Yakima Steelhead VSP Project

Resident/Anadromous Interactions Monitoring

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1. Executive Summary

A. Fish Population Status Monitoring (RM&E)

Sympatric population dynamics between anadromous and resident forms of *O.mykiss* are not well understood. In particular, little has been done in quantifying resident *O.mykiss* influence upon the viability of the anadromous form. Currently, NOAA's viability analysis and recovery criteria (YSFWRB 2009) are based solely on the anadromous form (distinct population segment) for all four Yakima steelhead populations. However, spawning interactions between the two forms have commonly been observed in two of the four populations (Naches and Upper Yakima). Spawning interactions resulting in varied offspring production from different breeding crosses should be considered when assessing abundance and productivity viability criteria. In addition to abundance and productivity, other viability metrics should be considered such as: 1) the ability of one ecotype to maintain spatial structure and diversity in absence of the other and 2) the ability of one life history type to successfully re-populate the other life history type if extinction were to occur. Understanding the complex interactions between life history forms in the Yakima Basin is one focus of this contract. One of our strategies to fill data gaps associated with resident/anadromous interactions is through the use of expanded PIT tag activities in the Basin. Briefly, *O. mykiss* in the upper Yakima population are PIT tagged in natal streams. Migrants in future years are detected during the smolt migration. The proportion of migrants are used back calculate the proportions of each life history type in each stream. Genetic analysis is used to control for differing anadromous spawning input into each stream. Geographic areas important to the longevity of the anadromous form will be identified in the upper Yakima Basin that can be protected or enhanced to benefit anadromous recovery in future years.

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)

1. Assess the status and trend of natural and hatchery origin abundance of fish populations for various life stages.

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 and those 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).

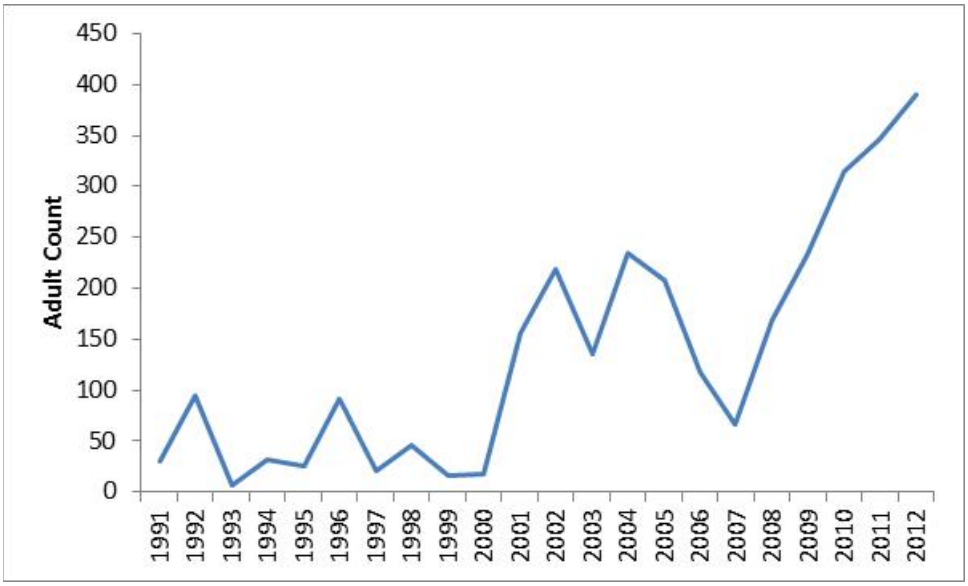

Figure 1. Annual adult summer steelhead return (run escapement) to the Upper Yakima River as enumerated at Roza Dam.

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. Major assumptions that must be noted using this modeling approach include 1) ocean survival remains within the range observed between 1991and 2012, 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, recovery targets would not be met until approximately the year 2042. This is likely a conservative estimate because the underlying assumptions are unlikely to be consistent or 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).

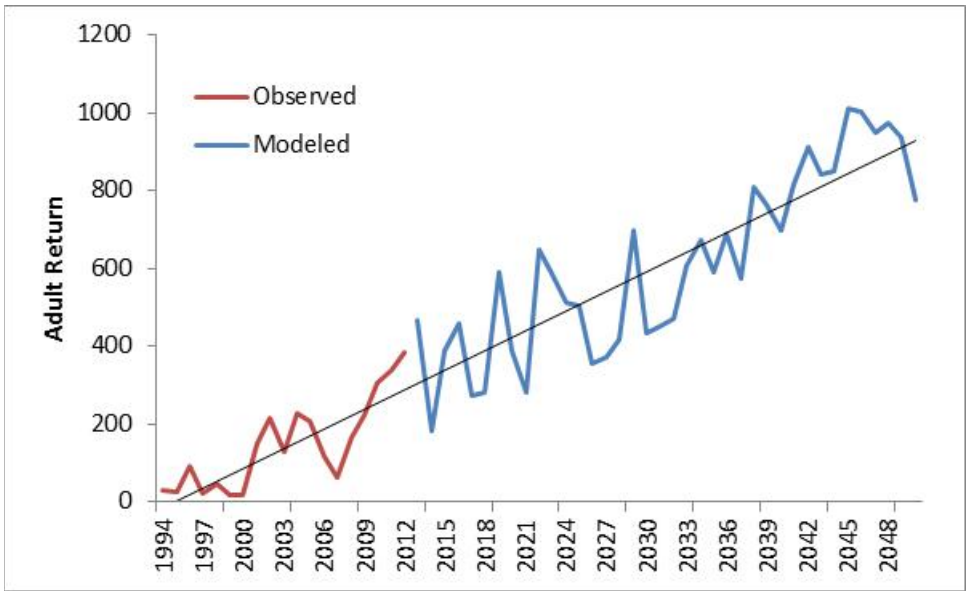

Figure 2. Observed and modeled population abundance trends in the Upper Yakima.

