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Yakima Steelhead VSP Project

Resident/Anadromous Interactions Monitoring

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1. Executive Summary

a. Fish Population Status Monitoring (RM&E)

This report provides status and trend monitoring for the Upper Yakima steelhead *Oncorhynchus mykiss* population group. An additional focus of the work relates to resident/anadromous interactions studies associated with the Yakima Steelhead Viable Salmonid Population (VSP) Project. The VSP metrics most desired from a status and trend monitoring standpoint of the upper Yakima steelhead population include abundance, productivity, spatial structure, and diversity. We strategically constructed our monitoring infrastructure to support adult and juvenile abundance and productivity data collection. One confounding factor affecting our abundance and productivity monitoring data is the operation and maintenance of our PIT tag interrogation system. We recommend minor equipment reconfiguration and continual troubleshooting to identify and reduce ambient noise, thereby improving the detection capability of our monitoring infrastructure. This will improve our confidence in our adult and juvenile abundance and productivity metrics. One additional complication in estimating these metrics is the uncertainty associated with the interactions between anadromous and resident life history forms. The upper Yakima population consists of a large, robust resident O. mykiss population, and a severely depressed anadromous population in a highly regulated system; a situation that is fairly unique in the Columbia Basin. The spawning interactions between the life history forms suggests that the resident form of *O. mykiss* may have considerable influence on the abundance, productivity, spatial structure, and diversity metrics of the anadromous form. One of our objectives is to attempt to quantify abundance of each form independent of each other, the productivity, spatial structure, and diversity of the anadromous form considering the influence of the resident life history form. These are no small tasks and have been identified as critical uncertainties that need to be addressed in all the major planning and recovery documents for steelhead in the Yakima population group. We recognize that generating robust VSP estimates takes considerable time. For example, NOAA recommends collecting a minimum of 12 years of spawner abundance data to generate robust productivity estimates. Data collection efforts under this project began in 2011 and we acknowledge that we are early in the data collection activities relative to the desired time series of data to generate these metrics. Our preliminary observations to date suggest that anadromous steelhead run escapement in the upper Yakima has generally been increasing in recent years while other Columbia River regions have generally been experiencing population declines. Thus, meeting recovery objectives for this population may be achievable, albeit not in the near future given the current observed rate of increase. While compiling VSP data, we are confident that this project will help identify geographic areas of the upper Yakima that support significant anadromous production, so we can make recommendations for future enhancement and protection.

b. Coordination and Data Management (RM&E)

We hope the results of our work will have far reaching effects. This includes improving our understanding of how sympatric resident and anadromous *O. mykiss* interact to influence the status of the depressed and listed anadromous form. The information collected during this contract have been uploaded to Ptagis (PIT tagging data), and have been presented in public and professional forums (e.g., AFS chapter and divisional meetings; annual Yakima Basin Science and Management Conference). Our data has also been used to help influence the selection of high priority populations for inclusion in high level reports that are either being drafted (e.g., Steelhead at risk report, WDFW unpublished) or that have been published in technical and non-technical forums.

2. Introduction

This report provides status and trend monitoring for the Upper Yakima steelhead population group. An additional focus of the work relates to resident/anadromous interactions studies associated with the Yakima Steelhead Viable Salmonid Population (VSP) Project. The VSP project was established through the Northwest Power Planning Council's fast track process (Skamania Workshops) in May 2010. The project (project # 201003000) is funded under two BPA contracts, one for the Yakama Nation and the other for the Washington Department of Fish and Wildlife (WDFW). The WDFW contract work focuses on the Upper Yakima Steelhead population while the YN contract has a much broader scope (e.g., MPG level). The current report was completed by the Washington Department of Fish and Wildlife in collaboration with the Yakama Nation. All results should be considered preliminary until they are published in the peer reviewed literature.

a. Fish Population Status Monitoring (RM&E)

F&W Program Strategy: 1. Assess the status and trend of natural and hatchery origin abundance of fish populations for various life stages.

F&W Program Management Question: What are the status and trend of abundance of natural and hatchery origin fish populations?

Hatchery steelhead have not been released in the upper Yakima Basin since 1993. These releases were relatively small and experimental in nature. Our status and trend monitoring under this contract is directed at the upper Yakima River wild population. A complete census of the adult brood year return is collected at Roza Dam for each return year. The geometric mean adult return for the Upper Yakima population as of the most recent status assessment was 85 adults. However, recently, there appears to be an increasing trend in annual wild adult return numbers (figure 1).

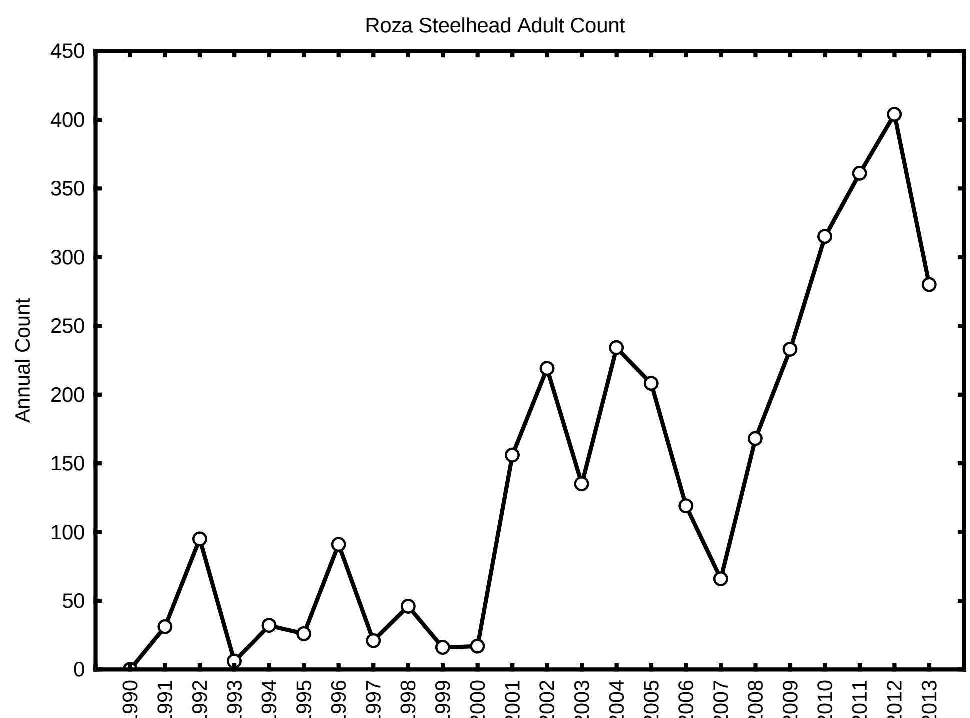

Figure 1. Annual adult summer steelhead return (run escapement) to the Upper Yakima River as enumerated at Roza Dam.

