Yakima Steelhead VSP Project

Yakima River Steelhead Population Status and Trends Monitoring

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Executive Summary

This project expands research, monitoring, and evaluation (RM&E) activities conducted by the co-managers in the Yakima Basin (Yakama Nation and Washington Department of Fish and Wildlife-WDFW) to better evaluate viable salmonid population (VSP) parameters (abundance, productivity, spatial structure, and diversity) for Yakima River steelhead (*Oncorhynchus mykiss*) populations. It was developed to fill critical monitoring gaps identified in the 2009 Columbia Basin monitoring strategy review and the FCRPS Biological Opinion reasonable and prudent alternative (RPA) review. Using information developed from this project (including the companion component monitoring resident/anadromous interactions) as well as the restoration and research, monitoring and evaluation work of several related projects (1995-063-25, 2008-458-00, 2007-401-00, 1997-051-00, 1996-035-01, and 1997-013-25), this report provides the latest status and trend information with respect to Yakima River Basin steelhead VSP metrics relative to data collected by the Yakama Nation.

The Yakima River steelhead major population group (MPG) is believed to consist of four individual, genetically unique populations spawning in the following areas: the Upper Yakima River consisting of the mainstem and all tributaries above the confluence with the Naches River; the Naches River system including Ahtanum Creek and Yakima Mainstem extending from the confluence of the Naches down to Toppenish Creek; Toppenish Creek; and Satus Creek. Adult population and productivity metrics for the Yakima River steelhead MPG are trending upwards. For the most recent five steelhead run years (June 30, 2010 to July 1, 2015) mean annual abundance was 5,210 steelhead for the MPG (average abundance at Prosser Dam) and 371 steelhead for the proportion of the Upper Yakima population spawning above Roza Dam (average abundance at Roza Dam). This compares to average annual abundance estimates of about 2,130 steelhead for the MPG and 108 steelhead spawning above Roza Dam between 1991-2010. With an increasing proportion of Yakima River steelhead comprising the Bonneville Dam count, Yakima River MPG steelhead are potentially experiencing greater survival relative to other steelhead populations above Bonneville Dam due to improved freshwater rearing conditions within the Yakima basin. Habitat restoration actions in the Yakima River Basin (see 1997-051-00, 1996-035-01, and Yakima Basin Fish and Wildlife Recovery Board summary), the Yakima kelt reconditioning program (see 2008-458-00 and 2007-401-00), as well as ongoing efforts to improve fish passage (see Yakima River Basin Water Enhancement Project) and limiting factors in the Yakima Subbasin (see Yakima Basin Fish and Wildlife Recovery Board) may partially explain these results.

Juvenile abundance and productivity metrics are generally positive at the MPG level, but these metrics are not as reliable as adult metrics due to uncertainties and complexities involved with estimating total juvenile abundance from relatively small samples of juvenile outmigrants. Redd survey and passive integrated transponder (PIT) detection data indicate that steelhead are fairly broadly distributed spatially throughout most known steelhead streams in the Yakima River Basin. Evaluation of data from adult sampling at Prosser and Roza Dams demonstrate that, on average, about 70% of the adult steelhead returning to the Yakima Basin are female. The vast majority (about 95%) of MPG steelhead returning to the Yakima River Basin are in the "Group A" size management range (< 78cm fork length) which is used for fishery management purposes in the Columbia River Basin. We are still compiling and evaluating age-at-migration and age-at-return information; more complete presentations and analyses using these data will be available in subsequent annual reports.

Although annual adult abundance of Yakima River steelhead at the MPG level can be estimated fairly reliably using Prosser Dam counts, there is a need for spawner abundance estimates for individual populations. In accordance with RPA 50.6 (Improve Fish Population Status Monitoring), this project conducted a three year telemetry study that provided spawner abundance estimates for each Yakima MPG steelhead population for spawn years 2012-14. The 3-year study also tested the efficacy of other proposed adult abundance monitoring methods needed for long-term status and trends monitoring including genetic stock identification (GSI) and the installation, management, and performance of remote Instream PIT-tag detection arrays. This project is also working towards improving the sampling and analytical methods for estimating juvenile abundance for both individual populations and the Yakima MPG as a whole. As this project progresses and matures over time, more complete presentations and analyses using this new information will be provided in subsequent annual reports.

Introduction

This project expands research, monitoring, and evaluation (RM&E) activities conducted by the co-managers in the Yakima Basin (Yakama Nation and Washington Department of Fish and Wildlife-WDFW) to better evaluate viable salmonid population (VSP) parameters (abundance, productivity, spatial structure, and diversity) for Yakima River steelhead (*Oncorhynchus mykiss*) populations. It was developed to fill critical monitoring gaps identified in the 2009 Columbia Basin monitoring strategy review and the FCRPS Biological Opinion reasonable and prudent alternative (RPA) review. Data from our research will be used to evaluate population status and trends, inform NOAA status reviews and implementation of the Federal Columbia River Power System (FCRPS) Biological Opinion, and address critical uncertainties (e.g., the relationship between resident and anadromous life histories in the Yakima River Basin), consistent with the Northwest Power and Conservation Council (NPCC) Fish and Wildlife program, Columbia Basin research plan (uncertainties 3.1, 7.1 & 7.3), NOAA mid-Columbia steelhead recovery plan, and Fish Accords. The improved understanding of steelhead population performance and dynamic interactions between anadromous and resident O. *mykiss* produced by this project will directly inform efforts to recover steelhead populations in the Yakima Basin.

This report presents fish population status and trend metrics for the Yakima River steelhead major population group (MPG). The Yakima River steelhead MPG is believed to consist of four individual, genetically unique populations spawning in the following areas: the Upper Yakima River consisting of the mainstem and all tributaries above the confluence with the Naches River; the Naches River system including Ahtanum Creek and Yakima Mainstem extending from the confluence of the Naches down to Toppenish Creek; Toppenish Creek; and Satus Creek (Loxterman and Young 2003). This report also updates the status of a three year radio telemetry study (September 2011 through June 2014) to apportion the Yakima River MPG run size enumerated at Prosser Dam to individual population spawner abundances (ICTRT 2007, YBFWRB 2009) and to address spatial distribution uncertainties relative to the Naches and Upper Yakima steelhead populations (Figure 1). The study will also test alternative methods for apportioning the total run at Prosser Dam to monitor long term status and trends at the population level. Another major research component of this project is monitoring resident/anadromous interactions; for the latest results see Temple et al. (2015) (for additional reference see Pearsons et al. 2007, Courter et al. 2013).

This work relies heavily on the infrastructure and staffing associated with the Yakima/Klickitat Fisheries Project (YKFP) and other related projects in the Yakima Basin. Status and trend metrics for spring Chinook (*O. tshawytscha*), summer/fall Chinook (*O. tshawytscha*), and coho (*O. kisutch*) RM&E work are reported under 1995-063-25. Related steelhead kelt reconditioning is reported under CRITFC projects 2008-458-00 and 2007-401-00.

YKFP-related habitat activities for the Yakima Subbasin are addressed under project 1997-051-00. Yakama reservation habitat and RM&E activities are addressed under project 1996-035-01. Hatchery Production Implementation (Operation and Maintenance) is addressed under project 1997-013-25. **Data and findings presented in this report**

should be considered preliminary until results are published in the peer-reviewed literature.

Purpose and Need for Project

Although annual adult abundance of Yakima River steelhead at the MPG level can be estimated fairly reliably using Prosser Dam counts, there is a need for spawner abundance estimates for individual populations. Stock status assessments used for recovery planning by the Interior Columbia Technical Review Team (ICTRT) rely on a combination of methods for apportioning Prosser Dam adult counts to individual populations. These include the use of a 1990-92 radio-tracking survey (Hockersmith et al. 1995), redd counts from Satus and Toppenish creeks, and Roza Dam counts.

In accordance with RPA 50.6 (Improve Fish Population Status Monitoring), this project is conducting a three year telemetry study that will provide spawner abundance estimates for each Yakima MPG steelhead population. The 3-year study will also test and validate the efficacy of other proposed adult abundance monitoring methods needed for long-term status and trends monitoring. The methods that will be tested during the 3 year telemetry study include:

1) **The use of Genetic Stock Identification (GSI) -** The concept of using GSI techniques for stock partitioning used stratified genetic sampling taken from the adult steelhead run at large at Prosser Dam. The sampling was conducted across the entire adult run-timing beginning in September and extending into the early part of May. Population-of-origin assignments from individual fish were compared to actual spawning locations of those fish using information from the telemetry study.

2) **The use of Remote Instream Passive Integrated Transponder (PIT) detection Arrays-** Several instream arrays were placed adjacent to radio telemetry fixed sites in areas below known spawning distributions of the Satus and Toppenish Creek steelhead populations. The functionality and detection efficiencies of the arrays have been preliminarily reviewed. Once finalized, refinement of spawner abundance estimates will be included in future reports.

The Yakama Nation and WDFW have emphasized maintaining the natural genetic composition of Yakima Basin steelhead stocks. The last release of hatchery-origin juvenile steelhead in the Yakima Basin occurred in 1993. While no hatchery programs exist within the Yakima Basin, stray hatchery-origin fish from other basins make up approximately 3% of the total steelhead run into the basin. The VSP project's primary focus is monitoring natural-origin abundance at the population scale, but will also enumerate and report on the number of out-of-basin stray hatchery spawners that are observed within each of the four Yakima River steelhead populations.

Steelhead smolts entrained into the Chandler Canal at Prosser Dam, and representing the entire Yakima steelhead MPG, are counted throughout the outmigration period each year. Smolt counts can be expanded to total downstream passage if the flow-dependent entrainment rate and the survival rate from the diversion headgate to the counting facility can be reliably estimated. This requires paired releases of PIT-tagged smolts into the dam forebay and at the canal headgates at a variety of river flows through several outmigration seasons, with tag detection in the fish screen bypass and the fish sample room. At present, steelhead smolt passage estimates rely on spring chinook flow-entrainment and canal survival estimates with no information on their applicability between species. The spring chinook passage estimates themselves have proven so unreliable in recent years, probably due in part to fluctuations in migration paths over Prosser Dam, that passage estimation using joint PIT-tag detections with downstream dams to estimate entrainment rate is likely to replace the current flow-entrainment model for that species. This alternative method is facilitated by the fact that over 40,000 hatchery juvenile spring chinook are PIT-tagged each year in the upper Yakima River. The same passage estimation method could be employed for juvenile steelhead, although substantially fewer PIT-tagged steelhead are available.

This project will provide necessary field work, sampling and analytical methods for estimating juvenile abundance for individual populations in the Yakima MPG. Partitioning adult and juvenile abundance will rely on GSI techniques and assignment probabilities. To date, limited sampling of juveniles has been used for a preliminary GSI analysis and associated assignment probabilities. Further sampling and GSI analysis of adults and juveniles are needed before GSI work can be used for population abundance and productivity estimates. Confidence limits for smolt production estimates (by population) will be developed to document the precision of GSI work used for partitioning productivity among the populations within the Yakima Basin MPG. We will conduct a power analysis of the applied reference genetic baseline to quantify assignment precision of steelhead smolts collected from the Chandler Juvenile Monitoring Facility (CJMF). Observed assignment bias for Yakima Basin steelhead populations (if present) will be used to enhance precision of genetic methods.

