RECLAMATION
Managing Water in the West

2016 Annual Report for Activities under the Endangered Species Act Biological Opinion

(For the period October 31, 2015 to December 31, 2016)

Lewiston Orchards Project, Lewiston Idaho
Submitted to the National Marine Fisheries Service
Boise, Idaho

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Snake River Area Office
Boise, Idaho

May 2017

U.S. DEPARTMENT OF THE INTERIOR

PROTECTING AMERICA'S GREAT OUTDOORS AND POWERING OUR FUTURE

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Front cover photograph – Sweetwater Creek looking upstream from the Sweetwater Diversion on the Lewiston Orchards Project

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Acronyms and Abbreviations

2010 Opinion	National Marine Fisheries Service 2010 Biological Opinion
cfs	cubic feet per second
ESA	Endangered Species Act
ESU	Evolutionarily significant units
IDEQ	Idaho Department of Environmental Quality
LOID	Lewiston Orchards Irrigation District
LOP	Lewiston Orchards Project
NMFS	National Oceanic and Atmospheric Administration National Marine Fisheries Service
Reclamation	U.S. Bureau of Reclamation
RPM	Reasonable and prudent measures
Tribe	Nez Perce Tribe
UI	University of Idaho
USGS	U.S. Geological Survey

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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 U.S. Bureau of Reclamation (Reclamation) for the operation and maintenance of the Lewiston Orchards Project (LOP). This report is submitted to comply with Reasonable and Prudent Measure (RPM) 6, requiring Reclamation to report to the NMFS annually on activities related to implementing the 2010 Opinion (Reclamation 2010).

This 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.

As a result of court-sponsored mediation in January 2011, Reclamation agreed to provide 90 acre-feet of LOP water annually to supplement instream flows in both Sweetwater and Webb Creek. The 90 acre-feet is timed to be released during normal operation periods in accordance with the direction of the Nez Perce Tribe (Tribe).

This annual report covers the LOP operation and maintenance activities from October 31, 2015 to December 31, 2016 for published streamflows, irrigation operations, and fisheries monitoring. The Lewiston Orchard Irrigation District (LOID) operated the surface water collection system from February 12, 2016, until October 31, 2016.

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 2016 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 (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
Sweetwater Creek	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 Creek Diversion Dams will be bypassed.

b During February and March, either the specified streamflow will be provided or all inflow (I) to the Sweetwater and Webb Creek 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 Creek 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 Creek 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 creek 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 Creek, and the storage conditions under which they would occur, are shown in Table 2. As of June 1, 2016 the combined storage was greater than 4,250 acre-feet. Instead of providing an addition 1.0 cfs in both Sweetwater and Webb creek, the Tribe negotiated adding the total 2.0 cfs to Webb Creek. The incremental add-in can be seen in Table 3.

Table 2. Increments of additional juvenile rearing flow as a function of combined storage for June 1 through September 15 (Reclamation 2015).

Combined Storage (June 1st (Mann Lake & Soldiers Meadow)	<3,800	3,900	4,000	4,100	4,200	>4,250
Sweetwater Creek (Incremental Increase)	0.0	0.0	0.0	0.0	0.0	0.0
Webb Creek (Incremental Increase)	0.0+0	0.5	0.9	1.3	1.8	2.0

In 2016, the Tribe negotiated an additional 90 acre-feet of water to be supplied at their discretion in Sweetwater and Webb Creek to assist in juvenile rearing flows. Table 3 shows the total flows and timing required in Sweetwater and Webb Creek including the minimum flows, the additional incremental flows, and the negotiated 90 acre-feet flows for 2016.

Table 3. Total flows required in Sweetwater and Webb Creeks with the additional volume and mediated flows.

2016 - Current as of 5/30/16														
Life Stage	Spawning			Juvenile Rearing										
Month	Feb	Mar	Apr	May	Jun	Jul 1-15	Jul 15-18	Jul 18-31	Aug	Sep 1-11	Sep 12-15	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	2.5	2.5	2.5	Bypass
Incremental Add-In	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Tribal Negotiated 90 AF 2011-2013 (1/28/11)	0.0	0.0	0.0	0.0	0.3	0.5	0.5	0.5	0.5	0.3	0.3	0.0	0.0	
Total Sweetwater Creek ByPass Flows	**7.8**	**7.8**	**7.8**	**3.0**	**2.8**	**3.0**	**3.0**	**3.0**	**3.0**	**2.8**	**2.8**	**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	1.0	1.0	1.0	Bypass
Incremental Add-In	0	0	0	0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Total Webb Creek ByPass Flows	**4.0**	**4.0**	**4.0**	**1.5**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	

* Specified Stream Flow or all Stream Flow will be bypassed, whichever is less, measured below discharge for Lake Waha and below Soldiers Meadow Reservoir

*Excludes flows at the Diverson at the West Fork of the Sweetwater

The proposed action states that Reclamation will monitor daily mean streamflows whenever the LOID is diverting water. Currently, 1-hour averages are posted for Sweetwater and Webb Creek 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 streamflows. 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 streamflow data are collected at 1-hour intervals below the weirs at Sweetwater and Webb Creek Diversion Dams. The automated data loggers record the bypass streamflow 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. The 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 Streamflow Results for Spring Spawning Period March 1 through 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 operated from February 12, 2016 to October 31, 2016. There were a few large spikes in late March through May due to high runoff (Figure 1). There were also some low natural flows recorded in early March where the flows dropped below the target bypass flow rate. Other flow fluctuations can be seen in Appendix A. This appendix notes the target bypass flow rates and the corresponding hourly rate in Sweetwater Creek.

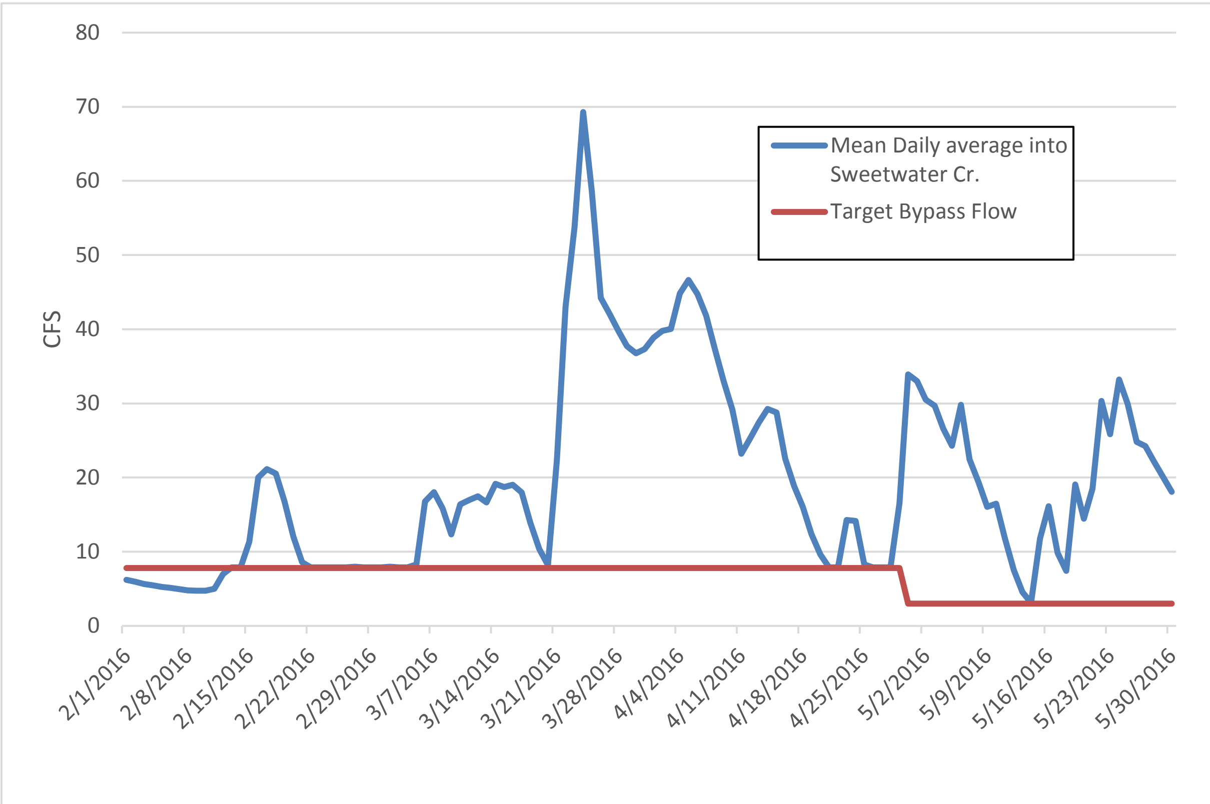


Figure 1. Mean daily streamflow (cfs) measured past the Sweetwater Diversion Dam and bypass flow targets for the first half of the irrigation season (March 1 through May 31, 2016).

2.2.2 Bypass Streamflow Results for Juvenile Rearing Period June 1 through October 31

Minimum streamflows 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. The Tribe negotiated putting all the additional flows into Webb Creek in 2016 thus no incremental flows were added to Sweetwater Creek. The additional 90 acre-feet of water was released into Sweetwater Creek according to Tribal direction from June through September. The minimum flows and mediated flows for 2016 are summarized in Table 3. The combined flows resulted in minimum flow targets for June at 2.8 cfs; July through August at 3.0 cfs; September 1 through 15 at 2.8 cfs; September 16 through end of irrigation season at 2.5 cfs. Measured streamflows, in relation to bypass flow targets, are shown in Figure 2.

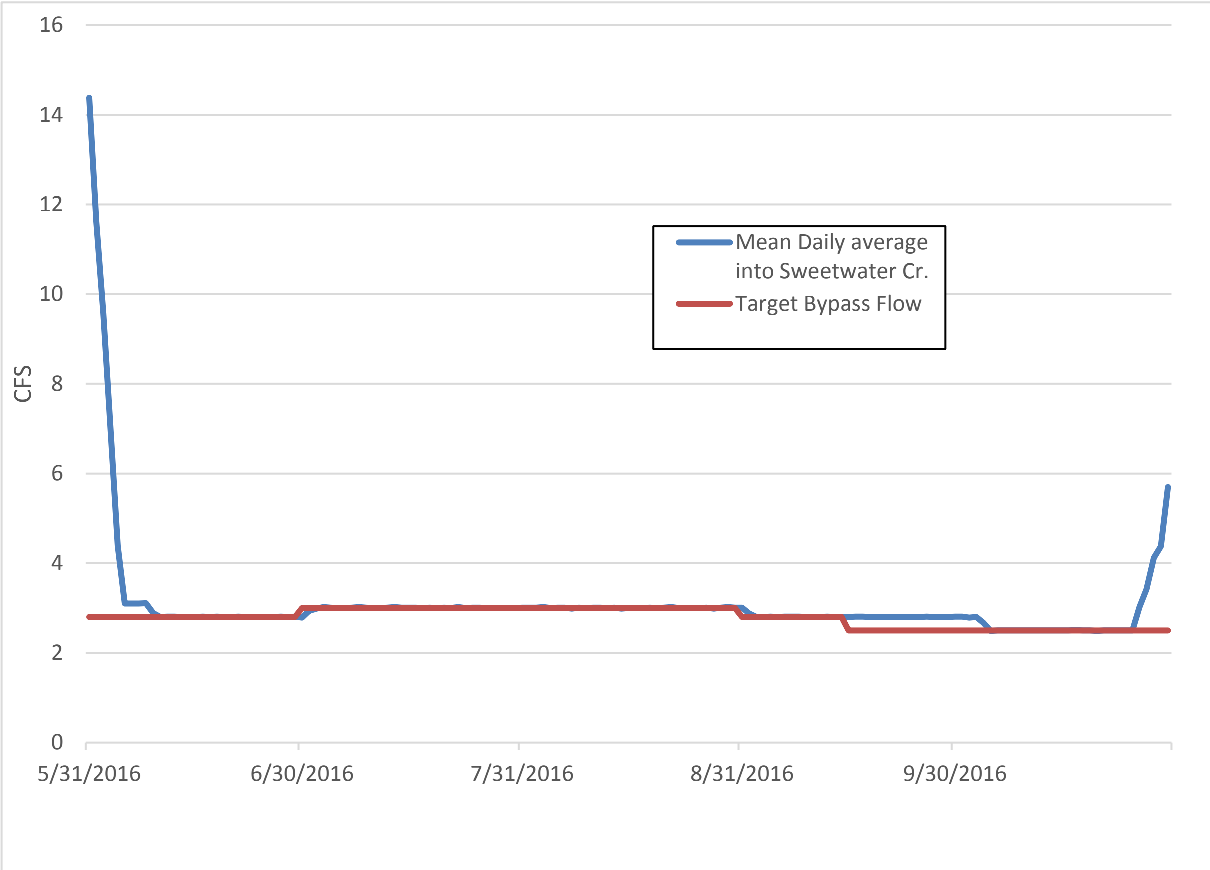


Figure 2. Mean daily streamflow (cfs) measured past the Sweetwater Diversion Dam for the second half of the irrigation season (June 1 through October 31, 2016).

2.3 Webb Creek

2.3.1 Minimum Bypass Streamflow Requirements in Webb Creek

The Webb Creek diversion was operated from February 12, 2016, until October 31, 2016. Measured streamflows, in relation to the bypass flow targets, are shown in Figure 3.

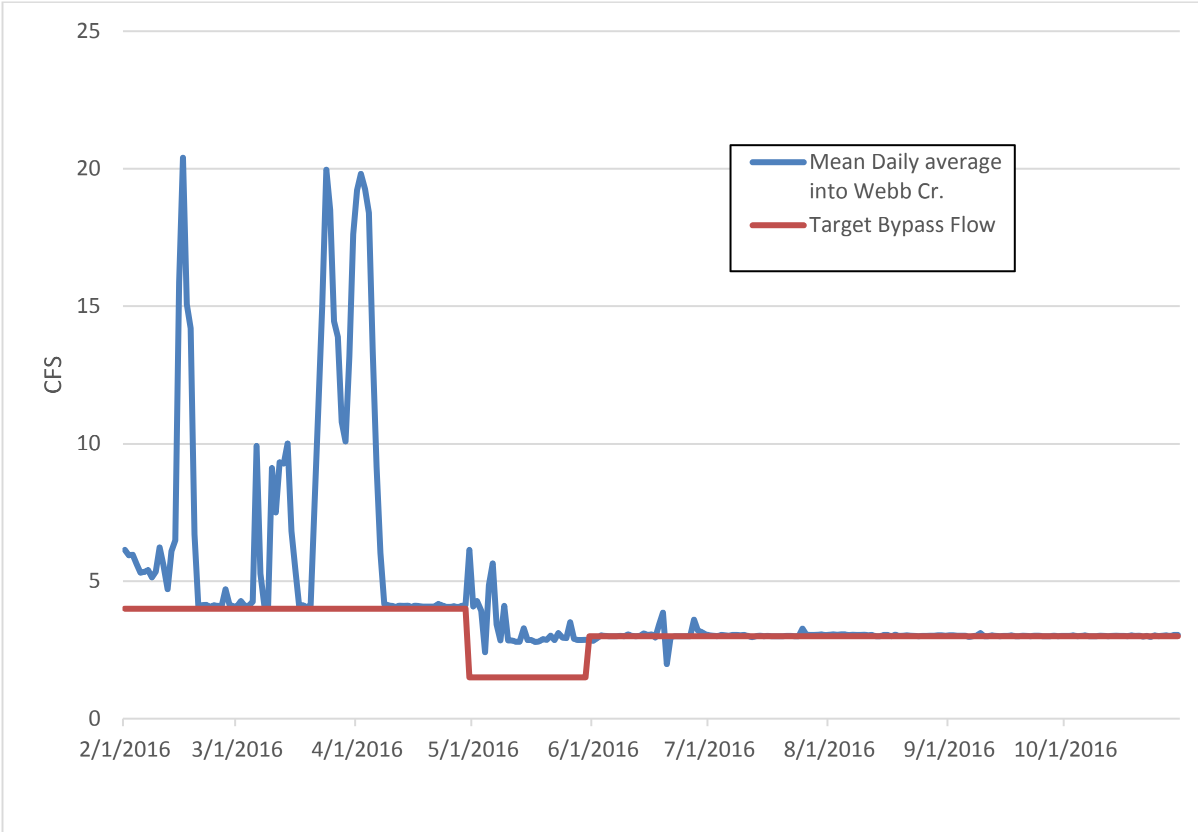


Figure 3. Mean daily streamflow (cfs) measured past the Webb Creek Diversion Dam for the irrigation season (2016).

Minimum flow targets for 2016 of 4.0 cfs in February, March, and April; 1.5 cfs in May; 3.0 cfs June 1 through the remaining irrigation season. All of the incremental add-in was added to Webb Creek only. An additional 2 cfs were added to the bypass flows to reach the 3.0 cfs minimum flows June through October 31, 2016. No tribal negotiated flows were designated for Webb Creek in 2016. On June 20 there was a drop in flows that was due to repairing the chain and replacing the gear motor at the diversion.

Other flow fluctuations can be seen in Appendix A. This appendix notes the target bypass flow rates and the corresponding hourly rate in Webb Creek.

2.4 Ramping Rates

Ramping flows were incorporated into the proposed action and described in Reclamation's *Biological Assessment for the Operation of the Lewiston Orchards Project* (Reclamation 2009, pages 4 through 11). 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. The following ramping rates were identified to simulate natural conditions of the stream as much as possible. When the streamflow is high (>70 cfs), the maximum gate adjustment will take 10 cfs from the stream per day. When the streamflow is moderate (20 to 70 cfs), the maximum gate adjustment will take 5 cfs from the stream per day. When the streamflow is <20 cfs, the maximum gate adjustment will take 1 cfs from the stream per day.

There is some confusion regarding ramping related to the daily fluctuations of streamflow 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 2009 BA below). Other fluctuations in streamflow occur naturally from climatic and precipitation conditions and these fluctuations in streamflow would be natural hydrologic conditions in the stream.

> *Proposed Action (Reclamation 2009, pages 4 through 11)*
>
> "Ramping of streamflows is intended to make gradual changes during gate operations that avoid stranding fish in dewatered or pooled areas when streamflows are reduced (diversion gates opened) or flushing fish downstream when increasing streamflows (diversion gates closed). These gradual alterations in streamflow are intended to allow fish that are rearing in the streams sufficient time to adjust to changes in stream habitat. Streamflow 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 2016, there were instances where streamflows fluctuated but were not associated with gate changes and therefore are not subject to ramping criteria. Some instances occurred naturally as the system fluctuated during spring runoff and hydrologic events; other instances were caused by mechanical failures and were be evaluated on a case by case basis.

2.5 Gravel Management Activities

Maintenance of the Sweetwater Creek Diversion Dam requires periodic removal of sediment that accumulates behind the dam, typically conducted every 4 to 6 years. Sediment was removed from the Sweetwater diversion dam pool during 2011 and was reported in the 2011 Annual Report (Reclamation 2012). Sediment removal activities were not conducted during 2016.

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 sampling site (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 2016.

4. RPM 3: Streamflow Monitoring

Streamflows are measured at both the mouth of Sweetwater and Webb creeks via USGS streamflow gages. Gage number 13342340 is the mouth of Sweetwater Creek 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 streamflow ranged from 4.71 to 42.0 cfs at the mouth of Sweetwater Creek, and from 1.15 to 14.2 cfs at the mouth of Webb Creek during water year 2016. Hydrographs from these sites show that peak flows occurred during February through March, and low flows occurred from July through September (Table 4, Figures 4 and 5).

Both graphs show the large variability in streamflows, even when LOID is not operating the diversion structures. The spring runoff and corresponding peak occurs in early March followed by the descending arm of the hydrograph in May. Flows continue on a downward trend through October.

Table 4. Mean monthly streamflow (cfs) measured from daily average data at the USGS monitoring gages at the mouth of Sweetwater and Webb creeks during water year 2016.

Sweetwater Creek at Mouth		Webb Creek at Mouth	
Month	Mean	Month	Mean
Oct-15	4.71	Oct-15	1.15
Nov-15	6.51	Nov-15	1.95
Dec-15	11.9	Dec-15	3.87
Jan-16	8.64	Jan-16	2.57
Feb-16	19.3	Feb-16	8.21
Mar-16	42.0	Mar-16	14.2
Apr-16	36.9	Apr-16	8.86
May-16	24.2	May-16	3.80
Jun-16	7.15	Jun-16	2.16
Jul-16	6.62	Jul-16	1.62
Aug-16	6.97	Aug-16	1.39
Sep-16	6.88	Sep-16	1.89

Figure 4. Mean daily streamflows (cfs) measured near the mouth of Sweetwater Creek (USGS gage 13342340) during water year 2016.

Figure 5. Mean daily streamflows (cfs) measured near the mouth of Webb Creek (USGS gage 13342295) during water year 2016.

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 the University of Idaho (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 a multi-year agreement (Agreement Number R12AC11005) 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. That agreement ended May 31, 2015. A new agreement (Agreement Number R14AC00042) with the UI, which goes through May 31, 2019, has been put in place to continue the steelhead density monitoring described in the monitoring plan for steelhead densities and critical uncertainties. The data collected during 2016 is summarized in an annual report (Appendix B; Kennedy et al. 2015). During these surveys, a total of 1,234 steelhead were captured during electroshocking. Total incidental mortality rate among all sites and visits during the 2015 sampling season was 0.88 percent.

PIT tag reading stations are being used to record the movement of tagged individuals. All systems use multiple antenna arrays (two or three) to determine direction of movement and detection efficiency. During 2016, PIT tag interrogation stations were operating at Lapwai, Sweetwater, Mission, and Webb. Sweetwater Creek had down periodic down time during the fall due to battery issues. The other stations did not experience any considerable downtime in 2016.

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 that will be used until 2020.

Four of the original six sites remain, which include: ULU, UMU, UWM and LSX (Figure 6). The other two original sites, LLL and 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 MLX and 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 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 2020 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.