We constructed simple linear models based upon the observed increasing trend in abundance and inherent stochastic variation to estimate the time it would take to reach NOAA's minimum recovery threshold recommendations for the upper Yakima steelhead population (figure 2). The minimum recovery target established for this population is to achieve 500 adults returning above Roza dam for a period of 10 consecutive years. The long term recovery goal is to maintain a run escapement of 1500 returning adults annually. Major assumptions that must be noted using this modeling approach include 1) ocean survival remains within the range observed between 1991and 2013, 2) habitat improvement projects of the same magnitude continue to be completed at approximately the same rate as they have over the period of record (and thus the habitat is not be completely restored prior to reaching recovery goal), 3) incidental harvest in commercial or recreational fisheries remain relatively constant and unchanged, and 4) iteroparous spawning rates remain similar through time. Although unrealistic, if these assumptions were reasonably achieved, the short term recovery goal (500 adults) would not be met until approximately the year 2041. This is likely a conservative estimate because the underlying assumptions are unlikely to be achieved over this time series. This relationship illustrates the need to be pro-active with recovery efforts in the Yakima Basin given the current threatened ESA listing status of Mid-Columbia Steelhead under this Major Population Group (MPG).

One major objective for the data collected under this work is to provide status and trend monitoring data for the upper Yakima steelhead population that is currently listed as threatened under the ESA. Our data collection activities are documenting progress towards meeting the documented recovery goals. Until recovery targets are met, we contend this project will be necessary to monitor the VSP metrics for the upper Yakima steelhead population until they are delisted and there is no obligation to report their population status or monitor the trends in their VSP metrics. The timeline to completion for these data collection activities is therefore, dependent upon the progress the population makes towards meeting recovery targets and could take a substantial amount of time (Figure 1).

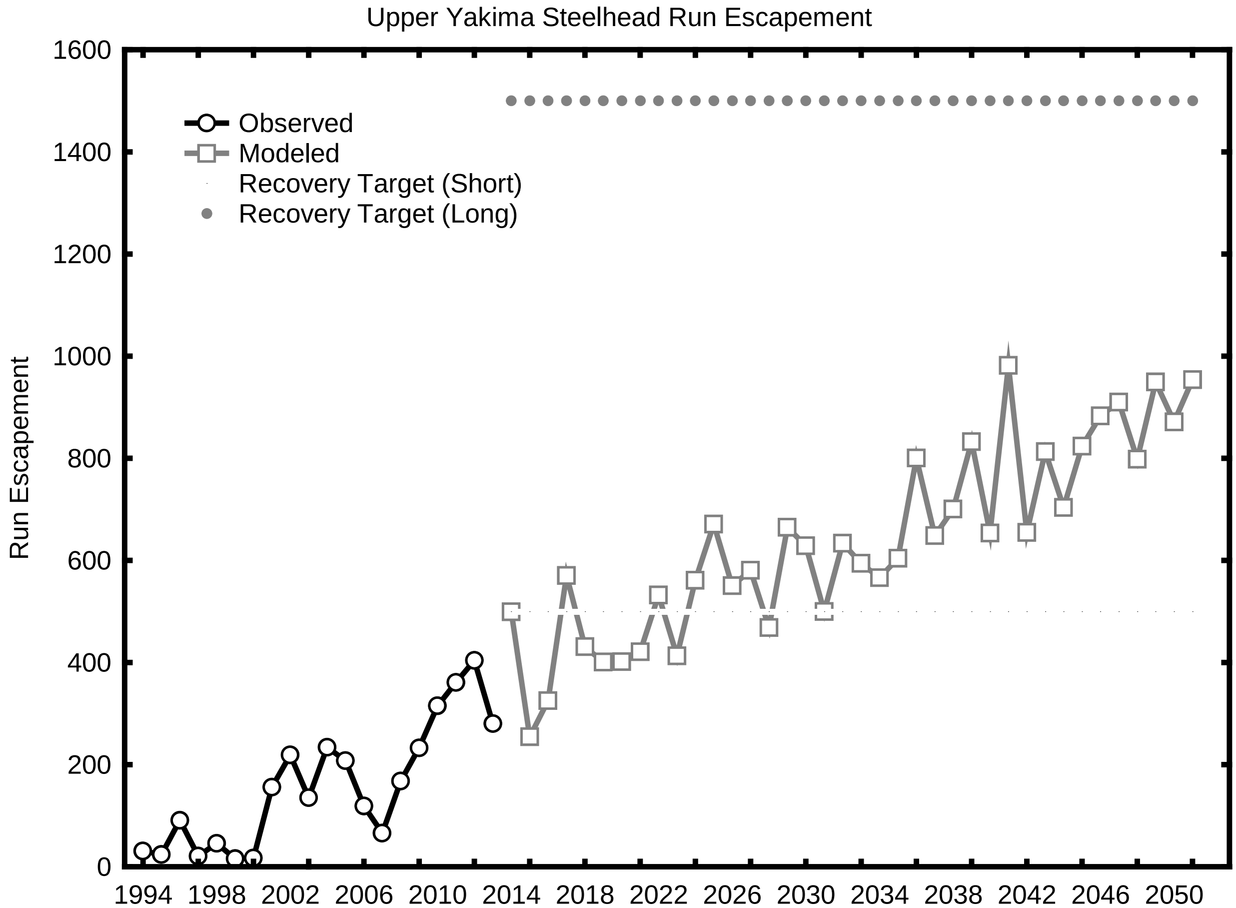

Figure 2. Observed and modeled annual summer steelhead run escapement into the Upper Yakima. The short term and long term recovery targets are presented as dashed lines.

One of our objectives in monitoring steelhead status and trends in population abundance is to use our PIT tag infrastructure to determine the spatial distribution and abundance of adult steelhead spawners and to make relative comparisons of anadromous smolt production from them. For adult spawner abundance in the upper Yakima, detections of Radio Tagged adults (that are also PIT tagged) at our PIT tag arrays are compared to the radio-telemetry mobile tracking detections that are conducted routinely to determine the detection rate of the PIT tagged individuals at the fixed monitoring sites. Fish that were known to have spawned in multiple streams were used to calculate array detection efficiencies for every interrogation site they were known to have passed. The tributary adult spawner abundance estimate was generated for each tributary by inflating the PIT tag detections upstream from each PIT tag array by the detection efficiency estimated at each array (from detections of radio tagged steelhead; Table 1). The annual run of adult steelhead migrating upstream from Roza Dam was estimated to be 287 fish during the 2013 migration. Using our detection efficiencies, we estimate 61% of the upper Yakima adults used the tributaries currently monitored. The remaining 39% of the population were presumed to have been a combination of Main stem Yakima river and unmonitored upper Yakima tributary spawners.

Table 1. Detections of adult steelhead that are double tagged (PIT tagged and Radio Tagged) and the adult detection efficiencies estimated during the spring spawning migration in 2013 in each tributary in the Upper Yakima that has an in stream PIT tag detection array.

