BUREAU OF RECLAMATION

2019 Annual Report for Activities under the Endangered Species Act Biological Opinion

(For the period November 1, 2018 to December 31, 2019)

Lewiston Orchards Project, Lewiston, Idaho

Columbia-Pacific Northwest Region

Submitted to the National Marine Fisheries Service Boise, Idaho

U.S. Department of the Interior May 2020

Cover photograph: Passive Integrated Transponder (PIT) tag fish detection site on Lapwai Creek.

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Acronyms and Abbreviations

2010 Opinion	National Marine Fisheries Service 2010 Biological Opinion
2017 Opinion	National Marine Fisheries Service 2017 Biological Opinion
af	acre-feet
BiOp	biological opinion
cfs	cubic feet per second
ESA	Endangered Species Act
ESU	Evolutionarily Significant Units
LLL	Lower Lapwai Lower
LOID	Lewiston Orchards Irrigation District
LOP	Lewiston Orchards Project
LSX	Lower Sweetwater
MLX	Lapwai Below Mission
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
Parties	Project Lead, Reclamation Biologist and Project Manager
PIT	Passive Integrated Transponder
Reclamation	U.S. Bureau of Reclamation
RPM	Reasonable and Prudent Measures
Tribe	Nez Perce Tribe
UI	University of Idaho
ULU	Upper Lapwai
UMU	Upper Mission
USGS	U.S. Geological Survey
USM	Upper Sweetwater Middle
USU	Upper Sweetwater
UWM	Upper Webb
UWU	Upper Webb Upper

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1. INTRODUCTION

On April 15, 2010, the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) issued a 2010 Biological Opinion (2010 Opinion) under the Endangered Species Act (ESA) to the Bureau of Reclamation (Reclamation) for the operation and maintenance of the Lewiston Orchards Project (LOP). On July 11, 2017, NMFS issued a 2017 Biological Opinion (2017 Opinion) for the Lewiston Orchards Project Water Exchange and Title Transfer. This report is submitted to comply with Reasonable and Prudent Measure (RPM) 6 from the 2010 Opinion as well as RPM 4 from the 2017 Opinion, requiring Reclamation to report to the NMFS annually on activities related to implementing Opinions (NMFS 2010, NMFS 2017a).

The 2010 Opinion requires that Reclamation provide minimum flows below the diversion dams as described in the proposed action. Reclamation may be required to provide additional flows from June through mid-September, based upon combined storage as of June 1 in Soldiers Meadow Reservoir and Reservoir A. The 2017 Opinion requires additional flows as the wells for the water exchange become operational. A summary of the multiple requirements and agreements can be found in the 2019 Annual Plan (Appendix A). This Annual Plan is developed cooperatively by the Lewiston Orchard Irrigation District (LOID) General Manager, Nez Perce Tribe (Tribe) Project Lead, Reclamation Biologist and Project Manager (the Parties). In 2019, exchange amounts as agreed upon in the Annual Plan, were fully met.

Part of the need for wells is to improve water reliability for the LOP, in dry years there may not be enough water in the reservoirs to equal the sustainable productive rate of the wells. This annual report covers the LOP operation and maintenance activities from November 1, 2018, to December 31, 2019, for published streamflows, irrigation operations, and fisheries monitoring. The LOID operated the surface water collection system from March 25, 2019, until October 31, 2019.

To enhance the project's ability to consistently meet minimum flow requirements, Reclamation and the LOID continue to operate and maintain water measurement and gate automation equipment at the headgates to Sweetwater Canal and Webb Creek Diversion Dam. The gate automation equipment continually self-adjusts to maintain minimum streamflow past the diversion dam. Gate automation greatly improves LOP's ability to maintain flow targets and minimize daily variability related to operations.

No injuries or mortalities of ESA-listed steelhead, associated with operations, were observed during the 2019 reporting period.

2. RPM 1: FLOW MANAGEMENT

2.1 Minimum Bypass Streamflow Requirements in Sweetwater and Webb Creeks

2.1.1 Background

RPM 1 of the 2010 Opinion, require LOP operations to bypass flows in Sweetwater and Webb creeks based on the life stage of steelhead. The minimum daily bypass flows for Sweetwater and Webb creeks are shown in Table 1.

Table 1. Instream flow minimum releases [cubic feet per second (cfs)] for Sweetwater and Webb creeks at their respective diversion dam sites (NMFS 2010).

Life Stage	Spawning			Juvenile Rearing							
Month	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep 1-15	Sep 16-30	Oct	Nov Dec Jan
Sweet-Water Cr.	7.8/I[b]	7.8/I	7.8	3.0	2.5	2.5	2.5	2.5	2.5	2.5	I[a]
Webb Creek	4.0/I[b]	4.0/I	4.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	I[a]

[a] During November, December, and January, all inflow (I) at Sweetwater and Webb Creeks Diversion Dams will be bypassed.

[b] During February and March, either the specified stream flow will be provided or all inflow (I) to the Sweetwater and Webb Creeks Diversion Dams will be bypassed, whichever is less.

The instream flow regime in Table 1 addresses all months of the year; these flows will be used to support spawning conditions during February through April and juvenile rearing conditions from May through January. The LOP will not operate the Sweetwater and Webb Diversion Dams during November, December, and January; therefore, all instream flow reaching the dams will be bypassed during those months. During February and March, if the inflows to either Sweetwater or Webb Diversion Dams are below the specified minimum flow, the LOID will bypass all inflow (I) to that diversion dam until it reaches the specified targets before beginning any diversions. In October the specified minimum flows will be passed when the diversion dams are in operation. When the diversion dams are turned off for the season, all inflow will be bypassed. For Webb Creek, the "I" flow is composed of all runoff from the watershed upstream of the diversion and below Soldiers Meadow Dam. For Sweetwater Creek, the "I" flow is composed of all runoff from the watershed upstream of the dam, except for any diversions occurring at the West Fork diversion which are being conveyed to Lake Waha (NMFS 2010).

In addition, Reclamation may supply additional flows into Sweetwater and Webb creeks for June through mid-September, based on the combined storage in Soldiers Meadow Reservoir and Reservoir A, as assessed on June 1. The additional increments allocated for Sweetwater and Webb creeks, and the storage conditions under which they would occur, are shown in Table 2. As of June 1, 2019, the combined storage was greater than 4,250 acre-feet. The additional 1.0 cfs for both Sweetwater and Webb creeks can be seen in Table 3.

Table 2. Increments of additional juvenile rearing flow as a function of combined storage for June 1–September 15 (NMFS 2010)

Combined Storage (af)	<3,800	3,900	4,000	4,100	4,200	>4,250
Sweetwater Creek (cfs)	+0	+0.5	+0.9	+1.0	+1.0	+1.0
Webb Creek (cfs)	+0	+0	+0	+0.3	+0.8	+1.0
Total Flow (cfs)	3.50	4.00	4.40	4.80	5.30	5.50

Table 3. Total flows required in Sweetwater and Webb creeks with the additional volume and incremental add-in flows

2019 - Current as of 05/07/2019											
Life Stage	Spawning			Juvenile Rearing							
Month	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep 1-15	Sep 16-30	Oct	Nov, Dec, Jan
Sweetwater Creek Base ByPass Flows	7.8	7.8	7.8	3.0	2.5	2.5	2.5	2.5	2.5	2.5	Bypass
Incremental Add-In	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	
Total Sweetwater Creek ByPass Flows	**7.8**	**7.8**	**7.8**	**3.0**	**3.5**	**3.5**	**3.5**	**3.5**	**2.5**	**2.5**	
Webb Creek Base ByPass Flows	4.0	4.0	4.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	Bypass
Incremental Add-In	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	
Total Webb Creek ByPass Flows	**4.0**	**4.0**	**4.0**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**	**1.0**	**1.0**	

In 2014, the U.S. District Court issued an order staying litigation through January 2020 in the Endangered Species Act case, Nez Perce Tribe vs. National Oceanic and Atmospheric Administration (NOAA) Fisheries and Reclamation. The order is based on a 2014 Term Sheet Agreement that provides a framework for collaboration to address issues related to the Lewiston Orchards Project. The principal component of the 2014 Term Sheet Agreement is to advance the Lewiston Orchards Water Exchange and Title Transfer Project as a comprehensive solution to LOP system issues concerning ESA-listed steelhead, Tribal cultural and natural resources, and irrigation water supply reliability.

The Water Exchange and Title Transfer Project involves incrementally replacing the existing surface water system, located primarily on the Nez Perce Reservation, with an off-Reservation groundwater system comprised of multiple wells. As groundwater wells come online, diversion of surface water from LOP are reduced in an amount equal to an agreed upon in-lieu water exchange quantity, to be left instream for the direct benefit of ESA-listed steelhead. Once full surface water supply is exchanged, title transfer to LOID and BIA in trust for the Tribe may occur.

The first groundwater well (pilot well or Well No. 5) was completed in November 2016 and tested in January 2017. Final testing resulted in a full well production capacity of approximately 4.5 cfs (2,000 gallons per minute or 9 acre-feet per day).

In order to develop a strategy with multiple benefits including establishing water exchange in the critical months for steelhead spawning/rearing and recognizing LOID’s domestic component, the Parties collaboratively developed water exchange amounts at each diversion point.

The exchange flows for each month in Table 4 were determined recognizing the value in managing the instream flows to maximize the designated instream habitat, rather than bypassing a consistent monthly amount throughout the irrigation season. The monthly exchange flows allow for more flexible water management capabilities, allowing more than 4.5 cfs to be left instream in the more critical fish habitat months, and recognizing LOID’s domestic component for Well No. 5.

Table 4. Total flows with water exchange flows added in for Sweetwater and Webb creeks

2019 - Current as of 05/07/2019											
Life Stage	Spawning			Juvenile Rearing							
Month	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep 1-15	Sep 16-30	Oct	Nov, Dec, Jan
Sweetwater Creek Base ByPass Flows	7.8*	7.8*	7.8	3.0	2.5	2.5	2.5	2.5	2.5	2.5	Bypass
Incremental Add-In	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	
Water Exchange Flows (total of 4.5 cfs)	2.2	2.2	1.0	2.0	1.5	1.5	1.0	1.0	1.0	1.0	
Total Sweetwater Creek ByPass Flows	**10.0***	**10.0***	**8.8**	**5.0**	**5.0**	**5.0**	**4.5**	**4.5**	**3.5**	**3.5**	
Webb Creek Base ByPass Flows	4.0*	4.0*	4.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	Bypass
Incremental Add-In	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	
Water Exchange Flows (total of 4.5 cfs)	2.3	2.3	2.3	5.5	3.8	1.5	1.5	1.5	1.5	1.5	
Total Webb Creek ByPass Flows	**6.3***	**6.3***	**6.3**	**7.0**	**5.8**	**3.5**	**3.5**	**3.5**	**2.5**	**2.5**	

The proposed action states that Reclamation will monitor daily mean stream flows whenever the LOID is diverting water. Currently, 1-hour averages are posted for Sweetwater and Webb creeks onto Reclamation's public Hydromet page. The 2010 Opinion describes the minimum flows as a mean daily average, with criteria that flows be adjusted when they fall more than 20 percent below the target as monitored on an hourly basis.

In past water years, Reclamation and LOID installed gate automation and water measurement equipment at the Sweetwater Diversion Dam and Webb Creek Diversion Dam to improve the ability to measure and maintain the target minimum stream flows. Although the gate automation equipment substantially improved the project's ability to meet instream flow requirements, occasional operational problems occur with the mechanical and electrical equipment. Operation or technical limitations may occur when equipment malfunctions or debris catches at the structures or around the gates. Debris can physically prevent the gate from adjusting and/or cause inaccurate measurement due to backwatering near the gauging equipment that sends information to the gate controls.

2.1.2 Data Collection

The stream flow data are collected at one-hour intervals below the weirs at Sweetwater and Webb diversion dams. The automated data loggers record the bypass stream flow released over the compound weirs installed on the top of the diversion dams and the 4-foot weir located in the sluiceways. The data logger is located on the diversion dam. Reclamation posts data from these measurement points at http://www.pn.usbr.gov/hydromet.

All data collected during the irrigation season is provisional and could contain recording errors. U.S. Geological Survey (USGS) and Reclamation reconcile the data at the end of irrigation season and post the data on the Hydromet at the end of the calendar year. The reconciled data is the official record.

2.2 Sweetwater Creek

2.2.1 Bypass Stream Flow Results for Spring Spawning Period March 1–May 31

It is important to note that the minimum flows are provided under the terms of the 2010 Opinion, which describes the minimum flows as a mean daily average, with criteria that flows be adjusted when they fall more than 20 percent below the target. This criteria recognizes that some fluctuations are expected while meeting the target minimum flows. The Sweetwater diversion began operating March 25, 2019. During the spring spawning period, LOID met the BiOp required flows as seen in Figure 1. In late April there were some issues with the Hydromet readings due to excess gravel. The gravel was cleaned out and the Hydromet system was corrected. The raw data for both the hourly and daily flows can be found in Appendix B. This appendix notes the target bypass flow rates and the corresponding hourly rate in Sweetwater Creek.

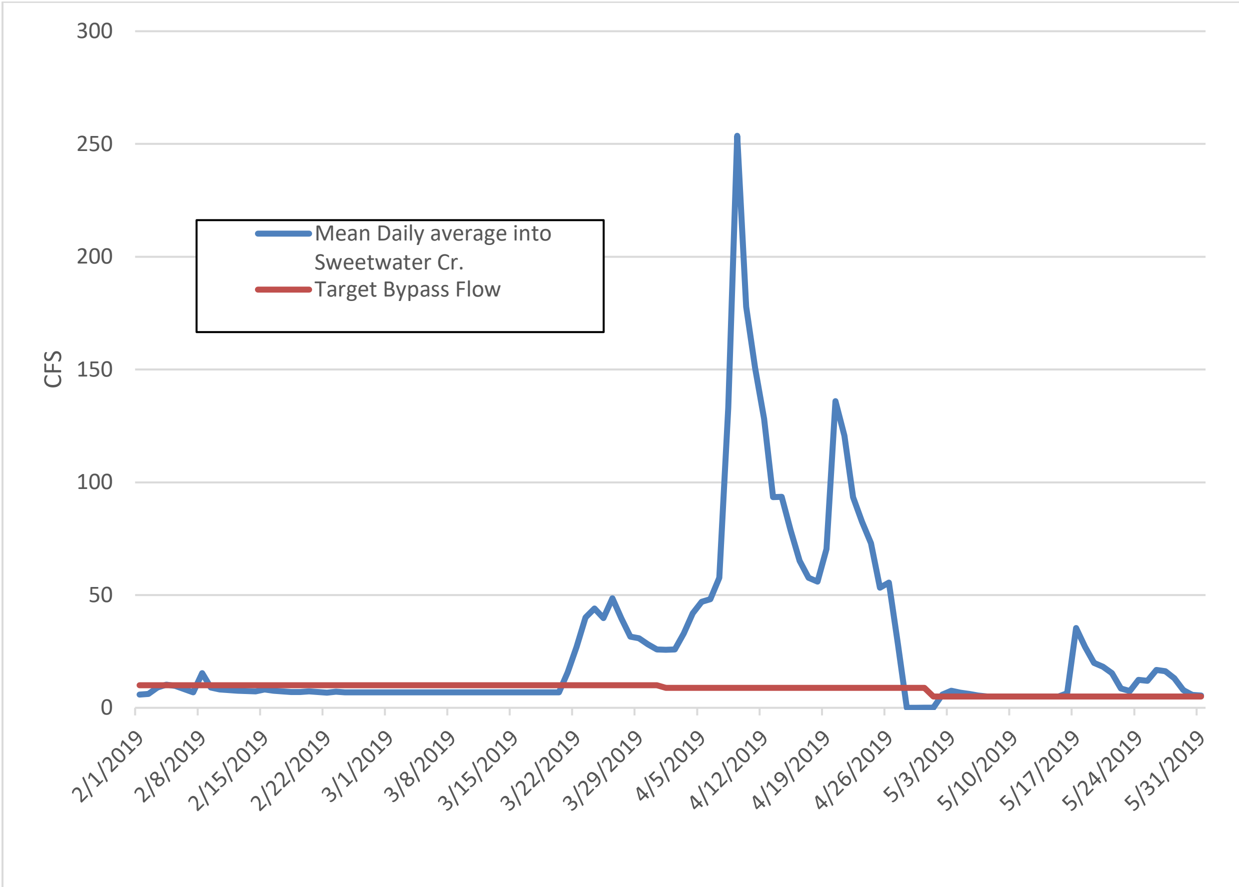

Figure 1. Mean daily stream flow (cfs) measured past the Sweetwater Diversion Dam and bypass flow targets and flow targets with water exchange flows for the first half of the irrigation season (March 1 – May 31, 2019.

2.2.2 Bypass Stream Flow Results for Juvenile Rearing Period June 1–October 31

Minimum stream flows for juvenile rearing in Sweetwater Creek are 2.5 cfs. Additional juvenile rearing flows are made available based on combined reservoir volumes of Soldiers Meadows and Reservoir A as of June 1 (Table 2). On June 1 the combined storage of Soldiers Meadows and Reservoir A were greater than 4,250 acre-feet thus adding additional juvenile rearing flows, in Sweetwater Creek between June 1 and October 31. In 2019 the incremental flows were added to Sweetwater and Webb creeks as shown in Table 2. The additional water exchange flows were released into Sweetwater Creek according to Table 4 during June–September as seen in Figure 2. The combined flows resulted in minimum flow targets for June–July at 5.0 cfs; August–September 15 at 4.5 cfs; September 16–October at 3.5 cfs. During the juvenile rearing period, LOID met the BiOp required flows and also met the added water exchange flows as seen in Figure 2. The raw data can be found in Appendix B.

Figure 2. Mean daily stream flow (cfs) measured past the Sweetwater Diversion Dam and bypass flow targets and flow targets with water exchange flows for the second half of the irrigation season (June 1 – October 31, 2019).

2.3 Webb Creek

2.3.1 Minimum Bypass Stream Flow Requirements in Webb Creek

The Webb Creek diversion was operated from May 9, 2019, until October 17, 2019. Measured stream flows, in relation to the bypass flow targets are shown in Figure 3. Minimum flow targets with water exchange flows for 2019 were 6.3 cfs in February, March, and April; 7.0 cfs in May; 5.8 cfs in June; 3.5 cfs July–September 15; and 2.5 cfs September 16–October. LOID met the BiOp required flows and also met the added water exchange flows as seen in Figure 3. The raw data for both the hourly and daily flows can be found in Appendix B. This appendix notes the target bypass flow rates and the corresponding hourly rate in Webb Creek.

