Evaluation of Juvenile Salmonid Outmigration and Survival in the Lower Umatilla River Basin

2017 Annual Report

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LIST OF ABBREVIATIONS AND ACRONYMS

AFS - American Fisheries Society
Avg. - average
BON - Bonneville Dam
BPA - Bonneville Power Administration
CI - Confidence Interval
CTUIR - Confederated Tribes of the Umatilla Indian Reservation
DPS - Demographic Population Segment
ESA - Endangered Species Act
g - grams
IC-TRT - Interior Columbia River Technical Recovery Team
JDD - John Day Dam
km - kilometer
mm - millimeter
no. - number
NMFS – National Marine Fisheries Service
NOAA - National Oceanic and Atmospheric Administration
ODFW - Oregon Department of Fish and Wildlife
PIT Tag - passive integrated transponder tag
PTAGIS - PIT Tag Information System
rm - river mile
RM&E - Research, Monitoring, and Evaluation
RPA - Reasonable and Prudent Alternative
SAR - Smolt-to-Adult Return
sd - standard deviation
se - standard error
sp. - species
TMFD - Three Mile Falls Dam
UMMEOC – Umatilla Management Monitoring and Evaluation Oversight Committee
USBR - United States Bureau of Reclamation
USDI - United States Department of Interior
USFWS - United States Fish and Wildlife Service
USGS - United States Geological Survey

1. Abstract

Fish Population Status Monitoring (RM&E)

This report summarizes Umatilla River steelhead monitoring and Three Mile Falls Dam (TMFD) PIT tag detection system operations for calendar year 2017. This report also includes updates to long-term status and trend data for the ESA-listed Umatilla steelhead population, which is a large population within the Umatilla/Walla Walla Major Population Group.

The project used two fixed site traps, PIT tags, and mark-recapture to assess the status and trend of juvenile abundance and productivity, estimate survival rates, and monitor life history characteristics. Spatial distribution and density of summer steelhead redds were determined using a spatially balanced random sample (Generalized Random Tessellation Stratified) within a temporally based panel design. Redd distribution data was collected from 25–35 individual sites.

Juvenile trap operations began a month late at TMFD; however, both traps were operated into late June for the first time since 2014. During trapping operations, 9565 natural and 705 hatchery origin juvenile summer steelhead were collected at the two sites.

Significantly fewer PIT tag detections were observed at TMFD in 2017 compared to the previous two years and was the fewest since 2012. The number observed in the juvenile bypass was similar to past years; however, only 30 adult steelhead with a known juvenile release location were detected, with one out-of-DPS hatchery steelhead observed.

Median emigration at TMFD for natural and hatchery summer steelhead occurred during the second week of May (May 7 to May 13). Consistent with previous years, the cumulative passage of hatchery and natural steelhead at TMFD was statistically different but no biologically significant divergence appeared evident.

Median and peak emigration from Birch Creek occurred in early May. Median emigration dates at TMFD and Columbia River detection sites were in mid to late May and approximately two weeks later compared to last year. However, travel time was similar to previous years.

A total of 8216 natural summer steelhead were PIT tagged between the two trap sites. Estimated abundance was 21,526 ± 2,327 juveniles leaving Birch Creek and 41,055 ± 2,056 smolts passing TMFD.

A total of 68 redds were enumerated at 31 survey sites. Spatial distribution was similar to previous years, but redd density was significantly lower than the past two years. The majority of sites had less than 5 redds, with only 2 sites having greater than 10 redds. No hatchery steelhead were observed during surveys in 2017.

Long-term trends in production and survival estimates continued to show that larger numbers of spawning females were associated with reduced numbers of smolts-per-female, a decreasing trend for egg-to-smolt survival, and increasing trend for smolt-to-adult return. These results suggested that habitat conditions and compensatory mortality limit freshwater production and favorable ocean conditions were the primary reason for increased adult returns.

2. Introduction

Fish Population Status Monitoring (RM&E)

Summer steelhead (*Onchorhynchus mykiss*) were substantially reduced, while Chinook (*O. tshawytscha*) and coho salmon (*O. kisutch*) were extirpated from the Umatilla River basin in the early 1900s. Agricultural and irrigation development during this time period led to extensive habitat destruction, compromised fish passage, and inadequate stream flows (USBR 1988). In the early 1980s the Umatilla Basin Fisheries Restoration Program was initiated by the Oregon Department of Fish and Wildlife (ODFW) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) to mitigate for population losses. A comprehensive plan incorporating habitat restoration, flow enhancement, fish passage improvements, and artificial production was developed in 1986 (Boyce 1986). The Columbia River Basin Fish and Wildlife Program authorized construction of the Umatilla Fish Hatchery in 1986. The Umatilla Hatchery Master Plan (CTUIR and ODFW 1989) was approved in 1990, and the hatchery was completed in 1991. Implementation of fish passage improvements began in 1984, habitat restoration efforts in 1987, and flow enhancement in the 1990s (St. Hilaire 2007; USBR and BPA 1989).

The Umatilla Fish Hatchery was the foundation for reintroducing Chinook salmon and supplementing steelhead in the Umatilla River (CTUIR and ODFW 1989). Annual return goals for naturally-produced adults of each species were established in the Umatilla Subbasin Plan (DeBano et al. 2004), but have rarely, if ever, been reached (Clarke et al. 2010). In 1999, NOAA Fisheries listed steelhead within the Middle-Columbia River Distinct Population Segment (DPS), which includes the Umatilla River population, as threatened under the Endangered Species Act. Umatilla steelhead population viability was rated as "maintained" but the Umatilla/Walla Walla Major Population Group is below viability criteria (Carmichael and Taylor 2009; NMFS 2009). The Umatilla steelhead population must reach and remain at viable status for the DPS to attain delisting criteria (Carmichael and Taylor 2009; NMFS 2009).

The Evaluation of Juvenile Salmonid Outmigration and Survival in the Lower Umatilla River Basin (1989-024-01) was established in 1994, following initial project work that evaluated fish passage at reconstructed juvenile and adult fish passage facilities in the Umatilla River. The project was requested by the ODFW and CTUIR based on both a local and regional high priority need for information on life history characteristics, survival, and success of hatchery- and naturally-reared salmon and steelhead in the Umatilla River (Boyce 1986; CTUIR and ODFW 1989; NPPC 1994). More specifically, the project was intended to supplement ongoing efforts by the Umatilla Hatchery Monitoring and Evaluation (1990-005-00) and Umatilla River Natural Production Monitoring and Evaluation (1990-005-01) projects to address critical uncertainties within the Umatilla Basin Fisheries Restoration Program.

All monitoring efforts were conducted in the Umatilla River basin which lies within Umatilla and Morrow Counties, Oregon, with a small portion of the headwaters located in Union County (Figure 1). The Umatilla River originates in the west slopes of the Blue Mountains near Pendleton, Oregon and flows northwest entering the Columbia River near Umatilla, Oregon. The mainstem Umatilla River flows through the Columbia Plateau ecological province for a distance of 89 miles and the river and its tributaries drain an area of approximately 2290 square miles (DeBano et al. 2004).

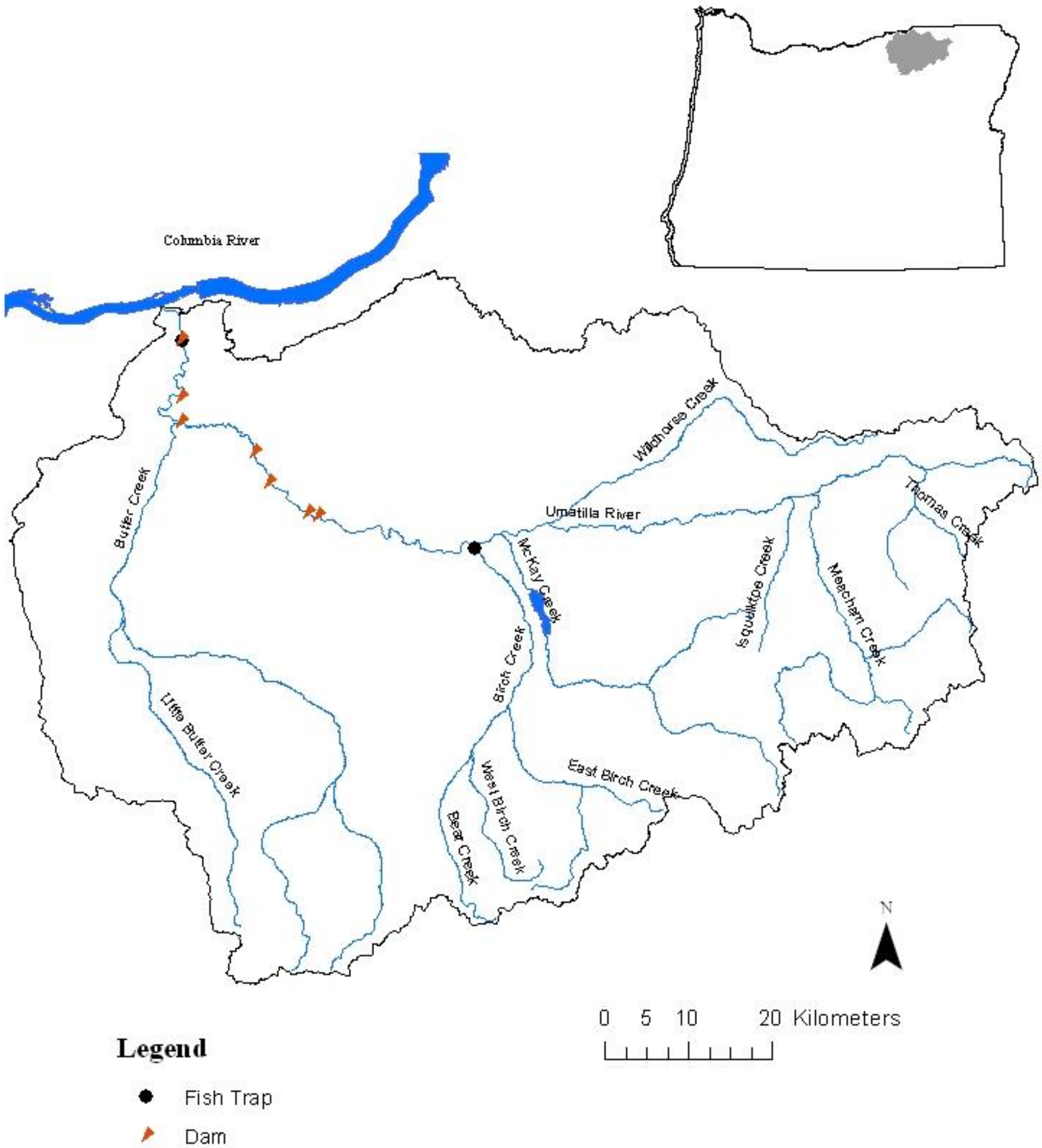

Figure 1. Map of the Umatilla River basin and fish trap locations.