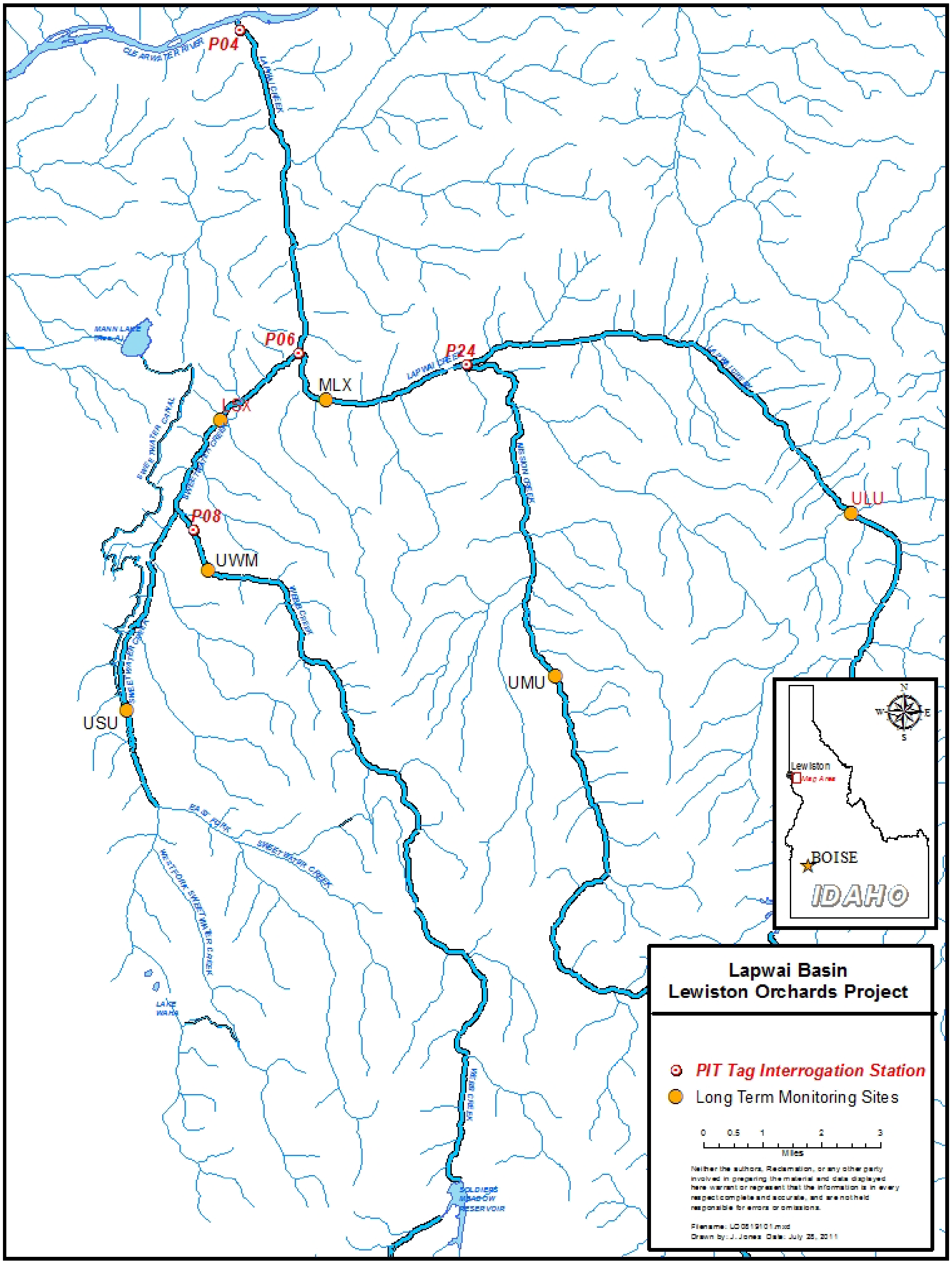


Figure 6. Map of the Lapwai Basin showing the six long-term monitoring sites.

Densities are based on abundance values estimated through 3-pass depletion in stream reaches 100 m 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 August for young of year (0+) combined with older fish (1+) are shown in Figure 7 for 2010 through 2016.

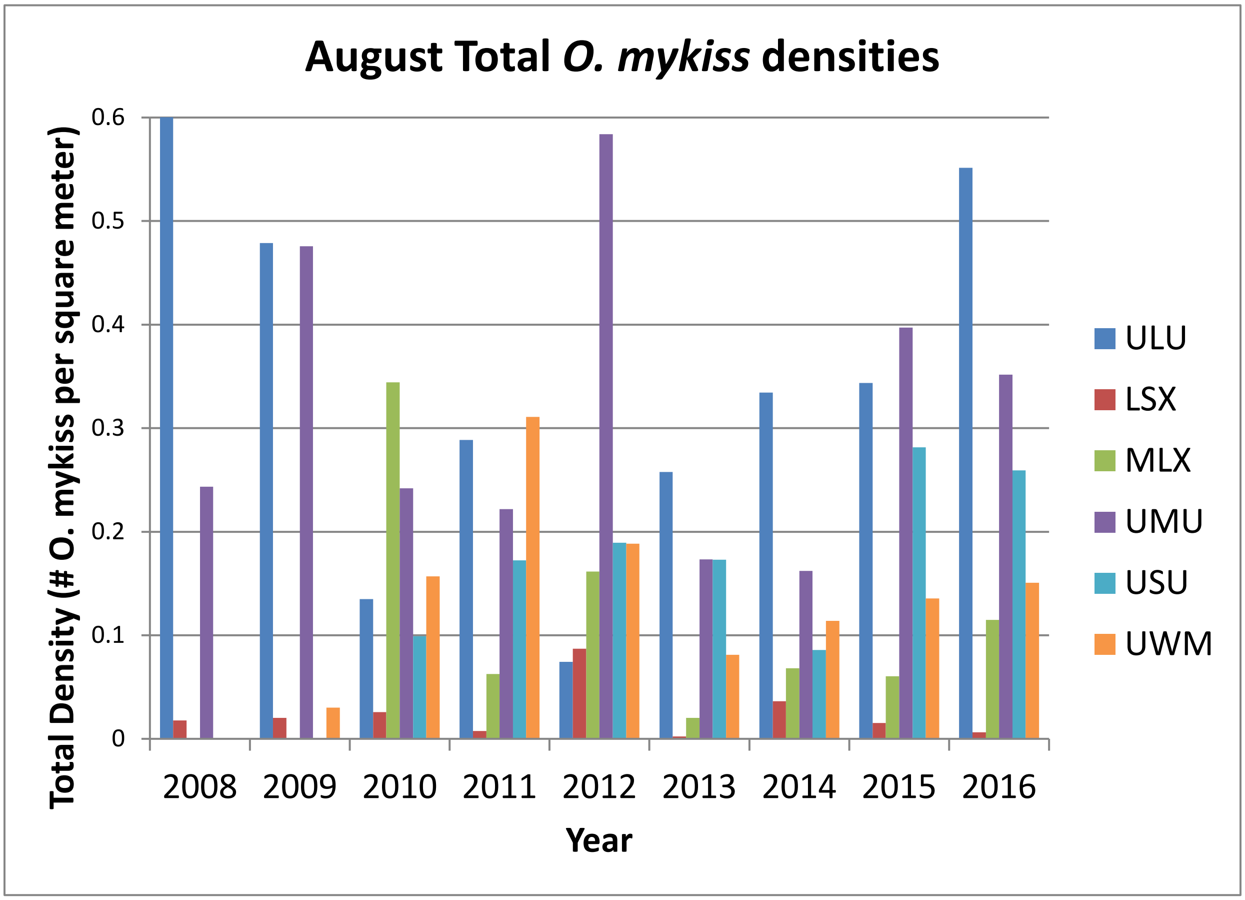


Figure 7. Total *O. mykiss* densities at 6 monitoring sites during August 2010 through 2015. Site codes are: LSX (lower Sweetwater), MLX (Lapwai below Mission), ULU (upper Lapwai), UMU (upper Mission), UWM (upper Webb), and USU (upper Sweetwater).

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 2016 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 Temperature Monitoring

5.3.1 Introduction

The year 2016 was the 8th year for temperature monitoring in the Sweetwater and Webb creek drainages of the Lapwai watershed. Temperature monitoring will continue to track and develop the understanding of temperature shifts, or lack thereof, as a result of discharge changes in the watersheds. 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 a water quality parameter 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 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 are restricted in distribution to a certain temperature range, 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 17 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 2016, Reclamation had data loggers deployed at the following locations:

- Lapwai Creek (four loggers deployed) – downstream from the confluence of Sweetwater Creek, upstream from the confluence of Sweetwater Creek, near the confluence of Tom Beal Creek, and near mouth of Lapwai Creek
- 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).
- Lower Sweetwater Creek (three loggers deployed) – upstream from confluence of Webb Creek, downstream from confluence of Webb Creek, near Sweetwater Creek mouth
- Upper Sweetwater Creek (three loggers deployed) – East Fork Sweetwater Creek, West Fork Sweetwater Creek, and below the Sweetwater Creek Diversion Dam

The data loggers collect water temperature (degrees Celsius) data every 15 to 60 minutes. Reclamation or LOID staff downloads the data from the monitoring loggers every few months. Occasionally loggers are lost, dewatered, or buried due to flow events, channel reconfiguration, or vandalism. Periodic downloads minimizes data lost due to these events. The data loggers used by Reclamation arrive from the factory pre-calibrated.

5.3.2.1 Temperature Data Summary

Below is a summary of stream temperatures at the Reclamation and LOID-maintained locations throughout the three watersheds from January through December of 2016. Due to scheduling conflicts and adverse weather conditions LOID was not able to download temperature loggers in the fall of 2016. Data from 2016 for East Fork Sweetwater, West Fork Sweetwater, below Sweetwater Diversion, at Webb Diversion, and in Webb canal are not currently available. This data should be downloaded in 2017 and will be included in the 2017 annual report. Summary statistics for the available site data are presented below.

Webb Creek

Temperature data from the Webb Creek system available for 2016 at two locations. The first of these was just below the outfall from Soldiers Meadows Reservoir (Figure 8). Hydromet collects temperature data at 15-minute intervals at this location. Temperatures are consistent with data collected throughout the study and seems to be representative of the reservoir discharge.

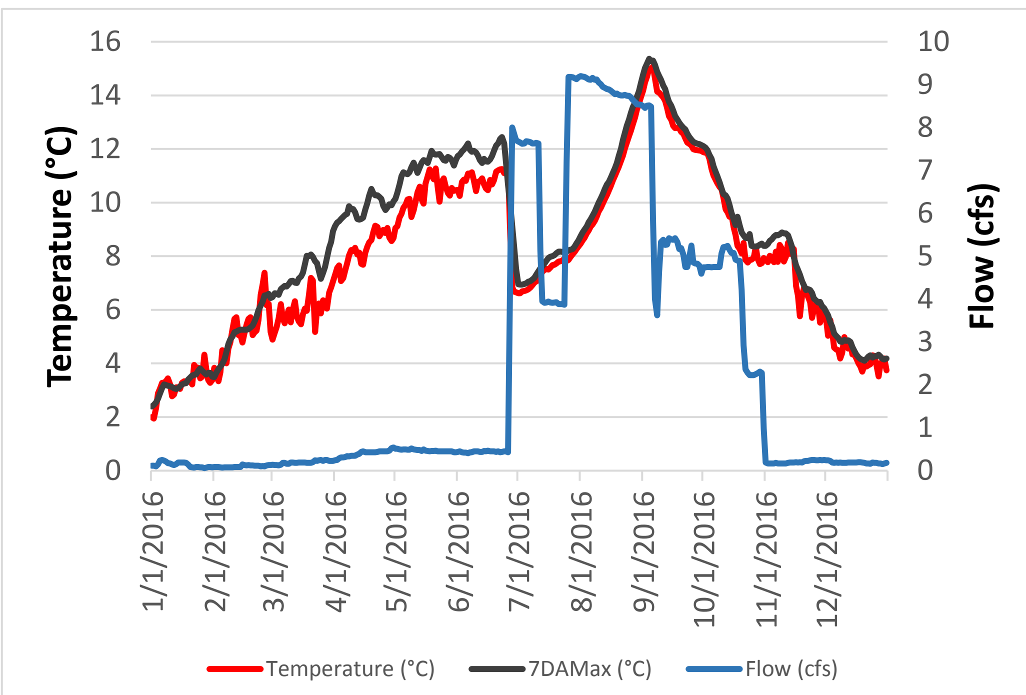


Figure 8. Maximum daily stream temperature (ºC) and mean daily flow (cfs) measured near the outflow from Soldiers Meadow Reservoir during 2016.

Daily average temperature variations during reservoir operations portion of the data set show daily variation was below 1°C (Figure 9). This is likely due to the modulating effect from the reservoir discharge, and likely corresponded to the temperature of the hypolimnion of the reservoir.

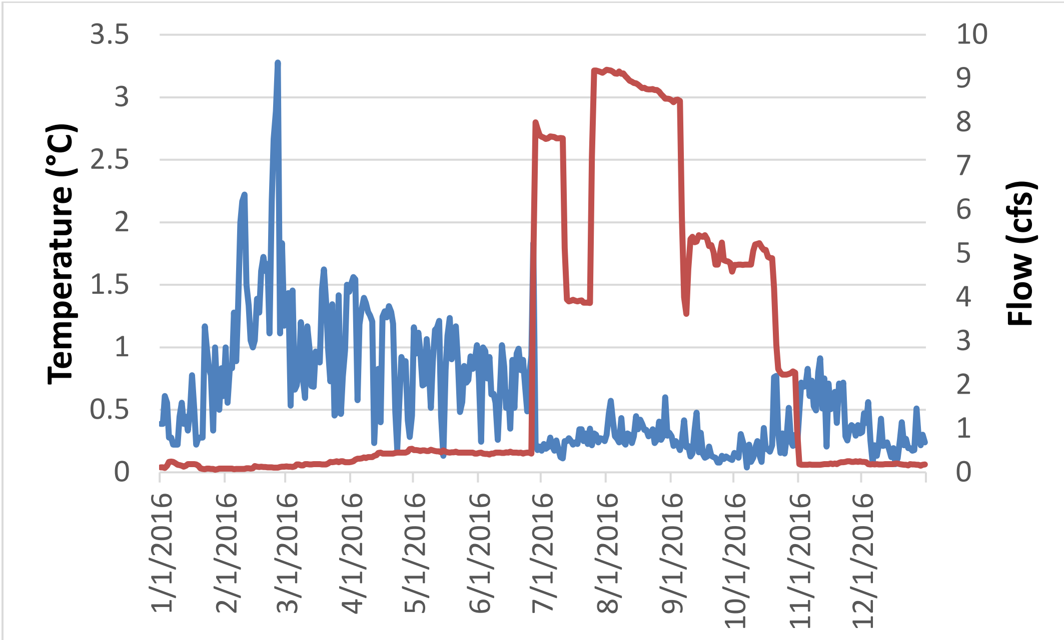


Figure 9. Daily stream temperature variation (ºC) measured near the outflow from Soldiers Meadow Reservoir (daily maximum – daily minimum).

Reclamation collected data at a third location on Webb Creek at the mouth of the system (Figure 10). Temperatures in 2016 were cooler than most of the previous years, but within the range of variability documented at this site.

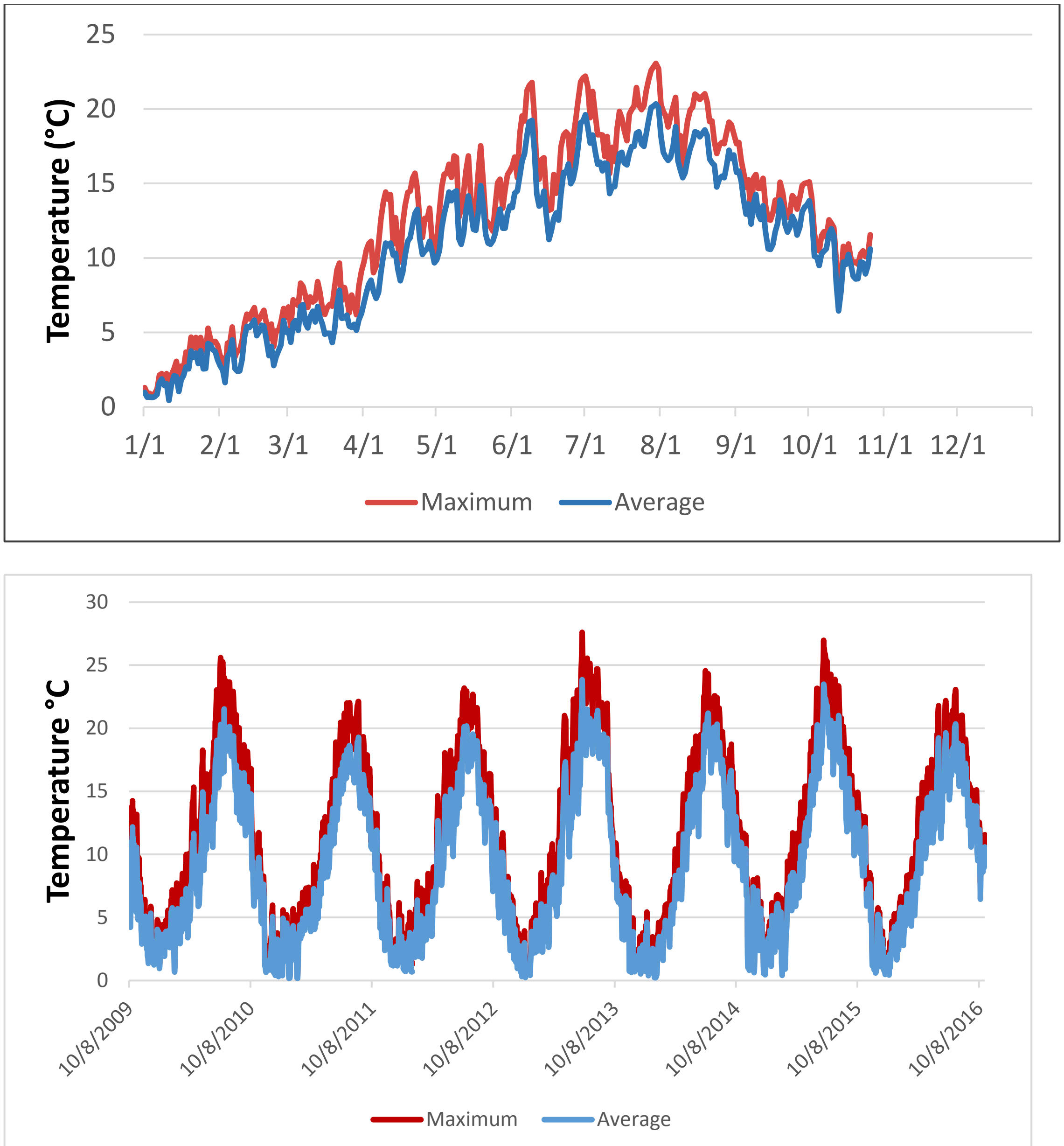


Figure 10. Maximum and average daily stream temperature (ºC) measured near the mouth of Webb Creek.

5.3.2.2 Sweetwater Creek

Reclamation and LOID have temperature loggers in seven locations in the Sweetwater Creek system. Three of these were downloaded in 2016 while the others will be included in next year's annual report.

Sweetwater Creek upstream from the confluence with Webb Creek had a malfunction and data is not available after June 1, 2016 (Figure 11).

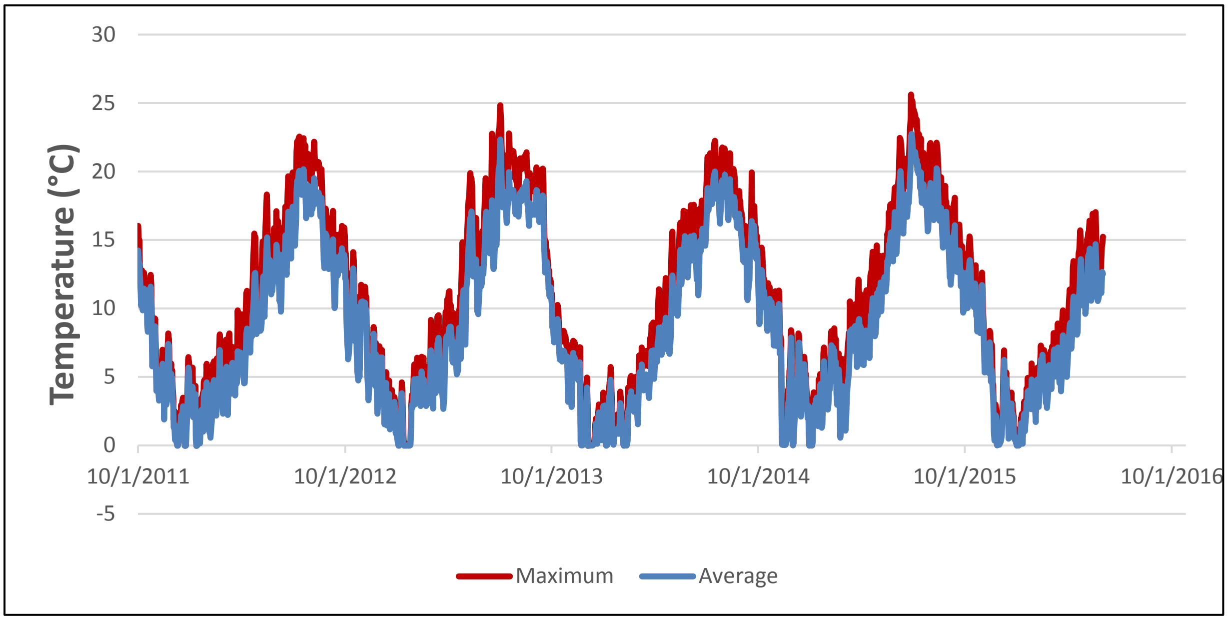


Figure 11. Mean and maximum daily stream temperature (°C) measured upstream from the Webb Creek confluence with Sweetwater Creek.

The next logger location on the mainstem Sweetwater Creek system was just below the confluence with Webb Creek (Figure 12).

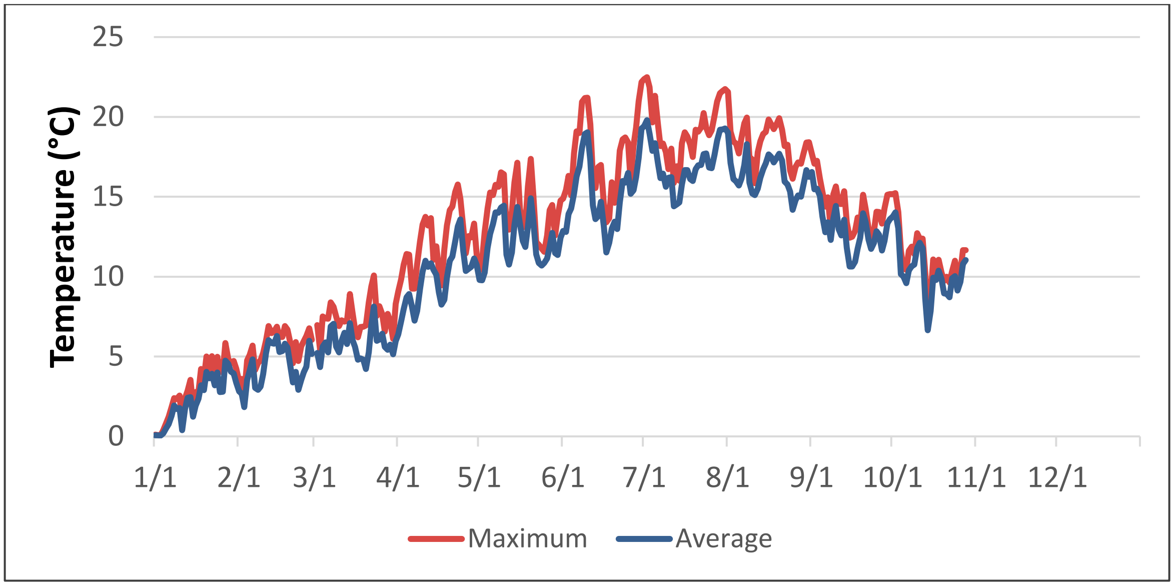
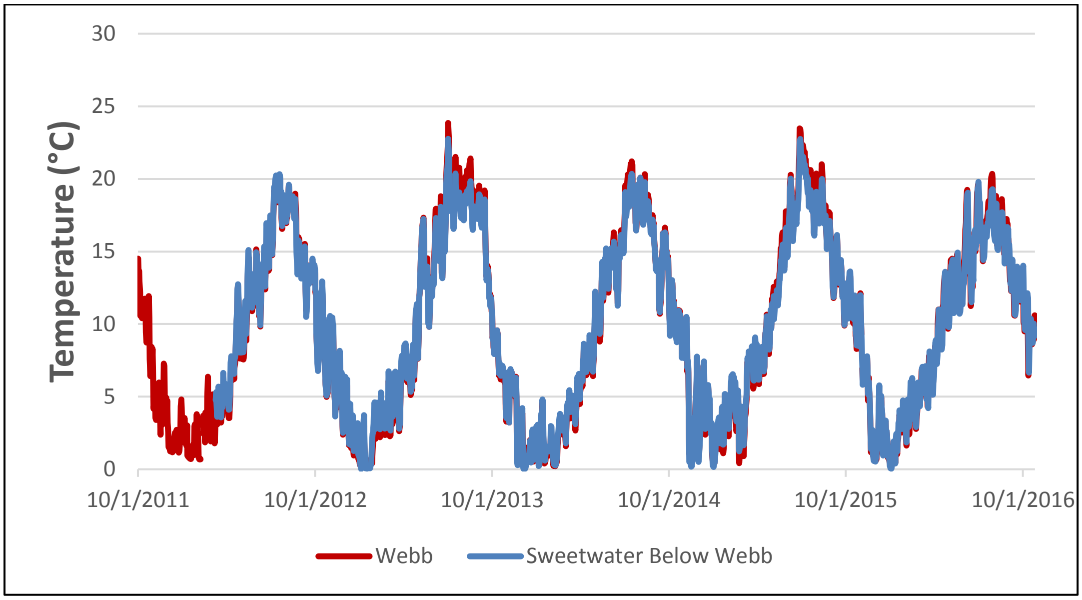


Figure 12. Maximum and average daily stream temperature (ºC) measured downstream from the Webb Creek confluence with Sweetwater Creek.

