Wallowa Falls Hydroelectric Project
FERC Project No. P-308
Updated Study Report
(Final Technical Report)

Aquatic Resources

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PACIFICORP ENERGY
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1.0 INTRODUCTION

PacifiCorp Energy filed a Notice of Intent (NOI) and associated Pre-Application Document (PAD) to commence the Federal Energy Regulatory Commission's (FERC) Integrated Relicensing Process (ILP) of the Wallowa Falls Hydroelectric Project on February 22, 2011. As part of the FERC Integrated Relicensing Process, prospective license applicants are required to submit relevant resource study plans (18 CFR 5.11).

During compilation of the PAD, PacifiCorp found limited information concerning aquatic fish and macroinvertebrate species in waters influenced by the project and encompassed within the project boundary. Historical data concerning aquatic species presence or absence; distribution, both spatial and temporal; and abundance was sparse. Prior to Study Plans implemented in 2012, the only empirical fishery data available from within project influenced streams stemmed from three fish salvages of the project tailrace channel due to de-watering during maintenance events and one truncated snorkel survey of the project bypass; no data had ever been collected concerning aquatic macroinvertebrates within the project boundary.

In consideration of available information, PacifiCorp identified three aquatic resource studies to be completed in 2012 in order to gain information on local aquatic resources and potential impacts of the Wallowa Falls Hydroelectric Project on these resources.

2012 Studies included:

- Relative Abundance, Composition, and Spatial and Temporal Distribution of Fish Species Residing in Waters within the Project Boundary

- Evaluation of Bull Trout use of the Project Tailrace Channel and Bypassed East Fork Wallowa River

- Relative Abundance and Composition of Macroinvertebrate Species Residing in Waters within the Project Boundary

At the completion of 2012 Studies, stakeholders in the Wallowa Falls Hydroelectric relicensing process identified several additional aquatic resource information needs for 2013. These needs triggered the 2nd Year of Studies and included:

- Kokanee Spawner Abundance in the West Fork Wallowa River

- Additional Year of Evaluating Bull Trout use of the Project Tailrace Channel and Bypassed East Fork Wallowa River

- Additional Year of Evaluating Relative Abundance and Composition of Macroinvertebrate Species Residing in Waters within the Project Boundary

- Completion of Fish Presence/Absence Surveys of the Project Forebay

This Updated Study Report is intended to fulfill 18 CFR 5.15(b) of the FERC Integrated License Process and contains the following information:

1. A description of the goals and objectives of each Study Plan;
2. Available background information;
3. Methods employed to implement Study Plans;
4. Results of information gathered during Study Plan implementation;
5. Discussion of results observed;

2.0 STUDY AREA

The Wallowa Falls Hydroelectric Project is located on the East Fork Wallowa River approximately 11 miles outside of the City of Joseph in Northeastern Oregon. The Project (Figure 2.0-1) reservoir/forebay lies over 1,600 meters (m) above mean sea level (msl) and is approximately 0.2 surface acres (0.08 ha) in size and averages 5 feet (1.5 m) deep. Because the Project operates as run of river, there is no measurable storage. Though no measurable storage is present in the forebay, habitat in this area is lacustrine, and given the shallow water depth no thermal stratification is present. Substrate in the forebay consists of deposited silt, sand, and other glacial fines.

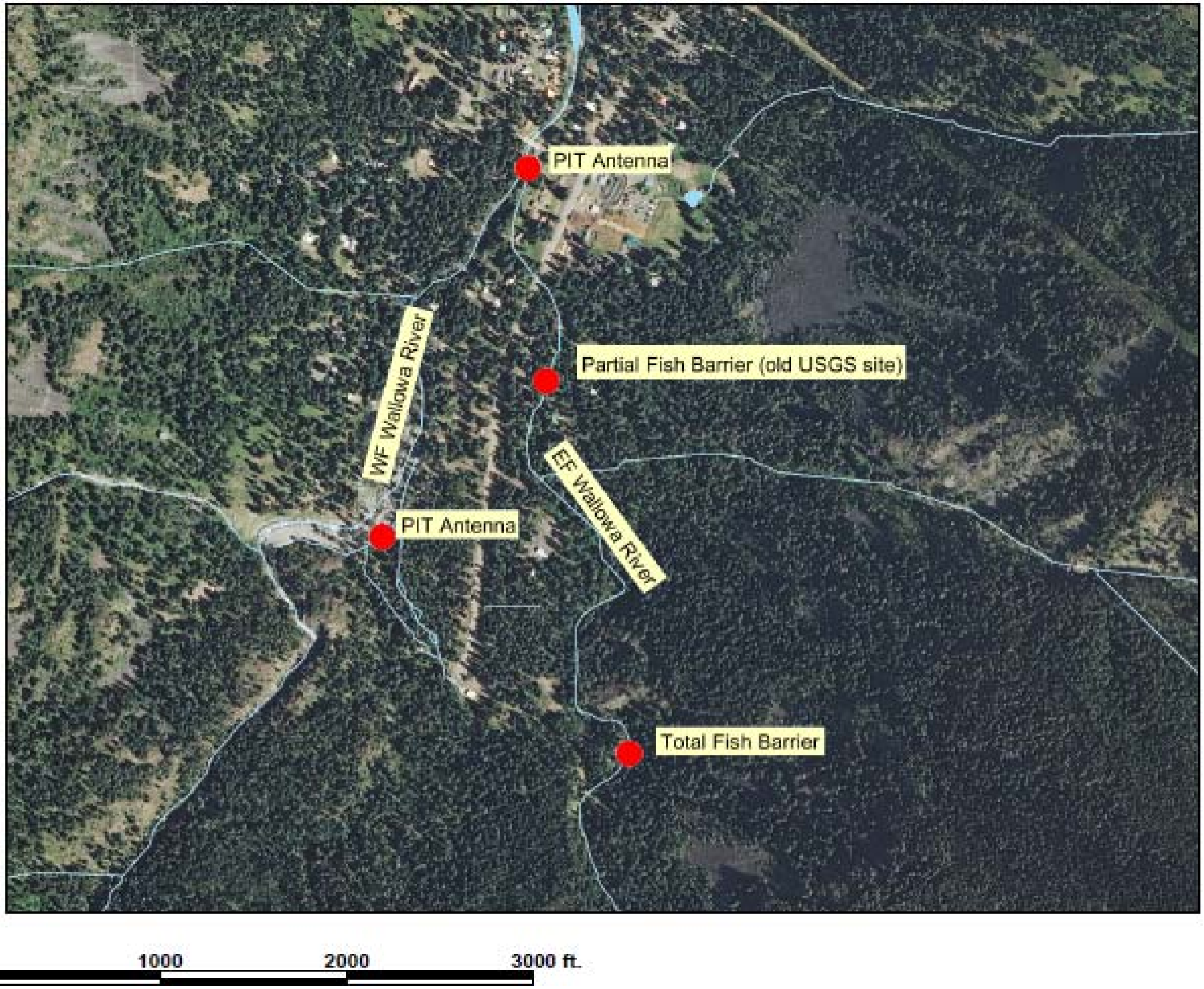
Water diverted at the forebay travels through the flow line and penstock to the generating turbine in the Project powerhouse. Water exits the turbine and is discharged into an approximately 985-foot (300 m)[1] long tailrace discharge channel that empties into the West Fork Wallowa River. This channel has an average wetted-width of 10 feet (3.1 m) and an average depth of one foot (0.3 m). The habitat type within the tailrace channel is dominated by high gradient riffle with very few pools.