Elevation ranges from nearly 5800 feet at the headwaters, to 260 feet at its confluence with the Columbia River (Saul et al. 2001). Identified by hydrologic unit number 17070103 (USDI 2010), it receives a mean annual precipitation of 10 to 50 inches per year within the lower and upper basin, respectively (Contor et al. 2000; Saul et al. 2001). The upper portion of the basin encompasses a section of the Umatilla National Forest as well as 172,000 acres of tribal land. The majority of land in the Umatilla River basin is privately owned (82%), with the remainder being divided amongst the State of Oregon, Umatilla County, and various cities (Saul et al. 2001).

The goal of the project was to provide status and trend data for summer steelhead in the Umatilla River to facilitate assessment of the Umatilla Basin Fisheries Restoration Program and to support Fish and Wildlife Program RM&E strategies. Specific Fish and Wildlife Program RM&E strategies and associated questions included:

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

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

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

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

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

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

In addition, monitoring was conducted as part of the ***Biological Opinion for the Federal Columbia River Power System, Reasonable and Prudent Alternative 50***. Project objectives funded in 2016 were (1) monitor the status and trend of the abundance and productivity of steelhead in the Umatilla River basin; (2) monitor the status and trend of the spatial structure of adult steelhead in the Umatilla River basin; (3) monitor the status and trend of the survival of Umatilla River basin steelhead; (4) monitor the status and trend of the diversity of summer steelhead in the Umatilla River basin. Project work elements performed in 2017 were:

A: Environmental compliance for monitoring work
B: Three Mile Falls Dam and Birch Creek natural summer steelhead smolt trapping
C: Umatilla River steelhead redd surveys and data collection
D: PIT tag up to 6000 natural summer steelhead
E: Upload PIT tag data to PTAGIS
F: Upload Three Mile Falls Dam interrogation data to PTAGIS
G: Statistical summary and analysis of Umatilla River natural summer steelhead smolt trapping data
H: Statistical summary and analysis of Umatilla River steelhead redd data
I: Coordinate with local and regional management and R M&E groups
J: Umatilla Outmigration & Survival Project Administration
K: Annual RME Report – January 2016 – December 2016
L: 2016 BiOp RPA Report
M: Quarterly Status Reports

3. Methods

Outmigration monitoring was conducted using downstream migrant traps and passive integrated transponder (PIT) tags. A Humphreys trap and Rotary Screw trap in Birch Creek (rm 0.2) and an inclined plane trap set in the juvenile bypass facility within the West Extension Canal at Three Mile Falls Dam on the Umatilla River (rm 3.7) were used to capture juvenile steelhead. Trap efficiency was measured by the rate that PIT tagged fish released above a trap were recaptured. Detailed methods are provided in past annual reports, CTUIR and ODFW (2006), and at the following links:

https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P128502
http://www.umatilla.nsn.us/Umatilla%20RME%20Plan%20Final.pdf
http://www.monitoringmethods.org/Protocol/Details/456

Spatial distribution and density of steelhead redds in the Umatilla River were determined using a spatially balanced random sample (Generalized Random Tessellation Stratified) within a temporally based panel design. Detailed methods are provided in past annual reports, CTUIR and ODFW (2006), and at the following links:

https://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=P128502
http://www.umatilla.nsn.us/Umatilla%20RME%20Plan%20Final.pdf
http://www.monitoringmethods.org/Protocol/Details/757

Status and trend monitoring of a variety of fish population criteria are critical aspects of the Umatilla River research, monitoring, and evaluation strategy (CTUIR and ODFW 2006) and are required for effective conservation and management of listed Middle Columbia River steelhead. Minimal data for the Umatilla River steelhead population are available before hatchery supplementation and habitat restoration efforts were implemented. Due to the lack of pre-treatment data, the study design was based on using previous year(s) data as baseline and reliance on correlative data to document progress and problems in achieving fisheries restoration and recovery objectives and goals.

4. Results

Fish Population Status Monitoring (RM&E)

Outmigration & Monitoring

Juvenile trap operations at TMFD began 3 April 2017 and ended 20 June 2016. A total of 289 hatchery and 3105 natural summer steelhead were captured during the trapping season (Table 1). Trapping effort at TMFD was high throughout the monitoring season (Figure 2). Of the 1872 hours sampled a total of 115 hours were lost during the monitoring season. April had the largest number of hours lost at 69, whereas June had the lowest number of hours lost at one.

A rotary screw trap was operated in Birch Creek from 20 January 2017 to 20 June 2017. A total of 6458 natural and 416 hatchery summer steelhead were captured (Table 2). A total of 44 trapping days were lost during the trapping season. The maximum consecutive days lost were from 15 February 2017 to 23 February 2017. No trapping was conducted in the fall of 2017.

A total of 576 interrogation files were uploaded to PTAGIS and 5150 PIT tags were detected at TMFD in 2017 (Figure 3). Observations in the juvenile bypass decreased by 27.9% while observations in the adult ladder decreased by 84.0% compared to 2016. A total of 28 natural and 2 hatchery adult steelhead with a known juvenile release location were detected (Figure 4). All natural adults were tagged as juveniles in the Umatilla River and one out-of-DPS hatchery stray was observed.

One, two, three, and four-year old juveniles accounted for 12.2%, 78.2%, 9.6%, and 0.0% of the steelhead captured at TMFD in 2017 (Table 2). Mean fork length was 172 (sd = 17) millimeters, mass 51.1 (sd = 15.7) grams, and condition factor 0.97 (sd = 0.06). One, two, three, and four-year old juveniles accounted for 10.7%, 79.3%, 9.9%, and 0.1% of the steelhead captured in Birch Creek. Mean fork length was 168 (sd = 17) millimeters, mass 49.1 (sd = 15.8) grams, and condition factor 1.02 (sd = 0.08).

Table 1. Number of juvenile summer steelhead captured at TMFD and Birch Creek, 1995–2017.

Outmigration	TMFD Trap		Birch Creek Trap		
year	Hatchery	Natural	Hatchery	Natural	Total
1995	10,652	1869	--	--	12,521
1996	12,432	3451	--	--	15,883
1997	162	194	--	--	356
1998	1924	2642	--	--	4566
1999	1882	1816	--	--	3698
2000	1078	626	--	--	1704
2001	4980	847	--	--	5827
2002	1029	630	--	--	1659
2003	1172	1015	--	--	2187
2004	1071	660	--	--	1731
2005	2197	1992	--	--	4189
2006	1720	1020	--	--	2740
2007	763	693	--	--	1456
2008	--	--	--	--	--
2009	1575	786	--	--	2361
2010	3628	3011	--	--	6639
2011	3824	1465	--	--	5289
2012	3713	2756	2	468	6,939
2013	4642	3569	111	4682	13,004
2014	4026	3071	75	5091	12,263
2015	4503	2122	3	7339	13,967
2016	3679	2670	17	3488	9,854
2017	289	3105	416	6458	10,268

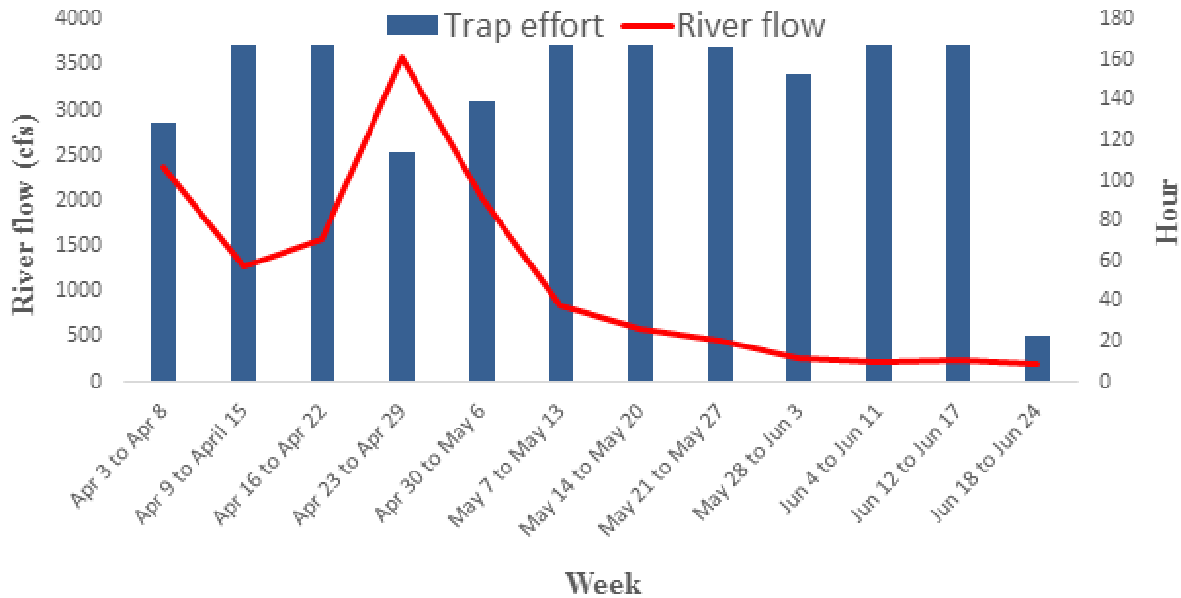

Figure 2. Weekly river flows and number of hours a subsample was taken at TMFD, Umatilla River, 2017.

