Clearwater River B-Run Steelhead Supplementation Monitoring Project 2018 Progress Report: January 1 to December 31, 2018

Project Number 2010-057-00

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ABSTRACT

The Nez Perce Tribe (NPT) Department of Fisheries Resources Management was contracted by the Bonneville Power Administration (BPA) to monitor the effectiveness of B-run steelhead releases in the Clearwater River (project 2010-057-00). This report presents estimates of hatchery and natural origin steelhead adult spawner distribution within the South Fork Clearwater River (SFCWR), hatchery and natural origin steelhead life history characteristics, natural origin juvenile steelhead abundance, natural origin juvenile steelhead size and age-at emigration, and juvenile survival to Lower Granite Dam (LGD) from the fall of 2017 to the spring of 2018.

Radio tagging of SFCWR steelhead in the spring of 2018 completed six years of data collection. No differences were found between the mean river kilometer (Rkm) spawned for Supplemental or Conventional hatchery steelhead. The mean Rkm spawned for these groups was Rkm 33.9 and Rkm 32.5, respectively. Consistent with past observations, only one of the 32 (3.1%) radio tagged steelhead tracked in 2018 was detected upstream of the suspected migration barrier at Rkm 71.

A total of 90.1% of the hatchery steelhead smolts released in 2018 occurred downstream of Rkm 71. The total number of hatchery steelhead smolts released into the SFCWR in 2018 totaled 1,324,354. No unmarked hatchery steelhead smolts were released but 27.5% were marked only with a coded wire tag (no fins were clipped). A total of 202,138 hatchery steelhead smolts were released into Lolo Creek without any code wire tags or fin clips (100% unmarked).

The juvenile rotary screw trap (RST) at the SFCWR operated normally from September 5, 2017 to November 29, 2017 during the fall. The SFCWR RST operated again from March 2, 2018 to May 10, 2018 until it was damaged. Juvenile abundance estimates for the fall and spring were 54 juveniles (95% C.I. 0 to 76 juveniles), and 1,366 juveniles (95% C.I. 301 to 1,800 juveniles), respectively. The estimate for the spring is not representative of the entire migration year due to the damage to the trap on May 10th. The RST at the Lolo Creek operated normally from October 2, 2017 to November 20, 2017 during the fall. The Lolo Creek RST operated again from March 15 to July 11, 2018. Juvenile abundance estimates for the fall and spring were 5,267 juveniles (95% C.I. 4,060 to 6,911 juveniles), and 6,959 juveniles (95% C.I. 2,264 to 14,872 juveniles), respectively. Past estimates of smolt abundance and age-at-emigration were used to produce the following estimates of smolts-per-escapement for three spawn years (fall to spring): 31.2 (2011-2012), 13.7 (2012-2013), and 30.7 (2013-2014).

It was not possible to estimate natural origin smolt survival from the SFCWR or Lolo Creek to LGD because an insufficient number of smolts were PIT tagged at each location. Survival of hatchery steelhead smolts released at SFCWR Rkm 31 to LGD was 79.1% (95% C.I. 77.7% to 82.1%). Survival of hatchery steelhead smolts released at Lolo Creek Rkm 87 to LGD was 58.4% (95% C.I. 52.8% to 65.9%).

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INTRODUCTION

The goal of the Clearwater River B-run Steelhead Supplementation Monitoring Project is to increase the existing understanding of the B-run steelhead life history type in the Clearwater River major population group (MPG) (Figure 1) by monitoring two distinct populations; Lolo Creek and the South Fork Clearwater River (SFCWR). Project objectives are to: 1) provide monitoring of B-run steelhead (*Oncorhynchus mykiss*), 2) incorporate and validate PIT tag array-based status and trend estimates of adult abundance, 3) provide descriptive biological data on natural-origin returns, and 4) account for run-reconstruction estimates of steelhead to known and unknown areas. Data generated through the implementation of this project is required under the Federal Columbia River Power System Biological Opinion (FCRPS BiOp) Reasonable and Prudent Actions (RPAs) 50.5 and 50.6 and is consistent with the Coordinated Anadromous Workshop Snake Basin strategy for high precision abundance data, hatchery effectiveness monitoring, and data collection and management. Funding for the study was provided by the Bonneville Power Administration (BPA) for BPA project 2010-057-00.

The 2008-2017 U.S. vs Oregon Management Agreement designated 200,000 unclipped (Supplemental program) steelhead reared at Dworshak National Fish Hatchery (DNFH) released into Lolo Creek and 330,000 unclipped steelhead juveniles reared at the Clearwater Anadromous Fish Hatchery (CAFH) released into the SFCWR. SFCWR releases are in addition to 840,000 conventionally reared, adipose fin clipped steelhead smolts (Conventional program). The objective is to increase escapement and bolster natural steelhead abundances through natural production. The integration of natural adults into the supplemental broodstock is decided annually by tribal, state, and federal co-managers. Objectives for this project are met by:

1) Monitoring of B-Run steelhead by radio telemetry tracking of adult steelhead to determine spawning locations, and rotary screw trap (RST) data to estimate juvenile emigration timing and survival to Lower Granite Dam (LGD), and monitor natural abundance and productivity,
2) Incorporating PIT tag array-based estimates of Nez Perce Tribe (NPT) steelhead harvest and NPT PIT array estimates produced by the BPA project # QCINC2010 into the IDFG lead Steelhead Run Reconstruction Group for estimating steelhead spawner abundance upstream of LGD,
3) Describing biological data summarizing the age-at-return of natural origin steelhead
4) Account for run reconstruction estimates of steelhead to unknown areas by sampling lower Salmon and Clearwater river tributaries for steelhead randomly PIT tagged at Lower Granite Dam (to begin in the spring of 2019) using Portable PIT tag arrays and temporary weirs.

RSTs utilized by the project are located at SFCWR river kilometer (Rkm) 9, Lolo Creek Rkm 2, and Newsome Creek at SFCWR Rkm 84. The latter two traps are primarily funded by BPA project 198335003S but also receive financial support from this project. Monitoring at these sites occurred during migration year 2018; where the migration year was defined as July 1, 2017 to June 30, 2018.

STUDY AREA

The Clearwater River Major Population Group (MPG) consists of five extant populations and one extirpated population (North Fork Clearwater River) within the Snake River Distinct Population Segment (DPS). The study area of this program covers three extant populations of the Clearwater River MPG: Lower Mainstem Clearwater River population, the South Fork Clearwater population, and the Lolo Creek population (Figure 1).

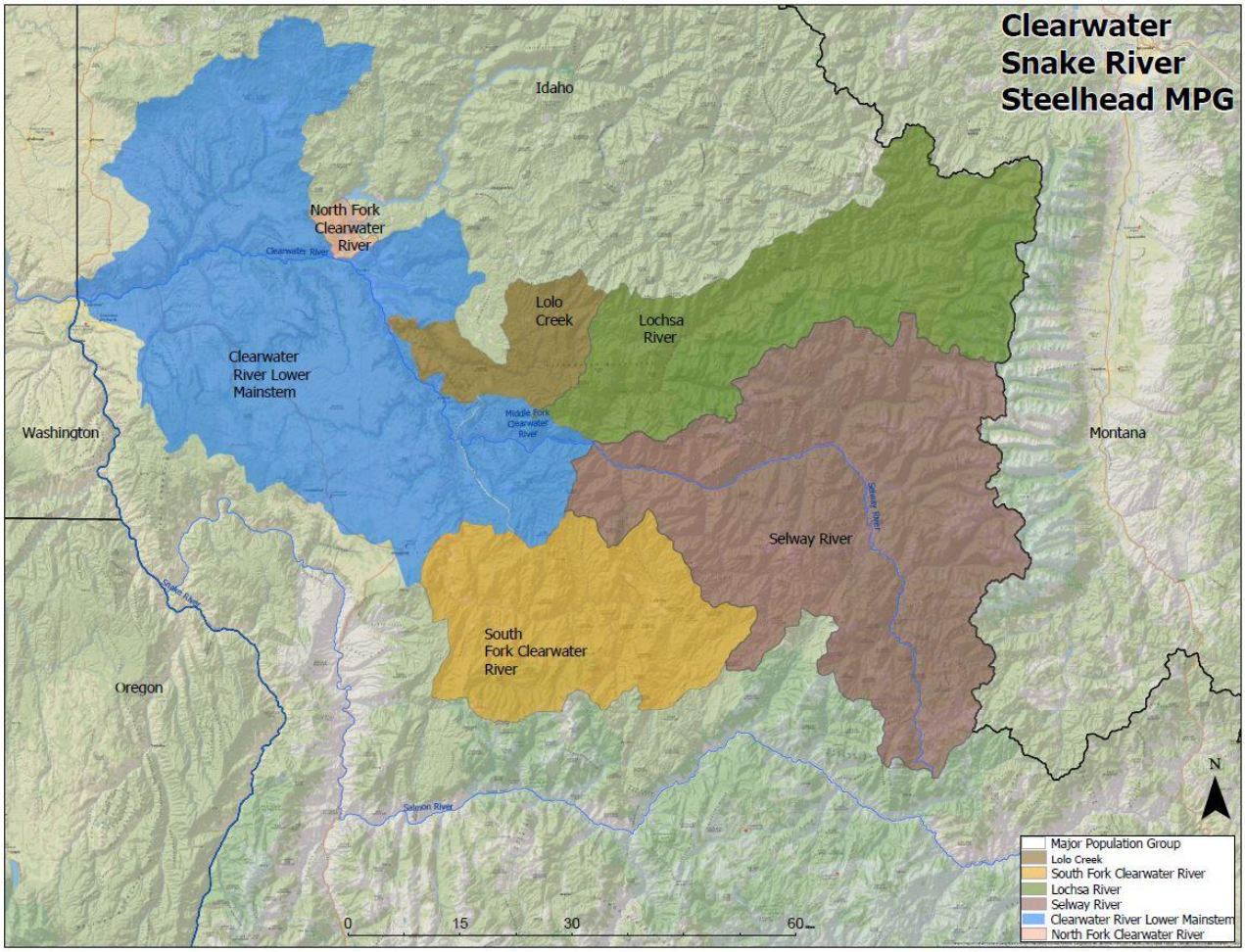

Figure 1. The Clearwater River Steelhead Major Population Group showing the Lolo Creek and South Fork Clearwater River populations within their watersheds.