Local topography divides the 1.7-mile East Fork Wallowa bypassed reach into distinct lower and upper segments. The lower segment of the bypassed reach (lower bypassed reach) is 4,700 feet (1,433 m) long and has an average slope between 6% and 7%. Substrate is comprised chiefly of cobble and boulder. The predominant mesohabitat types include sequences of steep riffles and rapids. Individual pools are present in the lower bypassed reach, but they are rare. The upper segment (upper bypassed reach) is 4,370 feet (1,332 m) long and has an average slope between 19% and 20%. Steep cascades with turbulent flow over boulders and bedrock chutes characterized the upper segment. The two segments are divided by a 12-foot (3.7 m) falls, an impassable fish barrier.

Wallowa Lake and portions of the East and West Forks of the Wallowa River are listed under the Bull Trout Critical Habitat Designation Final Ruling (Federal Register, Vol. 75, No. 200 – October 2010 pgs. 63,898 – 64,070). The waterways upstream of the irrigation dam at the terminus of Wallowa Lake are listed as Essential Fish Habitat for spring Chinook and Coho under the Magnuson-Stevens Fishery Conservation and Management Act (NOAA 2008).

[1] This figure only includes the primary tailrace channel. There are approximately 1,320 feet (310 m) of additional tailrace side channels. No fish species have ever been documented in the tailrace side channels.

Figure 2.0.1 East Fork and West Fork Wallowa Rivers with identified fish barriers and PIT antenna sites.



3.0 KOKANEE SPAWNER ABUNDANCE IN THE WEST FORK WALLOWA RIVER

3.1 Study Description and Objectives

Based on limited data concerning annual kokanee spawner use of waters within the Project boundary or waters directly influenced by project operations, surveys were conducted to quantify current spawner densities. Surveys were designed to assess and compare kokanee spawner densities within reaches of the West Fork Wallowa River. For comparison purposes, the river was broken into three reaches; Reach One consisted of the West Fork Wallowa River from its confluence with Wallowa Lake to the confluence of the East Fork Wallowa River, Reach Two was comprised of the West Fork Wallowa River between the confluence of the East Fork Wallowa River and the confluence of the Project tailrace discharge channel, and Reach Three consisted of the West Fork Wallowa River from the Project tailrace discharge channel confluence upstream to the barrier falls (Map 3.0-1).

The objective of the proposed study was to gain a better understanding of kokanee spawner densities in Reach Two of the West Fork Wallowa River and how these spawner densities' compare to the spawner densities in the other two reaches. As flows in Reach Two will be directly influenced by the proposed Project Tailrace Reroute, an assessment of how the flow reduction may affect kokanee spawners in this Reach was proposed. The first task in assessing potential impact was an evaluation of current use of the area by spawning kokanee. Downstream of the East Fork Wallowa River confluence, flows are attenuated and therefore no Project impact is expected.

Specific information regarding data obtained during the West Fork Wallowa River Kokanee Spawner Abundance Study was as follows: Live counts of spawning and holding kokanee by reach over the entire spawn time-frame (Aug-Oct); Average kokanee fork length, by sex, at spawn.

3.2 Background Information

No quantitative data concerning kokanee spawner densities in the West Fork Wallowa River was known to exist prior to this Study. The only known data prior was qualitative anecdotal evidence of kokanee spawning annually in the West Fork Wallowa River.

3.3 Methods

To enumerate kokanee spawners in the West Fork Wallowa River, surveyors from the USFWS, ODFW, or the Utility would start at the head of Wallowa Lake and count spawning and holding kokanee as they walked upstream. Surveys began August 24 and continued on a weekly basis through November 3, encompassing the entire spawn time-frame.

During each survey, kokanee counts were attempted in all three Reaches (Map 2.0-1) and the counts broken into two categories, spawners and holders. To be part of the spawner count, a kokanee was actively spawning or defending a redd. The holder count consisted of all other kokanee in the stream not associated with a redd during the time of the survey. The two distinct spawner and holder counts were utilized to establish a kokanee spawner residence time within the stream. The residence time represented how long a fish displayed holder behavior once entering the tributary. From the survey data, separate fish density curves (survey date fish count vs. time since first survey date) were generated for both holders and spawners. The time interval between the peaks of the holder and spawner fish density curve was taken as the residence time of holding fish. As expected, the peak of the holder curve occurred first.

Using AUC, a holder fish-density curve was generated (a data point for each survey date) in the form of total holding fish vs. time since first survey (in days). Upon the end of the spawning season the completed holder fish-density curve was numerically integrated by trapezoidal approximation to find the area under the curve. The area contained the units of *fish*days*. Taking consideration that a fraction of fish were counted multiple times between survey dates, the total area of the holder fish-density curve was divided by the observed holder residence time, resulting in a total spawn estimate (English et al, 1992).

