan Basin Monitoring and Evaluation Program (OBMEP) is conducted by the Colville Confederated Tribes and monitors key components of the ecosystem related to anadromous salmonids, including biological, physical habitat and water quality parameters. OBMEP has also developed baseline information where data were previously unavailable. The program addresses questions specifically related to Upper Columbia River steelhead, which are listed as threatened under the Endangered Species Act. Many of the program methods were based on 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 (NPPC 2004). Data collected under OBMEP are not only vital to monitoring the recovery of threatened species, but are used in planning efforts, management decisions, and population level action effectiveness.

OBMEP attempts to balance the Northwest Power and Conservation Council's (NPCC) Fish and Wildlife program requests with the needs of NOAA Fisheries, to evaluate trends toward recovery in the Upper Columbia ESU, as they inform the Federal Columbia River Hydropower system biological opinion. At the Columbia Basin level, OBMEP works with the Pacific Northwest Aquatic Monitoring Partnership, Integrated Status and Effectiveness Program, Columbia Habitat Monitoring Program, and NOAA Fisheries, to address basin-wide issues, test methodologies, and to develop basin-wide tools that can be adapted to our monitoring efforts. At the regional level, OBMEP coordinates monitoring several RPA's in collaboration with the Upper Columbia Salmon Recovery Board, the Expert Panel Process, the Canadian Bi-Lateral Okanogan Technical Work Group, and the Columbia River Inter-Tribal Commission. Within the Okanogan River sub-basin, OBMEP operates closely with the Upper Columbia Regional Technical Team, Okanogan River basin co-managers in the United States and Canada, local restoration practitioners, and nonprofits to prioritize restoration actions needed to restore summer steelhead and Chinook throughout the basin.

In 2012, OBMEP completed work elements for habitat status and trend, adult enumeration and, and juvenile steelhead abundance. 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. The knowledge gained through OBMEP prompted changes in monitoring in 2012 to more effectively track steelhead populations and associated habitats in the basin. Largely inefficient mainstem juvenile steelhead monitoring efforts were focused closer to tributaries of the Okanogan River, where the majority of juveniles are observed (refer to juvenile monitoring in WE D:157). A small pilot-level study allowed us to estimate the precision and bias associated with a new method of calculating juvenile population abundance before implementing the study basin-wide. Larger spatial scale rapid assessment methods for characterizing habitat were also implemented to describe habitat on a more continuous scale, while filling data gaps in the basin. The Okanogan Basin Monitoring and Evaluation Program continues to refine its monitoring design, while maintaining consistency in data collection, for long term analysis.

Data and reports are available through the Okanogan Basin Monitoring and Evaluation Program website, located at: http://www.colvilletribes.com/obmep.php.

II. Acknowledgements

We would like to thank Edward Berrigan, Tatum Gunn, Oly Zacherle, Vertis Campbell, Byron Sam, Mike Miller, Jack Roy, Rhonda Dasher, Dennis Papa, Darin Hathaway, Skyeler Folks, Joe Enns, Jamie Squakin, Camille Rivard-Sirois, and Lindsay George for their help in collecting, entering, and compiling field data for this report. Thanks also to Summit Environmental, Environmental Trust of the Colville Tribes, Okanagan Nation Alliance, Environment Canada, Canada Department of Fisheries and Oceans, Washington State Department of Ecology, Washington Department of Fish and Wildlife, and the USGS for their collaboration on projects and data collection efforts. Thanks to Dr. John Skalski from the University of Washington Columbia Basin Research for reviewing and providing comments on juvenile abundance monitoring statistics.

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.

Funding for the Okanogan Basin Monitoring and Evaluation Program is provided by Bonneville Power Administration (BPA).

III. 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 in the Okanogan basin. The collected data have greatly expanded the level of knowledge being used in planning efforts and for fisheries management in the basin. Information related to status and trends for 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 addresses questions related to anadromous fish management and recovery in the Upper Columbia and more specifically the Okanogan River basin. OBMEP is 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

Because the Okanogan basin is a trans-boundary watershed, the Colville Tribes work directly with the Okanagan Nation Alliance to implement the same study design and collect the same data in the Canadian portion of the Okanogan. Cross-coordination meetings are frequently held, and cross-training occurs regularly to align methodologies for collecting snorkel, habitat, water quality, and macroinvertebrate data.

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 during the Pleistocene Era, 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 and coho. 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 insufficient 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 under private landownership, and landowner cooperation is required for fisheries research activities to occur. Economic activity in the basin is centered around fruit crops, ranching, agriculture, mining, and timber harvest. In this relatively arid environment, a complex system of fisheries and water management requires coordination between many local stakeholders, state agencies, federal agencies, and Tribes, spanning two countries.

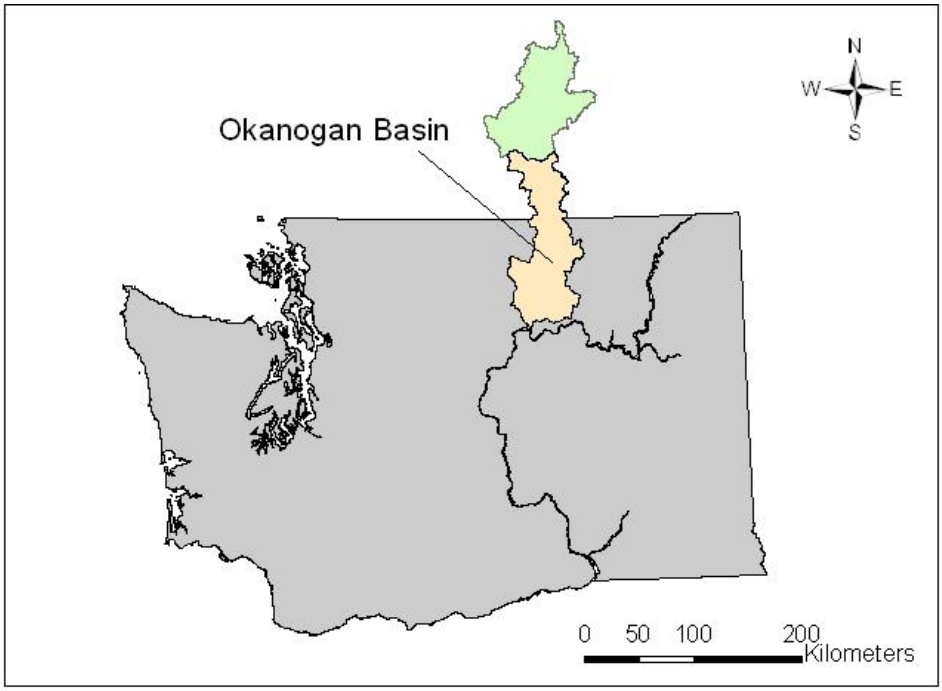

Figure 1. Study Site, the Okanogan basin in north-central Washington State and southern British Columbia.

IV. Work Elements / Tasks

Work Element A. 185: Produce Pisces Status Reports

All periodic status reports were completed.

Work Element B. 165: Produce Environmental Compliance Documentation

Permit applications were developed and submitted primarily for the installation and operation of PIT tag arrays, underwater video monitoring, and electro sampling of juvenile salmonids. All permits were procured before field studies began. Permits and issuing agencies included:

Title of Permit	Permit #	Issuing Agency
NOAA Section 10 Permit	16122	NOAA Fisheries
Hydraulic Project Approval (HPA)	121995-1	WDFW
Hydraulic Project Approval (HPA)	116267-2	WDFW
Hydraulic Project Approval (HPA)	116268-2	WDFW
Hydraulic Project Approval (HPA)	116269-2	WDFW
Shoreline Exemption	SE 2011-19	Okanogan County

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

Work Element C. 156: Develop RM&E Methods and Designs

The Okanogan Basin Monitoring and Evaluation Program occasionally updates protocols in order to reflect additions, changes, or refinements to methodology. OBMEP is transitioning from posting protocols and methods exclusively on our website (http://www.cctobmep.com/) to publishing and managing them on Monitoring Methods (https://www.monitoringmethods.org/Home/Index) during the current contract period.

Physical habitat in the Okanogan Basin includes a wide variety of variables, most of which are evaluated by the Habitat Monitoring Protocol. However, gaps were identified in the basin's habitat data collection. In 2012, a new rapid assessment habitat data collection protocol was developed. The Rapid Assessment procedure is intended to rate attributes of streams and rivers that are currently measured by "staff and tape" with field crews during OBMEP's traditional Physical Habitat Protocol. Rapid Assessment procedures provide a more complete dataset within the basin and monitor salmonid habitat at a larger, more continuous spatial scale. Fish passage barriers, icing, and bed scour will also be assessed under this protocol. In addition, a new protocol for estimating juvenile abundance (mark-recapture) was developed for a pilot trial on selected tributaries.

Work Element D. 157: Monitoring Changes in Standing Crop of Fish and Invertebrates at EMAP Sites

Juvenile *O. mykiss* Population Assessment in Omak Creek

Introduction

Steelhead are currently listed as threatened in the Upper Columbia basin. Monitoring the status and trends of tributary populations in the Upper Columbia allow researchers to track progress towards recovery goals, as outlined in the Monitoring Strategy for the Upper Columbia Basin (Hillman 2006). However, estimating the population size of naturally produced juvenile steelhead in the Okanogan basin continues to be a challenging task. Life history strategies and residence time of juvenile steelhead (*Oncorhynchus mykiss)* can be highly variable. The timing of outmigration can vary widely, even among the same brood year and between sexes (Peven et al. 1994). Consequently, interpreting migrational movements (i.e. resident vs. anadromous) can be challenging. The Okanogan Basin Monitoring and Evaluation Program operated a rotary screw trap (RST) since 2004 on the mainstem Okanogan River, but very few captures of naturally produced steelhead produced highly variable and unreliable estimates of population size.

Snorkel surveys of juvenile salmonids can show changes in relative abundance over time (Schill and Griffith 1984, Thurow 1994). Annual variation in relative abundance is calculable from the current long-term dataset for the Okanogan basin, but it is unknown how these values relate to absolute abundance. Data from snorkel surveys conducted from 2004 through 2012 (presented in WE D.157: Snorkel Surveys) show very low numbers of juvenile steelhead in the mainstem and considerably higher densities in tributaries. Therefore, in order to more accurately monitor population status and trends of wild juvenile steelhead in the basin, population monitoring efforts are being refocused to the cool water tributaries.

In 2012, the Washington Department of Fish and Wildlife (WDFW) and the Colville Confederated Tribes (CCT) installed a series of permanent and temporary PIT tag arrays near the mouth of tributaries with known or potential steelhead spawning habitat (BPA Project #2010-034-00). The arrays were primarily installed to monitor movements of adult steelhead during the spring spawning period and better define annual escapement estimates. However, these PIT tag interrogation systems also have the capacity to detect PIT tagged juvenile salmonids as they out-migrate from the system.

We conducted a pilot study to assess utilization of tributaries to the Okanogan River by juvenile steelhead and to determine population estimates and emigration rates from streams. This task was accomplished with the use of electrofishing, remote PIT tagging, mark-recapture events, and in-stream PIT tag antennas. The goals of this study were to: (1) determine an estimate of abundance of juvenile *O. mykiss* in small streams and (2) to calculate an independent, stream-based population emigration estimate from PIT tags. This pilot study was conducted on Omak Creek, a tributary that has known populations of adult spawning steelhead. If the goals are reasonably met, this study may be expanded in future years to additional tributaries.

Methods
OBMEP - Juvenile Abundance - Mark-Recapture (ID:194)
https://www.monitoringmethods.org/Protocol/Details/194

a. Study Location and Site Selection

Omak Creek is characterized as a perennial, medium sized tributary that enters the Okanogan River RKM 51.5, approximately 1.0 km upstream from the city of Omak, WA. Discharge rates in the creek range from a base flow of 10 cfs to over 150 cfs during the spring. During the base flow period, wetted widths range from approximately 2 to 8 m. A parallel PIT tag array (site OMK) is located near the mouth of Omak Creek and the site is located 0.24 km upstream from the confluence with the Okanogan River. The antenna arrangement consists of 6 pass-over PVC antennas grouped in two series, three upstream and three downstream (Figure 2).

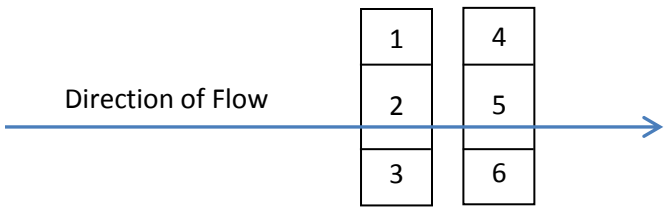

Figure 2. Antenna configuration of PIT tag interrogation site OMK, located near the mouth of Omak Creek.

A 5' rotary screw trap (RST) is operated in the spring, 225 m upstream of the PIT tag antennas. However, due to site and flow-based restrictions, operation of the trap is limited to discharges between 25 and 75 cfs. Captures and releases of PIT tagged juvenile steelhead at the RST will be used to determine detection efficiency at the downstream PIT antennas at various discharge rates.

Omak Creek was divided into six biologically distinct reaches below the anadromous barrier (Mission Falls) as part of an EDT analysis (Figure 3). Reach breaks were determined by changes in habitat, gradients, confluence with other streams, or man-made features in the stream that may affect distribution of fish (ex. culverts, adult fish weir). Within each of the six reaches, one random ~150 m site was selected to perform a site based population estimate. Four of the sites were drawn from a previous GRTS sampling effort for habitat monitoring. Two of the remaining reaches did not contain a GRTS site and a random site was selected within the respective reach boundaries. It was assumed that sites were representative of each reach because reaches were defined by analogous habitat type and a site was randomly located within respective reach bounds.

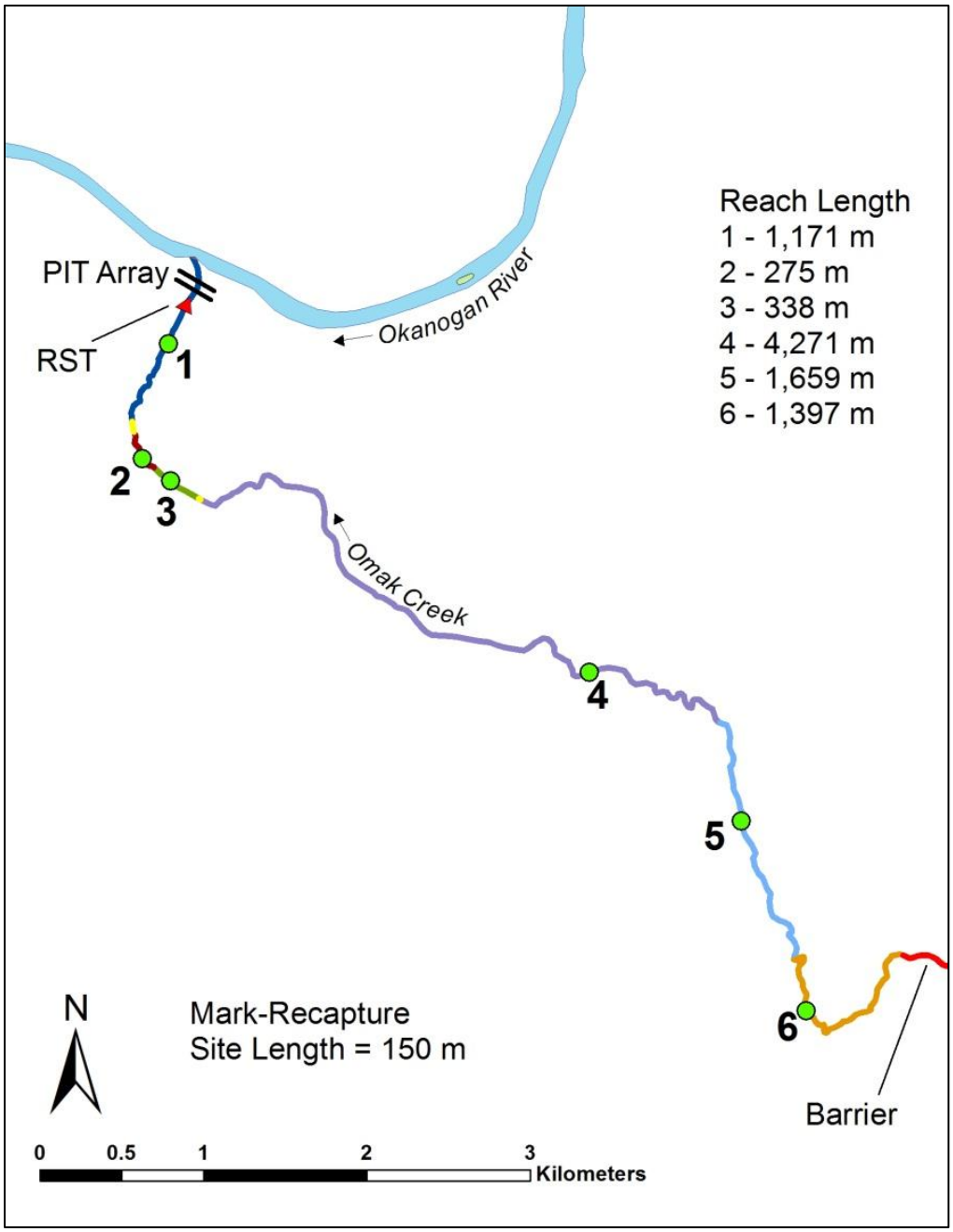

Figure 3. Omak Creek mark-recapture study site and strata.

b. Site Based Abundance Estimate

To estimate site abundance of juvenile steelhead within each site, a two-pass Lincoln-Petersen mark-recapture study was performed. Block nets were placed at the bottom and top extent of each site in order to create a closed population. Fish were sampled with a backpack electrofisher. Captured fish were anesthetized with MS-222 to reduce injury during handling and render fish immobile for tagging. During the first pass, *O. mykiss* greater than 95 mm were marked with a PIT tag and *O. mykiss* less than 95 mm were marked with a top caudal fin clip. All

other fish species handled had lengths measured and received a top caudal mark. Fish were released and evenly distributed throughout the reach, close to their initial capture locations.