The area of the Lower Mainstem Clearwater River population covers the tributaries in the lower elevation reaches of the Clearwater River and includes tributaries in the Middle Fork Clearwater River and the lower portion of the SFCWR (up to Mill Creek at SFCWR Rkm 52), but excludes the North Fork Clearwater River and Lolo Creek. Although steelhead in the Lower Mainstem Clearwater River are believed to be predominantly A-Run type steelhead, its estimated that less than 15% of the steelhead production in this population area produce B-run steelhead (NOAA 2016). The confluence of the Clearwater River is 746 Rkm from the confluence of the Columbia River at an elevation of 739 ft.

The SFCWR drainage covers 1,168 square miles (Figure 2). The confluence of the SFCWR is located downstream of the town of Kooskia, Idaho and is 866 Rkm upstream from the confluence of the Columbia River, and 171 Rkm upstream from LGD.

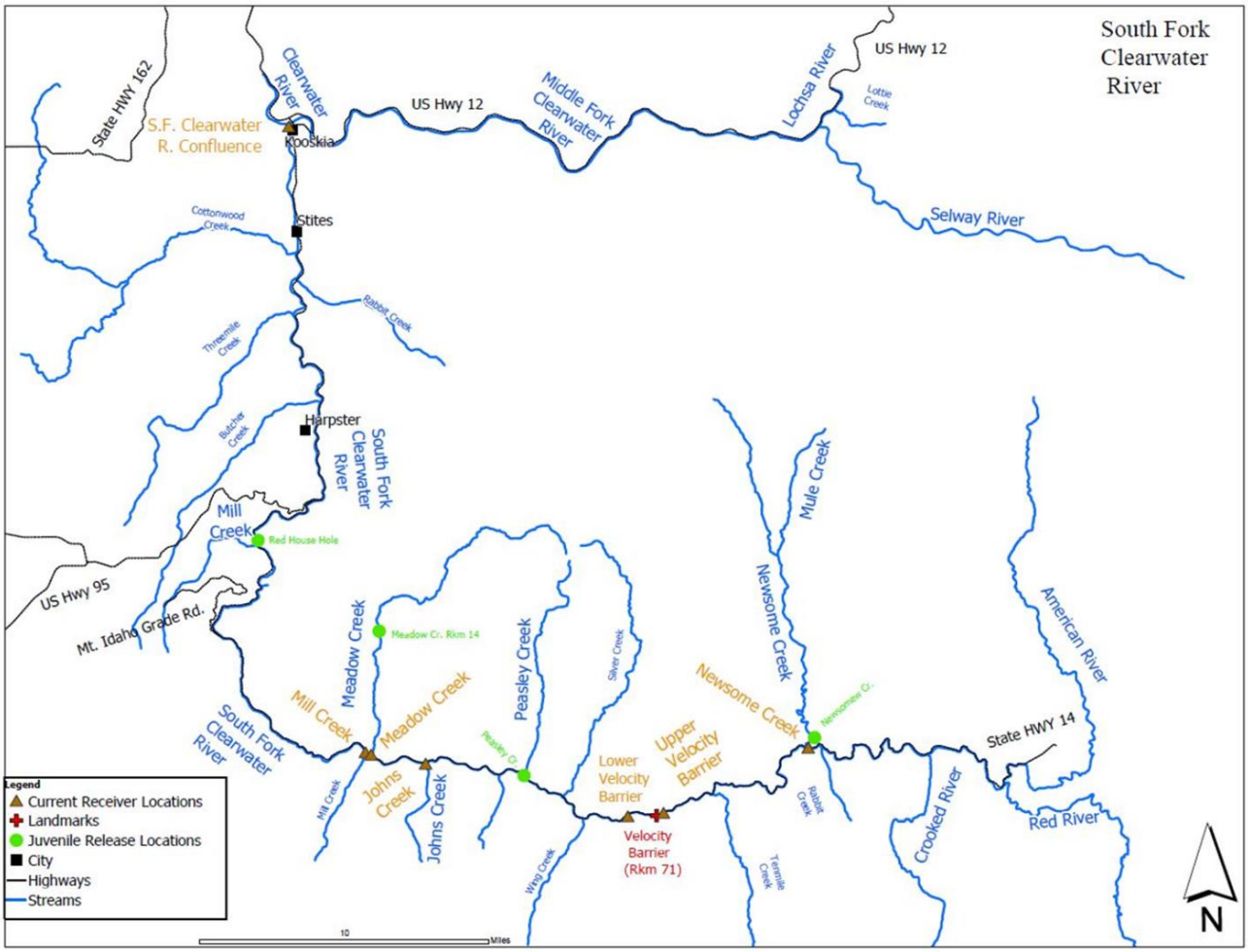

Figure 2. A map of the South Fork Clearwater River is shown with the major tributaries, juvenile release locations, and radio telemetry receiver locations.

The lowest point SFCWR discharge is measured is at the USGS gage station (13338500) located in Stites, Idaho at Rkm 6 and at an elevation of 1,312 ft. Mean annual discharge for approved USGS data from 1965 to 2017 has averaged 979 cfs and ranged from 448 cfs (1992) to 1,624 cfs (1975) with the peak discharge of 17,500 cfs occurring on June 8, 1964. The highest point stream discharge is measured is at the USGS gage station (13337500) located near Elk City, Idaho at an elevation of 3,810 ft. The area of the South Fork Clearwater River population is upstream of Mill Creek and includes Mill Creek at SFCWR Rkm 52 (Figure 2). The confluence of Mill Creek is 918 Rkm from the confluence of the Columbia River at an elevation of 2,311 ft.

The Lolo Creek drainage covers 243 square miles. The confluence of Lolo Creek is 833 Rkm upstream from the confluence of the Columbia River, and 138 Rkm upstream from Lower Granite Dam (LGD) on the Snake River. The lowest point Lolo Creek discharge is measured is at the USGS gage station (13339500) at an elevation of 1,080 ft. Mean annual discharge from 1980 to 2017 has averaged 322 cfs and ranged from 175 cfs (1992) to 564 cfs (1997) with the peak discharge of 6,810 cfs occurring on March 17, 2017. The area of the Lolo Creek population is all of Lolo Creek and supports both A and B-Run steelhead (NOAA 2016).

METHODS

BPA requires funded fish and wildlife projects to document methods at www.monitoringresources.org; the website for the Northwest Aquatic Monitoring Partnership. Numbered protocols and methods referred to hereafter refer to this Northwest Aquatic Monitoring Partnership's web site. Table 1 shows the protocols used for each contract work element activity.

Exceptions to these protocols are as follows:

1) Analysis of Juvenile Abundance - Due to the lack of recaptured steelhead at the SFCWR, juvenile trap efficiency data for natural Chinook salmon was used with the catch of natural juvenile steelhead to estimate of natural juvenile steelhead abundance in the fall and spring.
2) Analysis of Juvenile Survival - Only natural origin steelhead juveniles between 120 mm and 300 mm used in natural origin juvenile steelhead survival estimates.
3) Analysis of Stream Temperature – stream temperature metrics are defined in Table 2.
4) Estimation of smolts-per-escapement values are described in this section following Table 2.

Table 1. Protocols used for contract work element activities.

Work Element	Activity	Protocol Number	Status
158	Radio Tag Adult Steelhead	NA	
	PIT Tag Juvenile Steelhead and Chinook Salmon	NA	
157	Radio Telemetry Collection: SFCWR Steelhead	2242	Published
	RST Data Collection: SFCWR	2248	Published
	Stream Temperature Data Collection: SFCWR	2257	Draft
162	Analysis of Radio Telemetry: SFCWR Steelhead		
	Genetic Analysis to Verify Origin	2251	Draft
	Adult Spawner Spatial Distribution	2250	Draft
	Adult Spawner Timing	2248	Draft
	In-Hatchery Data Analysis: SFCWR Steelhead		
	Release Timing of Juveniles	2253	Draft
	Size-at-release at the RST	2253	Draft
	Juvenile condition factors at the RST	2253	Draft
	Analysis of RST Data Collection		
	Juvenile Abundance	2248	Draft
	Life History Data Analysis	2248	Draft
	Analysis of Survival and Productivity	2249	Draft
	Analysis of Stream Temperature: SFCWR	2252	Draft

Table 2. Definitions of stream temperature metrics used to analyze SFCWR stream temperature collected for migration year 2017.

Metric	Abbreviation	Method
Maximum Daily Maximum Temperature	MDMT	Highest of all measured temperatures. Equivalent to instantaneous maximum temperature or grand maximum temperature.
Maximum Weekly Maximum Temperature	MWMT	Starting with the 7th day of monitoring, the mean of the daily maximum temperatures for days 1 though 7 was computed. This procedure was repeated for days 2 though 8, 3 through 9, etc. The MWMT is the highest mean value obtained for the monitoring period.
Maximum Weekly Average Temperature	MWAT	Starting with the 7th day of monitoring, the mean of the daily average temperatures for days 1 though 7 was computed. This procedure was repeated for days 2 though 8, 3 through 9, etc. The MWAT is the highest mean value obtained for the monitoring period.
Maximum Daily Average Temperature	MDAT	Highest of all daily mean temperatures.

Smolts-per-escapement was estimated for Lolo Creek from brood years 2012 to 2014 by summing estimates of brood year smolts from one to four years after spawning and then dividing the total number of brood year smolts by the total brood year adult escapement (natural and hatchery). Adult escapement for Lolo Creek was obtained from Copeland et al. 2014, Copeland et al. 2015, and Stark et al. 2016. The method used for estimating adult escapement was referred to as the Run Reconstruction Box Car model. This model initially estimates returning adult steelhead populations at LGD and assumes all adults will return to where they were released as juveniles. Steelhead are removed from the populations as they progress upstream using harvest estimates. The numbers of brood year juveniles were estimated annually from the total migration year abundance estimates (fall and spring abundance) multiplied by the percent of the given age of brood year smolts observed during January through July for four consecutive years. Age 0+ fish were not used in calculating age structure percentages because juveniles must survive for full year to be counted as potential smolts. This method simplified calculations by assuming that 1) the age structure of juveniles transforming into smolts in the spring will be is similar to the age structure of spring migrants, and 2) juveniles observed in the fall will migrate in the spring.