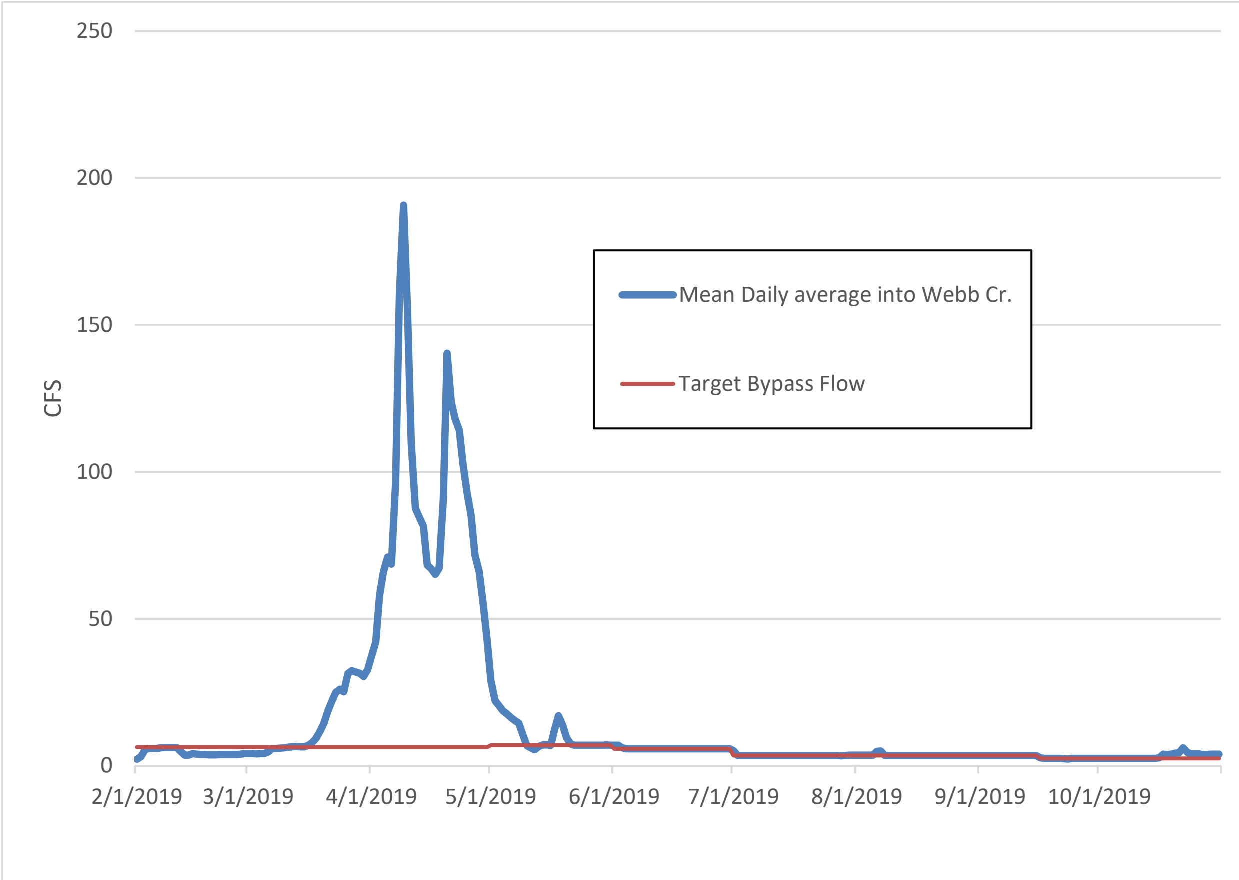

Figure 3. Mean daily stream flow (cfs) measured past the Webb Creek Diversion Dam for the irrigation season (2019).

2.4 Ramping Rates

Ramping flows were incorporated into the proposed action and described in the 2009 Biological Assessment (Reclamation 2009) (pages 4-11). The ramping rates were modified in the 2017 water year in order to help operational issues which were negatively affecting flows in the stream system (Thom 2017). Ramping will occur during the start of the irrigation period; the down-ramping from spawning flows to juvenile rearing flows on May 1; the end of the irrigation season; and any other time during the irrigation season for scheduled operation or maintenance purposes. Ramping rates were identified to simulate natural conditions of the stream as much as possible. The 2019 ramping rates can be seen in Table 5.

Table 5. 2019 Ramping Rates for Sweetwater and Webb creeks

Ramping Water into the SW or Webb Canal

		Max Rate	
0.00	**4.00**	**1.00**	Per Day
4.01	**8.00**	**2.00**	Per Day
8.01	**15.00**	**3.00**	Per Day
15.01	**30.00**	**5.00**	Per Day
25.00	**or Greater**	**10.00**	Per Day

Ramping Water out of the SW or Webb Canal

		Max Rate	
0.00	**4.00**	**2.00**	Per Day
4.01	**12.00**	**4.00**	Per Day
12.01	**25.00**	**6.00**	Per Day
25.01	**or Greater**	**10.00**	Per Day

There is some confusion regarding ramping related to the daily fluctuations of stream flow in Sweetwater and Webb creeks when gate changes are not being made at the facilities. Ramping is a requirement directly associated with gate changes (see excerpt from Reclamation 2009 below). Other fluctuations in stream flow occur naturally from climatic and precipitation conditions and these fluctuations in stream flow would be natural hydrologic conditions in the stream.

Proposed Action (Reclamation 2009 pages 4–11):

"Ramping of stream flows is intended to make gradual changes during gate operations that avoid stranding fish in dewatered or pooled areas when stream flows are reduced (diversion gates opened) or flushing fish downstream when increasing stream flows (diversion gates closed). These gradual alterations in stream flow are intended to allow fish that are rearing in the streams sufficient time to adjust to changes in stream habitat. Stream flow ramping will be implemented at the Sweetwater and Webb diversion headgates during the following periods: initial opening of the headgates at the start of the irrigation season; down-ramping from spawning flows to juvenile rearing flows on May 1; during the end of the irrigation season when the headgates are closed; and any other time that the headgates are opened or closed during the irrigation season for operation or maintenance purposes."

In 2019, there are instances where stream flows fluctuate but are not associated with gate changes and therefore are not subject to ramping criteria. Some instances occur naturally as the system fluctuates during spring runoff and hydrologic events; other instances are caused by mechanical failures and can be evaluated on a case by case basis.

2.5 Gravel Management Activities

Maintenance of the Sweetwater and Webb Creek Diversion Dams requires periodic removal of sediment that accumulates behind the dam, typically conducted every 4 to 6 years. Sediment removal during this reporting period occurred at Sweetwater Diversion dam in the December of 2018 and May of 2019. The December event was associated with emergency repairs to the diversion structure itself and the May event was after high flows filled the pool upstream of the diversion with debris. This was in accordance with the new gravel management plan developed by the Parties and approved by NMFS on September 7, 2017 (Ries 2017).

3. RPM 2: Connectivity Monitoring

On July 14, 2010, Reclamation submitted its connectivity monitoring plan to NMFS as required by Term and Condition 2 of the 2010 Opinion. Measurements in Sweetwater Creek were discontinued after 2012 with no connectivity issues identified. To better understand channel connectivity conditions in Webb Creek, walk-through surveys were conducted in 2012 and 2013 on the lower 3.3 km of Webb Creek between the upper University of Idaho (UI) sampling site (Upper Webb Upper or "UWU") and the mouth. The connectivity survey on Webb Creek was reported in Reclamation's 2012 and 2013 Annual Reports submitted in the springs of 2013 and 2014, respectively. No additional connectivity monitoring was conducted in 2019.

4. RPM 3: Streamflow Monitoring

Stream flows are measured at both the mouth of Sweetwater and Webb creeks via USGS stream flow gages. Gage number 13342340 is the mouth of Sweetwater and gage number 13342295 is the mouth of Webb Creek. These gages are monitored to validate fluctuations and/or erroneous readings caused by malfunctions at the diversion sites.

Mean daily stream flow ranged from 10 to 176.80 cfs at the mouth of Sweetwater Creek, and from 2.16 to 117.10 cfs at the mouth of Webb Creek during water year 2019. Hydrographs from these sites show that peak flows occurred in April and low flows occurred in December (Table 6, Figures 4 and 5).

Table 6. Mean monthly stream flow (cfs) measured from daily average data at the USGS monitoring gauges at the mouth of Sweetwater and Webb creeks during water year 2019

Sweetwater Creek at Mouth		Webb Creek at Mouth	
Month	Average Flow (cfs)	Month	Average Flow (cfs)
Oct-18	12	Oct-18	4.36
Nov-18	10.9	Nov-18	2.41

Sweetwater Creek at Mouth		Webb Creek at Mouth	
Dec-18	10	Dec-18	2.16
Jan-19	12.00	Jan-19	2.67
Feb-19	17.80	Feb-19	5.21
Mar-19	46.40	Mar-19	19.40
Apr-19	176.80	Apr-19	117.10
May-19	32.00	May-19	18.20
Jun-19	15.80	Jun-19	7.82
Jul-19	11.90	Jul-19	4.12
Aug-19	12.40	Aug-19	3.59
Sep-19	12.30	Sep-19	3.41

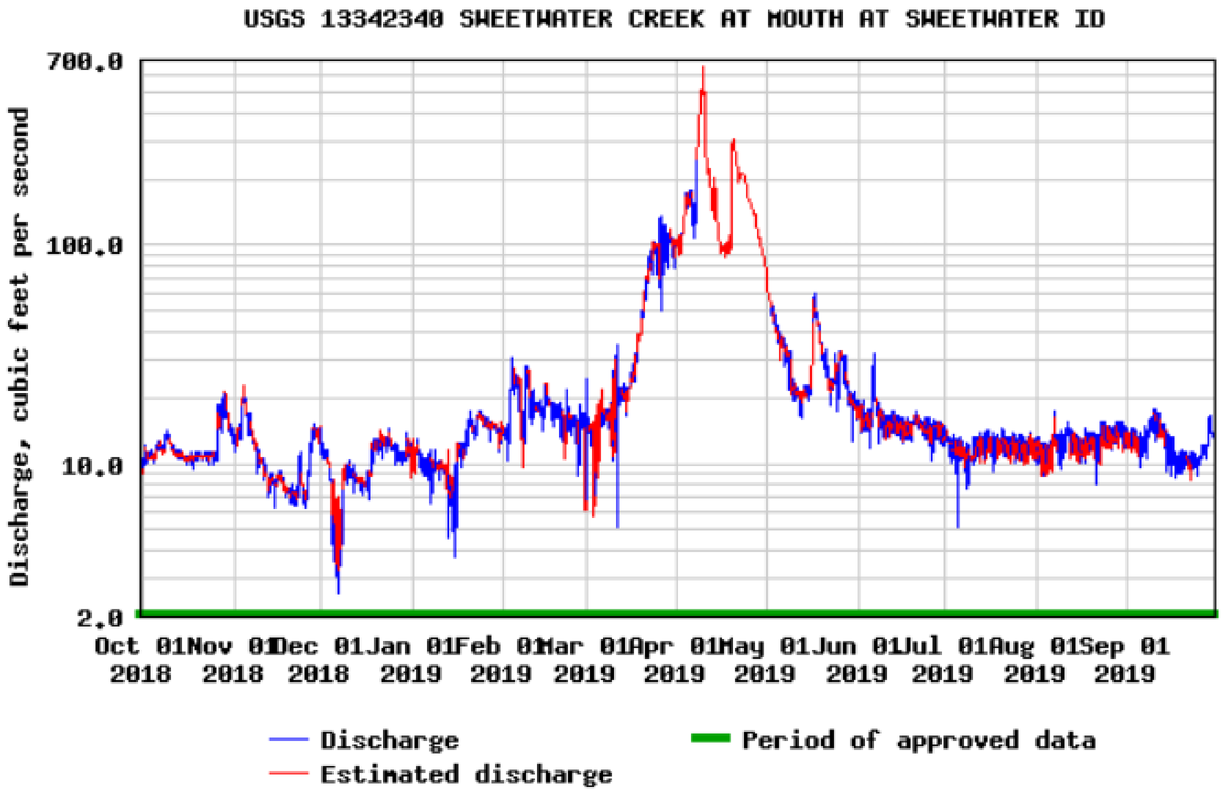

Figure 4. Mean daily stream flows (cfs) measured near the mouth of Sweetwater Creek (USGS gauge 13342340) during water year 2019.

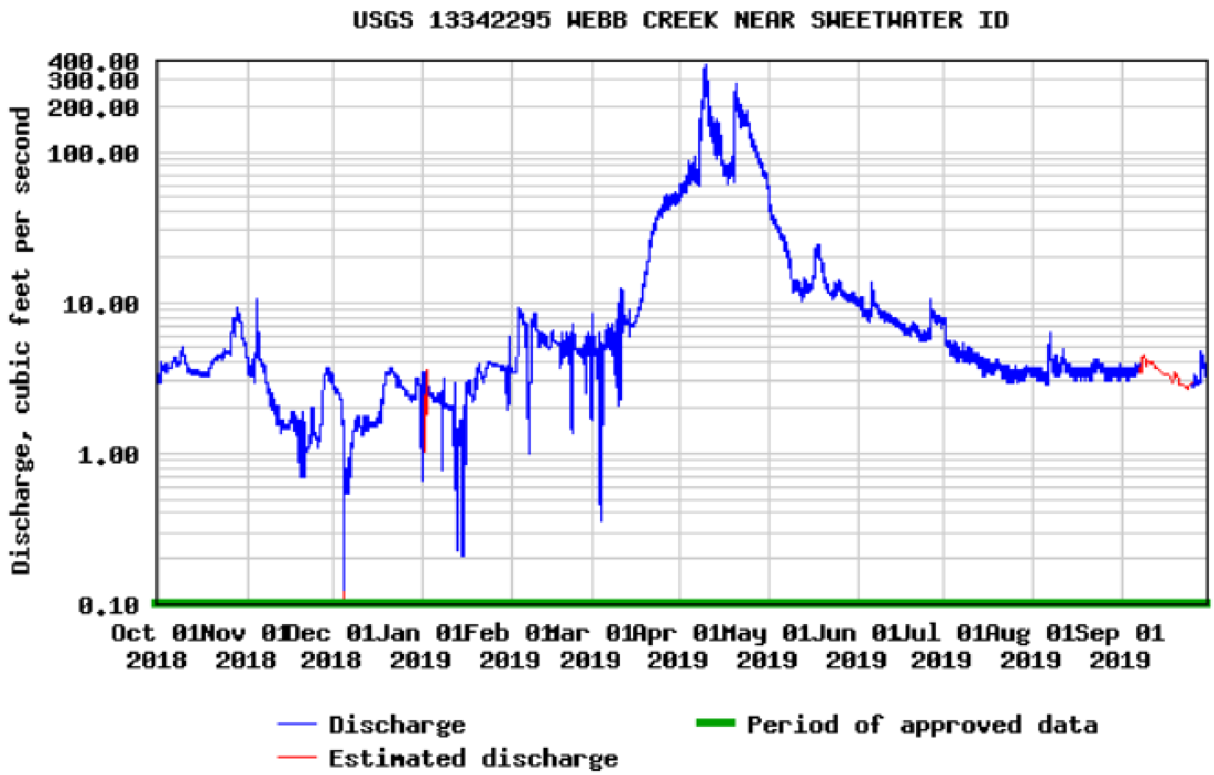

Figure 5. Mean daily stream flows (cfs) measured near the mouth of Webb Creek (USGS gauge 13342295) during water year 2019.

Both graphs show the large variability in stream flows, even when LOID is not operating the diversion structures. The spring runoff and corresponding peak occurred in April followed by the descending arm of the hydrograph in June. Flows continue on a downward trend through October. Some areas marked in red are estimated daily mean flows. These flows were estimated due to malfunctions in the gaging sites.

5. RPM 4: Monitoring Critical Uncertainties

RPM 4 requires Reclamation to monitor listed steelhead in areas of the Lapwai Basin impacted by the project and also requires Reclamation to address several critical uncertainties in relation to the project effects and the listed steelhead. As a result, Reclamation has collected information to address the critical uncertainties either directly, or through partnerships with either the State of Idaho, the Tribe, or UI.

Reclamation completed the monitoring plan for steelhead densities and critical uncertainties on January 27, 2011 (Reclamation 2011). This steelhead monitoring project was started under RPM 3 of the 2006 Opinion and continues as RPM 4 in the 2010 Opinion. The RPM required

Reclamation to monitor steelhead densities in the action area and to answer critical uncertainties regarding the effects of the action.

Reclamation had multi-year agreements (Agreement Numbers R12AC11005 and R14AC00042) with the UI to research and monitor the effects of streamflow on the growth and survival of juvenile steelhead and address several of the critical uncertainties identified in the Opinion. Those agreement ended May 31, 2019. As the Nez Perce Tribe takes over more responsibility in the basin in preparation for Title Transfer, a new contract (Contract Number 140R1019P0046) with the Tribe covered juvenile steelhead monitoring in 2019. During these surveys, a total of 611 steelhead were captured during electroshocking. There was one incidental mortality during the 2019 sampling season.

Passive Integrated Transponder (PIT) tag reading stations are being used to record the movement of tagged individuals. All systems use multiple antenna arrays (2 or 3) to determine direction of movement and detection efficiency. During 2019, PIT tag interrogation stations were operating at Lapwai, Sweetwater, and Mission Creeks. The Mission Creek array was damaged on April 9, 2019, and not operational for the remainder of 2019. Webb Creek lost power and was not operational for the 2019 spawn year.

5.1 *O. mykiss* Density Monitoring

Monitoring of juvenile *O. mykiss* densities was scaled back starting in 2014 as the objectives transitioned from monitoring critical uncertainties to long-term density monitoring. Due to low steelhead abundance, poor access, inadequate reach representation, and other physical issues resulting in little or poor-quality data, monitoring was discontinued at two of the original six sites where sampling started in 2008. Reclamation and the UI exchanged these two original long-term density monitoring sites with two of the sites developed by the UI in 2010. During a conference call on March 25, 2014, NMFS, UI, and Reclamation agreed on the six long-term monitoring sites.

Four of the original six sites remain, which include: Upper Lapwai (ULU), Upper Mission (UMU), Upper Webb (UWM) and Lower Sweetwater (LSX) (Figure 6). The other two original sites, Lower Lapwai Lower (LLL) and Upper Sweetwater Middle (USM) were replaced by sites that have been monitored by the UI since 2010. The LLL site experiences annual channel shifts due to spring high flows. This leads to shifts in steelhead densities that are linked more towards inter-annual changes in structural habitat conditions rather than temperature and flow conditions. Sampling at LLL is further complicated by the presence of spawning Coho in the fall. The USM site was inundated behind a beaver dam in the spring of 2010. Portions of the pool above the beaver dam were filled in with gravel in the spring of 2011, further complicating the site and reducing the viability of this site for meaningful long-term monitoring. The beaver dam no longer exists; however, due to the extreme habitat changes that have occurred since the original sampling in 2008, the UI and Reclamation have determined this site will no longer provide relevant, statistically viable data for inclusion into the overall monitoring framework.

Reclamation replaced LLL and USM with Lapwai Below Mission (MLX) and Upper Sweetwater (USU), respectively. MLX is more stable from year to year than LLL and has a lower likelihood of being influenced by spawning Coho. USU is also more stable than USM and is more representative of the available habitat within the Sweetwater Creek. Even though LLL and USM were part of the original six sampling sites, habitat modifications described above limit the number of years of data that would be comparable to future sampling. Long-term density monitoring at MLX and USU will provide more meaningful data with regards to the critical uncertainties identified in Term and Condition 4 and will provide statistically valid data, allowing for long-term trend analysis. The density monitoring from 2014 through 2019 includes three sites located in Webb and Sweetwater creeks (USU, UWM, LSX) that are influenced by the LOP water operations and three sites (MLX, UMU, ULU) that are not influenced by the project.