In order to complete the site in one day and to maintain a closed population with the use of block nets, a three hour wait period occurred before the second pass was conducted (Temple and Pearsons 2006). During the second pass, all fish were examined for a mark. If the fish was unmarked, the length was recorded and released at the location where captured. Unmarked *O. mykiss* greater than 95 mm also received a PIT tag in order to increase the number of PIT tagged fish available for later interrogation (i.e. when emigrating from the creek).

During mark-recapture sampling events, it was assumed that: (1) the population remained closed with the use of block nets, (2) sampling effort remained the same on the first and second pass, (3) marking of fish did not affect the likelihood of recapture, (4) marked fish were randomly distributed with unmarked fish, and (5) no marks were lost and all marks were detected upon recapture. Given those conditions, site based abundance estimates were calculated using the Lincoln-Peterson mark-recapture model, as modified by Chapman (1951):

$$N = \frac{(M+1)(C+1)}{R+1} - 1$$

where

N = Estimate of site abundance size for *O. mykiss*,
M = Number of *O. mykiss* captured and marked on the first pass,
C = Total number of *O. mykiss* captured on the second pass,
R = Number of marked *O. mykiss* captured on the second pass.

The site abundance (N) variance was estimated as:

$$var(N) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)(R+1)(R+2)} .$$

c. *Expanding Site Abundance to Reach and Tributary Population Estimates*

The site-based abundance N was expanded to estimate the population of juvenile *O. mykiss* in each of the six strata (i.e., $\widehat{N}_i$ for $i = 1, \ldots, 6$). It was assumed that each site was representative of the reach in which it is located and that fish were evenly distributed throughout the reach. Each reach has an expansion factor for the area not sampled (i.e., R_i),

$$R_i = \frac{Reach\ Length_{\ i}}{Sample\ Site\ Length_{\ i}} .$$

The expansion factor R_i was used to expand site based abundance estimate to individual reaches as follows,

$$\widehat{N}_i = N_i R_i .$$

Therefore, the total population estimate across all six strata was calculated as:

$$\widehat{N} = \sum_{i=1}^{6} \widehat{N}_i R_i \ ,$$

with variance of

$$\widehat{\mathrm{Var}}(\widehat{N}) = \sum_{i=1}^{6} R_i^2 \times \widehat{\mathrm{Var}}(\widehat{N}_i) \ ,$$

and a 95% confidence interval (CI) of

$$\widehat{N} \pm 1.96\sqrt{\widehat{\mathrm{Var}}(\widehat{N})} \ .$$

The coefficient of variation (CV) estimator was calculated as:

$$\mathrm{CV}(\widehat{N}) = \frac{\sqrt{\widehat{\mathrm{Var}}(\widehat{N})}}{N} \ .$$

d. Out-Migration Estimates Based on Tagged Fish

The location of a parallel PIT tag array (site OMK) and a 5' rotary screw trap near the mouth of Omak Creek may allow for determination of an emigration estimate from the creek. Efficiency of the PIT tag array will be monitored throughout the period of the study based on detection probability of each antenna, which will be determined using marked release groups from the RST and upstream hatchery plantings. The overall probability of detection $(\hat{P})$ can be calculated as:

$$\hat{P} = 1 - (1 - \hat{p}_1)(1 - \hat{p}_2)$$

or

$$\hat{P} = 1 - \left(1 - \frac{m}{n_2}\right)\left(1 - \frac{m}{n_1}\right)$$

where

n_1 = number of fish detected at the upstream array,
n_2 = number of fish detected at the downstream array,
m = number of fish detected at both arrays,
p_i = probability of detection at ith array.

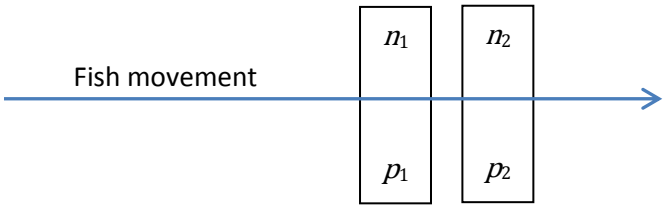

Figure 4. Diagram for probability of detection and estimated number of PIT tags past a parallel array.

Assuming that the fish tagged upstream are representitive of the total population of juvenile *O. mykiss*, the estimated proportion of tags from the study that pass the array will be applied to the population estimate to determine a total yearly emigration estimate.

Results

Steps a. through c. outlined in the methods section were conducted during the fall of 2012. Detection and calculation of out-migration estimate (step d.) will occur following the 2013 season, and thus, total emigration results will not be reported in this summary. During the 2012 field season, a total of 818 m of stream were sampled across the 6 sites. This represented 9.0% of the total stream length between the confluence of Omak Creek with the Okanogan River and the upstream anadromous barrier (Mission Falls). Site 6 was shortened from 150 m to 38 m, due to a large wildfire and 50 mph winds that forced field crews to evacuate from the site. Therefore, a larger expansion factor was used relative to the reach length when compared with the five sites downstream.

The population of juvenile steelhead in Omak Creek was divided into two size classes for analysis, based on the approximate size difference of fish between age 0 (< 95 mm) and age 1+ (> 95 mm) during the time of sampling. The population of juvenile steelhead larger than 95 mm in Omak Creek was estimated at 5,918 ± 607 (Table 1). The coefficient of variation was 5.2%. The average capture rate of this size class during mark-recapture sampling across all six sites was 52%. The population of juvenile steelhead less than 95 mm was estimated at 18,626 ± 1,953 with a coefficient of variation of 5.5% (Table 2). The average capture efficiency of this size class during mark-recapture sampling across all six sites was 34%.

Table 1. Mark-recapture and abundance estimates for O. mykiss > 95 mm by strata.

Strata	M	C	R	Site N	$\mathrm{Var}(N)$	Capture Efficiency	Reach Expansion	Reach $\hat{N}$	$\widehat{\mathrm{Var}}(\hat{N})$
1	51	39	22	89	80.8	0.43	6.69	596	3.6E+03
2	58	53	29	105	79.5	0.50	1.90	199	2.9E+02
3	81	71	56	103	11.8	0.69	2.21	228	5.7E+01
4	54	45	30	81	29.6	0.56	27.92	2,261	2.3E+04
5	54	46	27	91	58.3	0.50	10.77	980	6.8E+03
6	22	21	10	45	46.0	0.46	36.76	1,654	6.2E+04
							Total:	**5,918**	± 607 95% CI

Table 2. Mark-recapture and abundance estimates for O. mykiss < 95 mm by strata.

Strata	M	C	R	Site N	$\mathrm{Var}(N)$	Capture Efficiency	Reach Expansion	Reach $\hat{N}$	$\widehat{\mathrm{Var}}(\hat{N})$
1	84	79	31	212	511.9	0.37	6.69	1,415	2.3E+04
2	72	52	17	214	1209.9	0.24	1.90	406	4.4E+03
3	217	183	94	421	506.8	0.43	2.21	931	2.5E+03
4	120	105	47	266	481.0	0.39	27.92	7,431	3.7E+05
5	157	116	37	485	3111.9	0.24	10.77	5,230	3.6E+05
6	38	33	14	87	168.0	0.37	36.76	3,213	2.3E+05
							Total:	**18,626**	± 1,953 95% CI

Length frequency of juvenile *O. mykiss* in Omak Creek showed that 75.8% were less than 95 mm. For the purpose of this study, these fish were assumed to be age 0. Although scale samples were taken on a subsample of fish handled, those results are not yet available. Therefore, the general age class separation at 95 mm was used for analysis in this initial study year. In the future, the use of scale aging to link age 0 fish to a specific size class may allow us to further characterize the population by age. Length frequency distribution of juvenile steelhead in Omak Creek in the fall of 2012 is shown in Figure 5. These data were further divided by reach and summarized in Figure 6.

A total of 493 PIT tags were placed in fish greater than 95 mm. This value represented 8.3% of the population > 95 mm ($\hat{N}$ = 5,918). These fish will be used as a representative mark-recapture group to estimate the total emigrating population through the following year. Initial data showed that from September 2012 through February 2013, 14% of the tags had already been detected at the lower array and were presumed to be emigrating from the system. This represented an estimated fall and winter outmigration of 829 juvenile steelhead (from the larger size class). A final yearly emigration estimate will be reported at a later date following the spring freshet.

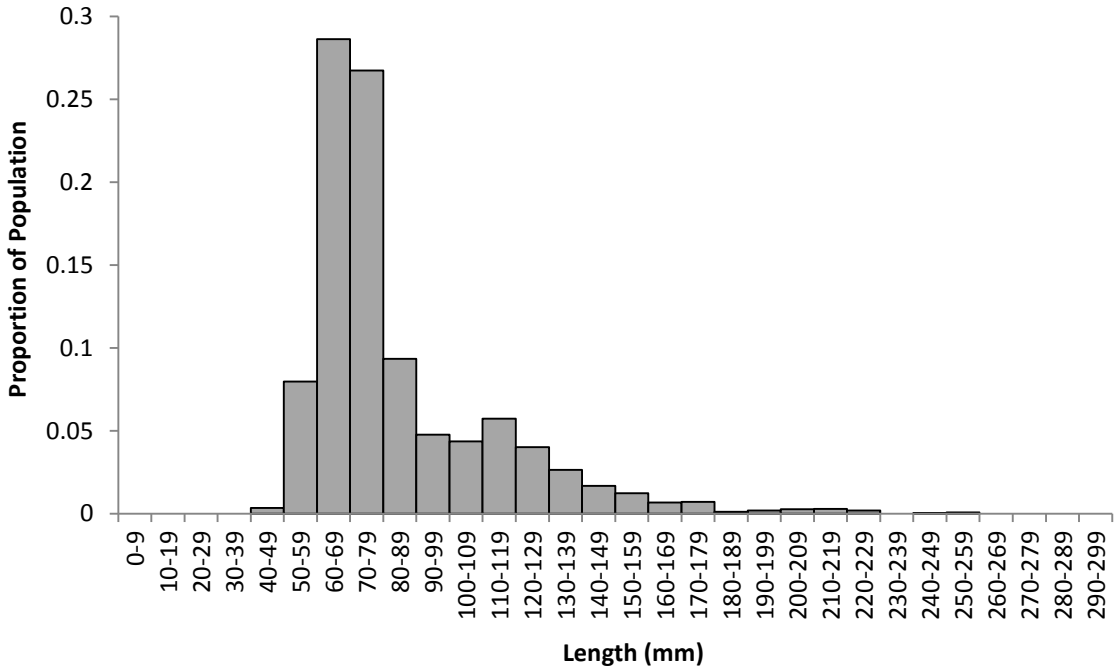

Figure 5. Population length frequency of juvenile O. mykiss in Omak Creek, adjusted for capture efficiency.

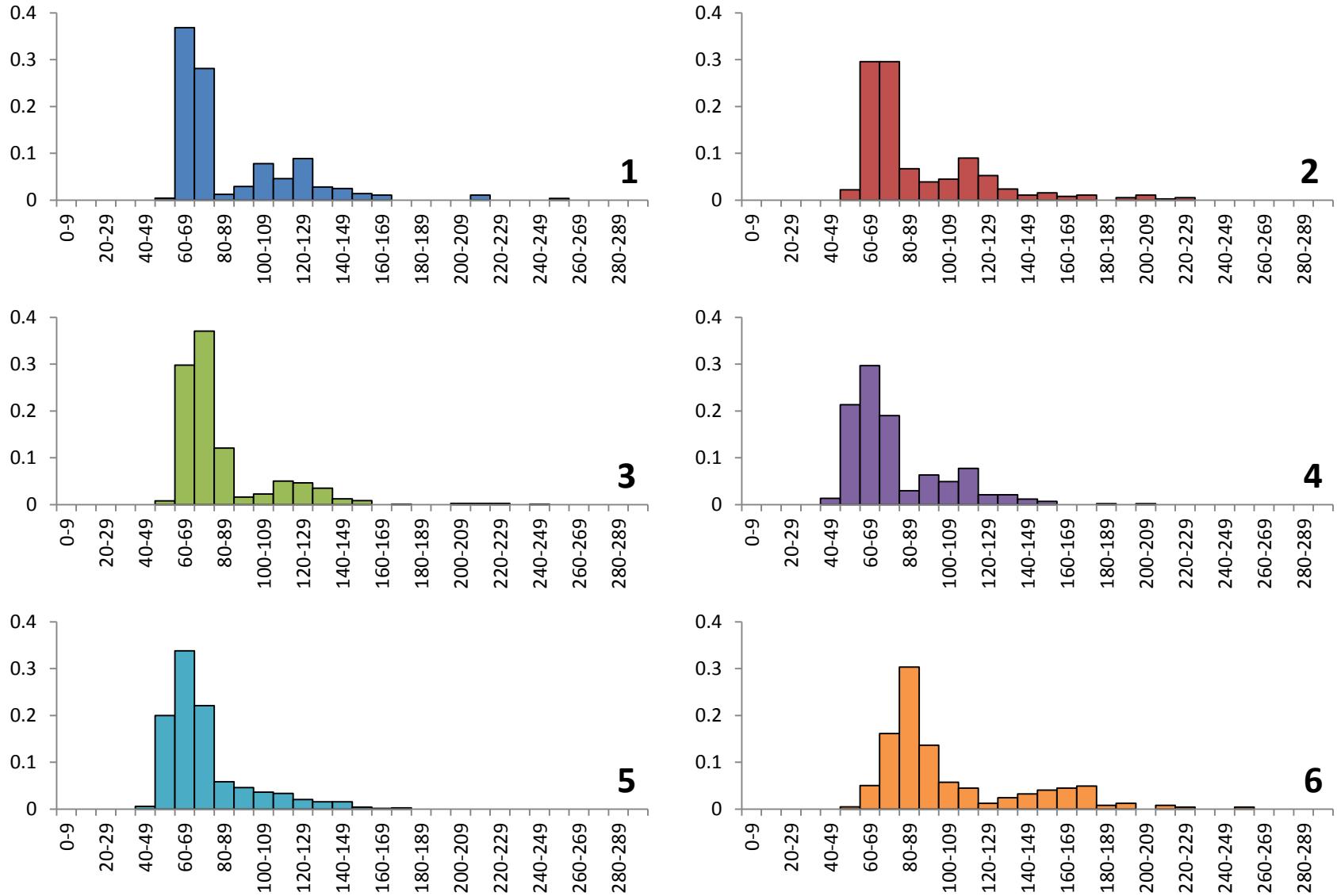

Figure 6. Length frequency (mm) of juvenile O. mykiss by strata, presented as a proportion of site abundance and adjusted for capture efficiency.

Conclusions

This pilot study demonstrated that it was possible to determine a population estimate of juvenile steelhead in a small creek with a defined measure of accuracy. While this technique might not be an optimal approach in larger systems, it was shown to be fairly precise in smaller watersheds, such as Omak Creek. With multiple years of data collection, it may be possible to detect change in status and trends in the population of juvenile steelhead in relatively small, spatially distinct watersheds. Expanding these methods to additional tributaries within the Okanogan basin will allow for further examination of juvenile steelhead production in this system and increase the number of PIT tagged fish available for interrogation to estimate out-migration.

