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ABUNDANCE, PRODUCTIVITY, AND LIFE HISTORY OF FIFTEENMILE CREEK STEELHEAD

BPA Project # 2010-035-00

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1. Executive Summary

Fish Population Status and Trends

We evaluated the population and life history characteristics of Fifteenmile Creek steelhead between January 1, 2015 and December 31, 2015, a population listed as 'threatened' under the endangered species act. These steelhead are a part of the Mid-Columbia Distinct Population Segment for Columbia River steelhead. To achieve study objectives, we deployed a rotary screw trap to capture, tag, and enumerate out-migrating juvenile steelhead, and operated a combination resistance panel/video weir to capture and enumerate returning adult steelhead and estimate escapement. Previous to 2011 we used stratified random spawning surveys (similar to spatially unbiased Generalized Random Tesselation Stratified (GRTS) design) to estimate adult steelhead escapement in Fifteenmile Creek. We continued to operate and maintain the in-stream PIT interrogation arrays during this period. The estimated efficiency of the entire array was 99% during the 2015 season for migrating adults. A total of 141 returning wild adult steelhead, 56 wild steelhead kelts, and 21 wild steelhead carcasses were captured. The estimate for wild adult steelhead escapement to Fifteenmile Creek during the 2014-2015 season was 424 spawners (95% prediction intervals (PI) between 415 and 454), which is the sixth largest adult abundance estimate, since robust statistical methods began in 2003. The lowest escapement estimate for Fifteenmile Creek Steelhead being 225 adults in 2008 and the largest being 988 adults in 2004. We captured 1393 juvenile steelhead, of which 1380 were PIT-tagged. Using detection histories of PIT-tagged juvenile steelhead, we estimated smolt abundance to be 8,317 individuals (95% CI between 6,941 and 8,645); this is the third smallest smolt estimate on record for Fifteenmile Creek steelhead – the smallest being an estimate of 7,436 smolts in 2007. Using age compositions for juvenile outmigrants and returning adults, we reported smolt production in the watershed. The Smolt-to-Adult return (SAR) rates to Fifteenmile Creek were updated for the 2007-2012 smolt outmigration years and ranged from a low 0.478% in 2011 to a high of 3.57% in 2009. Since 2010, SAR estimates have been below the 2.0% goal of recovery. We found significant differences ($p < 0.05$) between SAR rates to Bonneville Dam and SAR rates to Fifteenmile Creek for the 2008, 2009, and 2010 smolt outmigration years, which is consistent with the survival observed between Bonneville Dam and Fifteenmile Creek, suggesting a high mortality rate during Columbia River residence as pre-spawn adults. Survival of returning adults of all ages from Bonneville Dam to Fifteenmile Creek for spawning years 2010, 2011, 2012, 2013, 2014 and 2015 were similarly low and estimated to be 59%, 52%, 44% (95%CI, 42%-46%), 55% (95%CI, 28%-82%), 53% (95%CI, 50%-56%) and 48% (95%CI, 47%-50%) respectively. The recent introduction of PIT detection at The Dalles Dam fish ladders has informed us that the majority of Fifteenmile Creek steelhead ascend the ladders and pass above the dam in the summer and fall before returning to Fifteenmile Creek in the spring to spawn. This is one potential source of pre-spawn mortality that may be mitigated with flow augmentation at The Dalles Dam during critical migration months (December to March), particularly at the ice/trash sluiceway. Other sources of pre-spawn mortality should also be investigated.

The addition of weir trapping for abundance estimates provides an accurate assessment of smolt production. Results showing similar estimates of smolt production for the 2010 to 2013 outmigration years, despite varying adult escapement, suggest production may have been near carrying capacity. With the development of newly implemented technologies, the Fifteenmile Creek watershed has developed into an ideally-sized watershed to monitor Viable Salmonid Population (VSP) parameters for a steelhead population

recovery plan. Further increasing precision for smolt production estimates through the use of the PIT tag detections and trapping efficiency will be investigated to improve estimates, thereby improving our ability to detect productivity changes from habitat modifications. Based on our smolt/adult results, we suggest additional habitat restoration activities are required to increase the productivity and abundance of the Fifteenmile Creek population.

Finally, Viable Salmonid Population (VSP) indicator and metric data that support and feed ODFW's Recovery Planning and BiOP reporting needs are summarized and compiled into a standard format (Coordinated Assessments Data Exchange Standard; (DES) at the population level and stored in a central server location. VSP data in DES format is quality-checked, reviewed, and approved for sharing by a data steward and the primary VSP data contact for each population(s). Upon reviewer approval, data in DES format is made available to the public and interested parties through upload on ODFW's Salmon and Steelhead Recovery Tracker (http://odfwrecoverytracker.org /), NOAA's Salmon Population Summary (SPS; https://www.webapps.nwfsc.noaa.gov/apex/f?p=261:home:0) database, and StreamNet (http://www.streamnet.org /). In addition, incidental mortalities and carcasses are interrogated for parasites and pathogens, which are uploaded to the National Wild Fish Health Survey database (http://www.fws.gov/wildfishsurvey/). Key metrics specific to Fifteenmile Creek for the current reporting period are also shown in the results.

2. Introduction

Fish Population Status and Trends

This project supports the Fish and Wildlife (F&W) Program Strategies:

- Assess the status and trend of natural and hatchery origin abundance of fish populations for various life stages.
- Assess the status and trend of adult productivity of natural origin fish populations.
- Assess the status and trend of juvenile abundance and productivity of natural origin fish populations.
- Assess the status and trend of spatial distribution of fish populations.
- Assess the status and trend of diversity of natural and hatchery origin fish populations.

This project answers or provides data to answer the F&W Program Management Questions:

- What are the status and trend of abundance of natural and hatchery origin fish populations?
- What are the status and trend of adult productivity of fish populations?
- What are the status and trend of juvenile abundance and productivity of fish populations?
- What are the status and trend of spatial distribution of fish populations?
- What are the status and trend of diversity of natural and hatchery origin fish populations?

The information generated from this project will significantly improve the quality of the viability status assessments and serve as a basis for evaluating long term changes in productivity that may result from tributary habitat improvement of an ongoing project that is funded through Bonneville Power Administration. That project has addressed habitat issues on Fifteenmile Creek and its tributaries for greater than twenty years (BPA, project #1993-040-00).

The Fifteenmile Creek watershed in North Central Oregon hosts a native population of steelhead (*Oncorhynchus mykiss*) that is without influence of previous hatchery augmentation (Newton and Nelson 2000). The Fifteenmile Creek steelhead are a subpopulation within the Distinct Population Segment (DPS) of the Middle Columbia River steelhead, which consists of all historical populations of steelhead in tributaries to the Columbia River upstream of the Hood River and Wind River systems, up to and including the Yakima River. This steelhead DPS was listed as 'threatened' by the National Marine Fisheries Service (NMFS) first on March 25, 1999 and relisted as a DPS on January 5, 2006 (71 FR 834, Figure 1).

Subsequently, a conservation and recovery management plan was developed for the Middle Columbia River steelhead DPS within Oregon state borders. The goal of the plan is to recover Middle Columbia River steelhead to a level that would allow the removal of threatened status, in addition to providing a long-term goal to recover the population sufficiently to provide "sustainable fisheries and other ecological, cultural, social and economic benefits for future generations" (Carmichael and Taylor 2010). The DPS-level recovery plan sets specific recovery goals for the areas within the DPS, which designates Fifteenmile Creek explicitly.

The Fifteenmile Creek steelhead population is considered the most inland winter race of steelhead in the Columbia River Basin, as designated by NOAA fisheries. However review of this designation may be

necessary at the next Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) status-review (scheduled for 2015) because the run-timing of adult steelhead passing Bonneville Dam has been inconsistent with known winter-run steelhead in the area. The population was identified as "must have viable" status by the Interior Columbia Technical Recovery Team (ICTRT) reaching viable status is essential for achieving DPS delisting. The ICTRT, Recovery Plan, and the Federal Columbia River Power System (FCRPS-BiOp) have all identified this population as high priority for improving precision and accuracy of abundance, productivity, diversity, and spatial structure information. This status and trend monitoring by ODFW is designed to establish a comprehensive monitoring and evaluation program for abundance, productivity, and life history of steelhead in the Fifteenmile Creek population. This work is critical to gaining a better understanding of the status of the population and DPS, monitoring and adapting recovery actions, and improving the knowledge of steelhead critical habitat.

To establish pertinent management actions for Fifteenmile Creek steelhead, this project seeks to:

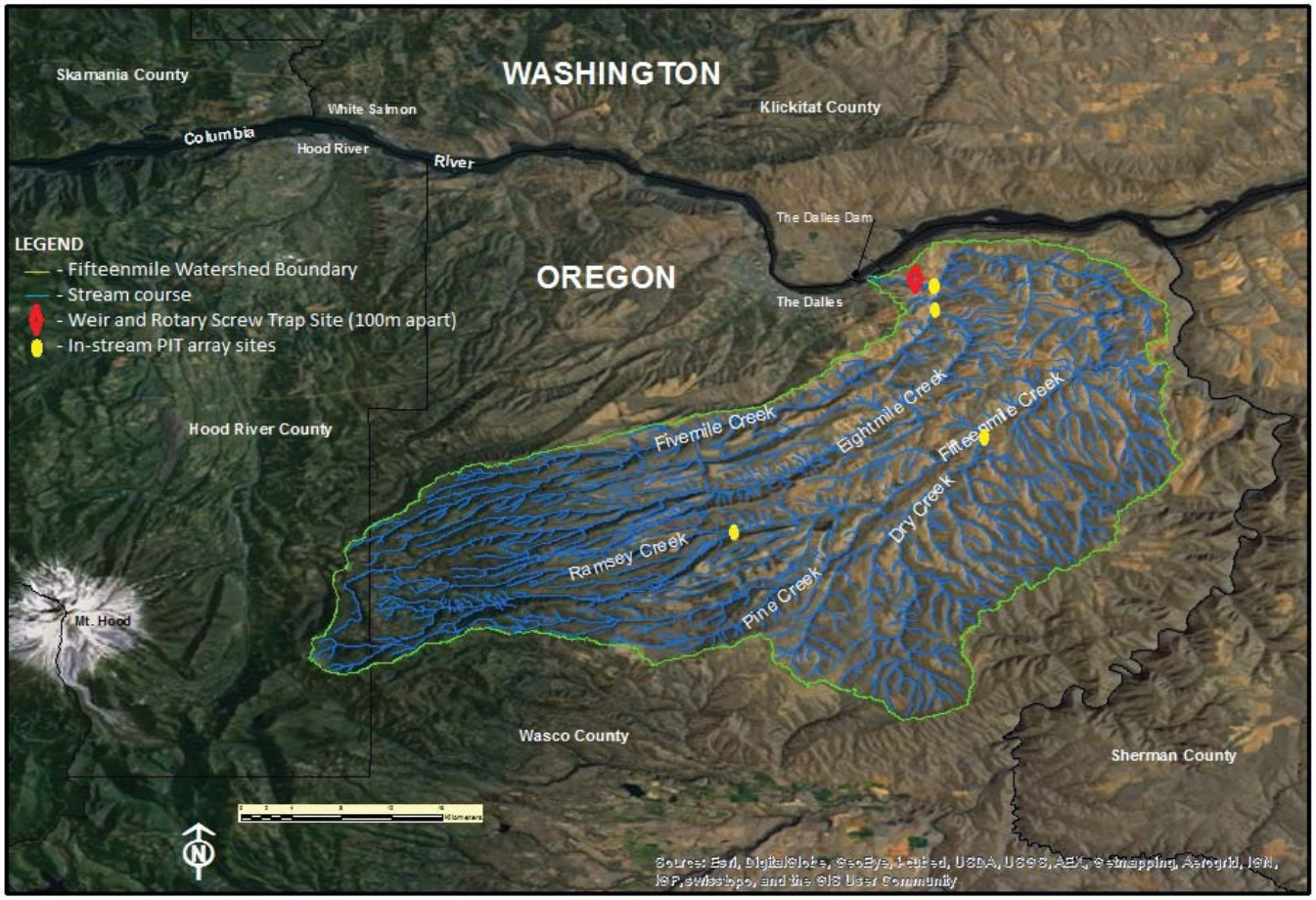
1. Improve accuracy and precision of estimates of spawner abundance
2. Improve accuracy and precision of estimates of abundance of stray hatchery fish
3. Determine life history characteristics (through metrics associated with life history attributes)
4. Determine population dynamics for Fifteenmile Creek steelhead

In order to accomplish these critical goals, population performance metrics were evaluated for Fifteenmile steelhead in 2015 including: age structure; hatchery fraction; adult life history characteristics; juvenile life history characteristics; smolt abundance; smolt migration survival; smolt-to-adult survival; spawner distribution; recruits-per-spawner; and smolts-per-spawner.

Population metrics were evaluated from data collected through the installation and operation of a weir trap to sample adult steelhead, a juvenile outmigrant trap (rotary screw trap), juvenile salmon surveys throughout the watershed, and from the installation of passive integrated transponder (PIT) tag arrays at strategic sites throughout the basin. Analyses integrate life-stage specific survival and life history information in order to derive and assess the performance metrics. The 2015 sampling season marks the fifth year of monitoring and research that has specifically addressed these objectives; however smolt outmigration has been monitored since 2006 through the use of PIT-tagged out-migrating smolts (Macnab and Springston 2009) from which essential data has been provided, and is included in this report. Smolt returns from prior years were also used in our analyses. This status and trend monitoring project is a long-term endeavor that will span multiple steelhead generations.

a. Maps

Watershed Map:



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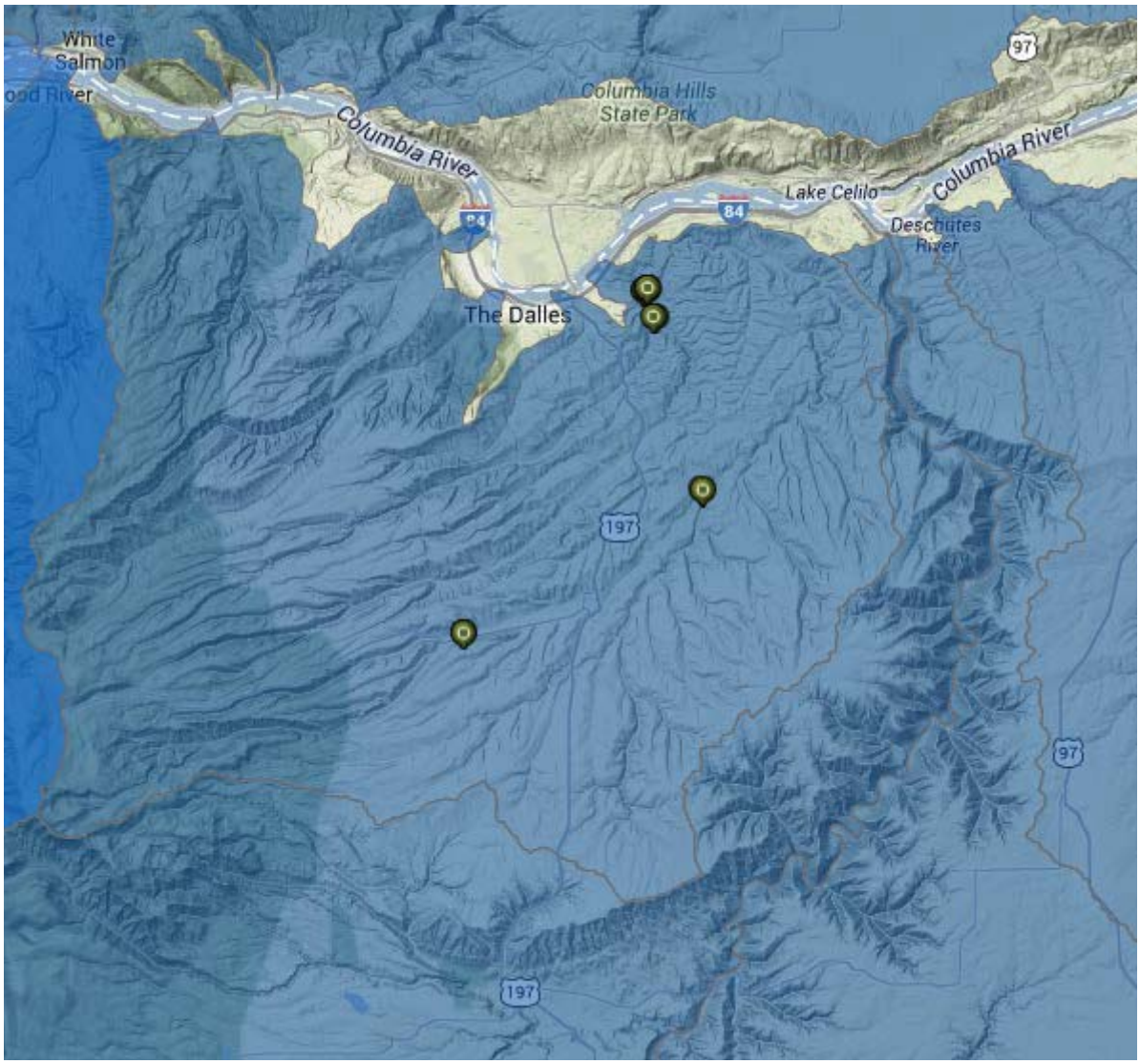
Project Map:

http://www.cbfish.org/Project.mvc/Map/2010-035-00

Contract Map(s):

http://www.cbfish.org/Contract.mvc/Map/60980



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

Protocol Title: Interim Protocol- Fifteenmile Creek Adult and Juvenile Steelhead Abundance and Distribution 2010-035-00

Protocol Link: https://www.monitoringresources.org/Document/Protocol/Details/2176

Protocol Summary: The purpose of this protocol is to describe installation and operation of a weir, adult trap, and underwater video cameras to: assess adult escapement; estimate productivity as adult recruits per spawner; determine the proportion of returns that are hatchery origin strays; determine adult life history patterns. We will use a combination of live box capture and video monitoring to count passage. Sample size should not be a factor unless the weir fails and we need to mark/recapture adults. All handled adults will be marked to maintain the maximum possible sample size.