Stream	Radio tag detections	Radio and Pit tag detections	Detection efficiency	Pit tag Detections (n)	Expanded Estimate	Percent of total run
Swauk Creek	4	3	75%	47	59	20.6%
Taneum Creek	4	4	100%	37	37	12.9%
Main stem Teanaway River	8	5	63%	16	22	7.7%
North Fork Teanaway	4	4	100%	37	37	12.9%
Upper Main stem Teanaway River (West and Middle Fork)	4	4	100%	20	20	7.0%
All monitored tributaries	24	20	83%	157	175	61.0%

Making comparisons of migrant production across tributary streams requires some measure of in stream PIT tag retention rates, tag induced mortality rates, and detection efficiency of the migrants. In 2013, we estimated PIT tag retention rates using a dual tagging procedure in Manastash Creek, WA. Briefly, rainbow trout that were captured under our routine sampling were PIT tagged, and in addition, were tagged with a Coded Wire Tag (CWT) in the dorsal skin tissue. Fish were released near their point of capture following the tagging procedure. We then resampled the same locations 24 hours, 48 hours, and 2 weeks later and enumerated the number of fish containing a CWT only and those containing both a CWT and PIT tag. PIT tag loss over 24h, 48h, and 2weeks was estimated as the number of fish containing only a CWT divided by the number of fish that were double tagged. Long term tag induced mortality has not yet been estimated directly, however, we are currently developing a tag mortality study proposal to estimate it. While the detection efficiency of adult steelhead at our in stream arrays was generally high, our detection efficiency of juvenile migrants appears generally low (where we have adequate samples to evaluate it). Low juvenile detection efficiency is likely due to the limitations of the equipment under the influence of the environmental conditions we observe during the major detection period (spring runoff). Equipment limitations include the orientation of the antenna in the stream bed. We installed our in stream antennas in a “swim over” design. This design allowed us to anchor the antennas to the stream bed, making them less likely to become damaged by debris during high water events. On the other hand, detection efficiency for juvenile migrants is generally lower than installation in a pass though hoop type design. Significant spring smolt migrations often occur during large water runoff events when there is increased velocity and overall increased volume of water in the stream channel. These events can decrease detection efficiency simply because of the increased potential migration pathways and increased stream velocity coupled with decreased proximity of migrants to the detection antennas.

We indexed our detection efficiency for juvenile migrants at our North Fork Teanaway River interrogation site by using spring Chinook salmon releases from the Jack Creek Acclimation facility located upstream from this PIT tag Array. Approximately 30% of the Cle Elum Spring Chinook Supplementation Program’s PIT tagged Smolts are acclimated and released from this facility. This event take place annually on approximately March 15, the facility opens its raceways so spring Chinook smolts are allowed to volitionally migrate from the acclimation facility. The number of tags detected at our Lower Main stem Teanaway interrogation site are enumerated daily and compared to the number also detected at the North Fork Teanaway site located upstream. The ratio NFT detections/LMT detections was assumed to be our detection efficiency at the upper site. We calculated the detection efficiency on a daily time step during the migration window to eliminate large variation that could result in differences in environmental conditions over larger time lags. It was our observation that actively migrating smolts released from the acclimation facility moved through the Teanaway system and were detected at both arrays over a short time interval (approximately 8.5 hours).

Status and Trend Monitoring

F&W Program Strategy: 3. Assess the status and trend of juvenile abundance and productivity of natural origin fish populations.

F&W Program Management Question: What are the status and trend of juvenile abundance and productivity of fish populations?

Juvenile monitoring of upper Yakima River steelhead is complicated by the large degree of overlap in life history forms during the rearing period. Combined resident and anadromous rearing *O. mykiss* abundance estimates are generated in index monitoring sites annually. One objective of this project is to estimate productivity of each of the life history forms independent from one another. Because there is a high degree of overlap between the life histories during the rearing period, this analysis can only be completed after the spring smolt migration window when known anadromous fish are positively identified as migrants and the population abundance estimates from the year prior can be partitioned by life histories (Figure 3).

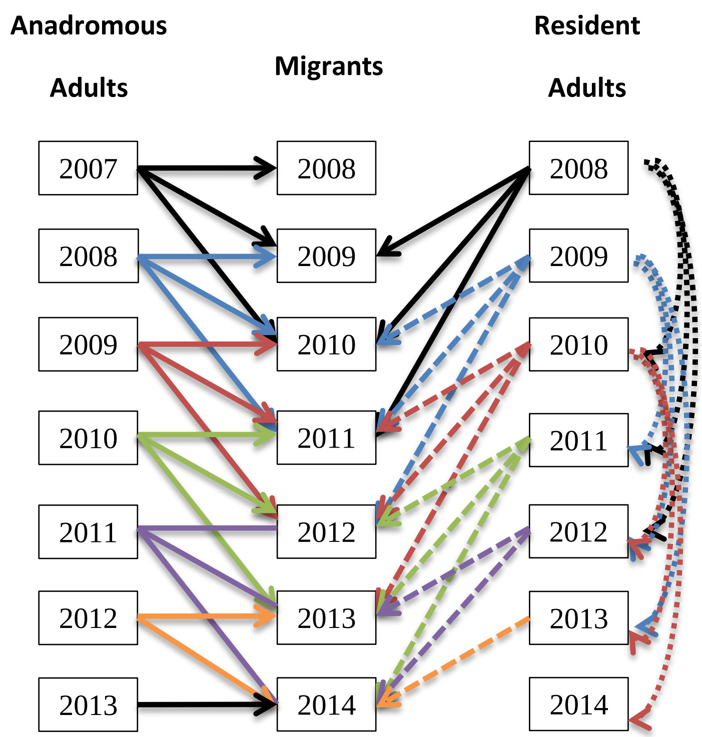

Figure 3. Diagram of potential migrant production from anadromous and resident adult spawners for a sample of brood years. Adult spawners in the spring produce 1 year old migrants the following spring, 2 year old migrants 2 years in the future, and so forth. Four year old migrants are not included although they have been observed, but generally in very small numbers.

This evaluation is further complicated by the fact that there is a high degree of overlap in the length at age of fish in the upper Yakima Basin. Partitioning the abundance estimates into juvenile and resident adult components requires information on the age structure of the population. We use the mixed distribution algorithms proposed by Du (2002) to partition the length frequency distributions of the fish sampled to estimate the age structure of the population in each stream sampled. We included constraints to the model fitting procedure by incorporating the scale/age data acquired from a subsample of fish in each stream. The proportions of fish at age sampled during this contract period are presented in Table 2.

Table 2. Estimated proportions of fish at age for Yakima River Tributaries including Big Creek (BIG), the Cle Elum River (CLE), Little Creek (LITT), Manastash Creek (MAN), Middle Fork Teanaway River (MFT), Main stem Teanaway River (MST), North Fork Teanaway River (NFT), Rattlesnake Creek (RATT), Swauk Creek (SWK), Taneum Creek (TAN), the Tieton River (TIET), Umtanum reek (UMT), Wenas Creek (WEN), the West Fork Teanaway River, and Main Stem Yakima River sampling sections including the Lower and Upper Canyon sections (LCYN and UCYN respectively), Ellensburg (EBURG), Thorp (THORP) and Cle Elum (CELUM) sections.