STATUS AND TREND MONITORING

11/01/2011-10/31/2012 54906 C: PIT tag Juvenile *O. mykiss* in select locations

The objective was to tag 10,000 *O. mykiss* during this contract period.

In order to standardize the sampling locations in the upper Yakima, the tributary streams were systematically subdivided into 200 m sampling reaches up the stream channel using GIS mapping software. Each reach of each stream was labeled systematically from the confluence to the upstream boundaries at the headwaters. Fish were sampled throughout each stream until the targeted number of fish were sampled and PIT tagged. Fish were generally collected by electrofishing in an upstream direction throughout the stream channel until a sufficient number of taggable sized *O. mykiss* were collected, at which point they were processed and length (FL mm) and weight (g) were recorded, nearest collection site ID recorded, fish over 65mm in length were PIT tagged (PTAGIS), and a small fin clip was collected and preserved in ethanol, and banked for future use. In cases where insufficient numbers of fish were collected because fish densities were so low that the target number could not be obtained, tags were allocated to other areas to increase sample sizes in other areas. At the end of processing, fish were released near their point of capture.

11/01/2011-10/31/2012 54906 E: Generate abundance of life history types in pre-selected locations

Mark-recapture abundance estimates of *O. mykiss* (combined unknown proportions of resident and anadromous fish) were generated in long term index monitoring sites (under BPA project

199506325) annually (Temple and Pearsons 2007). The number of juvenile migrants was retrospectively calculated as the proportion of migrants (identified by downstream detections) relative to the total number of tags put out in each stream for that year. The final abundance estimate for each life history type is computed by multiplying the proportion of migrants detected by the abundance estimate for the year prior. The resident population is then computed by subtracting the migrants from the total estimated abundance.

11/01/2011-10/31/2012 54906 G: Generate pre-spawning steelhead population estimates

Prespawning steelhead population estimates (Run Escapement) for the upper Yakima was simply reported as the annual Roza Dam Steelhead count for each return year. Since the steelhead trout adult migration spans 2 calendar years, each return year was reported as the adult returns during the migration window. Prespawning population estimates for the other 3 populations are computed by partitioning the adult return by the proportion of fish allocated to each population by radio tags and are presented in the Radio Telemetry reports (Frederiksen et al. 2013).

OTHER

11/01/2011-10/31/2012 54906 J: Present resident/anadromous interactions study at YBS&M conference

The resident/ anadromous interactions work under the Yakima steelhead VSP project is presented annually at the Yakima Basin Science and management conference held at Central Washington University. Abstracts and annual presentations are generally posted on the YKFP website (www.YKFP.org). The Resident/Anadromous interactions work was also recently presented at the Western Division American Fisheries Society annual meeting held in Boise, Id.

3. Assess the status and trend of juvenile abundance and productivity of natural origin fish populations.

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 is 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.

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 1.

Table 1. Estimated proportions of fish at age for Yakima River Tributaries including Manastash Creek (MAN), Middle Fork Teanaway River (MFT), Main stem Teanaway River (MST), North Fork Teanaway River (NFT), Swauk Creek (SWK), Taneum Creek (TAN), and 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			
MAN	0.05	0.27	0.66	0.02	
MFT	0.00	0.62	0.25	0.08	0.03
MST	0.44	0.53	0.03	0.00	
NFT	0.49	0.49	0.01	0.01	
SWK	0.06	0.28	0.53	0.13	
TAN	0.19	0.48	0.29	0.04	
WFT	0.21	0.75	0.04		
		Main stem Yakima River			
LCYN	0.00	0.83	0.04	0.10	0.03
UCYN	0.00	0.73	0.11	0.14	0.02
EBURG	0.00	0.70	0.17	0.12	0.02
THORP	0.00	0.79	0.14	0.05	0.02
CELUM	0.00	0.71	0.17	0.06	0.06

STATUS AND TREND MONITORING

11/01/2011-10/31/2012 54906 D: *O. Mykiss* abundance and bio sampling

O. mykiss were systematically sampled in 7 Tributary streams and 5 main stem Yakima stream reaches annually. Abundance and Bio data recorded during sample collections were entered electronically into a relational database and stored on the WDFW corporate computer server in Olympia, Wa. Physical samples are banked and held at the WDFW District 8 field office in Ellensburg, WA, with the exception of samples processed in the molecular genetics lab, or scale ageing lab at the WDFW Headquarters Office in Olympia, WA where they are processed.