This project will also expand the flow entrainment study at Prosser Dam to include the estimation precision of total steelhead smolt production. Known assignment bias, total smolt production estimates, and a fixed sampling rate of steelhead smolts at the CJMF will be used to generate confidence intervals bounding the estimation of smolt production by stock.

Steelhead have the most complex life history spectrum of all species of anadromous salmonids in the Columbia Basin. Our current understanding of life history and other population diversity traits within and among Yakima steelhead populations is limited because sufficient time and resources have not been dedicated to understanding the complexity of this task. A population's viability and long-term persistence strongly depends on its ability to withstand environmental perturbations and changes caused by either natural or anthropogenic induced factors. Diversity allows a species to use a wider array of environments than they could without it (McElhany et al. 2000), and populations exhibiting greater diversity are generally more resilient to these environmental changes in the short and long term (ICTRT 2007). A population's diversity comprises a broad range of phenotypic life history traits and underlying genetic diversity. Characterizing and understanding these traits within and among populations will provide necessary information for recovery planners to build more explicit recovery criteria for the diversity component of the VSP framework (YBFWRB 2009). Furthermore, this type of information should be considered essential for understanding temporal and spatial linkages between a population's life history traits, and the habitat types utilized by them.

The Yakima River steelhead VSP project will analyze biological data collected by three projects: Yakima River Monitoring and Evaluation-Yakima/Klickitat Fisheries Project (1995-063-25), Yakama reservation Watershed Project (1996-035-01), and this project. Life history information will contribute to assessing an overall risk rating for the spatial structure and diversity VSP parameters by providing data needed for assessing individual metrics in NOAA's hierarchical format as outlined in the document "Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs" (ICTRT 2007).

Study Area

The Yakima Subbasin is located in south-central Washington. It drains an area of 6,155 square miles and contains about 1,900 river miles of perennial streams (Figure 1). The Yakama Nation Reservation is located in the southwest corner of the subbasin just south of the city of Yakima. Major Yakima River tributaries contained within the Reservation include Satus and Toppenish watersheds. The Yakima River originates near the crest of the Cascade Range above Keechelus Lake at an elevation of 6,900 feet and flows 214 miles southeastward to its confluence with the Columbia (RM 335.2). Major tributaries outside the Yakama Nation Reservation include the Kachess, Cle Elum and Teanaway rivers in the northern part of the subbasin, and the Naches River in the west. Six major reservoirs are located in the subbasin. The Yakima River flows out of Keechelus Lake (157,800 acre feet), the Kachess River from Kachess Lake (239,000 acre feet), the Cle Elum River from Cle Elum Lake (436,900 acre feet), the Tieton from Rimrock Lake (198,000 acre feet), and the Bumping from Bumping Lake (33,700 acre feet). Topography in the subbasin is characterized by a series of thrust fault ridges extending eastward from the Cascades. These Ridges divide the Yakima River into several macro floodplain reaches, each unique to its own physical characteristics. Elevations in the subbasin range from about 7,000 feet in the Cascades to about 350 feet at the confluence of the Yakima and Columbia rivers.

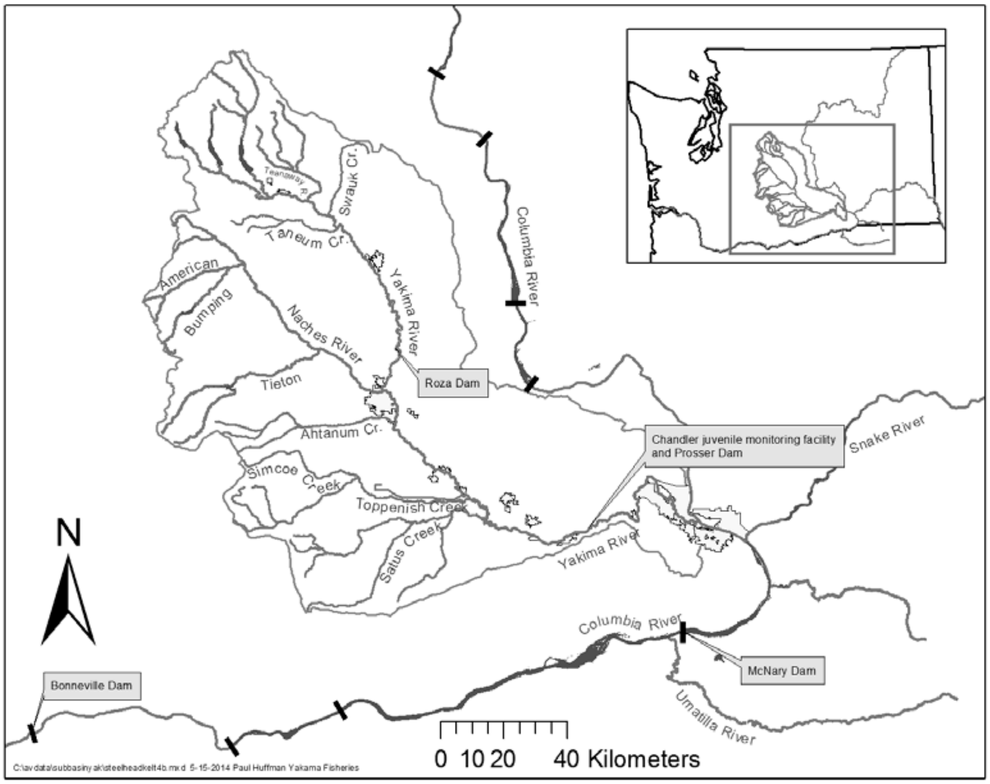

Figure 1. Yakima River Basin showing major steelhead streams and monitoring locations (map courtesy of Paul Huffman).

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

Contract Map(s): *http://www.cbfish.org/Contract.mvc/Map/55510*

Status and Trend of Adult Fish Populations (Abundance)

Methods:

Summer-run steelhead in the Yakima River Basin are enumerated at Prosser and Roza Dams (Rkm 75.6 and Rkm 205.8 respectively) using video equipment installed in adult fish ladders (monitoringmethods.org methods 143, 144, 307, 418, 515). At both Prosser and Roza Dams, adult fish traps are also used on a seasonal basis for biological sampling and enumeration (monitoringmethods.org methods 135). When the Roza adult trap is not in operation, video equipment is also employed at the adult fish ladders there. However, camera placement and actual viewing area are limited; these combined with water clarity issues during certain river conditions all affect video enumeration at Roza Dam. Automatic Passive Integrated Transponder (PIT) tag detectors are also employed at all fish ladders at both dams (see sites RZF and PRO in ptagis.org). For the safety and protection of personnel and equipment, video and PIT-detection equipment are removed during periods of high river flow. In these instances, biologists attempt to extrapolate fish counts using data from before and after the high flow event. Although adult passage over spillways is believed to occur when flows are favorable, Prosser Dam counts are generally considered by Yakama Nation biologists to be within +/- 5% of actual fish passage. Roza Dam counts during trap operation (the entire spring steelhead counting period, February-June, and the forefront of the following run year, July-Oct) are considered virtually 100% accurate; however during the late fall and winter counting period when video equipment is used at least part of the time, accuracy may fall to only 50-75% of actual fish passage based on preliminary evaluation of PIT tag detection data. Fish are denoted as hatchery- or natural-origin based on presence or absence respectively, of observed external or internal marks (monitoringmethods.org method 342).

At Prosser Dam, time-lapse video recorders (VHS) and a video camera were used at viewing windows at each of the three fishways. Digital video recorders (DVR) and progressive scan cameras (to replace the VHS systems) were tested at each of the three Prosser fishways in 2007 and became fully operational in February of 2008. The new system functions very similarly to the VHS system but provides digital video data readily downloadable to the viewing stations in Toppenish. This new system also allows technicians in Toppenish to scan rapidly to images of fish giving a more timely and accurate fish count. The technicians review the images and record various types of data for each fish that migrates upstream via the ladders. These images and information are entered into a Microsoft Access database, and daily dam count reports are regularly posted to the ykfp.org and Data Access in Real-Time (DART) web sites. Similarly at Roza Dam, adult trap data are entered into a Microsoft Access database, and daily dam count reports (with video counts integrated) are regularly posted to the ykfp.org and DART web sites. Post-season, counts are reviewed and adjusted for any data gaps. Historical final counts are posted to the ykfp.org and DART web sites.

Results:

Table 1. Yakima Basin steelhead counts at Prosser and Roza Dams, 1983 – present.

Run Year[1]	Prosser Dam			Roza Dam		
	Wild	Hatchery	Total	Wild	Hatchery	Total
1983-84	911	229	1,140	15	0	15
1984-85	1,975	219	2,194	6	0	6
1985-86	2,012	223	2,235	3	0	3
1986-87	1,984	481	2,465	0	0	0
1987-88	2,470	370	2,840	0	0	0
1988-89	1,020	142	1,162	0	0	0
1989-90	686	128	814	0	0	0
1990-91	730	104	834	0	0	0
1991-92	2,012	251	2,263	107	9	116
1992-93	1,104	80	1,184	15	0	15
1993-94	540	14	554	28	0	28
1994-95	838	87	925	22	1	23
1995-96	451	54	505	90	2	92
1996-97	961	145	1,106	22	0	22
1997-98	948	165	1,113	51	0	51
1998-99	1,018	52	1,070	14	0	14
1999-00	1,571	40	1,611	14	0	14
2000-01	3,032	57	3,089	133	7	140
2001-02	4,491	34	4,525	232	5	237
2002-03	2,190	45	2,235	128	6	134
2003-04	2,739	16	2,755	212	2	214
2004-05	3,377	74	3,451	224	3	227
2005-06	1,995	10	2,005	120	2	122
2006-07	1,523	14	1,537	59	0	59
2007-08	3,025	285	3,310	171	5	176
2008-09	3,444	25	3,469	206	0	206
2009-10	6,602	194	6,796	311	15	326
2010-11	6,064	132	6,196	336	10	346
2011-12	6,206	153	6,359	398	6	404
2012-13	4,516	271	4,787	280	18	298
2013-14	4,083	60	4,143	372	4	376
2014-15	5,181	31	5,212	470	5	475
Means:						
1983-15	2,542	128	2,669	130	4	133
2005-15	4,264	118	4,381	272	7	279
2009-15	5,210	129	5,339	371	9	380

[1] July 1 to June 30 run year.

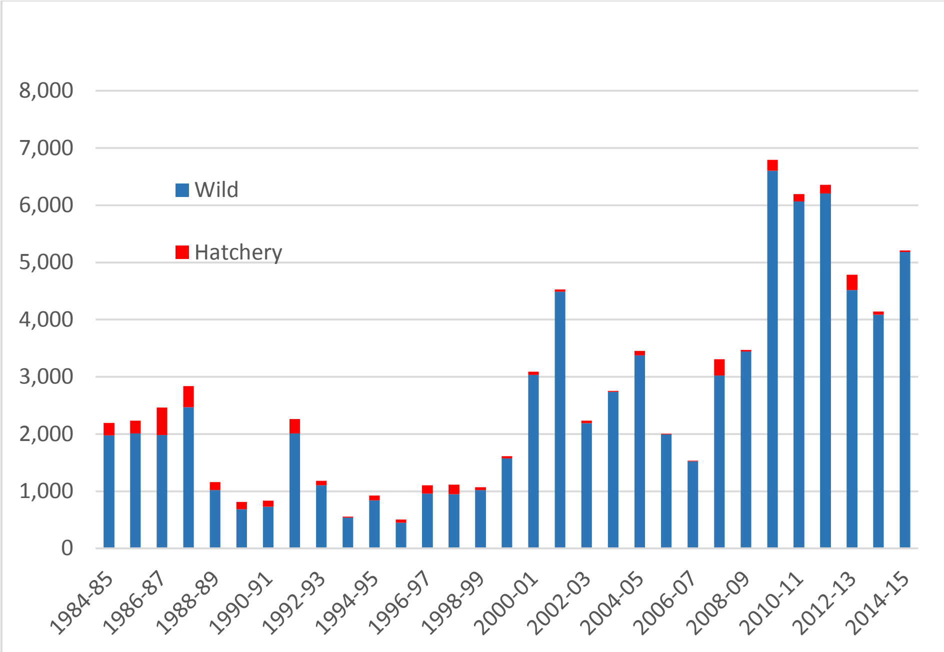

Figure 2. Estimated counts of wild and hatchery-origin steelhead at Prosser Dam, 1983-present.