Protocol Title: Fifteenmile Creek Steelhead Spawning Surveys (2010-035-00)

Protocol Link: https://www.monitoringresources.org/Document/Protocol/Details/2177

Protocol Summary: The purpose of this protocol is to describe spawning surveys that are done in Fifteenmile Creek, Eightmile Creek, Fivemile Creek, and Ramsey Creek (99.27mi total; 44.93 in Fifteenmile Creek, 24.32mi in Eightmile Creek, 20.02mi in Fivemile Creek, and 10.00mi in Ramsey Creek).

Study Area:

The Fifteenmile Creek drains approximately 370 square miles (966 km^2) of the eastern slopes and foothills of the Cascade Range in north-central Oregon. From its headwaters in Mount Hood National Forest, Fifteenmile Creek flows northeast through the city of Dufur before turning north and then west and flowing into the Columbia River just downstream of The Dalles Dam (Figure 1). The watershed lies entirely within the boundary of lands originally occupied by member tribes of the Confederated Tribes of The Warm Springs. Current land-ownership is largely private, except for the headwaters portions lying within the National Forest boundaries. The majority of private lands are used for agricultural production, including wheat and other grains, hay and alfalfa, orchard fruits, and cattle production. The major tributaries to Fifteenmile Creek, working downstream of the headwaters, are Ramsey Creek (entering Fifteenmile in the Dufur Valley), Pine Creek (entering in the city of Dufur), Dry Creek (entering Fifteenmile downstream of the city of Dufur), and Eightmile Creek (entering Fifteenmile approximately 2.5mi upstream of its confluence with the Columbia River). Eightmile Creek is the largest tributary to Fifteenmile Creek, and its main tributary is Fivemile Creek, which enters Eightmile Creek approximately one mile upstream of the confluence of Eightmile and Fifteenmile creeks.

The Fifteenmile basin is situated at the eastern end of the Columbia River Gorge, a zone where the cooler, moister conditions typically found in the Gorge transition to the warmer, drier conditions typically found in eastern Oregon. As a result, many characteristics of the basin exhibit greater diversity than would

be found in either the Gorge or further east. General flora community structure in Fifteenmile watershed ranges from pine- and fir-dominated coniferous forest in the headwaters, to mixed-oak-pine woodland in the middle to lower elevations, and finally to bunchgrass- and sagebrush-dominated grasslands in the eastern and low-elevation portions of the watershed (Clark 2003). Mean annual precipitation can vary widely within the watershed, and generally ranges from upwards of 70 inches in the headwaters to approximately 10 inches near the confluence of Fifteenmile Creek and the Columbia River. Precipitation falls primarily as snow during the winter months, but moderate-to-heavy fall and spring rainfall events are not uncommon.

The hydrologic regime in Fifteenmile Creek is characterized by high spring runoff (resulting from snowmelt, sometimes in combination with warm spring rains) followed by low summer and fall flows. Normally low summer discharge is typically compounded by stream and water-table withdrawals made primarily for crop irrigation and livestock watering. High summertime air temperatures are common, and as a result, summertime temperatures in many stream reaches in the lower and middle portions of the watershed can exceed the salmonid rearing threshold temperature of 17.8°C (Macnab and Springston 2009).

In addition to the wild population of steelhead native to Fifteenmile Creek, the native fish community includes coho salmon (*O. kisutch*), cutthroat trout (*O. clarkii*), Pacific lamprey (*Lampetra tridentata*), western brook lamprey (*L. richardsoni*), northern pikeminnow (*Ptychocheilus oregonensis*), redside shiner (*Richardsonius balteatus*), chiselmouth (*Acrocheilus alutaceus*), mountain sucker (*Catostomus platyrhynchus*), largescale sucker (*C. macrocheilus*), and several species of dace (*Rhinichthys* spp.) and sculpin (family Cottidae).

4. Results

Key Tables

Table 1. Summary table of key metrics for Fifteenmile Creek steelhead

Abundance and Life History:			95% CI		
Natural Origin Spawner Abundance (NOSA)	Year	Estimate	Lower	Upper	Notes
	2003	836	502	1170	Based on stratified spawning surveys
	2004	988	534	1442	Based on stratified spawning surveys
	2005	352	0	2231	Based on stratified spawning surveys
	2006	*	*	*	* No survey conducted
	2007	196	0	433	Based on stratified spawning surveys
	2008	129	46	213	Based on stratified spawning surveys
	2009	*	*	*	* No survey conducted
	2010	737	251	1222	Based on stratified spawning surveys
	2011	415	198	692	Based on weir mark-recapture
	2012	557	308	806	Based on weir mark-recapture
	2013	290	266	316	Based on video counts, weir data, and PIT array data
	2014	513	464	571	Based on video counts, weir data, and PIT array data
	2015	424	415	454	Based on video counts, weir data, and PIT array data
			95% CI		
Hatchery Origin Spawner Abundance (HOSA)	Year	Estimate	Lower	Upper	
	2011	17	8	28	Based on percentage of hatchery origin fish caught above the weir
	2012	27	15	39	Based on percentage of hatchery origin fish caught above the weir
	2013	21	19	23	Based on video data and video based escapement data
	2014	12	11	14	Based on video data and video based escapement data
	2015	8.2	8.15	8.28	Based on video data and video based escapement data
Adult Sex Ratio:	Year	Male	Female	n-captured	
	2011	43.9%	54.1%	98	
	2012	40.0%	60.0%	180	
	2013	34.6%	65.4%	188	
	2014	37.3%	62.7%	158	
	2015	35.4%	64.6%	212	

Spawning Distribution, 2015:		PIT Array	Surveys				Values are percent of adult run
Stream Reach:	Fifteenmile – Lower[a]	48.3%	47.2%				PIT Array: Spawning reach determined by PIT detection histories from the PIT array Surveys: based on number of redds found in each stream reach [a]Lower Fifteenmile refers to the section of Fifteenmile Creek between the Fifteenmile/Eightmile confluence and the Fifteenmile/Dry confluence. Mid-Fifteenmile refers to the section of Fifteenmile Creek between the Fifteenmile/Dry confluence and the Fifteenmile/Ramsey confluence. Upper Fifteenmile refers to the section of Fifteenmile above its confluence with Ramsey Creek.
	Fifteenmile – Mid[a]	20.8%	26.4%				
	Fifteenmile – Upper[a]	3.9%	12.5%				
	Fivemile	1.1%	0%				
	Eightmile	23.6%	13.9%				
	Dry	1.9%	-				
	Ramsey	0.56%	0.0%				
Adult Freshwater Age:		Age 1	Age 2	Age 3	n-aged		
	2011	62.7%	37.3%	0.0%	86		
	2012	69.7%	29.3%	1.0%	208		
	2013	70.4%	28.6%	1.0%	210		
	2014	60.8%	39.2%	0.0%	181		
	2015	64.1%	36.0%	0.0%	214		
Adult Total Age:		Age 3	Age 4	Age 5	Age 6	Age 7	
	2011	19.8%	59.2%	19.8%	1.2%	0.0%	Total age = FW age + SW age + number of years after first freshwater re-entry
	2012	29.8%	51.0%	16.8%	1.4%	1.0%	
	2013	21.0%	64.3%	13.3%	1.4%	0.0%	
	2014	26.0%	60.8%	10.5%	2.2%	0.6%	
	2015	27.6%	51.9%	19.2%	1.4%	0.0%	
Incidence of Repeat Spawning (Iteroparity):		1st Spawn	2nd Spawn	3rd Spawn	n-fish		Determined from scale pattern analysis of adults captured at the weir
	2013	92.1%	7.4%	0.5%	189		
	2014	93.6%	5.8%	0.6%	156		
	2015	97.2%	2.8%	0.0%	214		

Smolt Abundance:

Year	Released (n)	Estimate	95% CI Lower	95% CI Upper
2007	286	7436	4200	13349
2008	1232	7905	6953	9016
2009	2735	16549	15223	18016
2010	2135	26972	23361	31197
2011	2202	25817	21296	31414
2012	2527	25775	21962	30484
2013	2012	33311	28580	39842
2014	406	10601	6988	18624
2015	1394	5395	4824	6054

Smolt Age: Year	Age 1	Age 2	Age 3	n-aged
2011	80.3%	19.3%	0.4%	226
2012	78.9%	19.3%	1.8%	342
2013	80.0%	19.8%	0.2%	1859
2014	71.6%	28.2%	0.3%	387
2015	85.5%	14.5%	0.1%	1581

Survival:

	Estimate	95% CI Lower	95% CI Upper
Smolt Migration, 2015:			
% Surviving To Bonneville	66.3%	27.7%	98.8%
% Surviving To Estuary	14.6%	0%	63.0%
Adult Migration, 2014-15:			
% Bonneville to Fifteenmile	48%	47%	50%

Cormack-Jolly-Seber (CJS) model based on migrant juvenile steelhead tagged at Fifteenmile screw trap (n = 1394)

Based on detections at Bonneville and Fifteenmile

Production:

Smolts-per-Spawner:

Brood Year	Estimate	95% CI Lower	95% CI Upper
2006	20.7	13.1	34.2
2007	29.6	26.4	33.2
2008	82.3	74.4	91.2
2009	68.2	58.6	79.7
2010	31.6	26.3	38.3
2011	65.0	55.4	77.1
2012	53.2	44.6	66.6
2013*	30.4	20.7	50.4

*Estimates preliminary - missing one or more age class

	2014*	13.9	11.6	14.4	*Estimates preliminary - missing one or more age class
Smolt-to-Adult Return Rates: Year	Outmigration	Estimate	Lower	Upper	To Fifteenmile Creek, years shown refer to smolt
	2007	2.45	1.17	5.04	outmigration years; return rates in percent
	2008	3.57	2.67	4.77	
	2009	2.05	1.58	2.65	
	2010	1.22	0.83	1.78	
	2011	0.59	0.34	1.01	*Preliminary estimates - not all ocean age-classes
	2012*	0.64	0.39	1.03	represented
Recruits-per-Spawner: Year	Brood	Estimate	Lower	Upper	
	2008	3.22	1.96	9.13	By brood year, based on 2011-2015 adult returns.
	2009	1.04	*	*	* An estimate of the spawner abundance for 2009 is made by reconstructing the unknown 3 - 6 yr old cohorts from brood years 2003 - 2006 based on the average proportion at age by brood year for years with observations, therefore no confidence limits are provided.
	2010	**	-	-	**Not enough ocean year returns represented to
	2011	**	-	-	estimate
	2012	**	-	-	
			95% CI		
Outside Influence & Straying:		Estimate	Lower	Upper	
Hatchery Fraction, 2015		1.91%	1.80%	1.98%	Based on video data and video-based escapement est.
Stray Rates:					
of Fifteenmile Steelhead, 2015		4.29%	-	-	Based on PIT Tag detections of fish with known origins
into Fifteenmile Creek, 2015		0%	-	-	Based on PIT Tag detections of fish with known origins

Key Figures

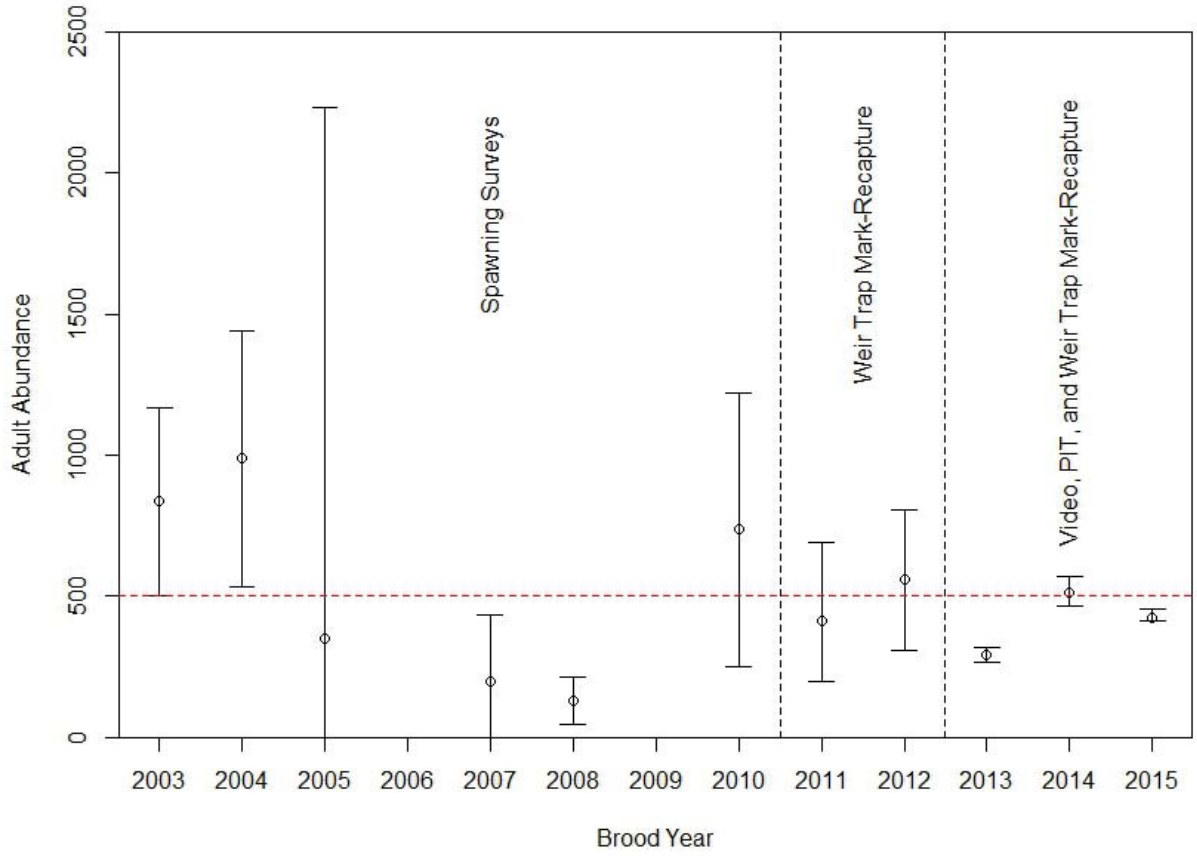


Figure 1. Time series of spawner abundance estimates for Fifteenmile Creek steelhead, presented by brood year. Before 2011, spawner abundance estimates were calculated based on redd counts and a fish-per-redd estimate from Deer Creek (Grande Ronde watershed, Oregon). For 2011 and 2012, spawner abundance estimates were produced using a Peterson-style mark-recapture estimator and mark-recapture data from the adult weir trap. Starting in 2013, spawner abundance was estimated from a combination of video-weir counts, weir-trap data, and PIT antenna array detection data. The dashed red line indicates the adult abundance threshold for population viability.