Many of the stated assumptions used in this study were sufficiently met. Block nets were meticulously placed to create a closed population, detections of marks were easily distinguishable with the use of PIT tags and top caudal clips, sampling effort was monitored to remain consistent between the first and second pass, and fish were evenly distributed throughout the site upon release in the mark-recapture sampling close to their initial capture location. Assumptions that could not be validated include that handling and marking of fish did not affect the likelihood of recapture and that no marks were lost. In this study, no fish were recaptured that had a tag puncture wound and were found without a tag. Additionally, studies have shown that short term retention of PIT tags to be quite high, near 100% (Prentice et al. 1990, Zydlewski et al. 2003).

One factor that may warrant further consideration is the assumption that fish are evenly distributed throughout the reach. Violation of this assumption may lead to less certainty in the abundance of fish within that reach. In fact, studies have shown that spatial variation in fish density across a watershed may be considerable (Bisson et al. 1988, Kiffney et al. 2006). This bias may be inflated in longer reaches (such as Reach 4) where the site only covered 3.6% of the reach length. However, this bias was minimized in Omak Creek by sampling all six of the biologically distinct reaches. Additionally, the relatively large site length-to-wetted width ratio (150 m / ~5 m) may accommodate habitat variation within this small system. If time and budget allow, the placement of multiple randomly selected sites within a reach will allow us to quantify inter-site variability of fish density within each reach. For reaches that are too short for multiple sites (ex. Reach 2, 275 m in total length), sampling of the entire reach could remove concern of site variation within the reach.

Spatial distribution of fish throughout the creek may vary by age and size class (Roper et al. 1994). For example, density of age 0 steelhead may be linked to spawning location of adults the previous spring. Distribution of juvenile salmonids may also be linked to specific habitat variables, such as water velocity and substrate (Bisson et al. 1988, Everest and Chapman 1972, Nielsen et al. 1994), log/beaver jams (Roni and Quinn 2001), and overhead cover (Fausch 1993), among others. While the distribution of fish in relation to specific habitat variables was not examined in this initial study period, it will be possible to explore this hypothesis in the future, due to the fact that these abundance data were collected at existing habitat monitoring sites. Determining the abundance of fish in respect to specific habitat characteristics may help to further describe variables favored in this system and assist in focusing habitat restoration efforts.

A final yearly outmigration estimate has not been determined at this date. However, representatively marking a known proportion of the population upstream of the PIT tag array may enable us to estimate emigration, even in the absence of an RST. This means we may be able to monitor numbers of out-migrating juveniles at reduced costs when compared to traditional methods. This method can also be applied to small watersheds where monitoring of juvenile production was previously infeasible. Dividing the creek into distinct biologic reaches allowed for subsampling to occur at a finer scale and site-based abundance of juvenile steelhead were only expanded within similar habitat types. Although the methods outlined in this report might not be applicable for larger systems, the representative fish sampling approach was shown to provide an estimate of juvenile steelhead in a small watershed with a high degree of accuracy.

Snorkel Surveys

Introduction

Monitoring abundance of salmonids at various life stages is important to understanding the population as a whole and can reveal when and where limiting factors may be affect salmonids throughout their life history. It is also useful for understanding species distributions, estimating size structure, evaluate habitat use, and observe behavior. OBMEP conducts snorkel surveys during base flows in the tributaries and mainstem of the Okanogan, enumerating juvenile *O. mykiss* before they have undergone smoltification and emigrated from the system. Counts of juveniles (defined as <300mm) are primarily used for relative abundance and species distribution among tributaries and the mainstem. Electrofishing was conducted for the first time this year in conjunction with snorkel surveys to validate them, which will enable us to calculate population estimates and the associated error of those estimates.

Methods

OBMEP - Juvenile Abundance - Snorkel surveys (ID:7)
https://www.monitoringmethods.org/Protocol/Details/7

The Colville Tribes' Fish and Wildlife Department conducted snorkel surveys in established EMAP sites and some new habitat sites (WE H:157) throughout the Okanogan basin as part of the Okanogan Basin Monitoring and Evaluation Program. Data from 2008 were omitted in this analysis due to questions surrounding the quality of data during that year. Tributaries were snorkeled by the same observers as in 2011, and those who snorkeled the mainstem Okanogan and Similkameen rivers in 2011 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. 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.

Results

In the US portion of the Okanogan, a total of 31 out of 35 sites were snorkeled successfully. Two sites were dry and were not snorkeled on Salmon Creek because they were located below the irrigation diversion, which typically dewaters the creek from August through October. One site on Tonasket Creek and one on Wildhorse Spring Creek were not sampled because they were

dry. Current work on the database (described under work element N) includes reformatting the snorkel data and creating a data entry tool for snorkel data to be entered directly into the SQL Server database. We are waiting for this tool to be built before we enter and analyze all species observed during snorkel events; however, we preliminarily report on *O. mykiss* numbers in the US.

Juvenile *O. mykiss* were observed in the Okanogan and Similkameen basins. The highest densities observed at any single site on a creek was on Loup Loup Creek (11,156 fish/ha), followed by Tunk Creek (8,615 fish/ha), and Salmon Creek (7,571 fish/ha). Four sites were sampled on Salmon Creek, and densities among these sites ranged from 854 to 7,571 fish/ha. Two sites below the anadromous barrier on Omak Creek had densities of 2,314 and 3,427 fish/ha. In contrast, the density of juvenile *O. mykiss* at four sites above the anadromous barrier ranged from 292 to 919 fish/ha. No juvenile *O. mykiss* were observed in 9 out of 12 sites on the mainstem Okanogan. Total numbers and densities of juvenile *O. mykiss* for all streams and rivers are shown in Table 3. Due to the GRTS rotating panel design, not all tributaries are sampled each year and are labeled as "not sampled" in the table below.

Results are shown in further detail in Appendix B, organized by individual site. In Appendix B, Figure 15 and Figure 23 provide a geographic reference for annual snorkel survey sites in the Okanogan basin. Trends of observed juvenile *O. mykiss* during snorkel surveys for tributaries to the Okanogan River are shown in Figures 16 – 22 and for mainstem locations in Figures 24 – 28. The highest densities of juvenile *O. mykiss* continue to be observed in the Okanogan basin tributaries, when compared with the mainstem Okanogan and Similkameen Rivers.

Table 3. Total observed numbers and densities of juvenile O. mykiss.

Stream Name	**Total Observed *O. mykiss* (N)**	**Density (fish/ha)**
Aeneas Creek	11	47
Antoine Creek	not sampled	n/a
Chiliwist Creek	not sampled	n/a
Bonaparte Creek	144	5,899
Johnson Creek	not sampled	n/a
Loup Loup Creek	484	11,156
Ninemile Creek	72	2,255
Okanogan River	5 [a]	0.1 [b]
Omak Creek	628 [a]	1,454 [b]
Salmon Creek	842 [a]	3,022 [b]
Similkameen River	87 [a]	8 [b]
Siwash Creek	not sampled	n/a
Stapaloop Creek	not sampled	n/a
Tonasket Creek	site dry	0
Tunk Creek	288	8,615
Wanacut Creek	not sampled	n/a
Wildhorse Spring Cr.	site dry	0

[a] sum of all juvenile *O. mykiss* from multiple sites per creek.
[b] average density of all juvenile *O. mykiss* from multiple sites per creek.

Conclusions
Snorkel surveys conducted in the Okanogan basin continue to show a distinct difference between densities of *O. mykiss* in the mainstem compared to the tributaries. In the mainstem Okanogan, water temperatures commonly exceed 24˚C in most years, which potentially limits the distribution of juvenile salmonids during that timeframe (see WE H.157: Water Temperature and Discharge). The apparent absence of juvenile salmonids during the summer months may be attributed to mortality or avoidance behavior of harsh conditions.

Quantity of water (i.e. dry creeks, as noted in Appendix B) appeared to limit distribution in some small streams. 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.

Macroinvertebrate Sampling

Introduction
Macroinvertebrates are an important food source for rearing juvenile salmon. The distribution and composition of the macroinvertebrate community in a given stream may also be a good indicator of the stream's health and water quality. Disturbances such as chemical pollutants, changes in temperature, increasing sedimentation, organic loading, and invasive species can all impact the spatial distribution and species composition of macroinvertebrate communities. If pollution or contaminants are impacting the diversity and abundance of these organisms, the carrying capacity of salmonids in the creak may also be adversely impacted. Therefore, it is important to sample these organisms and monitor changes in composition over time.

In 2011 and 2012, aquatic macroinvertebrate sampling was expanded to cover all tributaries and the mainstem Okanogan in GRTS habitat sites, within both Washington and British Columbia. As additional years of data collection continue, macroinvertebrate composition will be compared to fish abundance and water quality data, to help further describe population structures.

Methods
OBMEP - Habitat Monitoring (ID:9)
https://www.monitoringmethods.org/Protocol/Details/9

Data collected 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 show below in Table 4 and 5 for reference.

Table 4. Hilsenhoff Biotic Index key for data shown in Table 6 and Table 7.

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 5. EPT and Taxa Richness key for data shown in Table 6 and Table 7.

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

Results and Conclusions

Macroinvertebrate samples collected in 2012 are currently being analyzed at the lab. Because results are not yet available, we provided data from 2011 for reference at this date. Data collected in 2012 was the third year of OBMEP macroinvertebrate collection. On average, tributaries to the Okanogan River had better HBI, EPT, and Taxa Richness ratings when compared to the mainstem sites. Continued years of data will allow us to further describe ecosystem health as it relates to salmonids.

Table 6. 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 7. Summary of macroinvertebrate data from the mainstem Okanogan 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 E. 157: Okanogan River Summer Chinook and Steelhead Smolt Trapping

Summary

The Colville Tribes' Fish and Wildlife Department continued enumerating juvenile salmonids using a rotary screw trap (RST) in 2012. However, project management of the mainstem Okanogan River RST was transferred to the Colville Tribes' Chief Joseph Hatchery Program (CJHP). Financial and personnel support was provided to this project by OBMEP, which previously operated the RST since 2006.

Two 8-foot RSTs were deployed on the Okanogan River downstream of the Highway 20 Bridge in Okanogan, WA. 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*). Results from the 2012 operations will be reported by the CCT CJHP. Interested parties may contact Keith Wolf (CCT CJHP, keith.wolf@colvilletribes.com) for data and summaries from the 2012 mainstem Okanogan RST.

Work Element F. 157: Enumerate Adult Returns to the Okanogan River Basin

Adult Steelhead Enumeration

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.

Methods
OBMEP - Adult Abundance - Redd Surveys (ID:192)
https://www.monitoringmethods.org/Protocol/Details/192
OBMEP - Adult Abundance - Adult Weir and Video Array (ID:6)
https://www.monitoringmethods.org/Protocol/Details/6

The Okanogan River flows from the northern headwaters near Vernon, BC to the confluence with the Columbia River near Brewster, WA. OBMEP developed protocols in 2004, derived from the Upper Columbia Strategy (Hillman 2004), that called for a complete census of all steelhead spawning. Preliminary methods for implementing redd surveys were developed in 2005 (Arterburn et al. 2004) and these methods were later revised in 2007 (Arterburn et al. 2007c). 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.

Results
Redd surveys were largely unsuccessful at documenting the spawning activity of steelhead in mainstem reaches in 2012. Due to an early runoff period in the Okanogan and Similkameen Rivers, only two initial surveys could be completed on most mainstem reaches. Flows dramatically increased from a mean daily average of 2,450 cfs to 12,500 cfs in a matter of days. Flows remained high through the end of July, when spawning had long since concluded and steelhead redds were indistinguishable.

Tributary redd surveys were considered more successful at documenting locations of spawning steelhead, when compared to the mainstem, in 2012. However, survey efforts on tributaries were occasionally limited by localized high water events from snow melt and precipitation. Some tributaries were successfully surveyed across the spawning period, while others were not surveyed at times when visibility remained poor. Above-normal precipitation and discharge in 2012 allowed adult steelhead to access many of the small tributaries which are frequently inaccessible due to low flows or dry creek beds.

Data presented in Figure 7 summarizes spawning estimates from 2005 through 2011, for both hatchery and wild steelhead. Estimates were compared with recovery goals outlined by the Upper Columbia Spring Chinook and Steelhead Recovery Plan (USCRB 2007). Data from 2012 are not presented in this report as data from contributing agencies has yet to be made available, and are required for a detailed estimate. These data will be available soon, and at such time, a technical report on total steelhead escapement will be posted to the OBMEP website with updated values for 2012.

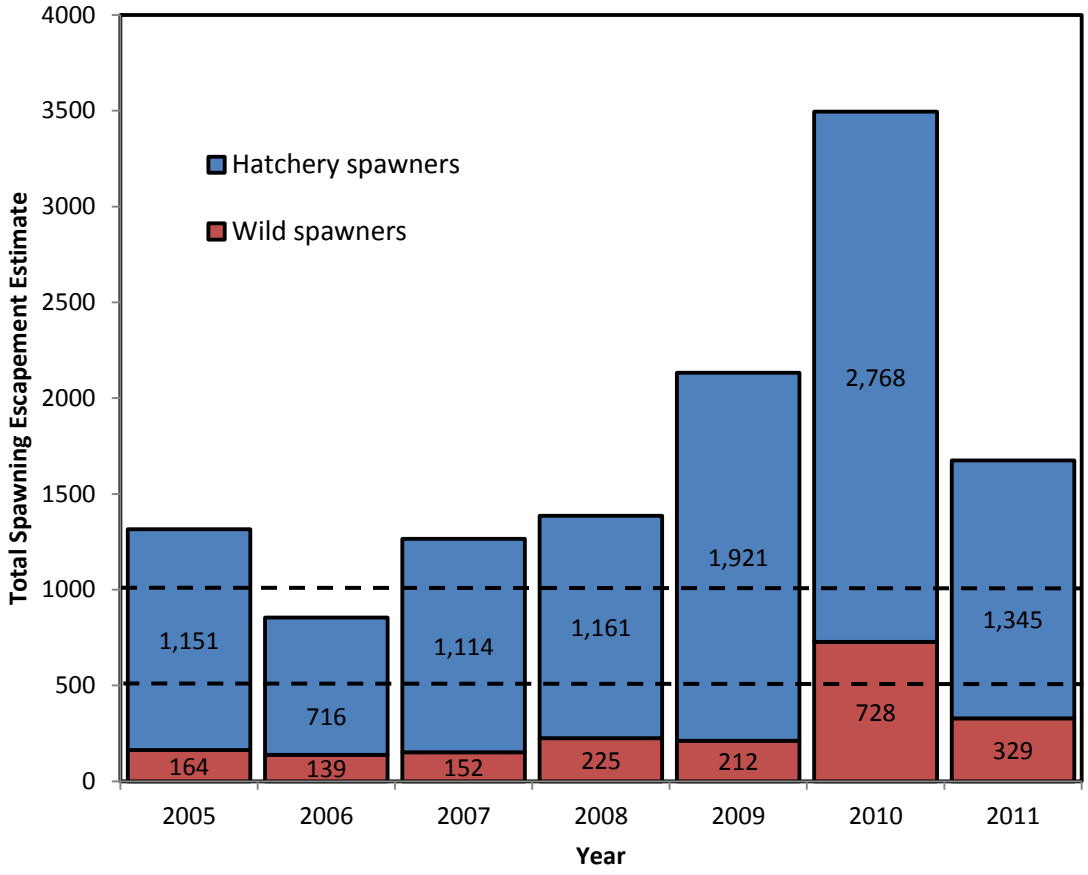

Figure 7. Escapement estimates determined by OBMEP compared with steelhead recovery goals, as outlined in the Upper Columbia Spring Chinook and Steelhead Recovery Plan (UCSRB 2007). The Interior Columbia Basin Technical Recovery Team (ICBTRT) determined that 500 naturally produced steelhead adults would 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).

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 has continually been most heavily concentrated below Zosel Dam on the Okanogan River and in braided island sections of the lower Similkameen River. It is likely that spatial distribution of spawning hatchery fish is influenced by stocking location because steelhead redds are commonly observed near locations were juvenile hatchery steelhead were scatter-planted in Omak Creek, Salmon Creek, and the Similkameen River. Steelhead redds were often observed 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. Defining the origin of returning adults continues to be difficult. 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). Accurate and reliable determination of origin is critical for tracking recovery of Upper Columbia summer steelhead within the Okanogan River basin. 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 through 2012, 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 can 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 2013 at the downstream extent of most tributaries throughout the Okanogan River system and returning adults will continue to be implanted with PIT tags at mid-Columbia PUD facilities. Local interrogations of PIT tagged adult steelhead 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 cannot be conducted, and further improve our ability to describe habitats used by summer steelhead in the Okanogan subbasin.