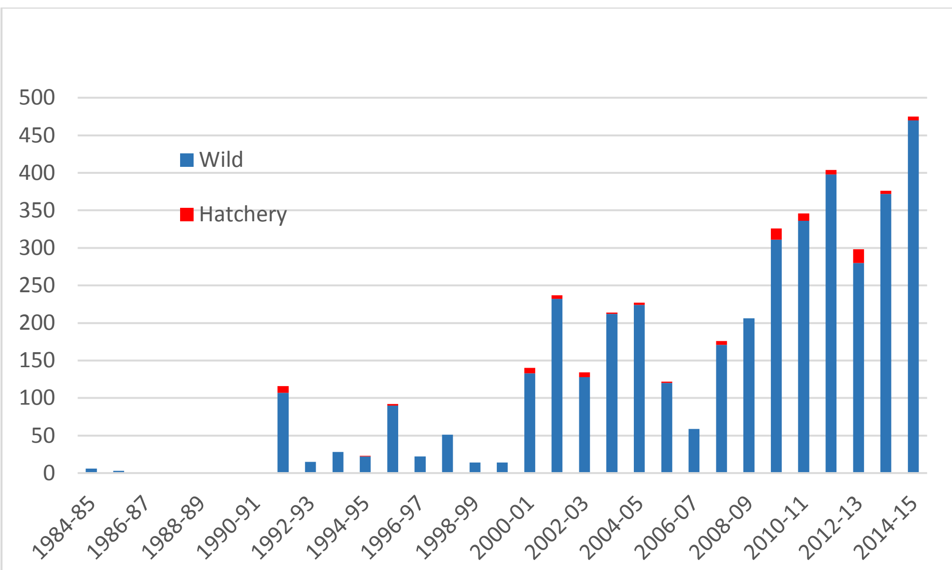

Figure 3. Estimated counts of wild and hatchery-origin steelhead at Roza Dam, 1983-present.

Discussion:

Trends in annual abundance of Yakima River MPG steelhead (Prosser Dam; Figure 2) and Upper Yakima steelhead (Roza Dam; Figure 3) are increasing. For the most recent five steelhead run years (June 30, 2010 to July 1, 2015) mean annual abundance was 5,210 wild steelhead for the MPG and 272 wild steelhead for the portion of the Upper Yakima population spawning above Roza Dam (Table 1). This compares to average annual abundance estimates of about 1,400 steelhead for the MPG and fewer than 25 steelhead for the Upper Yakima population (proportion spawning above Roza Dam) in the 1980s and

1990s. The observed increases in annual abundance can be attributed to numerous factors including but not limited to; habitat restoration actions in the Yakima River Basin (see 1997-051-00, 1996-035-01, and Yakima Basin Fish and Wildlife Recovery Board summary), the Yakima kelt reconditioning program (Hatch et al. 2013), improved freshwater passage conditions, and improved marine survival. Notable droughts occurred during 2001 and 2005 which may have impacted adult returns.

From 1961 until 1986, an average of 63,500 hatchery steelhead smolts were released in the Yakima basin (Phelps 2000), originating primarily from the Skamania steelhead stock. From 1987-1994 steelhead releases ranged from 23,000-155,000, originating from native Yakima steelhead. No hatchery releases of steelhead have been made since 1994 in the Yakima Basin.

For the most recent 10 return years, both the aggregate MPG and the Upper Yakima population returns have averaged greater than 97% wild with some hatchery-origin strays from other Columbia River Basin tributaries (Table 1, Figures 2 and 3).

Steelhead counts at Prosser Dam represent total adult escapement for the Yakima River Major Population Group (MPG). The large geographic distribution of steelhead in the Yakima Basin results in diverse pre-spawning migration and holding patterns that influence the proportion of fish that survives to spawn. Historically, there have been no reliable means of estimating population-specific spawner abundances due to limited methods, enumeration points, and unknown pre-spawn mortality rates. This project conducted a 3 year radio telemetry study that estimated spawner escapement for the Yakima River steelhead populations including Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River populations. In addition to estimating spawner escapement for 3 consecutive years, data from the study will be used to assess the potential long term monitoring methods including the use of GSI and PIT-tagging techniques for apportioning the total run at Prosser Dam.

Status and Trend of Adult Productivity

Methods:

We are still in the process of compiling a comprehensive adult age-at-return database for Yakima steelhead using scale and PIT sampling data from the Prosser denil adult sampling operation (monitoringmethods.org methods 1090, 3916). Until additional data are available, we are using average age-at-return estimates (from 1986-87, 1990-92, and 2002-2004) for years lacking such data in order to conduct brood year cohort analysis (monitoring methods.org method 438) for the time series spanning 1985-2013. Adult-adult return rate estimates presented in Figures 4 and 5 are preliminary and derived from a single enumeration point (Prosser Dam). These estimates have not been adjusted for density dependent effects, harvest, or additional pre-spawn mortality factors. Therefore, these values should not be used to estimate the Intrinsic Productivity for the Yakima River steelhead MPG.

We also assessed the status of the Yakima steelhead MPG relative to the aggregate Bonneville Dam wild Group A population (all wild steelhead <78cm fork length destined to any tributary above Bonneville Dam) by simply dividing the Prosser wild steelhead count for a given steelhead run year (Table 1) by the Bonneville Dam "Group A" wild steelhead count for the same return year (ODFW/WDFW 2014).

Results:

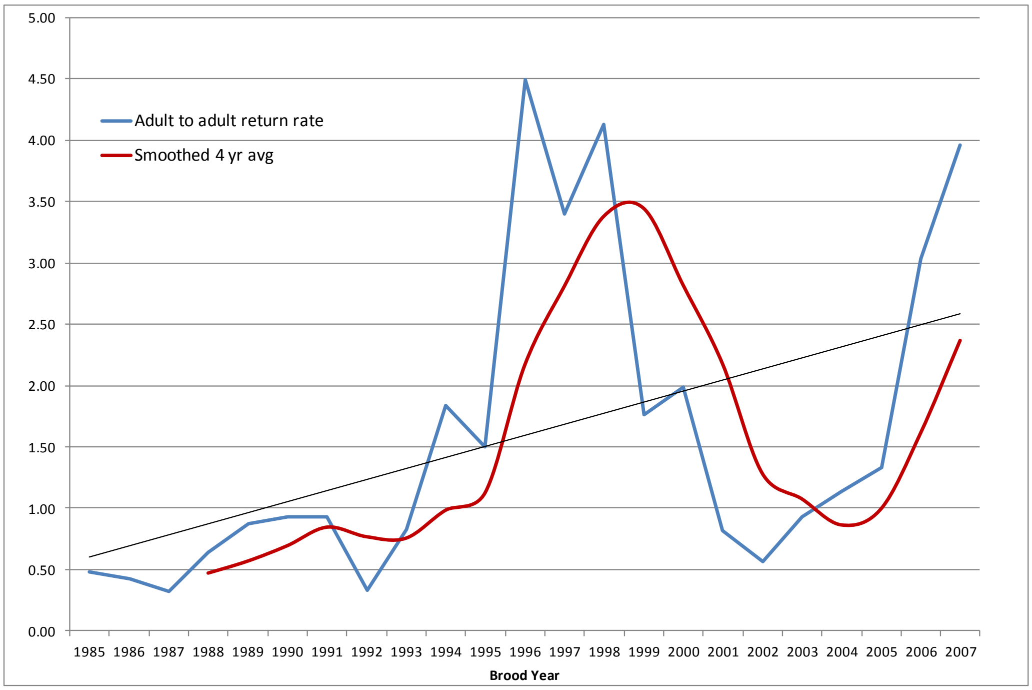

Figure 4. Surrogate adult-to-adult return rate indices for Yakima River MPG steelhead. The majority of age structures used for brood year cohorts rely on averages of age-at-return derived from 9 of 23 years, and are subject to revision when additional age data becomes available. The "smoothed" line represents a four-year running average.

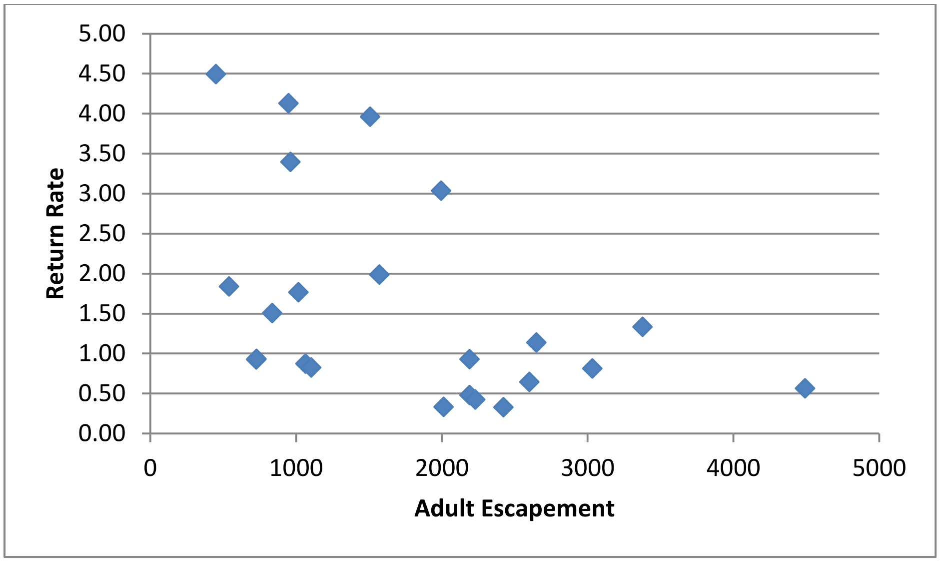

Figure 5. Yakima River MPG steelhead adult-to-adult return rate index.