4. Assess the status and trend of spatial distribution of fish populations.

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 due to low adult counts and the large geographical area encompassing potential spawning locations (i.e., needle in haystack).

5. Assess the status and trend of diversity of natural and hatchery origin fish populations.

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 broodyear run escapement dating back to 2007 under the first year of this project.

B. Tributary Habitat RM&E

1. Monitor and evaluate tributary habitat conditions that may be limiting achievement of biological performance objectives.

What are the tributary habitat limiting factors (ecological impairments) or threats preventing the achievement of desired tributary habitat performance objectives?

The Mid-Columbia steelhead recovery plan (NMFS 2009) summarizes the habitat limiting factors thought to be limiting the success of the MPG. Briefly, the limiting factors presented in that document include migration passage issues, unnatural hydrograph resulting from irrigation delivery flow manipulation, degraded riparian areas and poor woody debris recruitment, altered sediment routing, degraded water quality, loss of historical habitat resulting from blocked or impaired passage, degraded floodplain connectivity and function, degraded channel structure and complexity, and reduced outmigration survival. The Yakima steelhead recovery plan (YBFWRB 2009) that was included as a supplement to the Mid-Columbia steelhead recovery plan (NMFS 2009) contains a detailed outline with additional habitat limiting factors for all four of the populations within the MPG.

STATUS AND TREND MONITORING

11/01/2011-10/31/2012 54906 F: Analyze Genetic samples to disaggregate MPG into population

The adult steelhead collected at Prosser during the adult spawning migration under the radio telemetry study of this project were also genetically sampled. The genetic samples were processed in the WDFW molecular genetics lab and were compared to the genetic stock baseline data to determine their area of origin. The second year of genetic samples were collected, however, they will not be analyzed or reported on under this contract.

Genetic samples were also collected from additional tributaries in the Naches basin to improve the baseline. Additional samples were collected from Oak Creek, Cowichee Creek, and from Satus Creek. These samples were added to the reference baseline.

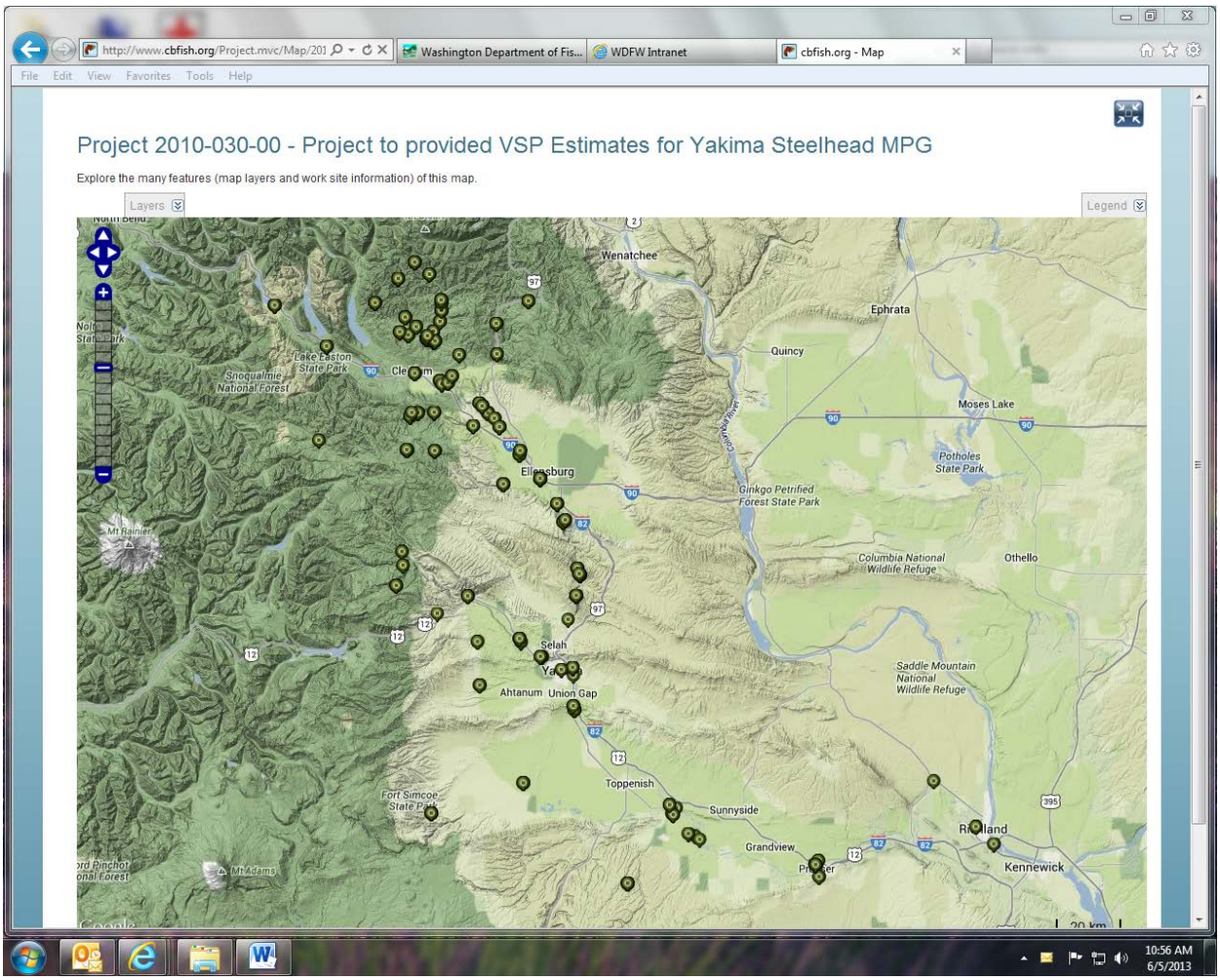

Figure 3. Map of sampling locations associated with the Yakima Steelhead VSP project.