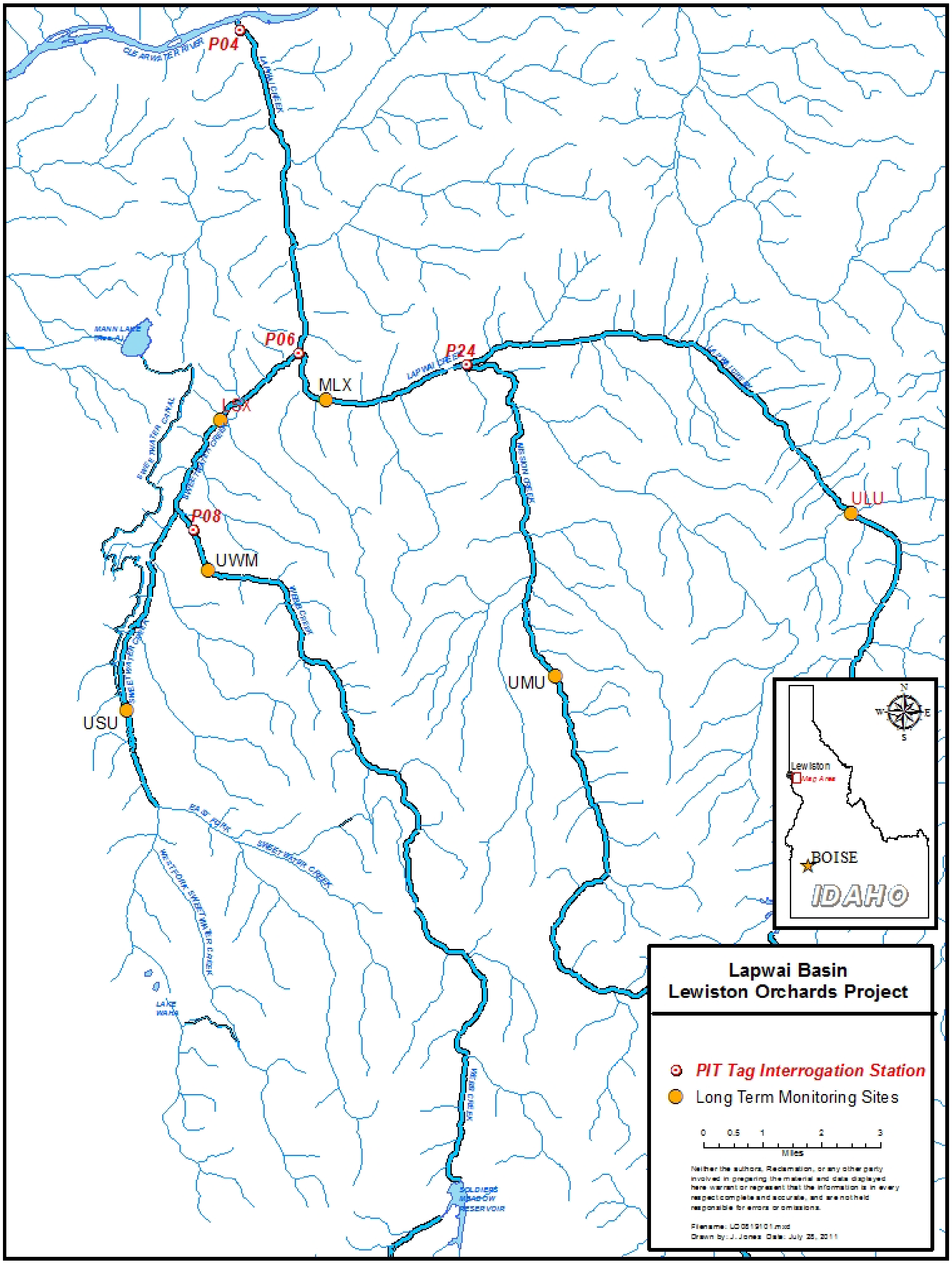

Figure 6. Map of the Lapwai Basin showing the six long-term monitoring sites.

Densities are based on abundance values estimated through three-pass depletion in stream reaches of approximately 100 meters in length. Reach-scale area is calculated from several measurements of reach width made within the study area at each sampling event. Stream area generally decreases from July to September, though this change has little influence on density estimates compared to change in fish abundance. The total densities estimated during September for young of year (0+) combined with older fish (1+) are shown in Figure 7 for 2010 through 2019.

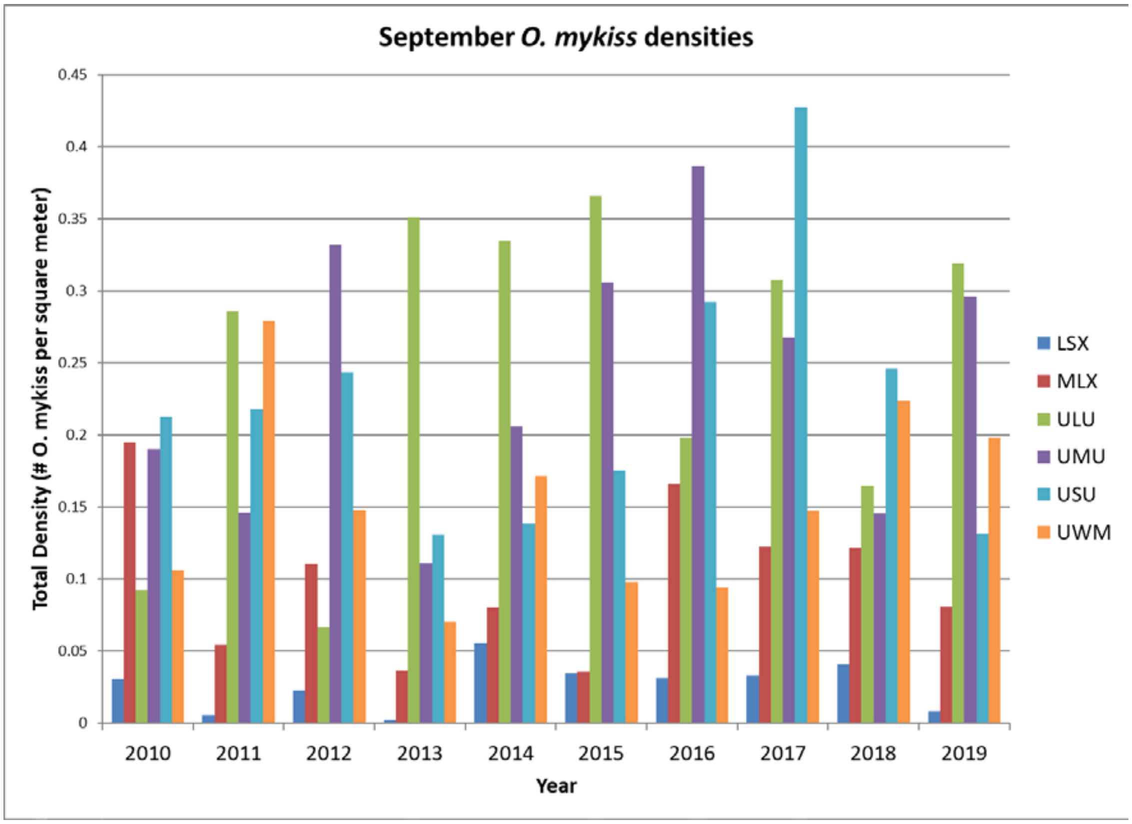

Figure 7. Total *O. mykiss* densities at six monitoring sites during September 2010 through 2019. Site codes are: LSX (lower Sweetwater), MLX (Lapwai below Mission), ULU (upper Lapwai), UMU (upper Mission), UWM (upper Webb), and USU (upper Sweetwater).

5.2 *O. mykiss* Adult Returns

In 2012, Reclamation entered into agreements with LOID and the Tribe to operate, maintain, and manage four PIT tag arrays in the Lapwai Basin to collect fish-movement data within the basin. The operation and maintenance of the four arrays provide tributary-scale data for populations in the Snake River evolutionarily significant units (ESUs); including the Lower Clearwater population. Data collected about escapement into this basin would be very informative in relation to the status of listed *O. mykiss* in the Snake River ESUs as well as the role and potential of Lapwai Creek at the spawning aggregate, local population, and larger ESU-level scales.

The 2019 adult PIT tag detections at the four Lapwai Basin instream arrays are summarized in an annual report to Reclamation from the Nez Perce Tribe Department of Fisheries Resource Management (Appendix C).

5.3 Water Quality and Temperature Monitoring

5.3.1 Introduction

The year 2019 was the 11th year for temperature monitoring in the Sweetwater and Webb creek drainages of the Lapwai watershed. The most pronounced changes noted in previous years were water year changes driven by climactic variables such as day time temperature or annual precipitation.

Temperature is integral to the life cycle of fish and other aquatic species. Different temperature regimes also result in different aquatic community compositions. Water temperature dictates whether a warm, cool, or cold-water aquatic community is present. The temperature of stream water usually varies on seasonal and daily time scales, and differs by location according to climate, elevation, extent of streamside vegetation, and the relative importance of groundwater inputs. Other factors affecting stream temperatures include solar radiation, cloud cover, evaporation, humidity, air temperature, wind, inflow of tributaries, and width-to-depth ratio. Anthropogenic factors affecting water temperature include riparian zone alteration, channel alteration, and flow alteration.

Diurnal temperature fluctuations are common in small streams, especially if stream-side shade is lacking, due to day versus night changes in air temperature and absorption of solar radiation during the day. Aquatic species distributions are restricted to certain temperature ranges, and many respond more to the magnitude of temperature variation and amount of time spent at a particular temperature rather than an average value. Although species have adapted to cooler and warmer extremes of most natural waters, few cold-water taxa are able to tolerate very high temperatures. Reduced oxygen solubility at high water temperatures can compound the stress on fish caused by marginal dissolved oxygen concentrations. Indirect effects of elevated stream temperatures could include reduced growth and feeding, greater susceptibility to disease, and increased metabolic costs. However, most stream environments often have cold-water refugia (such as areas with groundwater or spring inflows) that biota may utilize to reduce some of these effects.

Water quality criteria for temperature primarily focus on time of year and consider maximum temperature thresholds (either instantaneous or averaged) above which the water body is considered impaired. Alterations to the thermal regime of a water body may influence incubation time and growth rates of anadromous fish and other aquatic organisms in either a positive or negative manner. The Lewiston Orchards impoundments and diversions themselves do not act as heat sources, but rather they act to change the temperature regime within the drainages.

5.3.2 Monitoring

In 2008, Reclamation, as required by Term and Condition 4 of the 2010 Opinion, established monitoring stations throughout the Sweetwater, Webb, and lower portions of Lapwai Creek drainages. Water temperature monitoring has been conducted at most of these locations since that time. An additional temperature logger was installed at the Webb Canal Hydromet station in spring of 2014.

The current temperature monitoring in the LOP includes data loggers or Hydromet stations deployed at 13 of the monitoring locations to assess the changes in temperature that occur as water moves from the impoundments and springs in the headwaters to the lower reaches of Sweetwater Creek and into Lapwai Creek. In 2019, Reclamation had data loggers deployed at the following locations:

- Webb Creek (four loggers deployed, one Hydromet location) – Soldiers Meadow's outflow (logger and Hydromet), Webb Creek Diversion pool, near Webb Creek mouth, and the Webb Creek Canal Hydromet station (logger, Hydromet only collects flow).
- Upper Sweetwater Creek (three loggers deployed) – East Fork Sweetwater Creek, West Fork Sweetwater Creek, and below the Sweetwater Creek Diversion Dam
- Lower Sweetwater Creek (three loggers deployed) – upstream from confluence of Webb Creek, downstream from confluence of Webb Creek, near the Sweetwater Creek mouth
- Lapwai Creek (three loggers deployed) – downstream from the confluence of Sweetwater Creek, upstream from the confluence of Sweetwater Creek, and near the mouth of Lapwai Creek. The logger at the Tom Beal Bridge was lost and will not be replaced.

The data loggers collect water temperature (degrees Celsius) data every 15 to 60 minutes. Tribal staff has taken over downloading the loggers as Reclamation's monitoring requirements will likely decrease with the new Opinion. Limited staff time and hazardous weather conditions did not allow for loggers to be downloaded in 2019. Loggers have the ability to hold multiple years of data and a complete record should be available when they are downloaded.

6. RPM 5: Optimal Streamflow Allocation

Reclamation's proposed action and streamflow allocations are based on the best available scientific data and were developed cooperatively with NMFS and the Tribe. Term and Condition 5 of the 2010 Opinion requires Reclamation to submit a completed study and report to NMFS, related to optimizing streamflow allocations between the Sweetwater and Webb creeks. After discussions with the Tribe, Reclamation submitted the *Lewiston Orchards Project Sweetwater and Webb Creek Flow Allocation Analysis Report* to NMFS on July 7, 2015.

7. Literature Cited

Parenthetical Reference	Bibliographic Citation
NMFS 2010	National Marine Fisheries Service. 2010. *Endangered Species Act Section 7 Formal Consultation 2010 Opinion and Magnusen-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Operation and Maintenance of the Lewiston Orchard Project.* NMFS Consultation number 2009/06062. Submitted to the U.S. Bureau of Reclamation, Boise, Idaho.
NMFS 2017	National Marine Fisheries Service. 2017. *Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery and Conservation Management Act Essential Fish Habitat Response for the Lewiston Orchards Project Water Exchange and Title Transfer.* NMFS Consultation number WCR-2017-7167. Submitted to the U.S. Bureau of Reclamation, Boise, Idaho.
Reclamation 2009	U.S. Bureau of Reclamation. 2009. *Biological Assessment for Operation of the Lewiston Orchards Project, Idaho.* Snake River Area Office. Boise, Idaho. October.

Parenthetical Reference	Bibliographic Citation
Reclamation 2011	U.S. Bureau of Reclamation. 2011. *Monitoring Plan for Steelhead Densities and Critical Uncertainties for the Lewiston Orchards Project 2010 Opinion*. Submitted to the National Marine Fisheries Service, Boise, Idaho.
Ries 2017	Ries, B. 2017. Email from Bob Ries, Fishery Biologist (NOAA Fisheries West Coast Region, Moscow, Idaho) to James Taylor, Environmental Compliance Group Manager (Reclamation, Boise, Idaho). Subject: Re: Sediment Management Plan for LOP. September 7, 2017.
Thom 2017	Thom, B. 2017. Letter from Barry Thom, Regional Administrator (NOAA Fisheries West Coast Region, Portland, Oregon) to James Taylor (Reclamation, Boise, Idaho) and Barney Metz (Lewiston Orchards Irrigation District, Lewiston, Idaho). Subject: Proposed Adjustment to Ramping Rate, Sweetwater and Webb Creek Diversion Dams, Lewiston Orchards Project, Idaho.

APPENDICES

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APPENDIX A

2019 Annual Plan, Lewiston Orchards Project ESA and Water Exchange Schedule

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2019 Annual Plan

Lewiston Orchards Project ESA and Water Exchange Schedule

In 2014, the U.S. District Court issued an order staying litigation through January 2020 in the Endangered Species Act (ESA) case, Nez Perce Tribe (Tribe) vs. National Oceanic and Atmospheric Administration (NOAA) Fisheries and the Bureau of Reclamation (Reclamation). The order is based on a 2014 Term Sheet Agreement that provides a framework for collaboration to address issues related to the Lewiston Orchards Project (LOP). The primary focus of the 2014 Term Sheet Agreement is to advance the Project as a potential comprehensive solution to LOP system issues concerning ESA-listed steelhead, Tribal cultural and natural resources, and irrigation water supply reliability.

In accordance with the 2014 Term Sheet Agreement, Water Exchange Appendix, and 2010 Biological Opinion for the Operation and Maintenance of the LOP; the Tribe, Lewiston Orchards Irrigation District (LOID), and Reclamation (collectively the Parties) have collaboratively developed the following 2019 Annual Plan, which establishes water exchange in the critical months for steelhead spawning/rearing and recognizes LOID's domestic component of the pilot well (also referred to as Well No. 5).

Minimum Instream Flows

The 2010 Biological Opinion for the Operation and Maintenance of the LOP states:

> *The BOR is proposing new operating and maintenance procedures that ensure certain minimum flows for conservation of Snake River Basin steelhead. The LOID will provide instream flows through the Idaho State Water Bank, consistent with LOP authorities and Idaho State law. The LOP will forego storage in Reservoir A and diversions at Sweetwater and Webb Creeks diversion dams to provide the minimum flows described in this proposed action. It is the responsibility of the Idaho Department of Water Resources Board [sic] to protect and monitor water rights and releases. The BOR's authority and ability to control this water ends at the Sweetwater and Webb diversion dams where the bypass flows will be provided. The proposed minimum instream flow regime for the LOP is shown in Table 1.*
>
> *The proposed instream flow regime in Table 1 addresses all months of the year; these flows will be used to support spawning conditions during February through April and juvenile rearing conditions from May through January. The LOP will not operate the Sweetwater and Webb diversion dams during November, December, and January; therefore, all instream flow reaching the dams will be bypassed during those months. During February and March, if the inflows to either Sweetwater or Webb diversion dams are below the specified minimum flow, the LOID will bypass all inflow to that diversion dam.*

The 2014 Term Sheet Agreement states:

> *Reclamation will operate the LOP consistent with the provisions of the Biological Assessment and 2010 Biological Opinion through January 31, 2020.*

Minimum instream flow requirements in both Sweetwater and Webb Creeks will remain the same, as required by the 2010 Biological Opinion for the Operation and Maintenance of the LOP. The minimum instream flows in cubic feet per second (cfs) for each month are listed in Table 1.

Life Stage	Spawning			Juvenile Rearing							
Month	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept 1-15**	**Sept 16-30**	**Oct**	**Nov Dec Jan**
Sweetwater Creek (cfs)	*7.8**	*7.8**	*7.8*	*3.0*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*BP*
Webb Creek (cfs)	*4.0**	*4.0**	*4.0*	*1.5*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*BP*

BP=Bypass Flows
*Specified stream flow or all stream flow, whichever is less, will be bypassed. Flows measured below Sweetwater and Webb creek diversions.

Table 1. Minimum instream flows for Sweetwater and Webb Creeks at their diversion dam sites (2010 BiOp)

Incremental Add-in

The 2010 Biological Opinion for the Operation and Maintenance of the LOP states:

> *When conditions permit, the BOR proposes to supply water to the system in addition to the minimum flows shown in Table 1. Due largely to the high variability in local hydrologic and climatic conditions, the BOR will provide additional flows for June through mid-September based on the status of the combined storage in Soldiers Meadow Reservoir and Reservoir A, as assessed on June 1. Table 2 shows the BOR's proposed allocations for Sweetwater and Webb Creeks and the storage conditions under which they would occur.*

The 2014 Term Sheet Agreement states:

> *The Parties here agree that combined storage volumes are limited to natural flow diversions and exclude water pumped by LOID and stored in Reservoir A, also known as Mann Lake. LOID is expected to maintain records which document the volume of pumped water stored in Reservoir A each water year, estimated to the nearest acre-foot in accordance with the timeframe specified for Table 2 of the 2010 Biological Opinion. Carryover to subsequent water years will not be considered. Volumes will be converted to elevations in Mann Lake for use in application of Table 2 to exclude pumped water.*

Incremental add-in will be calculated on June 1, as in years past, to determine additional bypass flows for the water year as shown in Table 2. As stated in the 2014 Term Sheet Agreement, beginning November 1[1], LOID will subtract the pumped water quantity from the total storage in Mann Lake prior to calculating the combined storage of Mann Lake and Soldiers Meadow to determine annual incremental add-in.

Combined Storage – June 1 **Mann Lake & Soldiers Meadow (acre-feet)**	<3,800	3,900	4,000	4,100	4,200	>4,250
Sweetwater Creek (cfs)	*0.0*	*0.5*	*0.9*	*1.0*	*1.0*	*1.0*
Webb Creek (cfs)	*0.0*	*0.0*	*0.0*	*0.3*	*0.8*	*1.0*

Table 2. Incremental flow as a function of combined storage (2010 BiOp)

Water Exchange Flows

[1] Intended that October 31 would mark the end of the previous water year and November 1 to mark the beginning of the new water year.

The 2014 Term Sheet Agreement states:

> *…As groundwater wells come online, diversions of surface water from the LOP would be reduced in an amount equal to an agreed upon in-lieu water exchange quantity, to be left instream through the Idaho State Water Bank for instream flows…*
>
> *…There will be an exchange of water between the Pilot well and LOP surface water diversions to be determined quantitatively only after the Pilot well becomes fully operational. For present understanding of the exchange of water for the Pilot well, a quantity of water will be protected instream for fish improvements in the Sweetwater Creek watershed in accordance with the Memorandum of Agreement (MOA) with LOID. Under the MOA, which applies to the Pilot well only, the exchange will be based on two points: 1) the well's full productive capacity (not how it is discretionarily operated by LOID) which is 2) applied during the time the LOP is diverting surface water from the Sweetwater or Webb diversions…*

The pilot well (Well No. 5) was completed in November 2016 and tested in January 2017. Final testing resulted in a full well production capacity of approximately 4.5 cubic feet per second (cfs) (2,000 gallons per minute or 9 acre-feet per day).