At this location, Sweetwater Creek is slightly warmer than Webb Creek. This is more pronounced in the summer (Figure 13).



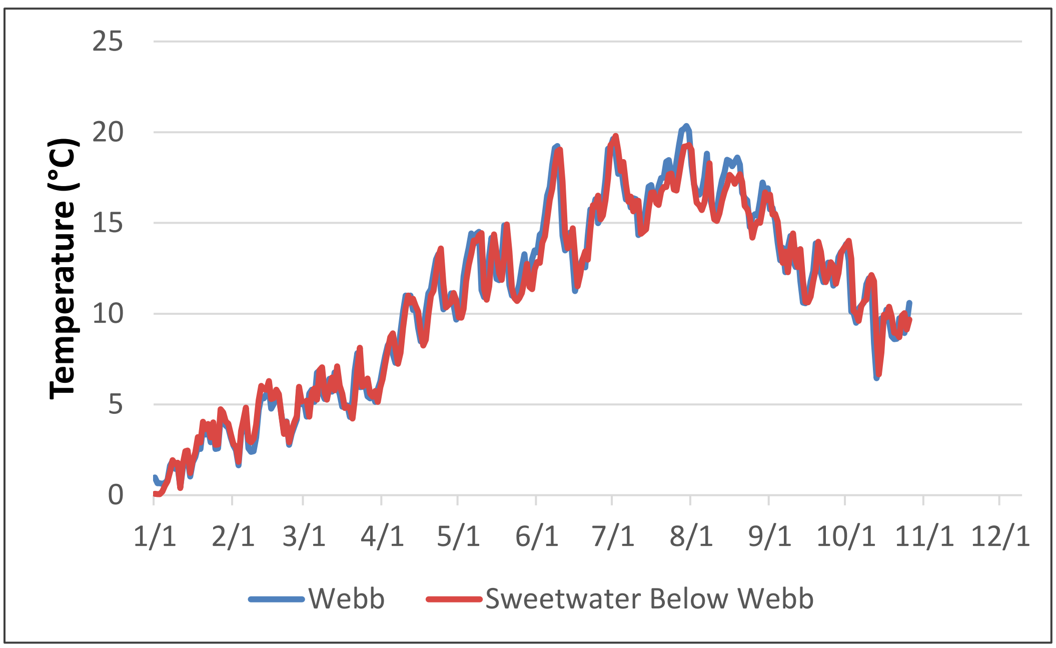
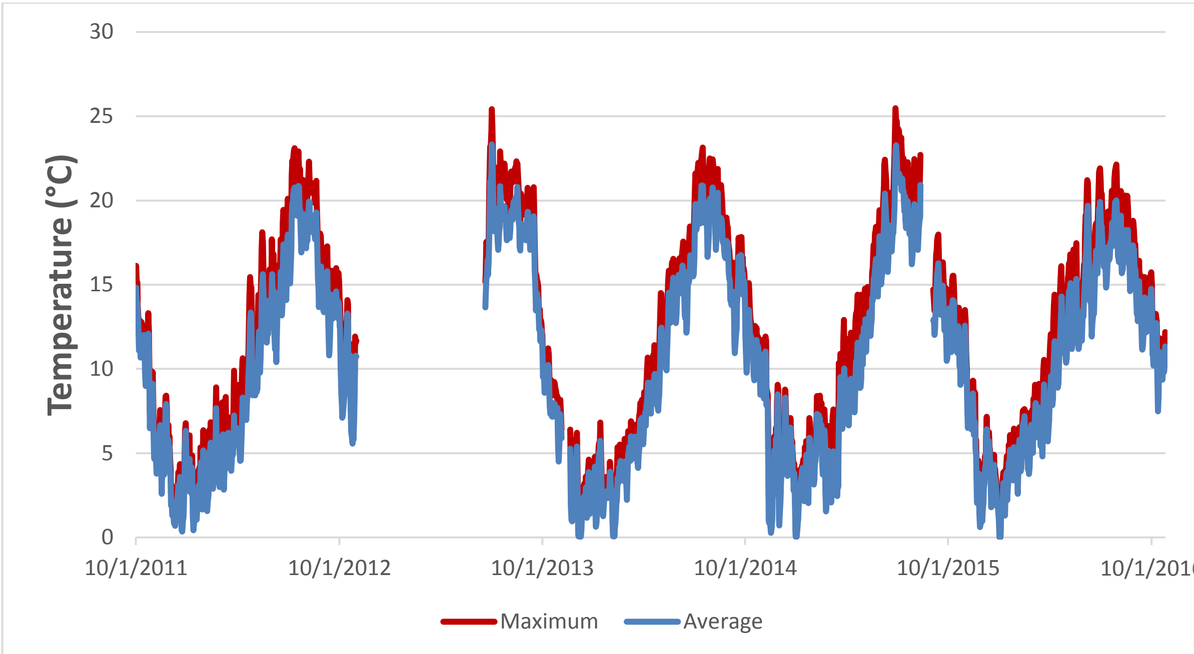


Figure 13. Mean daily stream temperature (°C) measured at the mouth of Webb Creek compared to mean daily temperature just downstream of the Sweetwater and Webb creek confluence.

The final logger location on the mainstem Sweetwater Creek system was at the mouth of Sweetwater Creek before it meets with Lapwai Creek (Figure 14). There is a small heat gain between the Webb and Sweetwater confluence down to this site at Sweetwater Creek mouth (Figure 15).



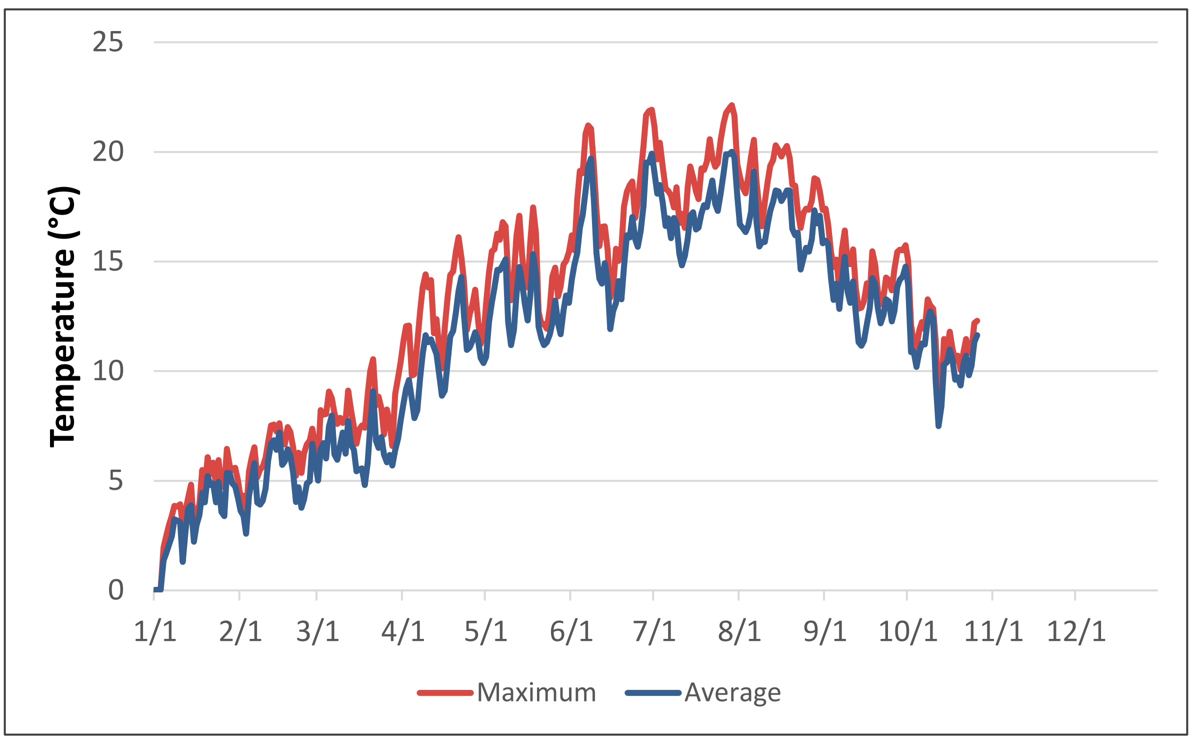


Figure 14. Maximum and average daily stream temperature (°C) measured near the Sweetwater Creek mouth.

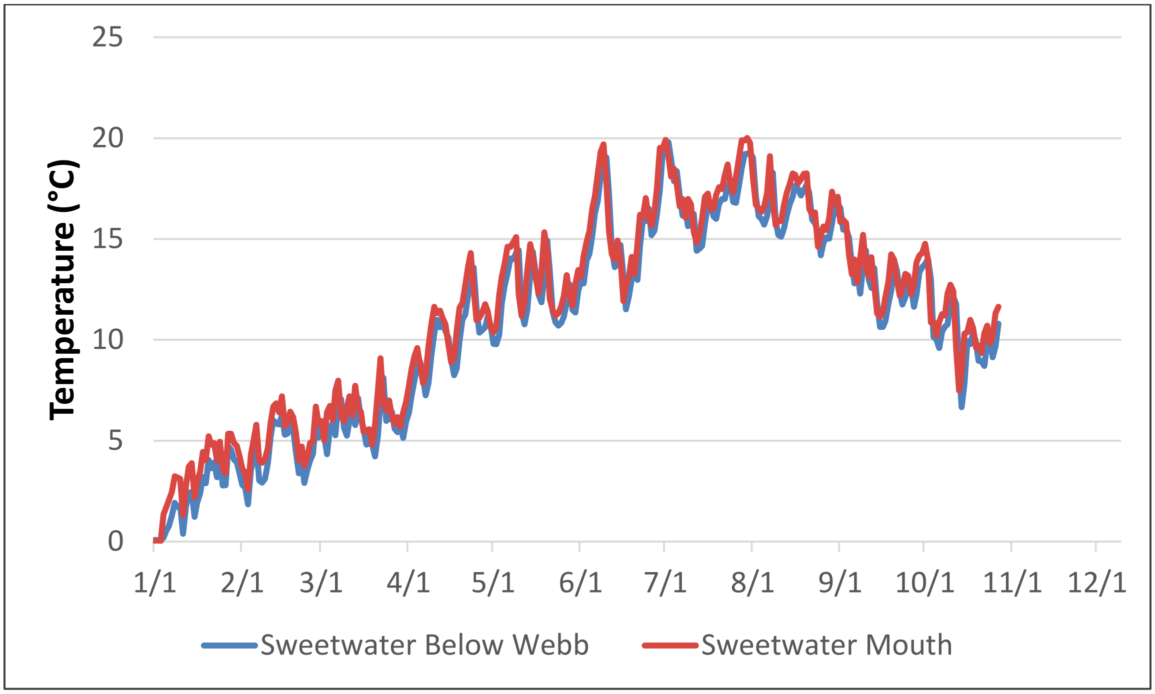
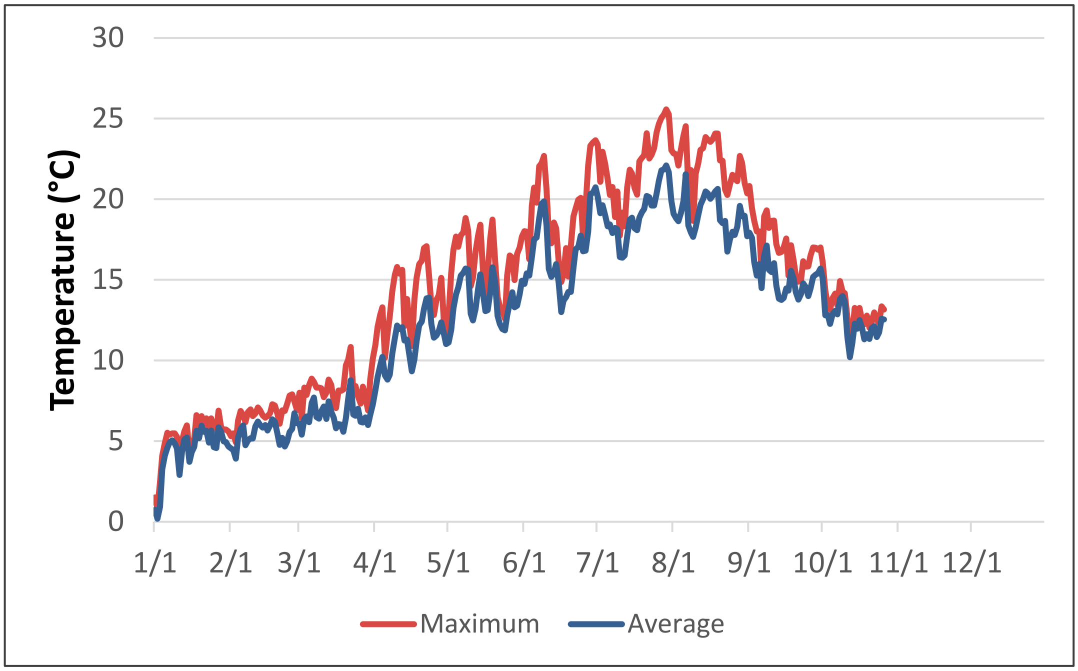


Figure 15. Mean daily stream temperature (°C) measured upstream from the Webb Creek confluence with Sweetwater Creek compared to mean daily temperatures measured near the mouth of Sweetwater Creek.

Lapwai Creek

Reclamation also collected temperature data at four locations in Lapwai Creek. The first of these was just above the Sweetwater Creek confluence (Figure 16).



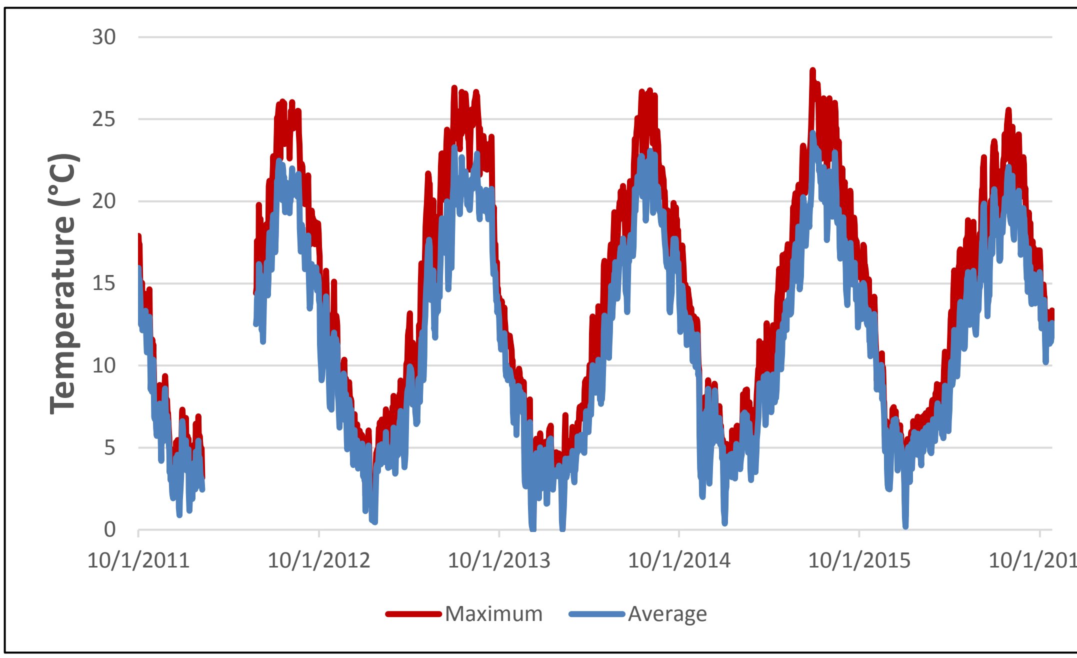


Figure 16. Maximum and average daily stream temperature (°C) of Lapwai Creek measured upstream from Sweetwater Creek.

The second Reclamation data collection location on Lapwai Creek was downstream from the Sweetwater Creek confluence, which allows for comparison with the effects from Sweetwater Creek (Figure 17). The influence of Sweetwater Creek cools Lapwai Creek down, especially during the summer (Figure 18). The following graphs show the slow increase in temperatures from downstream from the confluence of Sweetwater Creek to the mouth of Lapwai Creek (Figure 19 through 21).

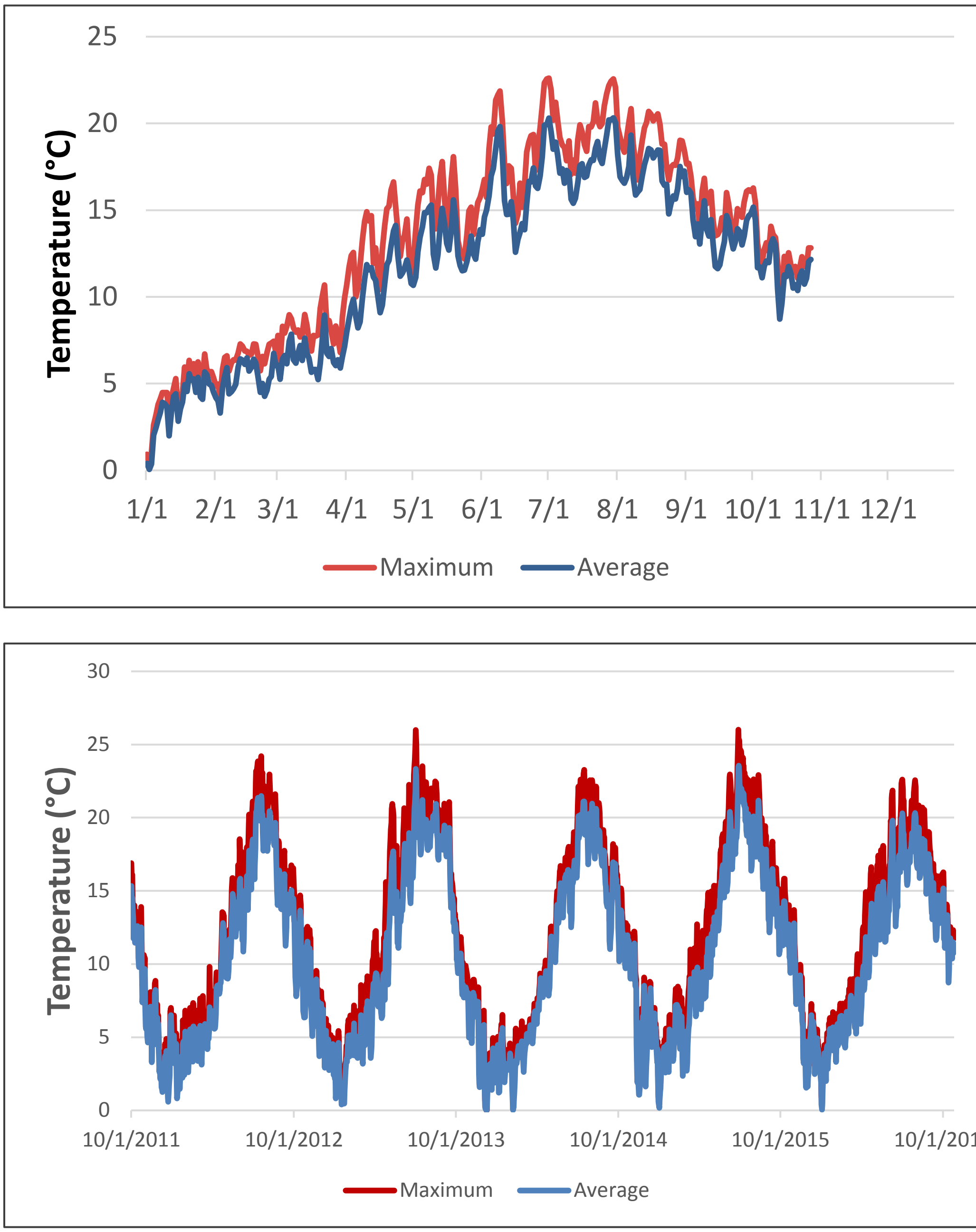
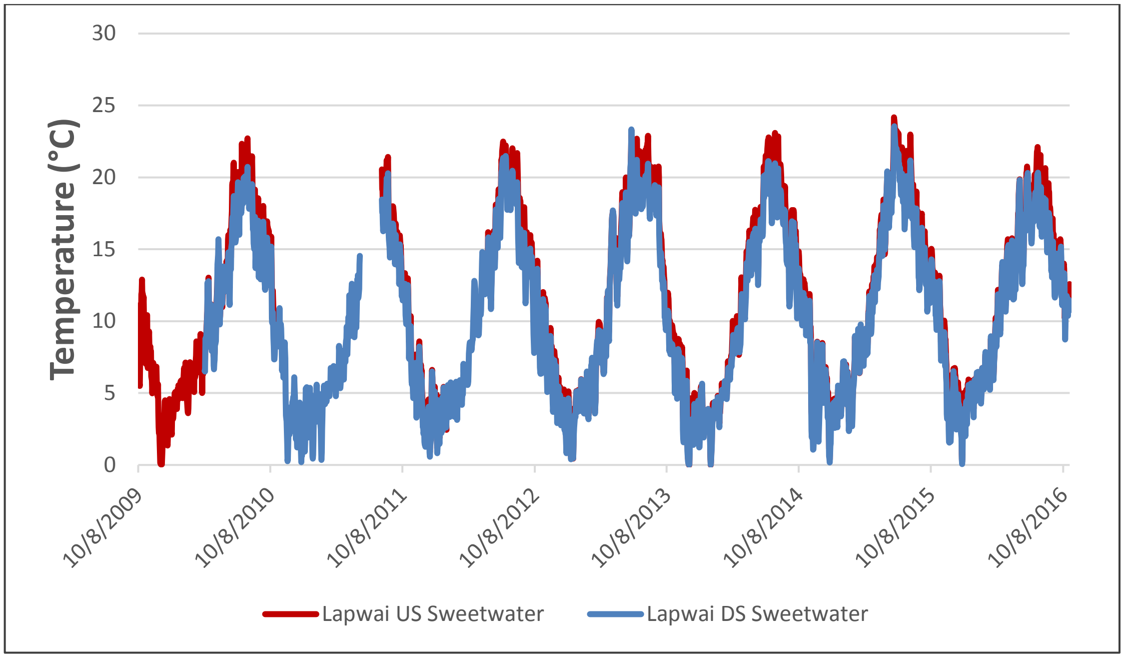


Figure 17. Maximum and average daily stream temperature (ºC) of Lapwai Creek measured downstream from Sweetwater Creek.