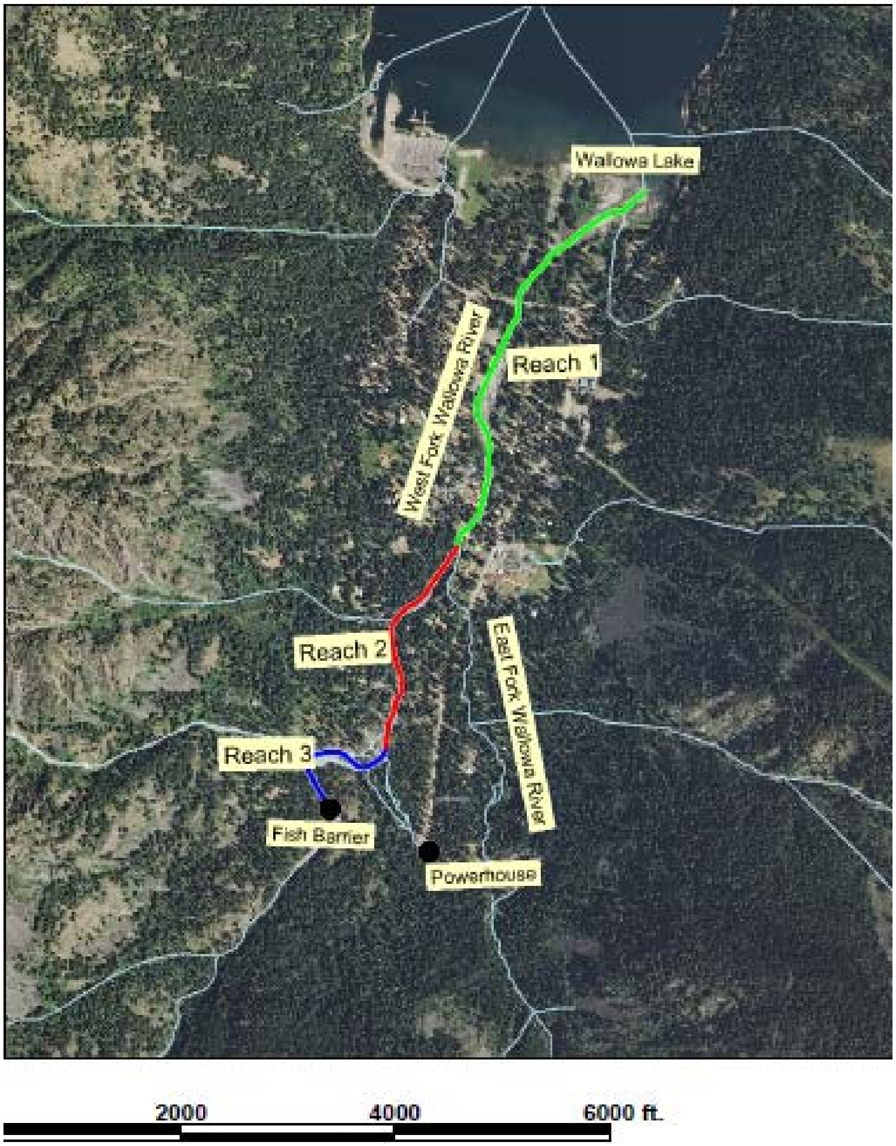
AUC methodology does not require equal time elapsed between surveying intervals, though short intervals between survey dates will provide more confidence in the estimation. Weekly surveys were performed to generate the holder residence time. It is important to minimize periods occurring between successive survey dates that are greater than the observed residence time. The closer counts are to zero fish during the first and last surveys, the more accurate the calculated AUC of the fish-density curve will be, thus enabling the fish-density curve to have closed ends and limiting the extrapolation needed to estimate the AUC (English et al, 1992).

Along with an AUC generated total spawner abundance estimate by reach, a peak spawner live count by reach was also quantified.

Additionally, average kokanee fork length at spawn was assessed by sub-sampling recovered spawn spent kokanee carcasses during each survey. 24 male and 46 female carcasses were recovered and sampled over the entire spawn time-frame.

Two surveyors were employed during each kokanee spawner count. In order to standardize expected surveyor error with concern to fish counts, care was taken, though not always realized due to time and logistical constraints, to have the same surveyors perform each weekly survey.

Figure 3.0.1 Site map of Kokanee Spawner Study Area and associated Reaches.



3.4 Results

The West Fork Wallowa River was surveyed for spawning kokanee on eight occurrences between August 24, 2013 and November 4, 2013. Conditions during each survey were favorable, with relatively good water clarity and seasonal low river levels. During each survey independent spawner and holder counts were conducted to evaluate fish residence time prior to spawn within each specified reach (Figure 3.4.1), as well as an overall peak season count (Figure 3.4.2).

Figure 3.4.1

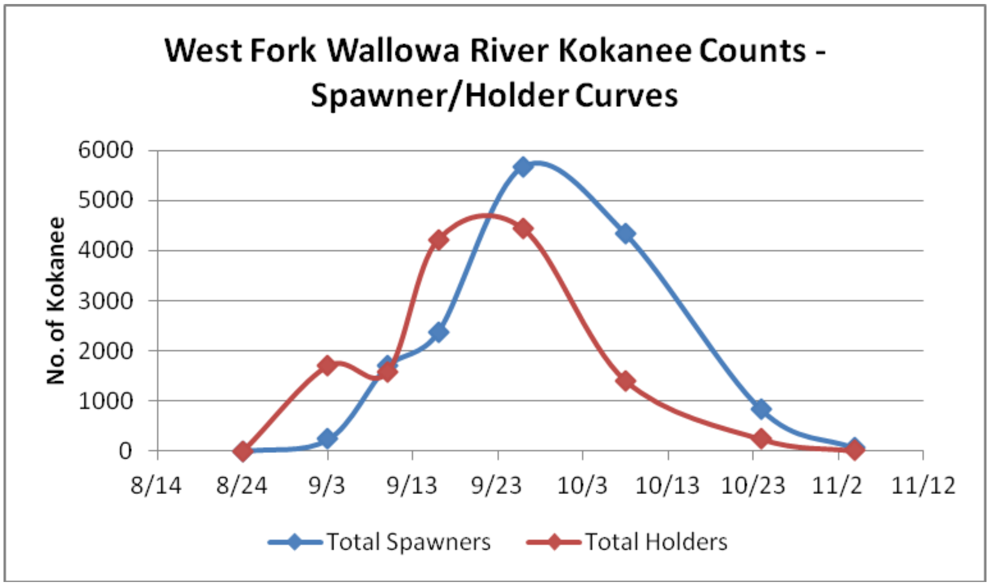
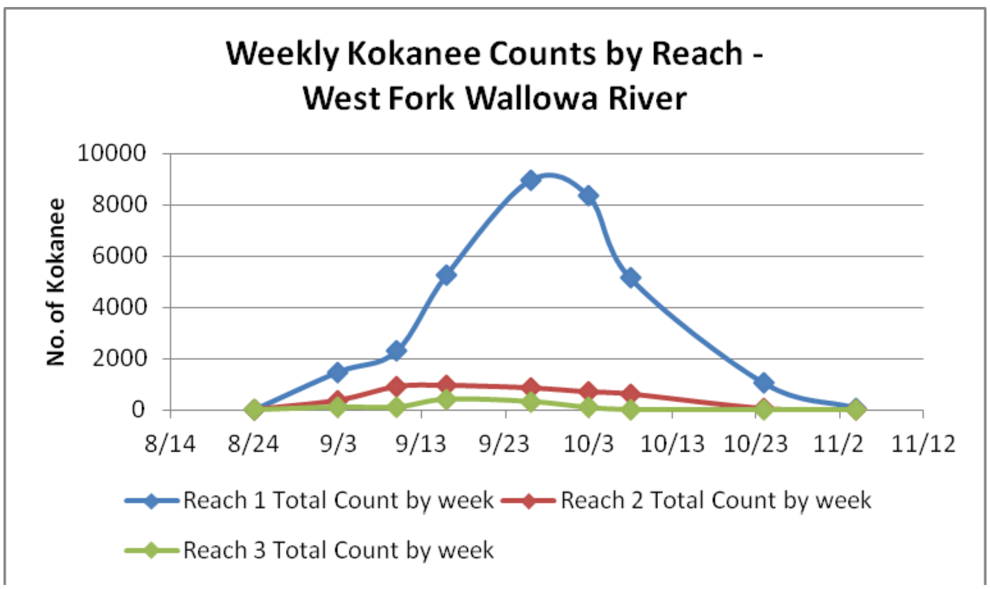