Stream	Age0	Age1	Age2	Age3	Age4
			Tributaries		
BIG	0.0	0.3	0.7	0.0	0.0
CLE	0.0	0.6	0.4	0.0	0.0
LITT	0.0	0.0	0.7	0.3	0.0
MAN	0.0	0.3	0.6	0.1	0.0
MFT	0.0	0.7	0.3	0.0	0.0
MST	0.4	0.6	0.0	0.0	0.0
NFT	0.0	0.7	0.3	0.0	0.0
RATT	0.0	1.0	0.0	0.0	0.0
SWK	0.0	0.9	0.1	0.0	0.0
TAN	0.1	0.7	0.2	0.0	0.0
TIET	1.0	0.0	0.0	0.0	0.0
UMT	0.0	0.7	0.3	0.0	0.0
WEN	0.4	0.6	0.0	0.0	0.0
WFT	0.0	0.7	0.3	0.0	0.0
			Main stem Yakima River		
LCYN	0	0.74	0.21	0.03	0.02
UCYN	0	0.83	0.13	0.04	0
EBURG	0	0.74	0.21	0.02	0.02
THORP	0	0.72	0.17	0.07	0.05
CELUM	0	0.49	0.35	0.03	0.12

The population abundance of *O. mykiss* is highly variable from year to year in Yakima River tributary streams (Figure 4). However, we still detected significant trends in the population abundance through time. The slope of the best fit trend lines were used to determine if the *O. mykiss* population in each stream is increasing, decreasing, or remaining stable. All 5 of the core long term monitoring streams have abundance trajectories with positive slopes, three of which are significant, and one that is nearly so (Swauk Creek, P = 0.0001; Middle Fork Teanaway River P = 0.01; West Fork Teanaway River P = 0.0005; and North Fork Teanaway River P = 0.06). The Taneum Creek *O. mykiss* population abundance is also highly variable, yet the trend remains fairly consistent across years. The migrant production in 2013 did not appear dependent with the overall O. mykiss abundance in each stream in the same year.

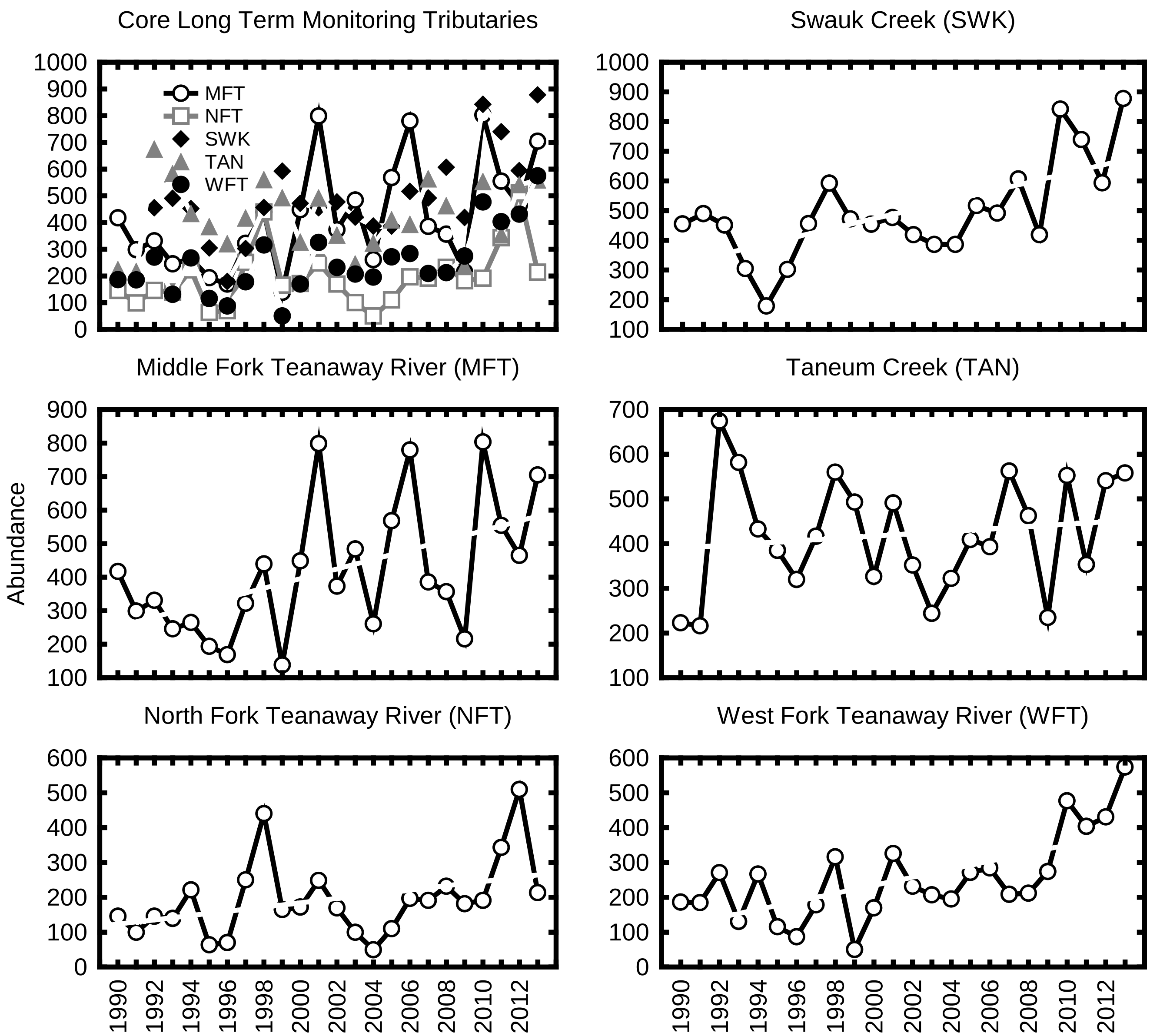

Figure 4. Annual population abundance of *O. mykiss* in core upper Yakima tributary streams. The dashed lines in the individual stream panels represents the best fit trend line.

Insert Applicable RM&E Types e.g. Status and Trends

F&W Program Strategy: 4. Assess the status and trend of spatial distribution of fish populations.

F&W Program Management Question: What are the status and trend of spatial distribution of fish populations?

The spatial distribution of *O. mykiss* in the upper Yakima basin are reported under routine monitoring under the Yakima/Klickitat Fisheries Project (YKFP; 199506325). Utilization (spatial distribution) in tributary streams is monitored via long term 200m long index monitoring sites following electrofishing protocols (Temple and Pearsons 2007). Under the monitoring prescriptions for *O. mykiss* established under the YKFP, tributaries are considered utilized when a minimum of 2 or more individuals occupy the site. When these minimum utilization criteria are met, the spatial distribution is extrapolated to the stream scale based upon the area the site represents. We began baseline data collection activities in 1990 and have a robust dataset for monitoring trends in spatial distribution. Our monitoring to date suggests *O. mykiss* spatial distribution remains stable in the Upper Yakima and substantial change in utilization trends has not been detected.

Spatial distribution in terms of NOAA's recommendations (e.g., spawner distribution; Crawford and Rumsey 2009) is not calculated for the Upper Yakima because we do not collect spawning information for the large resident population or for steelhead adults. This is due to low adult counts and the large geographical area encompassing potential spawning locations (i.e., needle in haystack).