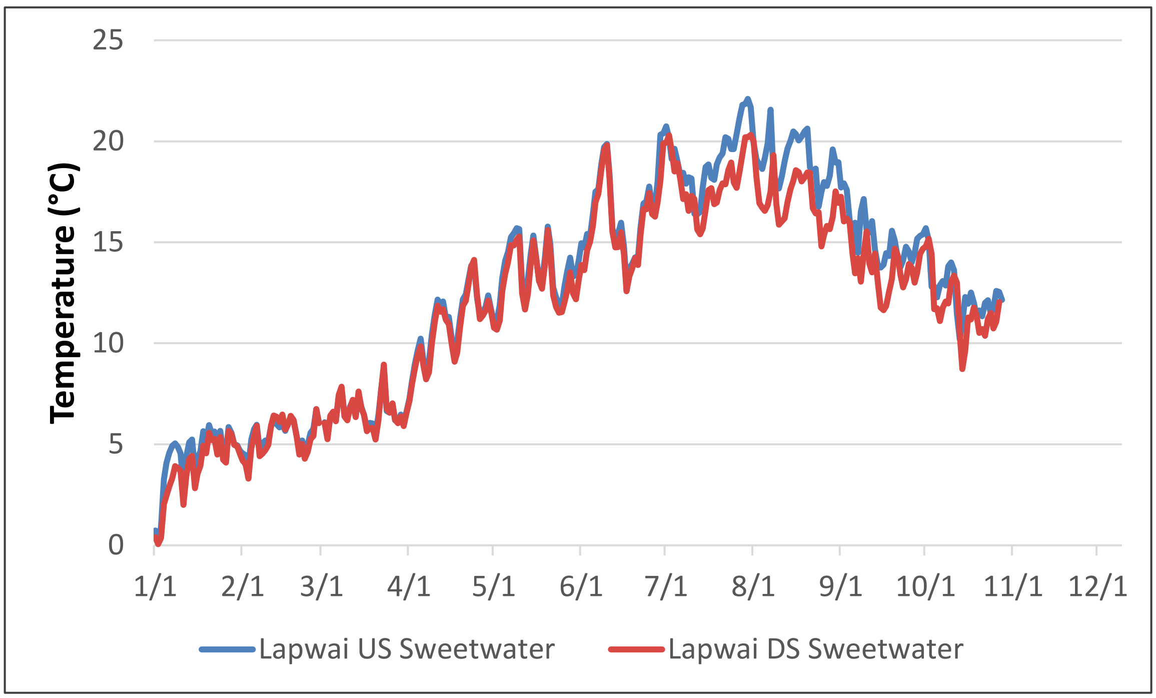


Figure 18. Mean daily stream temperature (°C) of Lapwai Creek measured upstream and downstream from the Sweetwater Creek Lapwai Creek confluence.

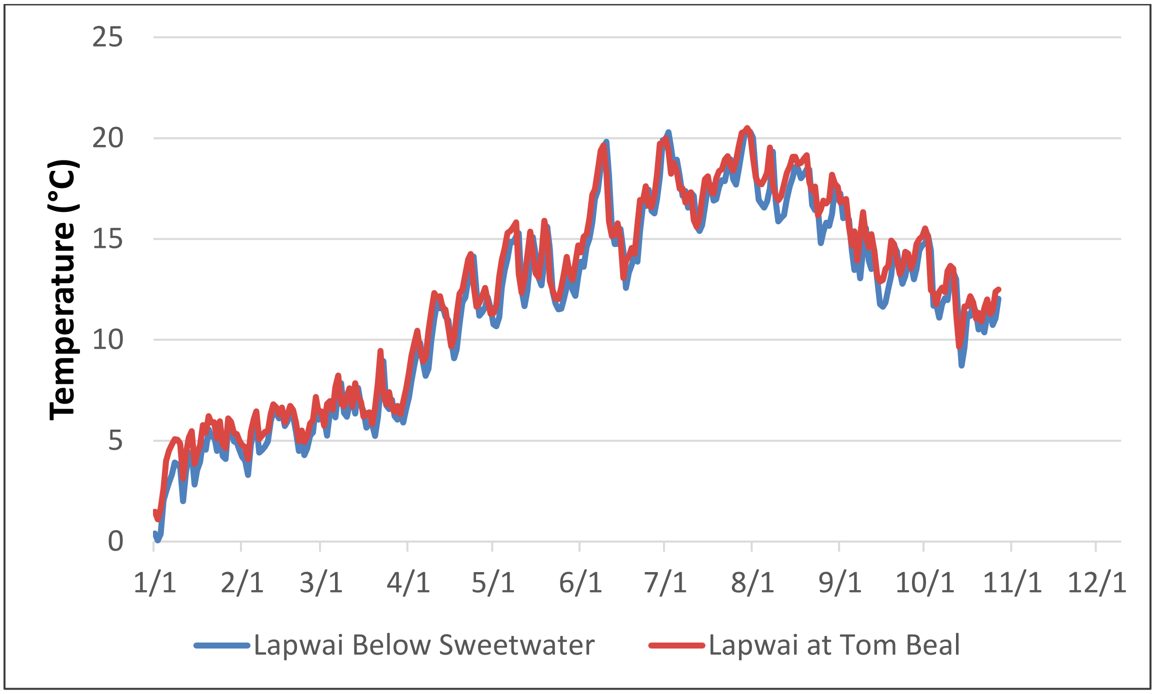


Figure 19. Mean daily stream temperature (°C) of Lapwai Creek measured downstream from the Sweetwater Creek Lapwai Creek confluence and near the Tom Beal Creek confluence.

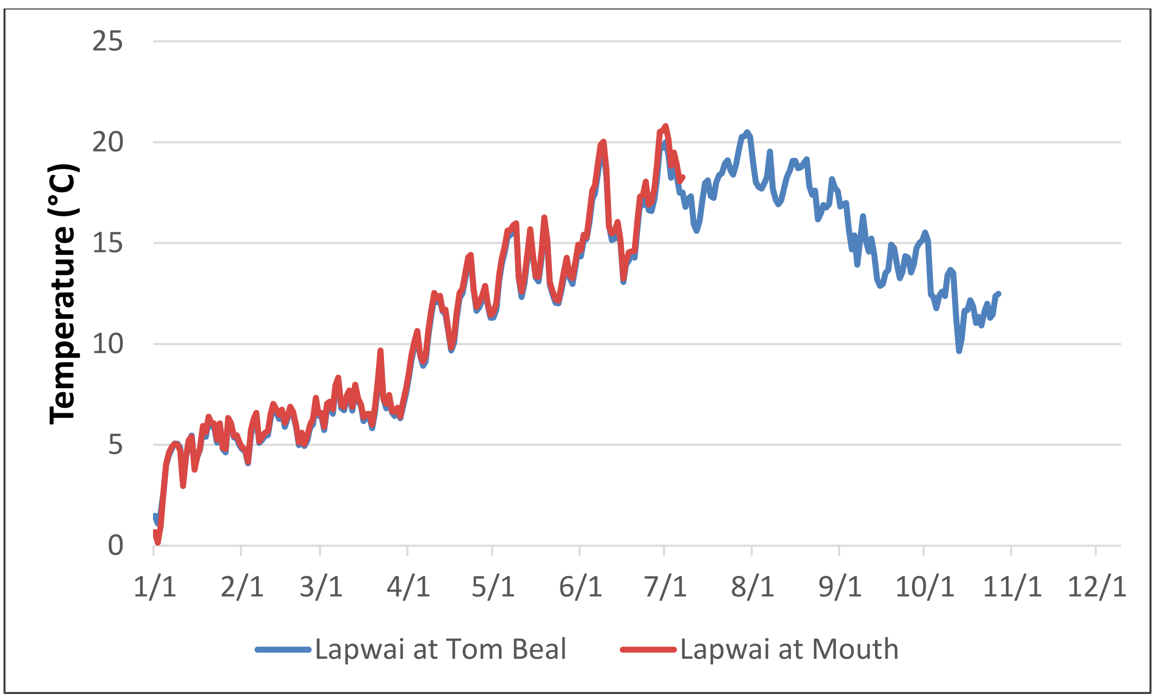


Figure 20. Mean daily stream temperature (°C) of Lapwai Creek measured near the Tom Beal Creek confluence and the mouth of Lapwai Creek.

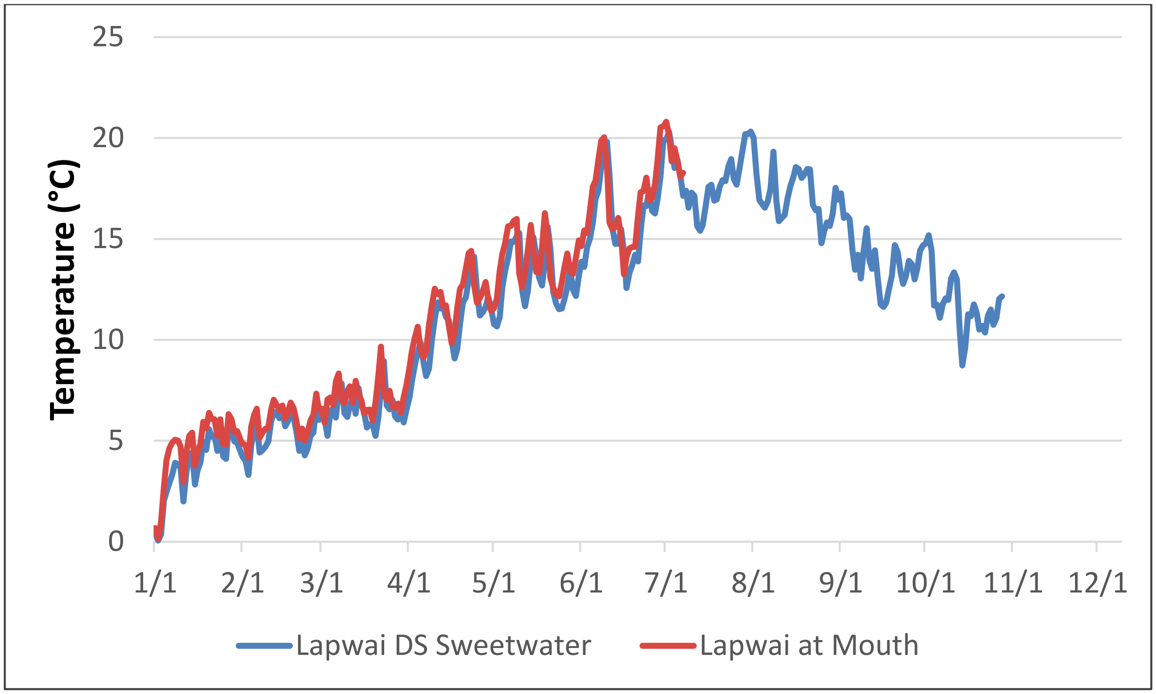


Figure 21. Mean daily stream temperature (°C) of Lapwai Creek measured downstream from the Sweetwater Creek Lapwai Creek confluence and the mouth of Lapwai Creek.

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 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
Kennedy et al. 2016	Kennedy, B.P., K.M. Myrvold, R. Hartson, and E. Benson. 2016. *Lewiston Orchards Project: Sweetwater Basin flow fish study*. Progress report prepared by the University of Idaho, Moscow, Idaho. Submitted to the Bureau of Reclamation, Snake River Area Office, Boise, Idaho.
NMFS 2010	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.
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.
Reclamation 2010	U.S. Bureau of Reclamation. 2010. *Lewiston Orchard Project 2009 Annual Report for activities under the Endangered Species Act 2010 Opinion*. Submitted to the National Marine Fisheries Service, Boise, Idaho.
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.
Reclamation 2012	U.S. Bureau of Reclamation. 2012. *2011 Annual Report on Monitoring and Implementation Activities Associated with the USFWS 2005 Biological Opinion for Operation and Maintenance of the Bureau of Reclamation Lewiston Orchards Project.* Snake River Area Office, Boise, Idaho.

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APPENDICES

APPENDIX A

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)

APPENDIX B

UNIVERSITY OF IDAHO 2016 REPORT
"THE ECOLOGY OF *ONCORHYNCHUS MYKISS* IN THE LAPWAI BASIN: DENSITY AND GROWTH MONITORING

The ecology of *Oncorhynchus mykiss* in the Lapwai Basin: Density and growth monitoring

Continuation of the Lewiston Orchards Project:
Sweetwater Basin Fish & Flow Study

Period of Study: July 1, 2014 – May 31, 2019

Progress report (July 2015 – December 2015) prepared for:

Bureau of Reclamation

USBR Snake River Area Office

Boise, Idaho

Prepared by:

Brian P. Kennedy

with

Natasha Wingerter, Ph.D.; Jeff Caisman, M.S. student; and Knut Marius Myrvold, post-doctoral researcher

Department of Fish and Wildlife Resources and Water Resources Graduate Program

College of Natural Resources

University of Idaho

LAPWAI ACTIVITIES REPORT 2014

Introduction and Background

The Bureau of Reclamation owns a series of water storage reservoirs, diversion dams and canals that provide irrigation water to the Lewiston Orchards area of Lewiston, Idaho. The Lewiston Orchards Project (LOP) is operated by the Lewiston Orchards Irrigation District (LOID), which distributes the water to agricultural, urban and suburban users. The Lewiston Orchards Project is contained entirely within the Lapwai Creek watershed. In order to maintain minimum water supplies to these users during long dry summer growing seasons, operations of the water diversions capture much of the water that would naturally be feeding Webb and Sweetwater Creeks, which together comprise approximately half of the area of the Lapwai basin.

Lapwai Creek contributes to one of the 6 major population groups (MPG), the Clearwater River, of the Snake River *Distinct Population Segment* (DPS) of federally endangered steelhead, *Oncorhynchus mykiss*. Within the Clearwater MPG, Lapwai provides a portion of the spawning and rearing habitat within one of 5 functional populations of interest (the Clearwater River – Lower Mainstem population). The LOP withdraws water from these creeks, some of which are designated as critical habitat for this subpopulation. Importantly, the major temporal impact that water withdrawals have are during the summer months when juvenile fish are trying to gain mass before smolting (migrating to the ocean) and diversion operations can have measureable impacts on in-stream flows. Decreased flows during spring may also impact spawning of adult A-run *O. mykiss* in the basin (NOAA 2006). Temporally, impacts during the other times of year are expected to be less severe. Spatially, the Lapwai basin likely represents habitat that could have supported approximately 1-2% of the population of the Clearwater-Lower Mainstream (CRLMA) population of the Snake River DPS (289 watersheds and 26 independent populations).

On April 15, 2010, the Bureau of Reclamation received the Biological Opinion prepared by National Ocean and Atmospheric Administration Fisheries (NOAA) pursuant to the Section 7(a)(2) of the Endangered Species Act (ESA) on the effects of the operation and maintenance of the Lewiston Orchards Project (Project). In this Opinion, NOAA concludes that the proposed action is not likely to jeopardize the continued existence of ESA listed species or adversely modify critical habitat. Reclamation and NOAA have cooperatively proposed a monitoring plan that includes annual monitoring activities and critical uncertainties relevant to this project (Reclamation 2011). This monitoring plan identifies the University of Idaho as an independent scientific entity who has been working on questions related to steelhead growth and survival since 2007 and identifies a more focused monitoring plan that seeks to identify annual and spatial trends in abundance and growth of juvenile steelhead in sites for which long term data now exist. Reclamation will continue these research activities to complete investigation into these critical uncertainties through 2019. This Interagency Agreement implements specific tasks from this monitoring plan using the University of Idaho as an independent research institution. The University of Idaho has been working on several of the tasks listed below since 2007, and this agreement will complete this research effort aimed at providing specific information on the impacts of the Lewiston Orchards Project operations on listed *O. mykiss* in the Lapwai Basin and understanding the status and role of the Lapwai Basin in relation to the Snake River ESU and Lower Clearwater Local Population.

Understanding the effects of hydrologic changes on fish populations requires an integrative approach that addresses 1) how the growth potential of individual fish is affected, 2) how changes in growth and growth potential influence survival of individuals and, ultimately, how processes for the individual scale up to population level dynamics, and 3) how population dynamics are influenced by altered connections among subpopulations. These changes can be a direct result of hydrologic change (Lopes et al. 2004) or an indirect effect through altered temperatures, productivity or trophic relationships (Almodovar and Nicola 1999, Horne et al. 2004, Hartson and Kennedy 2014, Myrvold and Kennedy 2014). Our monitoring efforts will continue to address how environmental conditions in the Lapwai system influence density, growth, and survival of juvenile *O. mykiss* and are designed to identify mechanistic relationships between fish performance and habitat. Herein, we report on the data collection and results from our seventh field season in the Lapwai basin.

Six of the possible 16 sites monitored in 2010 - 2013 were selected for continued abundance measurements of *O. mykiss* in 2014 - 2019 in order to quantify spatial and temporal variation among sites. The 16 original sites were intended to identify variables related to growth and production representing the elevation, geologic and ecological gradients across the Lapwai Basin. The six continued-monitoring sites were selected such that all sites provide enough production for a robust statistical design, and such that both impacted and “unimpacted” sites in the basin are represented. Unimpacted in this context is meant to simply refer to those sites that are not directly affected by BOR projects; impacts from land use, roads and other local disturbances are realized and documented.

As outlined in the monitoring plan for this project, beginning in 2014, the University of Idaho has begun (and will continue) ongoing research on the following tasks, in accordance with the timeline detailed in Table 1:

Task 1.1: Capture, PIT tag, and collect data on juvenile *O. mykiss* (i.e., length, weight, condition factor) at six established monitoring sites during the juvenile growing season (July - September) 2014 - 2019.

Task 1.2: Cooperatively collect and edit stream temperature data with Reclamation, Snake River Area Office and LOID efforts.

Task 1.3: Use data collected in task 1.1 to compare observed juvenile *O. mykiss* densities across years sampled at six established monitoring sites from 2008 through 2013 (and more sites if available, i.e. between 2010 and 2013).

Table 1. Reporting timeline (timeline of research activities in agreement).

Task	Deliverable	Draft due	Final due
1	Annual reports that include: data summary, *O. mykiss* density and growth estimates (with confidence intervals) and other data collected during the previous year	Feb 1, 2015 for 2014; and each year thereafter.	Mar 1, 2015 for 2014; and each year thereafter to 2019.
2	Synthesis of density trends based upon annual monitoring activities	Sept 30, 2019	Dec 31, 2019
3	Final Financial and Performance Reports	Feb 1, 2015 for 2014; and each year thereafter.	Mar 1, 2015 for 2014; and each year thereafter to 2019.

Methods

Study sites

In the first year of the study (2008) we established six study sites at which to obtain consistent information on productivity, fish population metrics, and mark-recapture information throughout the growing seasons. In the second year of the study, 2009, we continued sampling at five of these sites and moved one site (lower Lapwai) upstream approximately 4 km in an effort to sample more representative *O. mykiss* rearing habitat (Hartson and Kennedy, 2014). In 2010 and 2011 we continued to sample the same six sites as in 2009, and sampled ten additional sites (Fig. 1) despite our funding obligations only requiring monitoring at the original six sites. We learned from our 2008-09 field seasons that the survival and emigration models were data intensive and ideally were based upon more individually-tagged fish than we were sampling.

We developed a new naming scheme for our sites in 2010 (Table 2) in which the six sites from 2009 were renamed to fit the new naming scheme. Lower Lapwai is now lower Lapwai lower (LLL), lower Sweetwater is now lower Sweetwater (LSX), upper Sweetwater is now upper Sweetwater middle (USM), lower Webb is now upper Webb middle (UWM), upper Lapwai is now upper Lapwai upper (ULU) and upper Mission is now upper Mission upper (UMU). Each site is approximately 100 m in length. We added two sites to each of the tributaries (Sweetwater, Webb, Mission, and Lapwai), one on Lapwai below the Mission confluence (MLX), and one site on Lapwai below the Sweetwater confluence (LLU). In sum, nine of the 16 sites are considered within the project affected area, however, all sites represent some level of anthropogenic alteration, as even those outside of the affected area exhibit some hydrographic (e.g. irrigation withdrawal) and some geomorphic (e.g. leveeing) alteration.

In 2012 and 2013 we scaled back our sampling efforts in response to reduced field support. We sampled nine of the 16 sites that were sampled in 2010 and 2011; five are considered within the project affected area (LLU, LSX, USM, USU, and UWM), while four are not within the project affected area (MLX, ULU, UMM, and UMU). The nine sites we sampled spanned the environmental conditions in the basin, and the temporal detail was similar to previous years.

As the density and growth monitoring phase of the project began in 2014, we scaled back our sampling efforts to focus on six of the 16 sites that were sampled in 2010 and 2011: LSX, USU, UWM, MLX, ULU, and UMU (Table 2; Fig. 1). Sites were sampled three times over the field season. These six sites reflect the variety of environmental conditions within the basin, represent all four main tributaries, and four of them have been sampled consistently since the beginning of our fieldwork in the Lapwai basin in 2008. Half of the sites fall within the project affected area (LSX, USU, and UWM); the other half do not (MLX, ULU, and UMU).

Study design

Task 1.1: Density Monitoring

We visited each site once every five weeks between late July and early October 2015, resulting in three visits to each site despite our funding obligations only requiring two monitoring visits at each site; three visits allowed us to estimate growth rates over two periods. The dates for the visits are shown in Table 2. At each visit we collected data on: 1) the fish community and individual steelhead in particular, 2) the energy resources in the streams, and 3) a suite of physical environment factors.

Benthic invertebrate samples were collected using a Surber sampler (250 um mesh) at the six sites on all visits of the field season (dates shown in Table 2) as a measure of energy resources available in the streams. Due to the time consuming nature of processing invertebrate samples, we have not yet processed or analyzed the benthic samples from 2015.

In order to estimate habitat availability for juvenile *O. mykiss,* we measured physical habitat variables at each site during summer base flows (August 25-September 1), the period when impacts of water withdrawal were expected to be greatest. We established transects perpendicular to the channel five meters apart throughout the entire electrofishing reach, with the first transect 2.5 m above the lower end of the reach. We quantitatively measured wetted channel width and counted the number of large woody debris pieces (LWD; debris > 100 mm diameter and 1 m long) within 30 cm of each transect. Each transect was then split into five sections of equal width. We measured velocity using a Marsh McBirney flow meter (cm sec^{-1}), depth (using a wading rod), substrate size (D50), and visually estimated whether there was overhanging cover with live vegetation 2 m or less above the water surface, or undercut banks in each of the five sections of each transect.

Fish were captured during three-pass depletion electrofishing surveys (described below); non-salmonids were identified to species (except for sculpin, which were identified to family), counted, and batch-weighed in order to determine average individual weight for each taxa and each pass.

Task 1.2: Data Collection

We employed a combination of direct counting and mark-recapture techniques to estimate *O. mykiss* abundance and density. Direct counts were made by conducted three-pass depletion electrofishing surveys. For depletion estimates of population size we used R-gui and based our calculations on the methods of Carle and Strub (1978). Combined with estimates of stream area taken following each electrofishing effort, we used these population estimates to calculate densities of *O. mykiss*. Steelhead were scanned for a PIT (passive integrated transponder) tag, and, if not present, fish ≥ 65 mm (fork length) were equipped with one. For both first-time captures and recaptures, lengths and weights were recorded; recaptures were noted.

PIT tags are small glass encapsulated tags that are inserted into the body cavity of the fish; each tag has an individual identification code, making it possible to follow individuals through time in their natural environment. Additionally, PIT tags are used to monitor salmon and steelhead throughout the Columbia Basin, allowing fish that migrate out of our study area to be detected during outmigration and allowing us to make inferences about the migration behavior and success of juvenile fish tagged in the study area.

Fish recaptured over time were used to assess growth during various seasonal and environmental conditions as well as survival. We estimated age-specific cohort growth by measuring the change in average size of all individuals of each age class (subyearling and yearling) present at a site. Individual growth estimates were made by comparing recorded length and weight data over time for fish that were recaptured. We also used length and weight data to calculate the Fulton condition factor of *O. mykiss* individuals using the following equation:

$$K = (W(g)/L(mm)^3)*100,000$$

Individual *O. mykiss* were assigned to age classes (subyearling or yearling) using cut-off lengths based on body length histograms. Age class data are critical in order to establish environmental or annual effects on age classes within sites and to compare biomass across sites.