Figure 3.4.2



In order to generate a total estimate of kokanee spawners using Area Under the Curve, kokanee residence time (The time between the peak holder count and the peak spawner count) was required. The peak holder count was observed on September 21 with the peak spawner count following shortly thereafter on September 26, giving a residence time of five days. A peak kokanee count of 10,110 was observed on September 26, 2013. Area Under the Curve estimates of kokanee spawners by reach based on the holder curves illustrated in Figure 3.4.3 is expressed in Table 3.4.1.

Figure 3.4.3

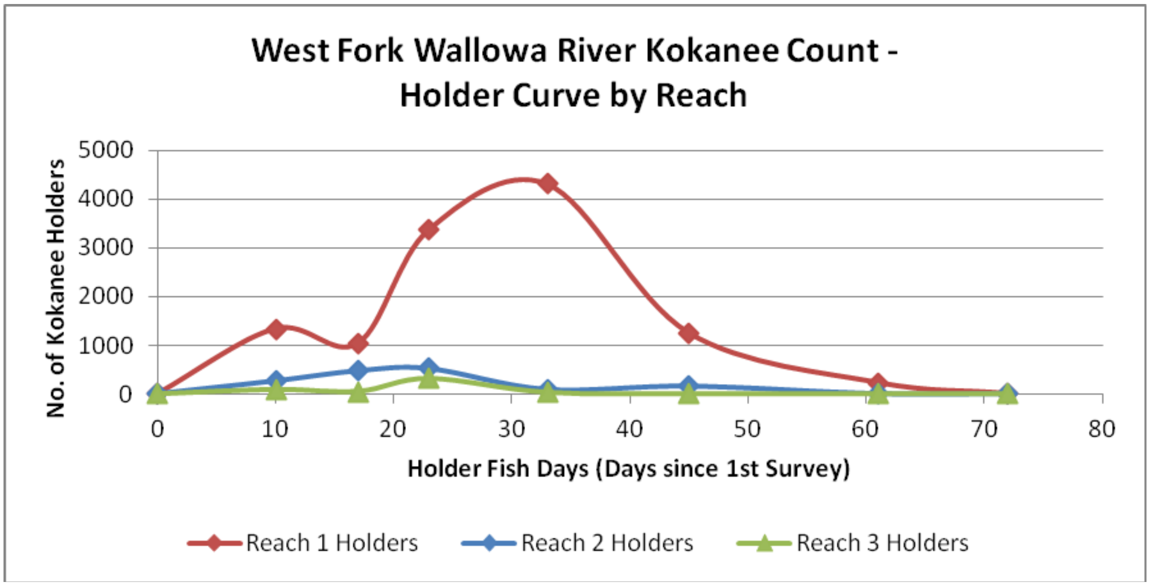


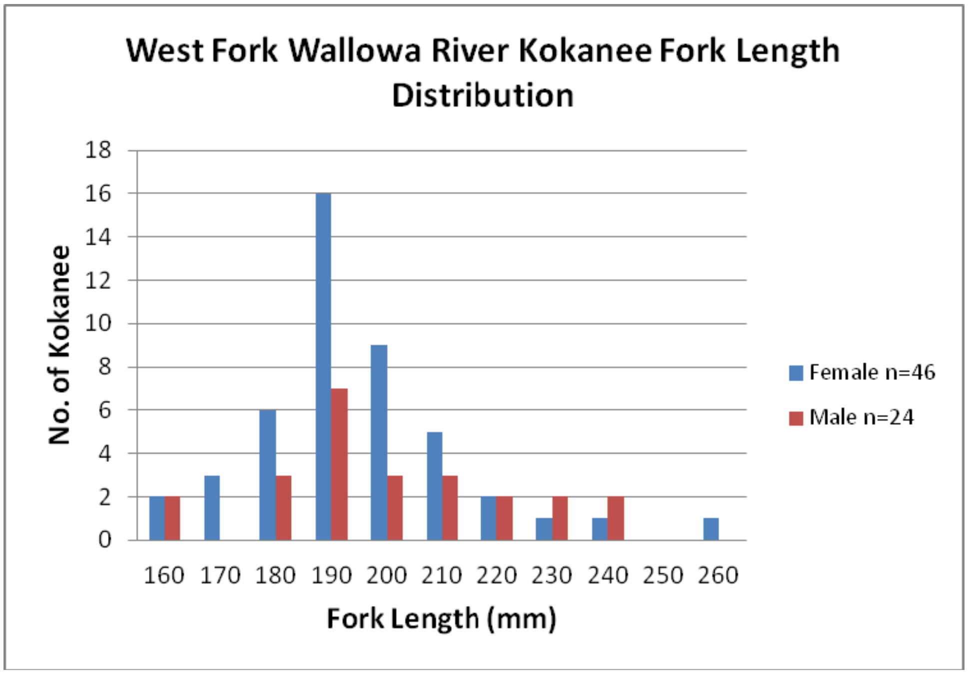
Table 3.4.1

Estimates of Spawning Kokanee by Reach using AUC (trapezoidal approximation)	
Reach	Total Kokanee
1	**23,455**
2	**2,607**
3	**791**
Total	**27,128**

86 percent of the estimated total number of spawning kokanee within the West Fork Wallowa River in 2013 were counted within Reach 1, as compared to ten percent of the total in Reach 2 and four percent of the total in Reach 3.