Underwater Video Enumeration

Introduction

OBMEP used underwater video to collect data on the run timing and abundance of adult salmonids. Underwater video observations allow us to monitor seasonal run timing of salmonids and estimate run abundance, in certain cases, by sex and origin. Video was also used in locations where redd surveys are infeasible due to expansive habitat.

Methods

OBMEP - Adult Abundance - Adult Weir and Video Array (ID:6)
https://www.monitoringmethods.org/Protocol/Details/6

Underwater video systems were installed at four locations in the Okanogan basin in 2012. Year-round video systems located in the fish ways of Zosel Dam allow observation of salmonids passing into the British Columbia portion of the Okanagan River basin. Three temporary video systems were installed on tributaries within the Okanogan basin during the spring to monitor adult steelhead: Salmon, Antoine, and Ninemile Creeks. Motion detection built into the system allowed observers to quickly review data when fish passed the location and bypass times when fish were not moving.

Results

Zosel Dam is operated to maintain the level of Lake Osoyoos, a natural, riverine lake on the international boundary. When the dam's spillway gates are raised to any level greater than 1 foot, fish will pass through the open spillway gates rather than through the fish ladders and video arrays. In 2012, the gates at Zosel Dam remained open greater than 1 foot from April 26th, to August 9th, allowing steelhead, Chinook, and sockeye to pass through the gates without being detected in the video arrays.

Chinook

The first Chinook salmon was observed in the Zosel Dam video array on August 27th (Figure 8). The last was observed on November 15th. An unknown number of Chinook may have passed through the video array prior to August 9th when the Zosel Dam spillway gates were open. There appeared to be two pulses of Chinook, with the first pulse peaking on August 28th with 22 fish. The second pulse of Chinook peaked on October 9th with 79 fish. A total of 826 Chinook were observed passing upstream at Zosel Dam (Table 8). Jack Chinook comprised 25% of the run. Adipose clipped Chinook comprised 23% of the run.

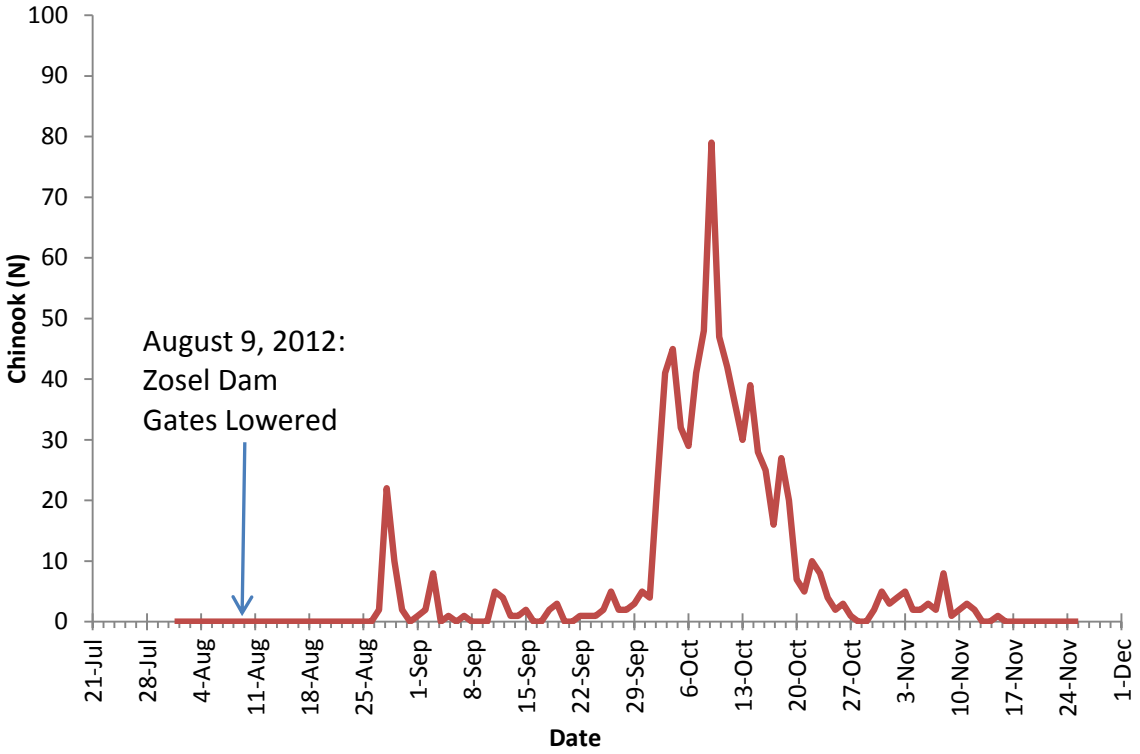

Figure 8. 2012 Chinook run through Zosel Dam.

Table 8. Chinook passage through Zosel Dam.

Origin	Adult	Jack	Unknown	Total
Hatchery	111	83	0	194
Wild	505	127	0	632
Total	616	210	0	826

Chinook Salmon were also observed in the Salmon Creek video array. The first Chinook salmon was observed in the Salmon Creek video array on June 2nd and the last was observed on July 3rd. A total of 4 adult Chinook were observed passing upstream at the Salmon Creek video array (Table 9).

Table 9. Spring Chinook passage through the Salmon Creek video weir.

Direction	Wild	Hatchery	Unknown	Total
Upstream	3	0	1	4
Downstream	1	0	0	1
Total	2	0	1	3

Sockeye

Our results for sockeye represent the latter portion of the run, probably after the peak of the run had already passed upstream. An unknown number of Sockeye passed through the video array prior to August 9th when the Zosel Dam spillway gates were open (Figure 9). Based on observations of some sockeye using the fish ladder while the gates were open, the peak of the Sockeye run may have occurred on July 21st, just 7 days after the peak occurred at Wells Dam on the Columbia River with 27,815 fish. The first Sockeye Salmon observed in the Zosel Dam video array after the gates were closed was on August 10th. The last was observed on November 17th. A total of 17,221 Sockeye were observed passing upstream at Zosel Dam.

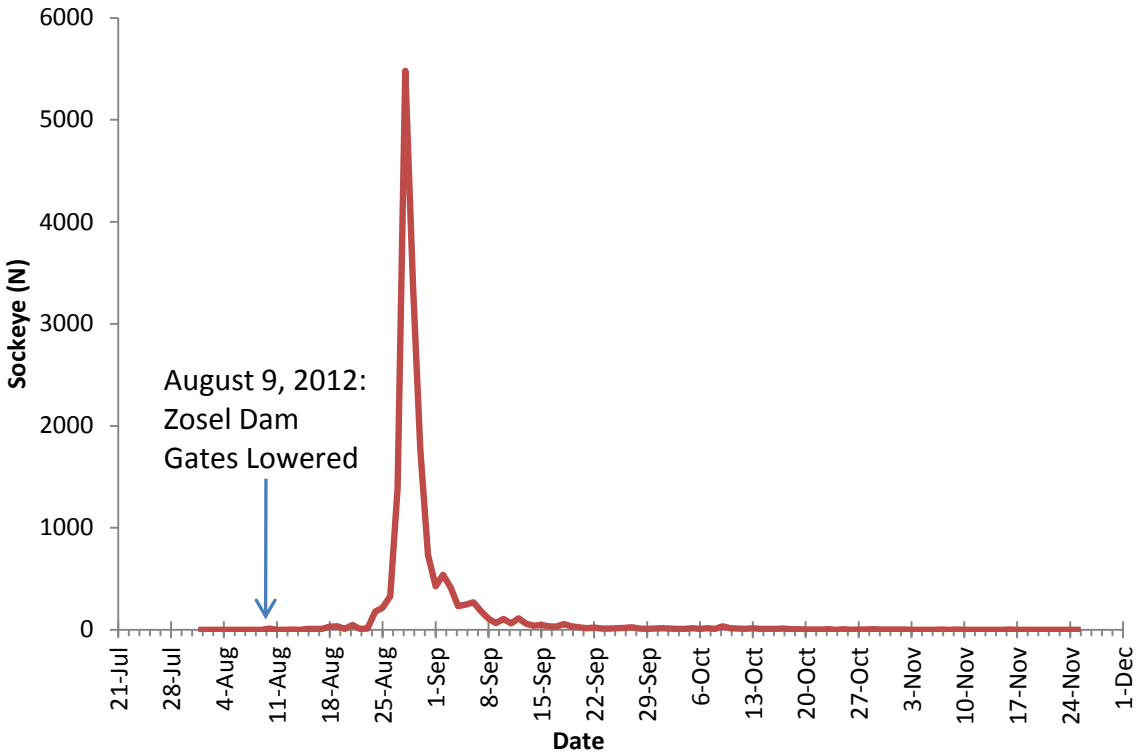

Figure 9. 2012 sockeye run through Zosel Dam.

Steelhead

Adult Steelhead were enumerated at Zosel Dam, Salmon Creek, Antoine Creek and Ninemile Creek. During the steelhead run, episodic high turbidity resulted in periods of poor visibility at Zosel Dam and all three tributary video arrays. A portion of the Steelhead run passing through Zosel Dam may have passed upstream undetected after April 26th when the spillway gates were raised. Results from underwater video at Zosel Dam, Salmon Creek, Antoine Creek, and Ninemile Creek for steelhead are reported on under Work Element F: 157 Adult Steelhead Enumeration.

Coho

Coho salmon were documented passing through the Zosel Dam video array for the first time in 2012. They were observed passing through the Zosel Dam video array from October 14th through November 6th. All 15 fish observed passing upstream through Zosel Dam had intact adipose fins (Table 10).

Table 10. Coho passage through Zosel Dam.

Direction	Wild	Hatchery	Unknown	Total
Upstream	15	0	0	15
Downstream	1	0	0	1
Total	14	0	0	14

Conclusions

Underwater video observation provided a means to easily identify fish species, in some species by sex and origin, and to document salmonid run timing in the basin. Identification of species was validated by saving still-images from video to be reviewed at a later date by additional, experienced staff. Video counts are used in combination with other methods of enumeration and can provide fish counts in case other methods fail. Underwater video has the capability to document fish that are not tagged and where no other means exist to document abundance. This method can be used to validate PIT tag expansion estimates. However, in-river conditions some years have resulted in not all fish being observed in the video array due to turbid water conditions. When this occurs, census counts are incomplete. In addition, fallback rates are not factored in to these video results at Zosel Dam. We are currently comparing PIT tag interrogation data to video data in order to calculate fallback rates and may use them in the future for reporting abundance estimates.

Work Element G. 157: Monitor Threats to Salmonid Habitats at up to 50 Sites Annually

Introduction

Of the multiple life stages a salmon will progress through, more occur in freshwater (spawning, egg development, emergence from gravels, fry, parr, smoltification and emigration) than in the ocean (rapid growth into adults preceding return to freshwater). Therefore, the quantity and quality of freshwater habitat is very important to the survival and abundance of salmon populations. When salmon are spawning, they select locations with optimal gravel size, groundwater and surface water interaction, and oxygenation that will provide developing eggs the best chance of survival. When alevins emerge from the gravels, their protection from predators will depend on substrate, riparian shade, woody debris, and flow. Their physiological development will also be influenced by food availability, temperature, and other water quality parameters. When juvenile salmon are ready to emigrate to saltwater, flow velocities and the amount of cover from predators will be important factors in their survival. As adults return to spawn in freshwater, their success can be influenced by water flow, temperature, predators,

passage through anadromous barriers and blockages, and water quality. It is essential to quantify and qualify salmon habitat, monitor changes in habitat over time, and address adverse impacts as they are identified.

Currently, the Colville Tribes are the only organization collecting comprehensive fish habitat data throughout the Okanogan basin in Washington. Cooperation includes the sharing of monitoring responsibilities between the Colville Tribes and the Okanagan Nation Alliance (ONA) in British Columbia.

Methods

OBMEP - Habitat Monitoring (ID:9)
https://www.monitoringmethods.org/Protocol/Details/9

Physical habitat data are collected annually at 50 GRTS sites (25 panel, 25 rotating panel) using 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 Okanagan Basin by the ONA. Of the 50 total GRTS sites, three were not sampled, due to climatic or landowner restrictions.

Physical habitat data are collected in an electronic template on a Trimble Yuma tablet. The information collected includes: 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 synchronized with 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 to produce scenarios or snapshots of the environment. The environmental scenario is coupled with biological assumptions (i.e. life history strategies, migration information, etc.) of the species of interest, which contributes to our understanding of how fish at their various life stages are experiencing their environment, and what are the limiting factors at the various life stages. The EDT model provides a framework for the evaluation of habitat data collected within the Okanogan River basin.

Summary

Habitat data through 2008 have been analyzed in EDT and have been summarized in a report published in 2010. Analyses involved first estimating the potential of habitat in the Okanogan River to support spring Chinook salmon and steelhead (i.e. system potential), and then comparing this system potential "template" to two "patient" scenarios. The change in limiting conditions between the template and patient scenarios were evaluated using Patient-Template Analysis (PTA). The two patient scenarios were based on what was largely expert opinion values generated in the 2004 Sub-basin Plan process and OBMEP data collected at GRTS sites through 2008.

We are currently working with ICF International to complete analyses that are based almost entirely on observed values and data collected under the OBMEP program. Data through 2009 were used to create a template scenario, then patient scenarios based on data from 2004-2009

were analyzed for changes in limiting factors. Habit status and trends were evaluated in terms of how each focal species performed at their various life stages. The results are currently being compiled in an extensive report which will summarize data by diagnostic units, as well as diagnostic reaches, similar to the EDT Analysis report published in 2010.

The 2010 EDT report and all other reports related to habitat data can be downloaded at:

http://www.colvilletribes.com/obmep.php

Work Element H. 157: Fill Data Gaps Related to Water Quality and Quantity Needed to Evaluate Status and Trend

Water Quality

Introduction

Water of sufficient quantity and quality are the two basic necessities for aquatic ecosystems. The water quality in which salmonids are found not only directly affects physiology, but also indirectly affects survival by influencing food webs and habitat characteristics. For example, dissolved oxygen (DO) is a basic requirement for all fish and aquatic life to carry on basic life functions. DO can be depleted if significant sources of nutrients (such as nitrates, nitrites, and ammonia) from fertilizers, animal waste, or municipal discharges are introduced in the stream. High turbidity or total suspended solids can raise water temperatures, lower DO, keep light from reaching aquatic plants, and directly affect fish behavior and physiology by increasing stress and reducing survival. Although direct impacts of pH, alkalinity, and conductivity are not well defined for salmonids, changes in these parameters can lead to increased toxicity of some contaminants and indirectly affect salmonids. Therefore, it is important to monitor water quality through time in order to understand population performance, abundance, and survival.

Methods

OBMEP - Water Quality Sampling (ID:5)

https://www.monitoringmethods.org/Protocol/Details/5

Water quality testing was conducted monthly from 2010 through 2012 at 18 sites in the Okanogan River, Similkameen River, and major tributaries in the basin. Three sites are located on the mainstem Okanogan near the USGS monitoring stations near the town of Malott (lower), Tonasket (middle), and Oroville (upper). Samples on the Similkameen were initially taken at two locations, but results were nearly identical between stations, so data are only collected near the USGS monitoring station in Oroville (site name Similkameen 1). Water chemistry was collected at the following tributaries to the Okanogan: Ninemile, Tonasket, Antoine, Siwash, Aeneas, Bonaparte, Tunk, Johnson, Wanacut, Omak, Salmon, and Loup Loup Creeks. Tonasket, Siwash, and Wanacut Creeks have very limited data sets because these creeks are typically dry for most of the sampling period. Therefore, data from these creeks are not included in this report. Historically, Loup Loup Creek was intermittently connected to the mainstem, until recently when the Colville Tribes secured water rights to keep the creek connected year around. The current dataset on Loup Loup is small and is not reported on here, but all data sets will be included in future EDT analyses.