In order to develop a strategy with multiple benefits including establishing water exchange in the critical months for steelhead spawning/rearing and recognizing LOID's domestic component, the Parties collaboratively develop water exchange amounts at each diversion point. The Parties met in February to evaluate current water year conditions, discuss water year forecasts, and draft the 2019 Annual Plan with tentative water exchange amounts. Recognizing the uncertainty in spring snowpack and runoff conditions, the Parties agreed to meet monthly to evaluate the draft plan as hydrologic conditions developed and targeted no later than June 1 to finalize the Annual Plan.

The exchange flows for each month in Table 3 were determined recognizing the value in managing the instream flows to maximize the designated instream habitat, rather than bypassing a consistent monthly amount throughout the irrigation season. The monthly exchange flows allow for more flexible water management capabilities, allowing more than 4.5 cfs to be left instream in the more critical fish habitat months, and recognizing LOID's domestic component for Well No. 5.

Life Stage	Spawning			Juvenile Rearing							
Month	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept 1-15**	**Sept 16-30**	**Oct**	**Nov Dec Jan**
Sweetwater Creek (cfs)	*2.2**	*2.2**	*1.0*	*2.0*	*1.5*	*1.5*	*1.0*	*1.0*	*1.0*	*1.0*	*BP*
Webb Creek (cfs)	*2.3**	*2.3**	*2.3*	*5.5*	*3.8*	*1.5*	*1.5*	*1.5*	*1.5*	*1.5*	*BP*
TOTAL	**4.5***	**4.5***	**3.3**	**7.5**	**5.3**	**3.0**	**2.5**	**2.5**	**2.5**	**2.5**	**BP**

BP=Bypass flows
*Specified stream flow or all stream flow, whichever is less, will be bypassed. Flows measured below Sweetwater and Webb creek diversions.

Table 3. Water exchange flows to be left instream for Sweetwater and Webb Creeks and replaced by flows pumped from the pilot well.

The water exchange flows combined with the instream flows established by the 2010 Biological Opinion will provide increase flows to designated critical habitat. These combined flows are shown in Table 4 which contains the sum of the values in Tables 1 and 3. The flows do not include the incremental add-in based on combined storage to be determined on June 1st.

Life Stage	Spawning			Juvenile Rearing							
Month	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept 1-15**	**Sept 16-30**	**Oct**	**Nov Dec Jan**
Sweetwater Creek (cfs)	*10.0**	*10.0**	*8.8*	*5.0*	*4.0*	*4.0*	*3.5*	*3.5*	*3.5*	*3.5*	*BP*
Webb Creek (cfs)	*6.3**	*6.3**	*6.3*	*7.0*	*4.8*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*BP*

BP=Bypass flows
*Specified stream flow or all stream flow, whichever is less, will be bypassed. Flows measured below Sweetwater and Webb creek diversions.

Table 4. Total minimum instream flows in Sweetwater and Webb Creeks for 2019[2]

Recognizing the Parties' collective intent to efficiently manage water supply in the Lapwai Basin watershed, stored flows are not intended to be released during spring runoff when natural flow is sufficient to meet flows as described in Table 4. Exchange flows are not intended to be additive towards an annual total water exchange quantity. Additionally, the minimum flow requirements outlined in Table 4 only begin to be applicable in the spring once LOID begins to operate either Lake Waha or Soldiers Meadow Reservoir.

[2] Total minimum flow does not include incremental add-in (Table 2) based on reservoir storage as of June 1.

Concurrence

The 2014 Water Exchange Appendix states:

> *After the pilot well is completed, by April 1st of each year, LOID, in consultation with the other Parties, will develop an annual plan using modeling and analysis to characterize the water year and how LOID operations are projected to meet the flows determined in Section 6.2. If there are concerns, the Parties will meet to resolve the issue, and if necessary, will use the dispute resolution process in Section 10.1.*

As described in the Term Sheet Agreement, this Annual Plan was developed by the Parties. It is recognized and agreed that this Annual Plan is for the 2019 Water Year and the team will reevaluate and develop a new plan annually.

APPENDIX B

Sweetwater and Webb Creek Flow Tables

(This is an excel data file for data sharing and is included as a CD at the back of this report)

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APPENDIX C

Nez Perce Tribe 2019 Lapwai Creek PIT Tag Detection Summary

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Lapwai Creek Wild Adult Steelhead Assessment for Spawn Years 2010-2019

Nez Perce Tribe Department of Fisheries Resources Management

March 2020

Lapwai Creek Wild Adult Steelhead Assessment for Spawn Years 2010-2019

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SUMMARY

The Nez Perce Tribe and Bureau of Reclamation entered into a Memorandum of Agreement in 2012 to monitor wild adult Hé-yey (*Oncorhynchus mykiss* (Steelhead)) escapement into Lapwai Creek via In-stream Passive Integrated Transponder (PIT) Tag Detection Systems (IPTDS) (Reclamation Agreement NO: R12MA11706). Adult steelhead monitoring in Lapwai Creek is greatly aided by ongoing regional monitoring efforts that utilize in-stream extended length PIT tag arrays coupled with adult PIT tagging at main-stem dams as a means to provide reliable and consistent adult escapement and life history metric estimates at the tributary scale. The biological data collected during adult sampling and PIT tagging at the Lower Granite Dam (LGR) adult fish trap and the subsequent PIT tag detections across the landscape are used to generate estimates of escapement, age proportion, sex proportions, and genetic diversity for individual wild populations of Chinook Salmon and steelhead. These regional monitoring efforts and associated data sets in conjunction with other developed data sets were used to describe the attributes of the wild spawning aggregate of steelhead in Lapwai Creek, Idaho.

The Lapwai Creek IPTDS have detected and recorded a total of 777 PIT tagged adult steelhead from 2010 through 2019. A total of 621 PIT tagged adult steelhead were detected consisting of 541 wild, 56 hatchery, and 24 of unknown origin. The vast majority of wild steelhead that return to Lapwai Creek ascend LGR in August and September with approximately 10% of all retuning adults ascend in the spring. Returning adults are consistently observed entering Lapwai Creek in association with increasing stream discharge events in January and February with spawners persisting in the stream through the end of May each year. Dip-in behavior was observed and appears more prevalent towards the end of the spawning season. Annual wild steelhead spawning abundance from 2010 through 2019 ranged from a high of 679 (0.09, CV) in spawn year 2015 to a low of 176 (0.17) in spawn year 2019. The number of estimated spawners in Lapwai Creek was a consistent proportion of the total annual number of wild steelhead adults estimated at LGR, averaging 1.5% (range 0.5%-2.2%, n=9) thus mirroring the overall wild adult return. The total age (the sum of juvenile fresh water and ocean residency time plus one) of returning wild steelhead into Lapwai Creek was dominated by age four and age five individuals, with a two year fresh water residency time as the dominant life history strategy. A one year ocean residency time was more prevalent than a two year ocean residency time. The one year ocean residency component of returning adults was composed of nearly equal proportions of males and females with an average length of approximately 580mm. The two year ocean residency component was composed primarily of females with an average length of approximately 700mm. The annual proportion of adult females in Lapwai Creek was 61%, ranging from a low of 42% to a high of 77%. The annual average proportion of repeat spawners from Lapwai Creek and observed within the hydro-system was estimated at 2.4% and a 1.4% repeat spawning rate back to Lapwai Creek. The annual average proportion of female repeat spawners observed in the hydro-system was 3.5% while only 0.4% for males. As a relative index, the minimum average annual proportion of observed kelts from Lapwai Creek was 27% for females and 16.5% for males. The length frequency distribution of observed kelts was similar to that of the spawners observed in Lapwai Creek however, the majority of repeat spawners were disproportionally composed of smaller individuals from the one ocean component of the run.

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ACKNOWLEDGMENTS

The authors would like to acknowledge and thank the many dedicated people that was required to achieve the consistent and reliable data collection that occurred in Lapwai Creek over the last 10 years. Anthony Prisciandaro with the Bureau of Reclamation provided administrative support in the operational and maintenance of instream PIT tag arrays and maintained and secured instream permits. The personal with the Lewiston Orchards Irrigation District provided site maintenance and assistance. Kevin Peterson and Biomark staff aided greatly with remote communications issues, with data downloads, and with data uploads to PTAGIS. Jay Hesse with the Nez Perce Tribe provided valuable administrative support and project guidance.

INTRODUCTION

Across the Pacific Northwest of the United States, populations of anadromous salmonids (genus *Oncorhynchus*) have experienced significant declines (e.g., Heard et al. 2007) with many runs now listed as either threatened or endangered under the Endangered Species Act (ESA). In the Snake River basin, the abundance of Nacó'x (*Oncorhynchus tshawytscha* (Chinook salmon), and Hé-yey (*Oncorhynchus mykiss* (Steelhead)) has decreased significantly over the past five decades (Nehlsen et al. 1991, Williams 2020). Because of historic declines and future threats to survival, two Chinook Salmon Evolutionary Significant Units (ESUs) and one steelhead distinct population segment (DPS) in the basin are listed as threatened under the ESA. The Nez Perce Tribe (NPT) and Bureau of Reclamation (BOR) entered into a Memorandum of Agreement (MOA) in 2012 to monitor adult steelhead escapement into Lapwai Creek via Passive Integrated Transponder (PIT) tag arrays (Reclamation Agreement NO: R12MA11706).

The Integrated Status and Effectiveness Monitoring Project (ISEMP) Salmon study design (QCInc 2005) proposed the use of extended length In-stream PIT Tag Detection Systems (IPTDS) coupled with adult PIT tagging at main-stem dams as a means to provide reliable and consistent adult escapement and life history metric estimates at the tributary scale (BPA project # 2003-017-00). The biological data collected during adult sampling and PIT tagging at the Lower Granite Dam (LGR) adult fish trap and the subsequent PIT tag detections across the landscape were used to generate estimates of escapement, age proportion, sex proportions, and genetic diversity (IPTDSW 2020) for individual wild populations of Chinook salmon and steelhead as defined by the Inter-Columbia Technical Recovery Team (ICTRT 2003).

This current research and monitoring effort, that allows fisheries managers to track the abundance, distribution, and diversity of steelhead and Chinook salmon in the Snake River basin through PIT tags, are performed as part of multiple projects executed by a number of state, federal, and tribal agencies. Trapping at LGR is coordinated by National Marine Fisheries Service (NMFS; BPA Project 2005-002-00; Harmon 2003; Ogden 2016). The Idaho Steelhead Monitoring and Evaluation Studies (ISMES; BPA Project 1990-055-00) and the Idaho Natural Production Monitoring and Evaluation Program (INPMEP; BPA Project 1991-073-00) have coordinated biological sampling of adults at LGR and have provided length, age, and passage timing data. The Snake River Chinook and Steelhead Parental Based Tagging (PBT) (BPA Project 2010-031-00) has provided PBT baselines within the Snake River basin, and the Snake River Genetic Stock Identification (BPA Project 2010-026-00) has provided SNP genotype data for population-level genetic diversity and structure analyses. The Integrated In-Stream PIT Tag Detection System Operations and Monitoring Project (BPA Project 2018-002-00) has developed and maintained much of the in-stream PIT tag detection infrastructure throughout the Snake River basin. In addition, the Bonneville Power Administration (BPA) funded the development of two critical run decomposition models that, 1) estimates the number of wild adults at LGR with uncertainty, and 2) partitions the LGR abundance into tributary level abundances with uncertainty based on PIT tag observations (BPA Project 2018-002-00, See et al. 2016, IPTDSW 2020). The Bureau of Reclamation and the Lewiston Orchards Irrigation District supported the installation, operations, and maintenance of PIT tag arrays in Lapwai, Mission, Sweetwater, and Webb creeks.

The purpose of this document is to summarize and disseminate key pieces of information that are now available to fisheries managers that can be used to evaluate the status and viability of salmonid populations in the Snake River basin. Here we present the available information for Lapwai Creek from 2010 through 2019 generated from PIT tag observations that includes; 1) IPTDS operations, 2) summary of all PIT tagged adults observed, 3) arrival timing and detection probabilities, 4) stream residency time and dip-in behavior, 5) wild adult steelhead annual abundance estimates, 6) estimates by age, sex, and length, and 7) kelts and repeat spawners.

The majority of results presented in this report are direct output of the models and computer packages that have been developed to decompose the run-at-large over LGR into tributary specific estimates of abundance and life history metrics (IPTDSW 2020). Unique analyses contained in this report include a summary of all adult PIT tags observed in Lapwai Creek (species, run, rear type, release location), passage activity, dip-in behavior, and the summary of kelts and repeat spawners, all which could be incorporated into the existing models and computer packages allowing similar but automated assessments and summaries for other spawning aggregates.

METHODS

STUDY AREA

Lapwai Creek drains approximately 174,600 acres with a maximum elevation of 1,463m and minimum elevation of 239m (Richardson et al. 2009). The following description was taken from Richardson, 2009: "Lapwai Creek, a 4th order stream, includes the tributaries of Mission, Sweetwater, Webb and Tom Beall Creeks. From its origin, Lapwai Creek flows 8.9 kilometers before discharging into Winchester Lake, near Winchester, Idaho. From the outflow of Winchester Lake, the creek continues its northward course for approximately 41 km and enters the Clearwater River 18 km east of Lewiston, Idaho. U.S. Highway 95 abuts the west bank of the creek from Winchester Lake to stream km 23. Lapwai Creek shows a high degree of channel confinement within this segment due to the combined effects of the highway location and steep, narrow valley. From stream km 23 to the mouth, the valley widens but confinement remains an issue due to a series of railroad prisms and dikes restricting access to the floodplain. The Lapwai Creek Watershed lies within Nez Perce and Lewis counties, as well as in Nez Perce and Lewis Districts. The watershed lies entirely within the Nez Perce 1863 Reservation boundary with several small communities, including Culdesac, Sweetwater, Lapwai and Spalding, located adjacent to main stem Lapwai Creek. Moderate grazing and irrigation activities were noted below stream km 23 with dryland agriculture prevalent throughout the headwaters (adapted from Chandler and Parot, 2003 and from WSU Assessment, 2001)."

Stream flow patterns in the Lapwai Creek drainage are driven primarily by storm events in streams that drain mid and low elevation plateaus, and by the timing and volume of snow-melt from streams draining Craig Mountain (Richardson et al. 2009). Rain-on-snow events occur in most years, and occasionally cause extreme floods (Richardson et al. 2009). In recent decades, the entire basin appears to be shifting toward a rain-dominated hydrograph characterized by flashy peaks, and extremely low flows during the summer drought period (Richardson et al. 2009). The hydrograph is significantly altered by agricultural runoff, water diversions, and manipulation by several reservoirs (Richardson et al. 2009).

Major fish species inhabiting Lapwai Creek include Hé-yey (*Oncorhynchus mykiss* (Steelhead)), bridgelip and largescale suckers, long-nose dace, sculpin, and the recently re-introduced K'állay (*Oncorhynchus kisutch* (Coho Salmon)).

LAPWAI CREEK IPTDS OPERATIONS

In 2009 and 2010, the Bureau of Reclamation (BOR) installed and operated four in-stream PIT tag detection systems (IPTDS) in the Lapwai Creek drainage, one system located one kilometer from the mouth of Lapwai Creek (site code LAP), one at the mouth of Mission Creek (MIS), one at the mouth of Sweetwater Creek (SWT), and one system located one kilometer from the mouth of Webb Creek (WEB) (Figure 1). The Nez Perce Tribe and Bureau of Reclamation entered into a Memorandum of Agreement (MOA) in 2012 to monitor adult steelhead escapement into Lapwai Creek via Passive Integrated Transponder (PIT) tag arrays (Reclamation Agreement NO: R12MA11706). As part of this agreement, the NPT assumed the operation and maintenance duties for the LAP and MIS IPTDS. In addition, the NPT assisted in the operations and maintenance of the SWT and WEB IPTDS.

REGIONAL MONITORING EFFORTS

The current research and monitoring efforts that allow fisheries managers to track the abundance, distribution, and diversity of steelhead and Chinook salmon in the Snake River basin through PIT tags, are performed as part of multiple projects executed by a large number of state, federal, and tribal agencies (IPTDSW 2020).

In general (see IPTDSW 2020 for detailed methods), site specific estimates are generated by first estimating the number of wild adults crossing Lower Granite Dam (LGR) with uncertainty by employing statistical models that use two independent estimates of abundance and that accounts for varying rates of nighttime passage and reascension over LGR during the adult run. In addition, a systematic random sample of the adult run is captured at the LGR adult fish trap, PIT tagged, and sampled for biological information (scales, genetics, length, marks). Next, in-stream PIT tag observations from the systematic random sample of PIT tagged adults are utilized in conjunction with a hierarchically structured, branch occupancy model to partition the estimated abundance at LGR into estimates for individual populations of steelhead and Chinook salmon. Further, the scale age data along with genetic sex data that are associated with each PIT tagged adult are used to detail the proportion and variance of returning females and age classes. Additionally available, but not reported here, are SNP genotypes that are also associated with each PIT tagged adult that can detail levels of genetic diversity, effective population size, and genetic relatedness among individual steelhead and Chinook salmon populations.

In-stream PIT-tag Detection Systems within the Lapwai Creek Watershed

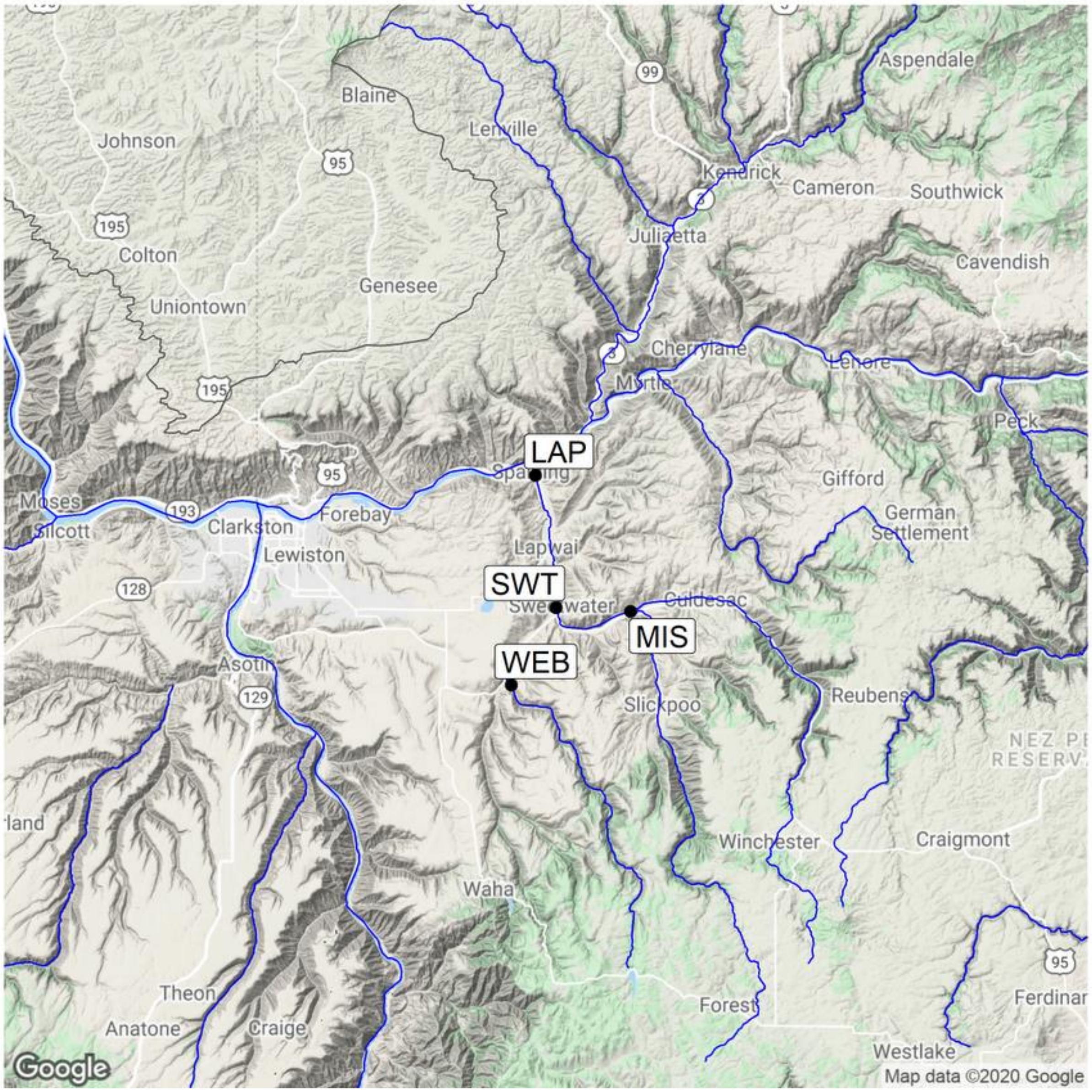

Figure 1. Map of the Lapwai Creek drainage, a tributary to the lower Clearwater River, showing the relative location of the four in-stream PIT tag arrays denoted by site code. The lowest array is located near the mouth of Lapwai Creek (LAP) followed by the SWT array at the mouth of Sweetwater Creek and the MIS array at the mouth of Mission Creek. The WEB array is located in Webb Creek, a tributary to Sweetwater Creek.