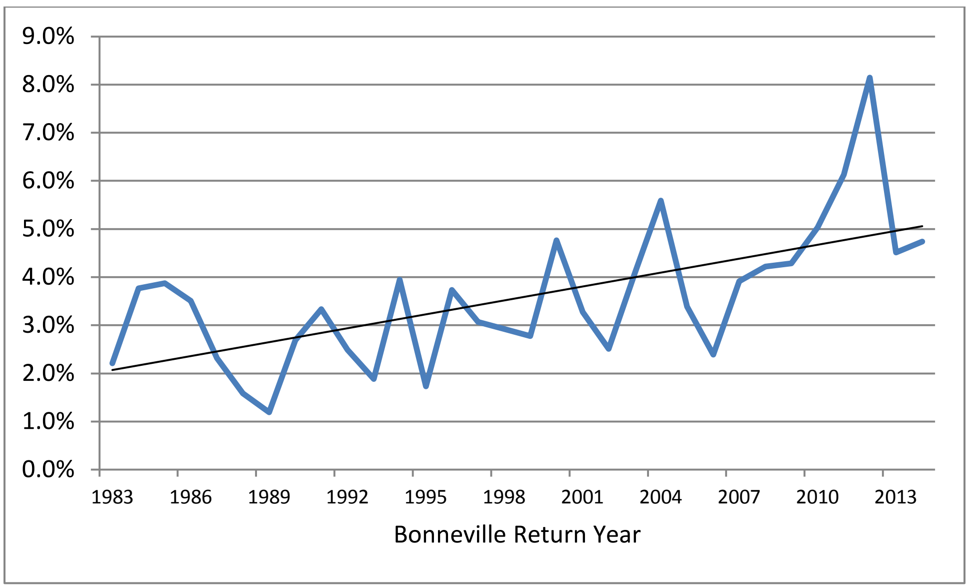

Figure 6. Yakima River MPG steelhead (Prosser wild abundance) as a percentage of Bonneville Dam wild Group A steelhead abundance, 1983 to present.

Discussion:

Adult productivity indices for Yakima River MPG steelhead are presently trending upward (Figures 4 and 6). Under present conditions, productivity appears to peak at about 1,000 to 1,500 spawners and decline at higher spawner abundances (Figure 5). These data indicate that in some years, density-dependent limiting factors (see ISAB 2004) may be depressing natural productivity at fairly low population abundance in the Yakima River Basin. However, Figure 6 indicates that Yakima River MPG steelhead are experiencing improved survival relative to other steelhead streams above Bonneville Dam over and above survival increases due to common freshwater and marine conditions. Habitat restoration actions in the Yakima River Basin (see 1997-051-00, 1996-035-01, and Yakima Basin Fish and Wildlife Recovery Board summary), the Yakima kelt reconditioning program

(Hatch et al. 2013), as well as ongoing efforts to improve fish passage (see Yakima River Basin Water Enhancement Project) and limiting factors in the Yakima Subbasin (see Yakima Basin Fish and Wildlife Recovery Board) may partially explain these results.

Status and Trend of Juvenile Abundance and Productivity

Methods:

Steelhead smolts entrained into the Chandler Canal at Prosser Dam (Figure 1), and representing the entire Yakima steelhead MPG, are counted throughout the outmigration period each year (generally late winter through early summer). Smolt counts can be expanded to total downstream passage if the flow-dependent entrainment rate and the survival rate from the diversion headgate to the counting facility can be reliably estimated. This requires paired releases of PIT-tagged smolts into the dam forebay and at the canal headgates at a variety of river flows through several outmigration seasons, with tag detection in the fish screen bypass and the fish sample room. For additional discussion of these methods see Neeley 2010 and 2012 and monitoringmethods.org methods 422, 512, and 519.

At present, Prosser MPG steelhead smolt passage estimates rely on spring chinook flow-entrainment and canal survival estimates with no information on their applicability between species. The spring chinook passage estimates themselves have proven so unreliable in recent years, probably due in part to fluctuations in migration paths over Prosser Dam, that passage estimation using joint PIT-tag detections with downstream dams to estimate entrainment rate is likely to replace the current flow-entrainment model for that species. This alternative method is facilitated by the fact that over 40,000 hatchery juvenile spring chinook are PIT-tagged each year in the upper Yakima River. The same passage estimation method could be employed for juvenile steelhead, although substantially fewer PIT-tagged steelhead are available. As part of this project, we will continue to explore and evaluate alternative methods for estimating juvenile abundance.

In addition to enumeration, biological data were collected from a portion of salmonid outmigrants sampled at the CJMF on a daily basis and all PIT tagged fish were interrogated. Sampling methods were described in Busack et al. (1997) and were consistent with monitoringmethods.org methods 1562, 1563, 1595, and 1614.

As described earlier in this report, we are still in the process of compiling a comprehensive adult age-at-return database. Until such time as this database is available, we developed a surrogate smolt-to-adult return index from Prosser juvenile and adult abundance estimates assuming all smolts outmigrate at age-2 and all adults return at age-4.

Results:

Table 2. Yakima River MPG Natural-origin steelhead smolt (estimates at Prosser) by brood year and outmigration year. Returning natural-origin adults counted at Prosser 2 years after that smolt migration, and surrogate smolt-to-adult return (SAR) index, 1988-present. Note these data are preliminary and subject to change. DO NOT CITE.

Year	Steelhead Smolts[1]		Adults[2]		SARs	
	Brood Year	Outmigrant Year	Produced by Brood Year	Produced by Outmigrant Year	Brood Year Cohort	Outmigrant Year Cohort
1985	93,477	83,461	1,001	1,700	1.07%	1.89%
1986	86,944	96,639	917	1,877	1.05%	1.81%
1987	49,194	89,657	786	917	1.60%	0.95%
1988	41,009	61,338	1,672	879	4.08%	1.33%
1989	38,058	38,536	927	1,004	2.44%	2.42%
1990	45,864	31,206	673	1,549	1.47%	4.62%
1991	30,238	29,933	679	875	2.25%	2.72%
1992	25,875	50,104	667	624	2.58%	1.16%
1993	31837	24,529	907	687	2.85%	2.60%
1994	47,003	26,748	993	625	2.11%	2.17%
1995	86,760	26,331	1,261	932	1.45%	3.29%
1996	102,951	69,454	2,021	962	1.96%	1.29%
1997	72,490	117,771	3,263	1,229	4.50%	0.97%
1998	36602	70,297	3,914	1,994	10.69%	2.64%
1999	47,597	36,293	1,809	2,641	3.80%	6.77%
2000	33,168	45,127	3,191	4,661	9.62%	9.60%
2001	46,122	31,391	2,473	1,099	5.36%	3.26%
2002	39,044	42,522	2,544	3,570	6.52%	7.81%
2003	46,343	32,599	2,136	3,052	4.61%	8.71%
2004	43,427	37,915	3,163	1,806	7.28%	4.43%
2005	26,113	50,550	4,527	2,040	17.34%	3.75%
2006	22,083	18,265	6,054	3,175	27.41%	16.85%
2007	28,527	30,650	5,977	4,489	20.95%	14.07%
2008	45,380	26,251	N/A	6,227	N/A	23.65%
2009	68,098	28,754	N/A	5,908	N/A	20.55%
2010	N/A	57,948	N/A	N/A	N/A	N/A
2011	N/A	76,000	N/A	N/A	N/A	N/A
2012	N/A	83,000	N/A	N/A	N/A	N/A
Mean	49,368	50,474	2,242	2,181	6.22%	5.97%
Geomean	45,138	44,758	1,752	1,701	3.95%	3.77%

[1]Juvenile age data available from 1985-2007. 2008-09 Used average age structures from prior years.
[2]Adult age data available 1986-87, 1990-92, 2002-2005. All other years used averages from available years.

Discussion:

Since 2000, annual returns of specific adult salmon *Oncorhynchus spp.* runs to the Columbia River Basin have often reached numbers not observed in many decades, with different species doing better in different years. At Bonneville Dam (Figure 1), steelhead counts were especially high in 2001-2002 and 2009-2011 (ODFW/WDFW 2014). Ocean conditions have frequently been cited as one of the factors for the increased abundance (e.g., Williams et al. 2014). However, there have also been many actions taken in recent years to improve passage and habitat conditions throughout the Columbia River Basin (NOAA 2014). Thus it is not unreasonable to expect to observe some evidence of increased productivity throughout the Columbia Basin such as that indicated for the Yakima River steelhead MPG in Figures 4 and 6 and Table 2. In fact, Williams et al. (2014) reported SARs as high as 23.5% for Columbia River sockeye salmon *O. nerka* coincident with recent large adult returns.

Still, there is much reason for caution in interpreting these results. Smolt accounting at Prosser Dam is based on statistical expansion of Chandler smolt trap sampling data using available flow data and estimated Chandler entrainment rates. Chandler smolt passage estimates are prepared primarily for the purpose of comparing relative marked versus unmarked passage estimates and not for making survival comparisons. While these Prosser smolt passage estimates represent the best available data, there may be a relatively high degree of error associated with these estimates due to inherent complexities, assumptions, and uncertainties in the statistical expansion process. Therefore, these estimates are subject to revision.

Given these complicating factors, Table 2 presents a surrogate smolt-to-adult survival index for Yakima River MPG steelhead. Because of the complexities noted above, these data are useful for analysis of trends but should not be used as direct citations of smolt-to-adult survival rates. The reader is encouraged to contact Yakama Nation technical staff to discuss these and other issues prior to any use of these data or any other estimation of Yakima Basin SARs that may be available through data obtained from public web sites such as RMPC, PTAGIS, DART, or other.

Status and Trend of Spatial Distribution

Methods:

Regular foot and/or boat surveys (monitoringmethods.org methods 30, 131, 285, 1508) were conducted within the established geographic range for each species. Redds were individually marked during each survey. The Yakama Nation conducted surveys in Satus, Toppenish, and Ahtanum Creeks. The U.S. Forest Service, WDFW, and other collaborators conducted surveys in the Naches River system. There are currently no organized efforts to conduct redd surveys within the geographic distribution of the upper Yakima population. River conditions vary from year to year and frequently preclude complete accounting due to issues such as water clarity, flow, and access.

In addition to redd surveys, the 3 year telemetry study is assessing and documenting the spatial distribution of radio tagged adult spawners. Detection methods include the use of fixed site locations and mobile tracking efforts with vehicles, boats, foot, and aerial surveys (planes and helicopters). Over the last 10 years, the spatial distribution of adult spawners has been well documented for the Satus and Toppenish Cr populations through redd surveys. Detailed results and maps illustrating the redd locations and spawner distribution for these populations can be viewed in reports provided by project 1996-035-01. The spawning distribution of the upper Yakima population has been estimated and documented from past radio telemetry efforts including a study spanning 1989-1993 (Hockersmith et al. 1995) and a study spanning 2002-2006 (Karp et al. 2009). Here, we present tracking and spawning distribution information for the Naches population generated from 2012 telemetry tracking efforts. A more complete analysis of spatial distribution information will be included in subsequent reports covering the 2012-14 telemetry study, and for the entire Yakima MPG.

Results:

Table 3. Yakima Basin steelhead escapement and redd survey summary, 1987 – present.

Run Year[1]	Prosser Dam Count	Redd Counts by Survey Stream					Roza Dam Count
		Satus	Toppenish	Ahtanum	Naches	Total	
1987-88	2,840	445				445	
1988-89	1,162	404	45			449	
1989-90	814	289	26			315	
1990-91	834	125				125	
1991-92	2,263						116
1992-93	1,184	73				73	15
1993-94	554	114				114	28
1994-95	925	85				85	23
1995-96	505	148				148	92
1996-97	1,106	76	5			81	22
1997-98	1,113	190	13			203	51
1998-99	1,070	130	78			208	14
1999-00	1,611	169	185	11		365	14
2000-01	3,089	252	355	8		615	140
2001-02	4,525	295	111	13		419	237
2002-03	2,235	319	161	16		496	134
2003-04	2,755	117	56	12	94	279	214
2004-05	3,451	110	99	16	140	365	227
2005-06	2,005	60	21	1	19	101	122
2006-07	1,537	87	44	4	44	179	59
2007-08	3,310	110	68	8	11	129	176
2008-09	3,469	119	79	3	29	230	206
2009-10	6,796	465	105		116	686	326
2010-11	6,196	293	100	28	77	498	346
2011-12	6,359	152	46		60	258	404
2012-13	4,787	223	78	20	60	381	298
2013-14[2]	4,143	267	134		40	441	376
2014-15	5,181	206	112		82	400	475

Blank = no data available
All surveys were partial or affected by poor redd visibility due to spring conditions.
[1] July 1 to June 30 run year.