Results

Basin-wide sampling resulted in monthly point measurements of DO, pH, turbidity, NO3, NH4, TDG, and temperature. Data were not collected when the stream was dry, ice covered the streams, or when sensors were out of calibration or damaged. Values for DO, pH, turbidity, and TDG were within an acceptable range. However, NO3 values were occasionally higher than normal during and just after spring runoff (Table 11). There were also distinct events when high NO3 values were collected at sites where cattle were observed to be near or in the river. Specific water quality data requests can be directed to the Colville Tribes' Fish and Wildlife Department, Anadromous Fish Division, (509) 422-7424.

Table 11. Water quality data from the Okanogan basin.

	DO		pH		SpCond		TDG		NH4		NO3	
Location	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Antoine Creek	8.5 - 15.0	11.4	7.7 - 8.8	8.4	175 - 651	486	718 - 753	737	0.0 - 2.1	1.8	0.4 - 5.5	3.1
Bonaparte Creek	8.4 - 15.4	11.2	7.5 - 8.5	8.3	235 - 500	366	716 - 751	737	0.1 - 1.7	0.7	0.2 - 4.2	1.0
Ninemile Creek	9.1 - 14.2	11.6	7.1 - 8.4	8.1	168 - 841	542	723 - 740	732	0.1 - 3.8	1.0	0.1 - 4.9	2.1
Omak Creek - Lower	9.4 - 16.2	11.4	6.9 - 8.6	8.0	75 - 194	133	726 - 751	739	0.0 - 0.9	0.3	0.1 - 3.9	0.9
Omak Creek - Upper	9.2 - 15.8	11.6	7.5 - 8.3	7.9	70 - 179	124	720 - 745	731	0.0 - 0.8	0.2	0.2 - 1.4	0.6
Salmon Creek - Lower	9.8 - 15.1	11.9	7.6 - 8.3	7.9	106 - 568	255	714 - 787	737	0.0 - 1.2	0.3	0.1 - 0.9	0.6
Salmon Creek - Upper	9.5 - 14.7	11.6	7.6 - 8.1	7.9	88 - 440	160	703 - 727	714	0.0 - 1.0	0.3	0.2 - 2.0	0.9
Tunk Creek	8.3 - 15.7	11.3	7.8 - 8.5	8.3	107 - 466	263	720 - 748	739	0.0 - 2.2	0.6	0.2 - 4.2	1.0
Okanogan Low (3)	8.3 - 12.5	10.5	7.6 - 8.5	8.0	112 - 326	238	732 - 829	764	0.0 - 0.9	0.2	0.0 - 4.4	1.3
Okanogan Mid (2)	7.9 - 15.3	10.6	6.9 - 8.3	7.9	106 - 316	214	719 - 815	764	0.0 - 2.0	0.3	0.0 - 4.4	0.6
Okanogan Up (1)	8.6 - 15.0	10.7	7.7 - 8.9	8.3	240 - 330	289	734 - 800	751	0.0 - 2.7	0.5	0.0 - 1.7	0.5
Similkameen River	8.6 - 16.2	11.7	7.4 - 8.2	8.0	74 - 220	155	738 - 828	777	0.0 - 1.6	0.4	0.1 - 4.3	1.0

Conclusions

Most of the observed water quality readings were within the surface water quality standards set by the Washington State Department of Ecology. The only values that might be a concern during certain times of the year were nitrates, although this finding was not surprising given the amount of agriculture, orchards, and livestock in the basin. Peer-reviewed literature suggests nitrate levels as low as 2.3-7.6 mg/L-N may induce mortality of Chinook salmon and rainbow trout in the egg and fry life stages (Kincheloe et al. 1979). Additionally, sub-lethal effects may include decreased ability of the blood to carry oxygen (anemia), which results in decreased fitness and health. The EDT analysis will include our water quality data and assess impacts of the various water quality parameters to Chinook salmon and steelhead at their various life stages.

Water Temperature and Discharge

Introduction

Based on long-term monitoring data and known limitations of cold-water salmonids species, water temperature may be a 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 2012 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 2013.

Methods

OBMEP - Habitat Monitoring (ID:9)
https://www.monitoringmethods.org/Protocol/Details/9

OBMEP Habitat Monitoring Protocols were developed according to the Monitoring Strategy for the Upper Columbia Basin (2004) by Tracy Hillman, and aligned with the methods of the Collaborative System-wide Monitoring & Evaluation Program (CSMEP), the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) and implemented following the Environmental Monitoring and Assessment Program (EMAP). To ensure compatibility with other regional and basin wide projects currently underway, OBMEP coordinates with multiple disciplines and agencies throughout the Okanogan River Basin, Columbia Cascade Province, and Columbia River Basin. Water temperatures were collected through USGS monitoring stations and with Onset® hobo temperature loggers at annual and panel sites.

Results

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 the archives available on the USGS web site, which provides easy access to the public and other agencies. Data links for USGS temperature monitoring sites within the Okanogan Basin include:

Okanogan River at Malott: http://waterdata.usgs.gov/nwis/uv?site_no=12447200

Okanogan River near Tonasket: http://waterdata.usgs.gov/nwis/uv?site_no=12445000

Okanogan River at Oroville: http://waterdata.usgs.gov/nwis/uv?site_no=12439500

Ninemile Creek: http://waterdata.usgs.gov/wa/nwis/uv/?site_no=12438900

Additionally, tributary temperature data were collected basin-wide, in Washington and British Columbia, at annual and panel habitat monitoring sites. A subset of data is presented for the lower (Figure 10), middle (Figure 11), and upper (Figure 12) Okanogan basin in Washington State. These graphs outline the difference in water temperature between mainstem and tributary habitats. Specific data are made available by contacting Jennifer Miller (Fisheries Biologist, Data Analyst, 509-422-7733).

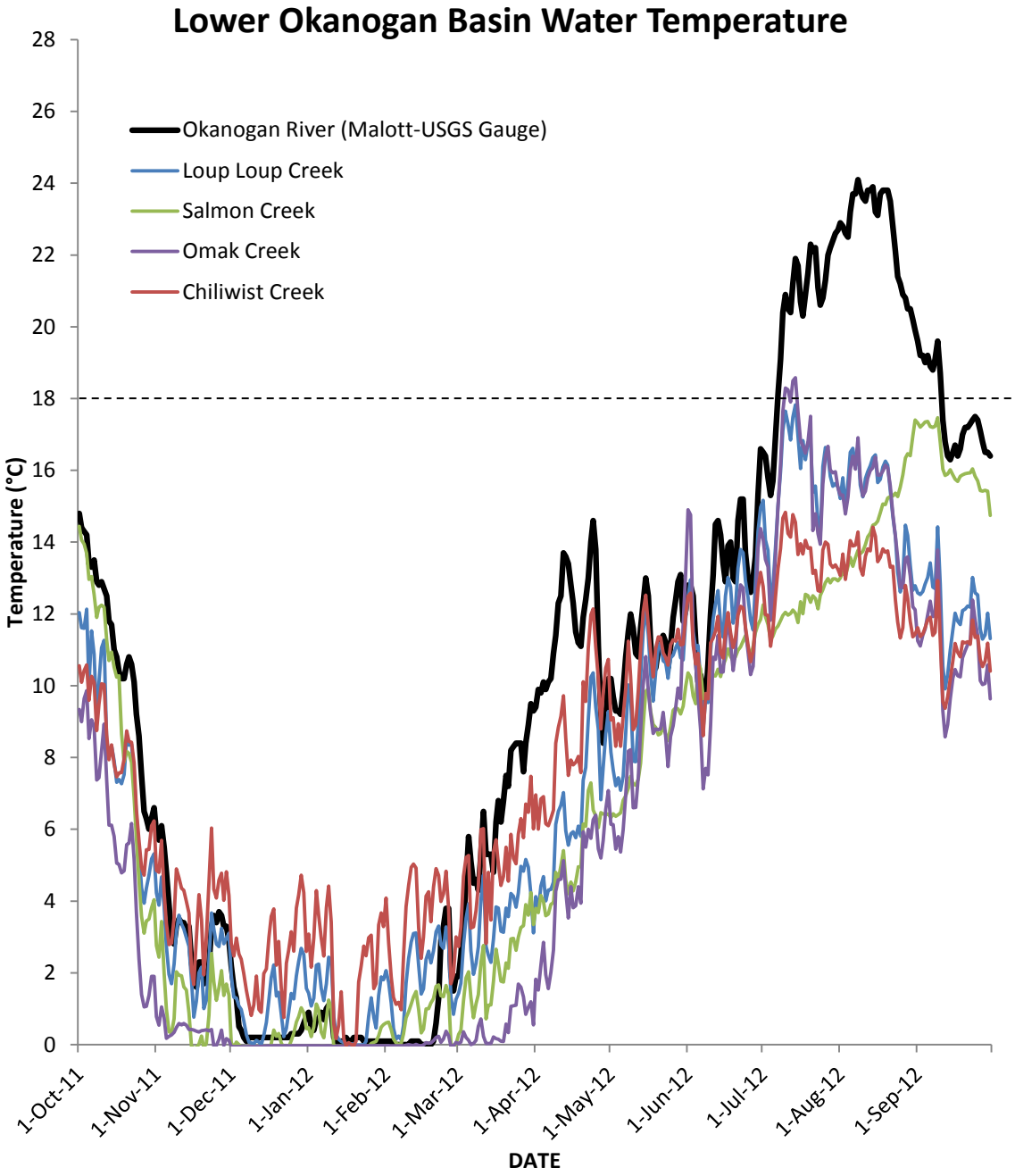

Figure 10. Water temperature in the lower Okanogan basin for the 2012 water year.

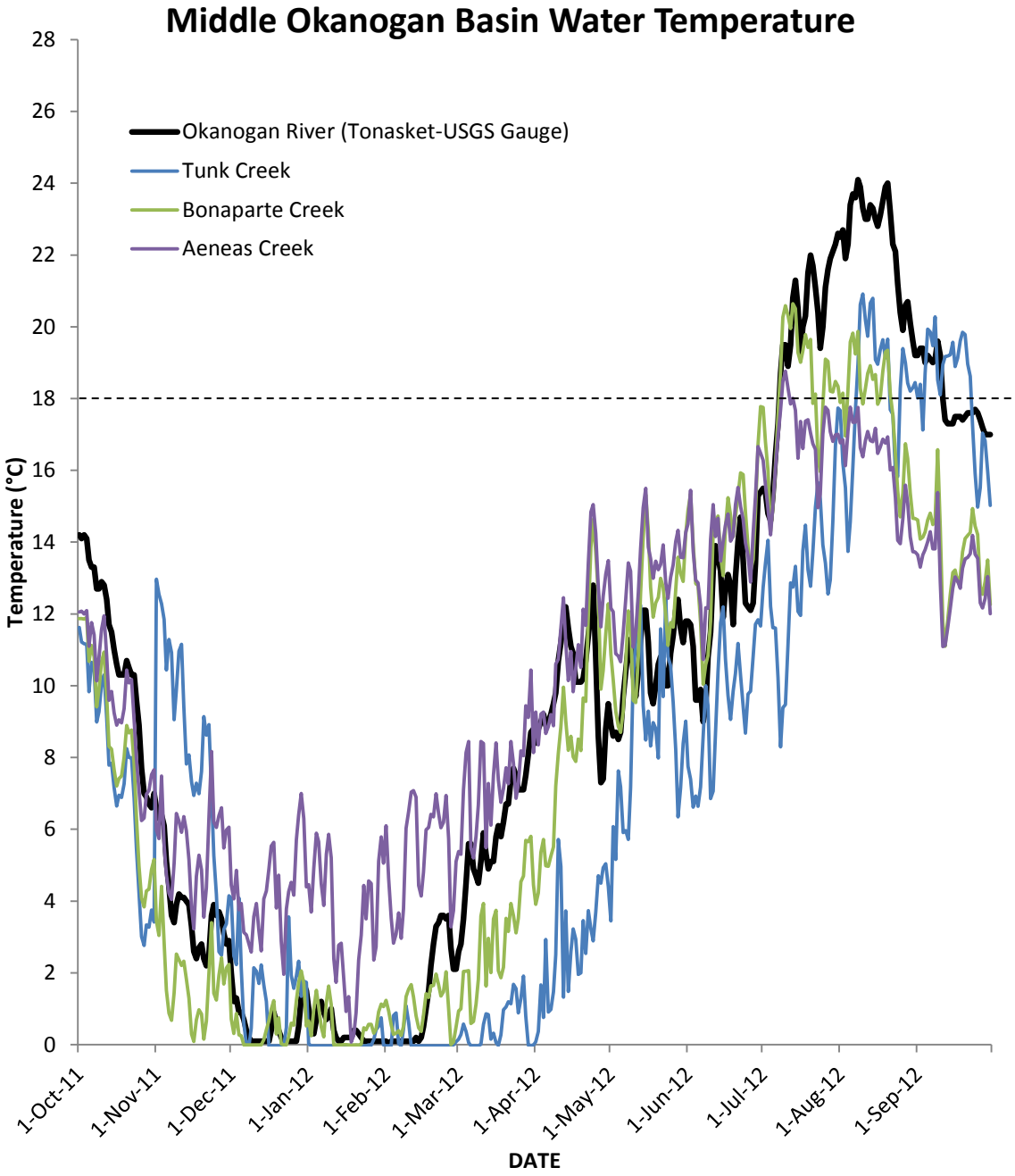

Figure 11. Water temperature in the middle Okanogan basin for the 2012 water year.

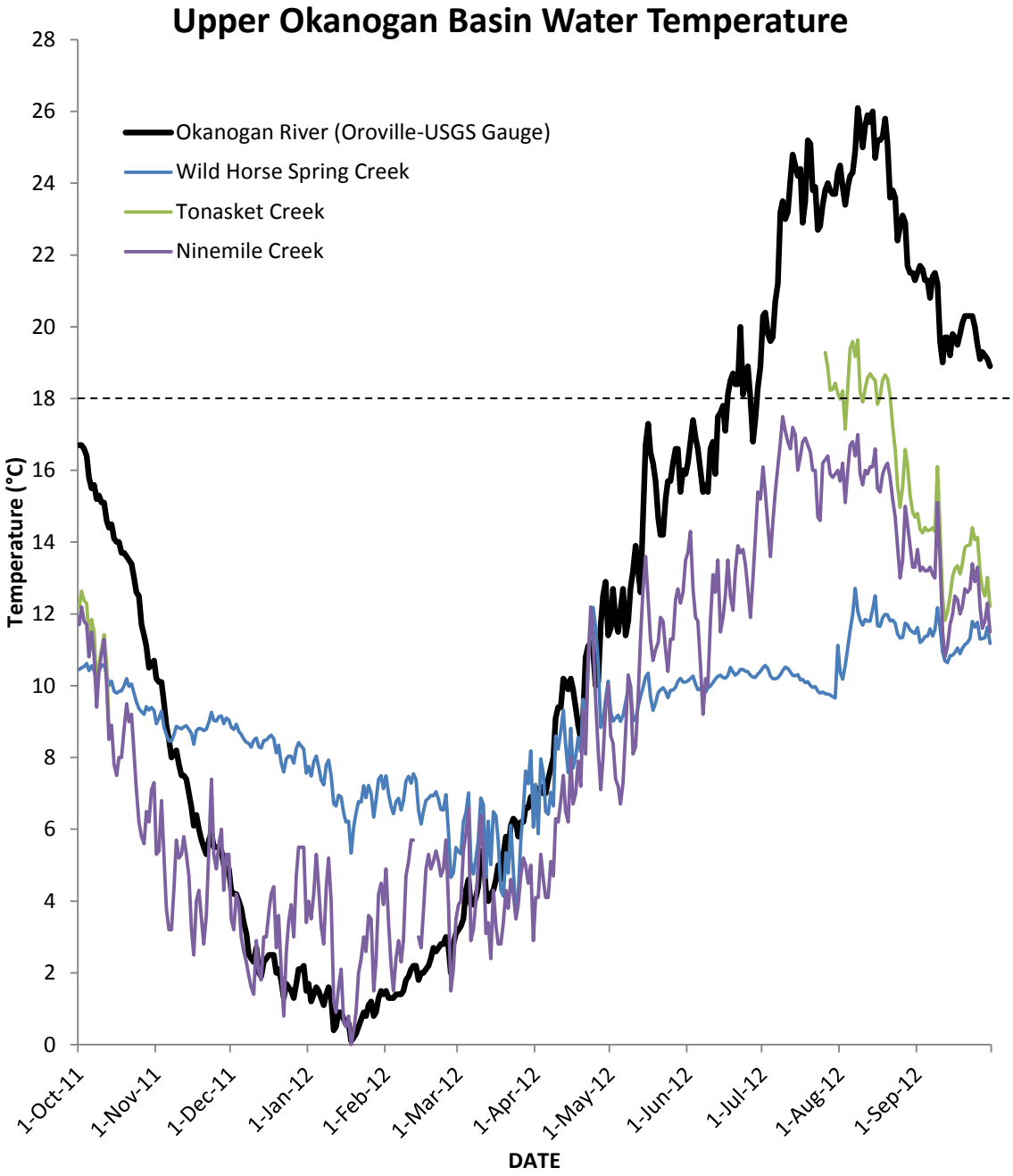

Figure 12. Water temperature in the upper Okanogan basin for the 2012 water year.