The methodology employed to decompose the run-at-large over LGR into ICTRT populations or into smaller tributaries or spawning aggregates including results, are detailed in full in a multi-agency status assessment report (IPTDSW 2020), and to a lesser extent in previous annual reports (Orme et al. 2019). The site specific information and results from the regional monitoring efforts are included in this report but limited to Lapwai Creek specific results. These results consists of the individual site specific abundance estimates, sex ratios estimates, estimated age, and length information. In addition and in conjunction to, this study also incorporated observations of the systematic random sample of adults from the annual LGR wild adult PIT tag groups to track the fate of adults observed in Lapwai Creek, allowing the identification and description of kelts and repeat spawners in association with length and sex information.

ADULT PIT TAG OBSERVATION

The PIT Tag Information System (PTAGIS), which is the regional PIT tag data base, was queried for all PIT tag observation from the four Lapwai Creek IPTDS for years 2010 through 2019. The resulting tag list contained both adult and juvenile observations. Adult observations were identified by PIT tag observations that occurred at the Lapwai Creek IPTDS and also observed at adult fish ways within the hydro-system in the appropriate adult migration period by species. The resulting lists were then examined by release date and release site to exclude any juveniles that may have been observed in the adult fish ways.

ARRIVAL TIMING AND DETECTION PROBABILITES

Detections at IPTDS from the annual LGR adult PIT tag groups provide a means to evaluate arrival timing for wild/natural fish both at LGR and at specific basins or spawning areas. This methodology assumes that the trapping and PIT tagging of individual fish does not change the original destination of the tagged fish. This methodology can provide a much larger sample size from which arrival timing is calculated compared to returning adults tagged as juveniles within each basin or population.

Adult arrival timing at LGR and at the lower Lapwai IPTDS (LAP) was calculated for the annual LGR adult steelhead PIT tag groups and for observed PIT tagged adult coho. For the annual LGR adult PIT tag groups, arrival timing at LGR was defined as the date the fish was captured and PIT tagged at the LGR adult fish trap and Lapwai Creek arrival timing defined as the minimum observation date on the lowest PIT tag array (LAP). For PIT tagged adult coho, arrival timing at LGR was defined as the minimum date observed at the LGR adult fish ladder (site code GRA) and Lapwai Creek arrival timing defined as the minimum detection date on any PIT tag array within Lapwai Creek due to limited samples sizes in some years.

WILD STEELHEAD STREAM RESIDENCY TIME AND DIP-IN BEHAVIOR

Passages of wild adult steelhead from the annual LGR adult PIT tag groups were evaluated at the LAP IPTDS. Passages were assessed to help define steelhead arrival timing, activity, and to identify potential dip-ins. Dip-ins were defined as fish that resided briefly in Lapwai Creek and left prior to spawning.

Detections at the LAP IPTDS were sorted by PIT tag code and then by observation date. Passages of individual tags were then denoted as either upstream or downstream based on the array or antenna that the detection occurred and on time of the detection. These processes are an automated function of the PITcleanr package used to prepare observations for model runs (IPTDSW 2020, Orme et al.

2019). Upstream and downstream passages were summed by day and compared to daily stream discharge to provide a summary of passage activity.

The identification of upstream and downstream passage and ultimately the identification of dip-ins with PIT tag arrays are dependent upon the detection probability of the arrays. For a PIT tag to be observed, the tag must pass over an antenna within the detection range of the antenna and the tag must be oriented perpendicular to the antennas. The upstream detection probability for adult steelhead at the LAP IPTDS averaged 0.89 (range 0.5 to 0.99, n=9). The downstream detection probability is much lower than the upstream detection probability. However, because the upstream detection probability for PIT tagged adults at LAP is very high, if a tag is observed moving downstream and is not observed again it is assumed that the fish migrated out of Lapwai Creek.

Unique PIT tags with an observed minimum upstream passage (lower then upper array observation) **and** an observed final downstream passage (upper then lower array observation) at the LAP IPTDS were plotted to provide a summary of dip-in behavior, stream residency time, and spawning duration. As the downstream detection probability is much lower than the upstream detection probability, the number of usable observations consist of a sub-set of the total annual number of unique PIT tags observed within Lapwai Creek. Therefore, the passages and dip-ins reported here are simply what was observed given the detection probabilities. However, assuming that the observations are a representative sample of all passages, the observations provide an accurate characterization of passage activity, stream residency time, and spawning duration. The dip-in behavior observed can be viewed as a minimum index and does not represent a quantitative measure.

ADULT STEELHEAD AGE, SEX, AND LENGTH

The age of fish was determined via the ageing of scales collected as part of biological sampling at LGR (Wright et al. 2015, Ogden 2016). Protocols for determining freshwater, saltwater, and total age are detailed in Wright et al. (2015). Here, total age is reported as the sum of fresh water and ocean residency time plus one to account for the one year of adult fresh water residency time during the spawning migration. Sex was determined post hoc using a sex-specific allelic discrimination assay (Campbell et al. 2012). Similar to age, fish lengths were also collected as part of the biological sampling at LGR (Ogden 2016). Therefore, the annual proportion of spawners by sex and age was calculated based on the biological information associated with each PIT tag from the annual LGR adult PIT tag groups. The sample size of the calculated annual proportions were therefore the total number of unique PIT tags observed anywhere in Lapwai Creek from the annual LGR adult PIT tag groups. The length frequency of wild adult steelhead spawners were calculated by pooling all years and assessed by fresh water residency time, by ocean residency time, and by sex and length.

KELTS AND REPEAT SPAWNERS

The minimum annual proportion of kelts from wild steelhead spawners was estimated utilizing the total annual number of unique PIT tag observations in Lapwai Creek from the annual LGR adult PIT tag groups. The minimum proportion was calculated as the annual number of PIT tags observed migrating down the hydro-system that was also observed in Lapwai Creek, divided by the total annual number of unique tags observed in Lapwai Creek. This assessment is a minimum estimate of the proportion of kelts as it is based on unique detections at and below LGR and does not account for the detection probability of kelts within the hydro-system. The actual annual proportion of repeat spawners from the Lapwai Creek observations of the LGR adult PIT tag groups were also calculated in two ways. Repeat spawners were calculated as the number of unique PIT tags observed migrating upstream through the hydro–system from a particular spawn year and calculated as the number of those tags that successfully migrated into Lapwai Creek, divided by the total number of unique tags originally observed within Lapwai Creek from that particular spawn year. In addition, the identified kelts and repeat spawners were also assessed by length and sex.

RESULTS

LAPWAI CREEK IPTDS OPERATIONS

All IPTDS within Lapwai Creek have operated with minimal downtime that would affect detections and estimation of adult steelhead with the following exceptions. The Lapwai Creek IPTDS (LAP) was flooded and damaged in late 2011 that precluded PIT tag observations in 2012. The Mission Creek IPTDS (MIS) was affected by extreme high flows on March 14, 2017 and again on April 9, 2019, thus ending data collection for the remainder of both spawn years. The Sweetwater Creek IPTDS (SWT) was affected by high flows on April 23, 2010 and again on May 10, 2012, ending data collection for the remainder of the steelhead spawning period in both years. The Webb Creek IPTDS (WEB) was damaged by high flows and stopped data collection April 2, 2011 through October 6, 2011 and the loss of power prevented data collection for adult steelhead in spawn year 2019.

ADULT PIT TAG OBSERVATION

Over the ten years of operations, the Lapwai Creek IPTDS have detected and recorded a total of 777 PIT tagged adults (Tables 1 and 2). A total of 621 PIT tagged adult steelhead were detected consisting of 541 wild, 56 hatchery, and 24 unknown origin steelhead adults (Table 1). The vast majority of wild steelhead adults were PIT tagged and released at the LGR adult fish trap whereas the majority of detected hatchery adults were released in the Tucannon River (Table 1). However, 20 of the 29 Tucannon PIT tag observations occurred in spawn year 2010. In addition, a total of 141 PIT tagged adult coho salmon were observed and consisted of 132 hatchery fish (all but one were released into Lapwai Creek), 6 fish designated as wild when tagged and released in the lower Columbia, and 3 unknown origin adults (Table2). However, hatchery coho are rarely marked prior to release in Lapwai Creek. Therefore, the 6 “wild” coho are more likely hatchery origin coho released into Lapwai Creek rather than a product of natural production or down river strays. There were also total of 14 fall Chinook salmon and one Northern Pike Minnow observed, all tagged and released outside of Lapwai Creek (Table 2).

Table 1. The number of PIT tagged adult **steelhead** observed in Lapwai Creek between 2010 and 2019 by origin (wild, hatchery, or unknown) and by release site (adapted from PIT Tag Information System (PTAGIS) release site code and description).

Release Site	Wild	Hatchery	Unknown
Bonneville Adult		1	14
Clearwater Juvenile Trap	3		
Coumbia River 2 Adult		1	
Coumbia River 3 Adult	2		5
Coumbia River 4 Adult			1
Coumbia River 5 Adult			1
Dayton Ponds	2	2	
Dworshack Hatchery		1	
John Day River Middle Fork Juvenile Trap	1		
John Day River South Fork Juvenile Trap	1		
Lapwai Creek	4		
LGR Adult Trap	440	14	
LGR Juvenile Barge	30	1	
LGR Juvenile In-River	20	1	
LGR Juvenile Release in Tailrace			1
LMN Juvenile Release into Bypass Flume	2		
Lyons Ferry Hatchery		1	
Meadow Creek		1	
Mill Creek	1		
Mission Creek	3		
Priest Rapids Adult	12	2	2
Snake River 2 Adult	3		
Sweetwater Creek	4		
Touchet River		2	
Tucannon River	5	29	
Umatilla River	1		
Walla Walla River	1		
Webb Creek	6		
Total	541	56	24

Table 2. The number of PIT tagged adult Fall Chinook Salmon, Coho Salmon, and Northern Pike Minnow observed in Lapwai Creek between 2010 and 2019 by origin (wild, hatchery, or unknown) and by release site (adapted from PIT Tag Information System (PTAGIS) release site code and description). Hatchery origin coho are rarely marked prior to release in Lapwai Creek and therefore the wild coho are likely hatchery origin coho released into Lapwai Creek rather than a product of natural production or down river strays.

Release Site	Fall Chinook			Coho Salmon			Northern Pike
	Wild	Hatchery	Unknown	Wild	Hatchery	Unknown	Minnow
Big Canyon Creek		3					
Bonneville Adult			1				
Coumbia River 1 Adult				1			
Coumbia River 3 Adult	1			5	1	3	
Grande Ronde River		1					
Lapwai Creek					130		
Lyons Ferry Hatchery		3					
North Lapwai Valley Acclimation					1		
Pittsburgh Landing Acclimation		2					
Snake River 3 Adult		3					1
Total	1	12	1	6	132	3	1

ARRIVAL TIMING AND DETECTION PROBABILITES

Under normal and continuous adult trapping operations at LGR, PIT tags from the annual LGR adult PIT tag groups are a representative sample of all wild/natural steelhead adults passing LGR. Therefore, observations of the annual LGR adult PIT tag group can be used to assess and make inference to the wild/natural run of steelhead into Lapwai Creek which includes estimates of arrival timing at Lower Granite Dam, arrival timing into Lapwai Creek, travel time, residency time, and dip-in behavior.

The estimated PIT tag detection probabilities at all Lapwai Creek IPTDS were generally greater than 90% for all years (Table 3). Detection probabilities in Webb Creek (WEB) was slightly lower although samples sizes were small (Table 3). High PIT tag detection probabilities provides a measure of confidence when assessing arrival timing and fish movement and activity.

There were 442 wild PIT tagged adults from the annual LGR adult PIT tag groups available to define LGR and Lapwai Creek arrival timing. The vast majority of wild steelhead that return to Lapwai Creek ascend LGR in August and September (Figure 2). Roughly 10% of all returning fish ascend LGR in the spring (Figure 2), similar to that observed for the general run-at-large (Orme and Albee 2013). Returning adults are consistently observed entering Lapwai Creek in association with increases in stream flows in January and February (Figures 3 and 4). Stream entry in association with increased stream flow was also observed at other IPTDS throughout the region (Orme and Albee 2012).

A total of 130 PIT tagged hatchery coho salmon were available to define migration LGR and Lapwai Creek arrival timing (Table 2). Coho salmon that were observed in Lapwai Creek (2010 through 2019) ascended LGR beginning in mid-September and continued through the end of October (Figure 3). Arrival in Lapwai Creek began in mid-October and continued through the first week of December (Figure 3). Arrival timing at LGR was less variable than arrival into Lapwai Creek (Figure 3). In six of the eight spawn years with adult PIT tags, the 50% arrival date at LGR occurred during the first week of October (Figure 3). Whereas the 50% arrival date into Lapwai Creek spanned a four-week time frame (Figure 3).

STREAM RESIDENCY TIME AND DIP-IN BEHAVIOR

PIT tag observations indicate that wild steelhead spawners arrive in Lapwai Creek beginning early January and persist through the end of May each year (Figure 5). Observations also show dip-in behavior, fish entering Lapwai Creek and then leaving within a day or two (Figure 5). Dip-in behavior appears to be more prevalent towards the end of the spawning season (Figure 5). However, the higher number of dip-ins later in the spawning season may be an artifact of the downstream detection probabilities increasing as stream discharge decreases.

Passage observations by sex suggest that males reside for a longer time period within the stream than females (Figure 6). The majority of PIT tagged fish observed leaving Lapwai Creek within four weeks of stream entry were females (Figure 6). Whereas males dominated the observed final downstream passages that were greater than 8 weeks post stream entry (Figure 6). Nearly equal proportions of male and female spawners were observed displaying dip-in behavior (Figure 6). Dip-in behavior has also been observed at other IPTDS throughout the region (Orme and Albee 2012).

Table 3. Detection probability and coefficient of variation (CV) of PIT tagged adult steelhead as estimated by the DABOM model and the number of unique tags observed at the Lapwai Creek PIT tag arrays from the 2010 through 2019 from the annual Lower Granite Dam adult PIT tag groups.

Spawn Year	Lapwai (LAP) Det. Prob. n Tags	Mission (MIS) Det. Prob. n Tags	Sweetwater (SWT) Det. Prob. n Tags	Web (WEB) Det. Prob. n Tags
2010	0.99 (0.02) 57	-	0.96 (0.05) 20	-
2011	0.5 (0.19) 12	0.9 (0.12) 10	0.85 (0.18) 4	0.64 (0.39) 1
2012	0 (0) 0	0.88 (0.09) 12	0.9 (0.13) 6	0.82 (0.22) 3
2013	0.97 (0.03) 47	0.96 (0.05) 18	0.91 (0.12) 7	0.41 (0.56) 1
2014	0.92 (0.05) 39	0.7 (0.18) 12	0.95 (0.07) 13	0.85 (0.18) 4
2015	0.99 (0.02) 52	0.87 (0.11) 11	0.96 (0.05) 16	0.85 (0.18) 4
2016	0.95 (0.03) 65	0.95 (0.06) 19	0.96 (0.05) 18	0.89 (0.13) 6
2017	0.88 (0.06) 40	0.51 (0.29) 5	0.95 (0.07) 12	0.88 (0.15) 5
2018	0.93 (0.04) 48	0.56 (0.26) 6	0.96 (0.05) 18	0.88 (0.15) 5
2019	0.93 (0.05) 34	0.51 (0.35) 3	0.94 (0.08) 11	-

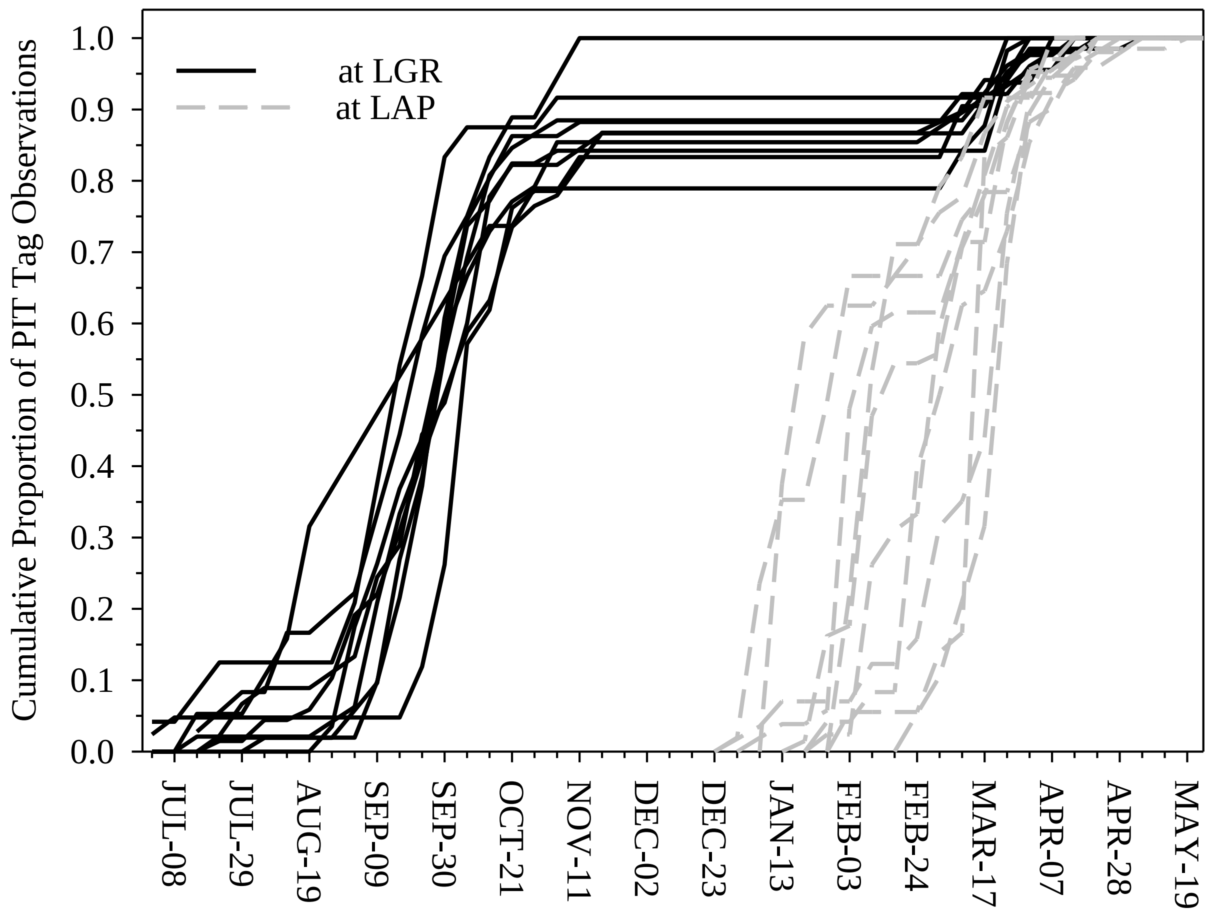

Figure 2. Arrival timing of paired PIT tagged observations of wild adult **steelhead** both at Lower Granite Dam (LGR)(solid line) and at the lower Lapwai Creek PIT tag array (LAP)(dashed line) from the annual LGR adult PIT tag groups for spawn years 2010 through 2019.