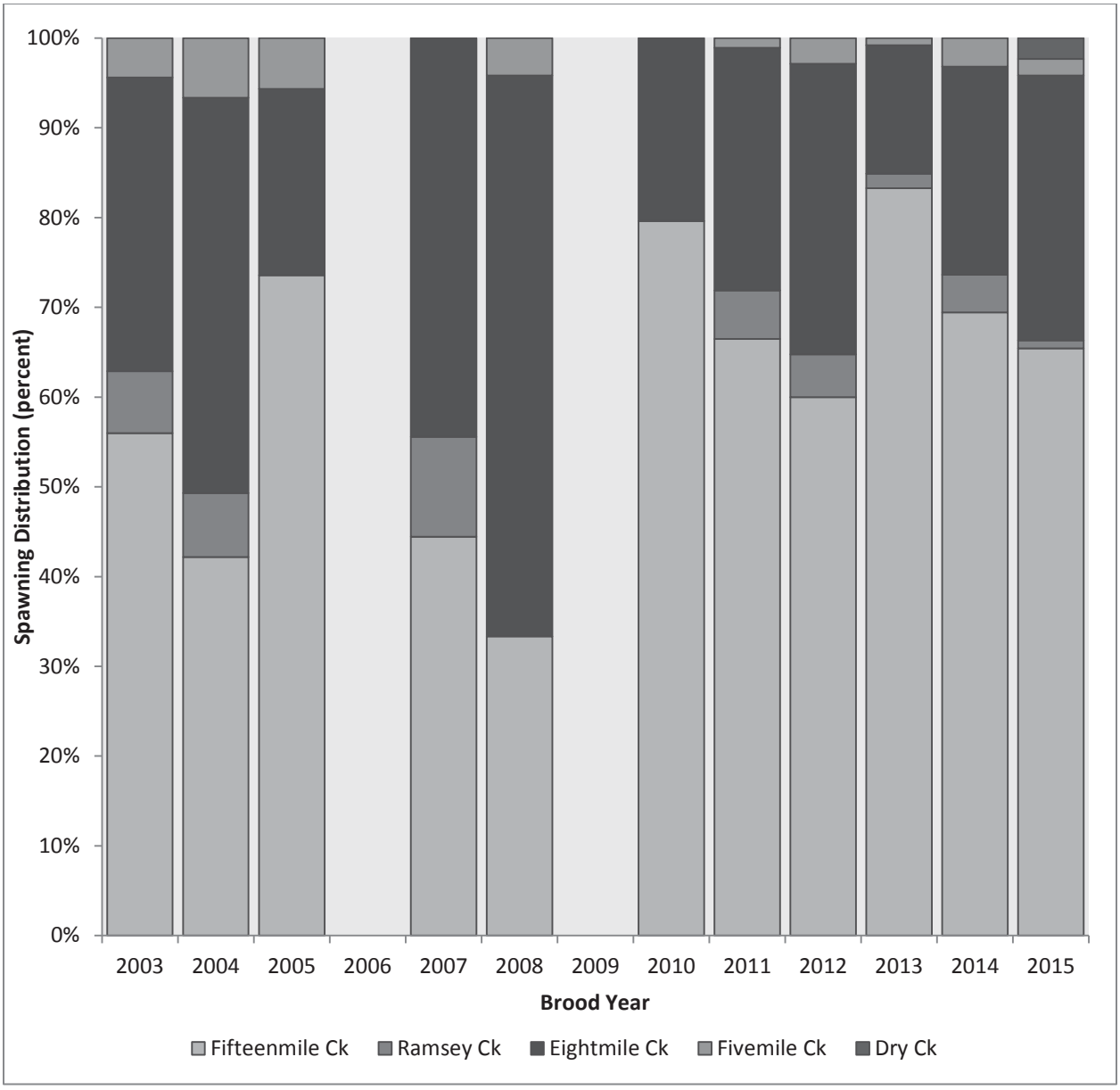


Figure 2. Time series of spawner distribution in Fifteenmile Creek, presented by brood year. Prior to 2013, spawner distribution was determined from redd counts, and therefore had the potential to include information from both natural-origin and hatchery-origin individuals. Starting in 2013, spawner distribution was determined from PIT array detections of PIT-tagged, natural-origin adult steelhead. The 2006 and 2009 brood years are intentionally omitted because not enough redd surveys were conducted to generate useful spawner distribution information.

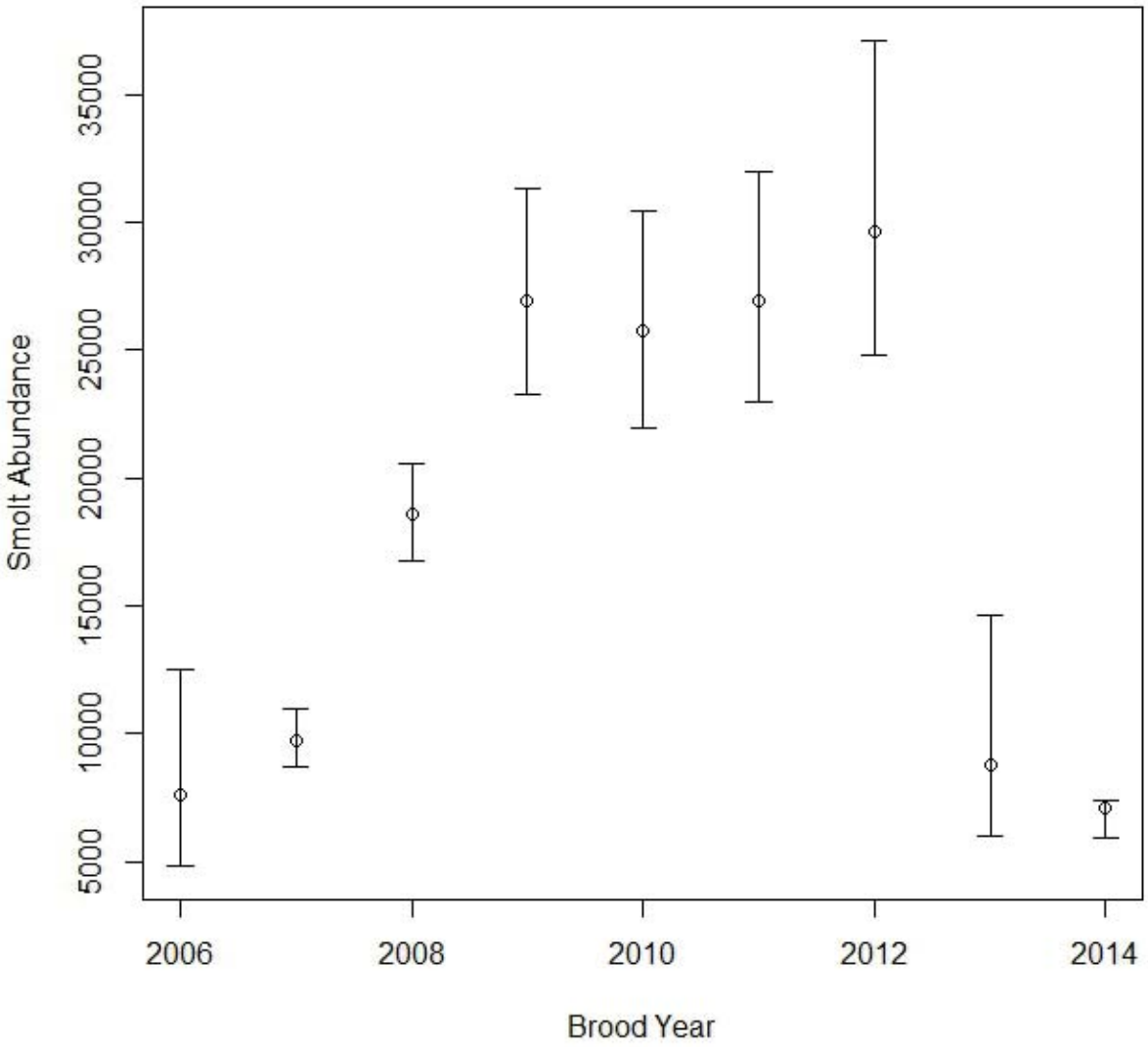


Figure 3. Time series of smolt abundance estimates for Fifteenmile Creek steelhead, presented by brood year. Brood year was determined from annual age-composition information resulting from scale sample analyses. Estimates for brood years 2013 and 2014 are preliminary as not all freshwater age classes are represented; we expect these estimates to increase as we continue to collect data.

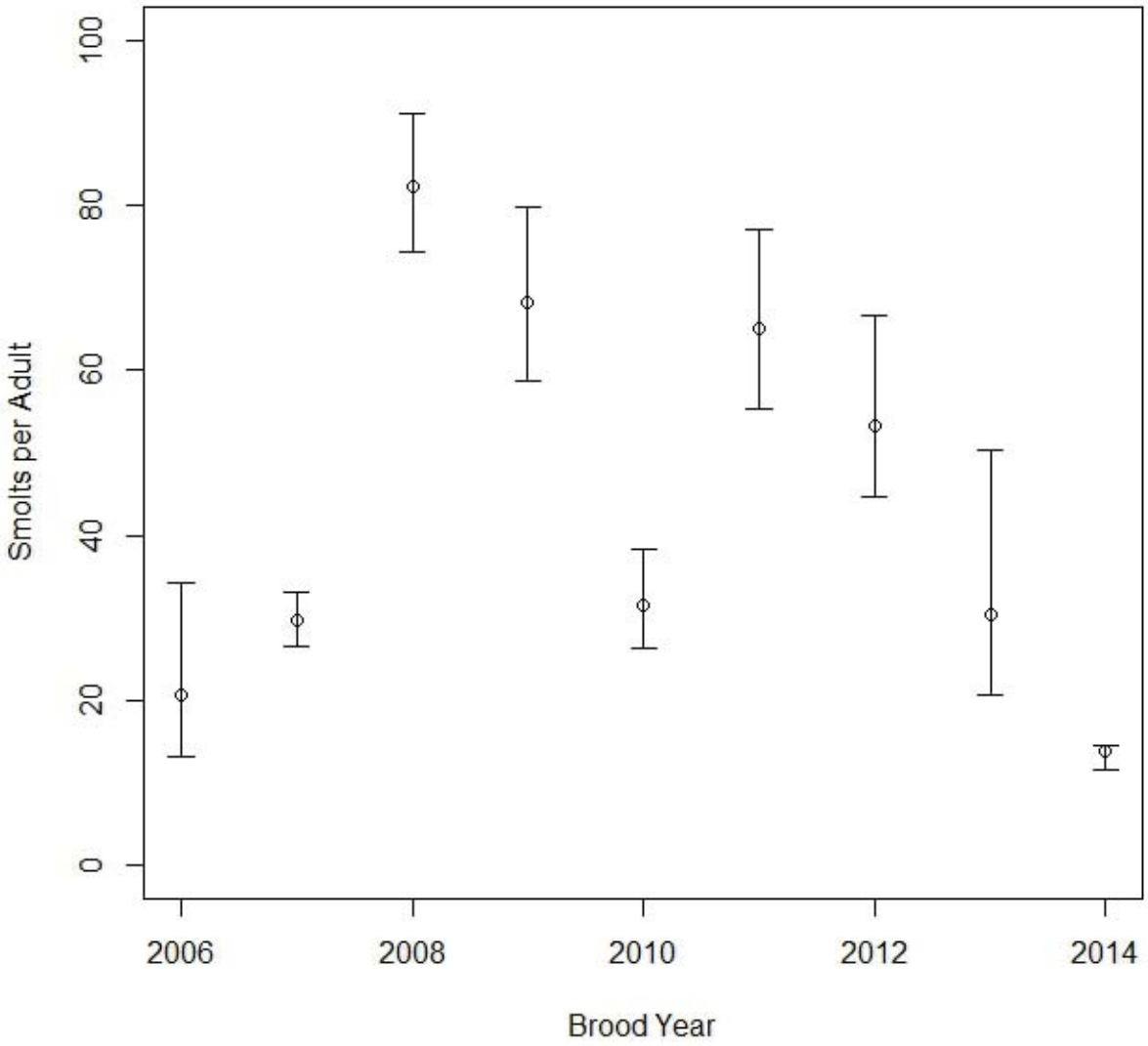


Figure 4. Time series of smolt production estimates for Fifteenmile Creek steelhead, presented as smolts-per-adult per brood year. Since spawner abundance estimates prior to 2011 had no associated measures of precision, we constructed the confidence intervals around these production estimates using the error associated with the smolt abundance estimates. Estimates for 2013 and 2014 brood years are preliminary – not all freshwater age classes are represented thus far in smolt migrations; we expect these estimates to increase as we continue to collect data.

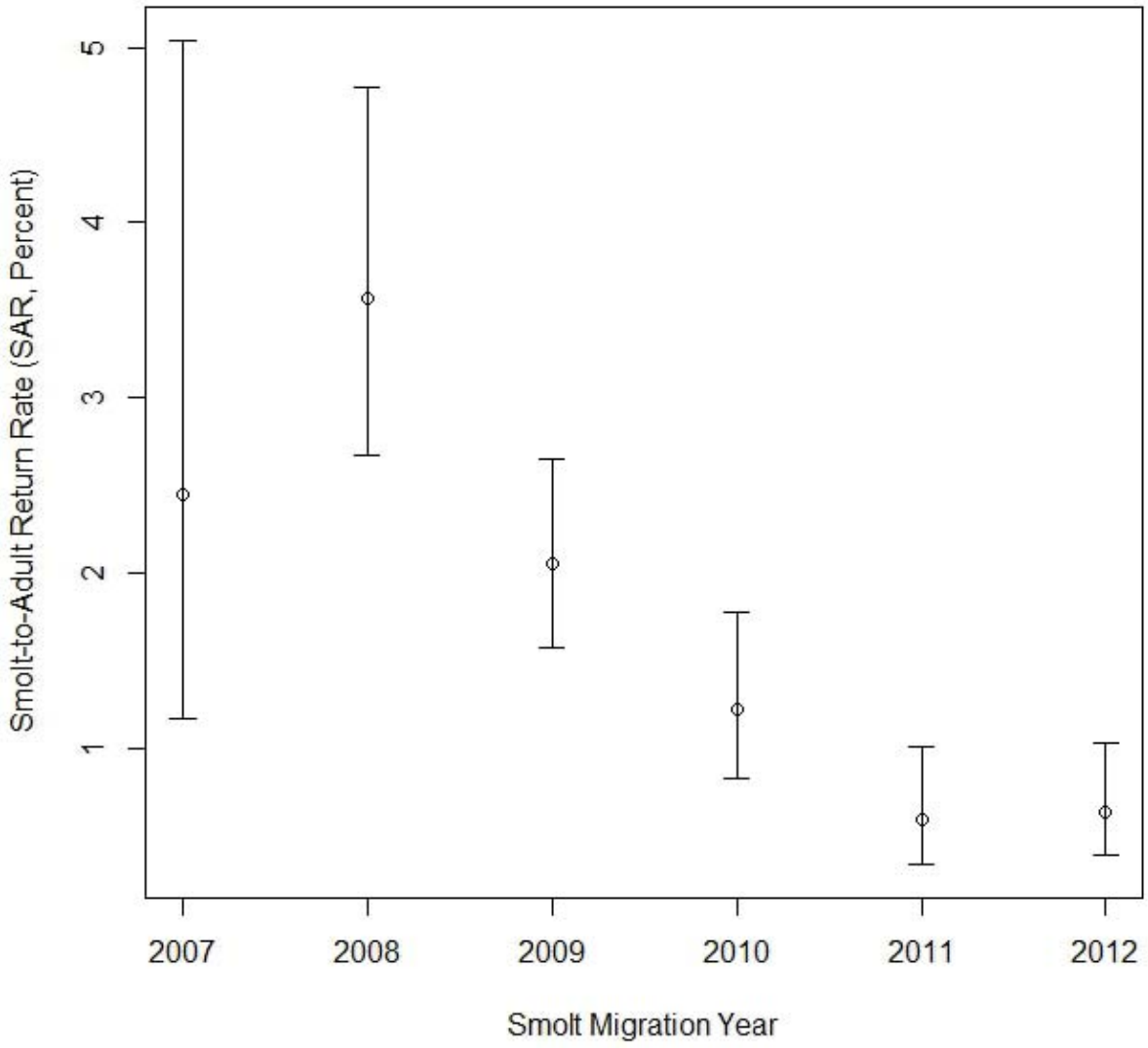


Figure 5. Time series of smolt-to-adult return rate (SAR) estimates for Fifteenmile Creek steelhead, presented by smolt migration year. These estimates represent return rates to Fifteenmile Creek (rather than to Bonneville Dam), and were produced with the Huggins closed-captures estimator using PIT detection data from the Fifteenmile in-stream PIT array and mainstem Columbia River interrogation sites. The estimate for 2012 is preliminary, as not all ocean age-classes are represented at this time; we expect these estimates to increase as we continue to gather data.