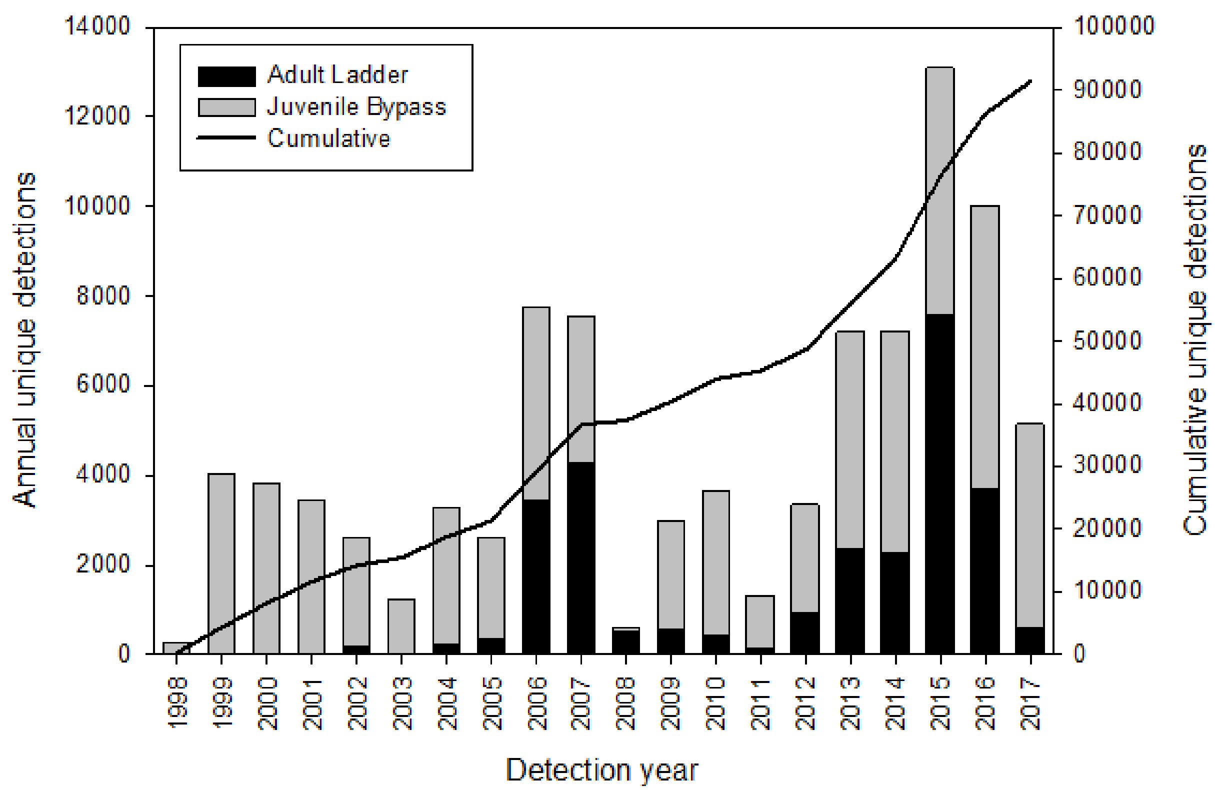

Figure 3. PIT tag detections by antenna location at TMFD, Umatilla River 1998–2017.

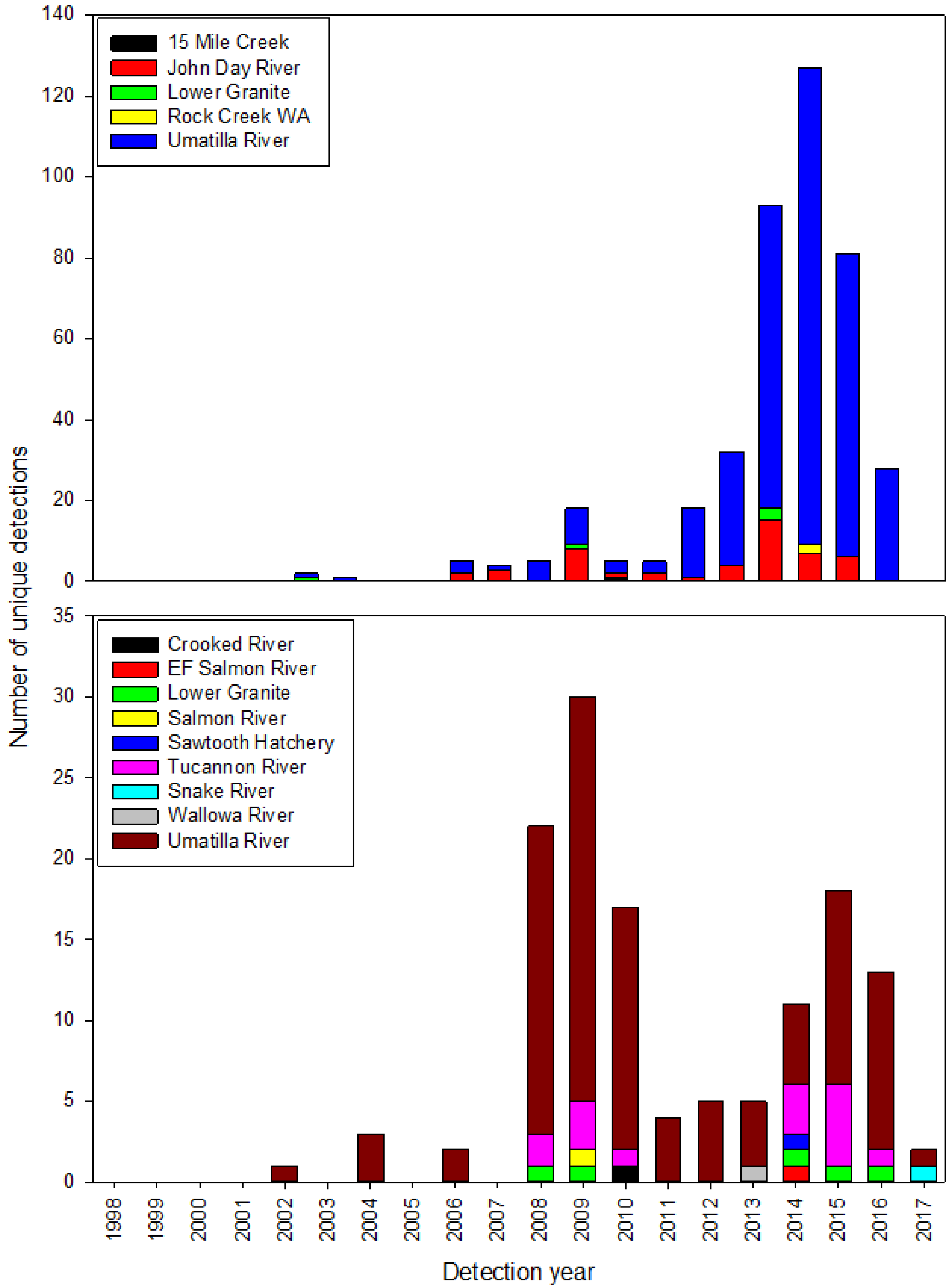

Figure 4. Detections of PIT tagged natural (top panel) and hatchery (bottom panel) adult steelhead at TMFD by juvenile release location, Umatilla River, 1998–2017.

Table 2. Natural summer steelhead smolt size and age at TMFD, Umatilla River, 1995–2017.

Outmigration year	Fork length (mm) (sd)	Sample size [a]	Fork length (mm) by freshwater age class 1 (sd)	2 (sd)	3 (sd)	4 (sd)	Freshwater age class (%) 1	2	3	4
1995	175 (28)	1612	--	--	--	--	--	--	--	--
1996	176 (24)	2970	--	--	--	--	--	--	--	--
1997	157 (23)	183	--	--	--	--	--	--	--	--
1998	186 (33)	2547	--	--	--	--	--	--	--	--
1999	181 (22)	1704	--	--	--	--	--	--	--	--
2000	180 (26)	619	--	--	--	--	--	--	--	--
2001	178 (28)	844	--	--	--	--	--	--	--	--
2002	166 (30)	571	--	--	--	--	--	--	--	--
2003	176 (30)	959	102 (6)	170 (27)	211 (42)	270 (53)	3.4	79.6	16.0	1.0
2004	167 (30)	655	104 (16)	165 (25)	292 (32)	202 (--)	5.9	82.6	11.3	0.2
2005	179 (25)	1511	160 (28)	185 (27)	210 (44)	--	7.5	88.1	4.4	0.0
2006	179 (26)	1005	164 (31)	184 (28)	191 (23)	--	17.6	77.4	5.0	0.0
2007	186 (20)	691	173 (15)	190 (19)	209 (25)	--	24.9	73.9	1.2	0.0
2008	--	--	--	--	--	--	--	--	--	--
2009	168 (16)	781	166 (17)	173 (13)	--	--	29.9	70.1	0.0	0.0
2010	177 (22)	2984	165 (19)	178 (21)	193 (26)	--	15.6	78.9	5.4	0.0
2011	173 (20)	1447	164 (17)	176 (20)	188 (19)	--	29.3	65.0	5.7	0.0
2012	180 (19)	2685	168 (18)	179 (19)	195 (24)	242 (8)	12.5	73.4	14.0	0.1
2013	174 (20)	3415	158 (22)	172 (17)	187 (23)	267 (42)	5.3	77.5	17.1	0.1
2014	175 (21)	1915	165 (23)	174 (20)	189 (22)	201 (--)	6.7	80.0	13.3	0.1
2015	184 (22)	2113	181 (22)	187 (19)	195 (20)	--	22.7	64.3	13.0	0.1
2016	185 (20)	2233	175 (17)	186 (19)	197 (22)	233 (27)	25.1	62.4	12.2	0.3
2017	172 (17)	2706	168 (15)	170 (15)	189 (19)	--	12.2	78.2	9.6	0.0

[a] *Sample sizes for age/length analysis from 2003 to 2014 were 381, 475, 588, 562, 575, 154, 2850, 1407, 2101, 1915, 1598 ; respectively.*

Table 3. Natural summer steelhead size and age from Birch Creek, 2012–2017.

Outmigration year[a]	Fork length (mm) (sd)	Sample size	Fork length (mm) by freshwater age class 0 (sd)	1 (sd)	2 (sd)	3 (sd)	4 (sd)	Freshwater age class (%) 0	1	2	3	4
2012	111 (23)	466	77 (10)	103 (23)	158 (23)	169 (12)	--	15.1	63.1	20.3	1.5	0.0
2013	144 (28)	917	64 (5)	119 (25)	156 (18)	173 (24)	--	0.9	33.0	60.0	6.1	0.0
2014	177 (23)	2260	90 (9)	139 (28)	178 (19)	188 (17)	256 (63)	0.2	7.5	75.0	17.2	0.1
2015	174 (29)	1979	86 (6)	145 (32)	182 (21)	190 (17)	--	0.3	24.3	62.0	13.4	0.0
2016	181 (22)	3381	--	161 (24)	184 (19)	190 (18)	203 (31)	0.0	16.4	72.1	11.4	0.1
2017	168 (17)	4771	--	153 (21)	169 (14)	186 (18)	202 (30)	0.0	10.7	79.3	9.9	0.1

[a] *A Humphreys trap was used to capture juveniles in 2012, a Humphreys and Rotary Screw trap in 2013–2014, and Rotary Screw trap from 2015 to present.*

The percentage of steelhead emigrants classified as smolts at TMFD in 2017 was 94.0%, nearly two times greater than the long-term average (Table 3). Mortality due to trapping and tagging was twice the long term average (Table 3). The majority of mortality occurred on a single tagging event and was a result of human error. Descaling continued to decline and was three times lower than the long-term average. Bird marks were significantly less than that observed in 2015 and 2016, while body injuries and presence of parasites continued to be high. Copepods (*Salmincola sp.*) were observed on 109 of 1604 fish with a parasite present and *Neascus* (black spot) on 1354. Leeches were observed on 69 fish and only seven fish presented with fungus.