RESULTS

Work Element 158: Tag Fish

Radio Tag Adult Steelhead

A total of 45 SFCWR steelhead adults were radio tagged. The steelhead adults were tagged at LGD from September 28, 2017 to November 5, 2017. A total of 21 Supplemental hatchery adults, and 24 Conventional hatchery adults were tagged. Efforts to radio tag additional fish in the SFCWR during the spring were unsuccessful and therefore no tissue samples were obtained for genetic analysis to confirm origin.

PIT Tag Juvenile Steelhead and Chinook Salmon

A summary of the juvenile steelhead PIT tagged at SFCWR, Lolo Creek, and the Newsome Creek RST locations are shown in Table 3. Additionally, the project used minnow traps and hook and line to capture and PIT tag 12 addition juvenile natural origin steelhead in the SFCWR from July 11 to July 19, 2018.

Work Element 157 Activities: Collect/Generate/Validate Field Data

Radio Telemetry Data Collection: South Fork Clearwater River Steelhead

A total of 194,047 records were collected from 7 stationary receivers (Table 4) from October 24, 2017 to June 7, 2018. An additional 2,747 records were collected from 6 different mobile survey routes driven from December 8, 2017 to June 13, 2018. A total of 32 of the 45 radio tagged steelhead were successfully tracked during the spring of 2018; 17 Supplemental steelhead, and 15 Conventional steelhead.

Table 3. A summary of the juvenile steelhead PIT tagged at Lolo Creek, and at the Newsome Creek and South Fork Clearwater River rotary screw trap locations in the South Fork Clearwater River during the fall of 2017 and spring of 2018. PIT tag totals do not include 12 fish captured by hook and line or by minnow traps.

Species	Trap Name	Dates Captured at Trap	PIT Tagged (n)
Summer Steelhead	South Fork Clearwater River	Oct. 2 to Nov. 28	6
		Mar. 16 to Apr. 26	45
	Lolo Creek	Oct. 2 to Nov. 20	550
		Mar. 15 to July 11	142
	Newsome Creek	Oct. 2 to Nov. 12	117
		Mar. 30 to Jul. 31	206
		Subtotal	1,066
Spring Chinook Salmon	South Fork Clearwater River	Oct. 2 to Nov. 29	83
		Mar. 10 to Apr. 26	233
		Subtotal	316

Table 4. A summary of the operation of radio telemetry stations and number of records collected by the Nez Perce Tribe for Bonneville Power Administration Project #2010-057-00. Unique fish and mean daily records represent only valid tag codes. Total records represent valid and invalid codes.

Station Type & Site	First Record	Last Record	Unique Fish (n)	Mean Daily Records (n)	Total Records (n)
Stationary					
SF Confluence	10/24/17	6/20/18	31	739.5	53,059
SF Confluence Tributary	10/25/17	6/13/18	10	1,038.8	45,032
Mill Cr Stationary	3/5/18	6/9/18	9	548.6	55,676
Meadow Creek	3/15/18	6/7/18	4	1,093.7	18,673
Johns Creek	3/21/18	5/25/18	9	391.3	10,338
Lower Velocity Barrier	3/31/18	6/7/18	2	39.3	10,971
Upper Velocity Barrier	3/1/18	6/7/18	1	1.5	298
		Subtotal:	66		194,047
Mobile					
Kooskia to Cottonwood Cr	12/8/17	6/14/18	9	9.4	634
Stites to Mt Idaho	12/14/17	6/14/18	26	49.6	1,481
Mt Idaho to Mill Cr	12/14/17	6/14/18	7	13.5	285
Mill Cr	3/20/18	3/28/18	3	9.5	62
Mill Cr to Johns Cr	2/21/18	6/1/18	5	8.7	34
Johns Cr to Lower Velocity Barrier	2/21/18	6/13/18	5	15.3	251
		Subtotal:	55		2,747

Rotary Screw Trap Data Collection: Clearwater River Steelhead

Operation of the SFCWR RST at Stites, Idaho occurred from September 5 to November 29 with a total of 6 steelhead juveniles captured and released upstream for trap efficiency trials with none recaptured. Scale samples were collected from all six SFCWR steelhead. During this same time period 87 natural origin spring Chinook salmon were captured at the SFCWR RST with 83 released upstream for trap efficiencies with 4 recaptured for a 4.8% estimated trap efficiency.

During the spring the SFCWR rotary screw trap operated from March 2 until it was damaged on May 10. During the time it operated a total of 46 natural origin steelhead juveniles were captured with 42 released upstream for trap efficiency trials with none recaptured. During this same time period a total of 242 natural origin spring Chinook salmon were captured with 202 released upstream for trap efficiency trials with 5 recaptures for estimated trap efficiency of 2.5%. The overall catch of all species totaled 5,387 fish during the spring (Table 5) and included 25 Pacific Lamprey. Scale samples were collected from all juvenile steelhead captured in the spring.

Operation of the Newsome Creek RST occurred from October 2 to November 12 and again from March 30 to July 31. A total of 236 natural origin steelhead juveniles were captured during the fall and 245 natural origin steelhead juveniles were captured in the spring. Trap efficiencies in the fall and spring were 20.5% and 10.8%, respectively. A total of 59 and 88 juvenile steelhead scale samples were collected in the fall and spring, respectively.

Operation of the Lolo Creek RST occurred from October 2 to November 20, 2017 and again from March 15 to July 11, 2018. A total of 576 natural origin steelhead juveniles were captured during the fall and 146 natural origin steelhead juveniles were captured in the spring. Trap efficiencies in the fall and spring were 10.3% and 1.4%, respectively. A total of 100 and 114 juvenile steelhead scale samples were collected in the fall and spring, respectively.

Table 5. A summary of the number of fish captured at the South Fork Clearwater River rotary screw trap from March 2 to May 10, 2018.

Species (Common Name)	Origin	Total
Summer Steelhead	Natural	46
Summer Steelhead	Hatchery	930
Spring Chinook Salmon	Natural	242
Spring Chinook Salmon	Hatchery	4,126
Northern Pike Minnow	Natural	2
Pacific Lamprey	Natural	25
Smallmouth Bass	Natural	5
Redsided Shiner	Natural	1
Sculpin & Sucker (various species)	Natural	10
	Total	5,387

Stream Temperature Data Collection: South Fork Clearwater River Steelhead

The project collected 5,784 temperature measurements in one hour intervals from October 7, 2017 to July 29, 2018 using a HOBO model UTBI-001 Tidbitv2 data logger at SFCWR Rkm 9. The project also obtained stream temperature data collected by the NPT Integrated Status & Effectiveness Monitoring Program (BPA project # QCINC2010). A total of 50,392 records were obtained representing water temperatures every ten minutes from August 1, 2017 to July 31, 2018 at Rkm 1. Data was summarized for the entire 2018 steelhead migration year from August 1, 2017 to July 31, 2018 and is presented in the Work Element 162 Activities for the analysis and interpretation of data from both Rkm 1 and Rkm 9.

Work Element 162 Activities: Analyze/Interpret Data

Analysis of Radio Telemetry Data: South Fork Clearwater River Steelhead

The mean Rkm spawned for the Supplemental evaluation group in 2018 was Rkm 33.9 (± 95% C.I. of 12.7 Rkm) (Table 6). The mean Rkm spawned for the Conventional evaluation group in 2018 was Rkm 32.5 (± 95% C.I. of 10.3 Rkm) and a student T-test showed no significant difference (P = 0.086) between the groups of Supplemental and Conventional hatchery steelhead. The majority of Supplementation and Conventional radio tagged fish spawned between the SFCWR confluence and Johns Creek with only one fish documented to have been detected upstream of Rkm 71 (3.1%).

Spawning locations of groups of Conventional and Supplemental hatchery

Table 6. The distribution of spawners during the spring of 2018 in the South Fork Clearwater River is shown by major river sections with the mean Rkm spawned and number passing a suspected migration barrier at Rkm 71.

Statistic	Supplemental	Conventional
Radio Tagged and Tracked	17	15
Spawning from Confluence at Rkm 0 to Johns Creek at Rkm 56 (%)	64.7%	80.0%
Spawning from Johns Creek at Rkm 56 to Newsome Creek at Rkm 84 (%)	35.3%	20.0%
Spawning Upstream of Newsome Cr., Rkm 84 (%)	0.0%	0.0%
Median Rkm Spawned	34.0	32.0
Mean Rkm Spawned	33.9	32.5
Confidence Interval (± 95%)	12.7	10.3
Number Upstream of River Kilometer 71	0	1

steelhead, and natural steelhead were compared from 2013 to 2018. Annually, 95% C.I. for estimates overlapped for most years (Figure 3) and no significant differences were found between the three groups (ANOVA P value =0.21). However, the Supplemental and natural evaluation groups tended to spawn slightly upstream of Conventional hatchery steelhead and Conventional hatchery steelhead spawning in 2014, 2015, and 20918 tended to be concentrated around Rkm 31 where the majority were released as smolts (Figure 4). Supplemental hatchery steelhead spawning from 2013 to 2017 tended to be concentrated around Rkm 53 and 62 where the majority were released as smolts.

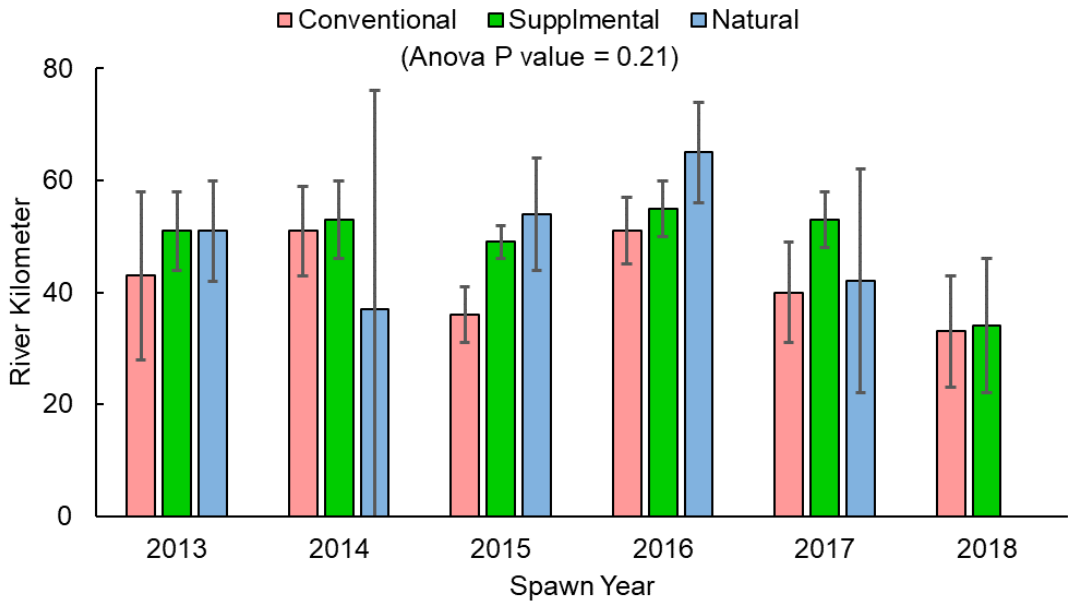

Figure 3. Annual mean spawning locations of Conventional and Supplemental hatchery steelhead and natural steelhead in the South Fork Clearwater River are shown from 2013 to 2018.