Insert Applicable RM&E Types e.g. Status and Trends

F&W Program Strategy: 5. Assess the status and trend of diversity of natural and hatchery origin fish populations.

F&W Program Management Question: What are the status and trend of diversity of natural and hatchery origin fish populations?

We report only the status and trend in diversity metrics for naturally produced *O. mykiss* because as previously noted, the upper Yakima is composed only of wild fish, and straying of hatchery origin fish into the Upper Yakima is generally very low. Because of the enormous variability of *O. mykiss* diversity metrics, observed change within these variables may reflect natural variation, rather than change in the diversity metrics. For instance, recent work suggests that *O. mykiss* can spawn during any month of the year in different locals, and that appears to be driven in large part by environmental factors (Bill McMillan, Personal Communication). Thus substantial change in spawn timing may actually reflect the species true plasticity and natural variation for this diversity metric. Detecting small significant changes to highly variable metrics is a difficult task, and generally result in statistical tests with low power (Ham and Pearsons 2000). Other diversity metrics currently monitored include adult spawn timing and distribution of anadromous fish that are radio tagged, age structure of returning anadromous adults, age structure of tributary rearing fish, and sex ratios of adults sampled at Roza Dam (collected via ultrasound). Finally, we address the long term diversity monitoring strategy (Crawford and Rumsey 2009) by collecting genetic tissue samples on adult steelhead returning to Roza dam. In addition, genetic samples have been collected and processed intermittently (e.g., prior to this project) for *O. mykiss* in the upper Yakima Basin providing long term genotypic trend monitoring information for the rearing population (e.g., Campton and Johnston 1985). Finally, we have processed the adult genetic baseline for brood year run escapement dating back to 2007 under the first year of this project.

Insert Applicable RM&E Types e.g. Status and Trends

b. Coordination and Data Management (RM&E)

F&W Program Strategy: Work with regional federal, state and tribal agencies, and non-governmental entities to establish a coordinated, standardized, web-based distributed information network and a regional information management strategy for water, fish, and habitat data. Establish necessary administrative agreements to collaboratively implement and maintain the network and strategy.

F&W Program Management Question:

How has your work supported exchange and dissemination of fish and wildlife data or the development of a database to manage data that may shared regionally, relative to the RM&E data management strategies roadmap?

1. Identification of Management Questions and Strategies
    a. This work is currently being used to inform the Washington Department of Fish and Wildlife draft steelhead at risk report. The information generated under this contract was used to support selection of the Upper Yakima as one of the focal populations for the steelhead at risk report. One of the goals of the report is to identify key threats to the population and key near and long term actions to remedy them.
2. Documentation of Protocols
    a. The methods and protocols used in data collection activities have been previously published in the AFS Salmonid Field Protocols Handbook (2007) and also uploaded as "published" methods in MonotoringMethods.org.
3. Data Collection and Generation
    a. Executing the field sampling activities during this contract period has generated a significant amount of data, both in the raw form, as well as digital data (e.g., PIT tag detections of adult and juvenile migrants).
4. Data Entry
    a. Field data collected in the field in raw or hardcopy format has been entered and stored in digital format during this contract period.
5. Agency Data Storage
    a. The digital data saved during this contract has been appended to our databases. The databases are housed on local PC's, as well as backed up on our local server. Our local server is backed up to our secured server housed in Olympia, WA, nightly.
6. Regional Sharing
    a. Much of the data generated under this contract was routinely uploaded to regional databases (e.g. PTAGIS) where it is publicly accessible.
7. Reporting
    a. The data collected under this contract is summarized in annual reports submitted as deliverables under the annual reporting requirements of the contract. The summarized information is also presented to professional audiences at American Fisheries Society Chapter, Divisional, and National Levels when appropriate, and to combined professional and non-technical audiences at the Yakima Basin Science and Management Conference held annually (generally at Central Washington University).

Insert Applicable RM&E Types e.g. Status and Trends

Location details: For each F&W Program Strategy above, insert maps, aerial photos, or pictures of where your work was conducted. Below are links to existing project or contract map options created in cbfish.org or insert your own.

Project Map:

http://www.cbfish.org/Project.mvc/Map/2010-030-00

Contract Map(s):