Table 4. Smolt status, mortality, descaling, and health summary for natural summer steelhead sampled at TMFD, Umatilla River, 1995–2017.

Outmigration year	% smolted	% mortality	% descaled	% bird mark	% body injury	% parasite
1995	59.6%	0.4%	1.0%	--	--	--
1996	55.6%	0.4%	2.2%	2.1%	1.6%	3.1%
1997	27.0%	3.6%	2.2%	0.5%	4.3%	1.4%
1998	30.8%	2.3%	1.0%	2.0%	2.3%	1.0%
1999	20.0%	1.5%	4.6%	1.4%	0.8%	8.3%
2000	52.4%	0.2%	2.0%	4.5%	3.0%	6.0%
2001	--	1.8%	3.2%	3.6%	3.5%	7.0%
2002	4.5%	1.0%	0.7%	2.3%	1.2%	6.8%
2003	42.9%	3.4%	1.8%	4.5%	2.6%	17.5%
2004	52.2%	0.9%	1.7%	0.9%	4.1%	19.3%
2005	69.6%	0.5%	1.7%	2.5%	2.1%	10.0%
2006	31.3%	1.8%	1.7%	1.1%	2.4%	17.0%
2007	1.2%	1.0%	0.6%	2.3%	3.5%	14.9%
2008	--	--	--	--	--	--
2009	1.9%	3.7%	0.8%	0.8%	2.1%	12.2%
2010	28.2%	1.2%	0.4%	1.4%	0.8%	20.2%
2011	60.6%	1.0%	0.3%	3.3%	2.2%	22.0%
2012	73.3%	0.5%	0.6%	3.4%	2.2%	18.5%
2013	90.4%	0.4%	3.6%	3.3%	3.0%	40.1%
2014	87.2%	0.2%	6.4%	2.9%	1.4%	44.8%
2015	96.4%	0.2%	0.9%	8.2%	6.0%	29.8%
2016	81.1%	0.6%	0.7%	6.7%	7.7%	43.2%
Mean 95 – 16	***48.3%***	***1.3%***	***1.8%***	***2.9%***	***2.8%***	***17.1%***
2017	94.0%	2.6%	0.6%	2.6%	7.5%	53.0%

In 2017, fifty percent of the natural summer steelhead passed TMFD by early May and peak passage occurred in mid-May (Figure 5). Median and peak passage for hatchery summer steelhead occurred by mid-May (Figure 5). Cumulative passage was statistically different between natural and hatchery steelhead (Figure 5).

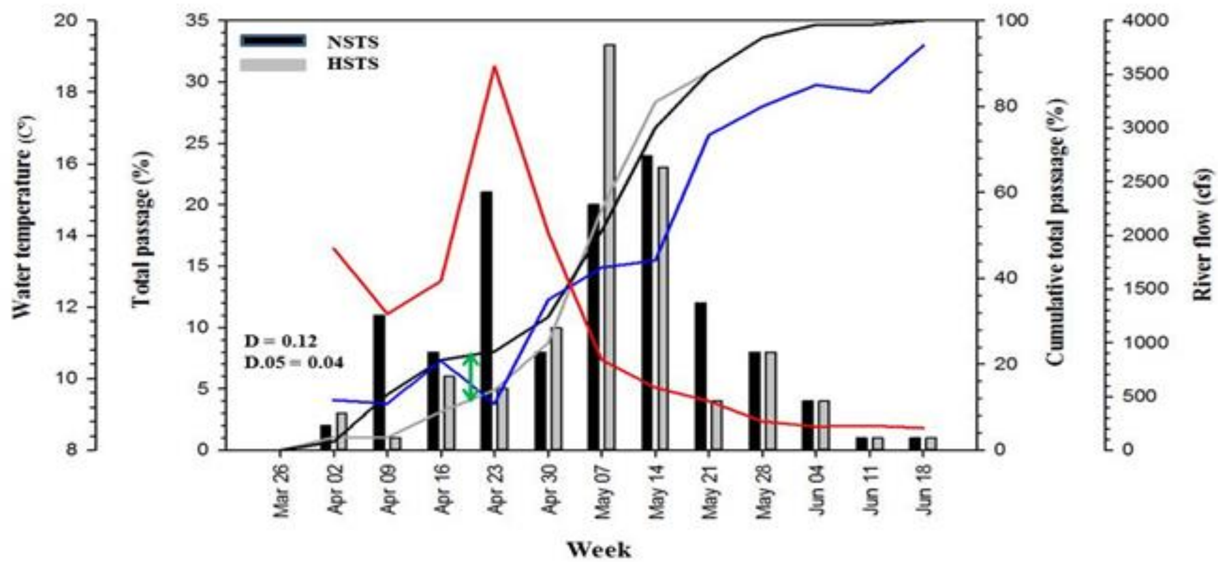

Figure 5. Natural and hatchery summer steelhead passage timing at TMFD, Umatilla River, 2017. Black and gray bars represent total number of steelhead passing through the juvenile bypass and lines represent cumulative percent of total passage through the juvenile bypass. Red line represents weekly average flow and blue line weekly average water temperature. *D* is the Kolmogorov-Smirnov statistic and the green arrow indicates week with maximum difference between cumulative distributions.

The first natural summer steelhead was captured in Birch Creek January 21 and the last on June 19 (Figure 6). Ten percent of the steelhead were captured by April 12, 50% by May 10, and 90% by May 27. Peak capture occurred May 6.

The cumulative detection past sites in the Umatilla and Columbia rivers for natural summer steelhead PIT tagged in Birch Creek are shown in Figure 7. Median detection at TMFD, JDD, BON, and the Columbia River estuary occurred on May 17, May 15, May 18, and May 18; respectively. Median travel time was 4, 7, 8, and 10 days to each site.

Long-term monitoring has shown inter-annual variation in passage timing at TMFD; however, no trends were evident (Figure 7). Median week of emigration differed by more than one week between hatchery and natural fish in only three of 21 years and were correlated (R^2 = *0.30; P-value = 0.01*). No relationship between passage timing of natural or hatchery summer steelhead and spring time maximum daily water temperature (*P-value = 0.38 and 0.93; respectively*) or average daily flow (*P-value = 0.76 and 0.51*) were found.

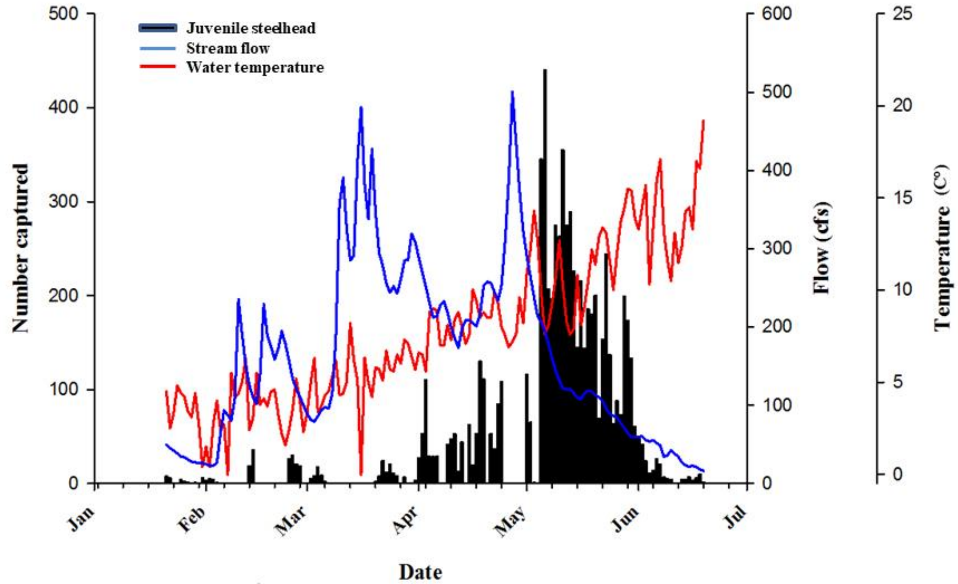

Figure 6. Natural summer steelhead catch, average daily flow, and maximum daily water temperature, Birch Creek, January 2017 to June 2017.

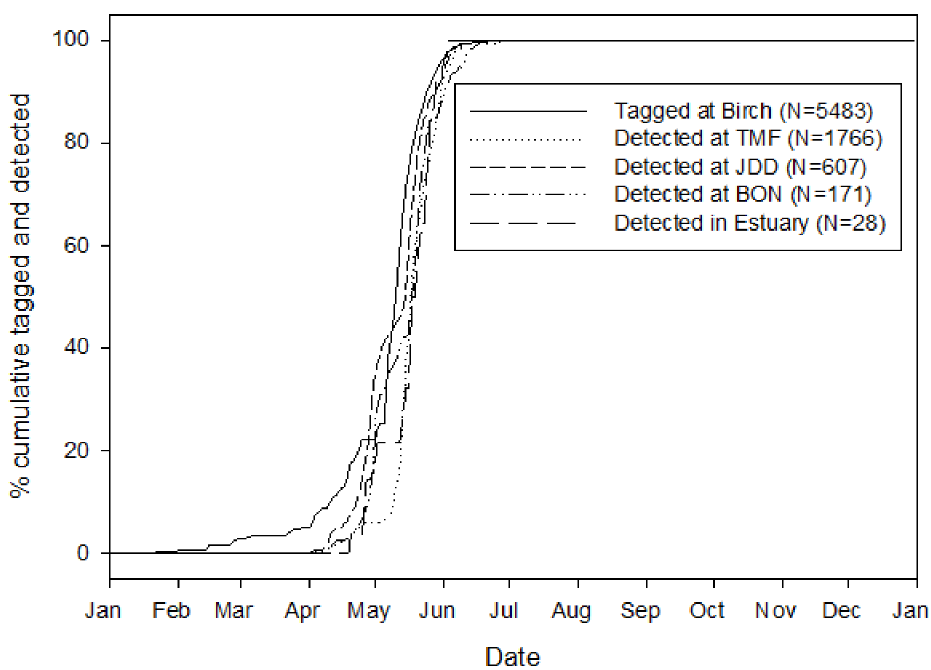

Figure 7. Cumulative tagging and detection of PIT tagged natural summer steelhead from Birch Creek at TMFD, JDD, BON, and Columbia River Estuary, January 2017 to December 2017.