[2] Preliminary.

Discussion:

During the spring of 2012, 138 radio-tagged steelhead presumably spawned within the geographic distribution of the Naches Steelhead population, which includes the Naches watershed in its entirety, the Yakima mainstem extending from the mouth of the Naches down to the Toppenish Cr confluence (RM 116.3-80.4), and Ahtanum Creek. A synthesis of combined holding and spawning detection points are summarized in Figure 7. The distribution of radio tagged steelhead among mainstem and tributary locations are summarized in Figure 8. Prior to the 2012 telemetry study, many of these tributary locations had documented spawning activity from either historical telemetry studies (Hockersmith et al. 1995), or recent redd surveys conducted between 2004 and 2011. Tributaries that were regularly surveyed during this time frame include Ahtanum Cr, Oak Cr (Tributary to Tieton River), Rattlesnake Cr, Nile Cr, Bumping R, and various parts of the Little Naches drainage. Radio tagged steelhead were detected in all of these tributary locations during the spring of 2012.

Other tributary and mainstem areas of special interest are those with little known or documented spawning activity. These include the Yakima River from Toppenish Cr (RM 80.4) to the confluence with the Naches River (RM 116.3), the Naches River floodplain reach (RM 3.3-17.1), Cowiche Cr, Tieton River, Rock Cr, numerous other Naches Mainstem reaches above the confluence with the Tieton, and other small tributaries in the Naches watershed. For many of these areas, not only were radio-tagged steelhead present, but several had unexpectedly high numbers of radio tagged fish that presumably spawned within them. The Tieton River system, for example, was assumed to be void of steelhead with the exception of Oak Cr, due to unsuitable conditions caused by altered flow regimes, reduction in sediment transport, and channel simplification (YSFWPB 2009). Yet among the tributaries of the Naches Subbasin, the Tieton River had the highest number of radio-tagged spawners, totaling 26 (Figure 8). The Naches River mainstem also had a presumably high number of steelhead spawners, both the floodplain reach between Cowiche Dam (RM 3.3) and Wapatox Dam (RM 17.1), and the upper mainstem above Wapatox Dam. Respectively, these areas had approximately 25 and 29 radio tagged steelhead spawners. For the upper mainstem above Wapatox Dam, nearly all the spawning activity took place above Horseshoe Bend (RM 21.2). Approximately 8 radio-tagged steelhead presumably spawned in the Yakima River mainstem between Wapato Dam (RM 106.6) and the Naches confluence (RM 116.3). The 1989-1993 telemetry study also found steelhead spawning in this reach, totaling 4% of the fish radio tagged at Prosser spanning all 3 years of the study (Hockersmith et al. 1995). An improbable find during the 2012 study revealed that 3 radio-tagged steelhead may have spawned within a 5.6 mi stretch of the Yakima River extending from Wapato Dam, and into the floodplain below Sunnyside Dam (RM 101-106.6). The detection histories of these fish were consistent with spawning and kelt like behavior, with none of these fish having migrated above Wapato Dam. Years 2 and 3 of the telemetry study should provide further evidence and validate the presence or absence of steelhead spawners within this section of the Yakima River.

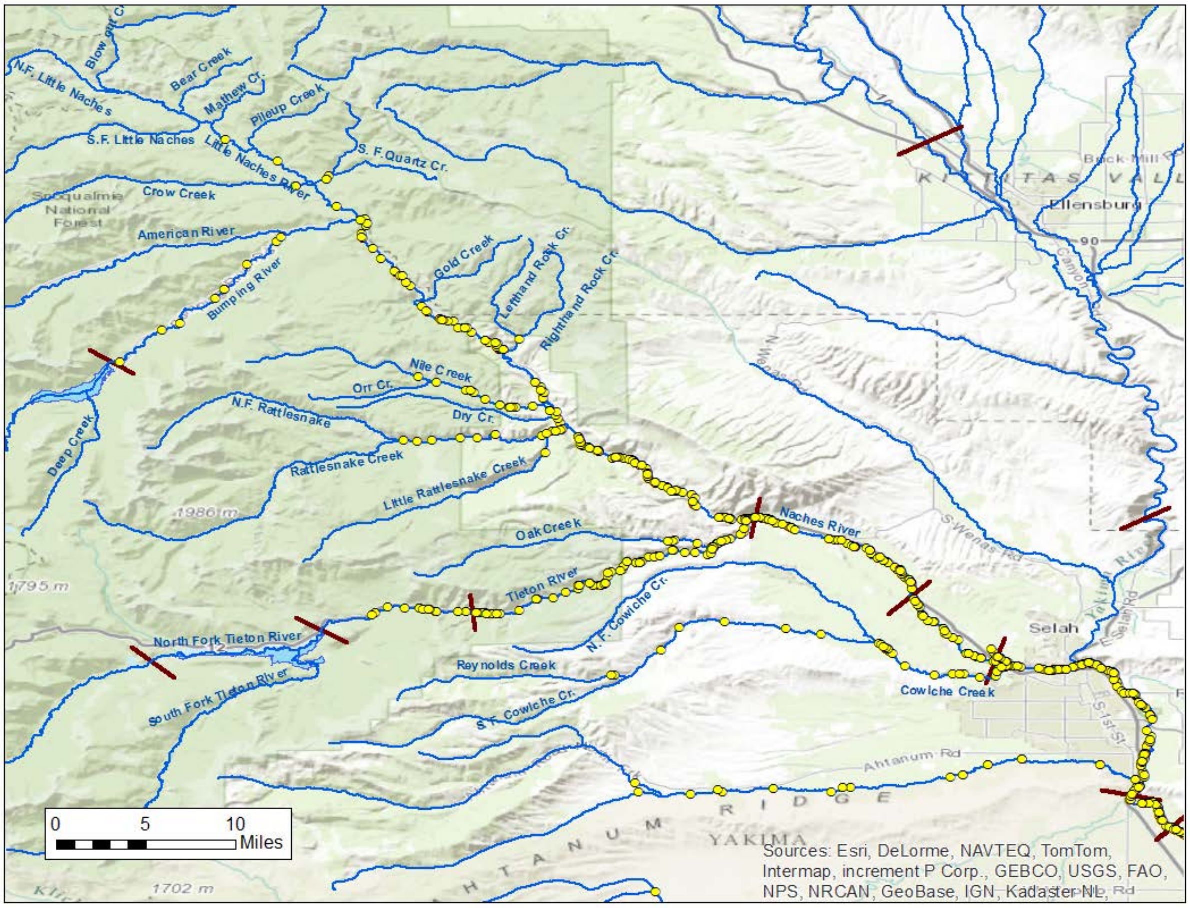

Figure 7. Synthesis of 2012 Detection points of adult steelhead holding and spawning locations for the Naches population.

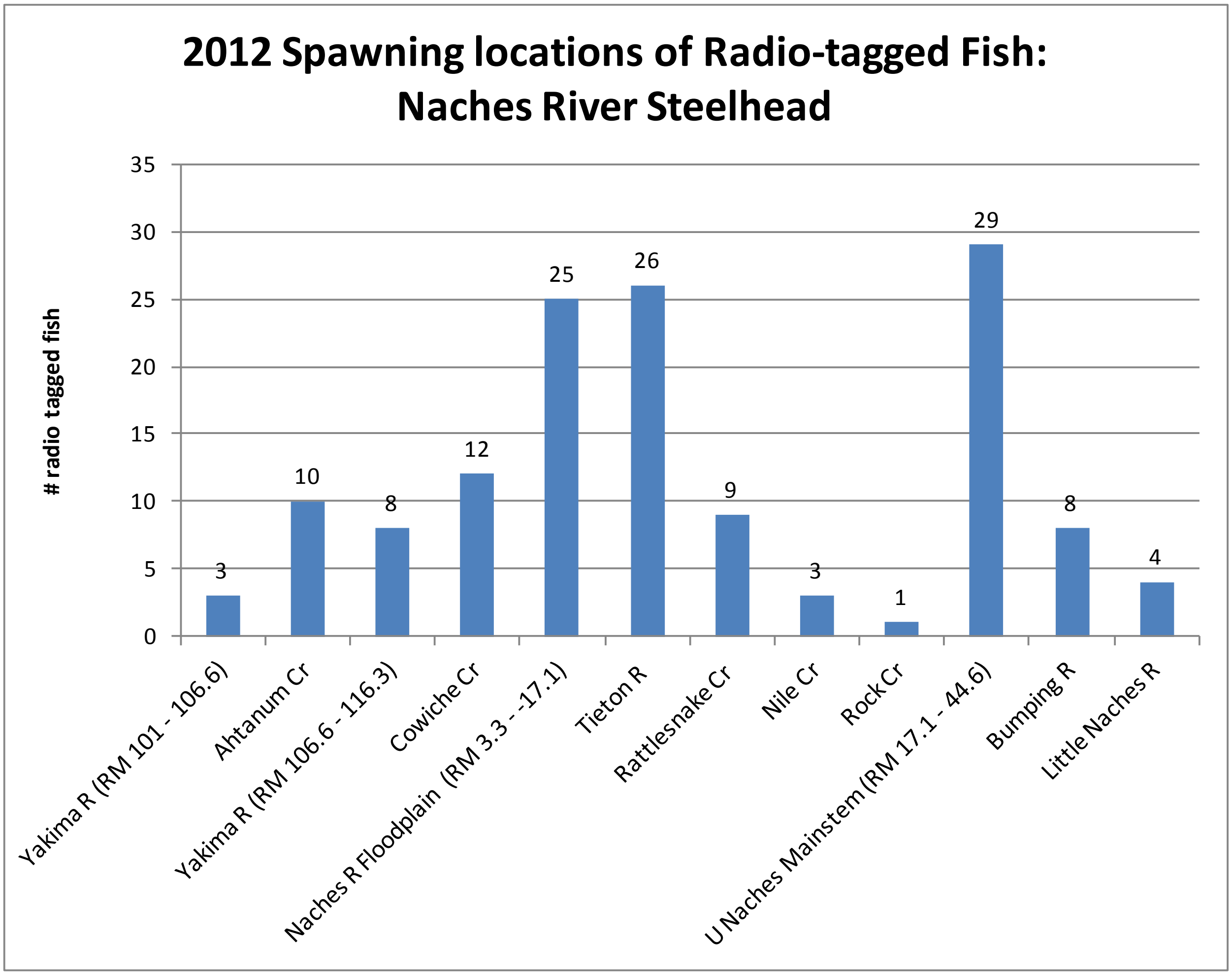

Figure 8. Number and location of Naches River Steelhead spawners in mainstem and tributary locations

Status and Trend of Diversity Metrics

Methods:

Sampling methods for evaluating juvenile steelhead at the CJMF were consistent with monitoringmethods.org methods 1562, 1563, 1595, and 1614. At both Prosser and Roza Dams, adult fish traps were used on a seasonal basis for biological sampling and enumeration (monitoringmethods.org methods 454, 1454, 1548, 1549, 1551, 4008, 4041). Methods for sampling and enumerating downstream migrating kelt (post-spawned) steelhead were described in Hatch et al. (2013). We used these data to describe and evaluate migration timing of juveniles, adults, and downstream migrating kelts; and sex ratios and size distribution of returning adults at Prosser and Roza dams as well as downstream migrating kelts at Prosser (diverted into Chandler canal and the CJMF).