In Hatchery Data Analysis: South Fork Clearwater River Steelhead

The numbers of hatchery steelhead juveniles released into the SFCWR during the spring of 2018 are shown in Table 7 with the location of release. Hatchery steelhead were released at Rkm 31 from April 2 to April 13, at Rkm 53 from April 3 to April 6, and at Rkm from April 9 to April 10. No unmarked hatchery steelhead were released into the SFCWR and 72.5% of the hatchery steelhead released into the SFCWR could be visually identified by an adipose fin clip. Almost half of the hatchery steelhead were released into the SFCWR at Rkm 31 (49.2%) with only 9.9% released at Rkm 84.

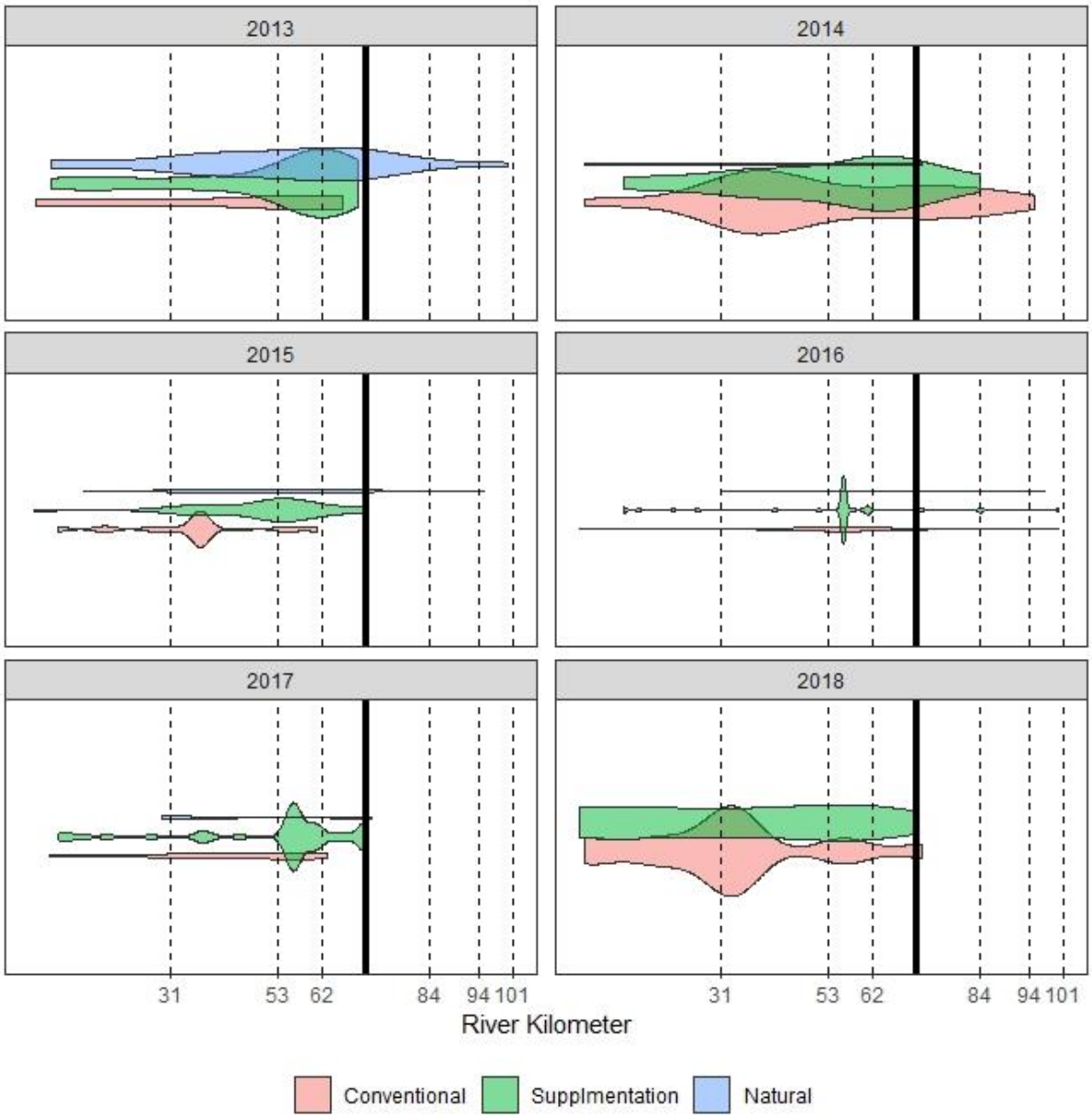

Figure 4. Annual spawning locations and relative density of Conventional and Supplemental hatchery and natural spawners within the South Fork Clearwater River from 2013 to 2018. Dashed lines represent hatchery release locations with the river kilometer noted on the X axis. The solid dark line represents a possible migration barrier at river discharge of 1,000 cfs or greater.

Not all hatchery steelhead were the same size at release. A total of 64.1% of the hatchery steelhead released at Rkm 31 were produced at DNFH and released at 5.8 Fish-Per-Pound (FPP) with the remaining 39.1% produced at CFH and released at 4.5 FPP (a larger size). Fish released at Rkm 53 and 84 were at 4.5 FPP when released.

Table 7. The number of hatchery steelhead juveniles released into the South Fork Clearwater River is shown below with their identifying marks by the release site river kilometer.

Release Rkm	Total Number Released (n)	Adipose Fin Clip and Coded Wire Tag (n)	Adipose Fin Clip Only (n)	CWT Coded Wire Tag Only (n)	Unmarked
31	651,437	59,973	591,464	0	0
53	541,323	0	308,466	232,857	0
84	131,594	0	0	131,594	0
Total	1,324,354	59,973	899,930	364,451	0

A total of 202,238 hatchery steelhead reared at DNFH were released at 5.8 FPP into Lolo Creek on April 16. None of the hatchery steelhead released into Lolo Creek were marked with adipose fin clips or code wire tags.

Analysis of Rotary Screw Trap Data: South Fork Clearwater River Steelhead

Normal 24-hour 7-day/week sampling at the SFCWR juvenile fish trap began on March 2 and ended during the week of April 1 when the weekly minimum discharge was 1,300 cfs and the weekly maximum discharge was 3,730 cfs (Figure 5). During the week of April 1 a subsampling protocol was implemented to accommodate hatchery releases and increasing stream discharge. Subsampling continued until the trap's anchoring system failed on May 10 at 7,200 cfs. This failure prevented data collection during the remainder of the spring. Therefore, the juvenile abundance estimate for the spring of 2018 is not representative of all natural origin steelhead abundance.

Trapping conditions for Lolo and Newsome creeks in the fall and spring are reported by the Nez Perce Tribe Hatchery Monitoring and Evaluation project and can be found annual reports for the project (BPA project 198335003S). Fall and spring natural origin juvenile steelhead abundance estimates for the 2018 migration year are presented in Table 8 for Lolo Creek, Newsome Creek, and the SFCWR at Rkm 9. Size at emigration and condition factors were calculated and are shown in Table 9.

The range of freshwater ages determined for Clearwater River traps in the spring of 2017 ranged from Age 1 to Age 4, and from Age 0 to Age 4 in the spring of 2018 (Table 10). The most abundant freshwater age of emigrants sampled for scales during the spring of 2017 at all Clearwater River traps was Age 2 with the composition of Age 2 migrants ranging from 52.3% at Newsome Creek to 70.5% at Lolo Creek. During the fall of 2017 freshwater Age 1 emigrants were the most abundant age class comprising 61.0% to 86.0% of all emigrants capture and sampled for age-at-emigration. And during the spring of 2018 the predominate age for of emigrants sampled for scales was Age 2 migrants composition ranging from 52.2% at SFCWR to 61.0% at Lolo Creek.

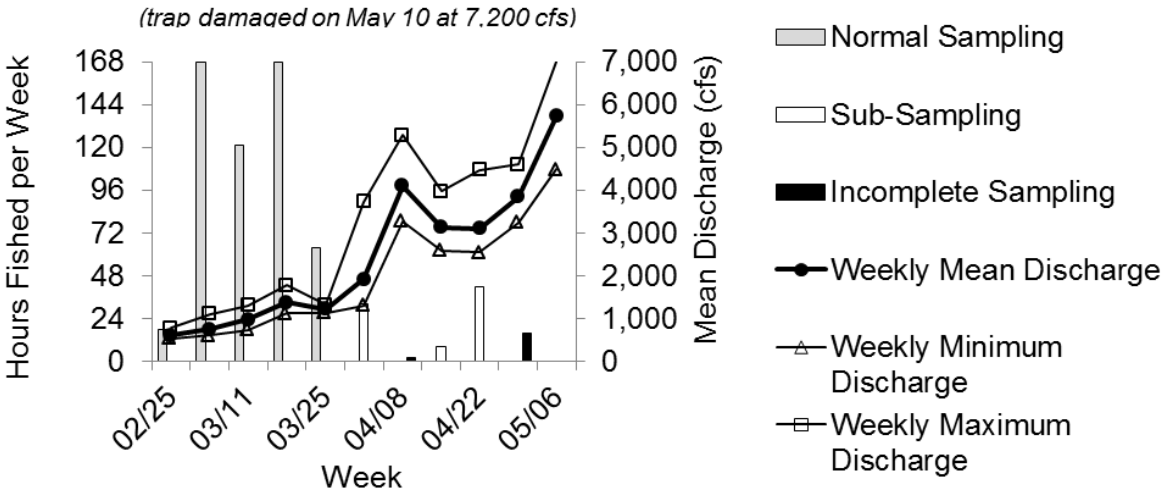

Figure 5. A summary of weekly rotary screw trap operations and weekly discharge from March 2 to May 10.