5. Synthesis of Findings: Discussion/Conclusions

Data Qualifications and Limitations

Escapement Estimation

We produced two estimates of adult steelhead escapement into Fifteenmile Creek for the 2013, 2014 and 2015 brood years. In 2013, the estimate produced via the 'combined approach' – an approach that used data from all available sources (weir mark-recapture, PIT array, and video data) – was preferred over the Lincoln-Peterson mark-recapture estimate due to its increased precision. In 2015, this continues to be the case. Prior to 2013, the Lincoln-Peterson escapement estimate was preferred over redd-counts through spawning surveys because of the inherent variability and low precision of spawning surveys for estimating steelhead abundance. However, with the development and implementation of the 'combined approach' method, we found that this approach produces the most accurate and precise escapement estimates of all methods previously utilized for Fifteenmile Creek steelhead. This is due to the following: 1) our video-monitored bypass system continues to show extremely low error rates; 2) our concurrent trapping operations at the same site allow us to evaluate and correct for the error associated with visual misidentification of kelts; and 3) our PIT array provides us with accurate information about both the fraction of the run we sample with the video bypass as well as the adult-to-kelt survival rate. A potential source of error that may affect estimates produced by the 'combined approach' is the error that would exist if individuals were bypassing the weir using a route other than the video-monitored bypass chute. In 2015 the season long low water conditions led us to conclude that this source of error was negligible. The weir was overtopped twice very early in the season (mid-January), however we did not detect any movement of fish tagged in prior years that bypassed the weir trap and video during these events (at upstream PIT arrays), which supported this conclusion . The detection probability within the video chute was 0.99, which means that there was a high likelihood that if a fish entered the chute it was captured on video. In 2015, a logistic regression was applied to the weir and kelt-trap data to estimate kelt proportion for the days that the video chute was open. This model provided the proportion of non-kelt fish for the 'combined approach' method for estimating escapement of fish passing the video-chute.

Smolt Abundance Estimation

Similar to 2014, we produced two estimates of steelhead smolt abundance for the 2015 Fifteenmile Creek steelhead outmigration. As in previous years, the estimate based on all tagged and released individuals (8,317 smolts; 95%CI 6,941 to 8,645) was higher than the estimate based only on individuals known to be migrants (5,395 smolts; 95% CI 4,824 to 6,054). We continue to recommend that managers and recovery status monitors utilize the migrant-only estimates for calculations that incorporate Fifteenmile Creek smolt abundance. This is especially useful as an alternative assessment of juvenile carrying capacity.

Adult Migration and Survival

Since PIT-antennas were installed in The Dalles Dam fish ladders in the spring of 2013, we have discovered that the majority of PIT-tagged Fifteenmile Creek adults pass upstream of The Dalles Dam in the summer and fall. This trend continued for 2014 and 2015. In 2014, a total of 32 of 44 returning PIT-tagged adult steelhead that passed Bonneville Dam also passed The Dalles Dam; as of December 31 2015, 27 of 31

PIT-tagged adult steelhead that passed Bonneville Dam in 2015 have also passed above The Dalles Dam. This necessitates downstream passage at The Dalles Dam before returning to Fifteenmile Creek to spawn in the spring, increasing the likelihood that they have to overwinter above the dam. This behavior of over-wintering in the Columbia River prolongs their exposure to Columbia River sport, commercial, and tribal fisheries, as well as potential adverse environmental conditions. Additional efforts to track the harvest of previously PIT tagged Fifteenmile Creek steelhead are warranted. In addition, the only benign route of passage downstream of The Dalles Dam, the Ice-Trash Sluiceway, is not operated during the period of 15 December to 1 March. This makes turbine routes or the navigation lock as the only available routes to return downstream to their natal Fifteenmile Creek until after 1 March. Through our observations of fish detected at Bonneville Dam, and subsequently detected in Fifteenmile Creek, the apparent survival of fish after passing Bonneville Dam heading to Fifteenmile in the Columbia River is approximately 37% to 59% (Tables 15 and 16, Appendix B). The lowest apparent survival took place in the 2012 outmigration year, however we expect that it will increase slightly since the six year old fish have not returned. These low survival rates of pre-spawn steelhead for the relatively short migration from Bonneville Dam to Fifteenmile Creek deserve further investigation, including passage at The Dalles Dam. Similar to the John Day and Umatilla River populations, recovery of the Fifteenmile Creek population may be hindered at the adult life stage by impacts of FCRPS operation despite the successes of upstream passage and instream habitat improvements.

Adult Escapement

The natural-origin spawner abundance estimate for the 2015 brood year (424 adults; 95% lower: 415 adults; upper: 454 adults) is the sixth largest for the 10 years that estimates have been possible, and is just below the viability threshold of 500 adults identified for the Fifteenmile Creek major population group in the Oregon Recovery Plan for Mid-Columbia Steelhead. Hatchery-origin spawner abundance for 2015 was the lowest (8.2 spawners) since we began estimating it in 2011.

Smolt Abundance

Smolt abundance was unusually low in 2015: the 'all-trapped-individuals' estimate of 8,317 is the third lowest on record for Fifteenmile smolts. We offer several factors, acting alone or in combination, as contributions to the low abundance observed this season: first, the low adult escapement of 2014; second, the inhospitable stream conditions in lower Fifteenmile Creek caused by drought conditions including warm stream temperatures and low flow during much of the summer of 2014; and last, the presence within the juvenile salmonid population in Fifteenmile Creek of *Ceratomyxa shasta* and *Myxobilis cerebralis* (Kenneth Lujan, USFWS, personal communication), pathogens known to have the potential to adversely affect juvenile salmonid survival. The percent of one year old juvenile steelhead captured at the Fifteenmile Creek rotary screw trap in 2015 (85.5% age 1) was higher than during 2014 (71.6% age 1) than in 2011 (80.3%), 2012 (78.9%), and 2013 (80.0%), suggesting either an early migration of the 2014 cohort or lower survival of previous years' cohorts.

Population Viability

The viability thresholds identified in the Recovery Plan for the Fifteenmile Creek population of steelhead are 500 spawners and production of 1.56 recruits-per-spawner (Carmichael and Taylor 2010). In terms of adult escapement, Fifteenmile Creek steelhead have met the threshold in 5 of the 12 years that escapement estimates have been possible. Those years are 2003, 2004, 2010, 2012, and 2014. In three of those years, lower bounds of confidence intervals were below the threshold abundance level. In terms of productivity,

this year was the first year we could get an estimate for the 2009 broodstock (1.04 recruits per spawner), which was lower than the viability threshold identified in 2010. Prior to this year, we have only been able to calculate the recruits-per-spawner metric for the 2008 and 2009 brood years. Assessment of population viability is revisited at each BiOp review, however the ongoing monitoring efforts will inform adaptive management strategies to insure that Fifteenmile Creek Steelhead remain a viable Mid-C DPS population.

Finally, with the addition of weir trapping abundance estimates, an accurate assessment of smolt production could be conducted. Similar estimates of smolt production despite varying adult escapement suggests that smolt production can reach carrying capacity with near historical run sizes. With the development of newly implemented technologies, the Fifteenmile Creek watershed has developed into an ideally-sized watershed to monitor VSP parameters for a steelhead population recovery plan. Further increasing precision for smolt production through the use of the PIT tag detections and trapping efficiency will be investigated to improve estimates, thereby improving our ability to detect productivity changes from habitat modifications. Based on our smolt/adult results, we suggest additional habitat restoration activities are required to increase the productivity and abundance of the Fifteenmile Creek population.

6. References

a. Literature Cited

Anderson, J. L., N. J. Hetrick, D. Spencer, J. P. Larson, and M. Santos. 2006. Design and Performance of a Digital Video Monitoring Station Incorporated in a V-Shaped Resistance Board Weir. United States Fish and Wildlife Service – Alaska Fisheries Technical Report Number 91, May 2006.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-27.

Carmichael, R.W., B. Taylor. 2010. Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment. November 2010.

Chapman, D. H. 1951. Some properties of the hypergeometric distribution with applications to zoological censuses. *University of California Publications in Statistics* 1: 131-160.

Cheng, Y.W., M.P. Gallinat, 2004. Statistical analysis of the relationship among environmental variables, inter-annual variability and smolt trap efficiency of salmonids in the Tucannon River. *Fisheries Research*, Volume 70, Issues 2-3, December 2004, Pages 229-238.

Clark, J. S. 2003. Fifteenmile Watershed Assessment. Report prepared for Fifteenmile Watershed Council. Wasco County Soil and Water Conservation District, The Dalles, Oregon.

Cormack, R. M. 1964. Estimates of survival from the sighting of marked animals. *Biometrika* 51:429-438.

Cormack, R. M. 1992. Interval estimation for mark-recapture studies of closed populations. *Biometrics* 48:567-576.

DART. Data access in real time. School of Aquatic and Fishery Sciences. University of Washington. http://www.cbr.washington.edu/dart/dart.html

Faber DM, GR Ploskey, MA Weiland, Z Deng, JS Hughes, JA Kim, T Fu, ES Fischer, TJ Monter, and JR Skalski. 2011. Evaluation of Behavioral Guidance Structure on Juvenile Salmonid Passage and Survival at Bonneville Dam in 2009 . PNNL-20338, Pacific Northwest National Laboratory, Richland, WA.

Frederiksen, C. R., D. Fast, G. Temple. 2012. Yakima steelhead Viable Salmonid Population (VSP) Status and Trends Monitoring – Annual Report 2011. BPA Project 201003000, contract period October 15 2010 – December 14 2011.

Guess, K. 2003. The Dalles Watershed Assessment. Clark, J. S. Ed. Document prepared for The Dalles Watershed Council by Wasco County Soil and Water Conservation District, The Dalles, OR.

Huggins, R. M. 1989. On the statistical analysis of capture-recapture experiments. *Biometrika* 76:133-140.

Huggins, R. M. 1991. Some practical aspects of a conditional likelihood approach to capture experiments. *Biometrics* 47:725-732.

Jolly, G. M. 1965. Explicit estimates from capture-recapture data with both death and immigration stochastic model. *Biometrika* 52:225-247.

Matala AP, French R, Olsen E, Ardren WR (2009) Ecotype distinctions among steelhead in Hood River, Oregon, allow real-time genetic assignment of conservation broodstocks. Transactions of the American Fisheries Society 138: 1490–1509.

Macnab, B.A., S.L. Springston. 2009. Fifteenmile Creek Habitat Restoration Project 1993-040-00 2009 Annual Report. Report to Bonneville Power Administration, Document Number P118121.

National Marine Fisheries Service. 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act.

Newton, J., L. Nelson. June 2000. Fifteenmile Creek Subbasin Summary. Oregon Department of Fish and Wildlife, The Dalles, Oregon.

Ploskey, G., M. Weiland, C. Woodley, D. Faber. 2012. Evaluate Route-Specific Passage and Survival of Steelhead Kelts at The Dalles and Bonneville Dams, 2012. USACE Project ADS-P-2012-2.

Satterthwaite, F. E. 1946. An approximate distribution of estimates of variance components. *Biometrics Bulletin* 2: 110-114.

Seber, G. A. F. 1965. A note on the multiple recapture census. *Biometrika* 52:249-259

Seber, G. E. *The estimation of animal abundance and related parameters*, 2nd ed. Macmillan, New York.

Skalski, J.R., S.G. Smith, R.N. Iwamoto, J.G. Williams, and A. Hoffmann. 1998. "Use of PIT-tags to Estimate Survival of Migrating Juvenile Salmonids in the Snake and Columbia Rivers." *Canadian Journal of Fisheries and Aquatic Sciences* 55:1484-1493.

Stewart, R. 2002. Resistance board weir panel construction manual. Alaska Department of Fish and Game, Division of Commercial Fisheries, Arctic-Yukon-Kuskokwim Region, Regional Information Report No. 3A02-21, Fairbanks, Alaska.

Stewart, R. 2003. Techniques for installing a resistance board fish weir. Alaska Department of Fish and Game, Division of Commercial Fisheries, Arctic-Yukon-Kuskokwim Region, Regional Information Report No. 3A03-26, Fairbanks, Alaska.

Tobin, J. H. 1994. Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers. U.S. Fish and Wildlife Service, Kenai Fishery Resource Office, Alaska Fisheries Technical Report Number 22, Kenai, Alaska.

Thompson, S. K. 1992. *Sampling*, 1st ed. Wiley, New York.

White, G.C. and K. P. Burnham. 1999. Program MARK: Survival estimation from populations of marked animals. Bird Study 46 Supplement, 120-138.

Zendt, J., N. Romero, S. Keep, and M. Babcock. 2010. Yakima-Klickitat Fisheries Project – Klickitat Monitoring and Evaluation: 2009 Annual Report. BPA Project 199506335, contract period May 1 2009 – April 30 2010.

b. Personal Communications

Borgerson, Lisa. October, 2011. Oregon Department of Fish and Wildlife, Corvallis Research Lab. 28655 Hwy. 34, Corvallis, Oregon 97333.

Lujan, Kenneth. November 2014. United States Fish and Wildlife Service, Lower Columbia River Fish Health Center. 201 Oklahoma Rd., Willard, Washington 98605.

Appendix A: Use of Data & Products

Viable Salmonid Population (VSP) indicator and metric data that support and feed ODFW's Recovery Planning and BiOP reporting needs are summarized and compiled into a standard format (Coordinated Assessments Data Exchange Standard; DES) at the population level and stored in a central server location. VSP data in DES format is quality checked, reviewed and approved for sharing by a data steward and the primary VSP data contact for each population(s). Upon reviewer approval, data in DES format is made available to the public and interested parties through upload on ODFW's Salmon and Steelhead Recovery Tracker (http://odfwrecoverytracker.org/), NOAA's Salmon Population Summary (SPS; https://www.webapps.nwfsc.noaa.gov/apex/f?p=261:home:0) database and StreamNet (http://www.streamnet.org/). In addition, incidental mortalities and carcasses are interrogated for parasites and pathogens, which are uploaded to the National Wild Fish Health Survey database (http://www.fws.gov/wildfishsurvey/). Key metrics specific to Fifteenmile Creek for the current reporting period are also shown in the Results section.

Appendix B: Detailed Results

Biological Sampling

Returning Adult Migrants

The Fifteenmile Creek upstream-migrant weir was operated from November 17, 2014 to May 22, 2015. The weir was overtopped twice during the trapping season – once on December 22, 2014, and again from January 19-20 – debris also clogged the trap January 4, 2015 and April 2, 2015 resulting in a total of 181 days fished. Stream discharge ranged from 5.1 cfs to 324 cfs, while stream temperature ranged from -0 °C to 18 °C. The live trap was operating from December 4, 2014. The first adult steelhead was caught on December 21, 2014, and catches peaked on March 28, 2014 (Figure 6). A total of 141 wild steelhead adults and three hatchery-origin adult steelhead were caught at the weir during the season (Table 2). Of the wild steelhead caught, one was a previously PIT-tagged individual that was originally tagged at the Fifteenmile rotary screw trap or weir in previous seasons.

The kelt trap was operated from March 16th through May 22, 2015. A total of 56 wild steelhead kelts were trapped during the season. Twenty-two of the wild kelts were PIT-tagged recaptures - 18 that were originally caught migrating upstream earlier in the season, and one that was a recapture from a previous year (Table 2). We also recovered the carcasses from a total of 21 wild adult steelhead upstream of the weir. Ten of the wild carcasses were PIT-tagged recaptures from earlier in the season. The 2015 wild adult steelhead run was composed of 64.6 percent females and 35.4 percent males (Table 3).

The video-monitored bypass chute was also installed and operational with two cameras on November 17, 2014. For the entire duration of the trapping season, both cameras were recorded based on motion detection parameters. A total of 1003 instances of steelhead passage through the bypass chute were recorded. This included 604 instances of upstream travel and 399 instances of travel downstream (Table 4).