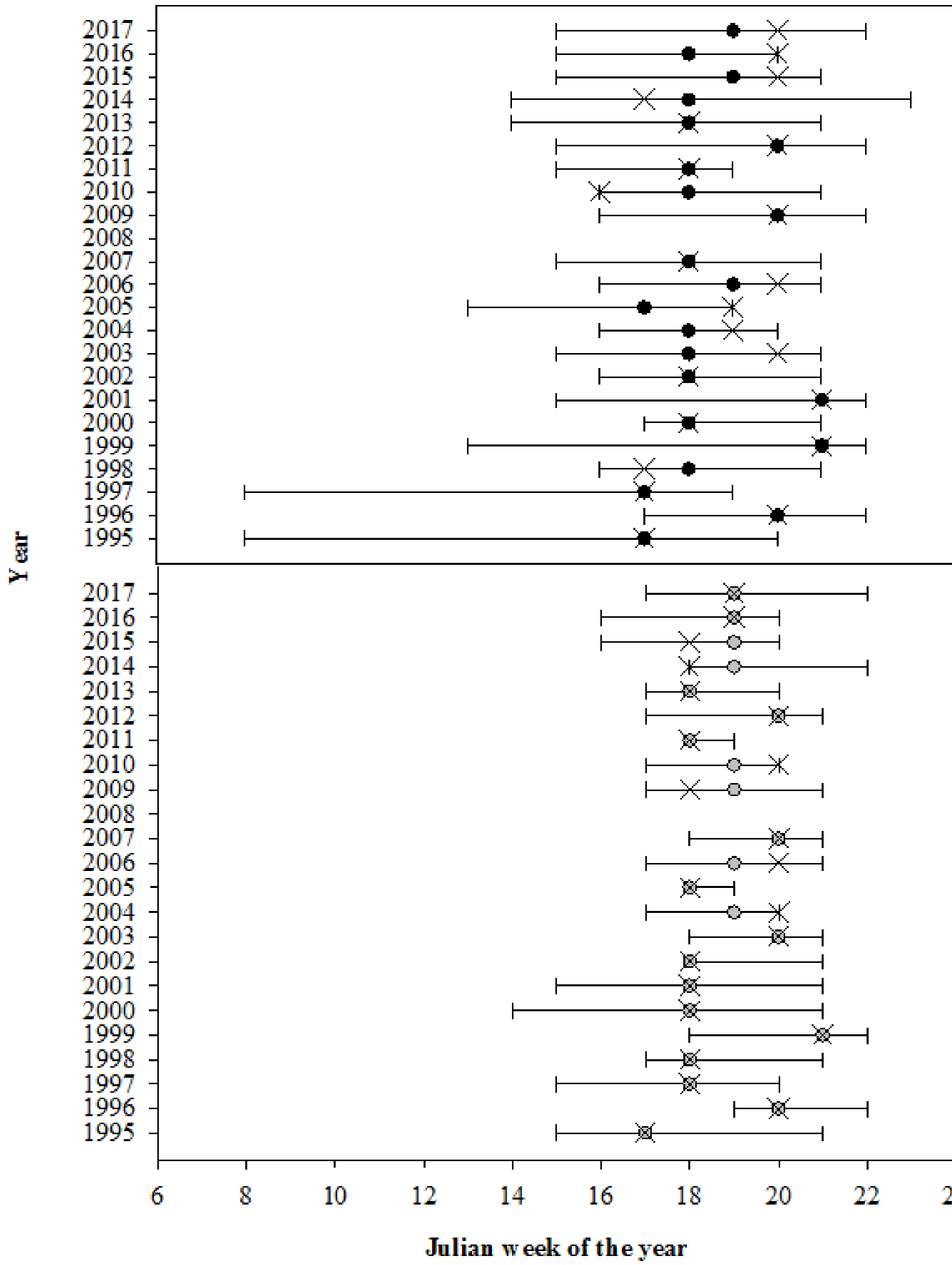

Figure 8. Emigration timing (10th, 50th, 90th, and peak (X)) of natural (top panel) and hatchery (bottom panel) summer steelhead smolts passing TMFD, Umatilla River, 1995–2017.

Production & Survival

A total of 2729 natural summer steelhead were PIT tagged and released for trap efficiency estimates at TMFD in 2017 (Table 4). An additional 14 fish were PIT tagged and released directly downstream of TMFD. Mean recapture rate for fish released above TMFD was 32.4% (sd = 16.5%) and median days to recapture was 0.6.

Table 5. Trap efficiency estimates for natural summer steelhead smolts at TMFD, Umatilla River, 2017.

Release date	No. released	No. recaptured	% recaptured	Median days to recapture	Avg. fork length (mm)	Avg. weight (g)
06 Apr	42	13	31.0	0.2	178	57.3
10 Apr	50	14	28.0	0.1	179	58.0
12 Apr	64	25	39.1	0.2	180	60.4
14 Apr	74	11	14.9	0.3	179	57.3
16 Apr	58	20	34.5	0.3	178	56.5
18 Apr	54	15	27.8	0.2	177	55.1
20 Apr	97	32	33.0	0.3	178	55.2
23 Apr	51	13	25.5	1.3	176	54.0
24 Apr	53	9	17.0	1.3	170	50.2
25 Apr	47	3	6.4	0.3	171	50.0
26 Apr	26	0	0.0	--	168	46.4
04 May	87	37	42.5	0.4	167	47.1
05 May	66	32	48.5	0.2	169	49.0
06 May	124	50	40.3	0.2	166	46.1
07 May	54	26	48.1	0.2	170	49.1
08 May	101	64	63.4	0.3	168	48.0
09 May	66	40	60.6	0.1	169	47.5
10 May	87	41	47.1	0.6	170	48.2
11 May	86	40	46.5	0.6	171	49.0
12 May	81	15	18.5	0.8	172	52.1
13 May	81	25	30.9	0.5	175	53.1
14 May	236	140	59.3	0.3	171	49.3
15 May	82	45	54.9	0.8	171	50.1
16 May	145	61	42.1	0.6	171	49.2
17 May	60	39	65.0	0.2	166	45.3
19 May	68	30	44.1	0.3	165	44.3
22 May	54	25	46.3	0.2	171	49.0
25 May	52	13	25.0	0.8	171	49.0
28 May	67	23	34.3	0.7	174	53.1
30 May	77	27	35.1	0.8	176	53.5
31 May	61	7	11.5	0.8	176	54.1
01 Jun	21	2	14.3	1.6	171	50.2
03 Jun	59	14	23.7	1.1	173	51.1
04 Jun	36	11	30.6	0.9	172	50.1
05 Jun	41	6	14.6	0.8	171	50.1
06 Jun	56	8	14.3	1.6	173	51.3
08 Jun	19	1	5.3	6.5	173	50.2
09 Jun	19	6	31.6	2.5	175	55.0
11 Jun	47	6	12.8	1.1	172	52.3
12 Jun	20	7	35.0	1.2	178	59.0
14 Jun	8	2	25.0	0.7	175	55.2
Mean (SD)	***65 (38.9)***	***24 (24.1)***	***32.4 (16.5)***	***0.6 (1.0)***	***173 (4)***	***51.0 (15.8)***

Smolt abundance (41,055 ± 2,056) was lower than the long-term average (Table 5). Abundance varied considerably from year to year, ranging from a low of 7899 in 1997 to a high of 82,005 in 2002 (Figure 9).

Table 6. Abundance estimates for natural summer steelhead smolts at TMFD, Umatilla River, 1995–2017.

Outmigration year	Abundance ± 95% CI	Coefficient of Variation
1995	46,657 ± 8167	8.9
1996	44,459 ± 4827	5.5
1997	7899 ± 2181	14.1
1998	69,328 ± 8151	6.0
1999	49,516 ± 2971	3.1
2000	56,007 ± 8028	7.3
2001	32,853 ± 3964	6.2
2002	82,005 ± 7914	4.9
2003	24,601 ± 3220	6.7
2004	32,105 ± 3100	4.9
2005	51,897 ± 5530	5.4
2006	36,080 ± 2561	3.6
2007	31,647 ± 3760	6.1
2008	--	--
2009	33,883 ± 4262	6.4
2010	63,017 ± 2828	2.3
2011	31,387 ± 3373	5.5
2012	48,602 ± 3563	3.7
2013	47,534 ± 2797	3.0
2014	36,581 ± 1893	2.6
2015	44,740 ± 4263	4.9
2016	39,672 ± 3617	5.1
Mean 95 – 16	***43,356± 4332***	***5.5***
2017	41,055 ± 2056	2.6

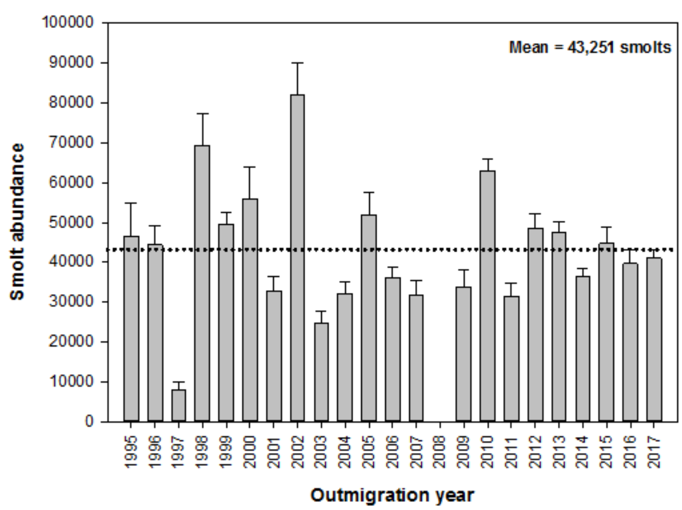

Figure 9. Abundance estimates for natural summer steelhead smolts at TMFD, Umatilla River, 1995–2017. Dotted line represents long-term average.

A total of 3273 natural summer steelhead were PIT tagged and released for trap efficiency estimates in Birch Creek. An additional 2209 fish were PIT tagged and released downstream of the trap. Trap efficiencies were separated into three temporal strata with an average recapture rate of 32.2 % (sd 10.6%) (Table 6). Estimated downstream migrant abundance was 21,526 ± 2,327.

Table 7. Summary of mark-recapture and abundance estimate data for natural summer steelhead juveniles migrating form Birch Creek in 2017.

Inclusive dates	Stratum	No. captured	No. marked	No. recaptured	Estimated efficiency (%)	Estimated abundance	95% confidence interval
20 Jan to 4 Mar	1	182	132	53	40.1	453	110
5 Mar to 5 May	2	1619	813	162	20.0	8125	1110
6 May to 8 Jun	3	4657	984	354	36.1	12948	1107
Total		**6458**	**1929**	**569**	**32.2**	**21526**	**2327**

The abundance of juvenile summer steelhead migrating from Birch Creek was the second lowest observed in our time series (Figure 10). Additional years of monitoring and refinement of abundance estimation protocol are required before analysis of inter-annual variability in downstream migrant abundance can be completed.