Table 8. Natural origin juvenile steelhead abundance estimates for the fall and spring of migration year 2018 with 95% confidence limits. Estimates include expansion for subsampling.

Trap Name	Season	Estimate	Lower 95% C.I.	Upper 95% C.I.
South Fork Clearwater River	Fall 2017	54	0	76
	Spring 2018	1,366	301	1,800
Lolo Creek	Fall 2017	5,267	4,060	6,911
	Spring 2018	6,959	2,264	14,872
Newsome Creek	Fall 2017	1,179	737	2,145
	Spring 2018	2,089	1,353	3,244

Table 9. Size-at-emigration and Fulton's condition factors of natural origin steelhead juveniles captured during migration year 2018 are shown with 95% confidence intervals.

			Length (mm)		Condition Factor	
Trap	Season	n	Mean	± 95% C.I.	Mean	± 95% C.I.
South Fork Clearwater River	Fall 2017	6	124	23.7	0.86	0.12
	Spring 2018	45	164	10.0	0.97	0.03
Lolo Creek	Fall 2017	505	146	1.7	0.94	0.01
	Spring 2018	146	142	5.6	1.02	0.02
Newsome Creek	Fall 2017	117	135	4.7	1.00	0.01
	Spring 2018	242	120	3.9	1.07	0.01

Table 10. The freshwater age-at-emigration of Clearwater River steelhead captured from the spring of 2017, fall of 2017, and spring of 2018 is shown for natural origin juveniles captured in the South Fork Clearwater River (SFCWR), Lolo Creek, and Newsome Creek.

Season	Trap Name	(n)	Age 0	Age 1	Age 2	Age 3	Age 4	Unknown
Spring 2017	SFCWR	184	0.0%	3.3%	62.5%	33.2%	0.5%	0.5%
	Newsome Cr.	218	0.0%	29.4%	52.3%	15.1%	1.4%	1.8%
	Lolo Cr.	244	0.0%	13.9%	70.5%	13.5%	0.4%	1.6%
Fall 2017	SFCWR	6	0.0%	83.3%	0.0%	0.0%	0.0%	16.7%
	Newsome Cr.	59	5.1%	61.0%	33.9%	0.0%	0.0%	0.0%
	Lolo Cr.	100	0.0%	86.0%	11.0%	0.0%	0.0%	3.0%
Spring 2018	SFCWR	46	0.0%	8.7%	52.2%	32.6%	4.3%	2.2%
	Newsome Cr.	88	1.1%	18.2%	58.0%	21.6%	1.1%	0.0%
	Lolo Cr.	109	0.0%	30.0%	61.0%	8.0%	0.0%	1.0%

Arrival timing of natural origin steelhead at rotary screw traps from the fall of 2017 to the spring of 2018 estimated from the percent of cumulative weekly catch varied (Appendix A). At the SFCWR RST 11.5% of the steelhead juveniles were captured prior to the spring of 2018 and represent only 20 fish. A cumulative total of 48.1% (fall 2017 and spring 2018) of the SFCWR steelhead had been captured by the week of April 16, 2018. During the following week of April 23 the remainder of the steelhead juveniles were captured. No additional steelhead juveniles were caught at the SFCWR RST after the week of April 23. The trap was damaged during the week of May 7. Therefore, the arrival timing given for the SFCWR in Appendix A is not representative of SFCWR steelhead during the spring of 2018. At Lolo Creek 79.8% of the juvenile steelhead were captured prior to the spring of 2018. At Newsome Creek 49.1% of the steelhead were captured prior to the spring of 2018.

Arrival timing at LGD of natural origin steelhead juveniles captured in Clearwater River juvenile fish traps and PIT tagged in the fall and spring occurred from April 3 to June 9 (Table 11). A total of 90% of the juveniles from the SFWCR arrived at LGD by May 3. The 90% arrival time of natural origin steelhead juveniles from Lolo and Newsome creek at LGD occurred later on May 25 and May 12, respectively. The time of tagging at the SFCWR trap likely influence arrive timing at LGD.

A total of 68.4% of Clearwater River natural origin steelhead smolts detected at LGD during the spring of 2018 were PIT tagged as juveniles during migration year 2018 with 98.8% of these smolts having fork lengths greater than 120 mm (Figure 6). The remaining 31.6% of the Clearwater River smolts detected were tagged during the previous migration years of 2016 and 2017. A total of 81.8% of the juveniles tagged during migration years 2016 and 2017 and detected as smolts at LGD during migration year 2018 were less than 120 mm when PIT tagged.

Table 11. Arrival timing statistics for natural origin steelhead juveniles released at traps during the fall and spring of migration year 2018 in the Clearwater River basin.

Event at Lower Granite Dam	South Fork Clearwater River	Lolo Creek	Newsome Creek
Observations (n)	12	109	60
First Observation	5-Apr	3-Apr	9-Apr
10% Passage	9-Apr	10-Apr	13-Apr
50% Passage	29-Apr	1-May	1-May
90% Passage	3-May	25-May	12-May
Last Observation	22-May	9-Jun	2-Jun

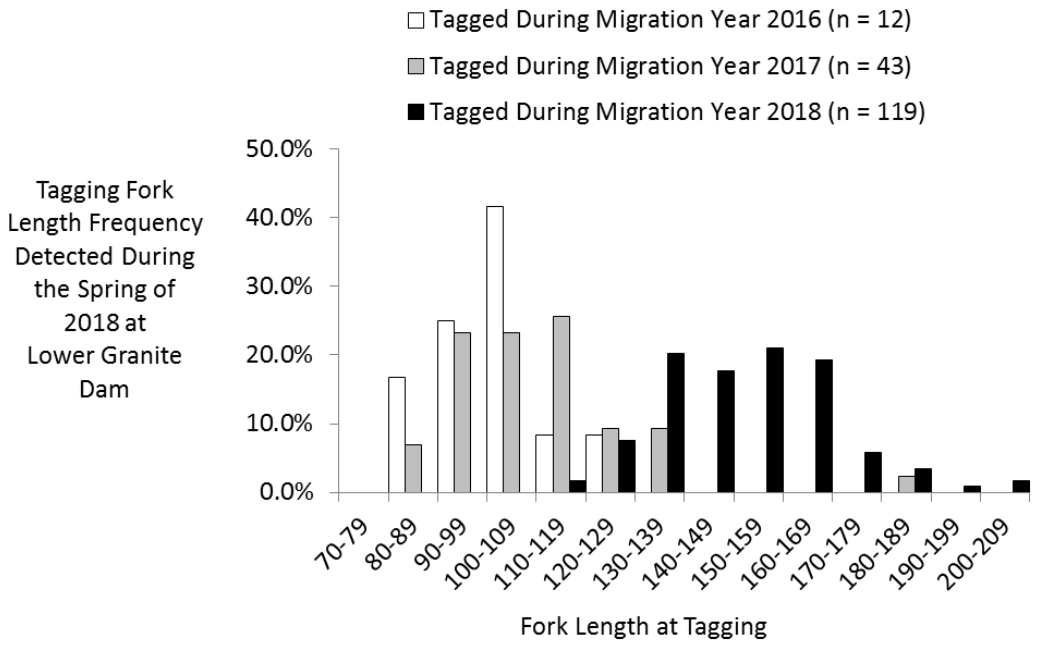

Figure 6. Fork length frequency of Clearwater River natural origin steelhead detected at Lower Granite Dam is shown by the migration year that juvenile steelhead were tagged.

PIT tagged hatchery adults from the Conventional and Supplemental hatchery programs for the SFCWR had similar arrival times at LGD and the SFCWR during the 2018 spawn year (Appendix C, Table 1). No PIT tagged natural origin adults from the SFCWR were detected at LGD in 2018. The first arrivals of PIT tagged adults from the Conventional and Supplemental hatchery programs occurred on September 18 and September 20, respectively. Median arrival timing of these two groups at LGD occurred within a five-day period from October 8 to October 13. Median arrival timing of these two groups at the SFCWR occurred within a 10-day period from January 24 to February 3 (Appendix C, Table 2). Of the 35 Conventional and 25 Supplemental adult hatchery steelhead detected at LGD from the fall of 2017 to the spring of 2018, a total of 54.3%

and 60% were detected at (or converted to) the SFCWR PIT tag arrays, respectively (Appendix C, Table 3). Arrival timing of SFCWR adult steelhead and conversion rates prior to 2018 for SFCWR steelhead adults can be found in Appendix C Tables 1,2, and 3.

Only hatchery Supplemental steelhead adults from Lolo Creek were detected at Lower Granite Dam from the fall of 2017 to the spring of 2018 (Lolo Creek does not have juvenile releases of Conventional steelhead and few natural steelhead juveniles are PIT tagged). The Conventional steelhead adults were first observed on October 8 with a median arrival time of October 17 at LGD and a median arrival time of October 29 at Lolo Creek (Appendix C, Tables 4 and 5). Of the seven Lolo Creek adults detected at LGD a total of 5 (71.4%) were detected in Lolo Creek (Appendix C, Table 6). Arrival timing of Lolo Creek adult steelhead and conversion rates prior to 2018 for SFCWR steelhead adults can be found in Appendix C Tables 4,5, and 6.

Analysis of Survival and Productively Data: Clearwater River Steelhead

The catch of natural origin steelhead at Clearwater River juvenile fish traps in the spring of 2018 did not provide enough fish to estimate juvenile survival from release to LGD for the SFCWR, Lolo Creek, or Newsome Creek RSTs. Detections of PIT tagged juvenile hatchery steelhead over in-stream arrays (designed to detect PIT tagged adult returns) and subsequent detections at Snake and Columbia River dams were sufficient to allow for estimates of post release survival within the SFCWR and Lolo Creek. Post release survival of SFCWR hatchery steelhead juveniles decreased with increasing upstream distance from the in-stream array at Rkm 1, and Rkm 2. Juvenile hatchery steelhead had a 100% survival rate with a 95% C.I. of 94.1% and 124.0%, respectively, from Rkm 31 to Rkm 2 (Table 12). Juvenile hatchery steelhead had a 91.5% survival rate with 95% C.I. of 80.0% to 109.4%, respectively, from Rkm 53 to Rkm 2. And juvenile hatchery steelhead had a 75.1% survival rate with 95% C.I. of 61.9% to 108.5%, respectively, from Rkm 84 to Rkm 2. Within Lolo Creek juvenile hatchery steelhead had an 81.1% survival rate with 95% C.I. of 65.5% to 107.7% From Rkm 87 to the instream array at Lolo Creek at Rkm 25.