Results:

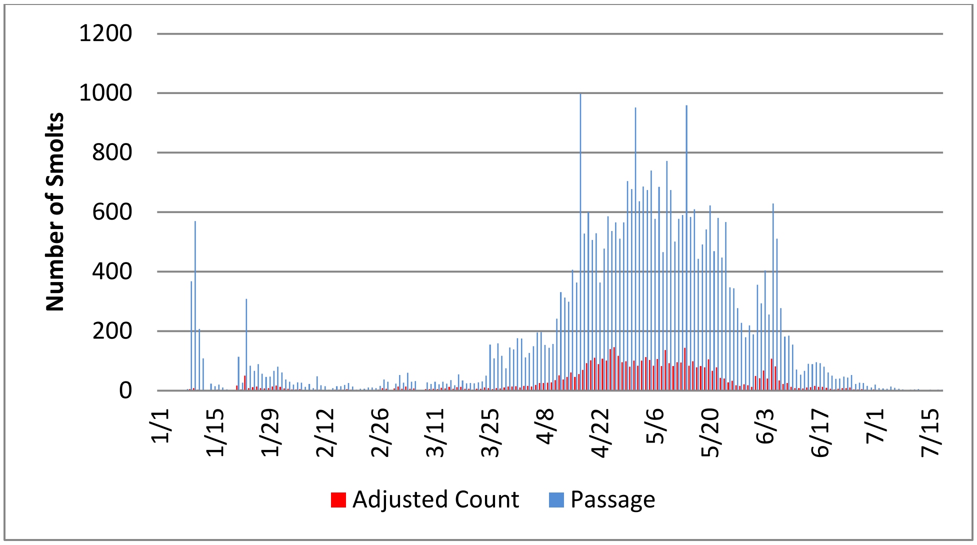

Figure 9. Distribution, average adjusted daily sample count, and estimated smolt passage of Yakima MPG Steelhead at Prosser Dam, 2000-2009.

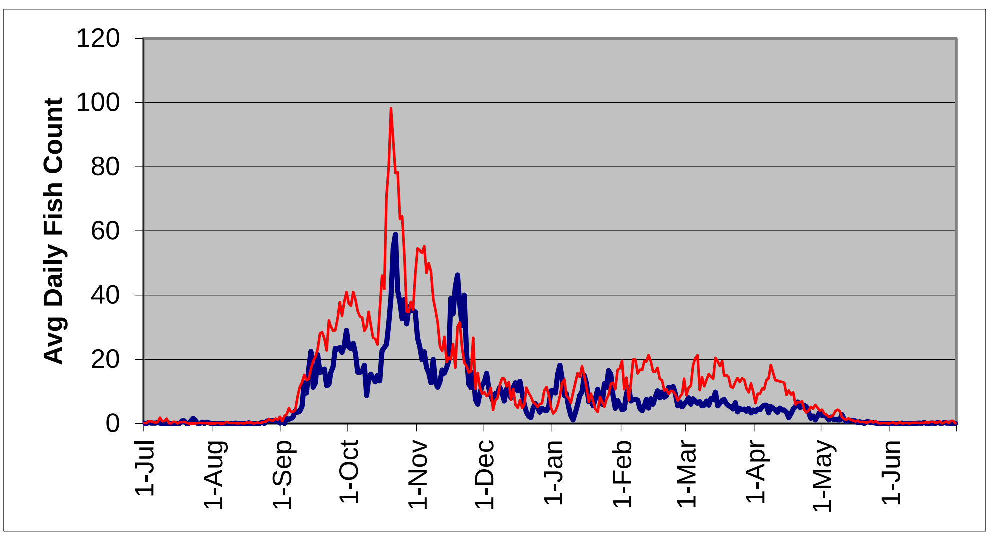

Figure 10. Average Adult Steelhead Run Timing at Prosser Dam, July 1, 1999 to June 30, 2005 compared to July 1, 2005 to June 30, 2015.

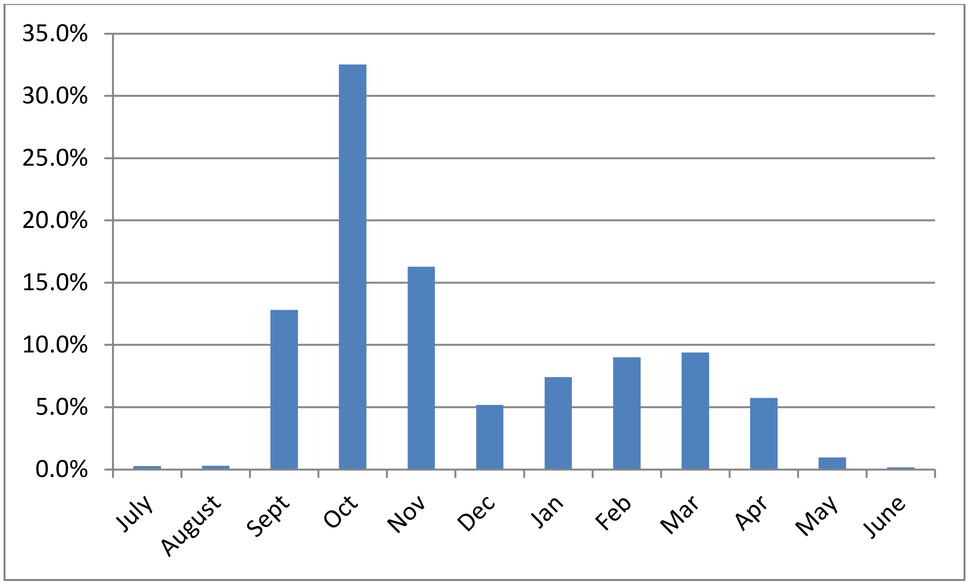

Figure 11. Recent 10-year Average Adult Steelhead Passage Proportions by Month at Prosser Dam.

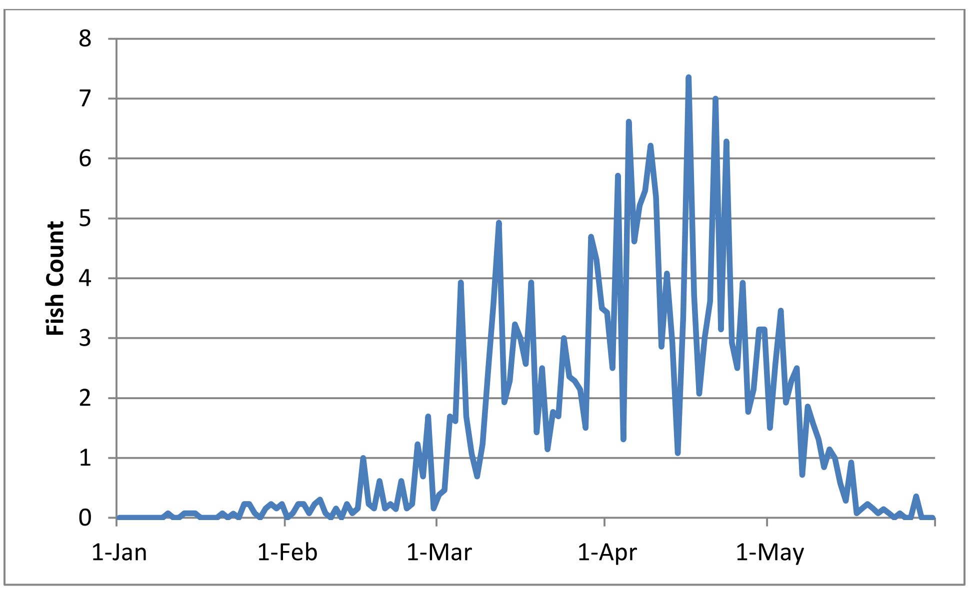

Figure 12. Average Daily Adult Steelhead Passage at Roza Dam, 2001 – 2015.

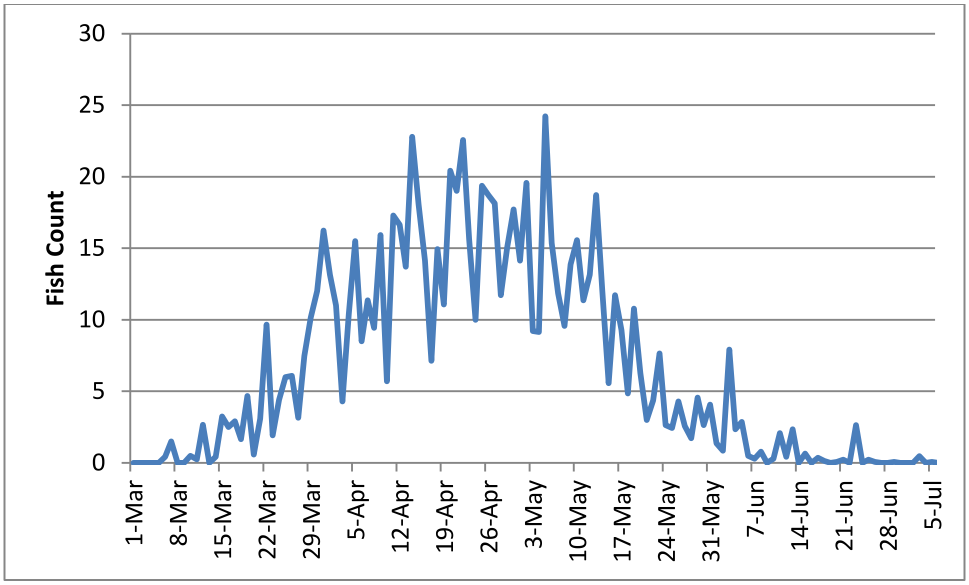

Figure 13. Average arrival timing of downstream migrating, post-spawned kelt steelhead at the Chandler Fish Monitoring Facility (Prosser Dam), 2001-2015.

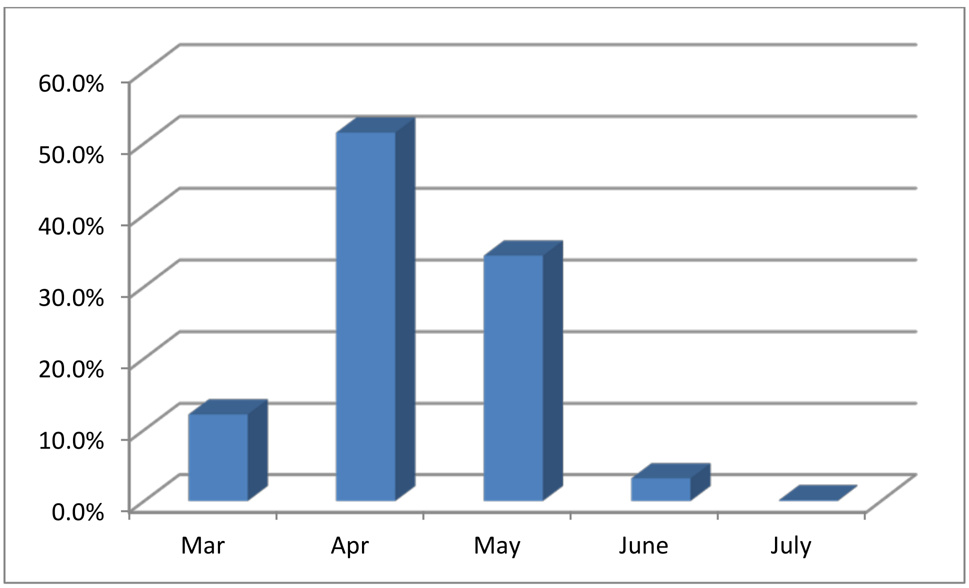

Figure 14. Average Kelt Steelhead Passage Proportions by Month at Chandler, 2001-2015.