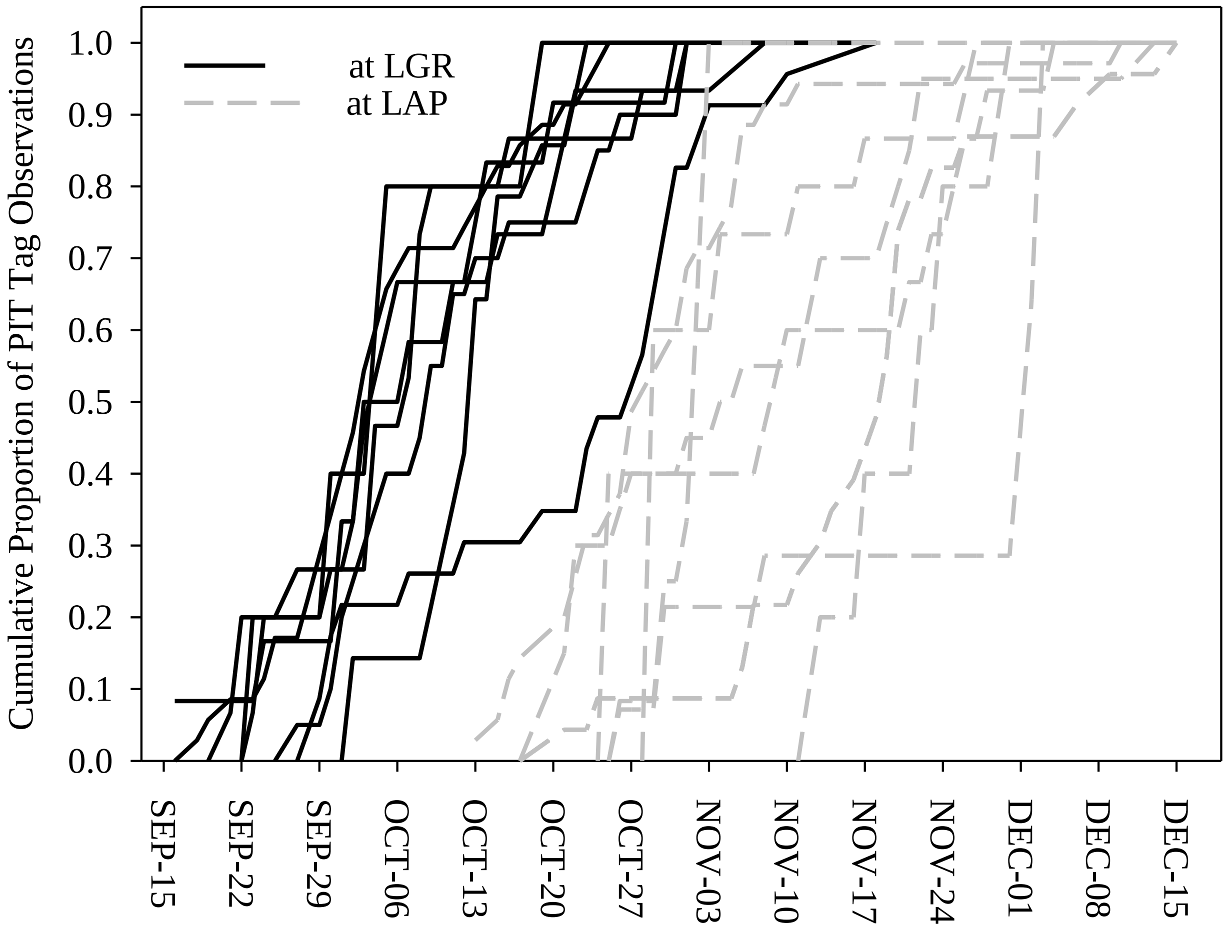

Figure 3. Arrival timing of paired PIT tagged observations of hatchery adult **coho salmon** both at Lower Granite Dam (LGR)(solid line) and at the lower Lapwai Creek PIT tag array (LAP)(dashed line). There were no PIT tag observations for spawn years 2010 and 2015.

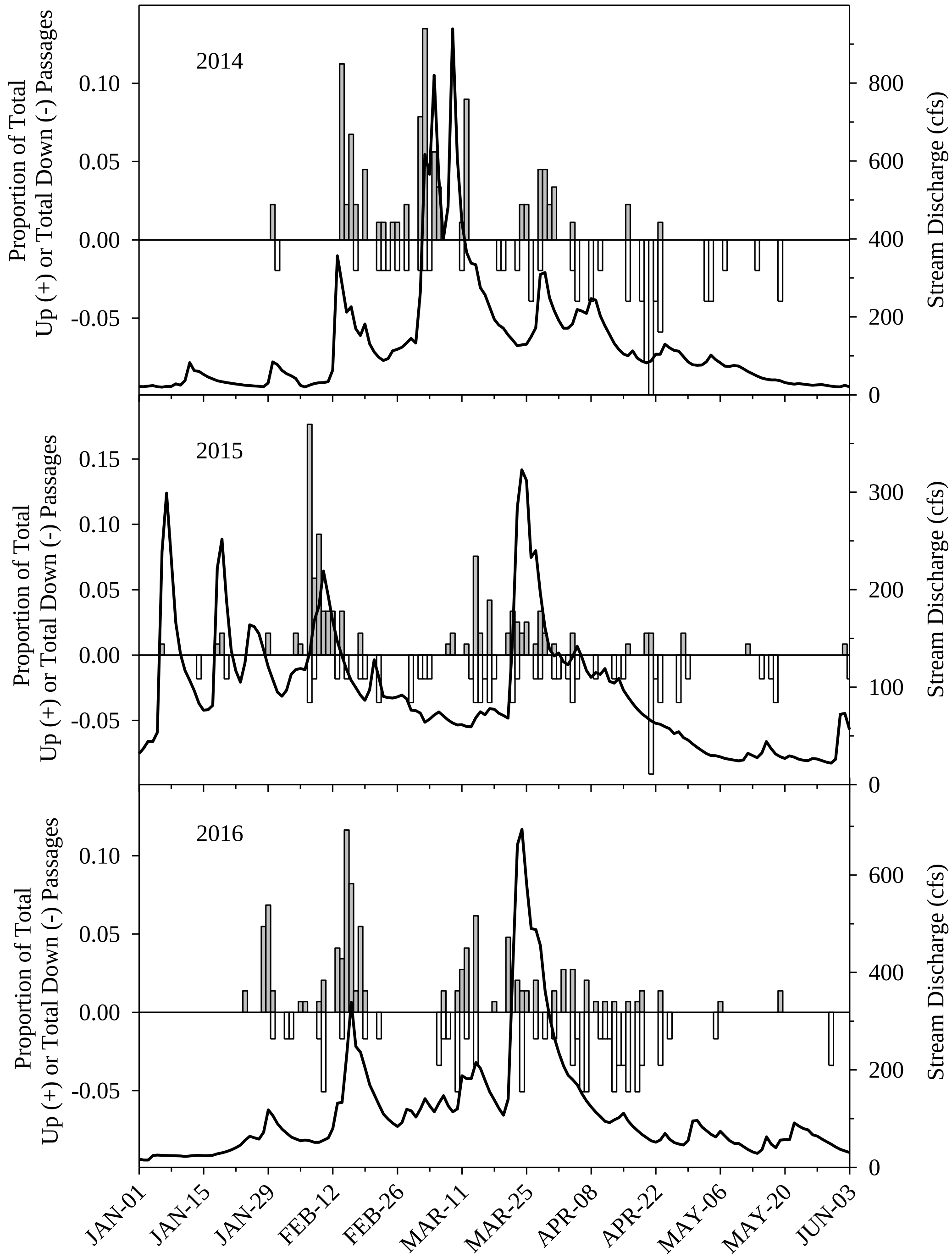

Figure 4. The proportion of total observed upstream (positive values) and downstream (negative values) daily passages of PIT tagged wild adult steelhead at the Lapwai Creek in-stream PIT tag array for spawn year 2014 to 2016 from the annual Lower Granite Dam adult PIT tagged groups. Also shown is the Lapwai Creek stream discharge (USGS Gage 13342450**)**.

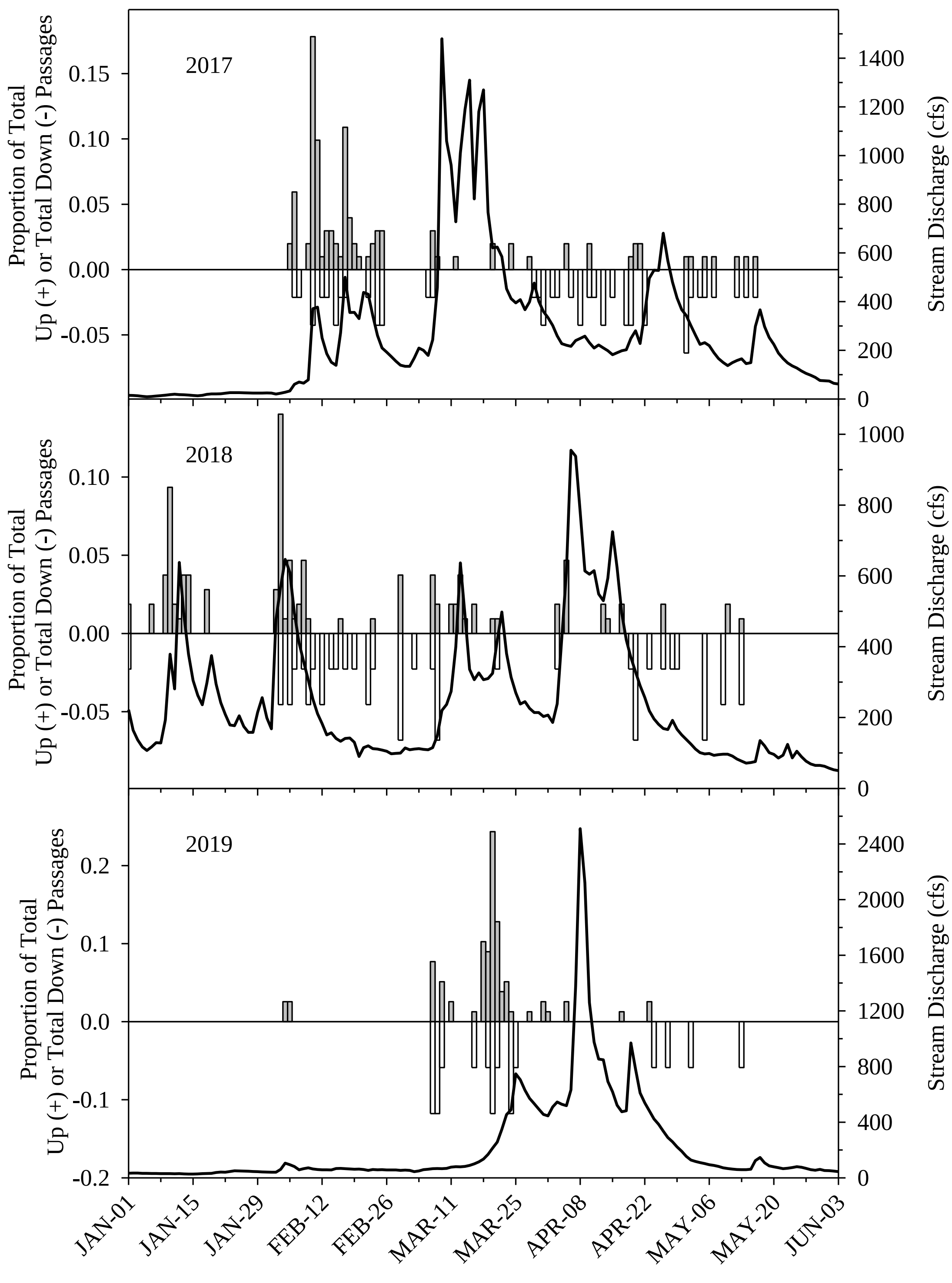

Figure 5. The proportion of total observed upstream (positive values) and total downstream (negative values) daily passages of PIT tagged wild adult steelhead at the Lapwai Creek in-stream PIT tag array for spawn year 2017 to 2019 from the annual Lower Granite Dam adult PIT tagged groups. Also shown is the Lapwai Creek stream discharge (USGS Gage 13342450).

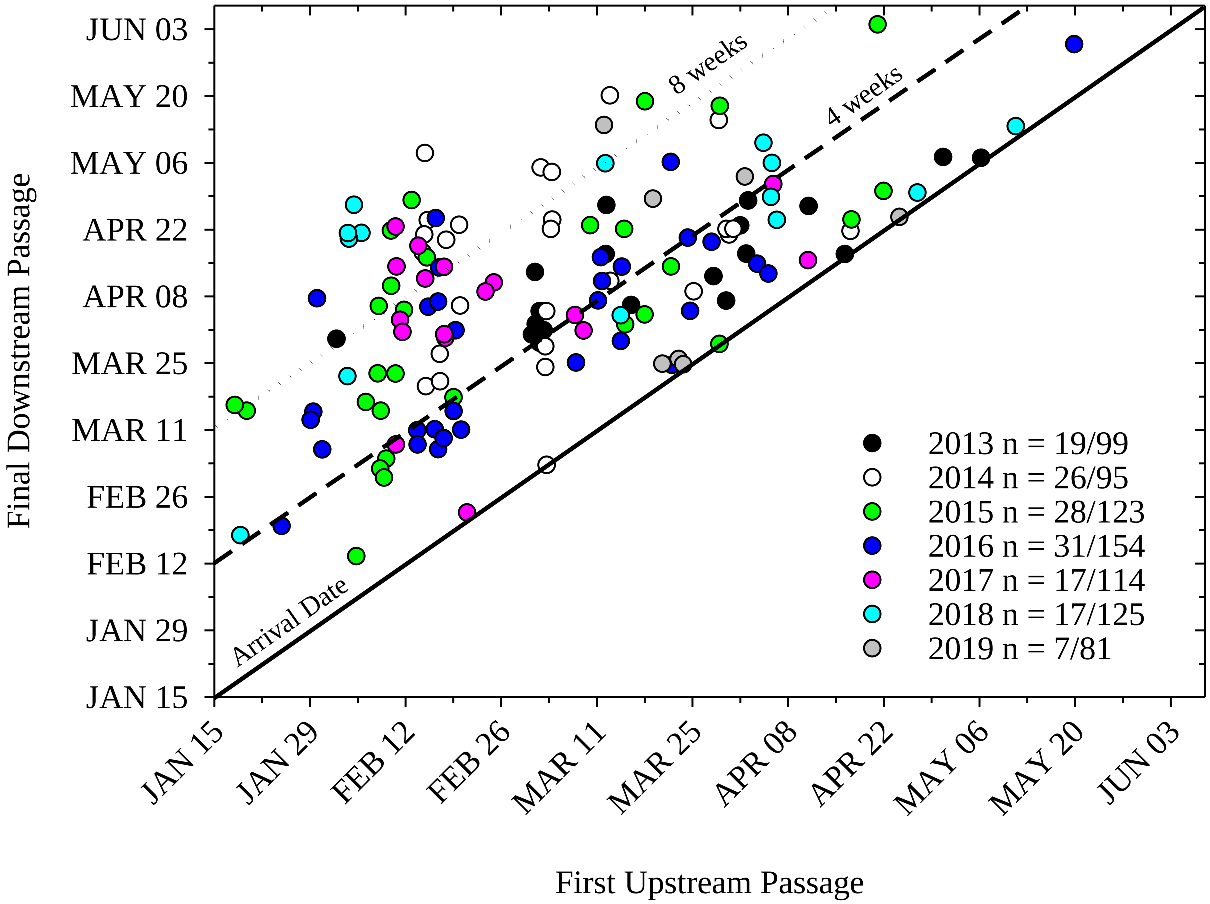

Figure 6. The first observed upstream passage date (x axis) and the final observed downstream passage date (y axis) of wild adult steelhead from the annual Lower Granite Dam adult PIT tag group for spawn years 2010 through 2019. Also displayed is the 1:1 line denoting stream entry (solid line), a dashed line denoting 4 weeks post entry, and dotted line denoting 8 weeks post stream entry. Symbol color indicates spawn year in addition to the number (n) of PIT tags observed and plotted (numerator) and the total number of unique PIT tags observed (denominator) during that spawn year.

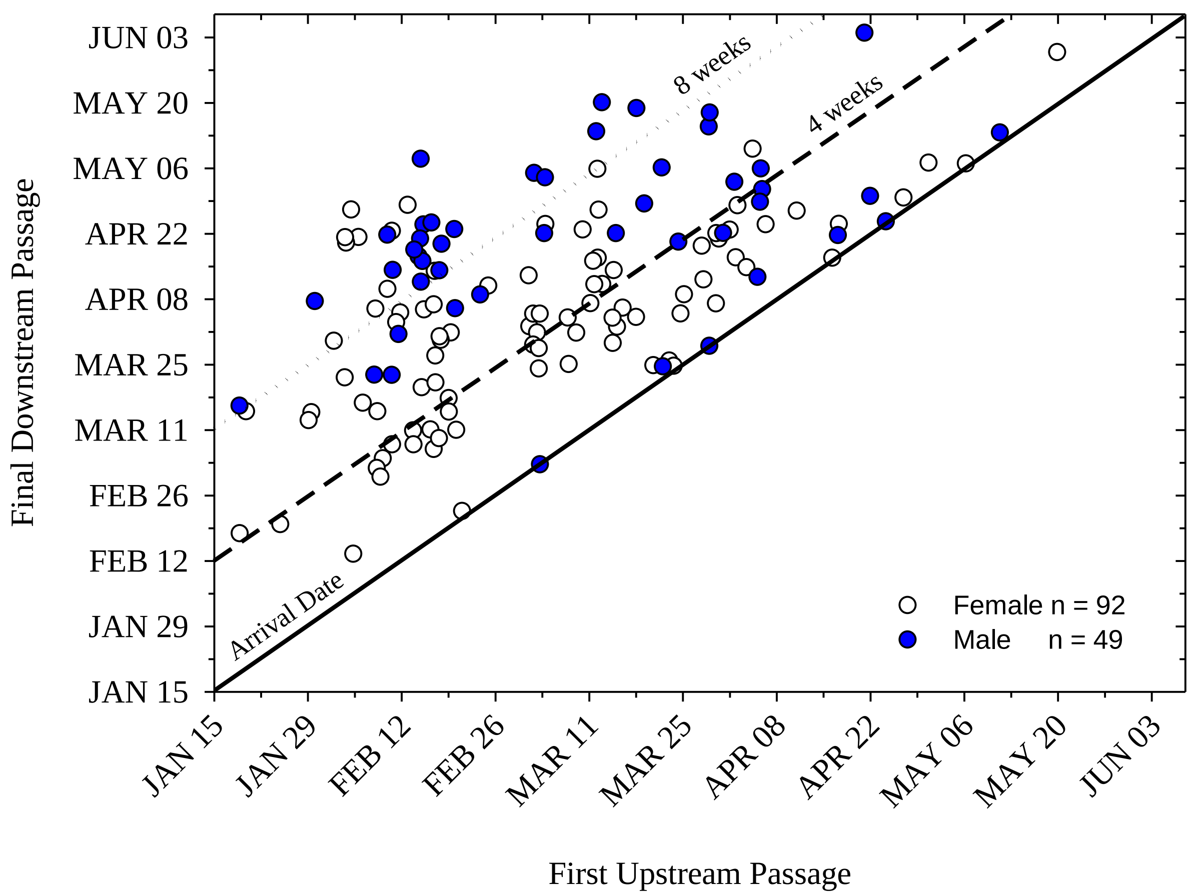

Figure 7. The first observed upstream passage date (x axis) and the final observed downstream passage date (y axis) of wild adult steelhead from the annual Lower Granite Dam adult PIT tag groups for spawn years 2010 through 2019. Also displayed is the 1:1 line denoting stream entry (solid line), a dashed line denoting 4 weeks post entry, and dotted line denoting 8 weeks post stream entry. Symbol color indicates sex with the number of paired PIT tag observations (n).