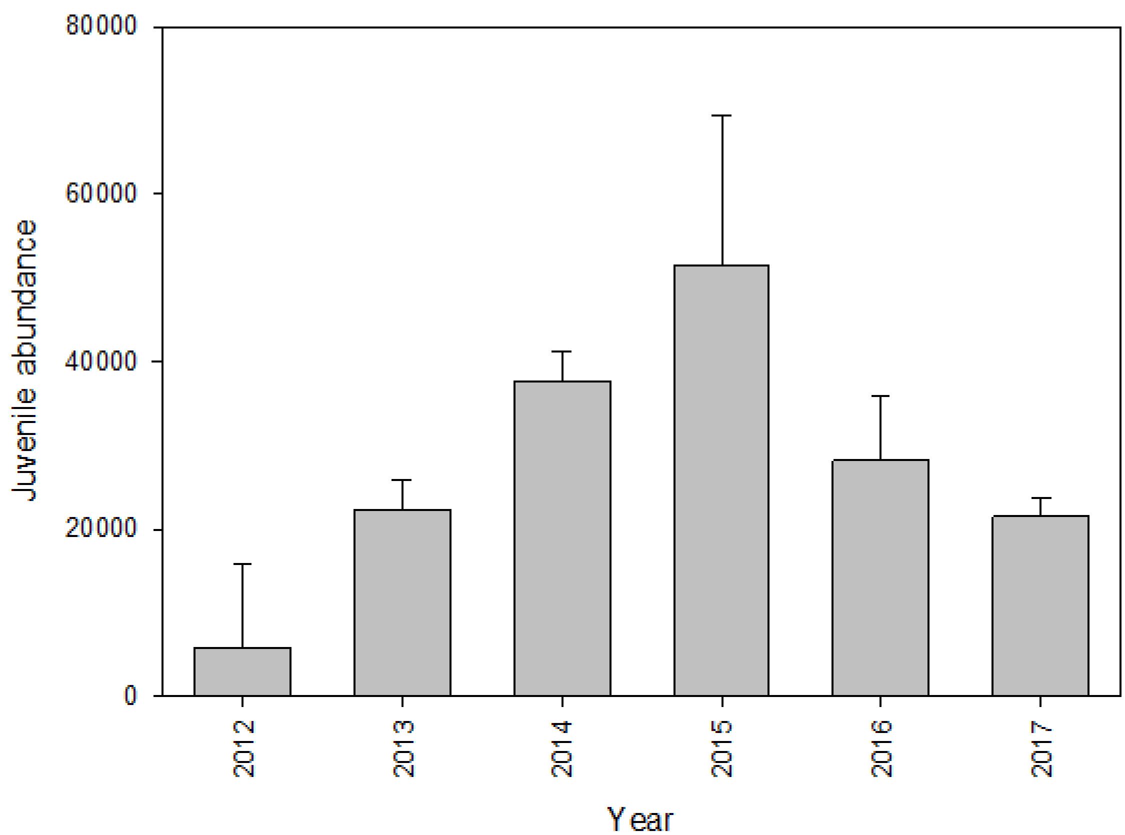

Figure 10. Abundance estimates of natural summer steelhead juveniles migrating from Birch Creek, 2012–2017.

In 2017, estimated survival probability of spring emigrants from Birch Creek to TMFD was 0.77 (se 0.03). This estimate was the highest of our time series through this reach (Figure 11). In contrast, survival from TMFD to JDD was 0.43 (se 0.06); the third lowest of our time series through this reach (Figure 11). Estimated survival from JDD to BON was above the long-term average; however, the estimate was extremely imprecise due to low detection rates at Bonneville Dam (Figure 11).

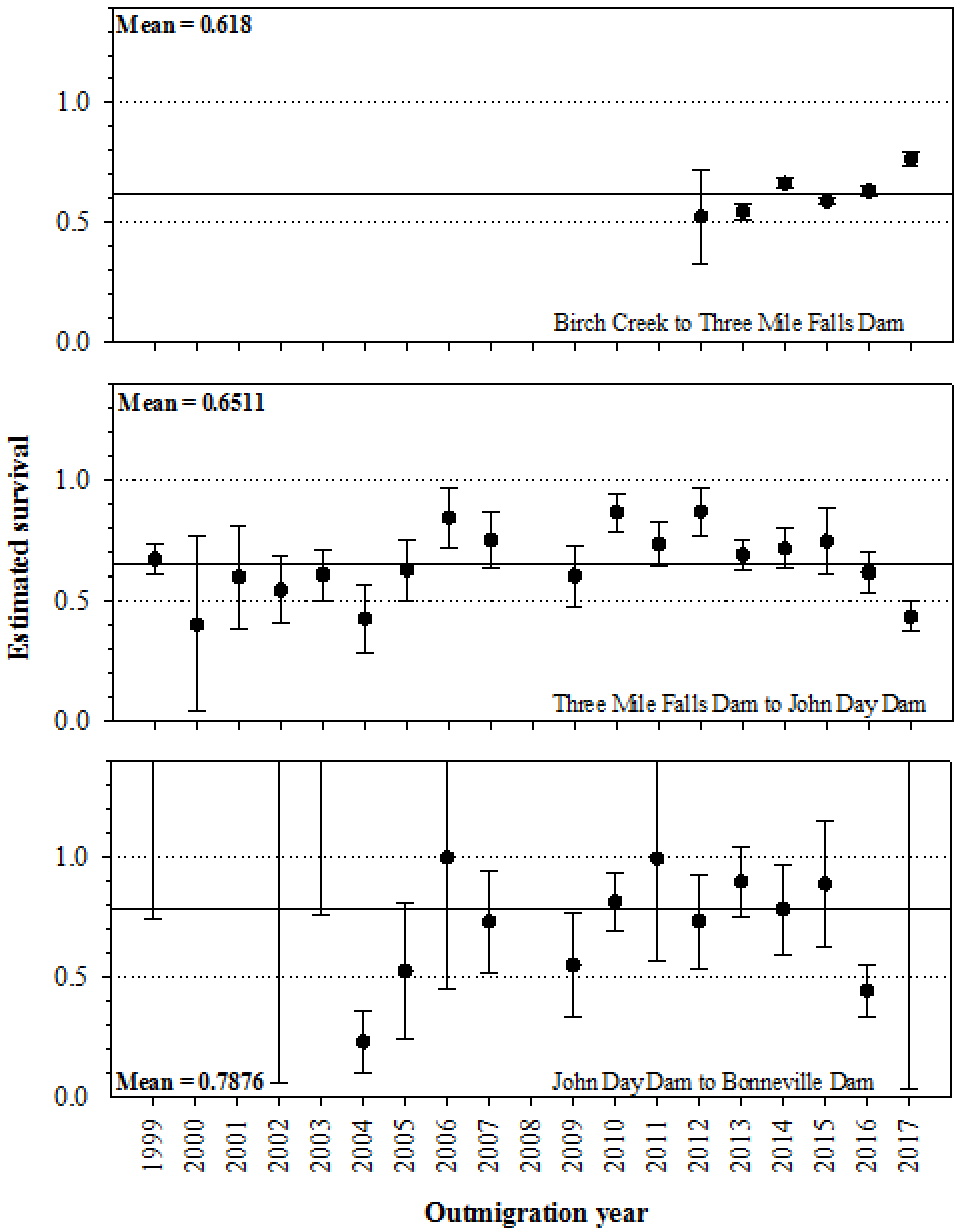

Figure 11. Estimated survival probability through various reaches for annual release groups of Umatilla River natural summer steelhead smolts, 1999–2017. Solid horizontal line represents mean survival (excluding years that exceed 1.00) and bars extend one standard error above and below point estimates.

Redd Distribution, Density, & Abundance

A total of 31 random, spatially-balanced sites throughout the Umatilla River subbasin were sampled during spring 2017 (7 March 2017 to 30 June 2017) (Figure 12). Survey sites encompassed 61.1 km of stream, approximately 9.1% of an estimated 668.4 km of steelhead spawning habitat within the subbasin. During these surveys, 68 redds and 19 live steelhead were observed with a redd density of 1.11 redds/km and estimated redd abundance of 742. Redds were observed at 18 of the 31 sites, with the highest densities observed in Isqúulktpe Creek and Meacham Creek (Figure 12). Hatchery steelhead composed 0.0% (0 of 19) of observed live fish where the presence or absence of an adipose fin clip could be determined. This was very dissimilar to the proportion of potential hatchery origin spawners (17.9%) estimated from TMFD adult counts.

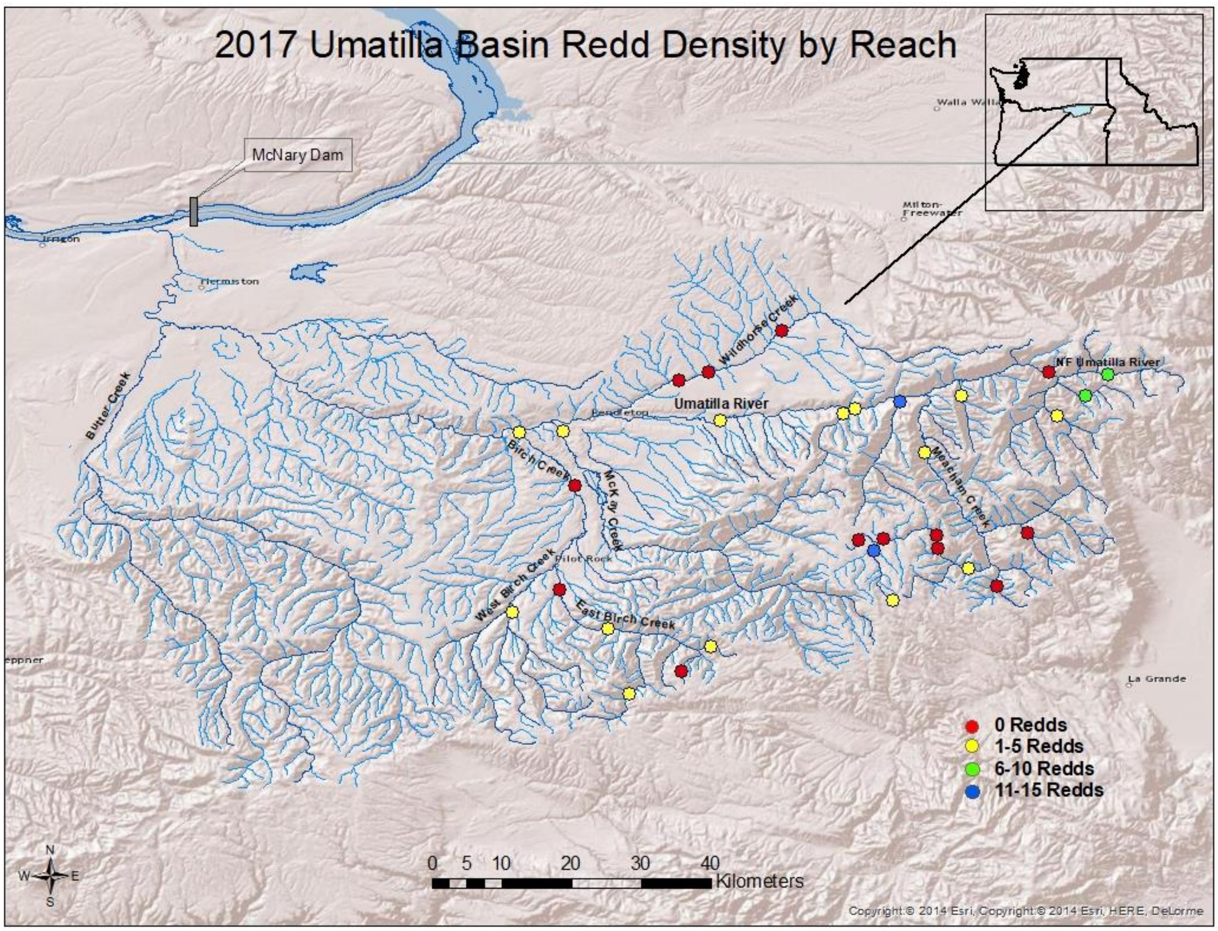

Figure 12. Locations and density of steelhead redd observations in the Umatilla River basin, 2017.