Table 4. Sex ratio of upstream migrating wild steelhead sampled at the Prosser Dam right bank denil ladder and fish trap[1], July 1, 2002 to June 30, 2015.

Run Year	Sample Size F	M	Female%	Sample Date Range First	Last
2002-03	144	29	83.2%	09/09/02	11/25/02
2003-04	388	185	67.7%	09/11/03	11/24/03
2004-05	617	356	63.4%	09/06/04	12/02/04
2005-06	274	81	77.2%	09/11/05	11/20/05
2006-07	152	40	79.2%	09/14/06	11/20/06
2007-08	205	67	75.4%	09/11/07	11/20/07
2008-09	165	76	68.5%	09/10/08	12/07/08
2009-10	473	289	62.1%	09/08/09	03/18/10
2010-11	247	109	69.4%	09/08/10	11/17/10
2011-12	455	231	66.3%	09/14/11	05/08/12
2012-13	553	272	67.0%	09/07/12	04/25/13
2013-14	647	279	69.9%	09/16/13	05/01/14
2014-15	556	298	65.1%	09/04/14	04/29/15
		Mean	70.3%		

[1] July 1-June 30 run year. Excludes any fish with a previously-inserted PIT tag to exclude reconditioned kelts which would skew sex ratios even further toward females.

Table 5. Sample size (N), mean fork and mid-eye to hypural plate (MEH) lengths (cm), and weights (pounds) of upstream migrating wild steelhead sampled at the Prosser Dam right bank denil ladder and fish trap[1], July 1, 2002 to June 30, 2015.

Run	Females				Males			
Year	N	Fork	MEH	Weight	N	Fork	MEH	Weight
2002-03	143	68.0	56.1	6.9	29	67.2	53.9	6.6
2003-04	388	60.0	49.4	4.8	185	60.3	48.8	4.8
2004-05	617	62.3	52.1	5.2	356	61.0	50.1	4.7
2005-06	274	65.9	54.6	6.3	81	66.0	54.0	6.2
2006-07	152	64.0	53.0	5.9	40	66.7	54.9	6.4
2007-08	205	61.1	48.7	5.1	67	63.3	49.2	5.3
2008-09	164	64.0	52.2	6.4	76	62.6	51.2	6.0
2009-10	473	62.9	48.7	5.4	289	63.3	48.2	5.7
2010-11	247	65.0	52.1	6.3	109	64.4	50.4	6.0
2011-12	455	65.8	54.3	5.9	230	64.9	52.3	5.6
2012-13	553	65.8	52.2	6.1	272	65.7	51.2	6.0
2013-14	646	62.4	50.5	5.1	279	62.4	50.1	4.9
2014-15	556	65.2	52.8	5.9	298	64.3	51.1	5.6
Mean		64.0	52.1	5.8		64.0	51.2	5.7

[1] July 1-June 30 run year. Excludes any fish with a previously-inserted PIT tag to exclude reconditioned kelts which could skew means.

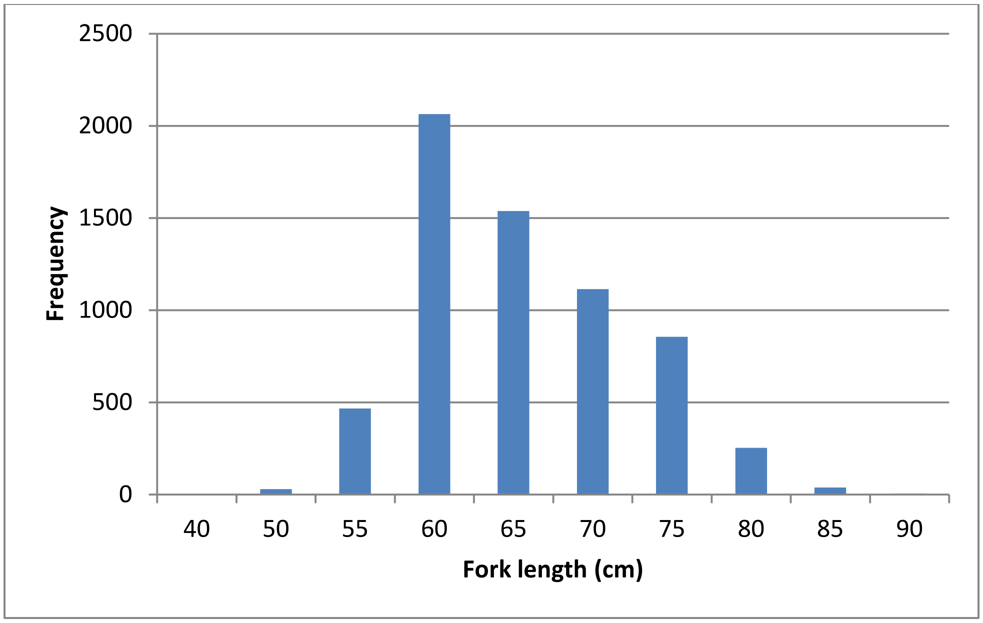

Figure 15. Frequency histogram of fork lengths (cm) for all upstream migrating wild steelhead sampled at the Prosser Dam right bank denil ladder and fish trap, July 1, 2002 to June 30, 2014 (n=6370). Excludes any fish with a previously-inserted PIT tag to exclude reconditioned kelts which could skew the data.

Table 6. Sex ratio of upstream migrating steelhead sampled at the Roza Dam adult fish trap[1], July 1, 2001-June 30, 2015.

Run Year	Sample Size F	M	Female%	Sample Date Range First	Last
2001-02	155	59	72.4%	01/10/02	05/15/02
2002-03	109	20	84.5%	11/18/02	05/13/03
2003-04	148	55	72.9%	07/24/03	06/24/04
2004-05	159	39	80.3%	01/24/05	06/02/05
2005-06	76	38	66.7%	01/13/06	05/15/06
2006-07	42	16	72.4%	02/13/07	05/14/07
2007-08	123	46	72.8%	09/13/07	05/16/08
2008-09	147	44	77.0%	02/25/09	06/03/09
2009-10	220	84	72.4%	07/25/09	06/29/10
2010-11	259	74	77.8%	07/10/10	05/23/11
2011-12	282	72	79.7%	07/10/11	06/19/12
2012-13	151	69	68.6%	09/07/12	05/14/13
2013-14	205	83	71.2%	09/16/13	06/21/14
2014-15	277	88	75.9%	07/09/14	05/20/15
		Mean	74.5%		

[1] July 1-June 30 run year. Excludes any fish with a previously-inserted PIT tag to exclude reconditioned kelts which would skew sex ratios even further toward females.

Table 7. Sample size (N), mean fork and post-eye to hypural plate (POH) lengths (cm), and weights (pounds) of upstream migrating steelhead sampled at the Roza Dam adult fish trap[1], July 1, 2001-June 30, 2015.

Run Year	Females N	Fork	POH	Weight	Males N	Fork	POH	Weight
2001-02	155	65.5	53.8	6.2	59	66.6	53.5	6.3
2002-03	109	69.3	57.1	7.4	20	71.3	57.0	7.6
2003-04	148	60.9	50.0	5.1	55	62.7	49.7	5.2
2004-05	159	66.9	55.4	6.4	39	68.9	55.5	6.7
2005-06	76	66.3	55.0	6.3	38	70.8	57.5	7.4
2006-07	42	64.4	53.6	4.1	16	67.2	54.2	4.7
2007-08	123	61.9	51.5	5.4	46	64.3	51.9	5.6
2008-09	147	65.3	54.1	6.2	44	66.2	53.3	6.2
2009-10	220	62.1	51.6	5.1	84	62.7	50.5	5.1
2010-11	259	66.3	55.3	6.3	74	67.5	54.5	6.5
2011-12	282	63.3	52.9	6.3	72	63.5	51.8	6.3
2012-13	151	63.6	53.3	6.4	69	64.9	52.7	6.8
2013-14	205	60.9	51.4	5.5	83	60.6	49.7	5.2
2014-15	277	63.1	53.2	5.5	88	62.0	50.9	5.0
Mean		64.3	53.4	5.9		65.7	53.1	6.0

[1] July 1-June 30 run year. Excludes any fish with a previously-inserted PIT tag to exclude reconditioned kelts which could skew means.

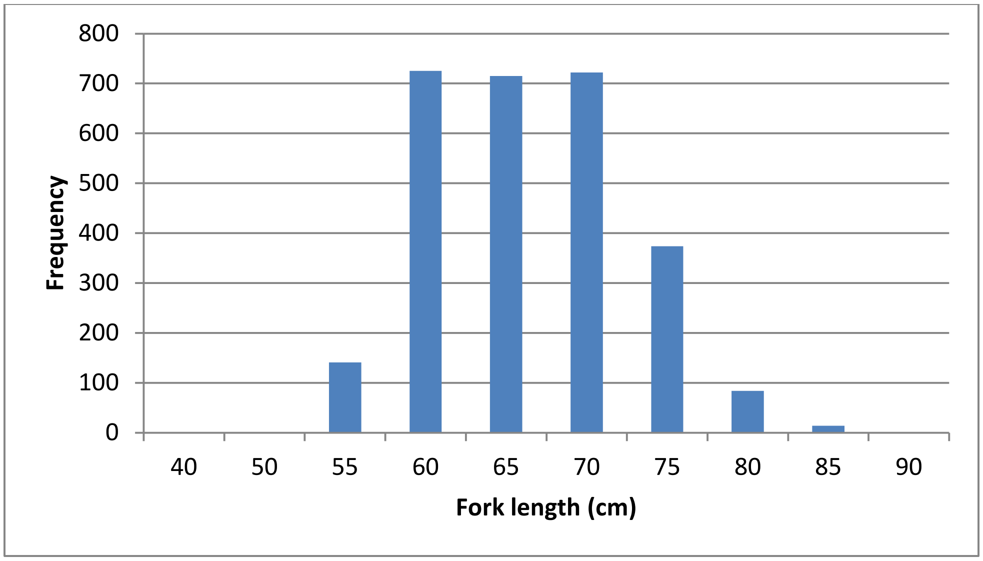

Figure 16. Frequency histogram of fork lengths (cm) for all upstream migrating steelhead sampled at the Roza Dam adult fish trap, July 1, 2001-June 30, 2014 (n=2778). Excludes any fish with a previously-inserted PIT tag to exclude reconditioned kelts which could skew the data.

Table 8. Sex ratio of downstream migrating kelt steelhead sampled at the Chandler juvenile fish monitoring facility, Jan. 1, 2001-June 30, 2015.