Task 1.3: Data summary and comparison across years of consistent sampling

We estimated *O. mykiss* density for each date we visited each site as described above. We compared densities across years over the maximum time record possible; four of the sites visited in 2015 have been monitored since 2008 (LSX, UWM, ULU, and UMU), while the other two have been monitored since 2010 (USU and MLX).

Results from reporting period (July 2015 – December 2015)

We have reported annually on the previous year's activities, and we refer to these reports for results from 2008 through 2014. Data from 2015 are presented here, and include demographic estimates (body size histograms, abundance, density, cohort growth, and condition factor) and their derivatives for juvenile *O. mykiss* and long-term *O. mykiss* density trends.

Tasks 1.1 and 1.2: Density monitoring and data collection of juvenile O. mykiss

We PIT tagged a total of 970 individual *O. mykiss* in the watershed and had 321 recapture events (any rehandled previously tagged fish – including multiple recaptures of some individuals) in 2015.

Histograms of abundance and size distributions describe the dominant patterns throughout the six study reaches (Figs. 2 – 7). In general, two size/age classes were distinguishable (i.e., sites tended to have bimodal size distributions), one composed of subyearling (0+) individuals that emerged in spring 2015 and a second composed of yearling or older fish (1+) that emerged in previous springs. During the first visit, yearling fish were usually more abundant or equal to subyearling fish (with the exception of ULU). By the second visit in late August/early September, when we were able to more effectively collect subyearlings with our sampling gear, subyearlings were relatively more abundant than they had been earlier in the season, and that pattern continued for the third and final visit of the sampling season in October. Subyearling body size at lower elevation sites (LSX and MLX) was larger on a given date compared to sites at higher elevations (USU, UWM, ULU, and UMU).

Notable abundance patterns this year included the high abundance of both subyearlings and yearlings at ULU and UMU relative to all other sites, and the high subyearling to yearling ratios observed at the sites lower in the watershed (LSX and MLX) compared to all other sites (Tables 3 – 5). In 2015, total densities of juvenile *O. mykiss* did not display the same temporal pattern across the six sampled sites. Over the course of the summer sampling season, total density increased slightly at ULU, changed little with a slight decrease at two sites (LSX and UWM), and decreased at three site (USU, MLX, and UMU) (Fig. 8). Subyearling densities displayed the same temporal pattern as total densities with the exception of ULU which decreased and UMU which increased (Fig. 9), suggesting that the relatively lower total densities early in the summer may have been due to our inability to sample small subyearlings during that time. Subyearling densities appear to display consistent spatial variation as LSX and MLX consistently had lower subyearling densities than high in the watershed). The highest densities of both age classes were consistently observed at ULU and UMU (Figs. 9 – 10). Yearling densities were relatively constant over the summer at LSX and UWM, and decreased at USU, MLX, ULU, and UMU (Fig. 10). Yearling densities were lowest at lower elevation sites (LSX and MLX), and there was little difference in density between those two sites.

We calculated cohort growth rates for juvenile *O. mykiss* over two five-week growth periods (first period = late July to late August/early September; second period = late August/early September to early October) at each site. Subyearling cohort growth rates were uniformly positive except UMU, where growth was near zero (Fig. 11). Yearling cohort growth rates were more variable, with most sites showing positive cohort growth during the first growth period (with the exceptions of USU, where growth was negative, and UMU, where growth was near zero) and positive cohort growth during the second growth period (with the exceptions of ULU and UMU, where growth was negative) (Fig. 12).

Condition factor for both subyearling and yearling fish (averaged across all individuals within an age class and site) tended to decline over the sampling season and reached a minimum at the end of the sampling season, though the pattern was variable at some sites (e.g. LSX) (Figs. 13-14). Subyearling fish had higher condition factors than yearling fish, particularly by the end of the sampling season. For both subyearling and yearling fish, condition factors at sites lower in the watershed were not substantially different from sites higher in the watershed. In general, there also did not appear to be significant differences in condition factor based on hydrologic alteration; however yearling fish at project affected sites tended to have slightly higher condition factors than yearling fish caught at control sites.

The overall mortality rate of *O. mykiss* that we handled over the course of the field season was 0.90% (Table 6), comparable to that of previous years. The majority of those mortalities (four out of seven) occurred during the first visit to the sites, when high temperatures and high fish density led to low oxygen conditions in a bucket being used to transport fish. Of the mortalities, two were yearling fish.

Task 1.3: Compare observed juvenile O. mykiss *densities across years*

Subyearling *O. mykiss* densities in 2015 fell within the range of variation we have observed in the Lapwai watershed since 2008 (Fig. 16). In previous years, subyearling densities have tended to peak in mid-summer before decreasing (though not all sites have followed this pattern in all years – notably, subyearling density increased throughout the entire field season at ULU in 2009 and 2013). In 2015 this pattern occurred at some sites (USU and UMU). We did not observe this pattern across all sites in 2015, when densities decreased throughout the field season at three sites (UWM, MLX, and ULU), and were constant at one site (LSX). Since 2008, ULU or UMU has generally been the site with the highest subyearling densities (with the exception of 2010, when subyearling densities at MLX were the highest). This pattern held true for 2015, when the highest subyearling densities during each visit were observed at ULU or UMU. Each year, the highest densities are typically observed at a control site (MLX, ULU, and UMU are all control sites); however, subyearling densities at the other control sites generally overlap with subyearling densities observed at project affected sites. As in previous years, this pattern occurred in 2015, with high densities observed at ULU but densities at other sites similar and overlapping.

Yearling *O. mykiss* densities in 2015 also fell within the range of variation we have observed in the Lapwai watershed since 2008 (Fig. 17). In previous years, yearling densities have tended to decrease throughout the field season at sites where densities are high, and to stay constantly low at sites with fewer fish (though not all sites have followed this pattern in all years; for example, densities increased throughout the season at USU in 2010). We observed this pattern at high density sites in 2015 (i.e., at USU, ULU, and UMU, where yearling densities were relatively high, density decreased over the field season), but also at relatively low density sites (LSX, UWM, and MLX). In the early years of the study (2008-2009), the highest yearling densities were observed at ULU and UMU, while other sites had low densities. Over the next four years (2010-2013), yearling densities continued to be low at LSX, but other sites were more variable, with no site consistently having the highest densities. In 2014 and 2015, we observed a repeat of the earlier pattern, with the highest yearling densities observed at ULU and UMU during each visit.

Additional Outreach and Educational Activities

In addition to the field density monitoring program, the following products of the Sweetwater – Lewiston Orchards juvenile steelhead project have been accomplished during this reporting period.

- We have published one manuscript to an international journal (Ecosphere, 2015) recently (Myrvold and Kennedy), and another was submitted for revisions at the Canadian Journal of Fisheries and Aquatic Sciences (see below for complete list of published manuscripts).
- One student, Jeff Caisman, funded by both this agreement and the previous agreement (#R12AC11005) completed his entitled, "Partial migration in Steelhead (*Oncorhynchus mykiss*): Identifying factors that influence migratory behavior and population connectivity across a watershed"
- Two manuscripts have been prepared for publication from Jeff Caisman's thesis entitled, "Variability of life history expression in *Oncorhynchus mykiss*: Causes of partial migration," and "Effects of barriers on movement, gene flow, and life history expression of *Oncorhynchus mykiss* in Lapwai Creek, Idaho" respectively.
- We have worked on the preparation and submission of at least one other manuscripts (Taylor, Myrvold and Kennedy 2015) for journal review.
- Talks were given at the national AFS meeting in Portland as well as internationally in Spain for a population dynamics of freshwater salmonids symposium (see below for complete list of conference proceedings).
- We initiated and finalized preparations and equipment inventory and maintenance for 2016 field season.

At the end of the summer of 2014, Ph.D. student Natasha Wingerter joined the Kennedy lab. She continued her involvement with the project throughout 2015. She helped supervise and support field sampling efforts during the summer. She is also working on processing macroinvertebrate and diet samples in the lab, and is continuing to analyze the data gathered from those samples. Natasha plans to present her findings at the Society of Freshwater Science's national meeting in May 2016.

The following are manuscripts and presentations from 2015 that were enabled by this funding:

Manuscripts

*Myrvold, K.M. and **Kennedy, B.P.** (2015) Metabolic constraints and physical habitat characteristics explain the spatial variation in the strength of self-thinning in a stream salmonid. *Ecology and Evolution, In press*.

*Myrvold, K.M. and **Kennedy, B.P.** (2015) Age-specific density dependence and its impact on individual growth rates for a stream salmonid. *Ecosphere, 6(12): NA.*

*Myrvold, K.M. and **Kennedy, B.P.** (2015) Variation in juvenile steelhead densities in relation to instream habitat and watershed characteristics. *Transactions of the American Fisheries Society. In press*.

*Hartson, R.B. and **Kennedy, B.P.** (2015) Competitive release modifies the impacts of hydrologic alteration for a partially migratory stream predator. Ecology of Freshwater Fish. 24(2): 276-292. **(*Included in application packet*)**

*Myrvold, K.M. and **Kennedy, B.P.** (2015) Interactions between body mass and water temperatures cause energetic bottlenecks in juvenile steelhead. Ecology of Freshwater Fish. DOI 10.1111/eff.12151.

Conference proceedings and presentations

August 2015. *American Fisheries Society Annual Symposium, Portland, OR, USA.* Densities of juvenile steelhead in relation to instream habitat and watershed characteristics. K.M. Myrvold*, and B.P. Kennedy.

August 2015. *American Fisheries Society Annual Symposium, Portland, OR, USA.* Variability of life history expression in Oncorhynchus mykiss: causes and consequences of partial migration. J. Caisman*, and B.P. Kennedy.

May 2015. *Advances in the Population Ecology of Stream Salmonids International Symposium. Gerona, Spain.* Interactions of climate and density on survival and movements of juvenile steelhead: Results from a 7-year study. B.P. Kennedy, K.M. Myrvold, J. Caisman, R. Hartson and E. Benson.

May 2015. *Advances in the Population Ecology of Stream Salmonids International Symposium. Gerona, Spain.* Local habitat conditions explain the variation in self thinning slopes in steelhead parr. K.M. Myrvold*, and B.P. Kennedy.

February 2014. *Annual meeting for the Idaho Chapter; American Fisheries Society, Idaho Falls, ID, US.* Effects of Anthropogenic Barriers on Movement, Gene Flow Potential, and Life-History Expression of *Oncorynchus mykiss* in Lapwai Creek, Idaho. J. Caisman*, B.P. Kennedy, M.W. Ackerman, C.J. Smith and J. Stedman.

Current and Future Efforts

We are currently in the process of analyzing the following data:

- Fish community structure: spatiotemporal variation in composition, densities and the effects on *O. mykiss*
- Diet (stomach samples) and available food resources (drift and Surber samples)
- Validation of age and analysis of maternal origin (of mortalities)
- Assessing site fidelity of PIT tagged juvenile *O. mykiss*
- Identifying drivers of population densities and the effects on growth rates and movement
- Relationships between habitat conditions and steelhead densities and individual performance.

Future efforts will consist of completing the analyses listed above, as well as continuing to work on the scientific manuscripts currently in preparation. Project members also plan to attend professional meetings throughout the coming year, where they will present the findings of this project.

Tables

Table 2. Names, three-letter codes, and dates for sites sampled in Lapwai watershed from late July to early October, 2015. Sampling effort in 2015 was reduced relative to previous years; gray rows indicate sites that were not sampled in 2015. Each site in white was sampled three times throughout the field season; sites were sampled five times throughout the season in previous years, except in 2008, when they were sampled four times.

Site name	Site code	Date of first visit	Date of second visit	Date of third visit
Lower Lapwai lower	LLL	Not sampled	Not sampled	Not sampled
Lower Lapwai upper	LLU	Not sampled	Not sampled	Not sampled
Lower Sweetwater	LSX	7/24/2015	8/29/2015	9/30/2015
Middle Lapwai	MLX	7/29/2015	8/26/2015	10/04/2015
Upper Lapwai lower	ULL	Not sampled	Not sampled	Not sampled
Upper Lapwai middle	ULM	Not sampled	Not sampled	Not sampled
Upper Lapwai upper	ULU	7/28/2015	8/25/2015	10/03/2015
Upper Mission lower	UML	Not sampled	Not sampled	Not sampled
Upper Mission middle	UMM	Not sampled	Not sampled	Not sampled
Upper Mission upper	UMU	7/22/2015	9/01/2015	10/6/2015
Upper Sweetwater lower	USL	Not sampled	Not sampled	Not sampled
Upper Sweetwater middle	USM	Not sampled	Not sampled	Not sampled
Upper Sweetwater upper	USU	7/23/2015	8/27/2015	9/29/2015
Upper Webb lower	UWL	Not sampled	Not sampled	Not sampled
Upper Webb middle	UWM	7/27/2015	8/31/2015	10/01/2015
Upper Webb upper	UWU	Not sampled	Not sampled	Not sampled

Table 3. Number, population size estimated using methods of Carle and Strub (1978), and density (number m^{-2}) of *O. mykiss* captured via electrofishing at six sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU) in **late July**, 2015 (first visit to each site). Each site was approximately 100 meters in length. Original name refers to the site name used in calendar years 2008 and 2009 and associated Activities Reports, and new name refers to the site name used in calendar years 2010-2015.

Original name (2008-2009)	**New name (2010-2015)**	**Number *O. mykiss* captured**	**Population estimate (standard error)**	**Density (number m^{-2})**
Lower Sweetwater	Lower Sweetwater (LSX)	21	28(9.613)	0.049
(not sampled)	Upper Sweetwater upper (USU)	79	88(6.018)	0.273
Lower Webb	Upper Webb middle (UWM)	39	46(6.53)	0.140
(Not sampled)	Middle Lapwai (MLX)	39	50(11.012)	0.154
Upper Lapwai	Upper Lapwai upper (ULU)	193	201(4.226)	0.494
Upper Mission	Upper Mission upper (UMU)	75	79(3.33)	0.247

Table 4. Number, population size estimated using methods of Carle and Strub (1978), and density (number m^{-2}) of *O. mykiss* captured via electrofishing at six sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU) in **late August**, 2015 (second visit to each site). Each site was approximately 100 meters in length. Original name refers to the site name used in calendar years 2008 and 2009 and associated Activities Reports, and new name refers to the site name used in calendar years 2010-2015.

Original name (2008-2009)	**New name (2010-2015)**	**Number *O. mykiss* captured**	**Population estimate (standard error)**	**Density (number m^{-2})**
Lower Sweetwater	Lower Sweetwater (LSX)	8	8(0.290)	0.015
(not sampled)	Upper Sweetwater upper (USU)	59	98(33.885)	0.281
Lower Webb	Upper Webb middle (UWM)	38	46(7.642)	0.136
(Not sampled)	Middle Lapwai (MLX)	17	17(1.028)	0.061
Upper Lapwai	Upper Lapwai upper (ULU)	125	136(6.021)	0.344
Upper Mission	Upper Mission upper (UMU)	132	143(5.878)	0.397

Table 5. Number, population size estimated using methods of Carle and Strub (1978), and density (number m^{-2}) of *O. mykiss* captured via electrofishing at six sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU) in **early October**, 2015 (third visit to each site). Each site was approximately 100 meters in length. Original name refers to the site name used in calendar years 2008 and 2009 and associated Activities Reports, and new name refers to the site name used in calendar years 2010-15.

Original name (2008-2009)	New name (2010-2015)	Number *O. mykiss* captured	Population estimate (standard error)	Density (number m^{-2})
Lower Sweetwater	Lower Sweetwater (LSX)	16	18(3.694)	0.034
(not sampled)	Upper Sweetwater upper (USU)	57	61(3.564)	0.175
Lower Webb	Upper Webb middle (UWM)	27	32(5.807)	0.098
(Not sampled)	Middle Lapwai (MLX)	12	12(2.646)	0.036
Upper Lapwai	Upper Lapwai upper (ULU)	117	133(8.462)	0.366
Upper Mission	Upper Mission upper (UMU)	97	104(4.579)	0.306

Table 6. Number of *O. mykiss* mortalities during electrofishing and fish handling/processing at six sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU); includes fish <65 mm fork length. Sites were sampled three times each between late July and early October, 2015. Total number of *O. mykiss* captured on a given visit is shown in parentheses; an addition 7 mortalities occurred while working in the watershed; total mortality rate among all sites and visits during the sampling season was 0.90%.

Site code	First visit	Second visit	Third visit
LSX	1(21)	0(8)	0(16)
USU	1(79)	0(59)	0(57)
UWM	0(39)	0(38)	0(27)
MLX	0(39)	0(17)	0(12)
ULU	2(193)	1(125)	1(117)
UMU	0(75)	1(132)	0(97)

Figures

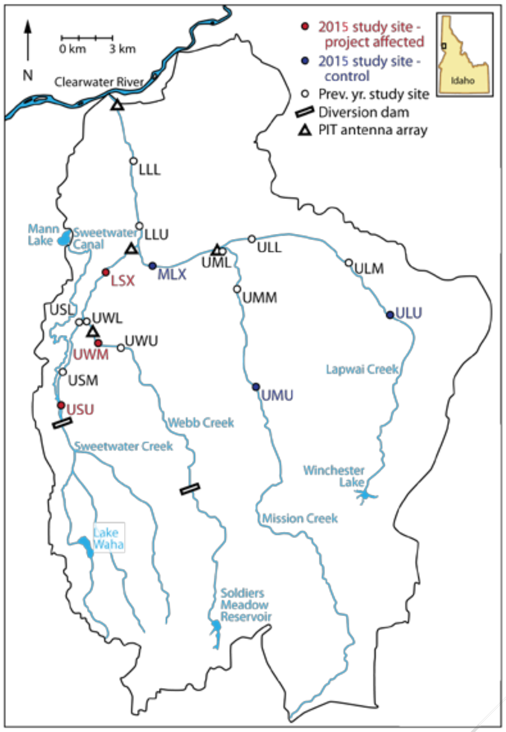

Figure 1. Study site locations in 2015 (and previous years). Red circles denote project affected sites visited in 2015, blue circles denote control sites visited in 2015, and sites visited only in previous years are represented by white circles. Diversion dams and PIT antenna arrays are also noted.

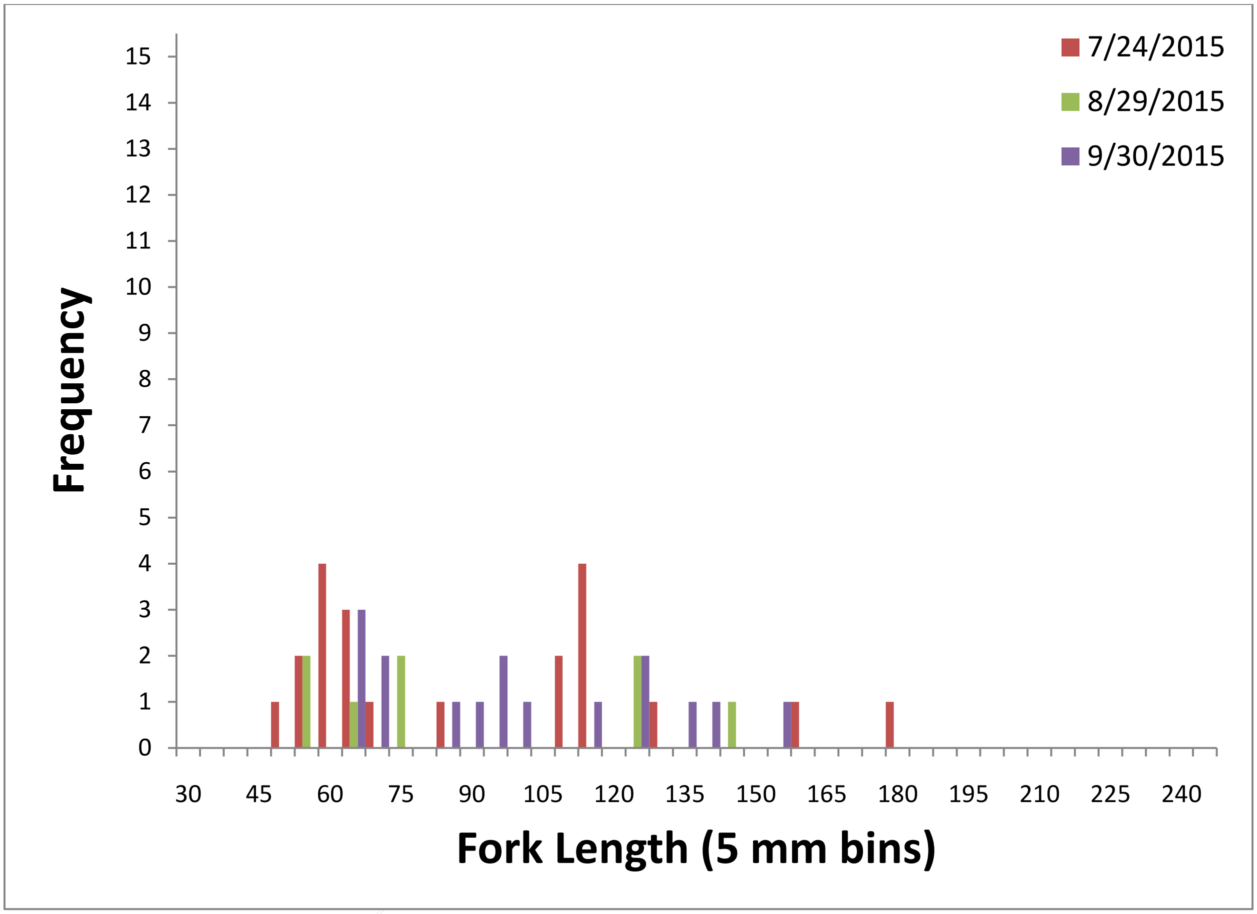

Figure 2. Histogram of juvenile *O. mykiss* fork length (mm) throughout 2015 at the lower Sweetwater site (LSX).

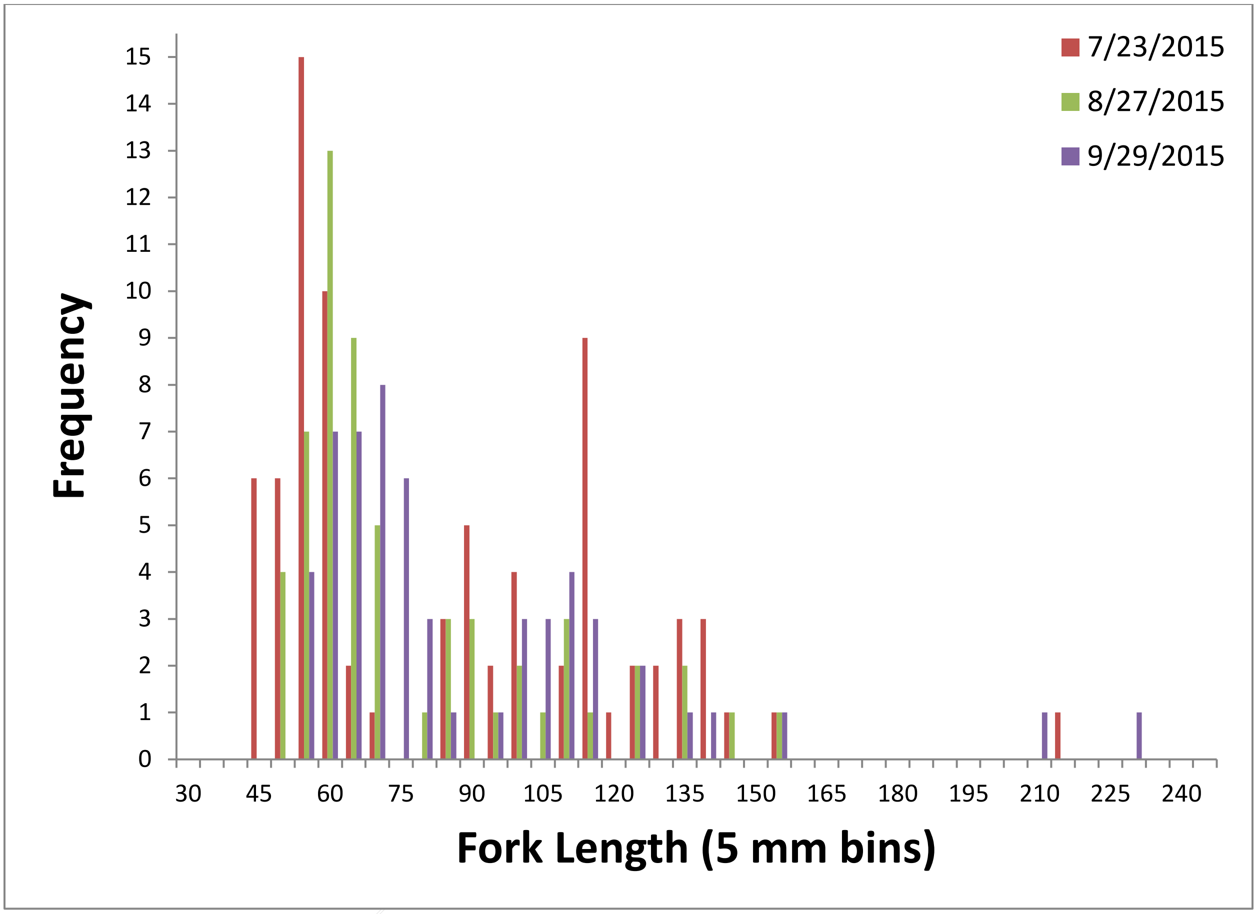

Figure 3. Histogram of juvenile *O. mykiss* fork length (mm) throughout 2015 at the upper Sweetwater upper site (USU).