WILD STEELHEAD ADULT ABUNDANCE

Results of previous regional efforts to produce ICTRT population abundance estimates (IPTDSW 2020) also produced the site specific estimates that are summarized and reported here. Results indicate that wild steelhead spawning abundance in Lapwai Creek ranged from a high of 679 (0.09, CV) individuals in spawn year 2015 to a low of 176 (0.17) in spawn year 2019 (Table 4). Estimated abundance was nearly 600 individuals or more in three of the ten study years and less than 300 individuals in four of the ten years (Table 4).

Estimates suggest that the majority of spawning occurs in the main-stem of Lapwai Creek although estimates in Sweetwater Creek was greater in two of the ten years (Table 4). Estimates of spawners in Mission Creek was generally similar to Sweetwater Creek, with estimates greater than 200 individuals in two of the ten years (Table 4).

Table 4. Abundance and coefficient of variation (CV) of wild adult steelhead by spawn year as estimated from the DABOM model by location (IPTDSW 2020). The estimates for the main-stem, Mission Creek, and Sweetwater Creek are components of the stream total, and Web Creek is a sub-component of Sweetwater Creek. * For 2010 the main-stem also includes Sweetwater Creek.

Spawn Year	Lapwai Total	Lapwai main-stem	Mission Creek	Sweetwater Creek	Web Creek
2010	636 (0.08)	408 (0.13)*	224 (0.2)	- (-)	- (-)
2011	248 (0.1)	92 (0.3)	46 (0.42)	107 (0.26)	36 (0.62)
2012	- (-)	- (-)	60 (0.33)	123 (0.19)	64 (0.39)
2013	370 (0.08)	171 (0.17)	58 (0.34)	138 (0.2)	54 (0.54)
2014	374 (0.1)	108 (0.29)	115 (0.25)	145 (0.23)	49 (0.42)
2015	679 (0.09)	305 (0.17)	208 (0.21)	160 (0.26)	44 (0.47)
2016	595 (0.07)	267 (0.15)	158 (0.22)	167 (0.2)	58 (0.37)
2017	233 (0.08)	115 (0.18)	63 (0.24)	53 (0.32)	23 (0.44)
2018	226 (0.09)	98 (0.18)	79 (0.2)	47 (0.3)	14 (0.45)
2019	176 (0.17)	92 (0.24)	54 (0.29)	30 (0.44)	- (-)

Table 5. Estimated wild steelhead abundance (1 SE) at Lower Granite Dam (LGR), the number of PIT tags released at LGR, the estimated number (CV) of wild adults in Lapwai Creek, the estimated number of PIT tags in Lapwai Creek from the LGR tag groups, and the proportion of the Lapwai estimate to the LGR abundance estimate (IPTDSW 2020).

Spawn Year	Wild Steelhead Abundance at LGR	Number of Tags Released LGR	Wild Steelhead Abundance at LAP	Estimated Number of Tags at LAP	Proportion of LAP Abundance to LGR
2010	45,093 (1,702)	4,011	636 (0.08)	58	0.014
2011	45,866 (1,706)	4,648	248 (0.1)	24	0.005
2012	40,373 (1,072)	4,111	- (-)		
2013	25,048 (1,059)	3,391	370 (0.08)	49	0.015
2014	28,106 (1,878)	3,436	374 (0.1)	43	0.013
2015	47,816 (1,710)	3,929	679 (0.09)	53	0.014
2016	36,082 (1,329)	4,302	595 (0.07)	69	0.016
2017	15,432 (606)	3,017	233 (0.08)	46	0.015
2018	10,096 (380)	2,306	226 (0.09)	52	0.022
2019	10,388 (2,746)	1,764	176 (0.17)	37	0.017

The number of estimated spawners in Lapwai Creek has been a consistent proportion of the total annual number of wild steelhead adults estimated at LGR (IPTDSW 2020). The annual Lapwai Creek wild steelhead abundance was on average 1.5% (range 0.5%-2.2%, n=9) of the total wild steelhead abundance at LGR (Table 5). Therefore, annual abundance fluctuations within Lapwai Creek mirrors the overall general return of wild adult steelhead at LGR. In addition, the Lapwai Creek wild steelhead spawning aggregate is similar in size to population abundances estimated in Big Creek (Middle Fork Salmon), the Lemhi River (upper Salmon River), Lolo Creek (Clearwater River), and the North Fork Salmon River (upper Salmon River) (Table 6) (IPTDSW 2020).

Table 6. The average, minimum and maximum proportion of Interior Columbia Technical Recovery Team (ICTRT) defined steelhead population abundances presented as a proportion of the total wild adult run at large over Lower Granite Dam and the number of spawn years with abundance estimates (IPTDSW 2020).

MPG	Popultion	Discription	Mean Proportion of LGR	Minimum Proportion	Maximum Proportion	Number of Spawn Years
Lower Snake	SNASO-s	Asotin Creek	0.032	0.020	0.041	10
	SNTUC-s*	Tucannon River	0.022*	0.016*	0.047*	10
Clearwater	CRLMA-s	lower mainstem	0.023	0.012	0.031	10
	CRLOC-s	Lochsa	0.039	0.035	0.043	2
	CRLOL-s	Lolo Creek	0.012	0.008	0.016	7
	CRSEL-s	Selway River	0.028	0.026	0.030	2
	CRSFC-s	South Fork Clearwater	0.023	0.012	0.032	8
Grande Ronde River	GRJOS-s	Joseph Creek	0.057	0.038	0.074	9
	GRLMT-s	lower mainstem	0.040	0.040	0.040	1
	GRUMA-s	upper mainstem	0.044	0.037	0.051	7
	GRWAL-s	Wallowa River	0.031	0.019	0.061	6
Imnaha	IRMAI-s	Imnaha Rvier	0.067	0.055	0.090	9
Salmon River	MFBIG-s	Big, Camas, Loon creeks	0.011	0.004	0.018	9
	SFMAI-s	South Fork Salmon River	0.028	0.015	0.048	10
	SFSEC-s	Secesh River	0.004	0.002	0.008	10
	SREFS-s	East Fork Salmon River	0.001	0.001	0.003	4
	SRLEM-s	Lemhi River	0.010	0.006	0.015	10
	SRLSR-s	Little Salmon, Rapid River	0.001	0.000	0.003	10
	SRNFS-s	Noth Fork Salmon River	0.011	0.004	0.021	3
	SRPAH-s	Pahsimeroi	0.003	0.001	0.005	8
	SRPAN-s	Panther Creek	0.009	0.008	0.010	2
	SRUMA-s	upper mainstem	0.008	0.004	0.013	10

ADULT STEELHEAD AGE, SEX, AND LENGTH

The age of returning wild steelhead into Lapwai Creek was dominated by age four and age five individuals, encompassing 75% to nearly 100% of the annual observations (Table 7, Figure 7). Age three and age six or older individuals were observed but generally as a minor annual fraction.

A two year fresh water residency time was the dominant life history strategy followed by a one year fresh water residency with a minor proportion of three year fresh water residency time observed (Figure 8). In addition, a one year ocean residency time was more prevalent than a two year ocean residency time (Figure 8). Total length at return appears to be driven by ocean residency time with one year ocean residence averaging roughly 580mm and two year ocean residency averaging roughly 700mm in total length regardless of fresh water residency time (Figure 8).

The one year ocean residency component of returning adults was composed of nearly equal proportions of males and females (Figure 9). In stark contrast, the larger individuals within the two year ocean residency component were composed primarily of females (Figure 9). Overall, the annual proportion of adult females in Lapwai Creek was 61%, ranging from a low of 42% in spawn year 2014 to a high of 77% in spawn year 2011 over the 10 years of the study (Figure 10, Table 8).

Table 7. Estimated age proportions (1 SE) of returning wild adult steelhead in Lapwai Creek and number of PIT tagged individuals with associated age estimates (n-Aged) used to calculate the proportion (IPTDSW 2020).

Spawn Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	n-Aged
2010	0.16 (0.02)	0.63 (0.03)	0.16 (0.02)	0.06 (0.01)	0 (0)	0 (0)	51
2011	0 (0)	0.48 (0.05)	0.52 (0.05)	0 (0)	0 (0)	0 (0)	23
2012	0 (0)	0.63 (0.06)	0.38 (0.06)	0 (0)	0 (0)	0 (0)	16
2013	0.05 (0.01)	0.4 (0.04)	0.48 (0.04)	0.05 (0.01)	0.02 (0)	0 (0)	42
2014	0.22 (0.03)	0.5 (0.04)	0.28 (0.03)	0 (0)	0 (0)	0 (0)	36
2015	0.18 (0.02)	0.57 (0.04)	0.25 (0.03)	0 (0)	0 (0)	0 (0)	44
2016	0.07 (0.01)	0.42 (0.03)	0.46 (0.03)	0.05 (0.01)	0 (0)	0 (0)	59
2017	0 (0)	0.2 (0.03)	0.73 (0.03)	0.08 (0.01)	0 (0)	0 (0)	40
2018	0 (0)	0.79 (0.03)	0.16 (0.02)	0.05 (0.01)	0 (0)	0 (0)	43
2019	0.06 (0.01)	0.55 (0.04)	0.32 (0.04)	0.06 (0.01)	0 (0)	0 (0)	31

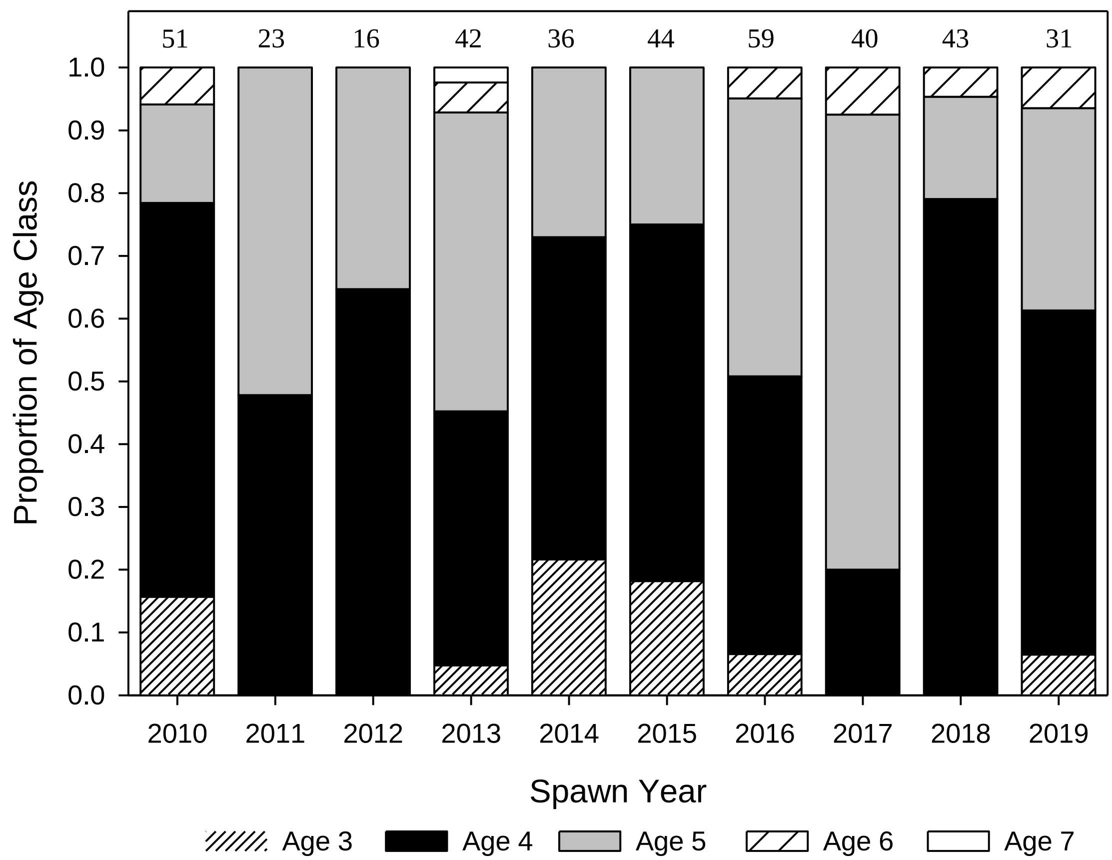

Figure 8. Proportion of age class return by spawn year of PIT tagged wild adult steelhead from the annual Lower Granite Dam adult PIT tag group returning to Lapwai Creek showing the number of PIT tags observed with associated age estimates from scale analysis (IPTDSW 2020).

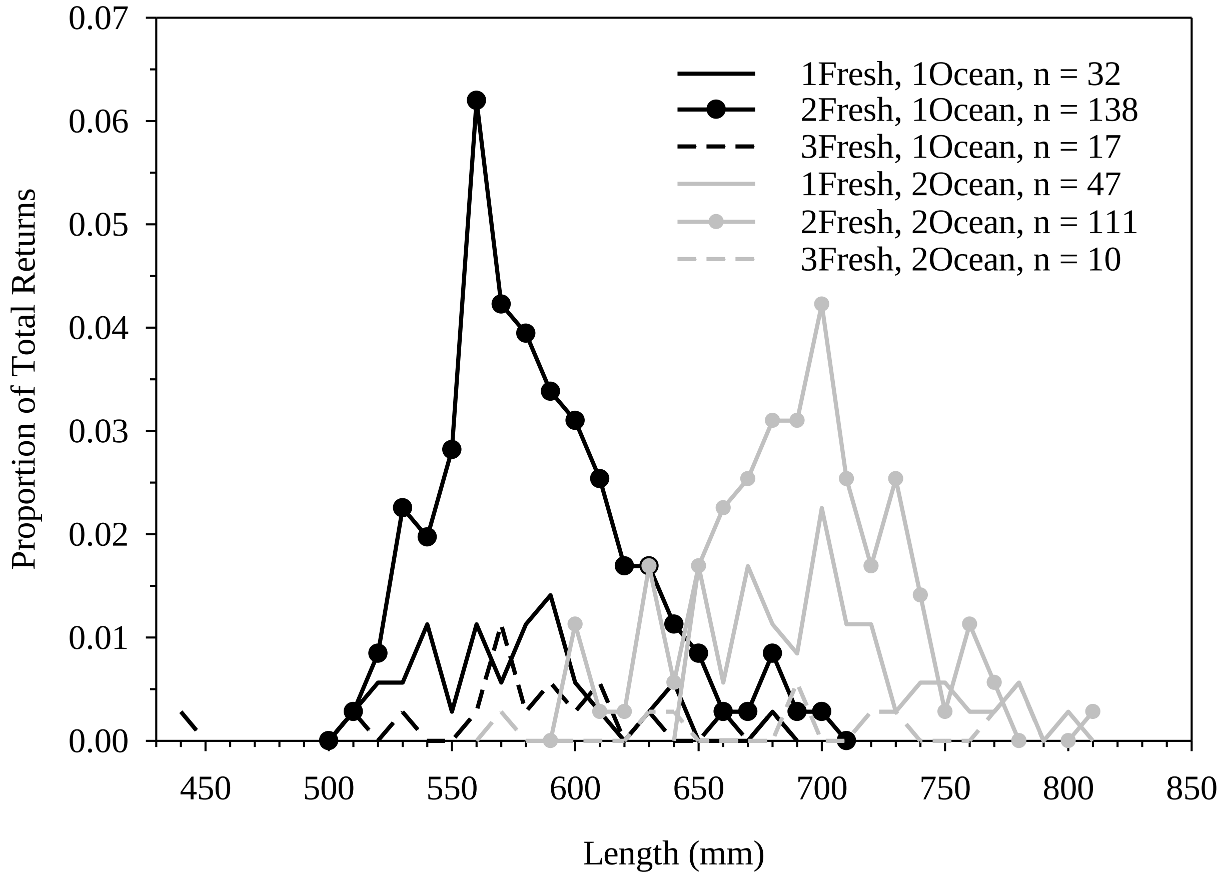

Figure 9. Proportion of total returns to Lapwai Creek by total length and by freshwater residency time shown by line type (1Fresh-one year fresh water (solid line), 2Fresh- two years freshwater (circle and line), and 3Fresh-three years freshwater (dashed line)) and by ocean residency time shown by line color (1Ocean-one year ocean residency (black color) and 2Ocean-two years ocean residency (gray color) and the number of PIT tags (n) observed with associated scale age estimates from the annual Lower Granite Dam adult PIT tag groups for spawn years 2010 through 2019.