Kelt	Sample Size			Sample Date Range	
Year	F	M	Female%	First	Last
2001	525	29	94.8%	03/12/01	06/20/01
2002	1012	116	89.7%	03/11/02	06/13/02
2003	774	51	93.8%	03/12/03	06/21/03
2004	874	121	87.8%	03/15/04	06/21/04
2005	750	79	90.5%	03/01/05	06/23/05
2006	489	44	91.7%	01/25/06	06/08/06
2007	507	74	87.3%	03/26/07	05/31/07
2008	756	97	88.6%	03/21/08	06/23/08
2009	567	49	92.0%	04/09/09	06/03/09
2010	1437	218	86.8%	03/19/10	06/23/10
2011	880	110	88.9%	03/17/11	06/15/11
2012	604	71	89.5%	03/16/12	06/29/12
2013	609	74	89.2%	03/15/13	06/25/13
2014	469	104	81.8%	03/21/14	06/26/14
2015	1158	130	89.9%	03/17/15	06/05/15
		Mean	89.5%		

Table 9. Sample size (N), mean fork and post-eye to hypural plate (POH) lengths (cm), and weights (pounds) of downstream migrating kelt steelhead sampled at the Chandler juvenile fish monitoring facility, Jan. 1, 2001-June 30, 2015.

Kelt	Females				Males			
Year	N	Fork	POH	Weight	N	Fork	POH	Weight
2001	511	64.9	52.6	4.5	25	60.4	48.6	3.9
2002	987	63.3	51.0	4.4	101	61.2	48.0	4.0
2003	774	68.8	56.4	5.6	51	63.1	50.1	4.4
2004	874	60.5	49.6	3.7	121	58.6	46.7	3.5
2005	750	63.6	53.0	4.2	79	59.2	47.7	3.6
2006	489	66.7	56.1	4.8	44	63.5	52.0	4.4
2007	509	64.4	54.0	4.6	76	61.8	50.4	4.1
2008	756	62.1	51.8	4.1	97	61.2	49.8	3.9
2009	568	64.6	54.1	4.6	51	60.6	49.7	3.9
2010	1437	62.2	52.3	4.0	218	60.7	50.2	3.8
2011	880	64.7	54.8	4.7	110	59.6	49.0	3.7
2012	604	64.0	54.3	4.6	72	59.1	48.8	3.8
2013	609	64.7	54.7	4.7	74	58.8	48.7	3.7
2014	469	60.8	51.0	3.5	104	57.8	47.1	3.0
2015	1158	63.5	53.5	4.0	130	57.2	47.1	3.0
Mean		63.9	53.3	4.4		60.2	48.9	3.8

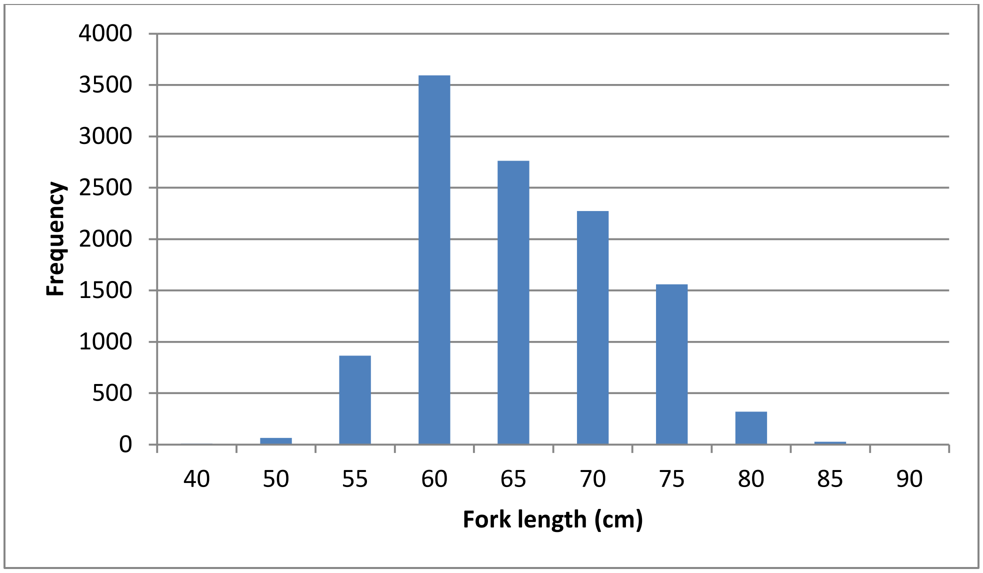

Figure 17. Frequency histogram of fork lengths (cm) for all downstream migrating steelhead sampled at the Chandler juvenile fish monitoring facility, Jan. 1, 2001-June 30, 2014 (n=11482).

Discussion:

Steelhead residing in the Yakima Basin are classified as summer-run based on their July-September run timing at Bonneville Dam (ODFW/WDFW 2014). Adult run timing into the Yakima Basin typically begins in late August or early September, and extends into May of the following year (Figures 10 and 11). After crossing Prosser Dam, the majority of fall migrants overwinter in mainstem areas near the tributary mouths of Satus and Toppenish Creeks. Part of the run will continue upstream, and overwinter in mainstem areas extending up to, and above Roza Dam. Steelhead will typically move upriver and into tributaries when spawning begins the following spring (Figure 12; tributary array PIT detection data). Post-spawned (kelt) and juvenile steelhead downstream passage at Prosser Dam is similar, generally occurring from March-June (Figures 9, 13, and 14). Adult steelhead migrants to the Yakima River Basin are predominantly female, with mean annual percentage female rates ranging from 62-83% (pooled mean 70.3%) at Prosser Dam (Table 4) and from 67-84% (pooled mean 74.5%) at Roza Dam (Table 6) for steelhead sampled from July 1, 2002 (2001 for Roza) to June 30, 2015. Downstream migrating kelt steelhead in the Yakima River Basin are even more skewed towards females, with mean annual percentage female rates ranging from 82-95% (pooled mean 89.5%) at the CJMF (Table 8) for kelt steelhead sampled from March 1, 2001 to June 30, 2015. Postspawn survival in steelhead has been reported to be higher for females than for males (Keefer et al. 2008; Seamons and Quinn 2010; Hatch et al. 2013).

Mean annual fork lengths of wild adult steelhead sampled at Prosser Dam ranged from about 60-68 centimeters (cm) from July 1, 2002 to June 30, 2015 and averaged 64.0 cm for females and 64.0 cm for males (Table 5). Nearly 90% of all wild steelhead sampled at Prosser Dam from July 1, 2002 to June 30, 2014 were between 55.1cm and 75.0cm fork length (Figure 15; range 32-89cm, median 62 cm). Mean annual fork lengths of adult steelhead sampled at Roza Dam from July 1, 2001 to June 30, 2015 ranged from about 61-71 centimeters (cm) and averaged 64.3 cm for females and 65.7 cm for males (Table 7).

Over 91% of all wild steelhead sampled at Roza Dam from July 1, 2001 to June 30, 2014 were between 55.1cm and 75.0cm fork length (Figure 16; range 38-86 cm, median 64 cm). Thus, the vast majority (about 95%) of MPG steelhead returning to the Yakima River Basin are in the "Group A" size management range (< 78cm fork length) which is used for fishery management purposes in the Columbia River Basin (ODFW/WDFW 2014). Mean annual fork lengths of downstream migrating kelt steelhead sampled at the CJMF from Jan. 1, 2001 to June 30, 2015 ranged from about 58-69 centimeters (cm) and averaged 63.9 cm for females and 60.2 cm for males (Table 9). Nearly 89% of all kelt steelhead sampled at the CJMF from Jan. 1, 2001 to June 30, 2014 were between 55.1cm and 75.0cm fork length (Figure 17; range 22-87 cm, median 62 cm).

Adaptive Management and Lessons Learned

One of the primary objectives of the project is to develop long term methods for estimating population specific abundances. Direct estimates were made for each of the populations spanning spawn years 2012-2014 with a 3-year telemetry study. The study also tested the efficacy of other proposed adult abundance monitoring methods for long-term status and trends monitoring, including the use of remote instream PIT-tag detection arrays and Genetic Stock Identification (GSI). The preliminary results for all three methods are summarized in appendix B. The GSI-based spawner estimates will require one more revision due to recent additions of genetic samples to the reference baseline. Here, we focus on the preliminary findings of the Instream PIT-tag arrays and their performance.

Radio Telemetry has become a well-established and common tool used for monitoring adult Salmonid life history characteristics and survival. In many instances, such as for this study, radio telemetry has been used to estimate spawner escapement of one or more populations tagged within a run at large, and containing unknown stock proportions. In addition to providing spawner escapement estimates for each of the 4 extant Yakima River Steelhead populations, the study was used to estimate detection efficiencies of remote Instream PIT-tag detection arrays and compare the accuracy and precision of spawner escapement estimates between the two methods. Detection efficiencies have not been calculated for 2013 and 2014 prior to this report, although efficiency estimates from 2012 demonstrated the Satus and Toppenish Cr Instream-arrays are capable of performing at a high level with efficiency estimates of 96.9% and 100% respectively. The instream arrays were operated continuously during 2013 and 2014, so it is anticipated that detection efficiency estimates were once again greater than 90%.

Thus far, we have been pleased with the monitoring capabilities demonstrated by the Satus and Toppenish Cr PIT-tag detection arrays. Not only have they proven useful for the VSP project, they have contributed valuable data to sister projects like the Kelt reconditioning program. Due to a greater PIT-tag sampling rate (compared to the # of fish radio-tagged each year), the spawner escapement estimates generated from the Instream PIT-tag arrays might actually be more accurate, and with a higher level of precision, than those generated by the radio telemetry data. Not only are the Instream-arrays capable of being used for generating population abundance estimates, they've also proven useful for collecting additional life history data critical for estimating the productivity and diversity parameters needed for population viability analysis.

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Appendix A: Use of Data & Products

All data and findings should be considered preliminary until results are published in the peer-reviewed literature.

Where will you post or publish the data your project generates?

Fish Passage Center
Yakama Nation Fisheries website
DART - Data Access in Real Time
RMIS - Regional Mark Information System
Yakima-Klickitat Fisheries Project website
BPA Pisces
StreamNet Database
BPA Fish and Wildlife publication page
PTAGIS Website

Describe the accessibility of the data and what the requirements are to access them?

- Automated integration of Prosser and Roza dam daily count data with Data Access in Real-Time (DART)
- Integration of PIT and CWT release and recovery data with PTAGIS, RMIS, and Fish Passage Center databases
- Production and support of data bases necessary to support BPA quarterly and annual reports (available via PISCES and BPA reports web site)
- Production and support of data bases necessary to support NPCC project proposals (available via CBfish.org)

Additional data for Yakima River steelhead is available on the ykfp.org web site and by email contact through Bill Bosch (bbosch@yakama.com) or Chris Frederiksen (chrisf@yakama.com). Project data managers participated in the Coordinated Assessments process to develop pilot exchange templates for adult and juvenile abundance and productivity parameters. However, as documented in a letter from Phil Rigdon, Director of Natural Resources for the Yakama Nation to Phil Anderson Director of the Washington Department of Fish and Wildlife, dated 7Nov 2012, the Yakama Nation would like to see the region develop strong, enforceable data sharing agreements before we can support broad population and unlimited use of, and access to these regional databases with data from YN/YKFP projects. We remain concerned about the potential for misuse of project data obtained from existing regional databases.