A total of 61 unique reaches were surveyed from 2012 to 2017. At least one redd was observed in 78.7% of the reaches (Figure 13). The proportion of reaches with a redd present in 2017 (58.1%) was significantly lower than 2016 (79.0%) and 2015 (82.8%), but similar to the first three survey years (53.5% (sd = 15.3%)). A combination of spawning escapement and water visibility may explain the year-to-year variability. We caution against making any conclusions on the mechanisms associated with redd distribution until more data becomes available.

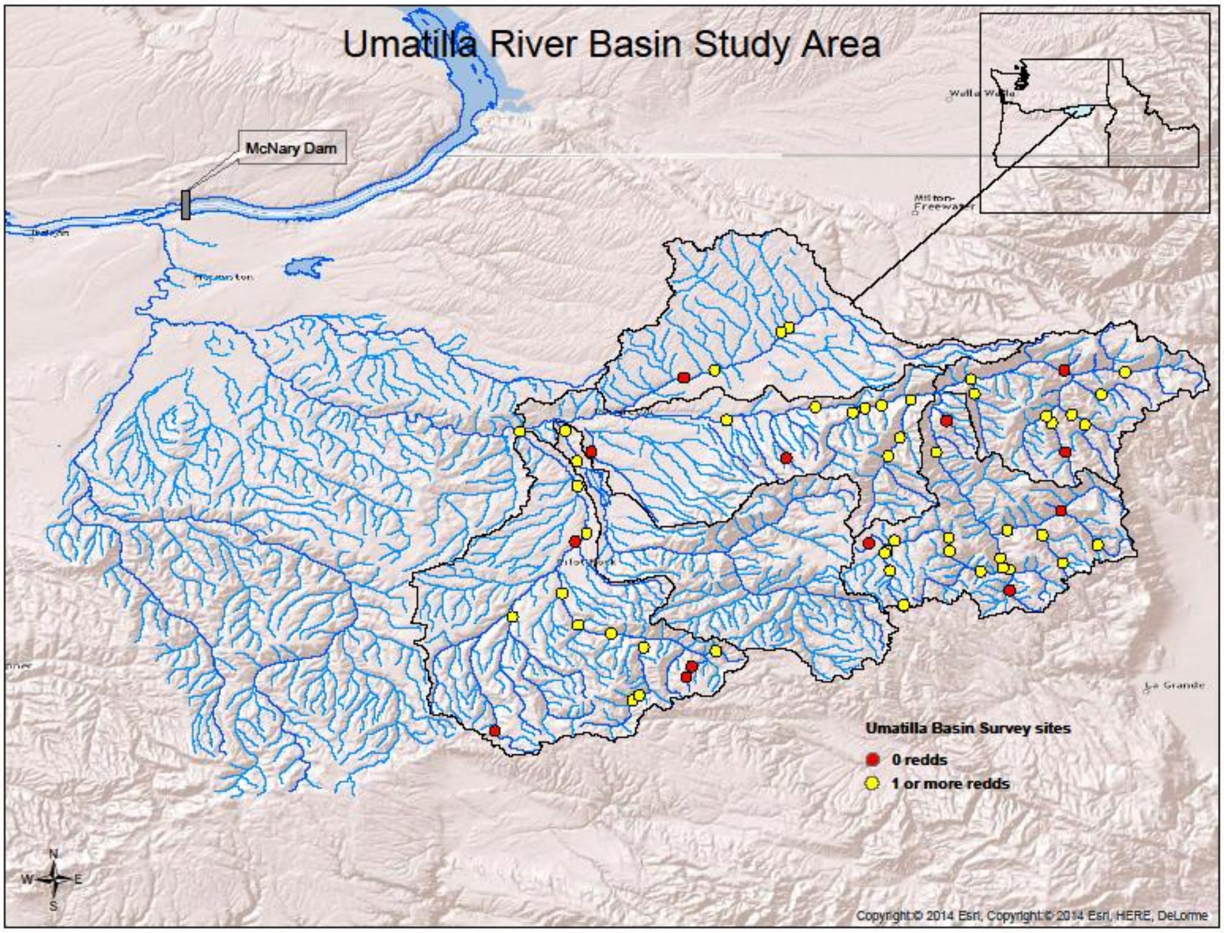

Figure 13. Locations and density of steelhead redd observations in the Umatilla River basin, 2012–2017.

Population Status & Trends

No distinct trend in natural smolt recruitment or hatchery female escapement was evident; however, natural female escapement showed an increasing trend and smolts-per-female a decreasing trend (Figure 14). Egg-to-smolt survival for summer steelhead (0.40%) was below the long-term average, but higher than the past four brood years (Figure 15). Smolt-to-adult return (SAR) for outmigration year 2014 (8.7%) remained above the long-term average (Figure 15).

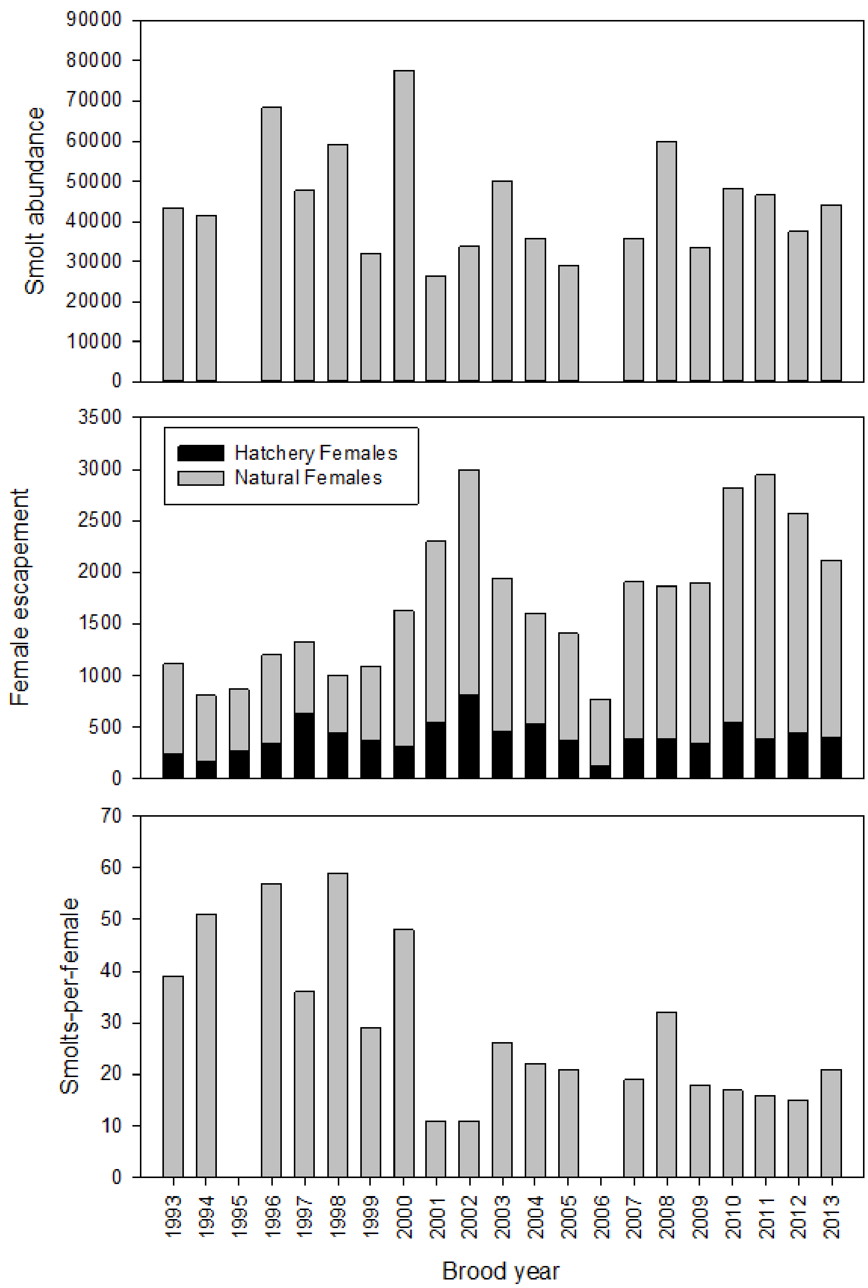

Figure 14. Smolt abundance, female escapement, and smolts-per-female for Umatilla River summer steelhead, brood years 1993– 2013.