http://www.cbfish.org/Contract.mvc/Map/59895

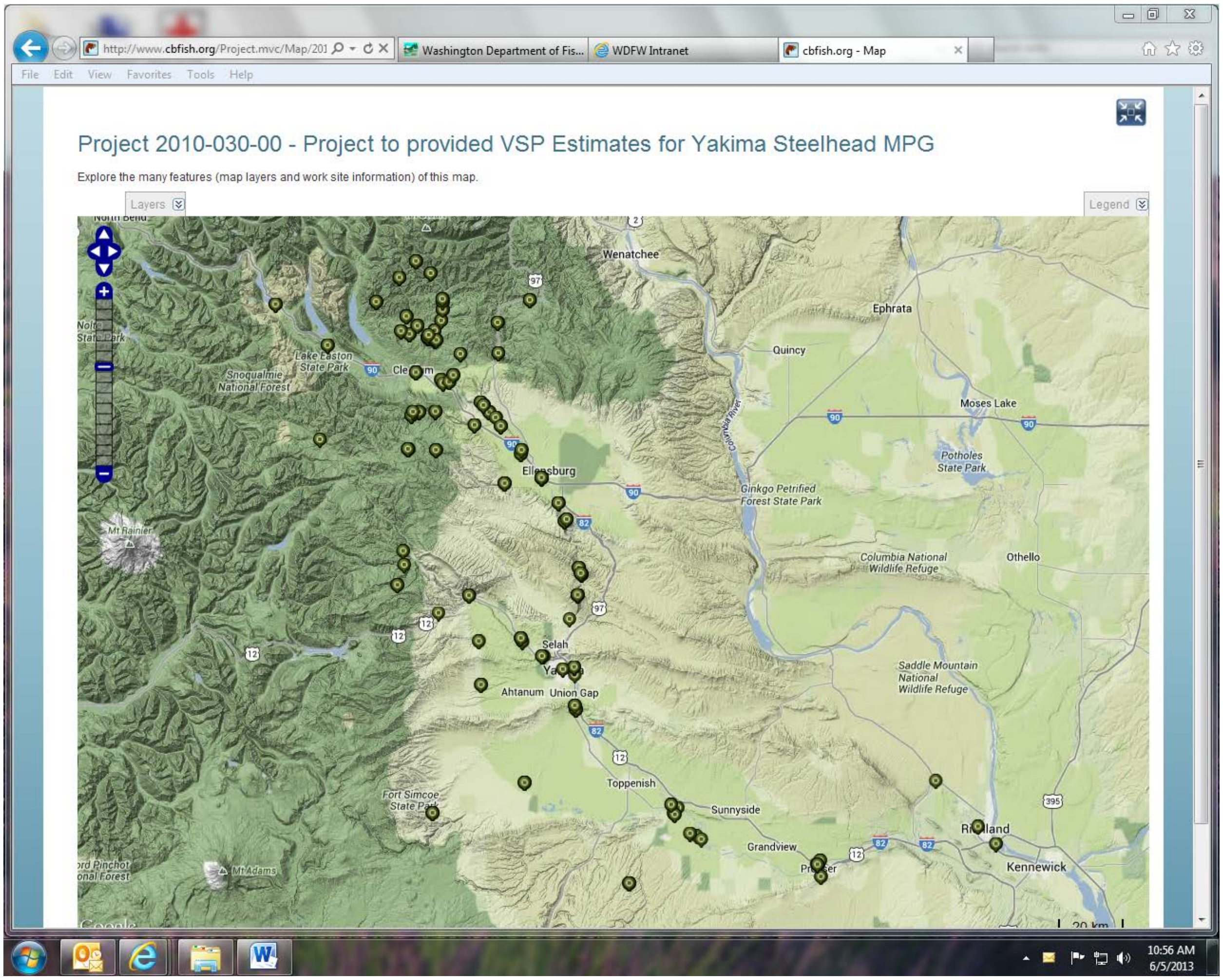

Figure 5. Map of sampling locations associated with the Yakima Steelhead VSP project.

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

Protocol Title: Resident/Anadromous (2010-030-00) v1.0

Annual abundance estimates of *O. mykiss* (combined life histories) are generated in tributary streams using mark-recapture methods following Temple and Pearsons (2007; http://www.monitoringmethods.org/Method/Details/118 and http://www.monitoringmethods.org/Method/Details/119). In larger stream reaches, a drift boat mounted electrofisher is used to conduct mark-recapture sampling (http://www.monitoringmethods.org/Method/Details/120 and http://www.monitoringmethods.org/Method/Details/121). The abundance estimates are partitioned into anadromous and resident components by determining the proportion of the population that is detected at downstream locations subsequent to the sampling. Downstream detections of juvenile migrants are obtained from regional PIT tag databases (e.g., Ptagis). Finally, we assign juveniles to their cohort based upon age assignments from reading scales (http://monitoringmethods.org/Method/Details/1120). The cohort tracking will allow us to determine anadromous production from various geographic areas in the upper Yakima after accounting for anadromous spawner input into those areas.

4. Results

a. Fish Population Status Monitoring (RM&E)

PIT tag Juvenile *O. Mykiss* in select locations

The target number of tags were successfully deployed during this contract period (10,000 in the upper Yakima, 4000 in the Naches sub-basin), however, tags allocated to the main stem Yakima River upstream from Easton Dam were re-allocated to other areas due to the low abundance of *O. mykiss* observed in this area (Figure 6).

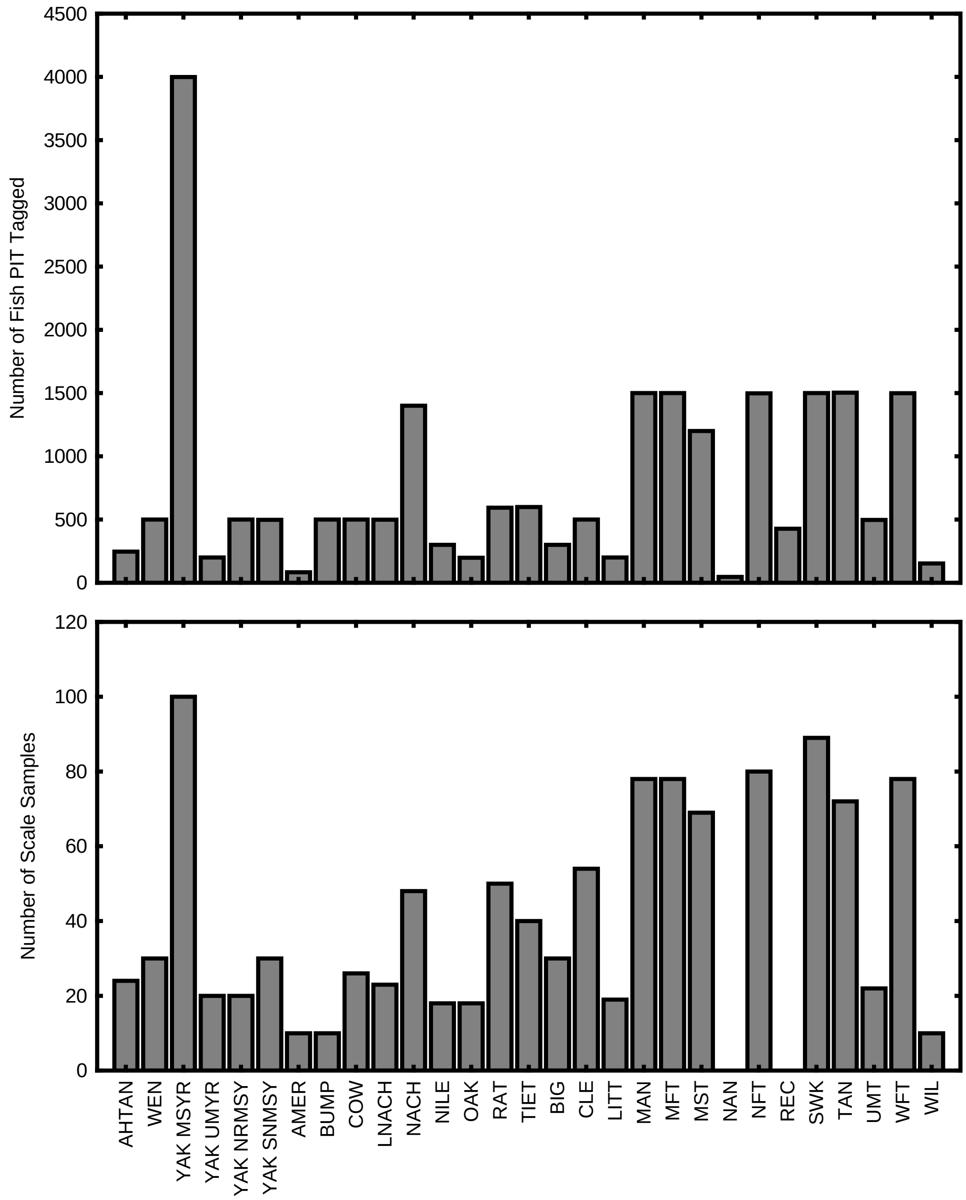

Figure 6. Number of *O. mykiss* PIT tagged and scale sampled collected during this contract period. Stream abbreviations include the AHTAN (Ahtanum Creek), AMER (American River), BIG (Big Creek), BUMP (Bumping River), CLE (Cle Elum River), COW (Cowichee Creek), LITT (Little Creek), LNACH (Little Naches River), MAN (Manastash Creek), MFT (Middle Fork Teanaway River), MST (Mainstem Teanaway River), NACH (Naches River), NAN (Naneum Creek), NFT (North Fork Teanaway River), NILE (Nile Creek), OAK (Oak Creek), RAT (Rattlesnake Creek), REC (Reecer Creek), SWK (Swauk Creek), TAN (Taneum Creek), TIET (Tieton River), UMT (Umtanum Creek), WEN (Wenas Creek), WFT (West Fork Teanaway River), WIL (Wilson Creek), YAK MSYR (Yakima River, Roza-Easton reach), YAK UMYR (Yakima River, Upstream from Easton), YAK NRMSY (Yakima River, Naches River confluence-Roza Dam), and YAK SNMSY (Yakima River, Sunnyside diversion- Naches River confluence).