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

Annual abundance estimates of *O. mykiss* (combined life histories) are generated in tributary streams using mark-recapture methods following Temple and Pearsons (2009; http://www.monitoringmethods.org/Method/Details/118 and http://www.monitoringmethods.org/Method/Details/119). In larger stream reaches, a driftboat 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)

1. Assess the status and trend of natural and hatchery origin abundance of fish populations for various life stages.

What are the status and trend of abundance of natural and hatchery origin fish populations?

STATUS AND TREND MONITORING

11/01/2011-10/31/2012 54906 C: PIT tag Juvenile *O. Mykiss* in select locations

All 10,000 tags were successfully deployed, however, tags allocated to the main stem Yakima River upstream from Easton Dam were re-allocated to other areas due to low abundance of *O. mykiss* in this area (Table 2).

Table 2. Numbers of genetic samples (and annual code) collected and *O. mykiss* PIT tagged over the course of this contract period under the Yakima Steelhead VSP monitoring Project and the Monitoring and Evaluation Project. Streams include the North Fork, Middle Fork, West Fork, and main stem Teanaway Rivers (NFT, MFT, WFT, and MST respectively), Cle Elum River (CER), Swauk Creek (SWK), Umtanum Creek (UMT), the Little Naches River (LNACH), Tieton River (TIET), Naches River (NACH), Big Creek (BIG), Taneum Creek (TAN), Upper Mainstem Yakima River upstream from Easton Dam (UMYR), Reecer Creek (REC), Manastash Creek (MAN), Yakima River between The Naches River and Roza Dam (NRMSY), Little Creek (LITT), and the main stem Yakima River (MSYR; Roza Dam to Cle Elum River).

Stream	GSI Code	Genetic Samples (N)	PIT tag Objective	Number Tagged	Project
NFT	12BQ	1500	M&E-600 VSP-1000	1500	M&E
MFT	12BS	1500	M&E-400 VSP-1000	1500	M&E VSP
CER	12CA	500	M&E-500	500	M&E
SWK	12BU	1499	VSP-1000	1499	VSP
WFT	12BR	1498	VSP-1000	1498	VSP
UMT	12CE	500		500	M&E

MST	12BT	1000	VSP-1000	1000	M&E/VSP
LNACH	12HD	130	VSP-500	130	VSP
TIET	12IR	500	VSP-1000	496	VSP
NACH	12CB	60	VSP-500	60	VSP
BIG	12CD	317		317	M&E
TAN	12BV	1500	M&E-1000	1500	M&E
UMYR	12BY	200	VSP-1000	200	VSP
REC	12CC	500		500	M&E
MAN	12BW	1000	VSP-1000	1000	VSP
NRMSY	12BZ	500		500	M&E
LITT	****	100		100	M&E
MSYR	12BX	4000	VSP-4000	4000	VSP

11/01/2011-10/31/2012 54906 E: Generate abundance of life history types in pre-selected locations

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 are lagged 1 year. Abundance was expressed as fish/km (Table 3). The abundance estimates were partitioned into life history components using the proportion of the migrants detected during the following year spring smolt migration period (e.g. during this contract cycle).

Table 3. *O. mykiss* abundance estimates in Yakima mainstem and tributary areas by life history type.

Stream	Total Fish/km	% migrants	Resident/km	Anadromous/km
Yakima	362	1.1	358	4
MFT	555	3.1	538	17
NFT	343	4.6	327	16
WFT	403	4.6	384	19
MST	250	5.1	237	13
SWK	739	3.2	715	24
TAN	353	2.8	343	10
MAN	254	1.2	251	3

11/01/2011-10/31/2012 54906 G: Generate pre-spawning steelhead population estimates

The pre-spawning abundance of anadromous adult steelhead in the upper Yakima Basin is currently indexed and reported as run escapement, or the number of steelhead enumerated at Roza Dam. Prespawning mortality rates will be estimated at the end of the 3 year radio telemetry study and will be used to convert the upper Yakima Population from a run escapement to spawning escapement. The pre-spawning run escapement for the other 3 populations is currently estimated using the similar methods of Hockersmith et al. (1995).

Briefly, adult steelhead radio tagged at Prosser dam throughout the adult migration are partitioned to their respective population based upon the proportions of radio tagged adults that are tracked returning to each basin. Although the long term strategy to determine the prespawning population estimate for each of the 4 populations will be to use mark-recapture methods based on PIT tag recaptures at interrogation stations, we currently partition the run at large based upon the information generated from the radio tagged adult migration. In addition, genetic stock separation of adults will provide an independent method to validate the population estimates to each of the 4 populations.