During each survey, along with kokanee live counts, a portion of spawned-out kokanee carcasses were also measured in order to evaluate size at spawn. Both male and female kokanee were evaluated (Figure 3.4.4). 46 female and 24 male kokanee were measured. Average female fork length observed was 198mm with a standard deviation of 20.6mm. Males were observed to be slightly larger, having an average of 206mm fork length with a standard deviation of 25.6mm. The largest measured male was 280mm and the largest female 260mm.

Figure 3.4.4



3.5 Discussion

In 2013, the bulk of kokanee spawners (>80 percent) were counted in Reach 1, the lower portion of the West Fork Wallowa River. The Wallowa Falls Hydro Project has limited influence on Reach 1 as this reach occurs below the confluence of the East Fork Wallowa bypassed reach where flows in the West Fork Wallowa River have been attenuated.

The observed discrepancy in kokanee use of available spawning habitat within the West Fork Wallowa River in 2013 seems to be a function of small kokanee size at spawn. The habitat within Reach 1 is dominated by a wide, un-confined stream-channel with numerous low-velocity side-channels much preferred by kokanee. Substrate in Reach 1 also appeared to be dominated by deposited fine gravel and sand, suitable for the small size of kokanee spawner observed in 2013. Contrary to Reach 1, spawning substrate in Reach 2 and Reach 3 is limited, and the substrate that is available did not appear to be of suitable size for fish averaging 200mm in fork length. Low-velocity off-channel spawning areas are also not as abundant in Reach 2 as compared to Reach 1 and simply do not occur in Reach 3.

The East Fork Wallowa bypassed reach was also surveyed for spawning kokanee during each West Fork survey. No kokanee were observed higher than 100 meters upstream from the confluence with the West Fork. A peak count of 100 kokanee was observed within the bypassed reach during the September 26, 2013 survey.

4.0 EVALUATION OF BULL TROUT USE OF THE PROJECT TAILRACE CHANNEL AND BYPASSED EAST FORK WALLOWA RIVER

4.1 Study Description and Objectives

An additional year of evaluating bull trout within Project waters was completed in 2013. This work was proposed in order to add to data gathered in 2012 and hopefully gain a better understanding of the Wallowa River bull trout population upstream of Wallowa Lake, especially with concern to waters directly influenced by the Wallowa Falls Hydroelectric Project. It was anticipated surveys completed in 2013 would shed light on the current distribution and life-history of previously captured bull trout in waters within the Project boundary. Seventeen captured bull trout in 2012 were inserted with a Passive Integrated Transponder (PIT) tag prior to release, much of the proposed 2013 study hinged on the ability to recapture these previously PIT tagged bull trout.

4.2 Existing Information

The Wallowa Lake bull trout population has undergone several major events, from eradication to reintroductions and, prior to PacifiCorp's relicensing studies, was thought to be extirpated in Wallowa Lake and its tributaries.

Bull trout were first observed by PacifiCorp within the Project area on July 12, 2010, during a salvage of the Project tailrace due to a planned de-watering event. Two bull trout were captured (Figure 3.2.1) downstream of the powerhouse, prior to the channel being de-watered, and were subsequently released into the West Fork Wallowa River, per the conditions of PacifiCorp's Oregon State Fish Collection Permit (permit no.15214). Later that year during a September 15, 2010 snorkel survey, one bull trout was observed just downstream of the turbine discharge and two bull trout were observed in the bypassed section of the East Fork Wallowa River approximately 250 m upstream from the confluence with the West Fork Wallowa River. These two fish in the bypassed reach were observed paired-up near a partially completed redd.

PacifiCorp again surveyed the project area for bull trout presence, relative abundance, and distribution during the summer of 2012. Areas sampled included the tailrace channel, forebay, bypassed East Fork Wallowa River and Wallowa Lake. The East Fork Wallow River was surveyed from its confluence with the West Fork Wallowa River upstream to a waterfall that appears to be a complete upstream fish passage barrier and also in the reach between the aforementioned passage barrier and the larger waterfall located immediately upstream of the first project penstock trestle. Sampling methods included use of tangle nets throughout Wallowa Lake and at the head of the lake near the terminus of the West Fork Wallowa River; hook and line, and electrofishing to document bull trout presence or absence. The project forebay was also sampled for fish presence on August 22 and September 25, 2012. During the August 22 survey the entire forebay was seined and no fish were captured. On September 25 the forebay was snorkeled and no fish were observed.

A total of 54 bull trout were observed during the 2012 sampling efforts; 47 in the East Fork Wallowa River downstream of the aforementioned waterfall, five in the tailrace channel, one bull trout at the head of Wallowa Lake, and one bull trout in BC Creek a tributary to the West Fork Wallowa River. No bull trout were observed in the reach of the East Fork Wallowa River between the waterfalls or in the hydroelectric project forebay.

4.3 Methods

Bull trout of sufficient fork length that were captured during 2012 seasonal electrofishing surveys and collection efforts at the head of Wallowa Lake were marked with half-duplex (HDX) PIT tags and then released. A main goal of 2013 activities was the hopeful recapture of these previously tagged bull trout. To that end, the East Fork Wallowa bypassed reach and the Wallowa Falls Project tailrace were again electrofished in August and all captured bull trout were interrogated for PIT tag presence. Previously tagged bull trout were also again monitored in 2013 using HDX stream-spanning PIT tag antenna arrays constructed within the EF Wallowa River bypassed reach and the Project tailrace.