The rearing abundance of *O. mykiss* (combined resident and anadromous life histories) were generated in tributaries to the upper Yakima as well as in the larger main-stem Yakima. Abundance estimates were generated under a separate project (199506325) and were lagged 1 year. Abundance was expressed as fish/km (Figure 7) and was partitioned into life history components using the proportion of the migrants detected during the spring smolt migration period (e.g. during this contract cycle). Each group of O. mykiss tagged in each calendar year that were subsequently detected during the smolt outmigration period 1, 2, and 3 years following the 2011 tagging event are presented in Figure 8. The 2011 tag group is the first group that we can account for the majority of all the potential migrants (migrants in 2011, 2012 and 2013).

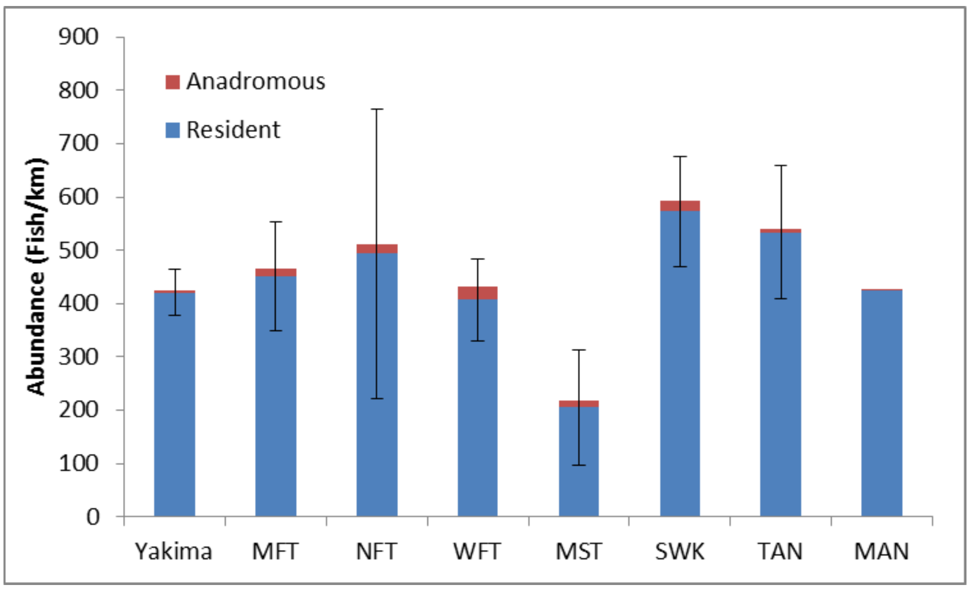

Figure 7. *O. mykiss* abundance estimates generated in 2012 partitioned by life history type using the migrant detections in 2013 for Yakima main stem and tributary areas.

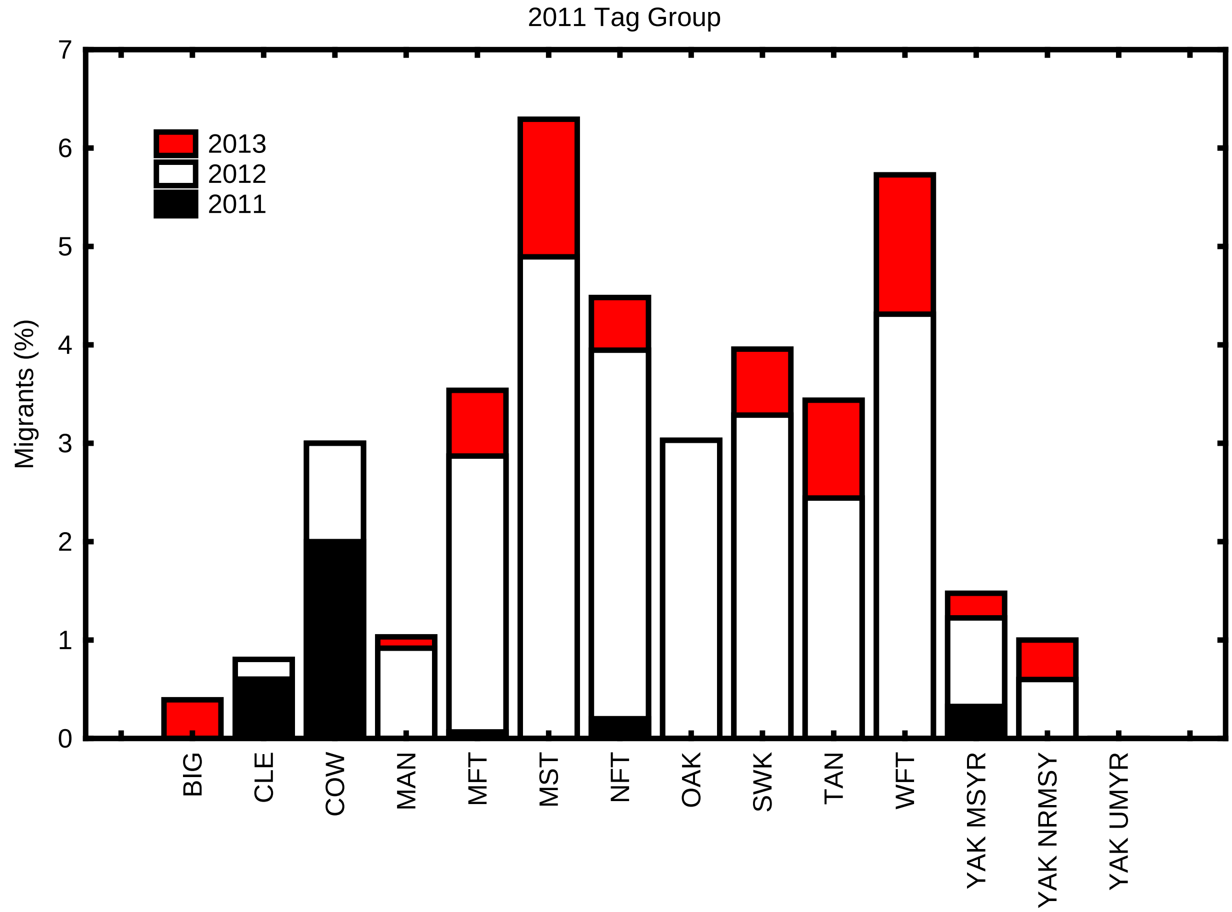

Figure 8. Proportion of the O. mykiss tagged in each tributary in 2011 that migrated in 2011, 2012, and 2013.

b. Coordination and Data Management (RM&E)

We hope the results of our work will have far reaching effects. This includes improving our understanding of how sympatric resident and anadromous O. mykiss interact to influence the status of the depressed and listed anadromous form. The information collected during this contract have been uploaded to Ptagis (PIT tagging data), and have been presented in public and professional forums (e.g., AFS chapter and divisional meetings; annual Yakima Basin Science and Management Conference). Our data has also been used to help influence the selection of high priority populations for inclusion in high level reports that are being drafted (e.g., Steelhead at risk report, WDFW unpublished).