OTHER

11/01/2011-10/31/2012 54906 J: Present resident/anadromous interactions study at YBS&M conference

The resident/ anadromous interactions work under the Yakima steelhead VSP project is presented annually at the Yakima Basin Science and management conference held at Central Washington University. Abstracts and annual presentations are generally posted on the YKFP website (www.YKFP.org). The Resident/Anadromous interactions work was also recently presented at the Western Division American Fisheries Society annual meeting held in Boise, Id.

3. Assess the status and trend of juvenile abundance and productivity of natural origin fish populations.

What are the status and trend of juvenile abundance and productivity of fish populations?

STATUS AND TREND MONITORING

11/01/2011-10/31/2012 54906 D: *O. Mykiss* abundance and bio sampling

The total annual abundance of juvenile rainbow trout in upper Yakima Tributary streams is highly variable annually (Figure 4). The trends in juvenile abundance will likely show similar variability in the trends once a time series of juvenile data can be calculated. Juvenile abundance in the Mainstem Yakima is also highly variable (Figure 5).

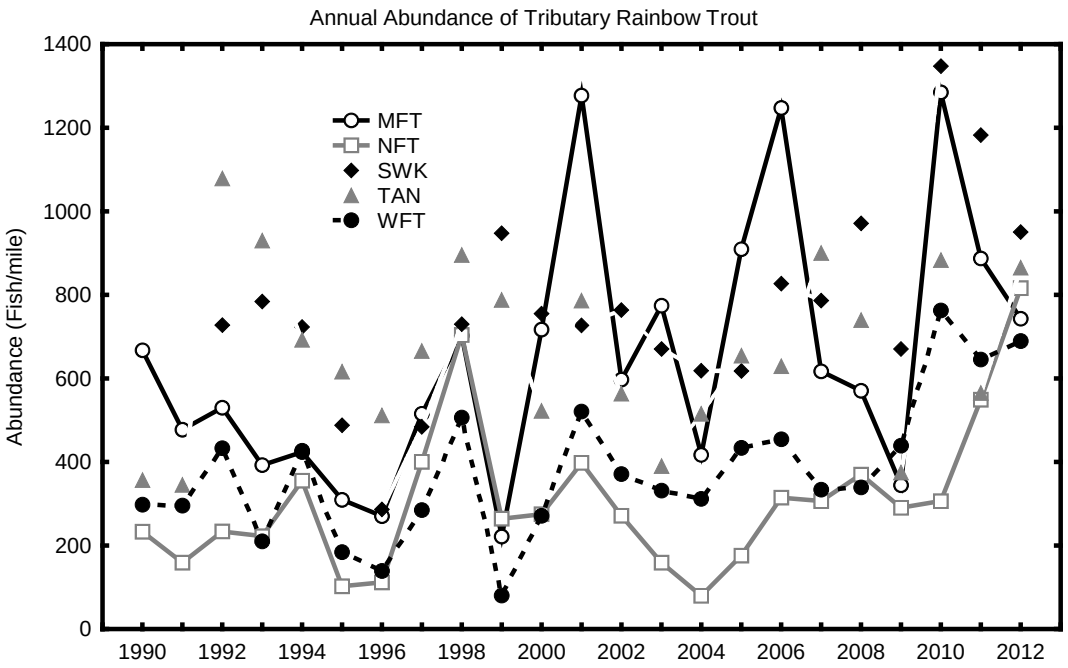

Figure4. Annual *O. mykiss* abundance estimates (fish/km) in the Middle, North, West forks of the Teanaway River (MFT, NFT, WFT respectively), Swauk Creek (SWK), and Taneum Creek (TAN).

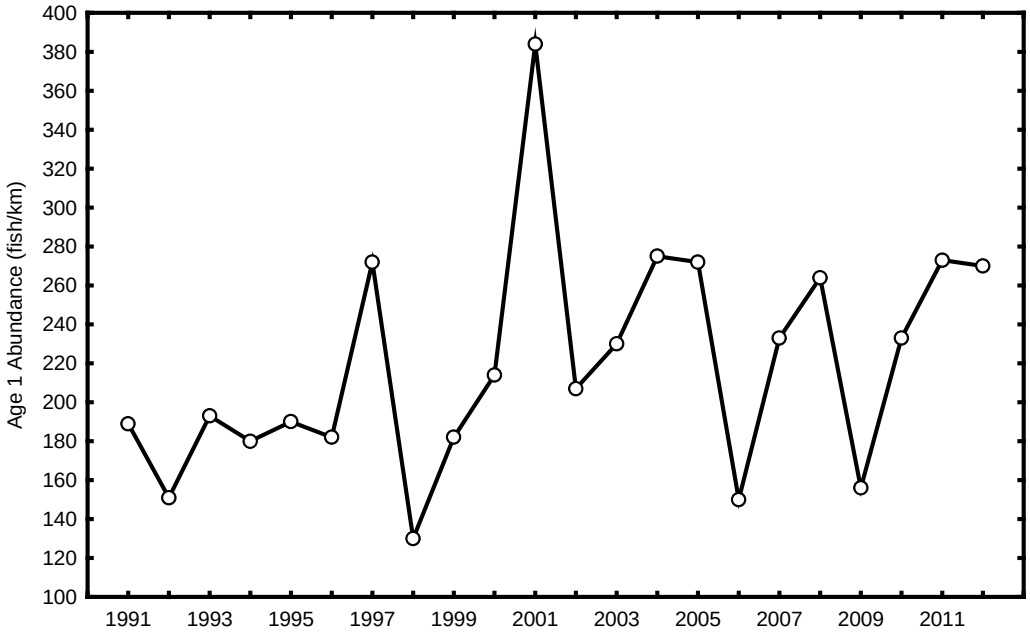

Figure 5. Annual Abundance estimate (fish/km) of Age 1 *O. mykiss* in the Upper Yakima River.