The August electrofishing survey of the East Fork Wallowa bypassed reach started at the highway bridge and proceeded upstream to the anadromous fish barrier using single-pass electrofishing methods. Electrofishing activities within the Project tailrace occurred during de-watering for annual maintenance and consisted of multiple pass methods as the tailrace water receded until all fish were rescued and the channel was dry. All electrofishing activities followed protocols as set forth in the National Marine Fisheries Service Backpack Electrofishing Guidelines (NMFS 2000). A Smith-Root® model LR-24 backpack electrofisher was used during surveys and was set to un-pulsed direct current (DC) at the lowest possible setting to still allow capture of fish.

All captured bull trout were measured to the caudal fork, interrogated for PIT tag presence and sampled for genetic material by means of a small fin-clip from the upper lobe of the caudal fin. All maiden captured bull trout >120 mm and <300 mm in fork length, were tagged with a uniquely coded 13 mm HDX PIT tag in the dorsal sinus, while bull trout >300 mm fork length were tagged with a 23 mm HDX PIT tag. PIT tags allowed for individual fish identification in case of interrogation at any remote PIT antenna array. PIT tags were inserted, using a tagging syringe or scalpel, just anterior to the dorsal sinus with the tag being gently pushed into the sinus toward the caudal peduncle.

To interrogate previously tagged bull trout that volitionally moved past PIT antenna arrays, stream-width HDX PIT tag antennae were placed at the mouth of both the Project tailrace channel and the East Fork Wallowa River bypassed reach. Antennas were specifically placed in shallow areas of each identified location. Per the manufacturer, 13 mm HDX PIT tags have a nominal read-range of 26 inches, while 23 mm tags exhibit a read-range of approximately 32 inches, making shallow stream areas more conducive to higher detection efficiencies. The higher water velocities of shallow riffles also facilitate better fish movement through the antenna array.

In order to determine directionality of fish movement, each PIT array consisted of two antennas multiplexed (synchronized) and spaced approximately two meters apart. Each antenna was comprised of a 10-gauge copper speaker wire looped along the stream bottom (flat-plate design). The loop started from one stream bank, spanned the entire wetted-width of the stream along the stream bottom to the opposite bank, and then looped back along the stream bottom to the original starting point creating a large flattened oval shape. Each 10-gauge copper speaker wire was then connected to an Oregon RFID® RI-Acc-008B antenna tuner unit. Copper twinax communication cable was then run from each tuner unit to an Oregon RFID® RI-RFM-008 reader board and data logger. Antennas were powered by two 12-volt deep-cycle marine batteries attached in parallel; batteries supplied enough power for two weeks of operation.

4.4 Results

During 2013 electrofishing surveys of the East Fork Wallowa River bypassed reach and dewatering events of the Project tailrace channel, 68 bull trout were captured. Three of the 68 were found to contain a PIT tag inserted during 2012 activities. In addition to the three recaptures, eight of the 68 bull trout encountered were maiden captures and of appropriate tagging size (>120 mm fork length) and were tagged with an HDX PIT tag. To date, 25 bull trout have been tagged with an HDX PIT tag (Table 4.4.6).

Table 4.4.1 and 4.4.2 illustrate bull trout fork lengths encountered during 2013 surveys as compared to bull trout encountered during 2012 surveys of the same area.

Table 4.4-1 Size data comparison between 2012 and 2013 bull trout captures from the East Fork Wallowa River bypassed reach electrofishing surveys.

SPECIES	Sample Size	MEAN LENGTH (mm)	STANDARD DEVIATION	MAXIMUM LENGTH
Bull trout & hybrids – 2012	47	113	44.46	245
Bull trout & hybrids– 2013	56	111	73.14	480

Table 4.4-2 Size data comparison between 2012 and 2013 bull trout captures from the Project tailrace electrofishing surveys.

SPECIES	Sample Size	MEAN LENGTH (mm)	STANDARD DEVIATION	MAXIMUM LENGTH
Bull trout & hybrids – 2012	5	300	175.49	550
Bull trout & hybrids – 2013	12	232	92.12	440

PIT antennas at the mouth of the Project tailrace and East Fork Wallowa River bypassed reach were constructed and powered up on August 16, 2013. The East Fork Wallowa River bypassed reach PIT antenna was turned off and taken out of the stream on November 3, 2013. The Project tailrace channel antenna was taken off-line on August 26, 2013. The short study duration for the Project tailrace antenna was due to the channel de-watering on August 26 and remaining de-watered until September 27 at which time a barrier weir was constructed at the mouth of the channel to prohibit fish from entering. This weir was kept in place during the entire bull trout study period. The East Fork Wallowa River bypassed reach antenna experienced no power loss and ran continuous throughout the study period (August 16 – November 3). The Project tailrace antenna also ran continuous during its study time-frame (August 16 – August 26).

Of the 25 bull trout tagged during 2012 and 2013 field activities, six were detected at one of the two fixed PIT tag antenna arrays.

Five bull trout were interrogated moving upstream past the antenna at the mouth of the East Fork Wallowa bypassed reach. Four of the five detected bull trout were captured and tagged during 2013 activities, of special note was the upstream interrogation of a bull trout captured and tagged from the upper bypassed reach in 2012 (Table 4.4.3).

Table 4.4.3 Bull trout interrogations at the East Fork Wallowa River bypassed reach PIT antenna.

PIT #	Capture Year & Location	FL @ capture	PIT Antenna Transit Times
C58803D	2012 - 600-700m EFW bypassed reach	179	8/27 @A2, downstream
AC35675	2013 - Project tailrace	440	8/30 @A2, upstream 9/18 @A4 and A2 downstream
C587230	2013 - Project tailrace	227	9/3 @A2, upstream
AC35672	2013 - 800-900m EFW bypassed reach	480	9/11 @A2, upstream
C583A3C	2013 - Project tailrace	246	10/13 @A4, upstream

Only one bull trout was interrogated at the Project tailrace antenna during its ten day operation window. This bull trout was initially captured and tagged within BC Creek, approximately 250 meters upstream. BC Creek is a small tributary of the West Fork Wallowa River which is located upstream from the confluence of the Project tailrace channel with the West Fork Wallowa River (Table 4.4.4).

Table 4.4.4 Bull trout interrogations at the Project tailrace PIT antenna.