5. Synthesis of Findings: Discussion/Conclusions

Lessons Learned: Explain how the results of this project benefit fish and wildlife. Address each applicable sub-strategy and management question(s), provided in the Introduction for higher-level or project/program level adaptive management. If studies are incomplete, discuss preliminary findings. (Refer to the RM&E Annual Technical Reporting guidance document for more information on content to include.)

a. Fish Population Status Monitoring (RM&E)

One of the primary objectives of this work is to collect population level status and trend data for the upper Yakima O. mykiss population (both life histories). These data collection efforts are ongoing. One of the secondary benefits is that the data are collected in a manner to answer critical uncertainties associated with the interactions of life history types in this sympatric population. Little is known about how the interactions between resident an anadromous forms of *O. mykiss* affects the recovery objectives mandated for the anadromous form. Bettering our understanding of these interactions will fill these data gaps, and help facilitate our recovery efforts.

This is the first year that our in stream PIT tag interrogation sites at all of our major tributaries were operating during the entire adult spawning migration period such that we could estimate adult detection efficiencies for our monitoring sites in the upper Yakima. The detection efficiencies were used to estimate spawner abundance in each major upper Yakima Tributary, and main-stem spawners were to be assigned by default. While the adult detection efficiencies were generally high, we have detected noise and interference issues at several of our PIT tag arrays that reduce our detection capabilities from what their potential is. We recommend minor equipment reconfiguration and continual troubleshooting to identify and reduce these sources of noise, thereby improving the detection capability of our monitoring infrastructure. This will improve our confidence in our adult and juvenile abundance and productivity monitoring metrics.

The proportion of the O. mykiss tagged in upper Yakima tributary streams that were detected as migrants in 2013 including detections as PIT tag mortalities on the Bird Colonies, Main stem Columbia River Dam detections of both juveniles and adult returns that were tagged as Juveniles, and the trawl surveys below Bonneville Dam, were consistent with our observations in previous years. On average, 3% of population PIT tagged in the upper Yakima were detected as migrants. The highest proportions of anadromous fish originated from the Main stem Teanaway River (MST) tag group (6.3%) and the West Fork Teanaway River (WFT) tag group (5.7%). Fish tagged in the Main stem Yakima River generated low proportions of migrants in 2013 (1.5%). We recommend continuing collection of adult spawning escapement and juvenile migrant production so we can generate productivity estimates in the coming years.

Our dual tagging study in Manastash creek indicates that PIT tag retention rates in of O. mykiss are high. One of our assumptions was that the retention rate of the second tag (the CWT in the dorsal tissue) was high and that our detection rates on the second tag were high. We learned that detecting the presence of each tag independent of the other in dual tagged fish that were small (e.g.80mm) was difficult, if not impossible, as the CWT handheld detection unit detects PIT tags as well as CWT's. We intend to replicate this study using elastomer marking that should circumvent incomplete detections with an easily identifiable mark in the field thereby facilitating increased sampling efficiency. The end product will be a PIT tag retention rate for tagged fish in the natural environment. We also need to estimate our tag induced mortality rate. We hope to append a tag mortality study to other research proposals that will provide estimates of long term tag induce mortality rates. These two pieces of information will be critical in generating long term in stream survival estimates that will be used to correct the tributary specific production estimates for each life history form.

b. Coordination and Data Management (RM&E)

The data collection activities associated with this work is ongoing. The data that is being collected is uploaded to regional databases where appropriate (e.g. PTagis), and has been made available and presented locally to help local recovery planning, as well as recovery planning efforts at the statewide level (e.g., WDFW).

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Appendix A: Use of Data & Products

Pit tag data files are contained at the regional PTagis Database: http://www.ptagis.org/

Raw electronic data files (Database) are secured on the WDFW Corporate server in Olympia, WA, as well as on WDFW district 8 field office personal computers. Data housed on personal computers are duplicated on the local office server which is in turn backed up on the WDFW corporate server in Olympia, WA nightly.

Published sampling protocols identified in this contract are accessible via the Monitoring Methods.org website: https://www.monitoringmethods.org/

Appendix B: List of Metrics and Indicators

Category	Subcategory	Subcategory Focus 1	Subcategory Focus 2
Fish	Abundance of Fish	Fish Life Stage: Adult - Pre-Spawner	Fish Origin: Natural
Fish	Abundance of Fish	Fish Life Stage: Adult - Spawner	Fish Origin: Natural
Fish	Abundance of Fish	Fish Life Stage: Adult Fish	Fish Origin: Natural
Fish	Abundance of Fish	Fish Life Stage: Juvenile - Migrant	Fish Origin: Natural
Fish	Abundance of Fish	Fish Life Stage: Juvenile Fish	Fish Origin: Natural
Fish	Age Structure: Fish	Fish Life Stage: Adult - Pre-Spawner	
Fish	Age Structure: Fish	Fish Life Stage: Adult - Spawner	
Fish	Age Structure: Fish	Fish Life Stage: Adult Fish	
Fish	Age Structure: Fish	Fish Life Stage: Juvenile - Migrant	
Fish	Age Structure: Fish	Fish Life Stage: Juvenile Fish	
Fish	Distribution of Fish Species	Fish Life Stage: Adult - Spawner	
Fish	Distribution of Fish Species	Fish Life Stage: Adult Fish	
Fish	Distribution of Fish Species	Fish Life Stage: Juvenile Fish	
Fish	Entrainment	Fish Life Stage: Juvenile - Migrant	
Fish	Genetics: Fish Diversity, Fitness or Variation	Fish Origin: Natural	
Fish	Length: Fish Species	Fish Life Stage: Adult Fish	
Fish	Length: Fish Species	Fish Life Stage: Juvenile Fish	
Fish	Mortality: Fish	Fish Life Stage: Adult - Pre-Spawner	
Fish	Productivity: Fish	Fish Life Stage: RANGE: Adult to Adult	Fish Origin: Natural
Fish	Productivity: Fish	Fish Life Stage: RANGE: Adult to Juvenile	Fish Origin: Natural

Fish	**Sex Ratio: Fish**	**Fish Life Stage: RANGE: Adult to Adult**	**Fish Origin: Natural**
Fish	**Stock Identity**	**Fish Life Stage: RANGE: Adult to Adult**	
Fish	**Survival Rate: Fish**	**Fish Life Stage: Juvenile Fish**	**Fish Origin: Natural**
Fish	**Survival: Fish**	**Fish Life Stage: Juvenile - Migrant**	**Fish Origin: Natural**
Fish	**Survival: Fish**	**Fish Life Stage: RANGE: Juvenile to Adult**	**Fish Origin: Natural**
Fish	**Timing of Life Stage: Fish**	**Fish Life Stage: Adult - Pre-Spawner**	