Temperature observations in the Okanogan basin reveal general trends among tributaries and the mainstem of the Okanogan. All tributaries were several degrees cooler than the mainstem Okanogan during the peak summer temperatures (i.e. Omak Creek, Figure 13 a.), and creeks with known groundwater inputs (i.e. Aeneas and Wild Horse Spring Creeks) tended to be warmer over the winter months (Figure 13 b.). For the 2012 water year (October 1, 2011 through September 30, 2012), the daily maximum temperature never exceed 28°C. However, temperatures exceeded 24°C an average of 7% in the mainstem and 0% in the tributaries, and exceeded 18°C an average of 23% of the time in the mainstem Okanogan and 7% of the time in tributaries.

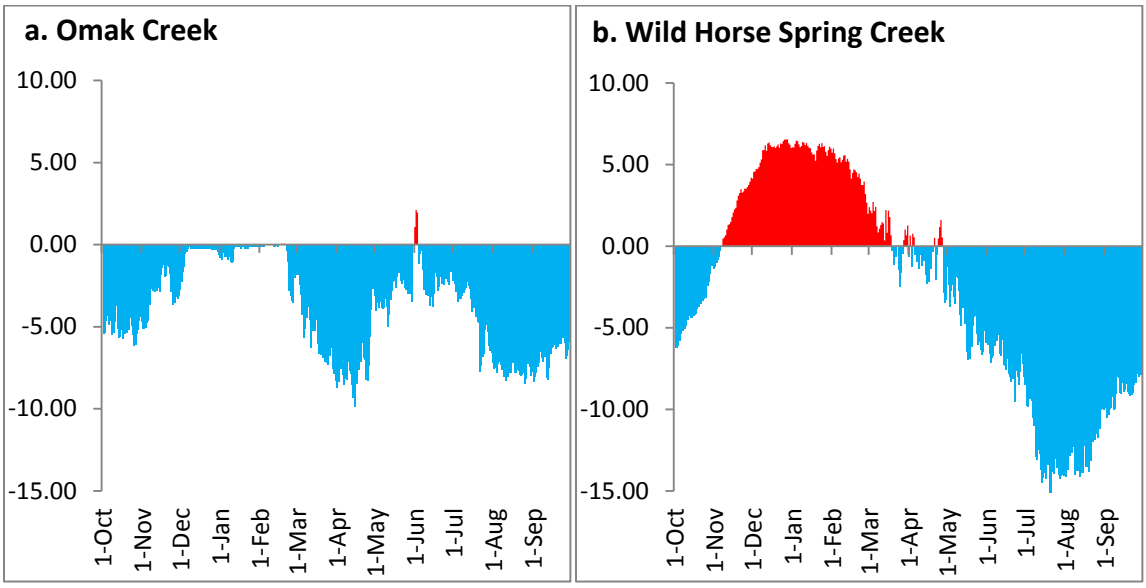

Figure 13. Difference in water temperature (degrees C) between (a.) Omak Creek and the Okanogan River (USGS Malott), and (b.) Wildhorse Spring Creek and the Okanogan River (USGS Oroville).

Conclusions

Temperature in the Okanogan and its tributaries is an important variable affecting the spatial, distribution, growth rate, abundance, and survival of juvenile salmonids. In bioenergetics models, temperature directly affects metabolic responses by determining what portion of an organism's energy budget is available to either support basal and active metabolism or contribute to somatic growth, reproduction, or high-energy lipid storage (Beauchamp et al. 2007). Although temperature tolerances in laboratory studies depend on initial acclimation temperatures, peer-reviewed literature suggests the preferred temperature of *O. mykiss* is approximately 18°C, incipient upper lethal temperature (IULT) is approximately 24°C and critical thermal maximum (CTMax) temperature is approximately 28°C (Wagner et al. 1997, Myrick and Cech 2000, Galbreath et al. 2004, and reviews in Currie et al. 1998, Beitinger et al. 2000, and Spina 2007). Our results showed that high summer temperatures in the mainstem, and to a lesser extent in some tributaries, could be adversely affecting salmonids directly, or indirectly causing behavior modifications and altering spatial distribution.

As shown in WE D.157: Snorkel Surveys (further detail in Appendix B), juvenile salmonids are consistently observed in greater numbers in the tributaries than in the mainstem Okanogan, where they are virtually absent. Thermal tolerances for juvenile salmonids suggest there should be few or no juvenile salmonids in the mainstem during high summer temperatures. However, there is concern over their apparent absence because over 50% of spawning occurs in the mainstem (see steelhead spawning survey reports, http://www.colvilletribes.com/obmep_publications.php). It is unknown if high summer temperatures are causing direct mortality to juveniles, alteration in behavior to avoid high temperatures, or both are occurring and to what degree they are occurring. Additionally, juveniles may be hiding in the interstitial space between gravels and the snorkel method may not be as efficient for observing juveniles in the mainstem. Monitoring temperature in the mainstem Okanogan and its tributaries will continue to play an important role in understanding the life history of steelhead in the Okanogan.

Work Element I. 119: Manage Projects: Produce Necessary Documents, Estimates, and Personnel Management

Completed

Work Element J. 191: 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.

OBMEP was developed 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 Okanagan 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 K. 161: 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 in which OBMEP staff contributed to in 2012 included:

- Columbia Cascade Regional Fisheries Enhancement Group
- Upper Columbia Regional Technical Team
- AFS WA/BC Chapter Conference in Victoria, BC
- Bilateral Okanagan Basin Technical Working Group
- Okanogan Irrigation District board meetings
- Native American Fish and Wildlife Society, Pacific Regional Conference
- Regional Fisheries Enhancement Group Advisory Board and Coalition
- PNAMP Habitat Metric meetings
- Monitoring Methods and reporting workshop
- HCP Hatchery Oversight Technical Team Conference
- Lake Osoyoos Board of Control Fisheries Advisory meeting
- PNAMP Steering Committee
- 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
- Columbia Habitat Monitoring Program post season workshop
- 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, Desautel-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: http://www.colvilletribes.com/obmep.php

Work Element L. 160: Manage, Maintain, and Expand the OBMEP Database

When OBMEP began in 2004, data were collected almost entirely on paper data sheets, entered into Microsoft (MS) Excel and stored on local computers. At the end of the 2006 contract year, OBMEP began using a MS Access database developed by Summit Environmental Consultants Ltd. to archive and run basic queries on the data. Data were collected on Trimble handheld GPS units or hand-written data forms and entered in to the database through custom entry forms or by appending custom MS Excel tables to the database tables. Towards the end of 2011, we began implementing a comprehensive data management system that includes software for data storage (MS SQL Server 2008) and custom templates and interfaces (MS ASP.NET) for data collection, QA/QC the data, and analysis and reporting (Figure 14).

In 2012, we used custom habitat data collection templates Summit Environmental Consultants Ltd. programmed in ASP.NET and installed on Trimble Yuma ruggedized tablet computers. Data were entered into the template, and automatically synchronized with the database in SQL Server every time the Trimble Yuma was connected to the CCT's network. The template is replacing the previous method of entering data into a Trimble GeoXT data dictionary template, which then had to be post-processed through a series of translations in MS Excel before it could be uploaded in the Access database.

With agencies in the Upper Columbia region and BPA requesting that our data are more accessible and shareable, we continued work on the webpage interface of the data management system that will enable entities outside of the Colville Tribes' network to easily query and download portions of the data. Beta versions of the webpage have been reviewed and work is currently underway to secure server space with the same company that hosts the OBMEP website and the CCT's website (Why Develop in Spokane, WA). Once space is secured, the webpage will be launched and users will be able to access all historical temperature data from all OBMEP monitoring sites in the Okanogan watershed. In the meantime, a temporary page has been added to the OBMEP website to share some types of commonly requested data (steelhead redd shapefiles, EDT reach coverage) and is available at:

http://www.colvilletribes.com/obmep.php

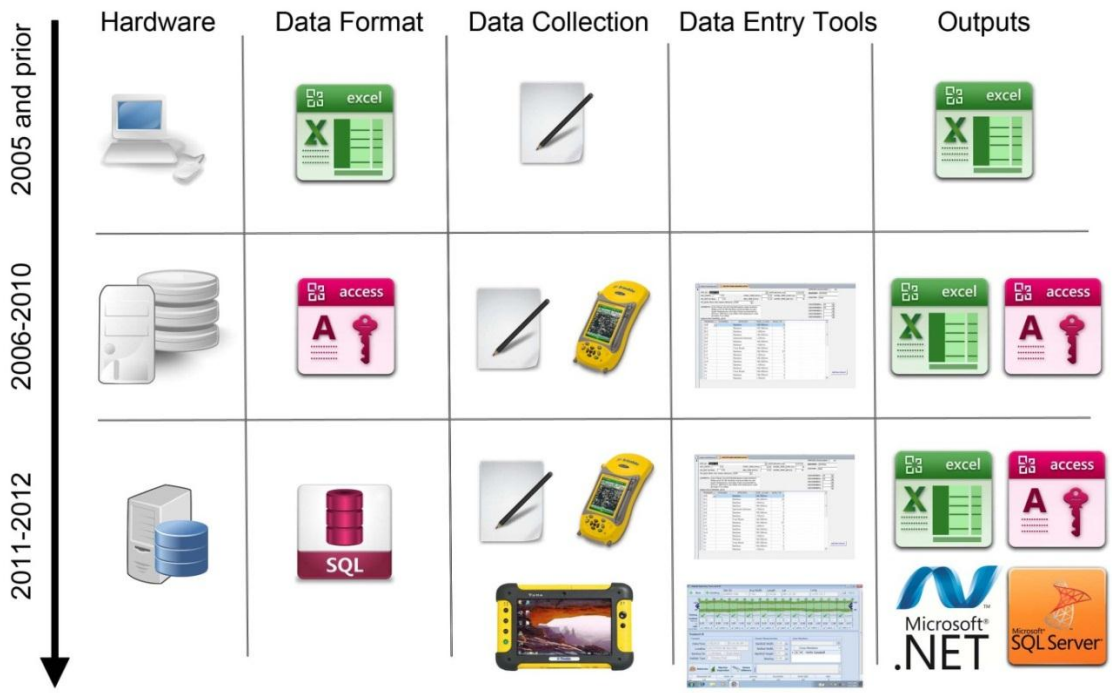

Figure 14. Progression of OBMEP data collection and management procedures.

The work plan for the remainder of the 2012-2014 budget includes finishing the habitat data collection template, continuing work on a dashboard interface application to replace the current Access interface, reformatting other data types (i.e. snorkel data, temperature, water quality) to match the format of the habitat data, and creating a dynamic reporting tool. The dashboard will be a huge part of the management system because it will enables 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, track data status (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 data queries, graphs, and reports and easily run status and trend reports on the data.

Work Element M. 162: Analyze Collected and Historical Data

Conducted periodically throughout the contract period.

Work Element N. 141: Produce Technical Reports

Included in this work element is the construction of technical reports, including the EDT habitat status and trends, adult steelhead spawning reports, and water quality data summaries.

Work Element O. 132: 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.

V. Synthesis of Findings: Discussion / Conclusions

The Okanogan Basin Monitoring and Evaluation Program completed another year of data collection, coordination, and reporting in 2012. 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 unmonitored 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. The use of underwater video allowed us to obtain spawning escapement estimates of steelhead in small tributaries, which was previously unfeasible with ground based spawning surveys. 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. New rapid assessment habitat procedures were implemented in 2012 to analyze habitat on a larger spatial scale and to fill data gaps in the basin. 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 A. Use of Data & Products

1. **Identify the database, web-links, or documented sources for related data sets for the project.**

Data collected under the Okanogan Basin Monitoring and Evaluation Program are stored in a MS SQL Server database. Data requests can be referred to Jennifer Miller (509-422-7733). Additional information about the OBMEP database can be found in WE L:160 Manage, Maintain, and Expand the OBMEP Database.

2. **Identify citations for other technical reports produced/published using data collected or evaluated by this project in the calendar year that could be included in potential review.**

Miller, B.F., J.L. Miller, and J.E. Arterburn. 2013. 2012 Okanogan Basin Steelhead Escapement and Spawning Distribution. Colville Confederated Tribes Fish and Wildlife Department, Nespelem, WA. Report submitted to Bonneville Power Administration, Project No. 2003-022-00.

Murdoch, A. R., T. L. Miller, B. L. Truscott, C. Snow, C. Frady, K. Ryding, J. E. Arterburn, and D. Hathaway. 2011. Upper Columbia Spring Chinook Salmon and Seelhead Juvenile and Adult Abundance, Productivity, and Spatial Structure Monitoring. BPA Project # 2010-034-00. Washington Department of Fish and Wildlife, Olympia, WA.

Appendix B. Detailed Results from Snorkel Surveys in the Okanogan Basin, 2004-2012

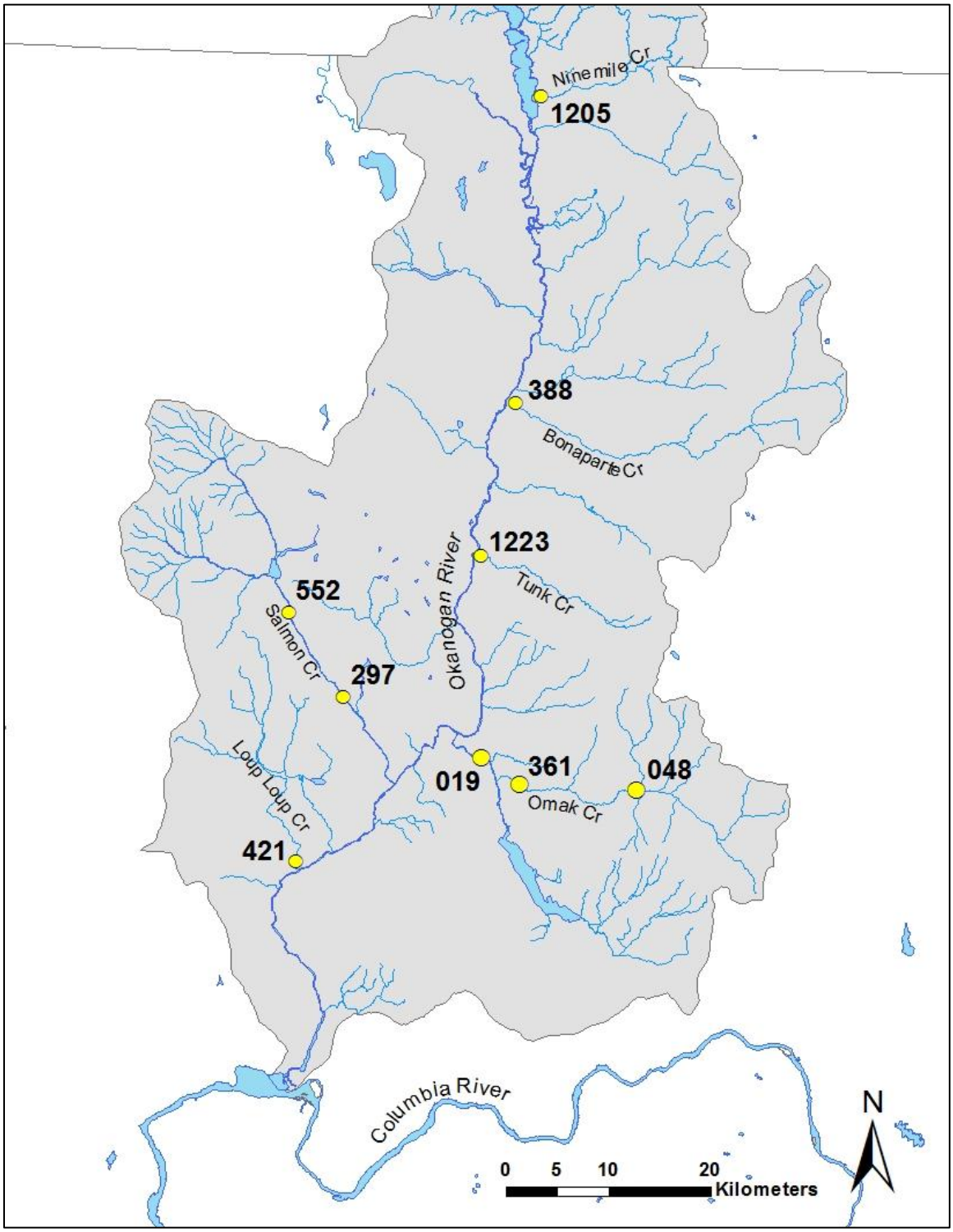

Figure 15. Location of annual snorkel survey sites on small tributaries to the Okanogan River. Rotating panel sites are not shown due to fewer years of data for each site.