Table 12. Survival of South Fork Clearwater River (SFCWR) juvenile hatchery steelhead and Lolo Creek juvenile hatchery steelhead from release to the nearest in-stream array (S_1) and overall survival (S_O)from the nearest in-stream array to Lower Granite Dam (LGR) is shown for hatchery fish released in the spring of 2018.

Release Information			Tags	Release to Array			Array to LGD		
Stream	Rkm	Tags (n)	at Array	S_1	95% L.L.	95% U.L.	S_O	95% L.L.	95% U.L.
SFCWR	31	10,584	151	1.068	0.941	1.240	0.797	0.775	0.821
SFCWR	53	10,757	75	0.915	0.800	1.094	0.842	0.818	0.868
SFCWR	84	2,590	20	0.751	0.619	1.085	0.682	0.636	0.737
Lolo Cr.	87	1,499	48	0.811	0.655	1.077	0.584	0.528	0.659

Estimates of smolts-per-escapement estimated for Lolo Creek from adults returning in 2011-2012 to 2013-2014 were as follows: 31.2 (2011-2012), 13.7 (2012-2013), and 30.7 (2013-2014). These estimates averaged 25.2 smolts-per-spawner (Table 13). No steelhead broodstock is collected from Lolo Creek and no harvest of steelhead occurred in Lolo Creek. Escapement estimates represented both natural and hatchery origin adults that could have spawned naturally after entering Lolo Creek

Estimates of adult escapement shown in Table 13 were produced using the Run Reconstruction Box Car model. The Run Reconstruction Box Car Model has produced adult escapement estimates for adults returning in 2014-2015 (Stark et al 2017) and 2015-2016 (Stark et al 2018). Estimates of natural steelhead escapement from Run Reconstruction Box Car model estimates were compared to estimates of natural steelhead escapement using PIT tag arrays (Orme et al 2019, Orme and Kinzer 2018, and See et al 2016) (Table 14). The SFCWR Run Reconstruction Box Car model estimates were consistently higher that PIT tag array escapement estimates for the SFCWR. Run Reconstruction Box Car model natural origin escapement estimates used for Lolo Creek smolt-per-escapement estimates differed from the PIT tag array natural origin escapement estimates by -9 to -12 adults for escapement completed from 2012 to 2014. Lolo Creek Run Reconstruction Box Car model estimates not used in smolt-per-escapement estimates from escapement completed from 2015 to 2016 were also lower than PIT tag array escapement estimates by -107 and -37, respectively.

Table 13. The estimated number of smolts per escapement produced by Lolo Creek Snake River summer steelhead is shown for spawn years 2011-2012, 2012-2013, and 2013-2014. Estimates of adult escapement are from Copeland et al. 2014, Copeland et al. 2015, and Stark et al. 2016. Escapement estimates represent natural and hatchery adult returns.

Spawn Year	Adult Escapement	Smolt Abundance				Total Brood Year Smolts	Smolts per Escapement
		Age 1	Age 2	Age 3	Age 4		
2011-2012	1055	26,379	4,914	1,356	280	32,929	31.2
2012-2013	675	3,363	3,843	1,957	109	9,272	13.7
2013-2014	547	4,749	8,349	3,682	0	16,780	30.7
						Average	25.2

Temperature Data: South Fork Clearwater River

Stream temperature data collected at Rkm 1 was analyzed for migration year 2018 and compared to stream temperature data collected at Rkm 9 from August 1, 2017 to July 31, 2018 (Appendix D). The thermograph at Rkm 9 malfunctioned during August and September 2017 and washed out during the month of May 2018. A paired student t-Test showed there were no statistical differences in the monthly MDMT or MWMT temperatures estimated for Rkm 1 and Rkm 9 ($P > 0.05$) for the nine comparable months of data collection. Monthly MWAT did significantly differ between

Rkm 1 and Rkm 9 ($P < 0.05$) for the nine comparable months of data collection. Gaps in data collection at Rkm 9 during October 2017, February 2018, April 2018, June 2018 and July 2019 may have affected average weekly maximum temperatures.

The MDAT at Rkm 1 exceeded 18 °C a total of 6 weeks in August and September of 2017 and an additional 5 weeks in June and July of 2018. The MWAT ranged from 0.7 °C in December 2017 to 21.6 °C in August 2018.

Table 14. Estimates of natural origin steelhead escapement to the South Fork Clearwater River and Lolo Creek that were produced by the Run Reconstruction Box Car model and PIT Tag Based estimates are compared and presented for escapement completed from 2012 to 2018.

Stream	Spawn Year	Run Reconstruction Box Car Model	PIT Tag Based Escapement Estimates	Difference
South Fork Clearwater River	2011-2012	2,165	1,183	982
	2012-2013	1,407	553	854
	2013-2014	1,222	559	663
	2014-2015	2,159	978	1181
	2015-2016	1,693	925	768
	2016-2017	NA	482	NA
	2017-2018	NA	130	NA
Lolo Creek	2011-2012	642	653	-11
	2012-2013	279	288	-9
	2013-2014	264	276	-12
	2014-2015	501	608	-107
	2015-2016	341	378	-37
	2016-2017	NA	126	NA
	2017-2018	NA	128	NA

DISCUSSION

Work to address Objective 1 (monitoring of B-Run steelhead) in 2018 continued to use radio telemetry to determine adult spawner distribution and rotary screw traps to estimate juvenile emigration timing and survival to LGD, and monitor natural abundance and productivity. Spawning distribution results of SFCWR hatchery and natural origin steelhead during the spring of 2018 were consistent with spawning distribution data collected from 2013 to 2017 (Cleary and Broncheau 2017, and Cleary 2018). These data show that Conventional hatchery, Supplemental hatchery, and natural origin spawning distribution within the SFCWR vary within and between years with no statistical differences ($P > 0.05$) between evaluation groups for most years. Additionally, spawning locations tend to concentrate around juvenile release sites for most years. Few of the 2018 radio tagged adults were detected upstream of Rkm 71, consistent with results from 2013 to 2017 (Cleary and Broncheau 2017, and Cleary 2018).

Juvenile release location is likely one of three factors in adult hatchery steelhead spawner distribution upstream of Rkm 71. Past reports have shown that less than 25% of the hatchery steelhead juvenile releases into the SFCWR from 2011 to 2017 occurred upstream of Rkm 84 (Cleary 2016, Cleary and Broncheau 2017, and Cleary 2018). The second factor is differing post release survival of hatchery release groups within the SFCWR. Post release survival estimated for 2018 showed that hatchery fish released at Newsome Creek Rkm 84 had a 75.1% survival rate (95% C.I. of 61.9% to 108.5%) to the in-stream adult arrays at Rkm 2. Survival of hatchery fish released at Meadow Creek at Rkm 53 had a 91.5% survival rate (95% C.I. of 80.0% to 109.4%) to Rkm 2. Survival of hatchery steelhead released at the Red House Hole at Rkm 31 had the best survival with zero mortality from release to the Rkm 2 (survival of 106.8%, with 95% C.I of 94.1% to 124.0%). It should be noted that the instream arrays placed in the SFCWR and Lolo Creek were designed to detect returning adults and not juvenile emigrants. But while the upper limit of these post release survival estimates are greater than 100% the trend with the lower limits of these survival estimates was consistent with the survival estimates and consistent with a past observation that survival decreases with increases in distance traveled (Muir et al. 2001). The third factor is a possible adult migration barrier at Rkm 71 (Timm et al. 2017, and Timm et al 2018).

The project accomplished a portion of Objective 1 and Objective 2 (incorporate and validate PIT tag array-based status and trend estimates of adult abundance) with the use of Run Reconstruction Box Car model's steelhead escapement estimates to produce estimates of smolts-per-escapement for Lolo Creek. Smolt-per-escapement estimates for 2011-2012 and 2013-2014 fall within the range of smolt-per-escapement estimates from 1962 to 1996 presented by Yuen and Sharma (2005) and within the range of 24.8 to 135.8 smolts-per-escapement estimates shown in Appendix A using data from Table 1 in Yuen and Sharma (2005). Since the first juvenile abundance estimate for the SFCWR was not produced until migration year 2017 a smolt-per-escapement for the SFCWR will not be available until 2021.

Scale age data for Objective 3 (provide descriptive biological data on natural-origin returns) showed that freshwater age classes during the spring of 2017 ranged from Age 1 to Age 4, and from Age 0 to Age 4 during the spring of 2018, with the majority of the capture steelhead being Age 2. The majority of natural origin juveniles PIT tagged during the spring of 2018 and detected at LGD in the spring of 2018 had fork lengths greater than 120 mm when PIT tagged at the SFCWR and Lolo Creek traps. The majority of natural origin steelhead detected at LGD during the spring of 2018 but tagged one and two years prior during migration years 2017 and 2016 had fork lengths less than 120 mm when PIT tagged. This data shows that migrating populations of juvenile steelhead consist of multiple brood years and suggest that a size threshold for juvenile emigration may exist for SFCWR and Lolo Creek steelhead.

The project was not able to accomplish Objective 4 (assign run-reconstruction estimates of steelhead to known and unknown areas) because sampling was limited to the SFCWR and Lolo Creek population areas. The project plans to expand sampling into the Clearwater River Lower Mainstem population area and the Lower Salmon River in 2019 with weirs and portable PIT tag arrays.

LESSONS LEARNED

The lesson learned from the failure of the trap anchor design was that the trap cable spanning the river between the trap anchors wasn't high enough to avoid debris when stream discharge in the South Fork Clearwater River was greater than 3,500 cfs. Figure 7 shows the cross section design of the trap anchoring system. The trap cable spanning the river between the trap anchors was placed 8 ft above the water. However, the engineered plans show that the cable may sag up to 5ft. A change in the river height from 3 ft at 500 cfs to 5.6 ft at 5,000 cfs would result in less than 1 ft of clearance between the cable and the surface of the water. When there is less than a 1 ft of clearance between the cable and the surface of the water there is a good chance that a downstream moving log or washed out tree will come in contact with the cable and create a log jam and damage the trap anchors. Future protocols for juvenile trapping at the South Fork Clearwater River will call for removing the trap and raising the cable above 8 ft. when the stream gage height is expected to be greater than 5.6 ft.