PIT #	Capture Year & Location	FL @ capture	PIT Antenna Transit Times
6586847	2012 - BC Creek	170	8/19 - 8/21 @A2

No previously tagged bull trout were encountered during the August 2013 electrofishing survey of the East Fork Wallowa bypassed reach. All handled recaptures (3) were encountered in the Project tailrace during the August maintenance de-watering event. Of specific interest concerning the tailrace recaptures, was the recapture of previously captured and tagged bull trout from the upper East Fork Wallowa bypassed reach in 2012. Along with these three handled recaptures, two additional bull trout captured and tagged during 2012 activities were also interrogated moving past passive PIT antenna sites in 2013 (Table 4.4.5).

Table 4.4.5 Bull trout recaptures in 2013.

PIT #	FL @ Initial Capture	FL @ Recap	2012 Capture Location	2013 Recap Location	Comments
591847	215	255	Project tailrace	Project tailrace	40mm growth
C586E5C	191	237	700-800m EFW bypassed reach	Project tailrace	46mm growth
658484B	179	234	700-800m EFW bypassed reach	Project tailrace	55mm growth
C58803D	179	unknown	600-700m EFW bypassed reach	EFW PIT antenna	
6586847	170	unknown	BC Creek	Project tailrace PIT antenna	

To date, maiden bull trout captures from 2013 activities have not been genotyped. It is anticipated this action will occur in early 2014. All bull trout captured during 2012 activities were genotyped for species identification by the United States Fish and Wildlife Service's Abernathy Fish Conservation Genetics Lab. Methods as well as results from this analysis can be found in the memo, "Genetic Species ID of Putative Bull Trout Collected in the Wallowa River System, OR" sent from Pat DeHaan to Jeremiah Doyle on May 9, 2013, which is located as an appendix to this Report (DeHaan 2013, Appendix A).

Table 4.4.6 PIT tagged bull trout during 2012 and 2013 field activities.

DATE	SPECIES	PIT#	FL (mm)	CAPTURE LOCATION	NOTES
7/4/2012	BT	A0F657C	378	Wallowa Lake	HDX 23mm tag, tangle net capture, genotyped
8/13/2012	BTxBRKT	591847	215	Project tailrace	HDX 13mm, genotyped
8/13/2012	BT	58484B	179	Project tailrace	HDX 13mm, genotyped
8/13/2012	BT	A0F65A8	415	Project tailrace	HDX 23mm, female, genotyped
8/13/2012	BT	A89AF23	550	Project tailrace	HDX 23mm, male, genotyped
8/23/2012	BTxBRKT	6594848	189	100-200m EFW bypassed reach	HDX 13mm. genotyped
8/23/2012	BT	C582635	171	200-300m EFW bypassed reach	HDX 13mm. genotyped
8/24/2012	BT	C58942B	181	500-600m EFW bypassed reach	HDX 13mm. genotyped
8/24/2012	BT	C58803D	179	600-700m EFW bypassed reach	HDX 13mm. genotyped
8/24/2012	BT	C58063A	168	600-700m EFW bypassed reach	HDX 13mm. genotyped
8/24/2012	BT	C586E5C	191	700-800m EFW bypassed reach	HDX 13mm. genotyped
8/24/2012	BTxBRKT	C58921A	151	700-800m EFW bypassed reach	HDX 13mm. genotyped
8/24/2012	BT	C58524D	155	800-900m EFW bypassed reach	HDX 13mm. genotyped
8/24/2012	BT	C58924A	245	800-900m EFW bypassed reach	HDX 13mm. genotyped
8/24/2012	BT	C589C51	169	800-900m EFW bypassed reach	HDX 13mm. genotyped
8/24/2012	BT	C588A60	164	800-900m EFW bypassed reach	HDX 13mm. genotyped
7/6/2012	BT	6586847	170	BC Creek	HDX 13mm. genotyped
8/15/2013	Field ID BT	C585E61	209	EFW bypassed reach	HDX 13mm
8/15/2013	Field ID BT	C58083A	208	EFW bypassed reach	HDX 13mm
8/15/2013	Field ID BT	AC35672	480	EFW bypassed reach	HDX 23mm
8/15/2013	Field ID BT	AC35679	330	EFW bypassed reach	HDX 23mm
8/26/2013	Field ID BT	AC3567A	365	Project tailrace	HDX 23mm
8/26/2013	Field ID BT	AC35675	440	Project tailrace	HDX 23mm
8/26/2013	Field ID BT	C587230	227	Project tailrace	HDX 13mm
8/26/2013	Field ID BT	C583A3C	246	Project tailrace	HDX 13mm

4.5 Discussion

The overarching goal of bull trout surveys and monitoring activities in and around the Wallowa Falls Hydroelectric Project in 2013 was the hopeful recapture of bull trout captured and tagged in 2012. It was anticipated recaptures would shed light on distribution and life history being exhibited by the local bull trout population. Data collected in 2012 strongly suggested this population to be mainly resident, localized in the upper portion of the East Fork Wallowa bypassed reach. Three main reasons contributed to the resident life history assumption; 1.) The lack of large, migratory sized bull trout captures in 2012; 2.) Due to the recent bull trout reintroduction in 1997, the most likely origin of this population may be from Big Sheep Creek whose bull trout historically exhibit a resident life history; and 3.) Most bull trout encountered in 2012 were captured in the remote, small geographic area of the upper bypassed reach. It was anticipated that electrofishing surveys of the East Fork Wallowa bypassed reach, as well as an additional year of PIT antenna operation, would either validate the residency assumption or provide proof of a more migratory (fluvial or adfluvial) life history.

Recaptures of bull trout in the same spatial area as first encountered during 2012 activities was implied as an indication of residency. Interrogations at passive PIT antenna sites or recaptures in areas other than first encountered in 2012 were an indication of a migratory life history.

No bull trout captured and tagged during electrofishing surveys of the East Fork Wallowa bypassed reach in 2012 were encountered during similar surveys of the same geographic area in 2013. 54 Of the 56 bull trout captured during the 2013 bypassed reach survey were less than 225mm in fork length. The remaining two were large, migratory-sized (>325mm) fish.

Two bull trout captured and tagged in 2012 from the uppermost section of available anadromous fish habitat within the bypassed reach were encountered within the Project tailrace channel during a 2013 electrofishing survey. When first captured in 2012, these two bull trout were 191mm and 179mm in fork length, respectively. This initial size corresponded with average fork lengths of mature resident bull trout encountered by the Oregon Department of Fish and Wildlife within neighboring local populations (Smith/Knox, 1992). Though this size can correspond with observed adult resident fork lengths, it also corresponds with typical average fork lengths exhibited by rearing migratory 2-3 year old bull trout (Fraley and Shepard 1989).