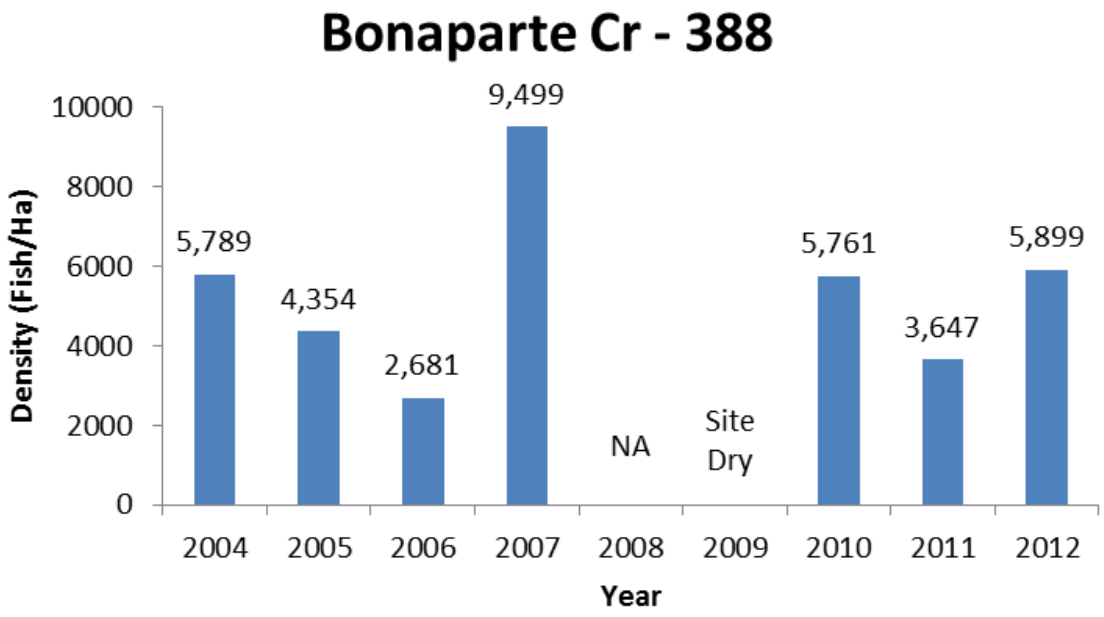

Figure 16. Observed densities of juvenile (<300mm) O. mykiss in Bonaparte Creek in the city of Tonasket, WA.

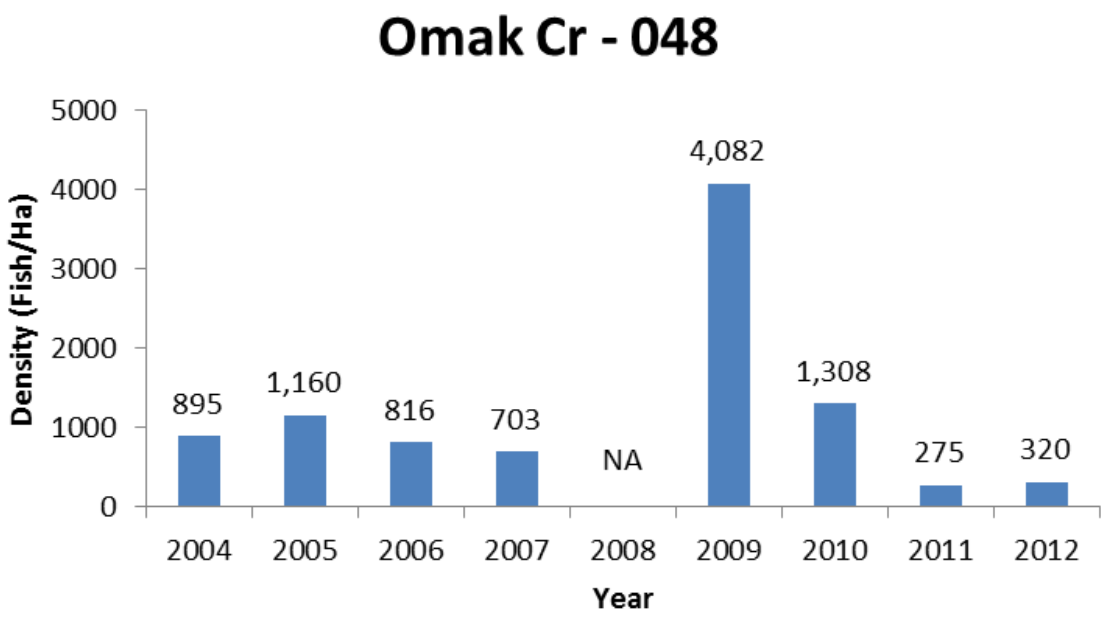

Figure 17. Observed densities of juvenile (<300mm) O. mykiss in Omak Creek, the upper most site in the Omak Creek watershed.

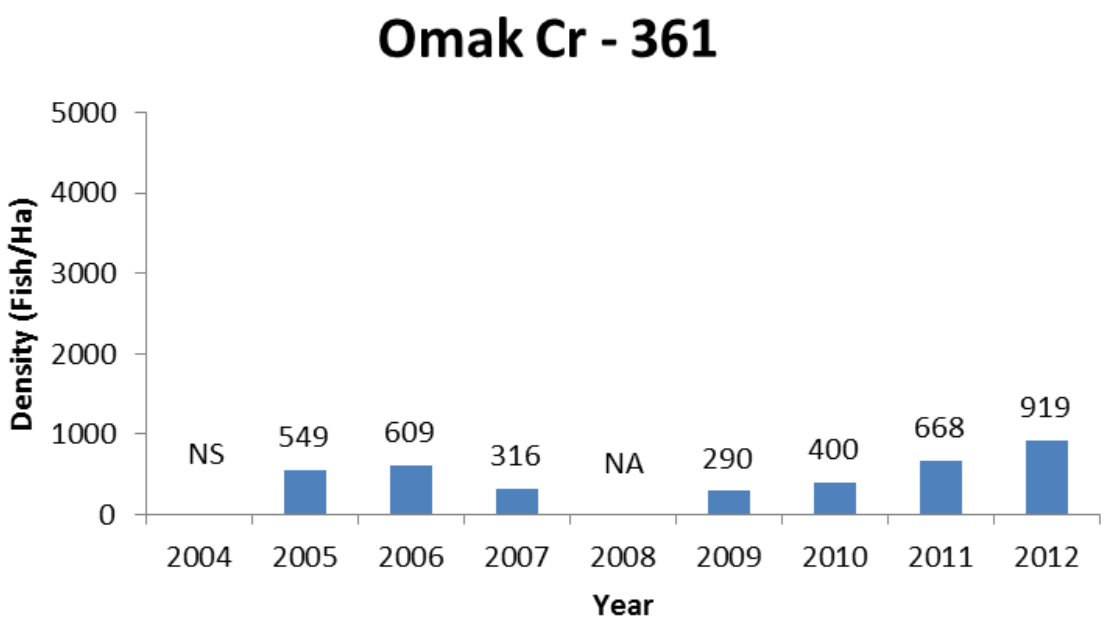

Figure 18. Observed densities of juvenile (<300mm) O. mykiss in Omak Creek, located in the middle portion of the watershed, but above Mission Falls (anadromous barrier).

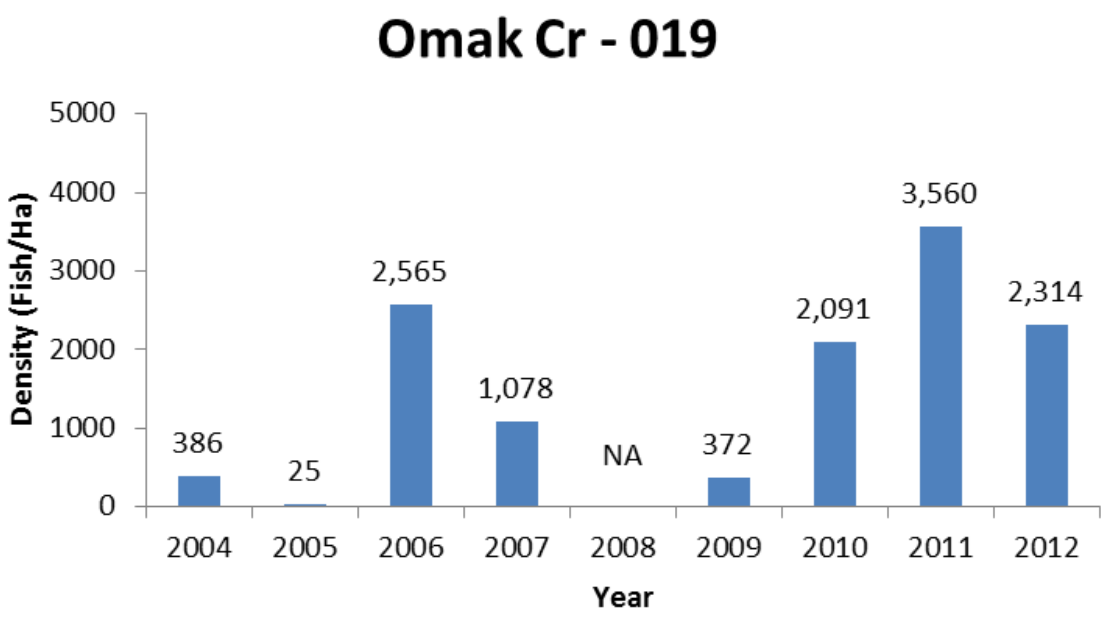

Figure 19. Observed densities of juvenile (<300mm) O. mykiss in Omak Creek, the lower most site on the creek, and the only annual site below Mission Falls.

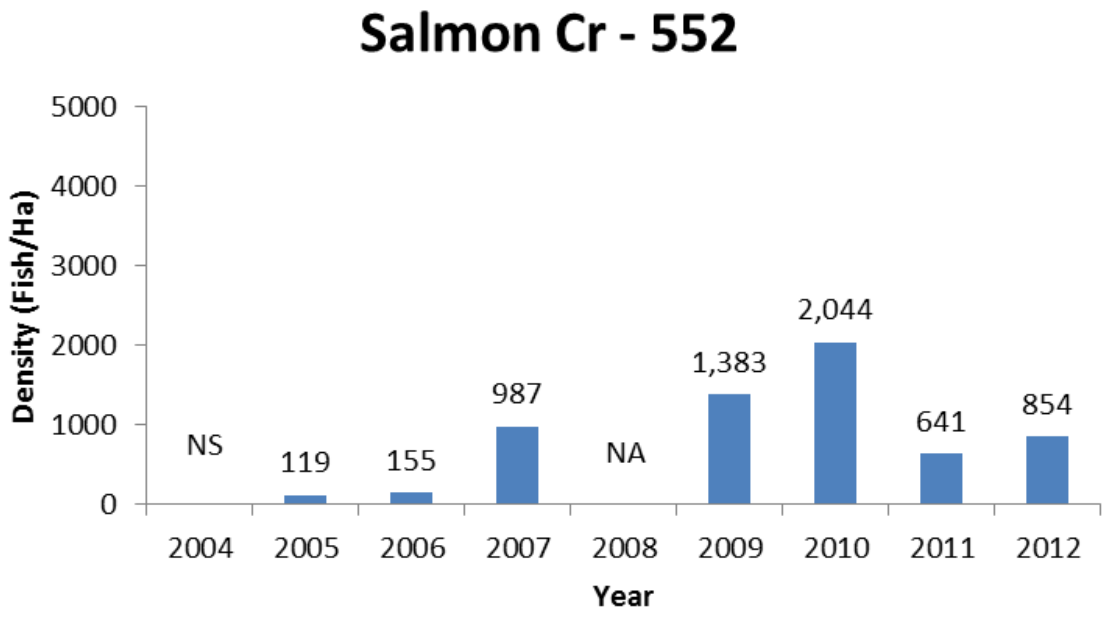

Figure 20. Observed densities of juvenile (<300mm) O. mykiss in Salmon Creek, the upper most annual site on the creek, near the historical townsite of Ruby.

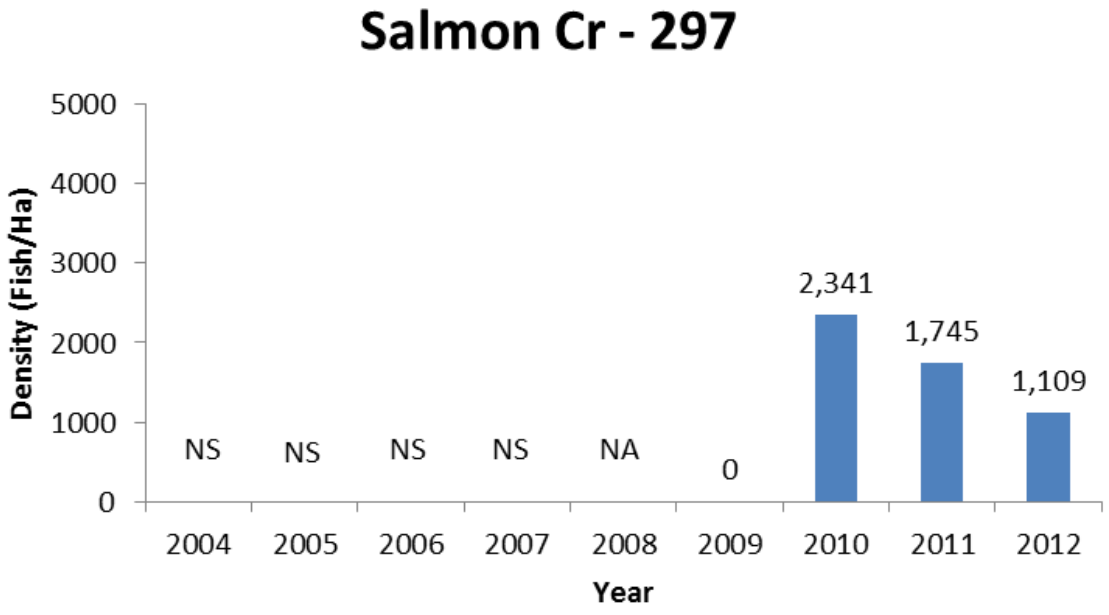

Figure 21. Observed densities of juvenile (<300mm) O. mykiss in Salmon Creek. This site replaced a nearby site (site 360) that was moved in 2009 due to access related issues. Therefore, fewer years of data exist for site 297.

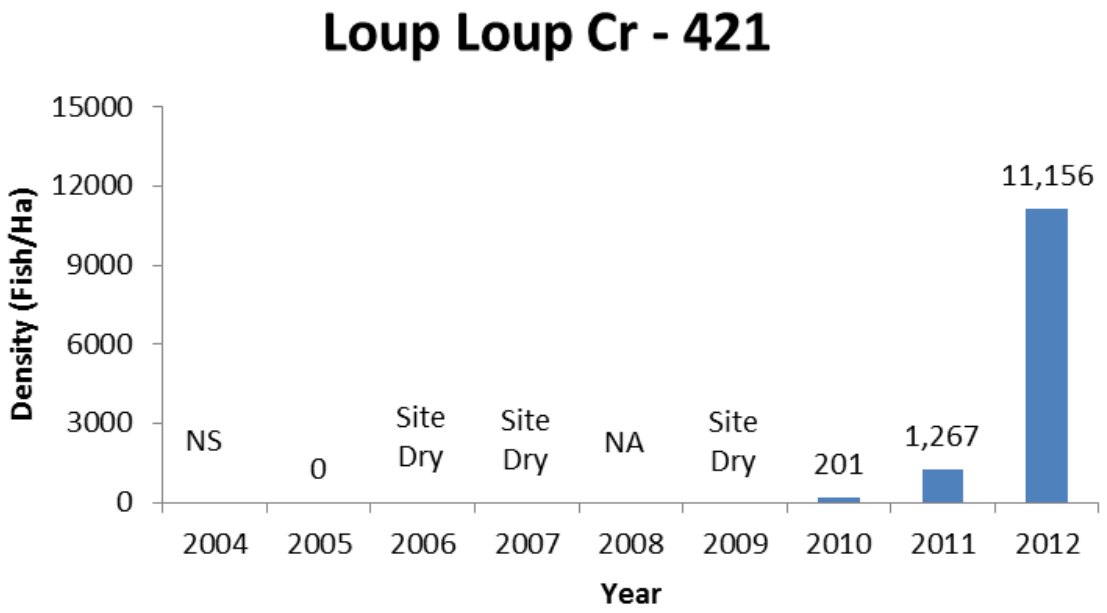

Figure 22. Observed densities of juvenile (<300mm) O. mykiss in Loup Loup Creek, in the town of Malott, WA.