Juvenile Outmigrants

The rotary screw trap was operated from December 27, 2014 to May 23, 2015. High flows and debris rendered the trap inoperable a total of 5 days throughout the 148 day season. We captured 1393 juvenile steelhead during the season, 1380 of which received PIT tags and were released upstream via the release devices to test trap efficiency (Table 5). Of the 1380 juvenile steelhead that received tags 13 died, and 275 were recaptured during the season. The juvenile steelhead out-migration peaked in May (Figure 7). By-catch included 247 juvenile coho salmon, 41 coho salmon fry, 1 juvenile sockeye salmon, 1 juvenile cutthroat trout, 3847 juvenile dace, 1003 juvenile sucker, 22 sculpin, 1113 Pacific lamprey ammocoetes, and 609 Pacific lamprey macropthalmia. During the season, we recaptured 275 of the 1380 PIT-tagged juveniles from the efficiency releases.

Fall Electrofishing

We used an electrofisher to sample juvenile steelhead in Eightmile creek for two days in early November 2014. We sampled four stream segments in Eightmile Creek for a total sample stream length of 1.12km. We captured and collected scales samples from 251 juvenile steelhead and PIT-tagged 174 of those individuals (Table 6).

PIT Interrogation

In-basin Detections

During the 2015 adult return season, the PIT antenna arrays in Fifteenmile Creek detected a total of 181 adult steelhead. Of those, 13 were originally tagged as juveniles at the Fifteenmile Creek rotary screw trap, one individual was originally tagged outside of the Fifteenmile Creek basin (Sawtooth Hatchery), six were originally tagged as adults at the Fifteenmile Creek weir in a previous season (i.e. repeat spawners), and the remaining were adults that were tagged at the Fifteenmile Creek weir during the 2015 season. The Huggins Closed-Captures model in Program MARK was used to estimate the efficiency of the entire array (eight detection sites, 24 antennas) from the detection histories of adult steelhead tagged at and released above the weir; array efficiency for tagged adult steelhead was estimated to be 96.9% (95% CL, 92.8%–98.7%). The confidence interval is asymmetrical due to the asymmetrical nature of the model likelihood. This was the detection percentage of adults tagged at the Fifteenmile Creek adult trap. This estimate includes all flow conditions, tag loss, adult fallback, mortality, and seasonal effects during the 2015 trapping season, and assumes that adult fish trapped and tagged at the weir have the same detection probability as fish tagged as smolt that were not trapped at the weir. The detection efficiency of the PIT array located at the confluence of Fifteenmile Creek and Eightmile Creek, as measured by calculating the combined probability of detection (Equations 2 and 3 in Method #4050 at monitoringmethods.org) for known PIT tags passing over the antenna array, was 99.9% (Table 7).

For each PIT-tagged adult steelhead that was detected on the in-stream array, we assumed that the stream reach where the individual spent the most time was the stream reach in which the individual spawned. Through this assumption we were able to identify spawning reaches for the tagged adult steelhead (Table 8, Figure 8).

Out-of-Basin Detections

Since tagging operations in the Fifteenmile Creek watershed began in 2006, steelhead PIT-tagged in Fifteenmile Creek have been detected outside the watershed at detection sites throughout the Columbia River and its tributaries. In 2006 and 2007 only juveniles were detected, however beginning in 2008, returning adults were detected. Since 2009, individuals at every life-stage (juvenile, adult, and kelt) have been detected (Table 9). In

early 2013, two interrogation arrays were installed that significantly added to our understanding of the movement habits of Fifteenmile Creek steelhead: 1. Detection capability was added to the adult ladders at The Dalles Dam (PTAGIS interrogation site code 'TDA') and, 2. An antenna array was installed in the Deschutes River near its confluence with the Columbia River (PTAGIS interrogation site code 'DRM'). During the 2014-2015 adult migration period, 32 of the 44 Fifteenmile Creek PIT-tagged adult steelhead that were detected passing upstream of Bonneville Dam were also detected passing upstream of The Dalles Dam. Twenty four of the individuals detected at The Dalles Dam were subsequently detected at the array at the mouth of the Deschutes River or its tributaries; two were subsequently detected at or upstream of John Day Dam, and two in the Zone-6 fishery as mortalities.

Surveys

Spawning Ground Surveys

Spawning ground surveys were conducted between June 4, 2015 to June 19, 2015. Surveys of the Index reaches were not run in 2015, and due to the lateness of the season only one pass was done. Following the modified design described in monitoring methods for this season's surveys, we found a total of 72 redds in the sampled units (Table 10).

Natural-Origin Adult Escapement

Weir Mark-Recapture Estimate

The Schnabel form of the Lincoln-Peterson mark-recapture abundance estimator was one of two methods used to estimate the escapement of natural-origin adult steelhead returning to Fifteenmile Creek in 2015. Using the weir and kelt trap numbers (M=141 individuals captured and marked at the weir; C=77 kelts and carcasses inspected for marks; R=28 individuals in C recaptured from M), natural-origin escapement was estimated to be 381 adults with an approximate 95% confidence interval of ±99 adults (Table 11).

Combined Approach – Video-Based Estimate

The second natural-origin escapement estimate, which used a combination of counts at the video-monitored bypass chute and kelt survival data from weir and PIT array data, produced a larger escapement estimate of 424 adult steelhead (95% CI: 415 to 454).

Smolt Abundance

Trapping Efficiency Estimates

Detection data from Fifteenmile Creek PIT tagged steelhead were analyzed with the Huggins Closed-Capture model to determine efficiencies for the Fifteenmile Creek screw

trap, the Bonneville Dam corner collector and juvenile bypass system, and the Columbia River estuary trawl for the 2015 outmigration. The analysis was conducted on two datasets: the set of all juvenile steelhead released above the screw trap in 2015, and the set of tagged juvenile steelhead from the rotary screw trap determined to be actual migrants from detection histories. The efficiency of the screw trap was 16.8% based on the all-released juvenile steelhead dataset (95% CI, 16.1% to 20.1%, n = 1394; Table 12), and 20.9% based on the set of known migrants (95% CI, 18.6% to 23.4%, n = 1127). Based on the all-released dataset, the PIT arrays at Bonneville Dam detected 9.8%, and the estuary trawl detected 0.02% of PIT-tagged outmigrants. However, when only known migrants were analyzed, the efficiency to BON increased to 12.3% and the estuary trawl detection decreased to 0.001%, respectively.

Smolt Abundance Estimates

The Huggins estimates of the Fifteenmile screw trap's efficiency were used to generate two smolt abundance estimates for the 2015 season: one abundance estimate based on the total number of juvenile steelhead trapped and another based only on juvenile steelhead determined to be migrants because they were detected moving downstream past the PIT tag arrays in the immediate vicinity of the trap. The juvenile steelhead abundance estimate based on all juvenile steelhead trapped was 8,317 (95% CI, 6,941 to 8,645; Table 13), while the estimate based on known migrants was 5,395 (95% CI, 4,824 to 6,054).

Survival

Juvenile Survival

Survival of Fifteenmile Creek PIT-tagged juvenile steelhead was estimated for the all-fish-trapped dataset at different migration-stages (including survival from upstream release to the screw trap, from the screw trap to Bonneville Dam, and from Bonneville Dam to the estuary) for the 2015 outmigration using PIT detections and the Cormack-Jolly-Seber model with a Markov-Chain Monte Carlo estimator in Program MARK. Survival between the release devices and the rotary screw-trap was 93.2% (95% CL, 83.4%-99.7%; Table 14). Survival from the screw-trap to Bonneville Dam was 36.2% (95% CL, 16.1%-70.8%, Table 14) and from Bonneville Dam to the estuary was 66.3% (95% CL, 27.7%-98.8%, Table 14). Survival and residualization of juvenile steelhead are indistinguishable using the CJS model with the all-fish-trapped dataset.

Smolt-to-Adult Return Rates

Smolt-to-adult return (SAR) rates to both Bonneville Dam and Fifteenmile Creek for steelhead from the 2007 through 2013 outmigration years were estimated using PIT detections and the Huggins closed-capture model. Data for smolt years 2011-2013 were updated to reflect adult returns to Bonneville in 2014 and to Fifteenmile Creek in 2015

(Tables 15, 16). At Bonneville Dam, SARs ranged from 1.09% (95% CI, 0.73%-1.62%) in 2011 to 6.74% (95% CI, 4.58% to 7.20%) in 2008, while SARs to Fifteenmile Creek ranged from 0.59% (95% CI, 0.34% to 1.01%) in 2011 to 3.57% (lower: 2.67%; upper 4.77%) in 2008. The SAR estimates to Bonneville were significantly greater compared to those to Fifteenmile Creek ($p < 0.05$) in 2008, 2009, 2010, and 2011.

Production

Recruits per Spawner

An estimate of recruits-per-spawner, or adult-to-adult production, requires information regarding age composition of adult and juvenile populations, as well as reliable annual estimates of spawner abundance. Given those, estimates are still not possible until a majority of ocean age-classes from a single brood year have returned to spawn; 2014 was the first year that we have had enough returns from the 2009 brood year to estimate this metric. The estimate of adult-to-adult production for the 2009 brood year was updated to reflect adult returns to Fifteenmile in 2015, and is now 1.04 recruits-per-spawner based on 2011-2015 adult returns. This estimate is preliminary because not all age classes have returned, and will necessitate updating over the next several years. We are not able to calculate the metric for the 2010 brood year due to the lack of an escapement estimate for that year.

Smolts per Adult

Juvenile production, measured as the number of smolts produced per adult, was calculated for each brood year from 2006 to 2014 (Figure 4, Section 4 – Results, above). Juvenile production ranged from a low of 13.9 smolts-per-adult (95% CI, 11.6 to 14.4) for the 2014 brood year to a high of 82.3 smolts-per-adult (95% CI, 74.4 to 91.2) for the 2008 brood year.

Life History Characteristics

Adult Run Timing

Using Bonneville Dam detections from all available years (2008–2015) of previously PIT-tagged Fifteenmile Creek steelhead, the median timing of adult Fifteenmile Creek steelhead returning to Bonneville Dam is August 14 (middle 95 percent arriving between June 6 and October 17; Figure 9). Using captures and detections at the weir and on the PIT array in Fifteenmile Creek for the 2012-2015 brood years, the median date of arrival of the natural origin steelhead spawning run in Fifteenmile Creek is March 25 (middle 95 percent arriving between January 27th and May 2; Figure 10).

Adult Age Structure and Iteroparity

The age structure of adult steelhead returning to Fifteenmile Creek in 2015 was determined through either visual scale analysis or a combination of scale analysis and PIT tag detection histories. We were able to determine freshwater age, saltwater age, and total age of 181 wild adult steelhead that were caught or detected in Fifteenmile Creek (Table 17). Of those, 110 (60.8%) individuals were determined to be freshwater age 1, and 71 (39.2%) individuals were freshwater age 2.

Steelhead that overwinter in the Columbia River and tributaries before reaching their spawning grounds do not show a final annulus on their scales before spawning (Lisa Borgerson, ODFW, personal communication). Therefore, the total age for Fifteenmile Creek steelhead was determined by adding freshwater age plus saltwater age plus the number of spawning events plus the years in between spawning events. Of the 181 adults with legible scales, 47 individuals (26.0%) were age 3, 110 (60.8%) were age 4, 19 (10.5%) were age 5, four (2.2%) were age 6, and one (0.6%) was age 7. Ten of the 156 individuals (6.4%) caught or detected at the weir were repeat spawners based on either scale pattern analysis or PIT interrogation data; nine of those individuals were spawning for a second time, and one individual was on its third spawning run.

Juvenile Age Structure

We successfully aged 98.8% (1581 out of 1600) of all juvenile steelhead sampled for scales during the 2015 trapping season using scale pattern analysis. Of the 1581 fish with legible scales, 85.5% (1351 individuals) were age 1, 14.5% (229 individuals) were age 2, and 0.06% (one individual) was age 3 (Table 18; Figure 11).

Stray Rates

We detected no known wild stray steelhead in the 2015 season, resulting in a stray rate of 0% for wild adult steelhead into the Fifteenmile watershed.

Fifteenmile Creek steelhead were detected at PIT arrays throughout the lower and middle Columbia River basin. During the spring of 2015, three of the 70 PIT-tagged Fifteenmile adult steelhead with PTAGIS interrogation records were last detected in a Columbia River tributary other than Fifteenmile Creek, resulting a stray rate of Fifteenmile Creek steelhead of 4.29 percent.

Hatchery Fraction

We used data from the video-monitored bypass chute to calculate the effective hatchery fraction for 2015. For the fish that were not of known origin we also used the data from the weir to assign unknown origin to an origin. There were 11 hatchery fish that moved

upstream and 5 hatchery origin fish that moved downstream. When the non-kelt function (calculated by logistic regression) was applied to these numbers there was a net movement upstream of 8.3 hatchery fish, which was adjusted to 8.2 to account for the detection error rate. We used this hatchery estimate and the 'combined approach' estimate of 428.5 to arrive at a hatchery fraction estimate of 1.91%.

Tables.

Table 2. Summary of the number of wild and hatchery-origin upstream-migrant and kelt steelhead captured at the Fifteenmile Creek adult weir, kelt traps and possibly the screw trap from December 21, 2014 to May 18, 2015. Carcasses encountered above the weir during this time period are also listed.

Trap	Source	Status[1]	Number Caught	Male	Female
Upstream	Wild	New	140	54	83
		Native Recap.	1	0	1
		Out-of-Basin Recap.	0	-	-
	Hatchery	New	3	3	0
		Recap.	0	-	-
	subtotals	*Wild*	*141*		
		Hatchery	*3*		
Kelt	Wild	New	34	10	24
		2015 Recap.	18	6	12
		Native Recap.	4	2	2
	Hatchery	New	0	-	-
		Recap.	0	-	-
	subtotals	*Wild*	*56*		
		Hatchery	*0*		
Carcass	Wild	New	11	1	9
		2015 Recap.	10	2	7
		Native Recap.	0	-	-
	Hatchery	New	0	0	0
		Recap.	0	-	-
	subtotals	*Wild*	*21*		
		Hatchery	*0*		
	Grand Totals	**Wild**	**218**		
		Hatchery	**3**		

[1] Status refers to tag status upon capture. 'New' refers to individuals that had not been previously tagged or marked. 'Native Recap' refers to individuals that were tagged at the Fifteenmile Creek weir or screw trap during a previous year. 'Stray recap' refers to wild individuals known or assumed to be straying from a population outside of the Fifteenmile Creek watershed (as evidenced by tags or marks that can be traced to specific sources) – this includes individuals we captured that were tagged at Bonneville Adult Fish Facility as adults (these fish were assumed to be of Fifteenmile origin). '2015 Recap' refers to individuals that were tagged at the Fifteenmile weir trap earlier in the 2015 trapping season.

[2]Grand totals are of unique adult individuals captured.

Table 3. Sex ratio of wild adult steelhead captured at the Fifteenmile weir (live-box and kelt trap) during their respective spawning seasons.

Year	% Male	% Female	# Captured
2011	43.9%	54.1%	98
2012	40.0%	60.0%	180
2013	34.6%	65.4%	188
2014	37.3%	62.7%	158
2015	36.7%	63.3%	199

Table 4. Number of recorded instances of adult and kelt steelhead passing through the video-monitored bypass chute during the 2015 spawning run. Observations are separated by apparent origin, direction of travel (upstream or downstream past the weir), and on which camera they were recorded. Unknown fish were captured on the camera but their origin could not be identified.

Origin	Direction	Both Cameras	Camera 1 Only	Camera 2 Only	Total
Natural (Unclipped)	Up	339	86	22	447
	Down	254	69	17	340
Hatchery (Adipose Clipped)	Up	9	1	0	10
	Down	3	0	0	3
Unknown Origin	Up	99	32	16	147
	Down	43	12	1	56
	Total	747	200	56	1003

Table 5. Number of juvenile fish trapped, PIT-tagged, and trap mortalities at the Fifteenmile Creek rotary screw trap during the 2015 trapping season (December 27, 2014 to May 23, 2015).

Species	#Trapped	#PIT Tagged	#Mortalities
Coho fry <65mm	41	NA	0
Coho parr/smolt	247	232	4
Coho Recap	63	NA	2
Cutthroat Trout	1	1	0
Dace	3847	NA	0
Lamprey Ammocoete	1113	NA	0
Lamprey Macrophthalmia	609	NA	0
Sculpin	22	NA	0
Sockeye parr/smolt	1	1	0
Steelhead fry <65mm	327	NA	0
Steelhead parr/smolt	1393	1380	13
Steelhead, RECAP	275	NA	4
Sucker	1003	NA	0
Unknown fry	17	NA	17

Table 6. Numbers of juvenile steelhead captured and tagged during the Fall 2014 electrofishing effort. Catch is broken down by stream segment. There were 8 steelhead fish that are not associated with a specific stream length, 5 of which were Pit-tagged.