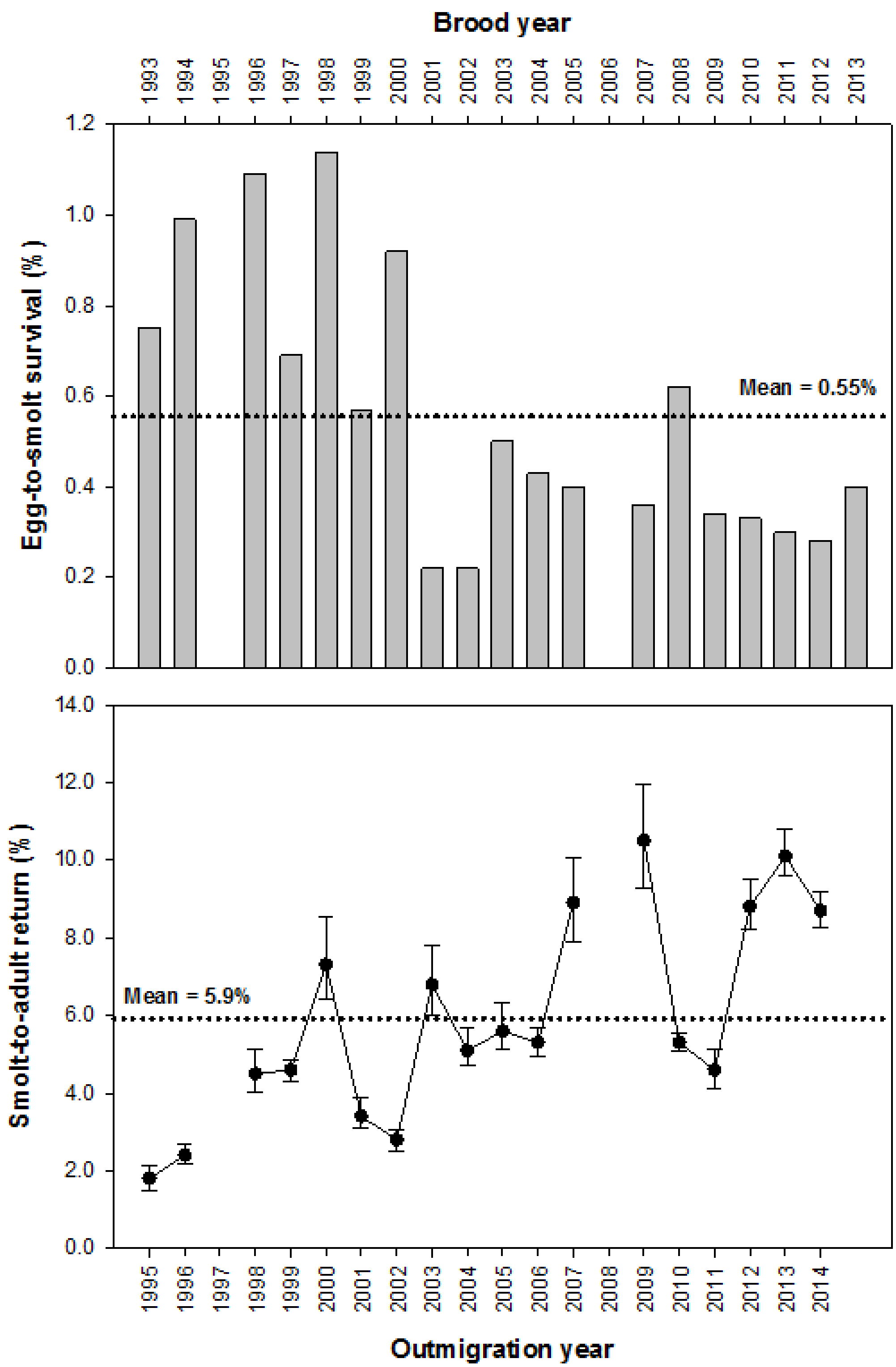

Figure 15. Umatilla River summer steelhead egg-to-smolt survival for brood years 1993–2013 and smolt-to-adult return for outmigration years 1995–2014.

5. Discussion/Conclusion

Fish Population Status Monitoring (RM&E)

Juvenile trap operations began a month later and canal operations 2 weeks later than typical at TMFD. The delay was a direct result of 2016 – 2017 winter being the coldest winter since 1992 – 1993. It was also one of the snowiest on record with Pendleton receiving 44.4 inches. The cold and snowy weather delayed winter maintenance on the main canal; resulting in delayed water up of both the fish bypass and canal.

Juvenile trap operations in Birch Creek were similar to previous years; however, no trapping occurred in the fall due to low flows. Approximately 97% of the catch occurs between January and June, thus the inability to trap during the fall likely had little effect on juvenile production estimate.

Time of release influenced steelhead recapture rate at the rotary screw trap in Birch Creek and may be leading to an overestimate of juvenile production. Trap efficiency estimates for night released fish were 2.9 to 11.8 times higher than daylight released fish (J. Hanson, unpublished data). This was significantly greater than the 1.7 times higher rate found by Tattam et al. (2013) for medium sized (116 – 145 mm) steelhead, but less than the 15 times higher rate observed by Cramer et al. (1992) for Chinook salmon. Preliminary analysis suggested cone rotation speed and fish size also influenced recapture rate.

A number of challenges were encountered during the operation of the PIT tag detection system at TMFD in 2017. The site continued to operate without the ladder entrance antenna that was lost in March 2016 and we saw a significant decrease in detection range of the viewing window antenna. Also, difficulties with onsite internet services resulted in manual file uploading for the majority of 2017. Continued difficulties resulted in discontinuation of internet service at the site and the lack of adequate alternative service providers suggested manual uploading for the foreseeable future.

The project finished the design and budget for three thin body ferrite tile PIT tag antennas, which was presented to the UMMEOC and the ODFW Fish Passage Program for review in fall 2016. Both groups approved the design and materials for the antennas were purchased. A proposal for antenna construction and installation was submitted to ODFW's Fish Restoration and Enhancement Program in February 2018.

The emigration timing of natural summer steelhead from the Umatilla River varied between years, but no trends were evident. McCormick et al. (1998) stated "photoperiod and temperature regulate physiological changes, whereas temperature and water flow may initiate migration" of smolts; however, water temperature and flow could not explain the inter-annual variation in emigration timing for either natural or hatchery summer steelhead smolts in the Umatilla River.

Survival from TMFD to JDD was below the long-term average; whereas survival from Birch Creek to TMFD was higher. A low detection rate at BON resulted in an extremely imprecise estimate for the JDD to BON reach.

Results from the sixth year of steelhead redd surveys indicated that the density of redds varied significantly across the spatial network sampled. Preliminary analysis suggests that adult abundance may play a role in spatial distribution of redds. Also, redds were observed at the majority of sites sampled but tended to be clustered and a gradient threshold around 8% may exist. A collaborative analysis with CTUIR to characterize landscape variables associated with redd distribution is currently in process.

Long-term monitoring of production and survival continued to follow trends that suggested steelhead abundance in the Umatilla River is limited by freshwater habitat quality and quantity, and density dependent survival restricted the increase in smolt production that was anticipated from supplementation and habitat enhancement. The most recent status reviews continued to rate the Umatilla steelhead population as “maintained” (Ford et al. 2010; NMFS 2011). Current and future habitat restoration work in priority areas as identified in the Umatilla Subbasin Plan (DeBano et al. 2004) and Mid-Columbia Steelhead Recovery Plan (Carmichael and Taylor 2009; NMFS 2009) will be essential to improvements in population viability. Evidence of strong density dependence (Hanson and Carmichael 2009) at current abundance levels suggests restoration actions that produce more rearing habitat and food should continue to be implemented.

Survival during emigration from the Umatilla River may be a significant bottleneck to recovery. Survival estimates indicated that nearly 200 juvenile steelhead were lost per kilometer traveled in the Umatilla River. This compares to approximately 35 lost per kilometer between TMFD and JDD. The impact of primary threats, including degraded water quality and habitat, predators, and irrigation dams needs further investigation to enable the development of threat- and site-specific management actions.

6. Adaptive Management and Lessons Learned

Fish Population Status Monitoring (RM&E)

Production, productivity, survival, and life history data sets collected, managed, and analyzed by the project are some of the longest and most complete for any steelhead Major Population Group in the Middle Columbia River DPS. The long-term data sets are necessary to assess population status and make informed management decisions. Data sets have and continue to be used for a variety of local and regional planning and modeling exercises, including DPS recovery tracking, population scale modeling, and watershed action plans. Increased funding for the project is critical to ensure continuation of these important long-term data sets.

The project has a long history with the development and implementation of PIT tag technologies in the Umatilla River. The project continued to operate and maintain the detection system at TMFD in collaboration with the USFWS and USBR. In addition, the project finalized the design for a more reliable and efficient system in the adult ladder at TMFD. However, fixed funding levels for the past five years has made maintenance of the aging system a challenge and significantly limited our ability to implement system upgrades. Improved detection of adults at TMFD would greatly enhance our understanding of "wandering" steelhead and monitoring of out of DPS strays.

The long-term trend of increasing adult returns provides optimism for improved viability of the Umatilla steelhead population, but the low and decreasing trend in egg-to-smolt survival suggested steelhead abundance in the Umatilla River is limited by freshwater habitat quality and quantity, and density dependent survival restricted the increase in smolt production that was anticipated from supplementation and habitat enhancement. Evidence of strong density dependence at current abundance levels suggests restoration actions that produce more rearing habitat and food should continue to be implemented. However, poor survival of downstream migrating juveniles in the Umatilla River suggests that current restoration efforts focused in tributary spawning and rearing habitat may be insufficient for recovery of the steelhead population. It is unknown if survival of downstream migrating juveniles has changed in the Umatilla River prior to irrigation and habitat simplification; but, building complex habitat in the lower river should be given more consideration and may be key to rebuilding the steelhead population.

Juvenile steelhead production estimates at TMF and Birch Creek meet NOAA data precision goals in all years, except for first year operations in Birch Creek. Monitoring in Birch Creek began with a Humphreys trap. The Humphreys trap appeared to be size biased and unable to capture fish under most flow scenarios in Birch Creek. The project learned that fish released during the day were recaptured in a rotary screw trap at a significantly lower rate than those released at night. Additional evaluations are being considered to determine a release strategy that produces the most accurate and precise abundance estimates.

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Appendix A: Data Sets

PIT tag interrogation files (site ID: TMF) and tagging files (coordinator ID: WAC (1999), SMF (2000 – 2007), and JTH (2008 – current) can be found at http://www.ptagis.org/.

Redd counts, survival, abundance, production, productivity, and life history data can be accessed by contacting Josh Hanson.

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Appendix B: Publications

No peer reviewed publications were produced in calendar year 2017.

Appendix C: List of Metrics and Indicators

Category	Subcategory	Subcategory Focus 1	Subcategory Focus 2	Specific Metric Title
Fish	Abundance of Fish	Fish Life Stage: Juvenile - Migrant	Fish Origin: Natural	Abundance of Emigrating Salmonid Smolts
Fish	Abundance of Fish	Fish Life Stage: Adult – Spawner	Fish Origin: Both	Hatchery vs Wild Observations
Fish	Age Structure of Fish	Fish Life Stage: Juvenile – Migrant		Smolt Age Composition
Fish	Condition Factor			Smolt Condition Factor
Fish	Spawning/Nesting	Fish Origin: Both		Number of Observed Steelhead Redds
Fish	Spawning/Nesting	Fish Origin: Both		Redd Density
Fish	Survival Rate: Fish	Fish Life Stage: RANGE: Egg to Juvenile	Fish Origin: Natural	Egg-to-Smolt Survival
Fish	Survival Rate: Fish	Fish Life Stage: RANGE: Juvenile to Adult	Fish Origin: Natural	Smolt-to-Adult Ratio
Fish	Timing of Life Stage: Fish	Fish Life Stage: Juvenile - Migrant		Smolt Migration Timing