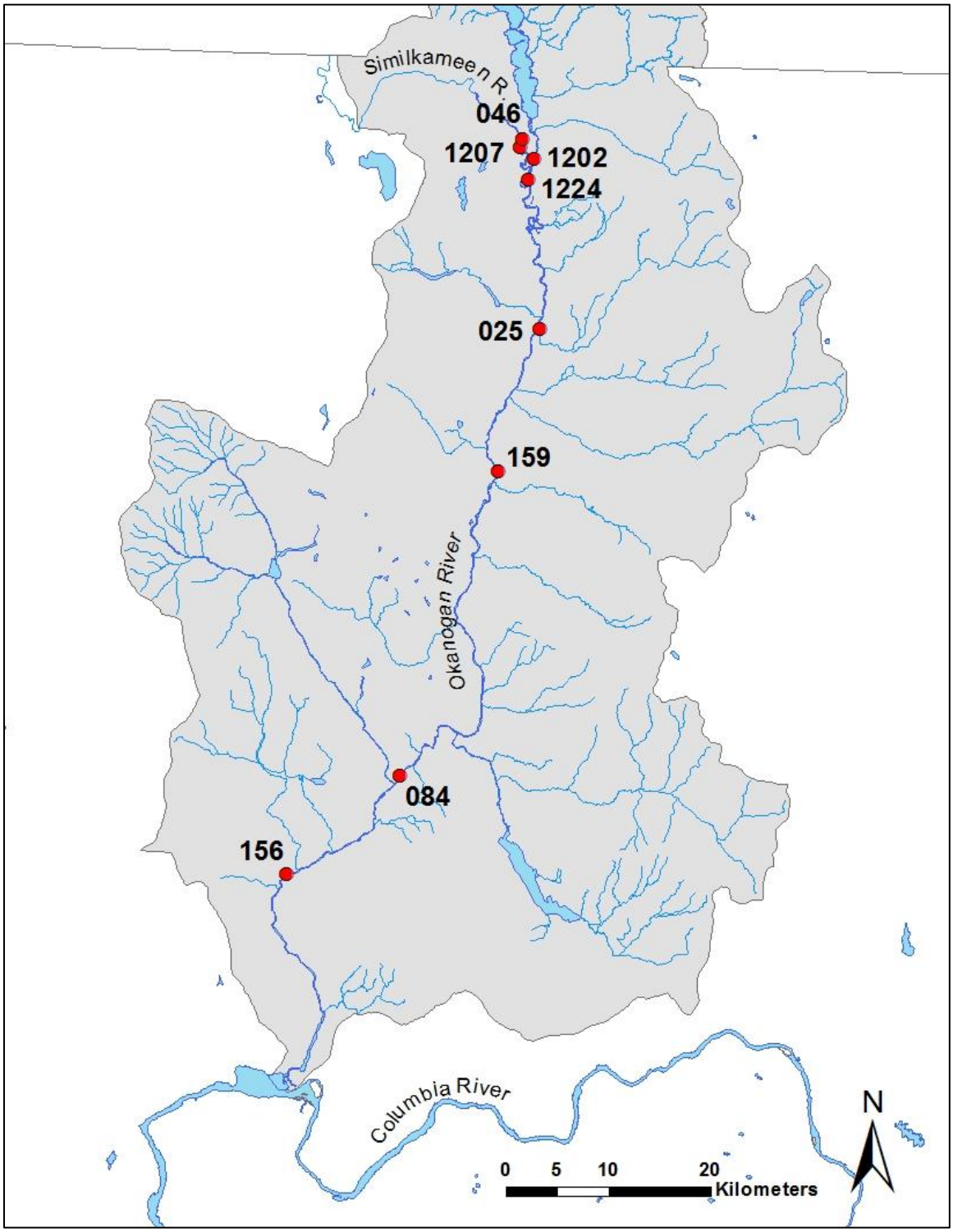

Figure 23. Location of annual snorkel survey sites on the mainstem Okanogan and Similkameen Rivers. Rotating panel sites are not shown due to fewer years of data.

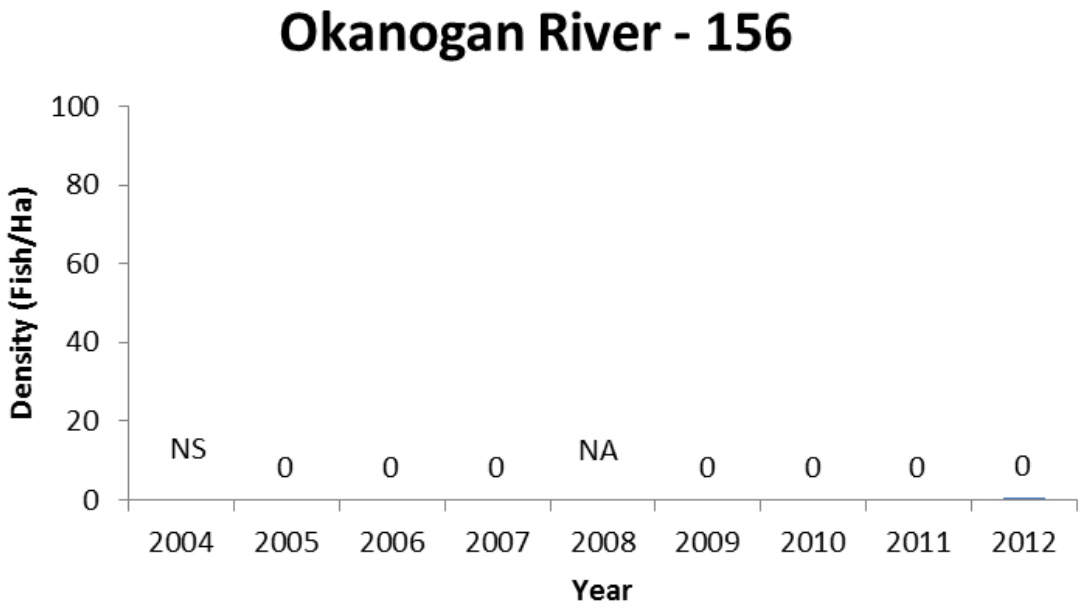

Figure 24. Observed densities of juvenile (<300mm) O. mykiss in the Okanogan River, downstream of the confluence with Loup Loup Creek.

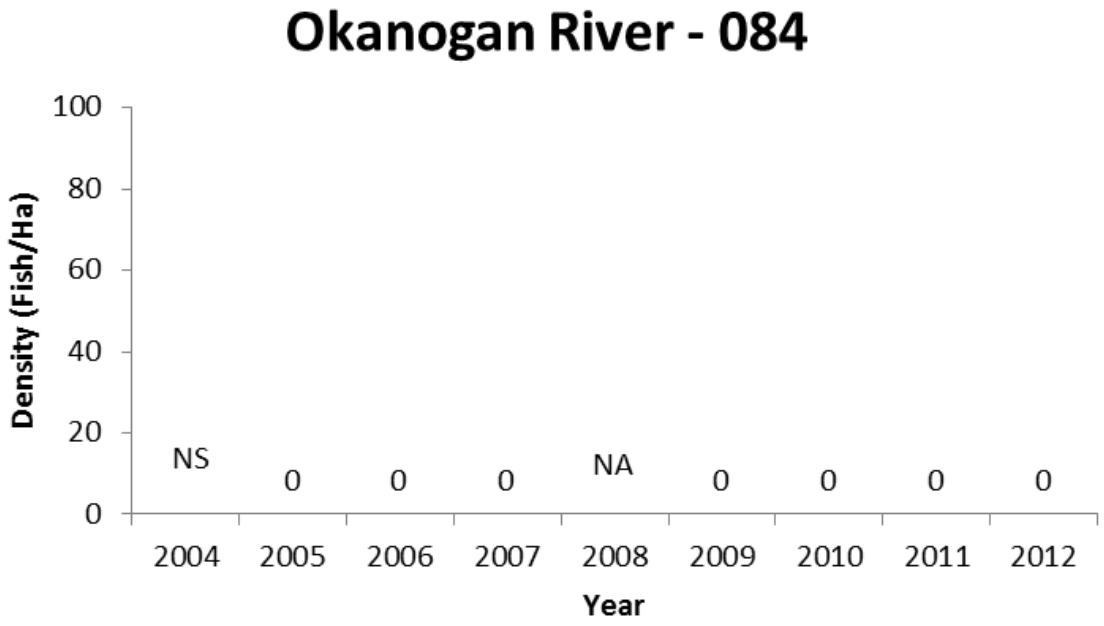

Figure 25. Observed densities of juvenile (<300mm) O. mykiss in the Okanogan River, upstream of the confluence with Salmon Creek.

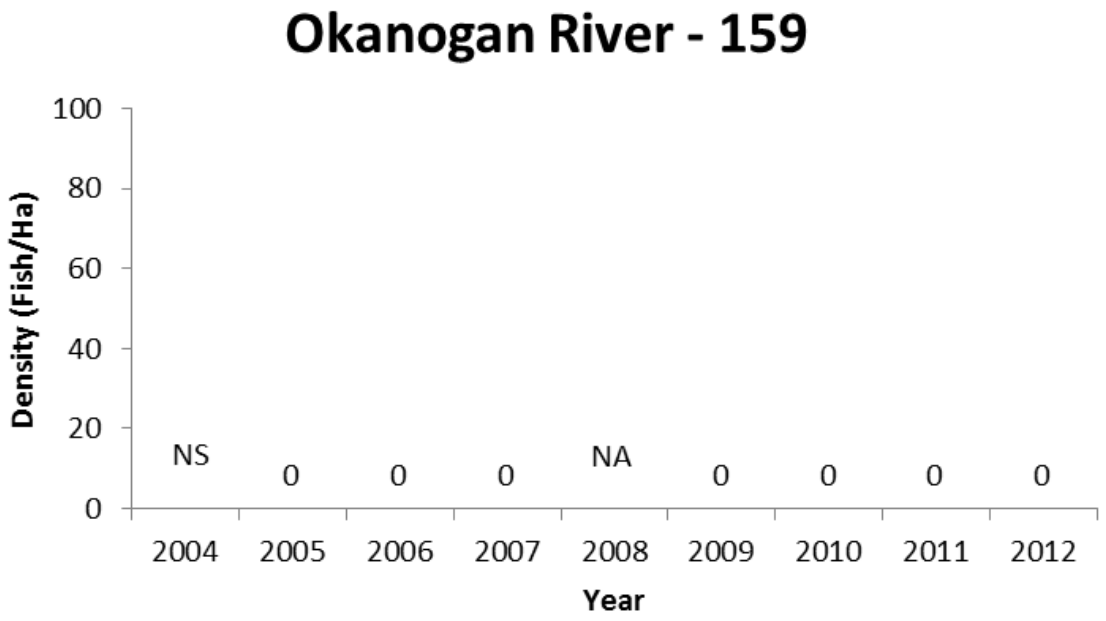

Figure 26. Observed densities of juvenile (<300mm) O. mykiss in the Okanogan River, south of Tonasket, WA, below Janis Bridge.

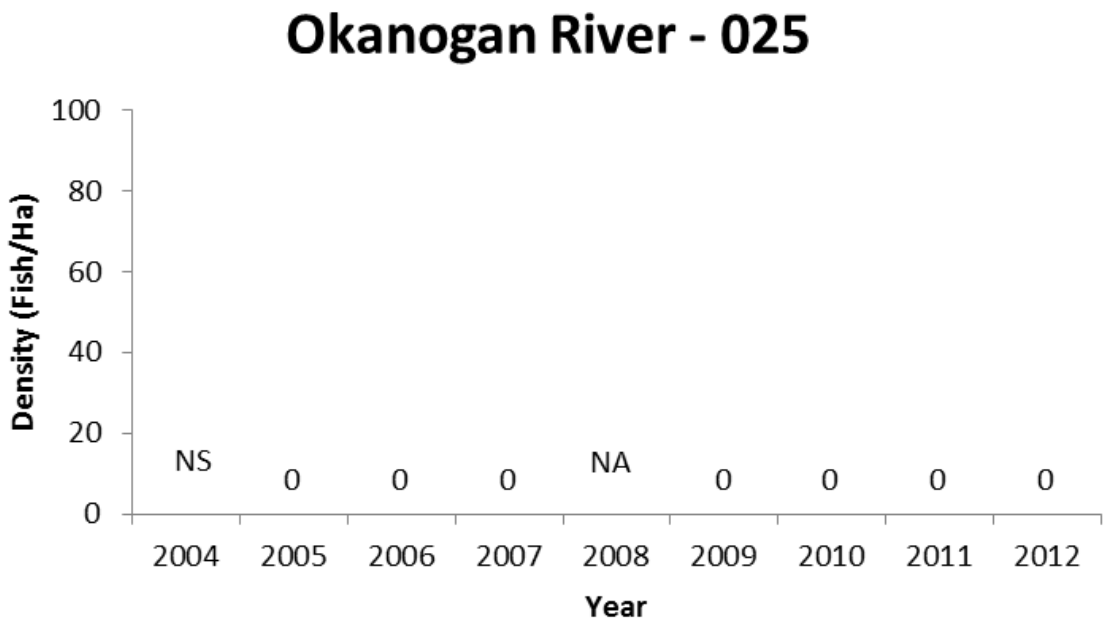

Figure 27. Observed densities of juvenile (<300mm) O. mykiss in the Okanogan River, upstream of the confluence with Antoine Creek.

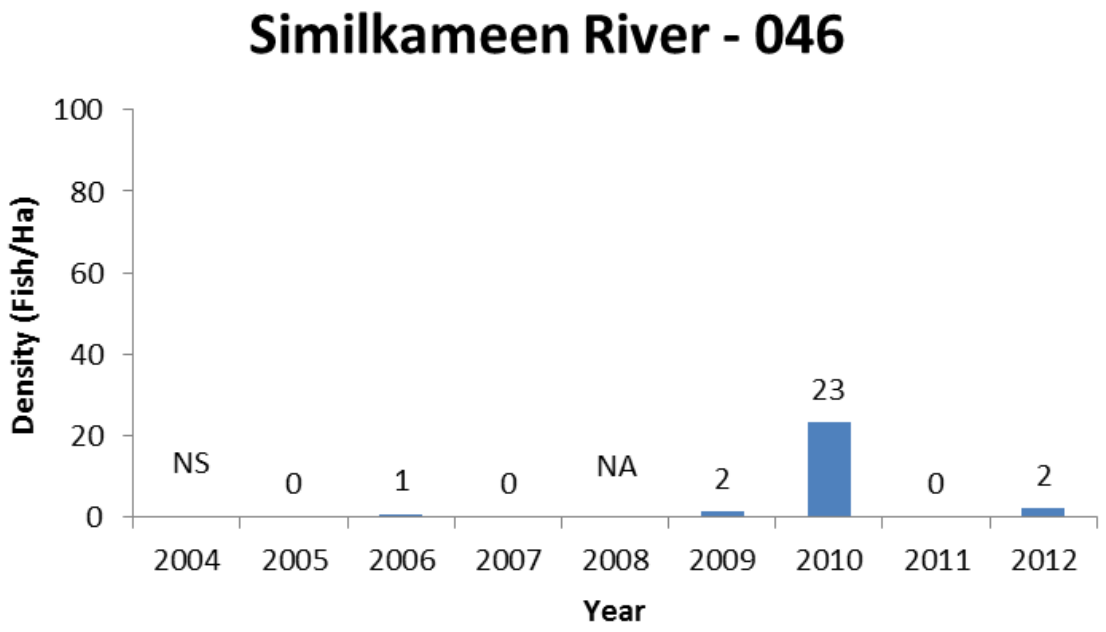

Figure 28. Observed densities of juvenile (<300mm) O. mykiss in the Similkameen River, near the city of Oroville, WA.