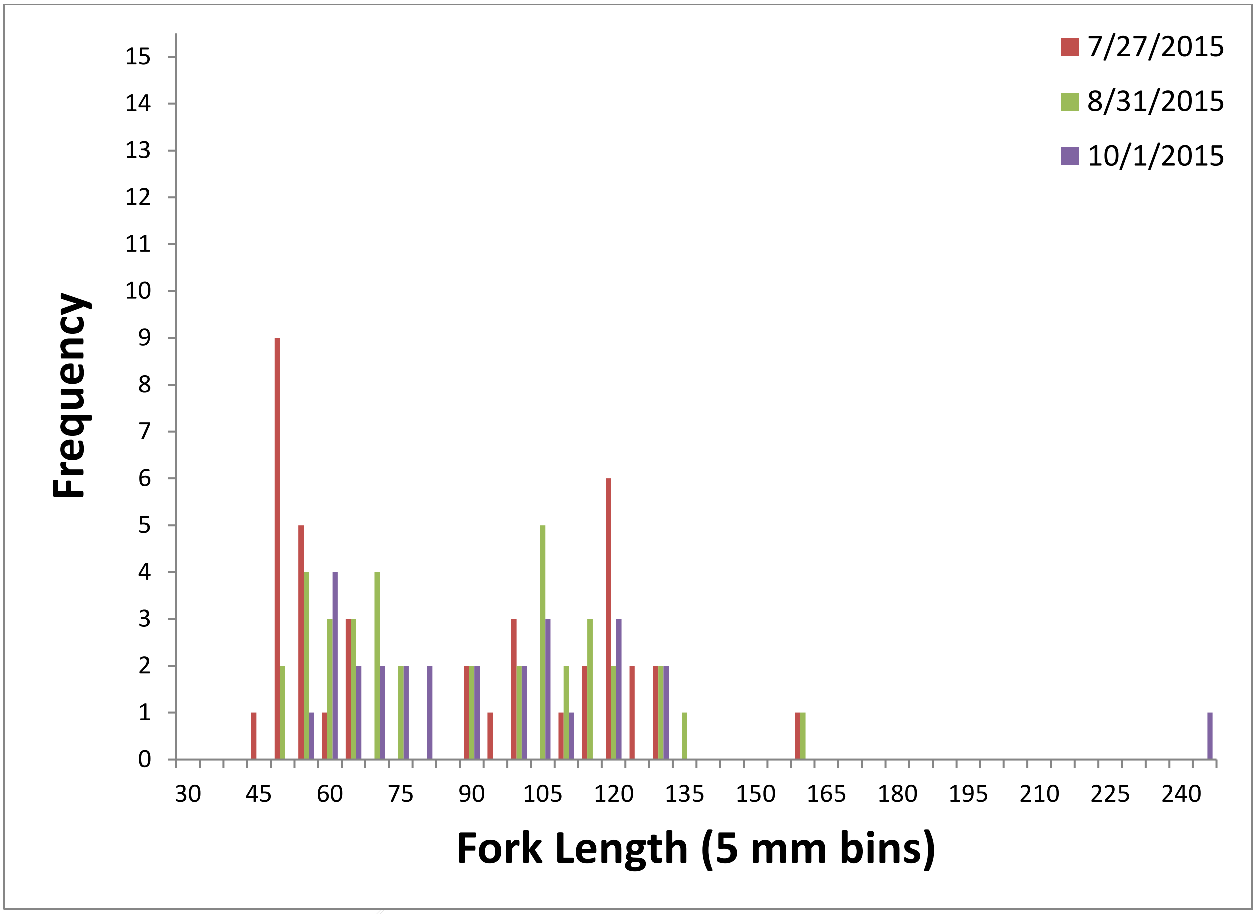

Figure 4. Histogram of juvenile *O. mykiss* fork length (mm) throughout 2015 at the upper Webb middle site (UWM).

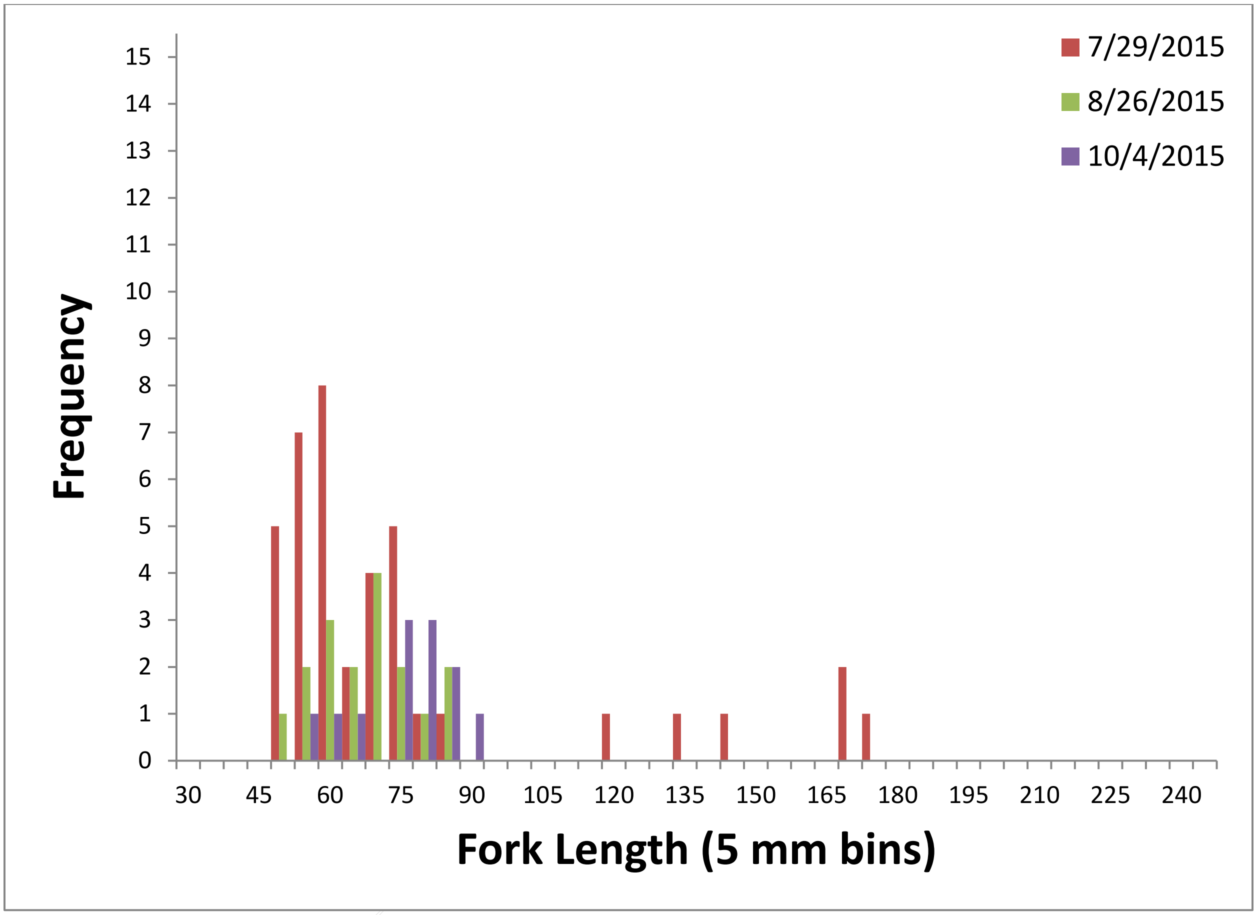

Figure 5. Histogram of juvenile *O. mykiss* fork length (mm) throughout 2015 at the middle Lapwai site (MLX).

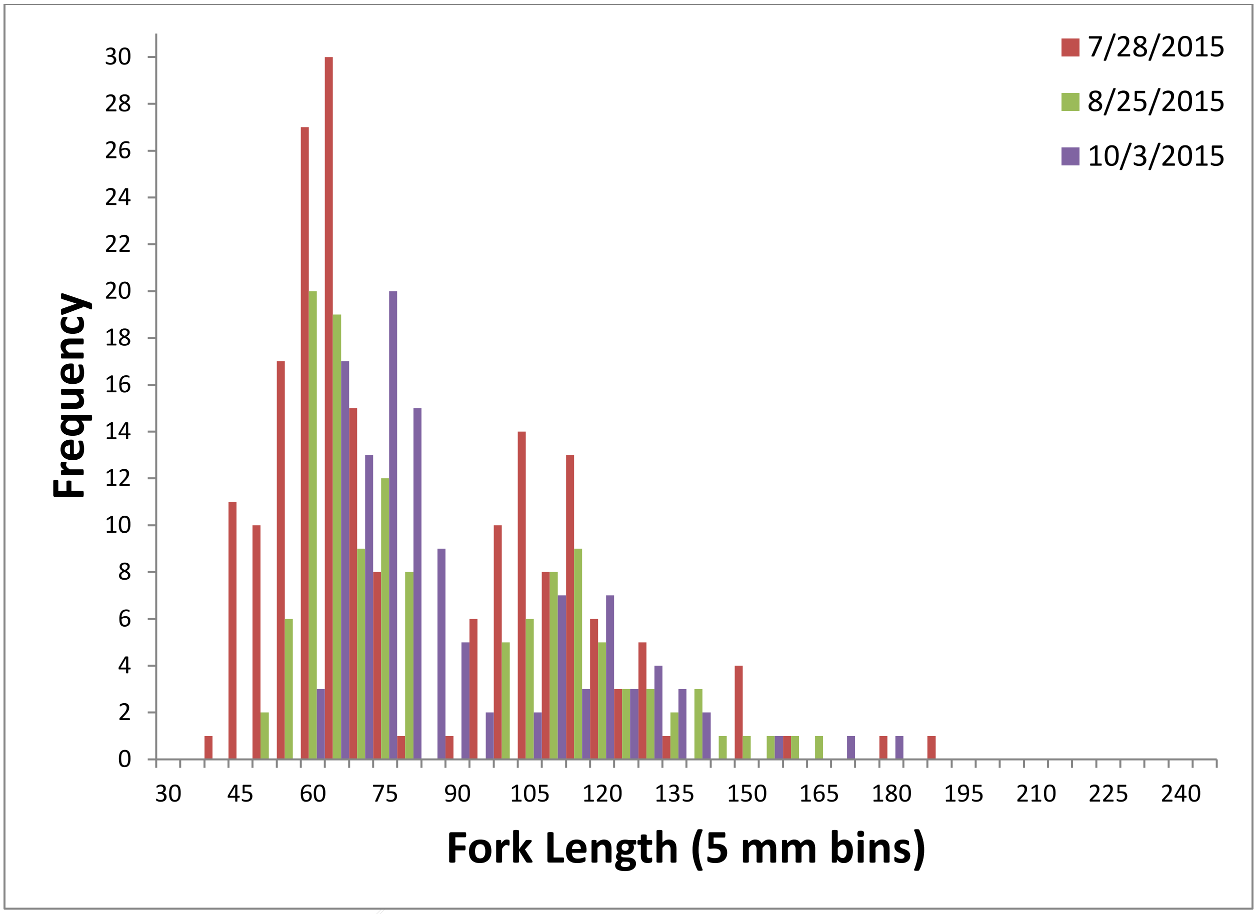

Figure 6. Histogram of juvenile *O. mykiss* fork length (mm) throughout 2015 at the upper Lapwai upper site (ULU). Note that y-axis scale is different from other histograms.

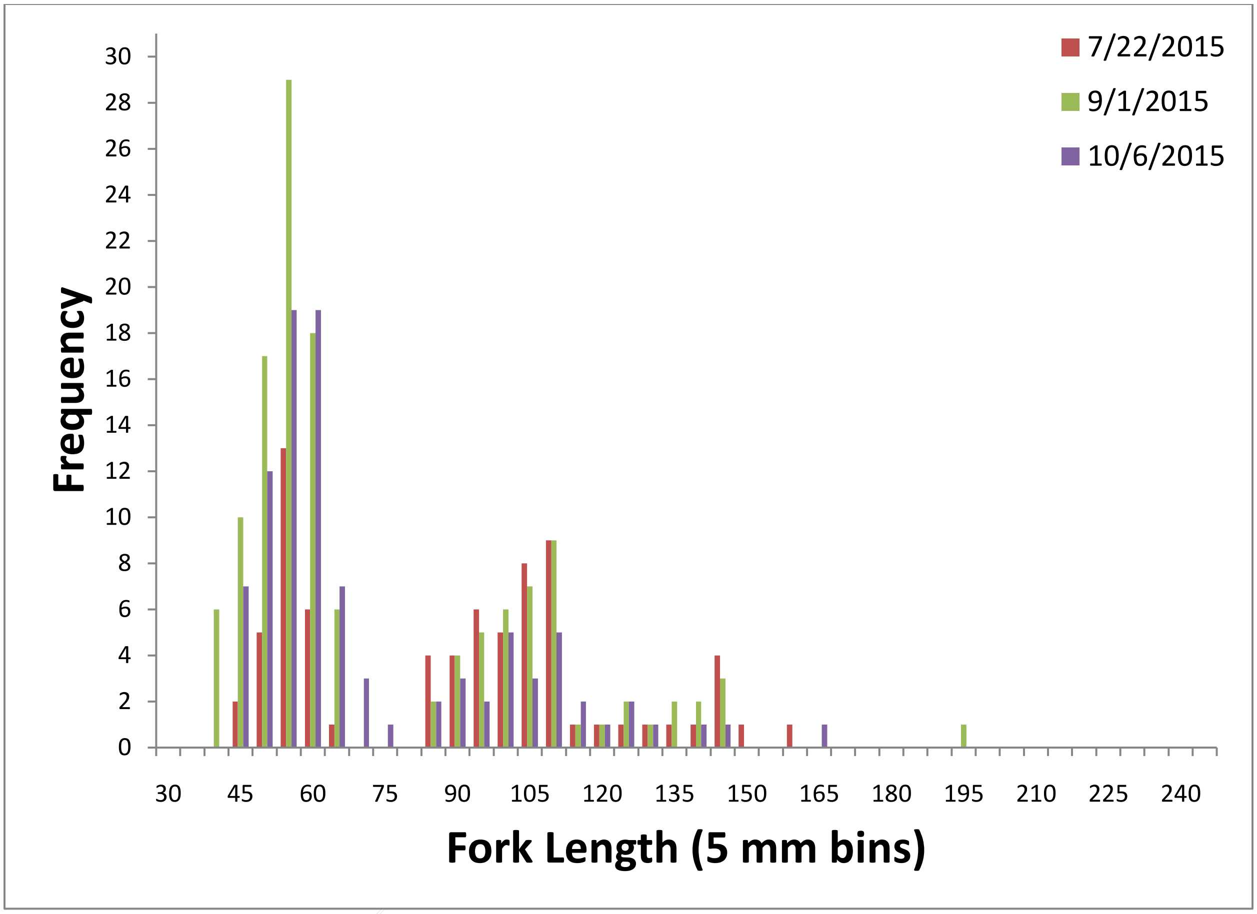

Figure 7. Histogram of juvenile *O. mykiss* fork length (mm) throughout 2015 at the upper Mission upper site (UMU). Note that y-axis scale is different from other histograms.

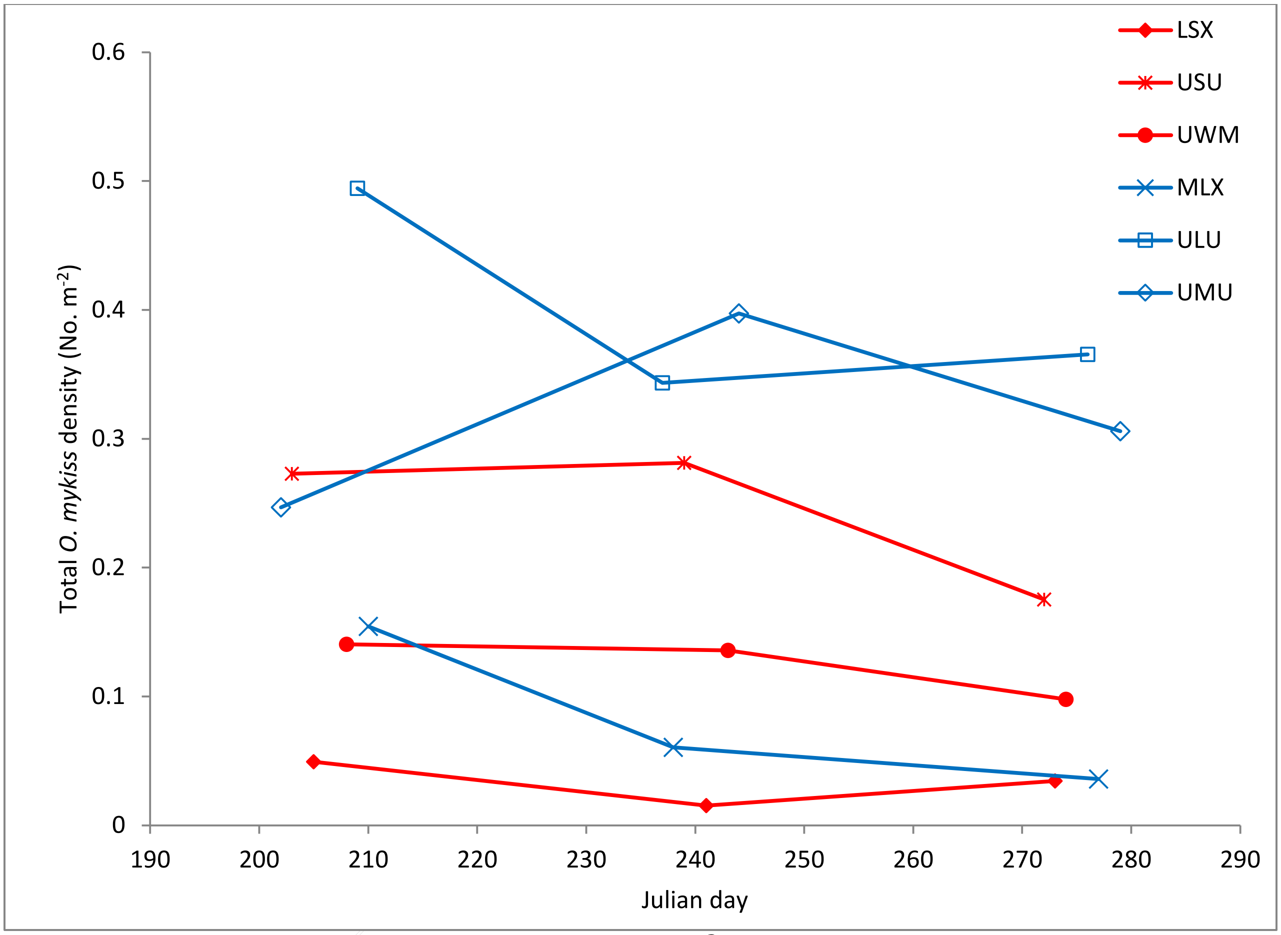

Figure 8. Density of juvenile *O. mykiss* (individuals m^{-2}) at six study sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU) from late July to early October, 2015. Sites on Webb and Sweetwater Creeks are in the project affected area (indicated by red color). Site names follow new naming scheme.

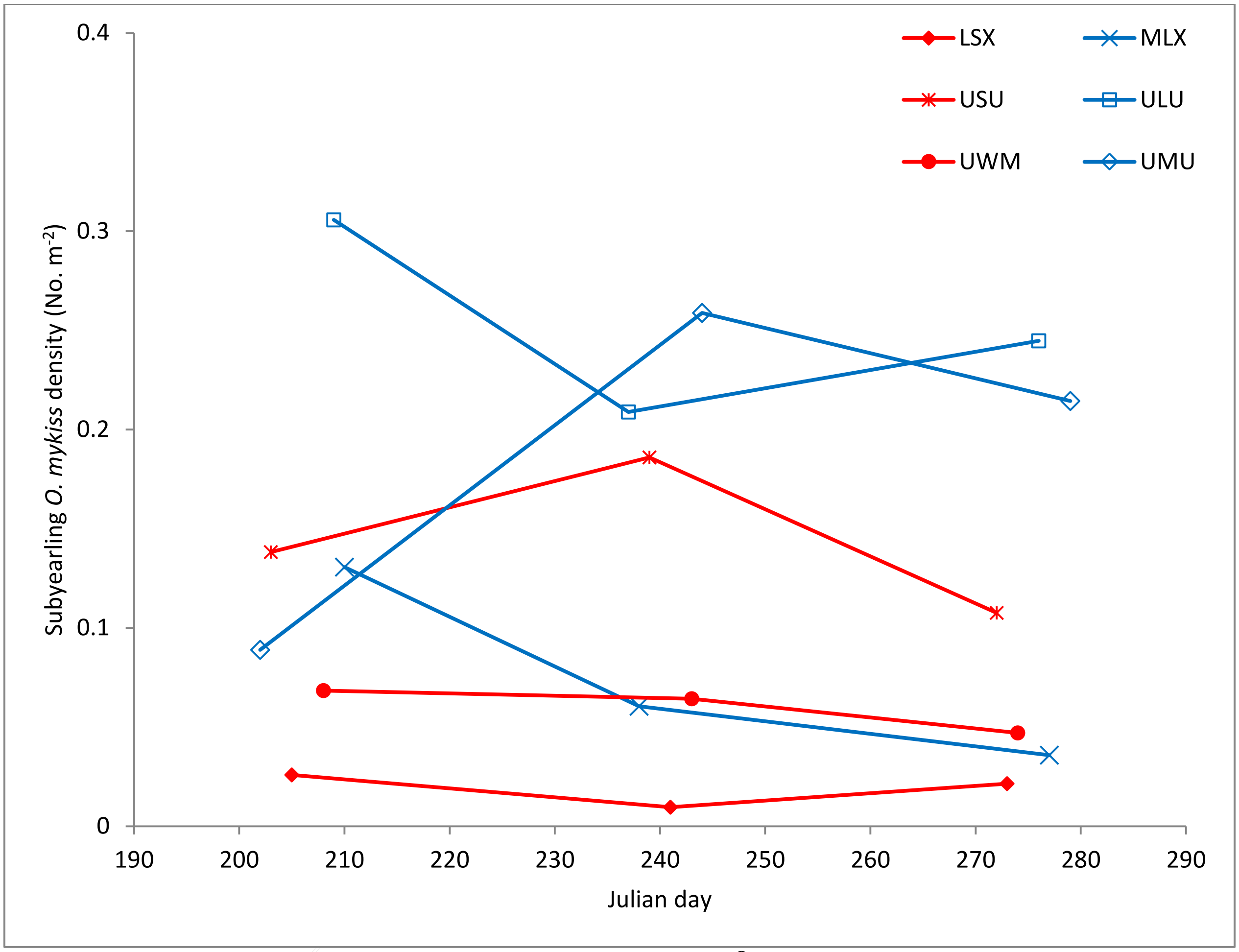

Figure 9. Density of subyearling *O. mykiss* (individuals m^{-2}) at six study sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU) from late July to early October, 2015. Sites on Webb and Sweetwater Creeks are in the project affected area (indicated by red color). Site names follow new naming scheme.