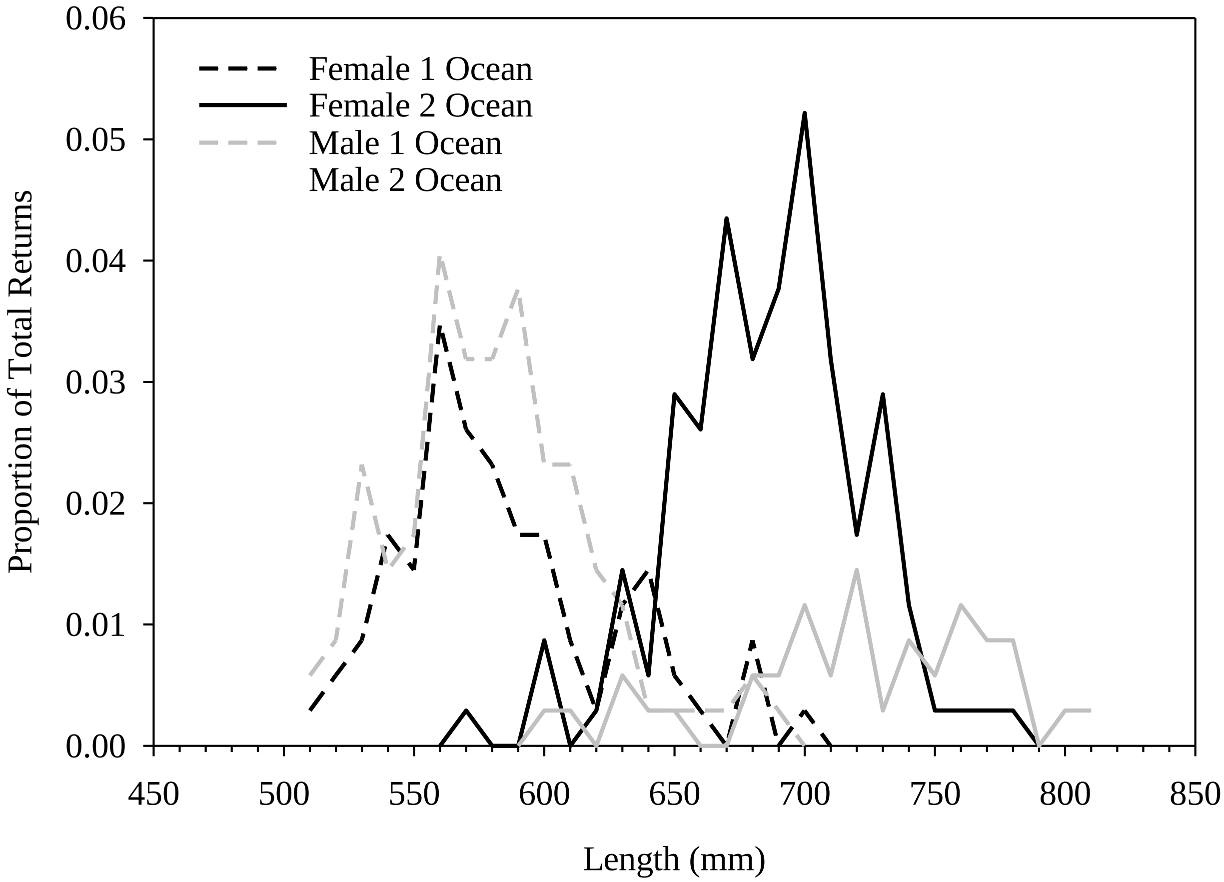

Figure 10. Proportion of total returns to Lapwai Creek by total length and by sex shown by line color (female black, male grey) and by ocean residency time shown by line type (1 ocean dashed line, two ocean solid line) from the annual Lower Granite Dam adult PIT tag groups for spawn years 2010 through 2019.

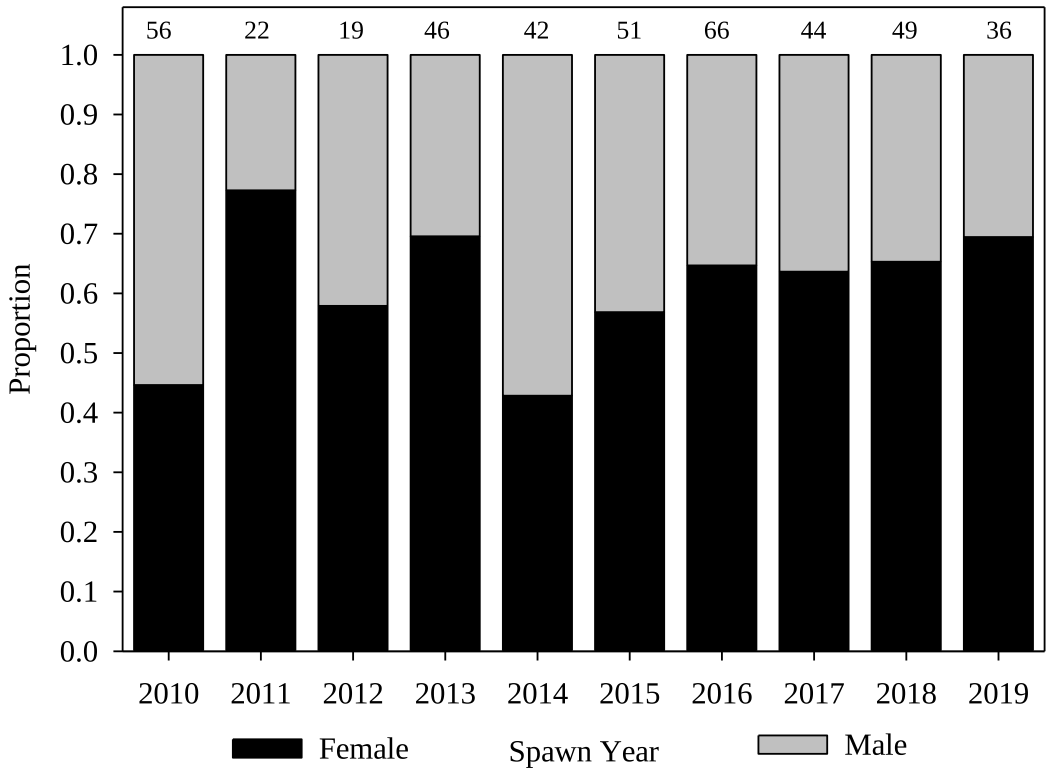

Figure 11. Proportion of total returns of wild adult steelhead to Lapwai Creek by sex from the annual Lower Granite Dam adult PIT tag groups for spawn years 2010 through 2019 also showing the number of PIT tags (above bars) observed with genetic sex assignments (IPTDSW 2020).

Table 8. Estimated female proportion and one standard error (SE) of wild adult steelhead spawners in Lapwai Creek by spawn year and number of PIT tagged individuals with associated sex determination used to calculate the proportion (n Sexed) from the annual Lower Granite Dam adult PIT tag groups for spawn years 2010 through 2019 (IPTDSW 2020).

Spawn Year	Prop. Female	SE	n Sexed
2010	0.446	0.066	56
2011	0.773	0.089	22
2012	0.579	0.113	19
2013	0.696	0.068	46
2014	0.429	0.076	42
2015	0.569	0.069	51
2016	0.652	0.059	66
2017	0.636	0.073	44
2018	0.653	0.068	49
2019	0.694	0.077	36

KELTS AND REPEAT SPAWNERS

Over the 10 years of the study, there were a total of 447 wild PIT tagged adults from the annual LGR adult PIT tag group from which kelts and repeat spawners could be assessed for Lapwai Creek. While a direct estimate of the annual proportion of kelts was not calculated due to low sample sizes and poor hydro-system detection probabilities, a minimum estimate was made based on unique PIT tag observations both with in Lapwai Creek and at and below LGR after spawning.

Overall, the minimum average annual proportion of steelhead kelts from Lapwai Creek was 26% (Table 9). The actual annual proportion was likely much higher as previous assessments of the annual LGR adult PIT tag groups suggest that approximately 50% of all spawning steelhead may successfully migrate to LGR as a kelt (Orme and Albee 2013). In addition, of the 447 observed PIT tags spawning in Lapwai Creek, only nine tags were observed as repeat spawners migrating up the hydro-system and only five PIT tagged repeat spawners were actually observed in Lapwai Creek (Table 9). The annual average proportion of repeat spawners within the hydro-system was estimated at 2.4% and a 1.4% repeat spawning rate to Lapwai Creek (Table 9). However, repeat spawners from the LGR adult PIT tag groups were only observed in Lapwai Creek in four of the nine available observation years (Table 9).

There was a large observed difference in the proportion of kelts and repeat spawners by sex. The minimum annual average proportion of observed kelts was 27% for females (Table 10) and 16.5% for males (Table 11). In addition, the annual average proportion of female repeat spawners observed in the hydro-system was 3.5% (Table 10) while only 0.4% for males (Table 11). The annual average proportion of female repeat spawners observed in Lapwai Creek was 1.6% (Table 10). Male repeat spawners were only observed in one year within the hydro-system with zero observed in Lapwai Creek from the annual LGR adult PIT tag groups over the ten available observation years of this study (Table 11).

The length frequency distribution of observed kelts was similar to that of the spawners observed in Lapwai Creek (Figure 11). However, the observed length frequency of repeat spawners showed a distinct left skew, in that the majority of repeat spawners were disproportionally smaller individuals (Figure 11) from the one ocean component.

Table 9. Total number of PIT tags observed in Lapwai Creek by spawn year from the annual Lower Granite Dam wild adult steelhead PIT tag group, the minimum proportion of total tags observed migrating down the hydro-system as kelts (**not** corrected for detection probability), the proportion of total tags observed in the hydro-system as repeat spawners, and the proportion of total tags observed in Lapwai Creek as repeat spawners.

Spawn Year	n Tags as Spawners	Observed as Kelt	Observed Repeat Hydro	Observed Repeat Lapwai
2010	57	0.02	0.00	0.00
2011	25	0.28	0.00	0.04
2012	20	0.35	0.10	0.05
2013	48	0.27	0.00	0.00
2014	43	0.23	0.05	0.02
2015	52	0.19	0.00	0.00
2016	70	0.24	0.03	0.03
2017	45	0.20	0.00	0.00
2018	51	0.18	0.04	0.00
2019	36	0.39	0.03	-

Table 10. Total number of **female** PIT tags (genetic assignment) observed in Lapwai Creek by spawn year from the annual Lower Granite Dam wild adult steelhead PIT tag group, the minimum proportion of total female tags observed migrating down the hydro-system as kelts (**not** corrected for detection probability), the proportion of total female tags observed in the hydro-system as repeat spawners, and the proportion of total female tags observed in Lapwai Creek as repeat spawners.

Spawn Year	n Tags as Spawners	Observed as Kelt	Observed Repeat Hydro	Observed Repeat Lapwai
2010	25	0.04	0.00	0.00
2011	17	0.29	0.06	0.06
2012	11	0.36	0.09	0.00
2013	32	0.34	0.00	0.00
2014	18	0.28	0.06	0.06
2015	29	0.21	0.00	0.00
2016	44	0.30	0.05	0.05
2017	28	0.18	0.00	0.00
2018	32	0.22	0.06	0.00
2019	25	0.52	0.04	-

Table 11. Total number of **male** PIT tags (genetic assignment) observed in Lapwai Creek by spawn year from the annual Lower Granite Dam wild adult steelhead PIT tag group, the minimum proportion of total tags observed migrating down the hydro-system as kelts (**not** corrected for detection probability), the proportion of total tags observed in the hydro-system as repeat spawners, and the proportion of total tags observed in Lapwai Creek as repeat spawners.

Spawn Year	n Tags	Observed as Kelt	Observed Repeat Hydro	Observed Repeat Lapwai
2010	31	0.00	0.00	0.00
2011	5	0.40	0.00	0.00
2012	8	0.25	0.00	0.00
2013	14	0.07	0.00	0.00
2014	24	0.17	0.04	0.00
2015	22	0.18	0.00	0.00
2016	24	0.13	0.00	0.00
2017	16	0.25	0.00	0.00
2018	17	0.12	0.00	0.00
2019	11	0.09	0.00	-

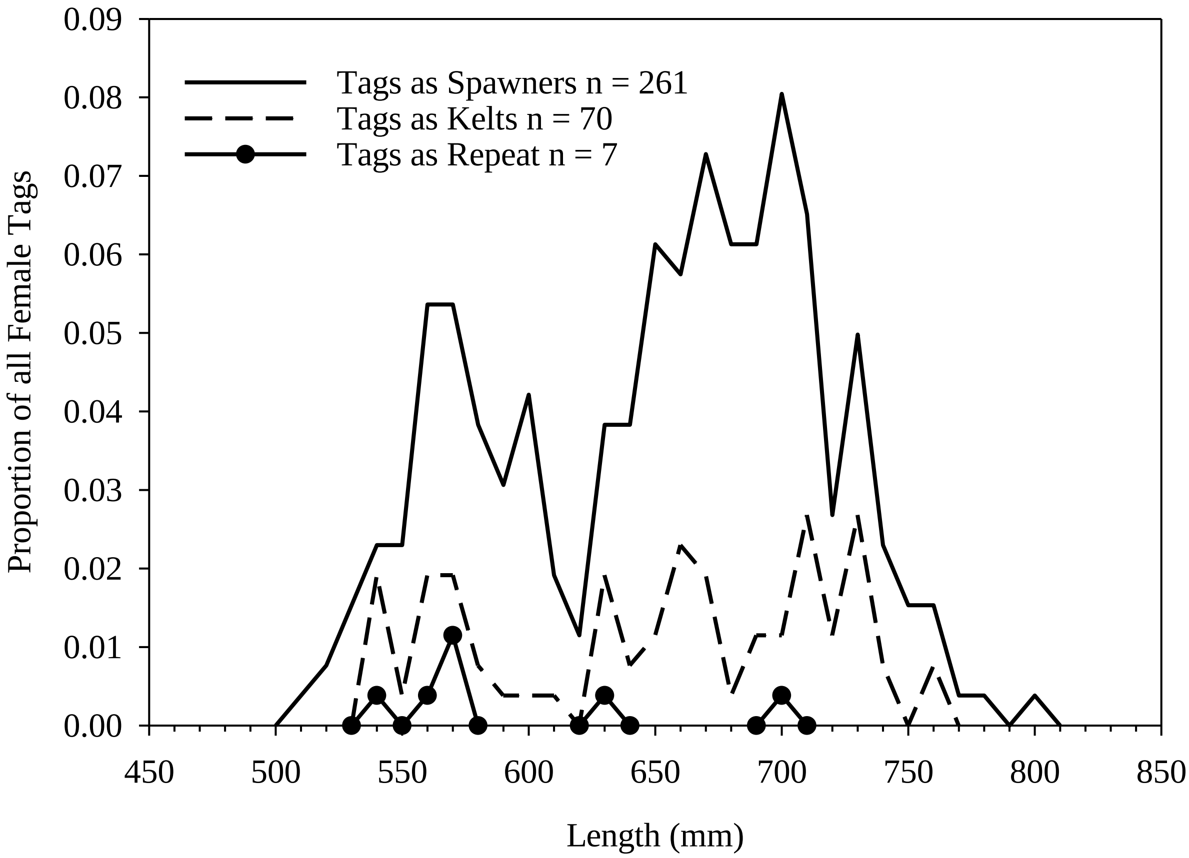

Figure 12. Proportion of total adult **female** PIT tag observations (genetic assignment, IPTDSW 2020) by total length (mm) for spawn years 2010 through 2019 that were observed as spawners in Lapwai Creek (solid line), the proportion of total tags observed migrating down the hydro-system as kelts (dashed line), and the proportion of total tags as repeat spawners observed in the hydro-system from the annual Lower Granite Dam wild adult steelhead PIT tag groups.

DISCUSSION

The data and summaries presented here represent an enormous step forward in the available information of returning wild adult steelhead to Lapwai Creek that will help guild local resource management decisions and actions. While juvenile steelhead studies have occurred in Lapwai Creek (Myrvold and Kennedy 2017, Taylor et al. 2016), this study provides previously unknown critical wild adult information that is needed to assess the status and trends of the spawning aggregate. In addition, this study defines other important attributes such as arrival timing, spawning duration, spawning distribution, and life history strategy that may be critical for resource management planning and decision making regarding current and future land use practices, restoration efforts, and water use and allocation.

Previous to this study, the relative size and importance of the Lapwai Creek spawning aggregate relative to other populations or aggregates within the Clearwater Basin or to others within the region was unknown. The results presented here show that the Lapwai Creek spawning aggregate is of similar size to that found in Big Creek, a tributary to the Middle Fork Salmon River and to the Lemhi River, a tributary to the main upper Salmon River. In addition, more wild adult steelhead were estimated in Lapwai Creek in spawn year 2019 than that estimated in the entire South Fork Clearwater River in 2019 (IPTDSW 2020). The annual number of wild steelhead spawners in Lapwai Creek was unexpected given habitat, water quality and quantity, and land use issues within the drainage (Richardson 2009).

Continued monitoring of PIT tags within Lapwai Creek is subject to continued local and regional resource management support of the current LGR adult PIT tagging, statistical model maintenance and development, and IPTDS operations and maintenance. The MOA between the BOR and NPT expired in 2019 as did the BOR support of the Lapwai Creek IPTDS. Continued monitoring of PIT tags within Lapwai Creek will require support to maintain the current infrastructure and remote communications expenses. The high spring flows in April of 2019 resulted in the loss of antennas both at LAP and the SWT IPTDS. Fortunately both systems consist of a three pass array design and are therefore still operational and functional for adult estimation. However, both of the MIS antennas were dislodged and the site is no longer functional.

The data presented here also represents an example of the technological and methodological advancements in monitoring population abundance and biological metrics with known statistical properties and estimates of uncertainty for endangered Chinook and steelhead populations and for individual spawning aggregates. The PIT tagged based run-decomposition methodology allows for the simultaneous monitoring of all populations and spawning aggregates (with the appropriate detection infrastructure) above LGR through a single sampling location and effort. In addition, the majority of data analysis (as presented here) is automated through R based packages and programs. Other data sets such as kelts, repeat spawners, passages activity, and summaries of all adult PIT tag observations could easily be incorporated into the existing R packages. Therefore, the current methodology employed can provide adult spawner data analysis and summaries for any or all populations or spawning aggregates with a single effort. Because the analysis are based on the annual systematic random sample of adults at LGR, results are directly comparable between all populations and spawning aggregates throughout the entire basin above LGR. In addition, monitoring additional populations, spawning aggregates or groups (to define spawning distribution) only requires the installation of additional PIT tag monitoring infrastructure and associated additions to the statistical models.

The data and results presented here are similar to data obtained through the operation of a weir for abundance and biological attributes. However, the current PIT tagged based methodology has some distinct advantages over weirs. While steelhead weirs are operated within the region, they are limited in scale and scope. Adult temporary weirs are generally limited to smaller headwater tributaries where the physical infrastructure can be installed and maintained through high spring flows and associated debris loads. In addition, temporary weirs generally require a large crew to install and remove the infrastructure annually in addition to one or more full time staff to handle fish and maintain the structure. In contrast, IPTDS are installed once at a similar infrastructure cost to that of a temporary picket style weir. In addition, multiple IPTDS can be maintained by a one or two person crew over a large geographic region. Furthermore, IPTDS can be installed and operated in much larger systems than temporary weirs, allowing a much broader monitoring strategy both in scale and scope. As an example, two IPTDS were installed and are currently operating in the Selway River, Idaho (site codes SW1 and SW2) to monitor adult steelhead and Chinook salmon with spring time flows of 20,000 to 30,000cfs annually.

The current run-decomposition methodology does have some population monitoring limitation. The annual estimates of age proportions can be used to partition annual adult returns into specific brood years. Annual estimates of age and abundance over a long enough time period allows for the summation of all returns from a single spawn year (brood year). For Lapwai Creek, there are currently four complete brood year returns beginning with the 2010 spawn or brood year that would allow for the calculation of a Progeny to Parent ratio. Progeny to Parent ratio is a measure of productively or replacement rate. However, the current methodology employed only estimates wild/natural adult returns. Spawning hatchery fish would result in an under estimate of Parents and thus result in an over estimate of productivity. The spawning abundance estimates in Lapwai Creek was limited to wild fish and there was no attempt made to estimate the proportion of hatchery spawners (pHOS). Approximately 10% of all adult steelhead PIT tag observations within Lapwai Creek were composed of hatchery fish. As the tagged to un-tagged ratio of hatchery fish in Lapwai Creek was unknown, the expansion of hatchery PIT tags into actual fish numbers was not possible.

The current run-decomposition methodology also has some physical limitations in monitoring adult steelhead and Chinook salmon populations. To a much lesser extent than weirs, extreme high spring flow or flood events have the potential to dislodge IPTDS components. Such events are rare but have occurred. When events do occur, repairs are generally limited to fall and winter periods under stream base flows, allowing for personal to work safely. As such, spring flood events that dislodge equipment can impact estimates at the tail end of the steelhead spawning season (April-May).

Regardless, the currently employed methodology provides nearly all information required to monitor and assess the status and trends of endangered steelhead populations and spawning aggregates as demonstrated by this study. Improvements to the sampling design and to the R packages to allow for the calculation of pHOS, productivity, and to monitor kelts and repeat spawners would constitute a major improvement in monitoring critical fish populations with potential for more advancement.

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