4. Assess the status and trend of spatial distribution of fish populations.

What are the status and trend of spatial distribution of fish populations?

NOAA's primary recommendation for monitoring the status and trends in spatial distribution relies heavily on spawning ground information. Spawning ground surveys have not been routinely collected within the MPG, and have only been occasionally collected in the Upper Yakima. Low spawner abundance and a rather large geographic region for which spawning to occur in has contributed to lack of effort directed at spawning ground surveys in this population. Our long term objective is to monitor anadromous spawner distribution within the upper Yakima using the PIT tag array infrastructure. The current detection network provides estimates of spawner abundance within individual select tributaries in the upper Yakima. Mainstem Yakima spawners are estimated by default. The Radio Telemetry work currently under way will help validate this approach. Finally, although inconsistent spawning surveys have been conducted, areas of known spawning activity are used in the TRT risk assessments. Additional spawner distribution information is presented in Frederiksen et al. (2013).

5. Assess the status and trend of diversity of natural and hatchery origin fish populations.

What are the status and trend of diversity of natural and hatchery origin fish populations?

As previously mentioned, the anadromous adult returns in the Yakima MPG are predominantly wild fish with few hatchery strays. Thus, diversity metrics are reported for wild fish only. 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). We have processed the adult genetic baseline for broodyear run escapement dating back to 2007.

B. Tributary Habitat RM&E

1. Monitor and evaluate tributary habitat conditions that may be limiting achievement of biological performance objectives.

What are the tributary habitat limiting factors (ecological impairments) or threats preventing the achievement of desired tributary habitat performance objectives?

STATUS AND TREND MONITORING

11/01/2011-10/31/2012 54906 F: Analyze Genetic samples to disaggregate MPG into population

Genetic samples were collected on the returning adult steelhead that were radio tagged at Prosser Dam. These samples were referenced against the genetic baseline to partition this group to their population of origin. This partitioning was used to divide the entire annual Prosser Dam steelhead count into pre-spawning run escapement estimates for each of the four populations in the MPG. The most recent genetic analysis for the genetic stock separation suggests 36.07%, 11.75%, 23.09%, and 29.10% of the total annual run escapement were allocated to the Satus, Toppenish, Upper Yakima, and Naches populations, respectively. Applying these proportions to the Prosser aggregate count for wild adults (6206 for the 2011/2012 return) provides run escapement estimates of 2239, 729, 1433, and 1806 fish to the four populations. We believe there is still substantial refinement to be made to these methods because the GSI based estimate is significantly greater than the census of the fish passing Roza Dam (1433 vs 408). Thus, this approach will still require refinement and should be treated cautiously as the estimates are likely suspect. We recommend the ICTRT method of stock partitioning continue to be used until the Radio Telemetry Study is complete, and the error in the Genetic Stock Identification are identified.

5. Synthesis of Findings: Discussion/Conclusions

Explain the benefit to fish and wildlife in terms of each applicable sub-strategy and management question(s) for higher-level or project/program level adaptive management.

A. Fish Population Status Monitoring (RM&E)

1. Assess the status and trend of natural and hatchery origin abundance of fish populations for various life stages.

What are the status and trend of abundance of natural and hatchery origin fish populations?

STATUS AND TREND MONITORING

11/01/2011-10/31/2012 54906 C: PIT tag Juvenile *O. Mykiss* in select locations

The largest component of the resident/anadromous interactions study is the capture and PIT tagging of substantial numbers of *O. mykiss* in the Upper Yakima, and eventually the Naches Basin. As more and more fish are tagged, eventually, the likelihood that tagged juveniles will migrate as anadroumous smolts, and further as returning adults will likely increase through time. We have not yet cycled through an entire cohort, but as additional years of tagging and tracking data are collected, we will begin to understand how both lifehistory forms interact. There appears to be some general trends beginning to emerge from the tagging data. One is that the Teanaway Basin appears to be an important anadromous area, both for anadromous spawning, as well as for juvenile smolt production. There is variation among the Teanaway River forks, but in general, this basin produces far more smolts than the other creeks in the upper Yakima. This basin also generally attracts more anadromous spawning activity. At this point, we

are unclear if the smolt production is more of a product of anadromous spawning, or of environmental conditions, or the product of resident spawners producing anadromous migrants. The genetic processing of the juvenile migrants compared against the Roza adults will help answer this question. For this approach to work, a large portion of the adult spawners will need to be sampled at the Roza facility. There are time periods when the facility is not operational during the adult spawning migration, and some steelhead pass upstream without being sampled (e.g., winter maintenance period for the facility). This complicates the analysis because unassigned juveniles will be arbitrarily assigned to resident parents because all potential anadromous adults have not been sampled. If this portion of the population is small, the error of misassignments is likely small as well. We intend to take a close look at this in the coming year.