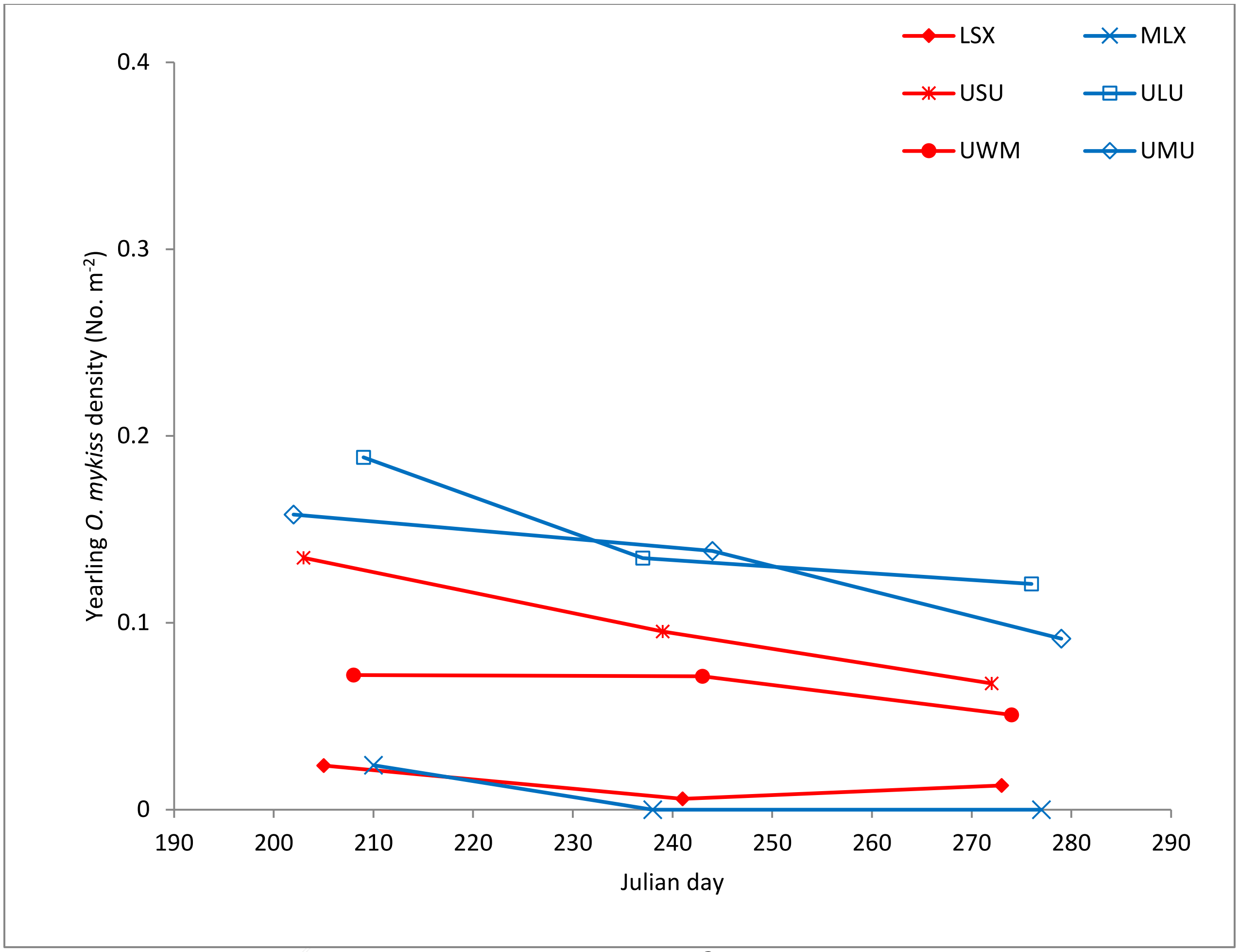

Figure 10. Density of yearling *O. mykiss* (individuals m^{-2}) at six study sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU) from late July to early October, 2015. Sites on Webb and Sweetwater Creeks are in the project affected area (indicated by red color). Site names follow new naming scheme.

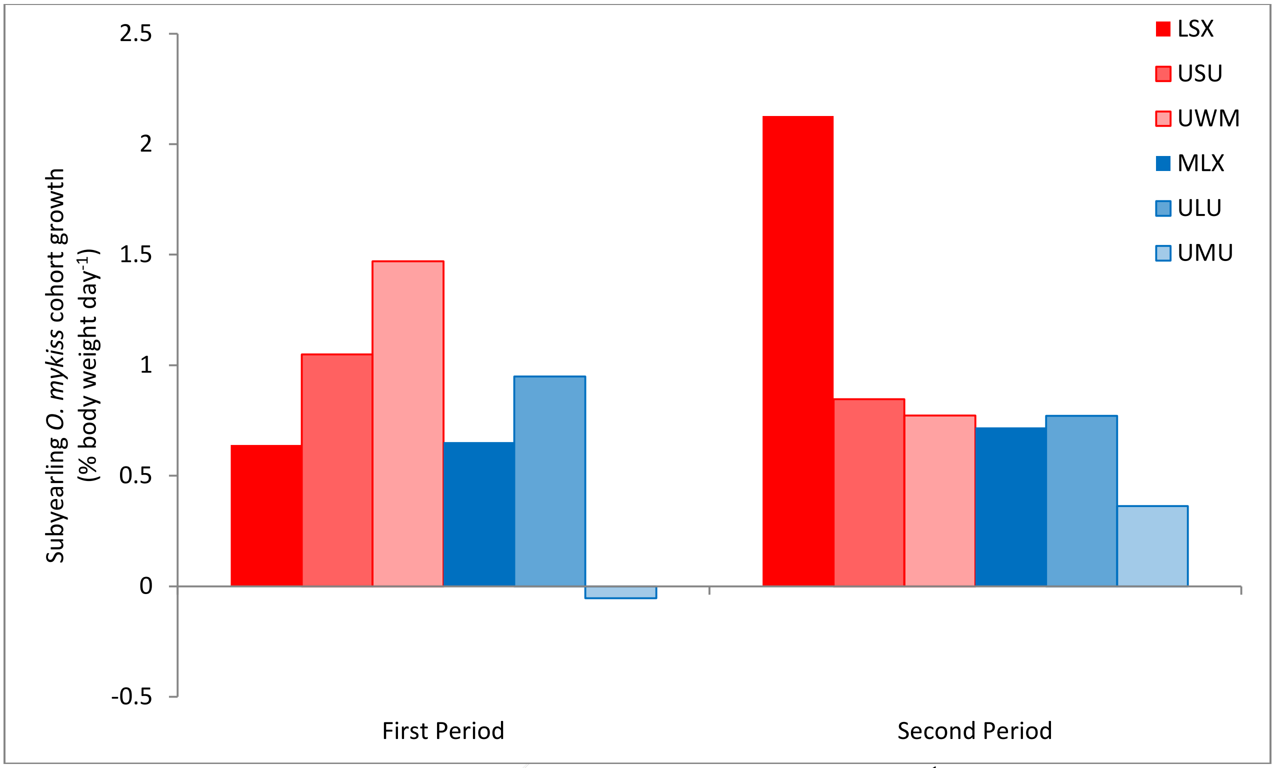

Figure 11. Cohort growth of subyearling *O. mykiss* (% body weight day^{-1}) at six study sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU) from late July to early October, 2015. Sites on Webb and Sweetwater Creeks are in the project affected area (indicated by red color). Site names follow new naming scheme.

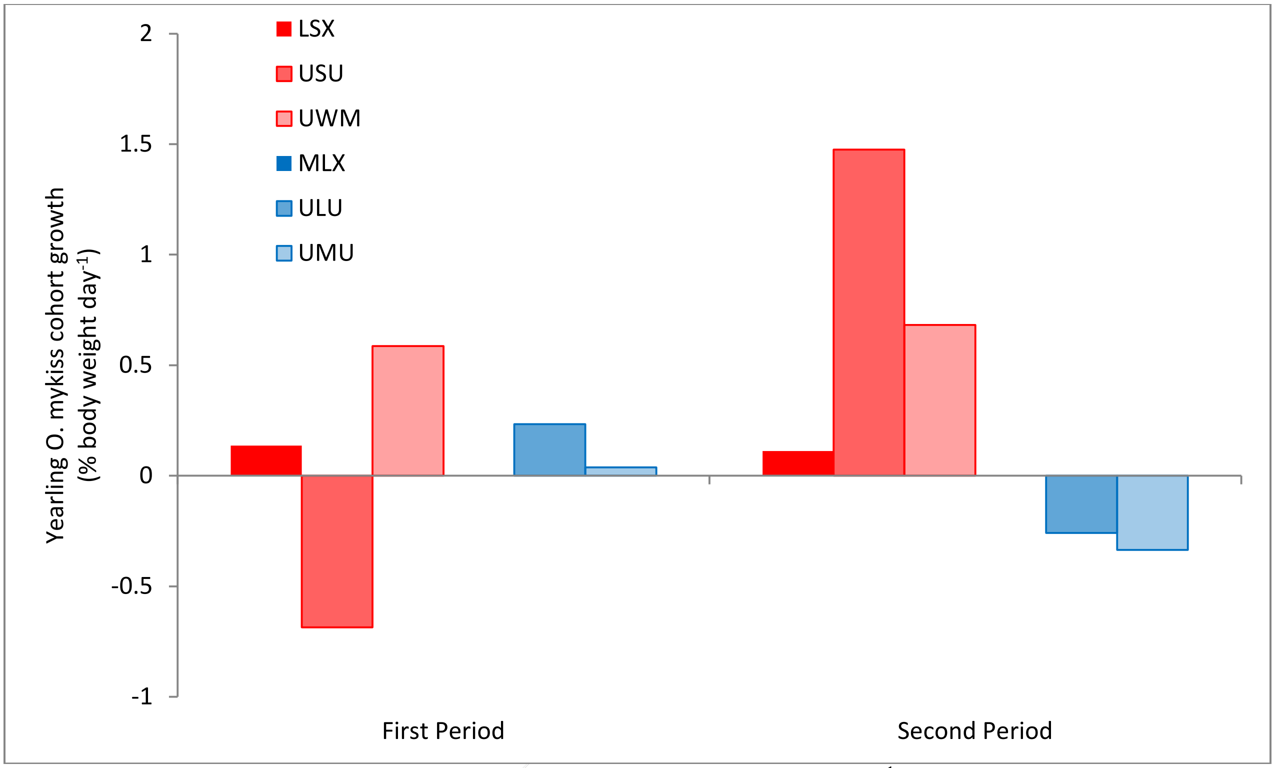

Figure 12. Cohort growth of yearling *O. mykiss* (% body weight day^{-1}) at six study sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU) from late July to early October, 2015. Sites on Webb and Sweetwater Creeks are in the project affected area (indicated by red color). Site names follow new naming scheme. Note that y-axis scale is different from subyearling figure.

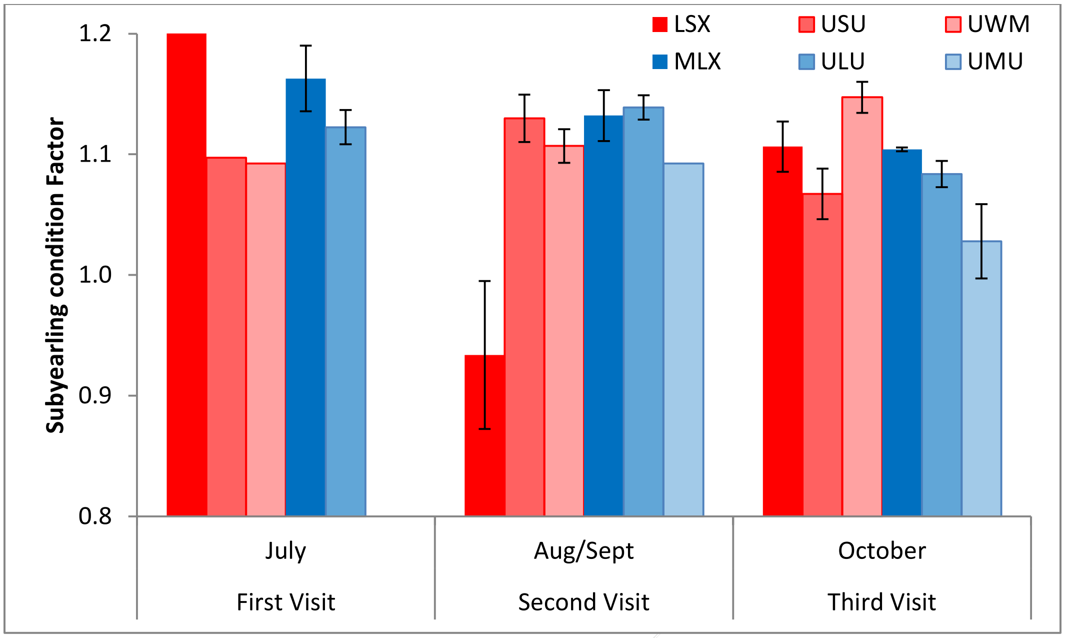

Figure 13. Condition factor of subyearling *O. mykiss* ≥ 65 mm fork length at six study sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU) from late July to early October, 2015. Sites on Webb and Sweetwater Creeks are in the project affected area (indicated by red color). Error bars indicate +/- 1 standard error. Site names follow new naming scheme.

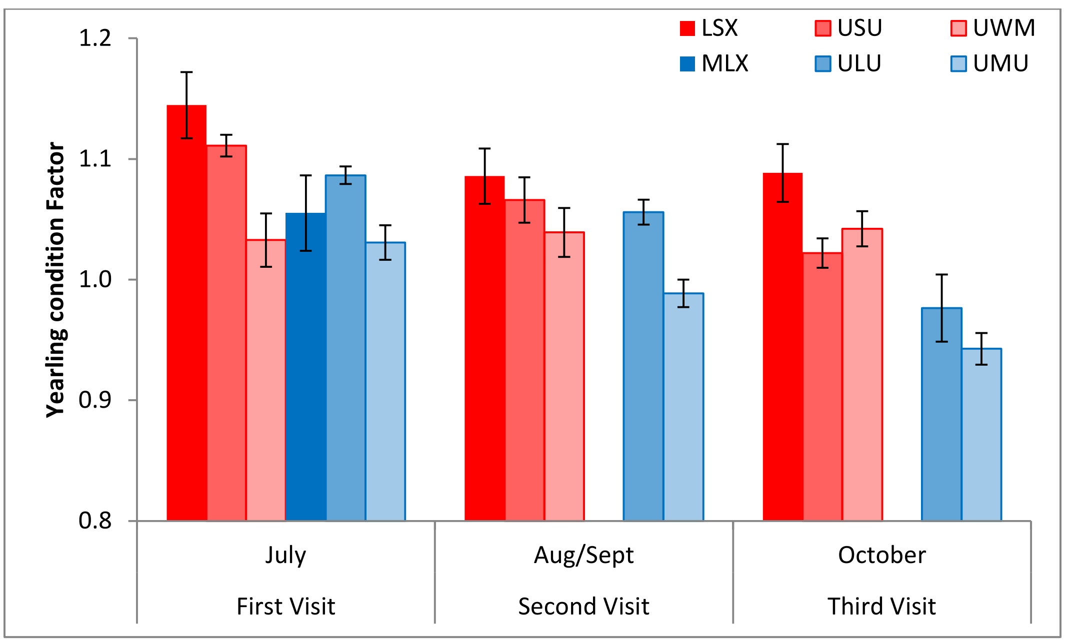

Figure 14. Condition factor of yearling *O. mykiss* at six study sites in Lapwai watershed (four of which have been sampled since 2008: LSX, UWM, ULU, UMU) from late July to early October, 2015. Sites on Webb and Sweetwater Creeks are in the project affected area (indicated by red color). Error bars indicate +/- 1 standard error. Site names follow new naming scheme.

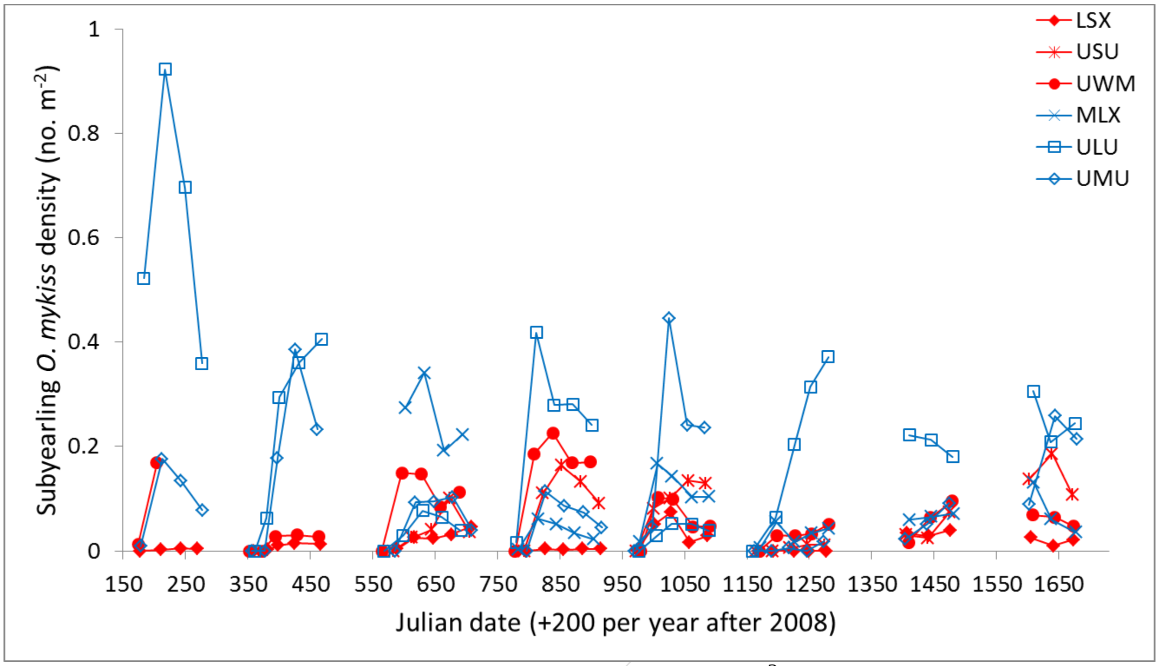

Figure 16. Density of subyearling *O. mykiss* (individuals m^{-2}) at six study sites in Lapwai watershed between 2008 and 2015 (note: USU and MLX were not sampled until 2010). Sites on Webb and Sweetwater Creeks are in the project affected area (indicated by red color). Site names follow new naming scheme.

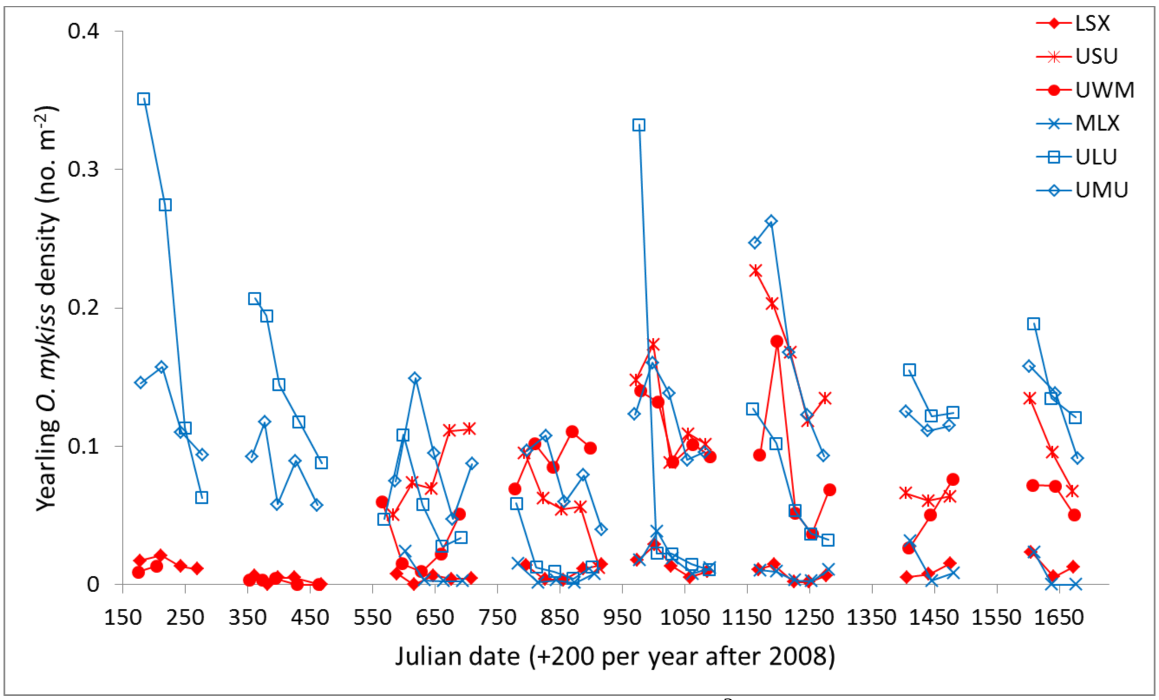

Figure 17. Density of yearling *O. mykiss* (individuals m^{-2}) at six study sites in Lapwai watershed between 2008 and 2015 (note: USU and MLX were not sampled until 2010). Sites on Webb and Sweetwater Creeks are in the project affected area (indicated by red color). Site names follow new naming scheme. Note that y-axis scale is different from subyearling figure.

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APPENDIX C

NEZ PERCE TRIBE 2016 LAPWAI CREEK PIT TAG DETECTION SUMMARY

Nez Perce Tribe

Department of Fisheries Resources Management

Administration • Enforcement • Habitat/Watershed • Harvest • Production • Research • Resident Fish

RESEARCH DIVISION

Date: March 16, 2017

To: Jay Hesse, Director Research Division
James Taylor, BOR ESA Planning Program Manager

From: Cameron M. Albee NPT ISEMP Biologist

Subject: 2016 Lapwai Creek PIT Tag Detection Summary

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). This summary report provides preliminary results for the period of July 1, 2015 through July 1, 2016. Final results are pending the completion of a multi-entity collaborative report for Snake River Basin In-stream PIT Tag Detection System (IPTDS). The data summarized here and in the final report is the product of multiple projects and agencies and is generated from the PIT tagging and biological sampling of a known proportion of adult steelhead and Chinook salmon as they migrate through the Lower Granite Dam (LGR) fish ladder and the subsequent detection of those PIT tagged adults at the Lapwai Creek IPTDS. The Integrated Status and Effectiveness Monitoring Project (ISEMP; BPA Project 2003-017-00) spearhead PIT tagging of adults at LGR, have been integral in the development and maintenance of IPTDS infrastructure throughout the Snake River, and developed the Bayesian patchwork occupancy model to estimate population-level estimates of abundance. Idaho Steelhead Monitoring and Evaluation Studies (ISMES; BPA Project 1990-055-00) and the Idaho Natural Production Monitoring and Evaluation Program (NPM; BPA Project 1991-073-00) coordinate biological sampling of adults at LGR and provide length, age, and passage timing data. The Snake River Genetic Stock Identification (BPA Project 2010-026-00) provides SNP genotype data for population-level genetic diversity and structure analysis. Trapping at LGR is coordinated by National Marine Fisheries Service (NMFS; BPA Project 2005-002-00; Harmon 2003; Ogden 2010, 2011). The Bureau of Reclamation and Lewiston Orchards Irrigation District support the maintenance of PIT tag arrays in Lapwai, Mission, Sweetwater, and Webb creeks.