Stream	Release RKM	Stream Length (m)	# Captured	# PIT-Tagged
Eightmile	309.004.008	212	62	38
	309.004.008	255	57	43
	309.004.008	312	70	42
	309.004.008	345	62	51
	total	1124	251	174

Table 7. Detection efficiencies for the in-stream PIT arrays in the Fifteenmile Creek watershed. Efficiencies were estimated using the Huggins Closed Captures model in Program MARK, and are shown by year (since installation) for each array as well as totaled for each site.

Interrogation Site	Array	Year				
		2011	2012	2013	2014	2015
Confluence of Fifteenmile and Eightmile	Fifteenmile	1.000	0.944	0.972	0.952	0.999
	Eightmile	1.000	0.996	0.999	0.994	0.999
	Site Total	*1.000*	*0.978*	*0.994*	*0.978*	*0.999*
Confluence of Fifteenmile and Dry	Fifteenmile	-	0.999	1.000	0.998	0.997
	Dry	-	0.952	1.000	0.962	1.000
	Site Total	-	*0.999*	*1.000*	*0.995*	*0.999*
Confluence of Fifteenmile and Ramsey	Fifteenmile	0.986	0.996	1.000	0.997	0.996
	Ramsey	1.000	1.000	1.000	1.000	1.000
	Site Total	*0.986*	*0.996*	*1.000*	*0.997*	*0.998*
Confluence of Eightmile and Fivemile	Eightmile	0.999	0.994	0.998	0.998	0.999
	Fivemile	1.000	0.998	1.000	1.000	0.999
	Site Total	*0.999*	*0.996*	*0.998*	*0.998*	*0.999*

Table 8. Apparent spawning distribution for 178 PIT-tagged adult steelhead detected by the PIT array on the Fifteenmile Creek watershed during 2015. Spawning reach was determined by PIT detection histories from the PIT array; spawning area was assumed to be the location an individual spent the most time before prior to detection at a more downstream antenna.

Stream Reach	Total	Percent of Run
Fifteenmile – Lower[a]	*86*	48.3%
Fifteenmile – Mid[a]	*37*	20.8%
Fifteenmile – Upper[a]	*7*	3.9%
Fivemile	*2*	1.1%
Eightmile	*42*	23.6%
Dry	*3*	1.9%
Ramsey	*1*	0.56%
Total	**178**	

[a]Lower Fifteenmile refers to the section of Fifteenmile Creek between the Fifteenmile/Eightmile confluence and the Fifteenmile/Dry confluence. Mid Fifteenmile refers to the section of Fifteenmile Creek between the Fifteenmile/Dry confluence and the Fifteenmile/Ramsey confluence. Upper Fifteenmile refers to the section of Fifteenmile above its confluence with Ramsey Creek.

Table 9. Numbers of Fifteenmile Creek PIT-tagged steelhead that were detected at interrogation sites outside of the Fifteenmile Creek watershed. Totals presented are number of unique individuals detected outside of the Fifteenmile Creek watershed in a given year. Also shown are the number of PIT-tagged juveniles that were released above the Fifteenmile Creek screw trap each year.

		Year:	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Tagged juveniles released:		131	294	1247	2831	2154	2299	2527	2012	610*	1835 *
Juvenile	BON		13	33	162	260	441	95	73	163	39*	169*
	HRM		0	0	0	0	0	0	0	0	0	2*
	TWX		3	5	22	57	49	23	30	46	2*	36*
	Total		*16*	*37*	*177*	*306*	*477*	*117*	*100*	*210*	*40**	*201**
Adult	BON		-	0	11	42	89	94	39	34	50	50
Adult		WSH	-	0	0	0	0	1	0	0	0	1
		LFF	-	0	0	0	0	1	1	1	0	0
		JDJ	-	0	0	1	3	0	0	0	2	0
		JD1	-	0	0	0	1	0	0	0	0	0
		MC1	-	0	2	3	5	2	2	2	1	1
		MC2	-	0	0	1	3	2	1	1	0	0
		MCJ	-	0	0	0	2	0	0	0	0	0
		ORB	-	0	0	0	1	0	0	0	0	0
		ICH	-	0	0	0	1	2	1	0	1	0
		LMJ	-	0	0	0	1	0	0	0	0	0
		LTR	-	0	0	0	0	1	0	0	0	0
		GRA	-	0	0	0	0	1	1	0	0	0
		TDA	-	0	0	0	0	0	0	24	25	19
		DRM	-	0	0	0	0	0	0	9	17	11
		WSR	-	0	0	0	0	0	0	0	0	4
		TR1	-	0	0	0	0	0	0	0	0	1
		TWX	-	0	0	0	0	0	0	0	2	0
		Total	-	*0*	*11*	*42*	*94*	*98*	*39*	*34*	*60*	*63*
Kelt	BON		-	0	0	0	3	6	15	19	6	6
Kelt		TWX	-	0	0	0	0	1	0	1	0	0
		JDJ	-	0	0	0	0	0	0	0	0	0
		TDA	-	0	0	0	0	0	0	4	5	4
		DRM	-	0	0	0	0	0	0	1	2	2
		LFF	-	0	0	0	0	0	0	1	0	0
		Total	-	*0*	*0*	*0*	*3*	*7*	*15*	*25*	*6*	*7*

[1] Detection Site codes refer to the following interrogation sites: BON = Bonneville Dam interrogation complex; TWX = Columbia River estuary trawl interrogation; WSH =Warm Springs Hatchery interrogation, Deschutes River; LFF = Lyle Falls Fishway, Klickitat River; JDJ = John Day Dam juvenile interrogation; JD1 = Lower John Day River interrogation; MC1 = McNary Dam Oregon shore interrogation; MC2 =McNary Dam Washington shore interrogation; MCJ = McNary Dam juvenile interrogation; ORB = Walla Walla River interrogation at Oasis Road Bridge; ICH = Ice Harbor Dam interrogation, Snake River; LMJ = Lower Monumental Dam juvenile interrogation, Snake River; LTR = Lower Tucannon River interrogation; GRA = Lower Granite Dam interrogation, Snake River; TDA = The Dalles Dam interrogation complex; DRM = Deschutes River Mouth in-stream array; WSR=Warm Springs River PIT Array; TR1= Lower Trout Creek

*Juvenile numbers presented for 2014 and 2015 also include fish tagged in electrofishing effort in Fall 2013 and Fall 2014, respectively.

Table 10. Numbers of steelhead redds found in survey reaches on spawning ground surveys during the 2015 spawning season.

Reach Information					Redd Counts
Stream	Stratum Number	Reach ID	Type	Length, mi	Total
Fifteenmile	1	3	R	1.09	4
		4	R	1.04	1
	2	3	R	1.19	9
		4	R	0.80	4
	3	2	R	0.99	3
		3	R	0.98	1
	4	4	R	1.09	1
		5	R	0.92	2
	5	3	R	0.94	3
		4	R	1.01	6
	6	4	R	0.92	6
		5	R	0.61	3
	7	4	R	0.70	7
		5	R	0.96	3
	8	5	R	1.06	8
	9	4	R	1.03	1
		5	R	1.30	0
Eightmile	1	1	R	1.08	3
		2	R	0.99	3
	2	5	R	1.12	4
	3	1	R	0.89	0
		5	R	0.95	0
	4	4	R	1.36	0
		5	R	0.96	0
	5	3	R	0.99	Not Surveyed
		4	R	1.11	Not Surveyed
Fivemile	1	4	R	1.02	0
		5	R	1.17	0
	2	1	R	0.96	0
		3	R	0.99	0
	3	1	R	1.08	0
		2	R	0.70	0
	4	4	R	0.82	0
		5	R	1.18	0
Ramsey	1	1	R	0.92	0
	2	4	R	1.00	0
		5	R	0.98	0
Total Redds					**72**

Table 11. Abundance estimate for wild adult steelhead returning to Fifteenmile Creek in 2015, using two different methods of estimation. The weir mark-recapture estimate uses the Schnabel form of the Lincoln-Peterson estimator. The 'combined approach' uses data from all available sources to produce an estimate with greater precision than had been previously possible, including: 1) error-adjusted video counts, and adult-to-kelt survival rates from 2) adult steelhead PIT-tagged at the weir, and 3) PIT interrogation data.

Method	Estimate	95% Lower	95% Upper	Comment
Weir Mark-Recapture	381	282	480	Based on 141 fish marked at the weir[1] and 28 marked fish found in 77 fish subsequently examined for marks
Combined Approach	424	415	454	Based on video counts, weir catch data, and PIT array data

[1]This number includes previously unmarked fish trapped and marked at the weir, as well as 'native recaptures' – individuals caught at the weir that were originally tagged at the Fifteenmile Creek rotary screw trap or at the weir in previous seasons.

Table 12. Capture efficiency of PIT tagged juvenile steelhead captured and released upstream of the Fifteenmile rotary screw trap. Recapture rates further downstream at Bonneville Dam PIT detections sites [Juvenile Bypass (JBS) or the Powerhouse II corner collector (BCC)], and at the Columbia River Estuary Trawl (TWX).

Trap Efficiency

		Screw Trap			Bonneville Dam			Estuary Trawl		
Year	n	Estimate	L95%CL	U95%CL	Estimate	L95%CL	U95%CL	Estimate	L95%CL	U95%CL
2007	286	3.8%	2.1%	6.8%	11.2%	8.0%	15.4%	1.7%	0.7%	4.1%
2008	1232	15.6%	13.7%	17.7%	13.4%	11.6%	15.4%	1.8%	1.2%	2.7%
2009	2735	16.5%	15.2%	18.0%	9.6%	8.5%	10.7%	2.1%	1.6%	2.7%
2010	2135	7.9%	6.8%	9.1%	20.6%	18.9%	22.4%	2.2%	1.7%	3.0%
2011†	1208	7.0%	5.6%	8.5%	3.8%	2.9%	5.0%	1.2%	0.7%	1.9%
2011††	994	11.8%	9.9%	13.9%	4.2%	3.1%	5.7%	0.9%	0.5%	1.7%
2012†	1489	11.6%	10.1%	13.3%	3.1%	2.4%	3.9%	1.4%	1.0%	2.0%
2012††	1038	7.3%	5.8%	9.0%	2.2%	1.5%	3.0%	0.9%	0.5%	1.5%
2012†††	2527	9.8%	8.8%	10.8%	2.7%	2.2%	3.3%	1.2%	0.9%	1.6%
2013†††	2012	6.0%	5.0%	7.0%	7.4%	6.4%	8.6%	2.3%	1.7%	3.0%
2013**	1546	8.3%	7.0%	9.7%	10.2%	8.7%	11.8%	3.2%	2.4%	4.2%
2014†††	406	3.8%	2.2%	5.8%	6.8%	4.6%	9.5%	0.6%	0.0%	1.6%
2014**	278	6.0%	3.6%	9.0%	11.3%	7.9%	15.3%	0.9%	0.2%	2.4%
2015†††	1394	16.8%	16.1%	20.1%	9.8%	9.5%	12.7%	0.02%	0.01%	.35%
2015**	1127	20.9%	18.6%	23.4%	12.3%	10.5%	14.3%	0.001%	<0.001%	.0098%

† Fifteenmile Creek release only; †† Eightmile Creek release only; ††† Fifteenmile and Eightmile combined releases; **Based on migrant individuals (from PIT data)

Table 13. Abundance estimates of smolts emigrating from Fifteenmile Creek based on the trap efficiency at the Fifteenmile rotary screw trap. The model used to generate trap efficiencies was a Huggins-Closed capture model (Huggins et al 1991).

Fifteenmile Watershed Smolt Abundance Estimates – Based on Trapping Efficiency

		Fifteenmile Watershed		
Year	Released (n)	Estimate	L95%CL	U95%CL
2007	286	7436	4200	13349
2008	1232	7905	6953	9016
2009	2735	16549	15223	18016
2010	2135	26972	23361	31197
2011	2202	25817	21296	31414
2012*	2527	25775	21962	30484
2012**	2229	21021	20158	21851
2013*	2012	33311	28580	39842
2013**	1546	18717	15905	22213
2014*	406	10601	6988	18624
2014**	278	4664	3103	7831
2015*	1394	8317	6941	8645
2015**	1127	5395	4824	6054

* Based on all juvenile steelhead tagged and released

** Based on individuals determined to be actual migrants (from PIT detection data)

Table 14. Single release survival rate estimates of juvenile steelhead captured and released upstream of the rotary screw trap on Fifteenmile Creek. Survival estimates are also shown for migrations between all downstream detection points (Bonneville Dam PIT tag array detections, and Estuary PIT- tag trawl detections). We used a Cormack-Jolly-Seber survival model in the program Mark to generate the probability distributions using Markov Chain Monte Carlo simulations.

Single Release survival for fish released upstream to →

		Upstream release to Fifteenmile Screw Trap			Fifteenmile Screw trap to Bonneville			Bonneville Dam to Estuary Trawl		
Year	n	Estimate	L95%CL	U95%CL	Estimate	L95%CL	U95%CL	Estimate	L95%CL	U95%CL
2007	286	39.3%	24.0%	64.9%	85.3%	58.2%	98.9%	*	*	*
2008	1232	57.8%	49.4%	67.9%	88.2%	66.5%	98.8%	76.5%	46.3%	98.1%
2009	2735	82.8%	70.5%	95.7%	84.3%	64.8%	98.2%	69.0%	34.9%	97.7%
2010	2135	92.6%	81.3%	99.4%	81.8%	61.4%	98.1%	60.2%	25.1%	97.4%
2011†	1208	77.6%	46.4%	97.9%	*	*	*	*	*	*
2011††	994	82.3%	56.7%	91.5%	*	*	*	*	*	*
2012†	1485	93.5%	77.3%	99.5%	*	*	*	*	*	*
2012††	1034	71.4%	36.9%	99.5%	*	*	*	*	*	*
2012†††	2519	93.3%	76.8%	100%	*	*	*	*	*	*
2013†††	2012	90.4%	70.9%	99.7%	82.8%	44.9%	99.5%	76.5%	47.4%	97.2%
2014†††	406	82.8%	44.9%	100%	61.8%	11.7%	99.9%	*	*	*
2015†††	1394	93.2%	83.4%	99.7%	66.3%	27.7%	98.8%	14.6%	0%	63.0%

* Lacked sufficient sample size to produce reasonable estimate.

† Released upstream of screw trap in Fifteenmile Creek.

†† Released upstream of screw trap in Eightmile Creek.

††† Fifteenmile and Eightmile creeks combined releases.

Table 15. Smolt-to-adult return (SAR) rates and apparent survival rates in the Bonneville Pool for Fifteenmile Creek steelhead. Confidence intervals are derived from closed-capture estimates, assuming steelhead tagged as smolt will return to Fifteenmile Creek to spawn. Apparent survival in Bonneville pool, is assuming the fish passing Bonneville are destined to go to Fifteenmile Creek.

Smolt Outmigration year	Number Released (n)	Smolt to Adult % To Bonneville			Smolt to Adult % To Fifteenmile Creek			Bonneville Pool
		Estimate	L95% CL	U95% CL	Estimate	L95% CL	U95% CL	Apparent Survival
2007	286	4.20%	2.40%	7.24%	2.45%	1.17%	5.04%	58%
2008	1232	6.74%	5.47%	8.28%	***3.57%***	2.67%	4.77%	53%
2009	2735	3.77%	3.12%	4.55%	***2.05%***	1.58%	2.65%	54%
2010	2135	2.25%	1.70%	2.97%	***1.22%***	0.83%	1.78%	50%
2011	2202	1.09%	0.73%	1.62%	***0.59%***	0.34%	1.01%	54%
2012*	2519	1.75%	1.30%	2.34%	***0.64%***	0.39%	1.03%	37%

Bold/Italic: significant difference ($p<0.05$) between Bonneville adult returns rate and adult returns to Fifteenmile Creek.

*Estimates for 2012 smolt outmigration are preliminary as not all year classes have returned.

Table 16. Return-year-specific apparent survival of Fifteenmile Creek adult steelhead (previously tagged at the Fifteenmile Creek rotary screw trap as juveniles) in the main stem Columbia River above Bonneville Dam assuming 100% detection efficiency at Bonneville Dam. Spawning migration year is defined as between April 1 of the first year to April 1 of the second year. Apparent survival in Bonneville pool, is assuming the fish passing Bonneville are destined to go to Fifteenmile Creek.