11/01/2011-10/31/2012 54906 E: Generate abundance of life history types in pre-selected locations

It will take a number of years to fully understand the complex interrelationship between the resident/anadromous forms of *O. mykiss* and the influence upon population status. However, by monitoring the abundance of each ecotype and the production of each in various geographical areas, we hope to identify those areas most influential on the longevity of the anadromous form. We believe our data will support our ability to identify causal mechanisms that favor the expression of one life history pathway over another. We will then be able to identify geographical areas to target or prioritize for protection and what the environmental conditions are in those areas that may influence the expression of anadromy. This information will allow us to make predictions on how other areas can support anadromy and what the benefit will be for restoration actions.

11/01/2011-10/31/2012 54906 G: Generate pre-spawning steelhead population estimates

The steelhead spawner abundance estimates are currently generated using a complex method that combines information using the Roza dam count, Satus and Toppenish red counts, and stock separation using the radio telemetry study conducted in the early 1990's (Hockersmith et al. 1995; figure 6). This method will be refined when the 3 year telemetry study is completed. Our vision for long term stock partitioning will rely heavily upon our PIT tag infrastructure. Prespawning population estimates will be generated in future years consistent with the ISEMP protocols generated in the Salmon River Basin and in the Upper Columbia Basin.

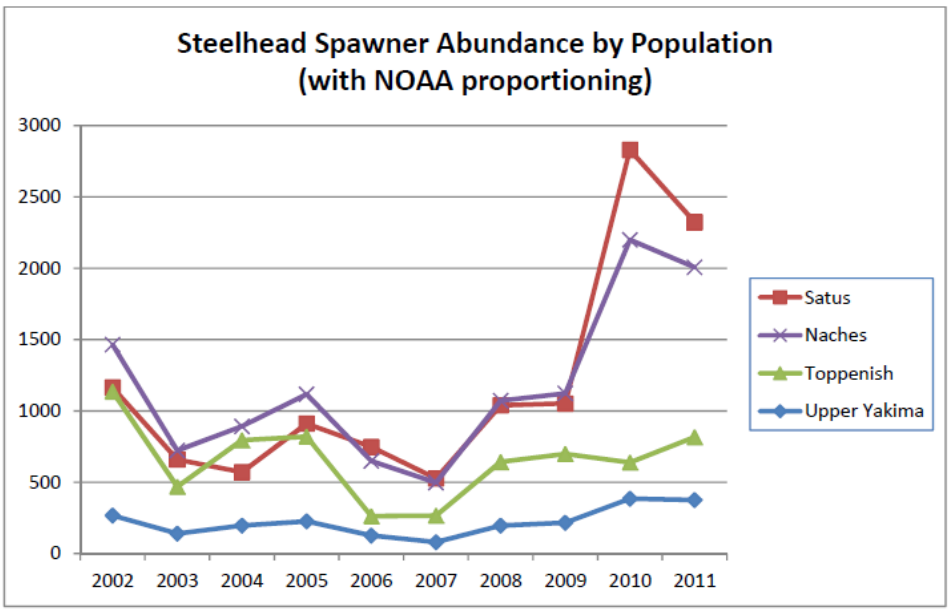

Figure 6. Current spawner abundance estimates partitioned by each of the 4 populations in the Yakima MPG (from Reiss et al, 2013).

OTHER

11/01/2011-10/31/2012 54906 J: Present resident/anadromous interactions study at YBS&M conference

The Resident/anadromous interactions study was presented at the Yakima basin Science and management conference held at CWU. It was also presented at the Western Division of the American Fisheries Society meeting held in Boise, ID (outside of this contract period). There was much interest in the information generated under this study and there were several presentations that explicitly referenced the need to generate an understanding of how this complex life history interrelationship affects either life history form. This study is collecting valuable data to inform this rather large data gap.

3. Assess the status and trend of juvenile abundance and productivity of natural origin fish populations.

What are the status and trend of juvenile abundance and productivity of fish populations?

STATUS AND TREND MONITORING

11/01/2011-10/31/2012 54906 D: *O. Mykiss* abundance and bio sampling

The population of *O. mykiss* in the main stem Yakima River is fairly stable from year to year. This may be due to the highly regulated nature of the system. The population of *O. mykiss* in the tributary streams is highly variable year to year, and that may be due to the unregulated and

more natural state of those systems. We have only just begun to collect age structure information in the tributary streams so we cannot yet infer the productivity in these areas. We have partitioned our *O. mykiss* abundance estimates in the Main stem Yakima into age1 and older age classes (lumped) for our monitoring prescriptions under the YKFP. If we assume the older age classes (age 2-4) represent the spawning population, and our Age1 abundance estimates can reference recruitment 2 years later, we can infer productivity measures by dividing the recruits/spawner lagged 2years (e.g., age1/age2-4, 2 years prior since we sample in the fall; Figure 7). The trend line appears to be decreasing slightly, but not significantly so (P=0.35). We will be able to generate a similar plot in the future for both the resident and the anadromous juvenile population, and thus, be able to determine if there are differences in the juvenile productivity between life history forms.