Adult Detections

Adult PIT tag detections at in-stream PIT tag arrays within Lapwai Creek were summarized for detections occurring July 1, 2015 through June 30, 2016. First and last adult steelhead detections in Lapwai Creek ranged from December 10, 2015 through May 30, 2016 (Table 1). For adults, only steelhead were detected for this reporting period. In prior years, PIT tags in hatchery Fall Chinook, Coho salmon, and a Northern Pike Minnow were also detected (Table 2).

Table 1. First and last adult PIT tag observation date by species from in-stream arrays within Lapwai Creek during the period of July 1, 2015 through June 30, 2016.

Species	First Observation Date	Last Observation Date
Coho	N/A	N/A
Fall Chinook	N/A	N/A
Steelhead	12/10/2015	5/30/2016

A total of 84 unique PIT tagged adults were detected between the Lapwai (LAP), Mission (MIS), Sweetwater (SWT), and Webb (WEB) creek in-stream arrays (Table 2). Both hatchery and wild/natural steelhead adults were detected within Lapwai Creek from 10 different release locations (Table 2). Of these, 79 were wild/natural (adipose intact), four were of hatchery origin (adipose clip), and one was of unknown origin (Table 2).

Table 2. Number of unique PIT tagged adults detected at Lapwai Creek in-stream arrays between July 1, 2015 through June 30, 2016 by species and rear type (Wild, Hatchery, and Unknown) and by release site.

Release Site	Steelhead Hatchery	Steelhead Unknown	Steelhead Wild	Total
Bonneville Adult		1		1
Dayton Ponds	1			1
Lapwai Creek			2	2
LGR Adult Trap	1		69	70
LGR Juvenile Barge			1	1
Mill Creek			1	1
Sweetwater Creek			2	2
Tocannon River	2		2	4
Umatilla River			1	1
Webb Creek			1	1
Total	4	1	79	84

Steelhead Detections

A total of 70 adult steelhead that were PIT tagged as adults at Lower Granite Dam adult trap (LGRLDR) were detected within Lapwai Creek for spawn year 2016 (Table 2). Of these, 69 were wild/natural (adipose intact) and one hatchery (Table 2). Under normal circumstances, PIT tags from LGRLDR are a representative sample of wild/natural steelhead adults passing Lower Granite Dam and therefore can be used to assess the wild/natural run of steelhead into Lapwai Creek that includes arrival timing at Lower Granite Dam, arrival timing into Lapwai Creek, residency time, and dip-in behavior.

Based on the LGRLDR adult PIT tags, the wild/natural adult steelhead that entered Lapwai creek arrived at Lower Granite Dam beginning in late-July 2015 through May 10 of 2016 (Figure 1). Thirty-three percent of Lapwai Creek steelhead crossed Lower Granite Dam in October, 2015 with approximately fifteen percent crossing Lower Granite Dam in the spring of 2016 (Figure 1). Arrival into Lapwai Creek began in December 2015 with the majority of the adults entering Lapwai Creek during March 2016 (Figure 1). In February, a significant increase in discharge attracted adult steelhead into Lapwai Creek (Figure 2). Detections during mid-March and April at the Lapwai Creek array were dominated by downstream passages indicating post spawn adults (Figure 2). Post spawn adult steelhead and a dip-in were observed passing the Lapwai Creek array (Figure 3), the Mission Creek array (Figure 4), and the Sweetwater Creek array (Figure 5). Six PIT tagged wild/natural adult steelhead were observed crossing the Webb Creek array.

The detection probability for all PIT tagged adult steelhead moving upstream at the Lapwai Creek array was 0.95 and 1.0 at the Mission Creek array. The detection probability for PIT tagged adult steelhead at the Sweetwater and Webb creek arrays was calculated to be 1.0. However, the operational status and operational time periods for the Sweetwater and Webb creek arrays were not assessed. It was assumed that the Sweetwater and Webb creek arrays operated normally and continuously over the entire time period of assessment. A violation of this assumption would result in an underestimate of PIT tagged adults entering Sweetwater and Webb creeks. The detection probability of downstream passages was not calculated but likely less than 1.0, therefore the number of dip-ins and post spawn adults may be underestimated. However, the available data suggest that 68 PIT tagged ad-intact steelhead adults from the tagging effort at LGRLDR entered and remained in Lapwai Creek for a preliminary estimated total abundance of 449 wild/natural adults based on a 6.6 expansion factor (Table 3). The preliminary estimated abundance within Mission Creek was 132 wild/natural adults, 112 wild/natural adults within Sweetwater Creek, and 40 wild/natural adults within Webb Creek (Table 3).

Table 3. The number of wild/natural Lower Granite Dam PIT tagged adult steelhead by array site detected moving upstream, the number leaving the site prior to spawning, the final number remaining upstream to spawn, and the approximate abundance by stream (6.6 expansion factor (1 / 0.15)).

Site	Upstream	Dip-ins	Final Upstream	Approximate abundance
Lapwai Creek	69	1	68	449
Mission Creek	22	2	20	132
Sweetwater Creek	19	2	17	112
Webb Creek	6	0	6	40

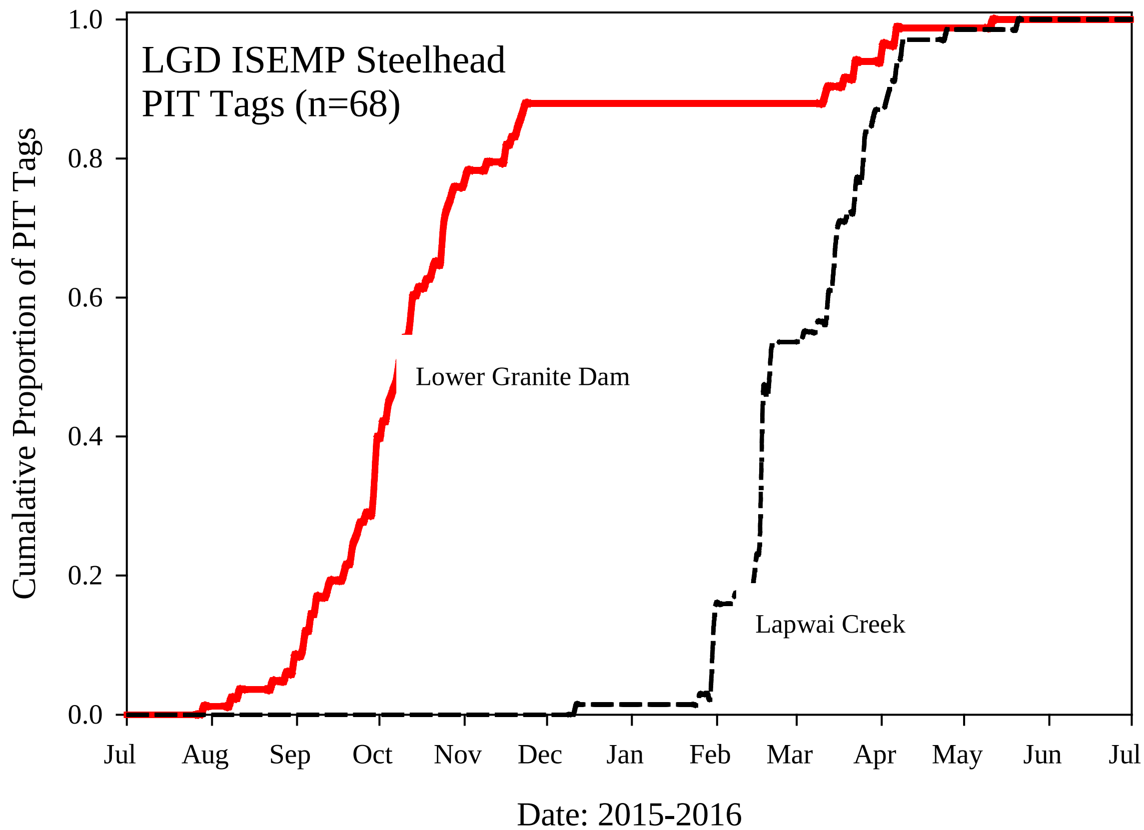

Figure 1. The cumulative proportion of Lower Granite Dam PIT tagged wild/natural adult steelhead by arrival date at the Lapwai Creek in-stream PIT tag array (dashed black line) and the date tagged and released at Lower Granite Dam (solid red line).

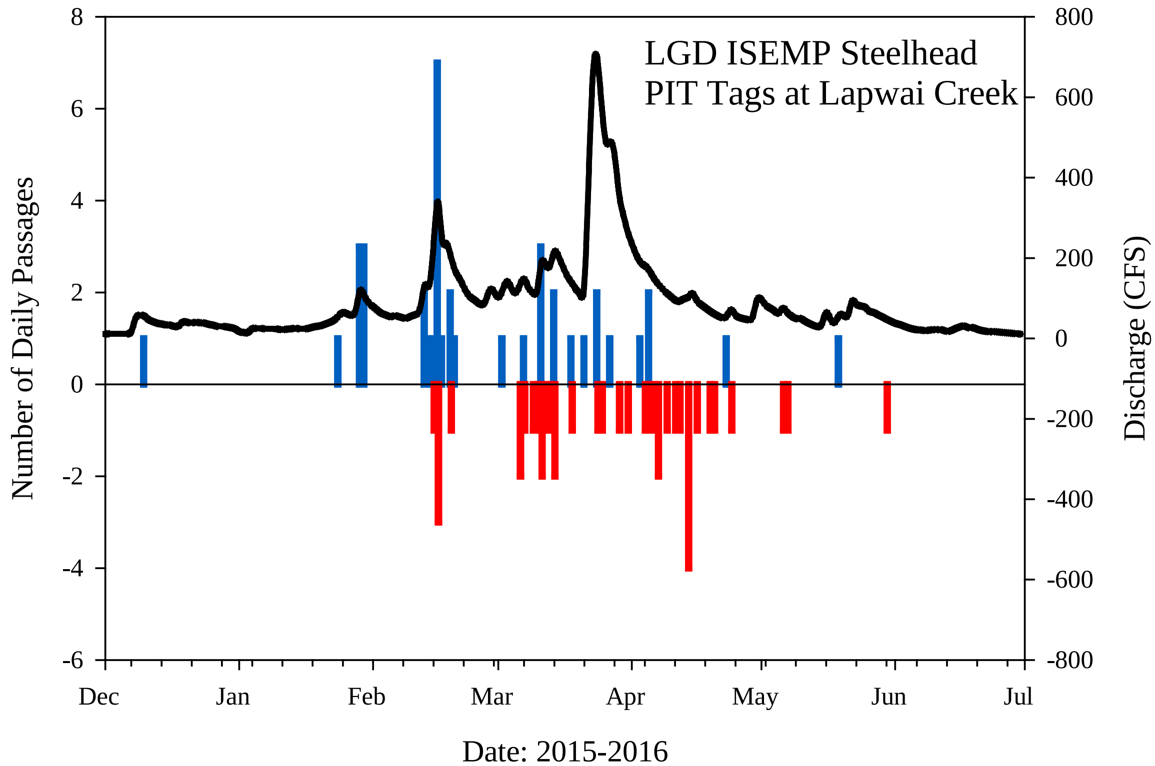

Figure 2. The number of observed upstream (positive blue bars) and downstream (negative red bars) daily passages of Lower Granite Dam PIT tagged wild/natural adult steelhead at the Lapwai Creek in-stream PIT tag array for spawn year 2016. Also shown is the Lapwai Creek discharge (cubic feet per second, solid black line).

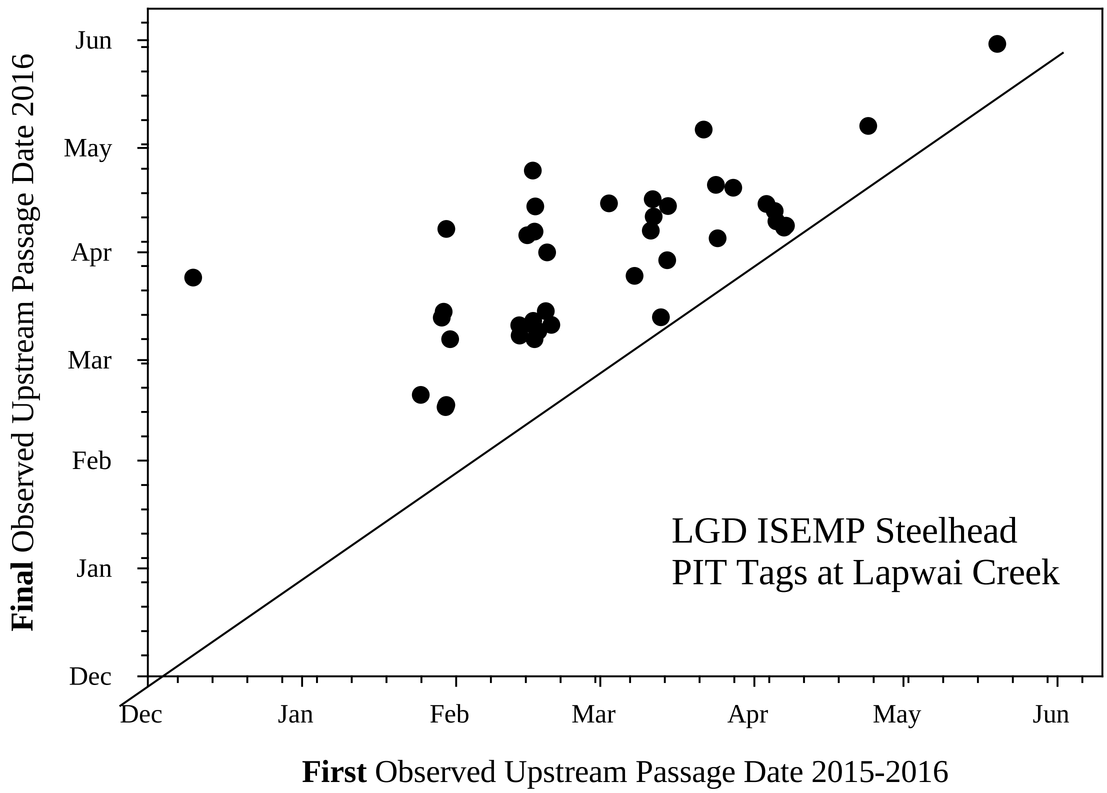

Figure 3. The first observed upstream passage (x-axis) and the final observed downstream passage (y-axis) of Lower Granite Dam PIT tagged wild/natural adult steelhead at the Lapwai Creek in-stream PIT tag array showing post spawn adults (above 1:1 line) and dip-ins (on or near the 1:1 line).

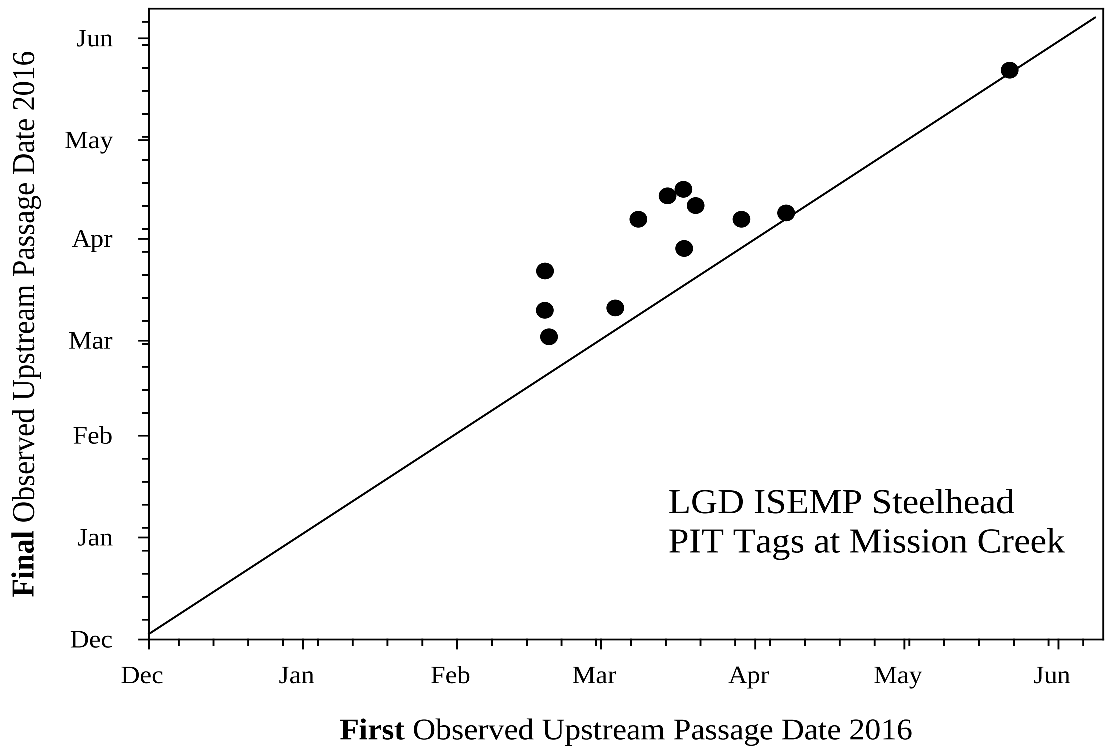

Figure 4. The first observed upstream passage (x-axis) and the final observed downstream passage (y-axis) of Lower Granite Dam PIT tagged wild/natural adult steelhead at the Mission Creek in-stream PIT tag array showing post spawn adults (above 1:1 line) and dip-ins (on or near the 1:1 line).

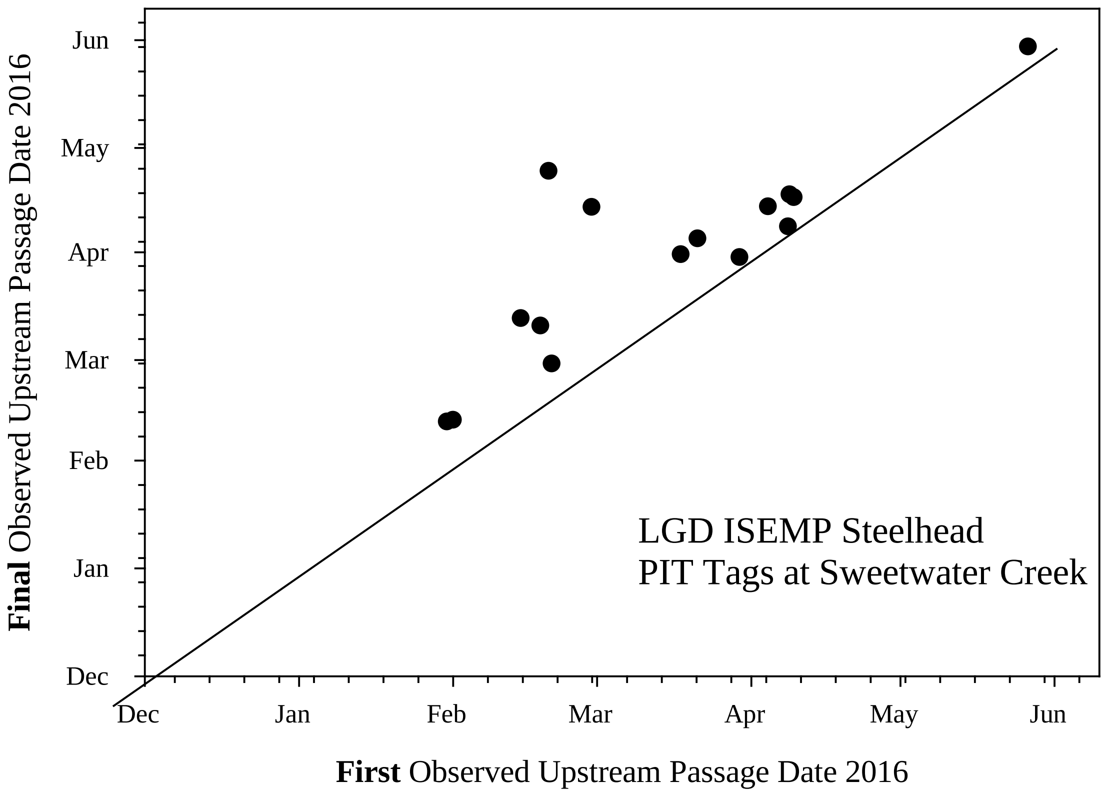

Figure 5. The first observed upstream passage (x-axis) and the final observed downstream passage (y-axis) of Lower Granite Dam PIT tagged wild/natural adult steelhead at the Sweetwater Creek in-stream PIT tag array showing post spawn adults (above 1:1 line) and dip-ins (on or near the 1:1 line).

Wild Steelhead Adult Abundance Estimates

Results of the Integrated Status and Effectiveness Monitoring Project's (ISEMP; BPA Project 2003-017-00) Bayesian patchwork occupancy model are presented in Tables 4 through 7 (See et al. in preparation, supplemental information).

Table 4. Lapwai Creek wild adult steelhead abundance estimates. The Lapwai Creek array (LAP) was not functional for spawn year 2012 (See et al. in preparation, supplemental information).

Spawn Year	Abundance	Lower 95% CI	Upper 95% CI	CV
2010	481	409	564	0.084
2011	233	194	279	0.095
2012	-	-	-	-
2013	328	281	390	0.089
2014	367	301	440	0.103
2015	580	489	690	0.091
2016	449*			

* Preliminary

Table 5. Mission Creek wild adult steelhead abundance estimates (See et al. in preparation, supplemental information).

Spawn Year	Abundance	Lower 95% CI	Upper 95% CI	CV
2010	-	-	-	-
2011	106	60	157	0.239
2012	124	83	176	0.189
2013	123	78	175	0.202
2014	141	78	208	0.236
2015	135	72	213	0.268
2016	132*			

* Preliminary

Table 6. Sweetwater Creek wild adult steelhead abundance estimates (See et al. in preparation, supplemental information).

Spawn Year	Abundance	Lower 95% CI	Upper 95% CI	CV
2010	166	105	223	0.187
2011	33	7	66	0.488
2012	59	24	99	0.328
2013	50	21	87	0.338
2014	112	62	165	0.238
2015	177	109	261	0.220
2016	112*			

* Preliminary

Table 7. Webb Creek wild adult steelhead abundance estimates (See et al. in preparation, supplemental information).

Spawn Year	Abundance	Lower 95% CI	Upper 95% CI	CV
2010	-	-	-	-
2011	13	9	1	0.753
2012	30	22	7	0.488
2013	19	14	2	0.618
2014	37	35	8	0.452
2015	48	36	12	0.452
2016	40*			

* Preliminary

Array Maintenance

The Lapwai Creek array (LAP) and Mission Creek array (MIS) were armored with large substrate to alleviate scouring from higher flows in July, 2016. On March 14, 2017 the Mission Creek array lost current to both antennas. The result will be a lost abundance estimate for adult wild/steelhead for spawning year 2017 in Mission Creek. Both antennas will need to be replaced in 2017. This may present the opportunity to re-locate the antennas to a more suitable location.

The Lapwai Creek PIT tag array (LAP) operated continuously without disruption during the period of July 2015 through June of 2016. The Mission Creek array had zero downtime during the same time period.