Additionally, it was learned that water temperatures at Rkm 1 were comparable to water temperatures at Rkm 9. Water temperatures at Rkm 1 are collected by the in-stream PIT tag arrays as part of the Integrated Status and Effectiveness Monitoring Project (BPA project # 2003-017-00). Therefore, in the future the project can redirect funding from temperature data collection at Rkm 9 to the other data collection tasks.

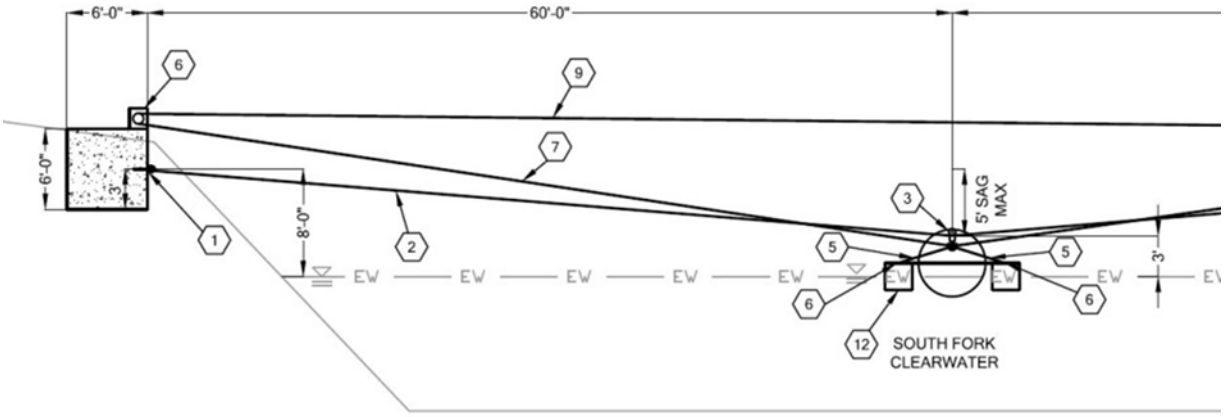

Figure 7. The cross section design of the west anchor of the South Fork Clearwater River juvenile fish trap is shown as it was designed by the Idaho Department of Fish and Wildlife in 2015.

ACKNOWLEDGEMENTS

The NPT Hatchery Monitoring and Evaluation Project contributed data for Lolo Creek and Newsome Creek juvenile fish traps for estimates of natural juvenile abundance and survival (BPA Project number 198335003S). Darren Ogden of NOAA Fisheries oversaw operations at the LGD adult trap and helped greatly with NOAA's Separation by Code system for the trapping of South Fork Clearwater River adult steelhead. Marika Dobos (IDFG) coordinated IDFG's support for radio tagging SFCWR adult steelhead at trapped LGD adult trap. Additionally, PIT tagged steelhead used in the post release survival estimates of hatchery origin steelhead from release to LGD were PIT tagged by IDFG.

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APPENDIX A

Appendix A Table 1. The weekly arrival timing of natural origin steelhead juveniles is shown for steelhead captured at Clearwater River rotary screw traps during the 2018 migration year.

Season	Week of the Year	First Day of the Week	South Fork Clearwater River (n = 52)	Lolo Creek (n = 722)	Newsome Creek (n = 481)
Fall 2017	40	1-Oct	0.0%	1.9%	9.8%
	41	8-Oct	1.9%	9.4%	10.8%
	42	15-Oct	1.9%	18.3%	11.6%
	43	22-Oct	1.9%	72.9%	46.4%
	44	29-Oct	1.9%	78.4%	47.6%
	45	5-Nov	3.8%	78.9%	48.4%
	46	12-Nov	7.7%	79.5%	49.1%
	47	19-Nov	7.7%	79.8%	49.1%
	48	26-Nov	11.5%	79.8%	49.1%
Spring 2018	11	12-Mar	13.5%	80.1%	49.1%
	12	19-Mar	15.4%	80.1%	49.1%
	13	26-Mar	17.3%	80.5%	49.3%
	14	2-Apr	44.2%	81.6%	50.7%
	15	9-Apr	44.2%	83.5%	51.6%
	16	16-Apr	48.1%	86.1%	55.5%
	17	23-Apr	100.0%	86.8%	61.5%
	18	30-Apr		87.8%	61.5%
	19	7-May		88.0%	61.5%
	20	14-May		88.9%	61.7%
	21	21-May		91.1%	62.4%
	22	28-May		93.5%	78.2%
	23	4-Jun		95.8%	87.1%
	24	11-Jun		96.8%	88.1%
	25	18-Jun		97.8%	89.6%
	26	25-Jun		98.5%	90.9%
	27	2-Jul		99.2%	91.3%
	28	9-Jul		100.0%	95.0%
	29	16-Jul			97.1%
	30	23-Jul			98.1%
	31	30-Jul			100.0%

APPENDIX B

Appendix B Table 1. Escapement index data and smolt production data from Table 1 in Yuen and Sharma (2005) with estimates of smolt production per escapement estimated without modeling. The escapement index represents the count at the uppermost Snake River dam minus tributary harvest (Snake River Dams were constructed between 1961 and 1975).

Escapement Year	Escapement Index	Smolt Production		Total Smolt Production per Escapement
		Age 2	Age 3	
1962	62,061	836,522	703,763	24.8
1963	42,418	892,290	791,733	39.7
1964	37,494	1,003,827	791,733	47.9
1965	35,363	1,003,827	571,807	44.6
1966	32,726	724,986	703,763	43.7
1967	16,033	892,290	791,733	105.0
1968	51,958	1,003,827	483,837	28.6
1969	34,827	613,450	571,807	34.0
1970	30,681	724,986	615,793	43.7
1971	35,859	780,754	351,882	31.6
1972	24,560	446,145	615,793	43.2
1973	17,065	780,754	219,926	58.6
1974	9,570	278,841	395,867	70.5
1975	12,651	501,913	483,837	77.9
1976	7,754	613,450	439,852	135.8
1977	13,536	557,681	571,807	83.4
1978	11,637	724,986	439,852	100.1
1979	14,792	557,681	351,882	61.5
1980	14,830	446,145	582,011	69.3
1981	13,292	417,989	394,074	61.1
1982	24,727	235,926	539,212	31.3
1983	18,011	280,788	377,115	36.5
1984	24,007	359,327	384,181	31.0
1985	26,174	415,819	269,091	26.2
1986	21,551	470,909	212,073	31.7
1987	24,961	727,927	58,209	31.5
1988	20,663	710,149	316,693	49.7
1989	24,469	401,531	316,693	29.4
1990	9,100	401,531	281,505	75.1
1991	16,975	356,916	263,911	36.6
1992	18,959	334,609	285,904	32.7
1993	7,207	362,493	235,321	82.9
1994	7,366	298,360	408,183	95.9
1995	7,831	517,528	372,994	113.7
1996	7,471	472,914	416,100	119.0

APPENDIX C

Appendix C Table 1. Cumulative adult arrival timing of South Fork Clearwater River steelhead at Lower Granite Dam is shown from the fall of 2010 (the start of spawn year 2011) to the spring of 2018 (end of spawn year 2018). Adult returns are grouped by program where NAT represents naturally produced steelhead, SUP represents Supplemental (adipose intact) hatchery steelhead, and CON represents adipose clipped hatchery steelhead.

Spawn Year	Program	n	First Observation	10%	50%	90%	Last Observation
2011	NAT	3	9/13/2010	9/13/2010	9/21/2010	9/25/2010	9/25/2010
	SUP	51	9/6/2010	9/16/2010	10/4/2010	11/24/2010	3/20/2011
	CON	161	8/28/2010	9/17/2010	10/6/2010	10/31/2010	4/1/2011
2012	NAT	0	ND	ND	ND	ND	ND
	SUP	64	9/9/2011	9/19/2011	10/3/2011	10/25/2011	2/29/2012
	CON	172	8/20/2011	9/11/2011	9/29/2011	10/25/2011	3/20/2012
2013	NAT	3	9/26/2012	9/26/2012	10/29/2012	4/6/2013	4/6/2013
	SUP	140	9/11/2012	9/19/2012	10/12/2012	12/10/2012	4/7/2013
	CON	67	9/14/2012	9/24/2012	10/16/2012	12/4/2012	3/17/2013
2014	NAT	1	10/4/2013	10/4/2013	10/4/2013	10/4/2013	10/4/2013
	SUP	80	9/20/2013	10/2/2013	10/12/2013	11/28/2013	3/30/2014
	CON	65	8/29/2013	9/29/2013	10/13/2013	11/30/2013	3/27/2014
2015	NAT	3	10/16/2014	10/16/2014	10/16/2014	10/27/2014	10/27/2014
	SUP	69	9/19/2014	9/28/2014	10/11/2014	11/16/2014	3/29/2015
	CON	51	7/18/2014	9/26/2014	9/29/2014	10/29/2014	3/27/2015
2016	NAT	6	9/21/2015	9/21/2015	10/5/2015	3/6/2016	3/6/2016
	SUP	39	9/22/2015	9/24/2015	10/6/2015	11/2/2015	12/26/2015
	CON	95	9/5/2015	9/21/2015	10/9/2015	10/30/2015	3/12/2016
2017	NAT	5	8/11/2016	8/11/2016	9/26/2016	3/24/2017	3/24/2017
	SUP	86	9/23/2016	10/1/2016	10/15/2016	11/16/2016	4/10/2017
	CON	116	9/8/2016	9/26/2016	10/8/2016	11/4/2016	4/16/2017
2018	NAT	0	ND	ND	ND	ND	ND
	SUP	25	9/18/2017	9/30/2017	10/13/2017	11/3/2017	11/5/2017
	CON	35	9/20/2017	10/1/2017	10/8/2017	3/10/2018	4/5/2018

Appendix C Table 2. Cumulative adult arrival timing of South Fork Clearwater River steelhead at South Fork Clearwater River PIT tag arrays is shown from the fall of 2011 (the start of spawn year 2012) to the spring of 2018 (end of spawn year 2018). Adult returns are grouped by program where NAT represents naturally produced steelhead, SUP represents Supplemental (adipose intact) hatchery steelhead, and CON represents adipose clipped hatchery steelhead.