Spawning Migration Year	Detection Efficiency of Fifteenmile Creek PIT array	Number passed Bonneville	Number Detected in Fifteenmile Ck.	Bonneville Pool Apparent Survival %	L95% CL	U95% CL
2009-2010	Unknown	44	26	59%	*	*
2010-2011	Unknown	87	45	52%	*	*
2011-2012	94%**	94	39	44%	42%	46%
2012-2013	95%**	31	17	55%	28%	82%
2013-2014	98%**	34	18	53%	50%	56%
2014-2015	97%**	44	21	48%	47%	50%

*Confidence level not possible because efficiency of Fifteenmile Creek PIT array was not known. However, efficiency of PIT array was likely very high due to the configuration of pass-thru PIT antennas deployed adjacent to a fish passage barrier (weir). The easiest passage option was through the PIT antennas.
** Actual detection percentage of adults tagged at Fifteenmile adult trap. This efficiency estimate includes all flow conditions, tag loss, adult fallback, mortality, and seasonal effects. Actual detection efficiency of the PIT array located at the confluence of Fifteenmile Creek and Eightmile Creek, as measured by known PIT tags passing over array antennas, was 99.5%.

Table 17. Freshwater and total age for 214 adult steelhead trapped (including kelts and carcasses) in Fifteenmile Creek during the 2015 season. Total age is the sum of freshwater and ocean ages, plus years since fish first reentered freshwater to spawn.

Freshwater Age	Total Age 3	4	5	6	7	subtotal	% of ***total***
1	58	73	5	1	0	*137*	64.0
2	1	38	36	2	0	*77*	36.0
3	-	-	0	0	0	*0*	0
subtotal	*59*	*111*	*41*	*3*	*0*	***214***	
% of ***total***	27.6	51.9	19.2	1.4	0		

Table 18. Age composition by trapping year of juvenile steelhead captured and tagged at the Fifteenmile rotary screw trap. In 2011 and 2012, we aged approximately 10% of the total number of individuals caught; in 2013 through 2015 we aged all individuals with readable scales.

Year	Age 1	Age 2	Age 3	# Fish Aged
2011	80.3%	19.3%	0.4%	226
2012	78.9%	19.3%	1.8%	342
2013	80.0%	19.8%	0.2%	1,859
2014	71.7%	28.1%	0.3%	385
2015	85.5%	14.5%	0.06%	1581

Figures.

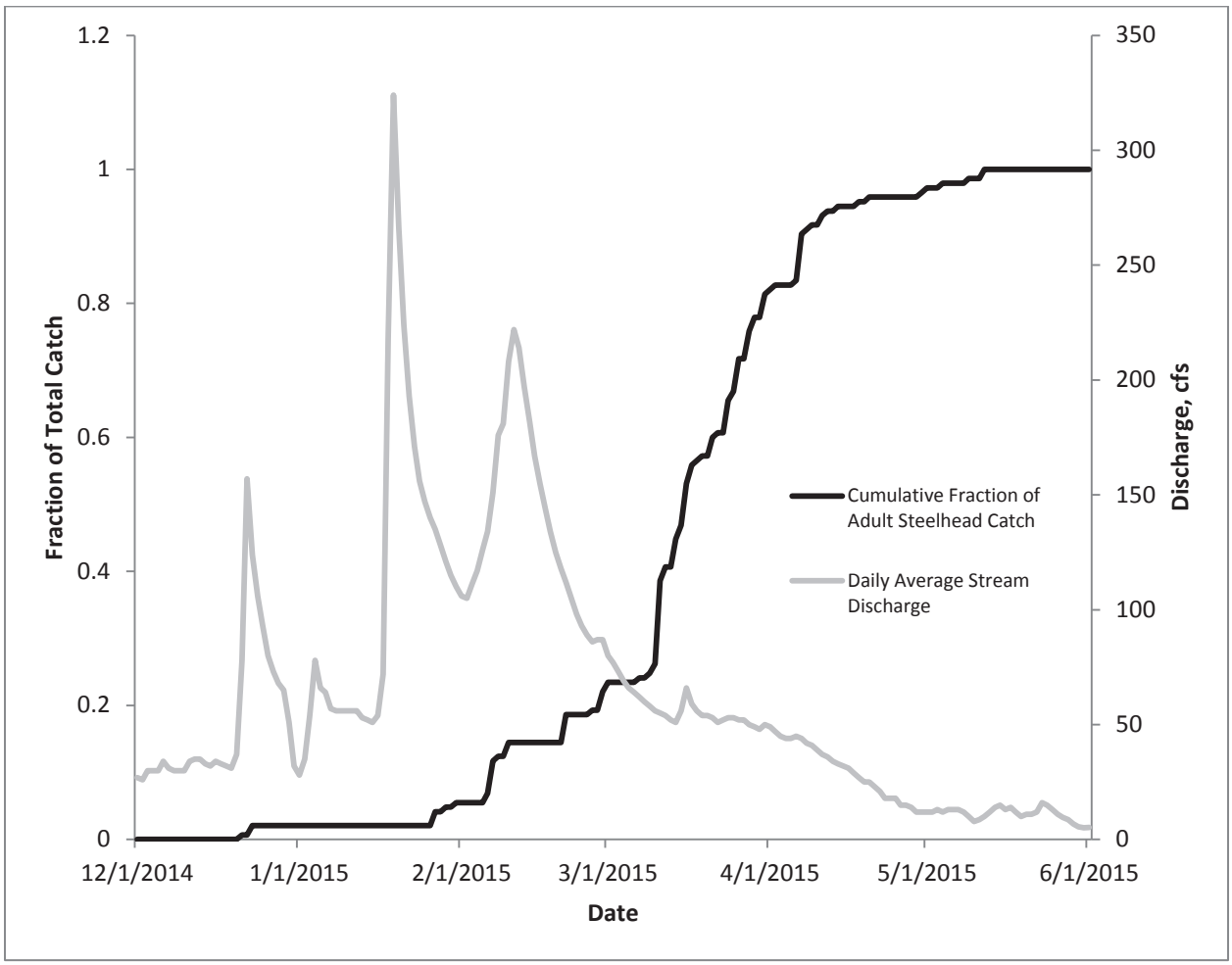


Figure 6. Cumulative numbers of wild adult steelhead captured at the Fifteenmile Creek weir (not including kelts) during the 2015 trapping season (1 December, 2014 to 1 June, 2015). Also shown is the mean daily discharge of Fifteenmile Creek.

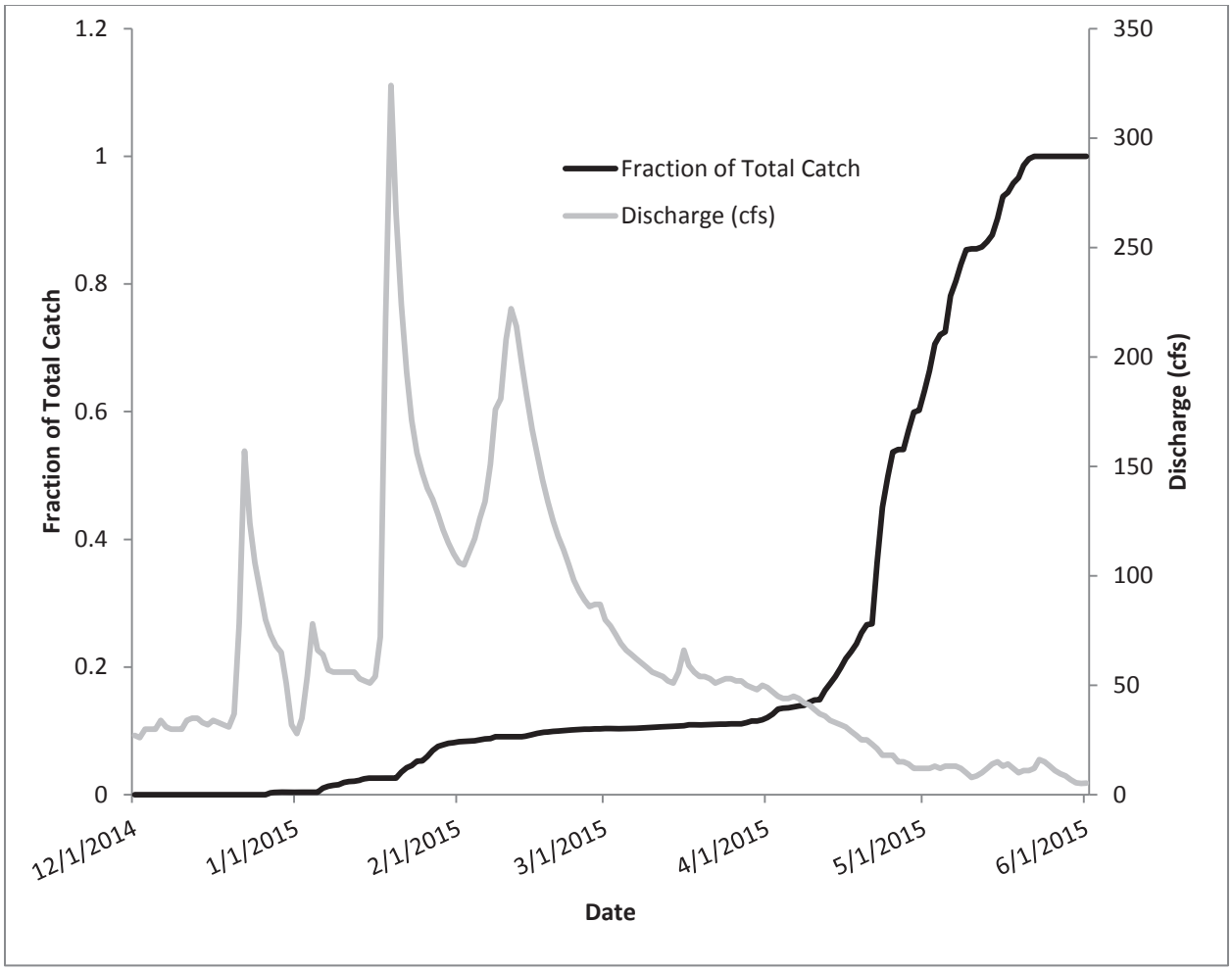


Figure 7. Cumulative capture of juvenile steelhead at the Fifteenmile Creek rotary screw trap during 2015. Mean daily discharge at the Oregon Department of Water Resources gauging station on lower Fifteenmile Creek is shown for comparison.

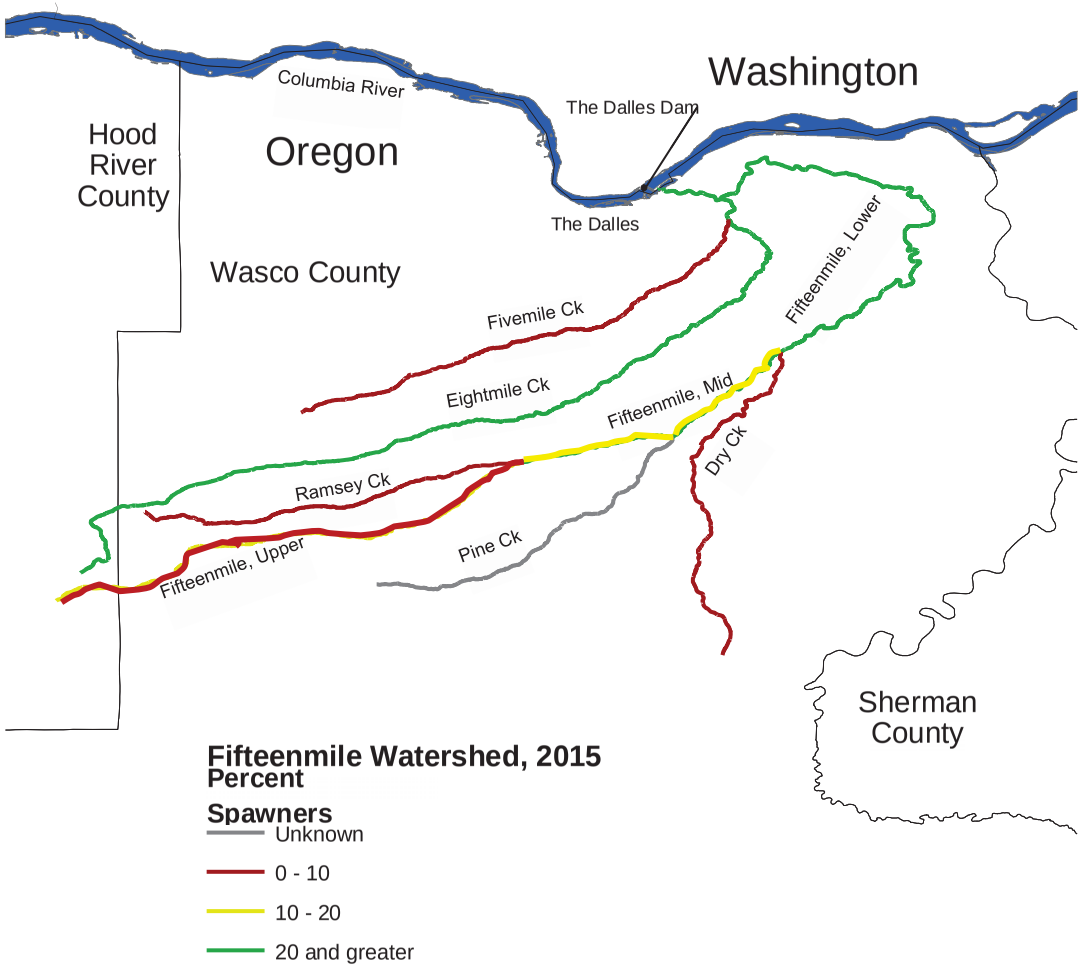


Figure 8. Distribution of spawning adult steelhead in Fifteenmile Creek during the 2015 spawning season, shown as percent spawners by major stream reach. The distribution of spawners was determined from PIT antenna data for 178 PIT-tagged adult steelhead detected on the Fifteenmile Creek in-stream arrays during the 2015 spawning season.

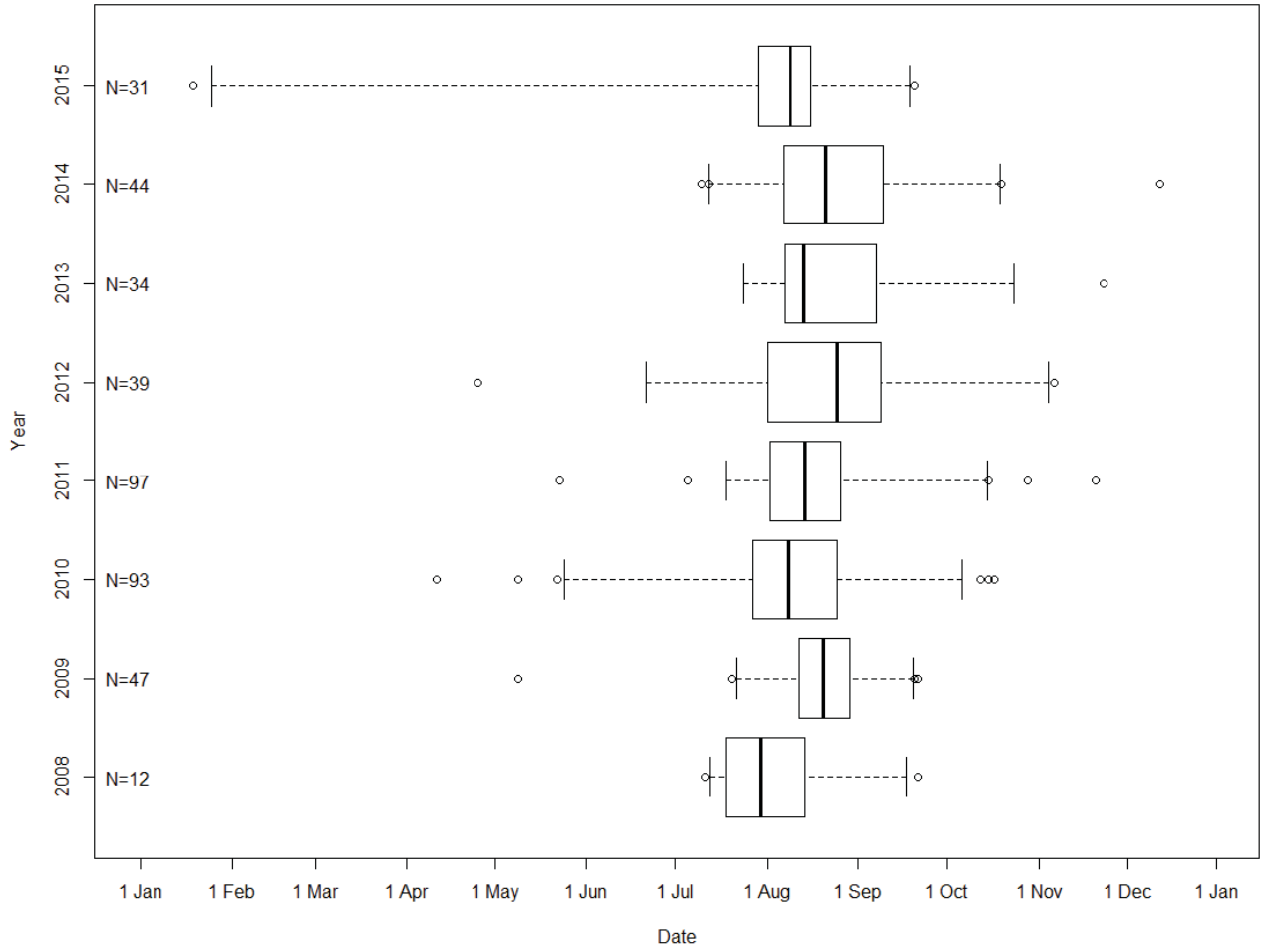


Figure 9. Time series of adult Fifteenmile Creek steelhead run-timing at Bonneville Dam, presented as box plots. Box plot whiskers encompass the middle 95 percent of the run distributions; boxes encompass the middle 50 percent of the run distributions; dark vertical lines within each box represent the median of the run distributions. Sample sizes shown next to the vertical axis are numbers of tagged individuals returning in each particular year. Run timing for 2015 is preliminary.