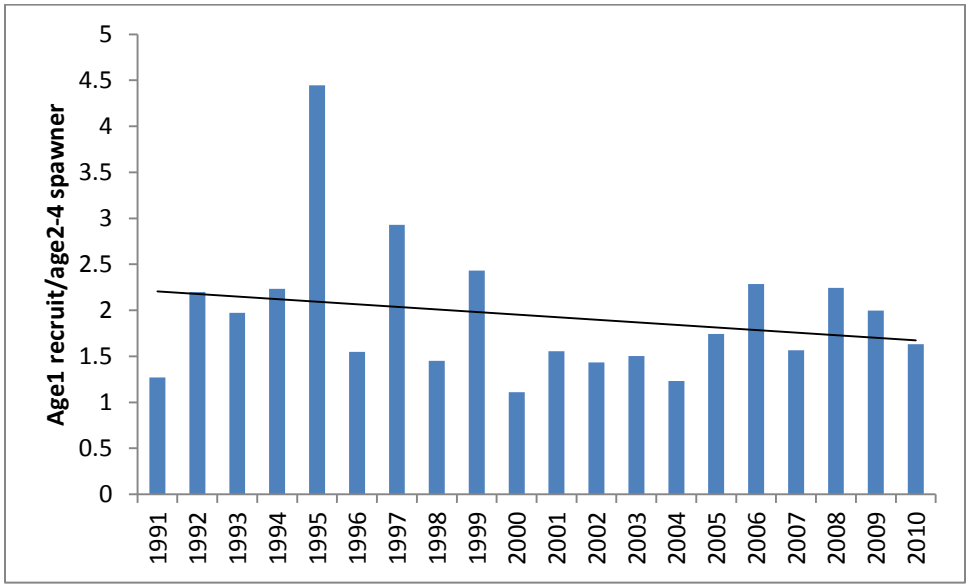

Figure 7. Productivity of *O. mykiss* (combined resident and anadromous) in the upper Yakima River main stem. Recruitment is expressed as age1 abundance, and spawners are the age2-4 population, and recruit/spawner is presented on the Y-axis.

4. Assess the status and trend of spatial distribution of fish populations.

What are the status and trend of spatial distribution of fish populations?

It appears the spatial distribution of the combined *O. mykiss* population is stable and has changed little through time. However, we are unclear if the proportion of anadromous and resident fish in the population is stable in each stream from year to year. Our data will be used to determine if recovery or habitat actions benefit the expression of anadromy, and thus to monitor the trends in spatial distribution of anadromous juveniles, and perhaps causative factors influencing the expression of one life history form over another.

5. Assess the status and trend of diversity of natural and hatchery origin fish populations.

What are the status and trend of diversity of natural and hatchery origin fish populations?

As previously stated, we have few to no hatchery steelhead in the Yakima Basin. Our status and trend monitoring is tracking the status of wild origin fish. This may be considered somewhat unique because there are very few steelhead populations in the mid-Columbia region that do not have sympatric wild and hatchery fish.

Tributary Habitat RM&E

1. Monitor and evaluate tributary habitat conditions that may be limiting achievement of biological performance objectives.

What are the tributary habitat limiting factors (ecological impairments) or threats preventing the achievement of desired tributary habitat performance objectives?

The Mid-Columbia steelhead recovery plan (NMFS 2009) summarizes the habitat limiting factors thought to be limiting the success of the MPG. Briefly, the limiting factors presented in that document include migration passage issues, unnatural hydrograph resulting from irrigation delivery flow manipulation, degraded riparian areas and poor woody debris recruitment, altered sediment routing, degraded water quality, loss of historical habitat resulting from blocked or impaired passage, degraded floodplain connectivity and function, degraded channel structure and complexity, and reduced outmigration survival. The Yakima steelhead recovery plan (YBFWRB 2009) that was included as a supplement to the Mid-Columbia steelhead recovery plan (NMFS 2009) contains a detailed outline with additional habitat limiting factors for all four of the populations within the MPG.

STATUS AND TREND MONITORING

11/01/2011-10/31/2012 54906 F: Analyze Genetic samples to disaggregate MPG into population

As previously noted, the genetic stock separation estimates are still being refined. There is an apparent error in the estimates that we are attempting to identify and correct. The GSI estimates generated this year should be considered suspect. One possibility is that there is a high amount of overwinter mortality that reduces the population allocations, however, this is not supported by the current Radio Telemetry study. We recommend the ICTRT method of population partitioning be maintained until the error in the GSI estimates are identified, and the Radio Telemetry study is completed next year.

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Appendix A: Use of Data & Products

The data used in this report is collected by WDFW's YKFP staff during field sampling activities unless otherwise stated. The data collected under this project is housed on raw data sheets that are subsequently entered into spreadsheets and relational databases on personal computers in the WDFW Ellensburg district office. The electronic data is backed up nightly on a resident server which is further backed up nightly to a secure location through the WDFW headquarters office in Olympia, WA (S-drive).