Spawn Year	Program	n	First Observation	10%	50%	90%	Last Observation
2012	NAT	0	ND	ND	ND	ND	ND
	SUP	41	10/17/2011	2/13/2012	2/25/2012	3/12/2012	3/27/2012
	CON	53	9/27/2011	1/1/2012	2/25/2012	3/16/2012	4/10/2012
2013	NAT	3	3/2/2013	3/2/2013	3/6/2013	4/16/2013	4/16/2013
	SUP	92	10/16/2012	11/2/2012	3/1/2013	3/16/2013	4/3/2013
	CON	33	10/27/2012	11/21/2012	3/2/2013	3/13/2013	3/28/2013
2014	NAT	0	ND	ND	ND	ND	ND
	SUP	61	2/16/2014	2/19/2014	2/28/2014	3/16/2014	4/3/2014
	CON	46	12/10/2013	2/19/2014	2/26/2014	3/16/2014	4/6/2014
2015	NAT	0	ND	ND	ND	ND	ND
	SUP	59	10/14/2014	11/7/2014	2/8/2015	3/21/2015	4/18/2015
	CON	19	10/24/2014	11/2/2014	2/15/2015	3/24/2015	4/2/2015
2016	NAT	5	10/10/2015	10/10/2015	2/29/2016	3/11/2016	3/11/2016
	SUP	33	1/19/2016	2/8/2016	2/15/2016	2/29/2016	4/6/2016
	CON	48	10/20/2015	2/11/2016	2/16/2016	3/12/2016	4/9/2016
2017	NAT	4	10/22/2016	10/22/2016	2/20/2017	3/4/2017	3/4/2017
	SUP	59	10/22/2016	2/16/2017	2/22/2017	3/12/2017	4/7/2017
	CON	63	10/16/2016	10/28/2016	2/20/2017	3/4/2017	3/28/2017
2018	NAT	0	ND	ND	ND	ND	ND
	SUP	15	11/23/2017	1/14/2018	1/24/2018	2/9/2018	2/17/2018
	CON	19	11/28/2017	12/3/2017	2/3/2018	3/20/2018	3/26/2018

Appendix C Table 3. The percent of South Fork Clearwater steelhead adults detected at the PIT tag arrays at the South Fork Clearwater River that were previously observed at Lower Granite Dam from the fall of 2011 (the start of spawn year 2012) to the spring of 2018 (end of spawn year 2018). Adult returns are grouped by program where NAT represents naturally produced steelhead, SUP represents Supplemental (adipose intact) hatchery steelhead, and CON represents adipose clipped hatchery steelhead.

Spawn Year	Program	Total Detections at Lower Granite Dam	Subsequent South Fork Clearwater River Detections		
			Detected	Not Detected	Percent Detected
2011	NAT	3	ND	ND	ND
	SUP	51	ND	ND	ND
	CON	161	ND	ND	ND
2012	NAT	--	--	--	ND
	SUP	64	41	23	64.1%
	CON	172	53	119	30.8%
2013	NAT	3	3	0	100.0%
	SUP	140	92	48	65.7%
	CON	67	33	34	49.3%
2014	NAT	1	0	1	0.0%
	SUP	80	61	19	76.3%
	CON	65	46	19	70.8%
2015	NAT	3	2	1	66.7%
	SUP	69	59	10	85.5%
	CON	51	19	32	37.3%
2016	NAT	6	5	1	83.3%
	SUP	39	33	6	84.6%
	CON	95	48	47	50.5%
2017	NAT	5	4	1	80.0%
	SUP	86	59	27	68.6%
	CON	116	63	53	54.3%
2018	NAT	--	--	--	ND
	SUP	25	15	10	60.0%
	CON	35	19	16	54.3%

Appendix C Table 4. Cumulative adult arrival Timing of Lolo Creek steelhead at Lower Granite Dam is shown from the fall of 2010 (the start of spawn year 2011) to the spring of 2018 (end of spawn year 2019). Adult returns are grouped by program where NAT represents naturally produced steelhead, and SUP represents Supplemental (adipose intact) hatchery steelhead.

Spawn Year	Program	n	First Observation	10%	50%	90%	Last Observation
2012	NAT	--	ND	ND	ND	ND	ND
	SUP	7	9/23/2011	9/23/2011	10/3/2011	10/23/2011	10/23/2011
2013	NAT	--	ND	ND	ND	ND	ND
	SUP	3	10/5/2012	10/5/2012	10/7/2012	3/14/2013	3/14/2013
2014	NAT	--	ND	ND	ND	ND	ND
	SUP	--	ND	ND	ND	ND	ND
2015	NAT	1	10/10/2014	10/10/2014	10/10/2014	10/10/2014	10/10/2014
	SUP	5	9/30/2014	9/30/2014	10/6/2014	10/22/2014	10/22/2014
2016	NAT	4	9/29/2015	9/29/2015	10/3/2015	10/11/2015	10/11/2015
	SUP	8	9/29/2015	9/29/2015	10/17/2015	4/1/2016	4/1/2016
2017	NAT	3	9/24/2016	9/24/2016	9/27/2016	10/2/2016	10/2/2016
	SUP	45	9/20/2016	9/27/2016	10/16/2016	3/26/2017	4/4/2017
2018	NAT	--	ND	ND	ND	ND	ND
	SUP	7	10/08/17	10/08/17	10/17/2017	3/22/2018	3/22/2018

Appendix C Table 5. Cumulative adult arrival Timing of Lolo Creek adult steelhead at Lolo Creek is shown from the fall of 2010 (the start of spawn year 2011) to the spring of 2018 (end of spawn year 2018). Adult returns are grouped by program where NAT represents naturally produced steelhead, and SUP represents Supplemental (adipose intact) hatchery steelhead.

Spawn Year	Program	n	First Observation	10%	50%	90%	Last Observation
2012	NAT	--	ND	ND	ND	ND	ND
	SUP	3	3/25/2012	3/25/2012	3/26/2012	4/9/2012	4/9/2012
2013	NAT	--	ND	ND	ND	ND	ND
	SUP	2	3/23/2013	3/23/2013	3/23/2013	3/25/2013	3/25/2013
2014	NAT	--	ND	ND	ND	ND	ND
	SUP	--	ND	ND	ND	ND	ND
2015	NAT	1	3/26/2015	3/26/2015	3/26/2015	3/26/2015	3/26/2015
	SUP	3	3/21/2015	3/21/2015	3/13/2015	3/26/2015	3/26/2015
2016	NAT	1	3/13/2016	3/13/2016	3/13/2016	3/13/2016	3/13/2016
	SUP	5	3/6/2016	3/6/2016	3/10/2016	4/5/2016	4/5/2016
2017	NAT	3	3/11/2017	3/11/2017	3/29/2017	4/8/2017	4/8/2017
	SUP	8	3/22/2017	3/22/2017	4/5/2017	4/27/2017	4/27/2017
2018	NAT	--	ND	ND	ND	ND	ND
	SUP	5	3/17/2017	3/17/2017	3/29/2017	4/20/2018	4/20/2018

Appendix C Table 6. The percent of Lolo Creek steelhead detected at the PIT tag arrays at Lolo Creek that were previously observed at Lower Granite Dam from the fall of 2011 (spawn year 2012) to the spring of 2018 (spawn year 2018). Adult returns are grouped by program where NAT represents naturally produced steelhead, and SUP represents Supplemental (adipose intact) hatchery steelhead.

Spawn Year	Program	Total Detections at Lower Granite Dam	Subsequent Lolo Creek Detections		
			Detected	Not Detected	Percent Detected
2012	NAT	--	--	--	ND
	SUP	7	3	4	42.9%
2013	NAT	--	--	--	ND
	SUP	3	2	1	66.7%
2014	NAT	--	--	--	ND
	SUP	--	--	--	ND
2015	NAT	1	1	0	100.0%
	SUP	5	3	2	60.0%
2016	NAT	4	1	3	25.0%
	SUP	8	5	3	62.5%
2017	NAT	3	3	0	100.0%
	SUP	45	8	37	17.8%
2018	NAT	--	--	--	ND
	SUP	7	5	2	71.4%

APPENDIX D

Appendix D Table 1. Analysis of water temperature metrics for stream temperature data collected at river kilometer (Rkm) 1 and 9 from the South Fork Clearwater River from August 1, 2017 to July 31, 2018.

Site	Year	Month	MDMT	MWMT	Weeks Where MDAT > 18° C (n)	MWAT	Collection Period
Rkm 1	2017	8	26.9	26	4	21.6	Aug. 1 to Aug. 31
	2017	9	24	22.4	2	16.6	Sept. 1 to Sept. 30
	2017	10	14	12.1	0	8.3	Oct. 1 to Oct. 30
	2017	11	6.6	5.5	0	4.1	Nov. 1 to Nov. 30
	2017	12	3.4	2.2	0	0.7	Dec. 1 to Dec.31
	2018	1	5.1	3.9	0	2.4	Jan. 1 to Jan. 31
	2018	2	5.1	4.6	0	2.3	Feb. 1 to Feb. 28
	2018	3	8.5	7.3	0	4.7	Mar. 1 to Mar.31
	2018	4	9.6	9	0	6.6	Apr.1 to Apr. 30
	2018	5	13.6	12.7	0	9.6	May 1 to May 31
	2018	6	18.7	18.3	1	13.7	Jun. 1 to Jun. 30
	2018	7	26.6	26	4	20.7	Jul. 2 to Jul. 31
Rkm 9	2017	8	ND	ND	ND	ND	(equipment malfunction)
	2017	9	ND	ND	ND	ND	(equipment malfunction)
	2017	10	11.1	9.7	0	8.1	Oct. 7 to Oct. 31
	2017	11	6.5	5.3	0	4.7	Nov. 1 to Nov. 30
	2017	12	3.6	2.3	0	1.8	Dec. 1 to Dec. 31
	2018	1	4.6	3.9	0	3.3	Jan. 1 to Jan. 31
	2018	2	5.4	4.9	0	4.3	Feb. 1 to Feb. 26
	2018	3	7.8	6.9	0	5.5	Mar. 1 to Mar. 31
	2018	4	8.9	7.9	0	6.6	Apr. 1 to Apr. 23
	2018	5	ND	ND	ND	ND	(thermograph lost)
	2018	6	17.8	16.4	0	14.8	Jun. 7 to Jun. 25
	2018	7	26.7	25.9	4	21.9	Jul. 4 to Jul. 29