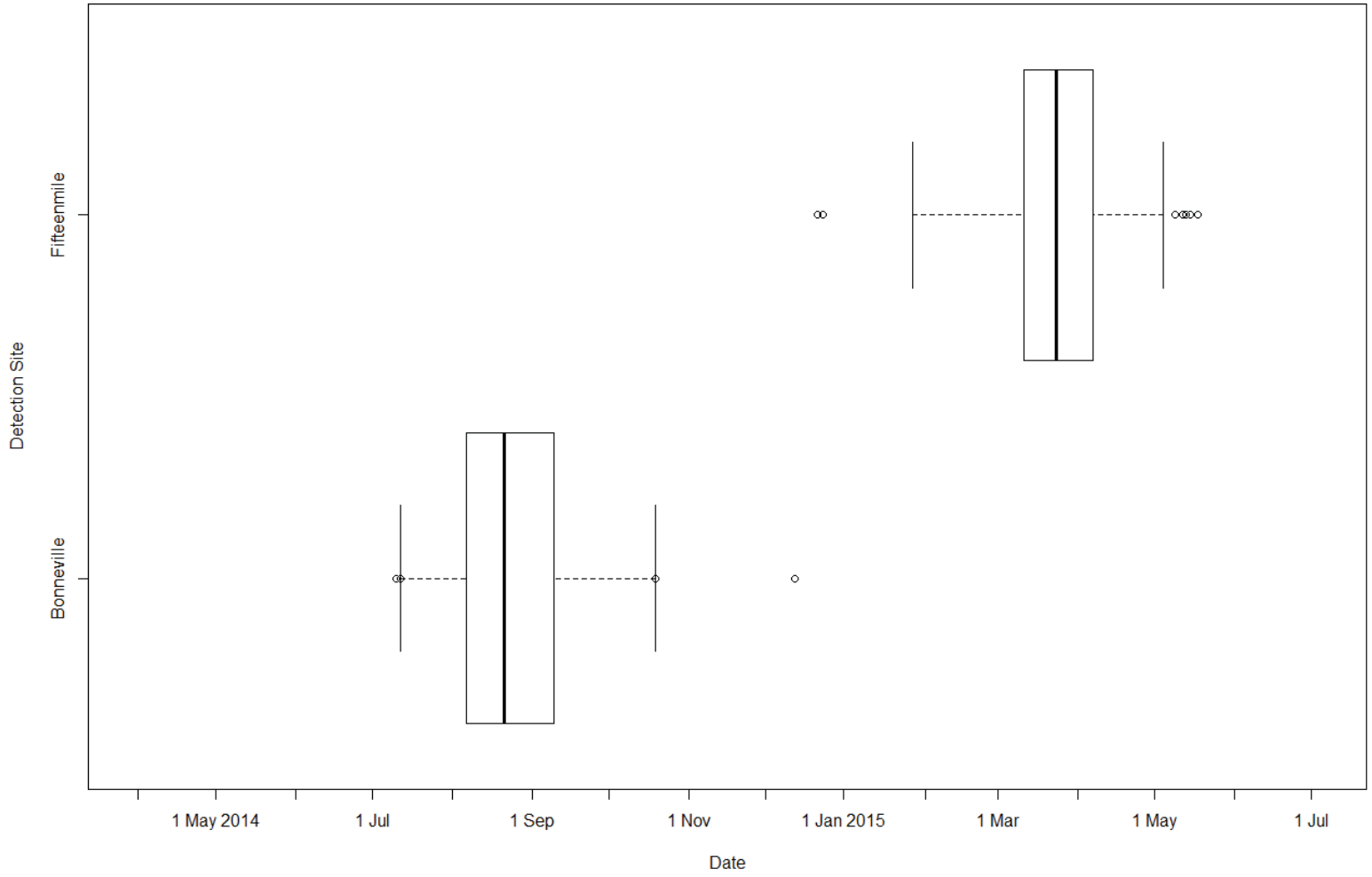


Figure 10. Run timing of the 2015 brood year adult Fifteenmile Creek steelhead run at Bonneville Dam (summer 2014) and at the Fifteenmile Creek adult weir (spring 2015), presented as box plots. Box plot whiskers encompass the middle 95 percent of the run distributions; boxes encompass the middle 50 percent of the run distributions; dark vertical lines within each box represent the median of the run distributions.

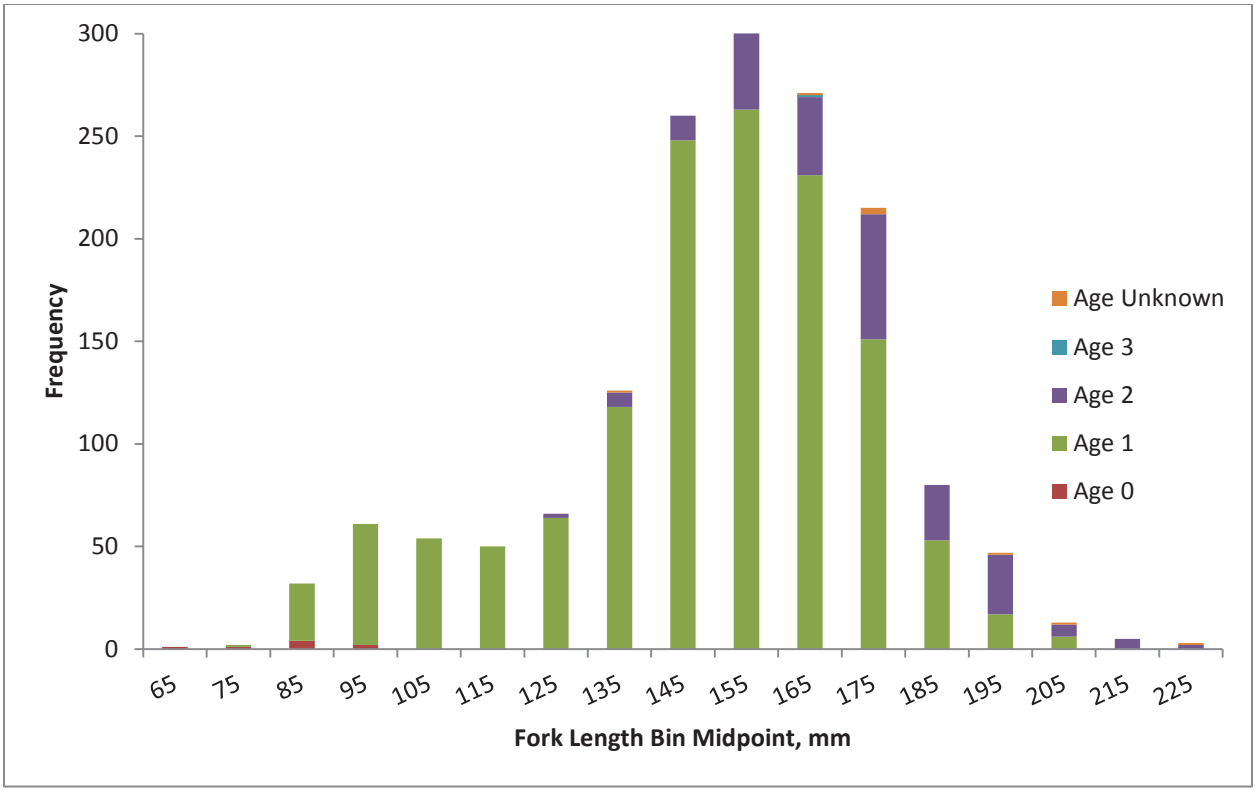


Figure 11. Length-frequency histogram and age composition of juvenile steelhead trapped in the Fifteenmile Creek rotary screw trap during 2015.

Appendix C: List of Metrics and Indicators

Abundance and Life History:			95% CI		
Natural Origin Spawner Abundance (NOSA)	Year	Estimate	Lower	Upper	Notes
	2003	836	502	1170	Based on stratified spawning surveys
	2004	988	534	1442	Based on stratified spawning surveys
	2005	352	0	2231	Based on stratified spawning surveys
	2006	*	*	*	* No survey conducted
	2007	196	0	433	Based on stratified spawning surveys
	2008	129	46	213	Based on stratified spawning surveys
	2009	*	*	*	* No survey conducted
	2010	737	251	1222	Based on stratified spawning surveys
	2011	415	198	692	Based on weir mark-recapture
	2012	557	308	806	Based on weir mark-recapture
	2013	290	266	316	Based on video counts, weir data, and PIT array data
	2014	513	464	571	Based on video counts, weir data, and PIT array data
	2015	424	415	454	Based on video counts, weir data, and PIT array data

			95% CI		
Hatchery Origin Spawner Abundance (HOSA)	Year	Estimate	Lower	Upper	
	2011	17	8	28	Based on percentage of hatchery origin fish caught above the weir
	2012	27	15	39	Based on percentage of hatchery origin fish caught above the weir
	2013	21	19	23	Based on video data and video based escapement data
	2014	12	11	14	Based on video data and video based escapement data
	2015	8.2	8.15	8.28	Based on video data and video based escapement data

Adult Sex Ratio:	Year	Male	Female	n-captured
	2011	43.9%	54.1%	98
	2012	40.0%	60.0%	180
	2013	34.6%	65.4%	188
	2014	37.3%	62.7%	158
	2015	35.4%	64.6%	212

Spawning Distribution, 2015:	PIT Array	Surveys	Values are percent of adult run
Stream Reach: Fifteenmile – Lower[a]	48.3%	47.2%	PIT Array: Spawning reach determined by PIT detection histories from the PIT array
Fifteenmile – Mid[a]	20.8%	26.4%	Surveys: based on number of redds found in each stream reach
Fifteenmile – Upper[a]	3.9%	12.5%	[a]Lower Fifteenmile refers to the section of Fifteenmile Creek between the Fifteenmile/Eightmile confluence and the Fifteenmile/Dry confluence. Mid-Fifteenmile refers to the section of Fifteenmile Creek between the Fifteenmile/Dry confluence and the Fifteenmile/Ramsey confluence. Upper Fifteenmile refers to the section of Fifteenmile above its confluence with Ramsey Creek.
Fivemile	1.1%	0%	
Eightmile	23.6%	13.9%	
Dry	1.9%	-	
Ramsey	0.56%	0.0%	

Adult Freshwater Age:	Age 1	Age 2	Age 3	n-aged
2011	62.7%	37.3%	0.0%	86
2012	69.7%	29.3%	1.0%	208
2013	70.4%	28.6%	1.0%	210
2014	60.8%	39.2%	0.0%	181
2015	64.1%	36.0%	0.0%	214

Adult Total Age:	Age 3	Age 4	Age 5	Age 6	Age 7	
2011	19.8%	59.2%	19.8%	1.2%	0.0%	Total age = FW age + SW age + number of years after first freshwater re-entry
2012	29.8%	51.0%	16.8%	1.4%	1.0%	
2013	21.0%	64.3%	13.3%	1.4%	0.0%	
2014	26.0%	60.8%	10.5%	2.2%	0.6%	
2015	27.6%	51.9%	19.2%	1.4%	0.0%	

Incidence of Repeat Spawning (Iteroparity):	1st Spawn	2nd Spawn	3rd Spawn	n-fish	Determined from scale pattern analysis of adults captured at the weir
2013	92.1%	7.4%	0.5%	189	
2014	93.6%	5.8%	0.6%	156	
2015	97.2%	2.8%	0.0%	214	

Smolt Abundance:

Year	Released (n)	Estimate	95% CI Lower	95% CI Upper
2007	286	7436	4200	13349
2008	1232	7905	6953	9016
2009	2735	16549	15223	18016
2010	2135	26972	23361	31197
2011	2202	25817	21296	31414
2012	2527	25775	21962	30484
2013	2012	33311	28580	39842
2014	406	10601	6988	18624
2015	1394	5395	4824	6054

Smolt Age: Year	Age 1	Age 2	Age 3	n-aged
2011	80.3%	19.3%	0.4%	226
2012	78.9%	19.3%	1.8%	342
2013	80.0%	19.8%	0.2%	1859
2014	71.6%	28.2%	0.3%	387
2015	85.5%	14.5%	0.1%	1581

Survival:

Smolt Migration, 2015:	Estimate	95% CI Lower	95% CI Upper
% Surviving To Bonneville	66.3%	27.7%	98.8%
% Surviving To Estuary	14.6%	0%	63.0%
Adult Migration, 2014-15:			
% Bonneville to Fifteenmile	48%	47%	50%

Cormack-Jolly-Seber (CJS) model based on migrant juvenile steelhead tagged at Fifteenmile screw trap (n = 1394)

Based on detections at Bonneville and Fifteenmile

Production:

Smolts-per-Spawner: Brood Year	Estimate	95% CI Lower	95% CI Upper
2006	20.7	13.1	34.2
2007	29.6	26.4	33.2
2008	82.3	74.4	91.2
2009	68.2	58.6	79.7
2010	31.6	26.3	38.3
2011	65.0	55.4	77.1
2012	53.2	44.6	66.6
2013*	30.4	20.7	50.4

*Estimates preliminary - missing one or more age class

	2014*	13.9	11.6	14.4	*Estimates preliminary - missing one or more age class
Smolt-to-Adult Return Rates: Year	Outmigration	Estimate	Lower	Upper	To Fifteenmile Creek, years shown refer to smolt
	2007	2.45	1.17	5.04	outmigration years; return rates in percent
	2008	3.57	2.67	4.77	
	2009	2.05	1.58	2.65	
	2010	1.22	0.83	1.78	
	2011	0.59	0.34	1.01	*Preliminary estimates - not all ocean age-classes
	2012*	0.64	0.39	1.03	represented
Recruits-per-Spawner: Year	Brood	Estimate	Lower	Upper	
	2008	3.22	1.96	9.13	By brood year, based on 2011-2015 adult returns.
	2009	1.04	*	*	* An estimate of the spawner abundance for 2009 is made by reconstructing the unknown 3 - 6 yr old cohorts from brood years 2003 - 2006 based on the average proportion at age by brood year for years with observations, therefore no confidence limits are provided.
	2010	**	-	-	**Not enough ocean year returns represented to
	2011	**	-	-	estimate
	2012	**	-	-	
			95% CI		
Outside Influence & Straying:		Estimate	Lower	Upper	
Hatchery Fraction, 2015		1.91%	1.80%	1.98%	Based on video data and video-based escapement est.
Stray Rates:					
of Fifteenmile Steelhead, 2015		4.29%	-	-	Based on PIT Tag detections of fish with known origins
into Fifteenmile Creek, 2015		0%	-	-	Based on PIT Tag detections of fish with known origins