Of the six bull trout interrogated at PIT antenna sites in 2013, two were recaptures from 2012 surveys. Both fish when initially encountered measured in the 170mm fork length range and both fish were initially encountered in anadromous headwater areas, one from the upper reaches of the bypassed reach and the other from upper BC Creek. The first recaptured bull trout was initially encountered in August 2012 from the upper bypassed reach, this fish was then recaptured moving downstream past the PIT antenna at the mouth of the East Fork Wallowa bypassed reach on August 27, 2013. The second bull trout was first captured in BC Creek, 250m upstream from its confluence with the West Fork Wallowa River. BC Creek is a small tributary of the West Fork Wallowa River located upstream of both the Project tailrace channel and the East Fork Wallowa River. This bull trout was subsequently interrogated (recaptured) at the PIT antenna located in the Project tailrace channel during its ten day operation window at the end of August 2013.

Given the lack of recaptures during the 2013 bypassed reach electrofishing survey, the recapture of 2012 bypassed reach bull trout within the Project tailrace channel in 2013, the capture of large migratory-sized bull trout just below the anadromous fish barrier in the bypassed reach in both the 2012 and 2013 surveys, and the 2013 interrogation of 2012 headwater bull trout captures at downstream PIT antenna sites, it appears the upper East and West Fork Wallowa River local bull trout population exhibits a migratory life history.

5.0 RELATIVE ABUNDANCE AND COMPOSITION OF MACROINVERTEBRATE SPECIES RESIDING IN WATERS IN AND AROUND THE PROJECT

5.1 Study Description and Objectives

The following study was proposed to gain additional information of the current aquatic macroinvertebrate species occupying the East Fork Wallowa River above the Project forebay and within the East Fork Wallowa River bypassed reach. This study provided additional information on the composition of aquatic macroinvertebrates in the study stream sections as well as relative abundance of identified species in catch per unit of effort (CPUE) to what was gathered during 2012.

5.2 Methods

A Surber Sampler® was used to obtain a sample of aquatic macroinvertebrates residing at specified representative riffle locations within the study stream. Standard protocols when using a Surber Sampler® were employed in order to obtain a consistent sample of macroinvertebrates from each sample site (Surber 1936). A representative riffle habitat type was sampled once at the following three locations of the East Fork Wallowa River bypassed reach; 1) in the East Fork Wallowa River above the Project forebay, 2) in the high gradient portion of the bypassed reach, and 3) in the low gradient portion of the bypassed reach near its confluence with the West Fork Wallowa River.

To remove water, large pieces of gravel and detrital material from the macroinvertebrate sample, the contents of the Surber Sampler® collection cup was filtered with a 500 micron mesh sieve. The sample was then placed in a bottle and preserved with 95 percent ethanol for later lab analysis.

Each sample was sent to the Aquatic Biology Associates lab in Corvallis, OR for analysis. Analysis consisted of identifying all macroinvertebrate species present in each sample to Genus as well as enumerating all macroinvertebrates within each sample.

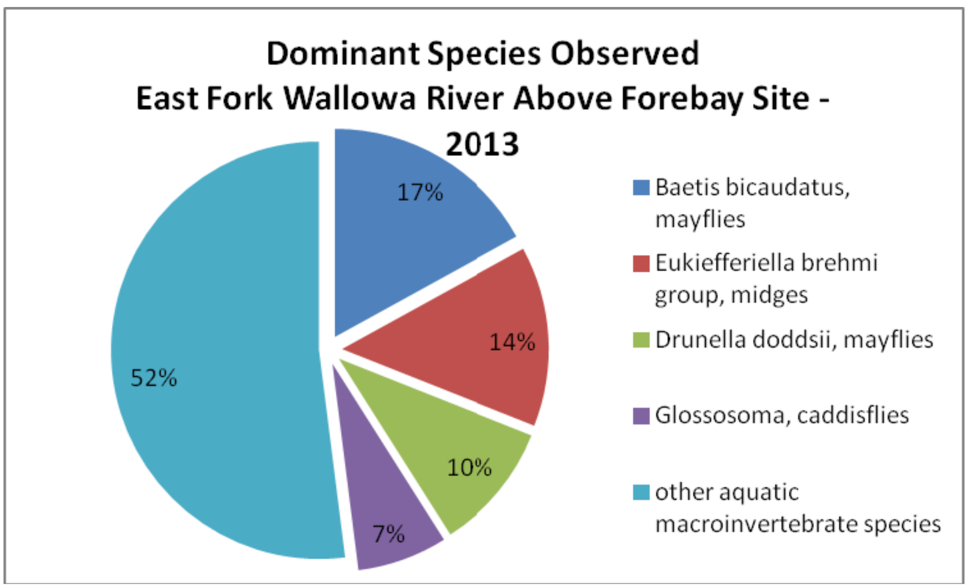
5.3 Results

Square meter macroinvertebrate samples were collected on August 12, 2013 from sites established during 2012 activities. Areas sampled included s site in the upper East Fork Wallowa River bypassed reach above the Project forebay; from a riffle within the 500 m stream section of the lower East Fork Wallowa River natural channel below the anadromous barrier; and from the East Fork Wallowa River bypassed reach at its confluence with the West Fork Wallowa River. Samples were sent to Aquatic Biology Associates for analysis in September 2013. Each sample was analyzed for species composition and associated species relative abundance within the sample as expressed in the table in Appendix C. Along with quantifying and identifying species within each macroinvertebrate sample, Aquatic Biology Associates also submitted a short memo with further analysis and recommendations (Wisseman, 2013 Appendix B).

During collection of the macroinvertebrate sample from the upper East Fork Wallowa River bypassed reach above the Project forebay on August 12, the Project forebay itself was also surveyed for fish presence. Using snorkel survey techniques, the entire forebay was surveyed. Three brook trout parr were observed. These fish were most likely out-migrants from Aneroid Lake upstream of the forebay.

The sample taken from the East Fork Wallowa River above the Project forebay in 2013 was dominated by Ephemeroptera (mayflies), Chironomidae (midges), and Trichoptera (caddisflies) with the four most prevalent species expressed in Figure 5.3.1. In all, 41 different aquatic macroinvertebrate species were identified and enumerated from this sample.

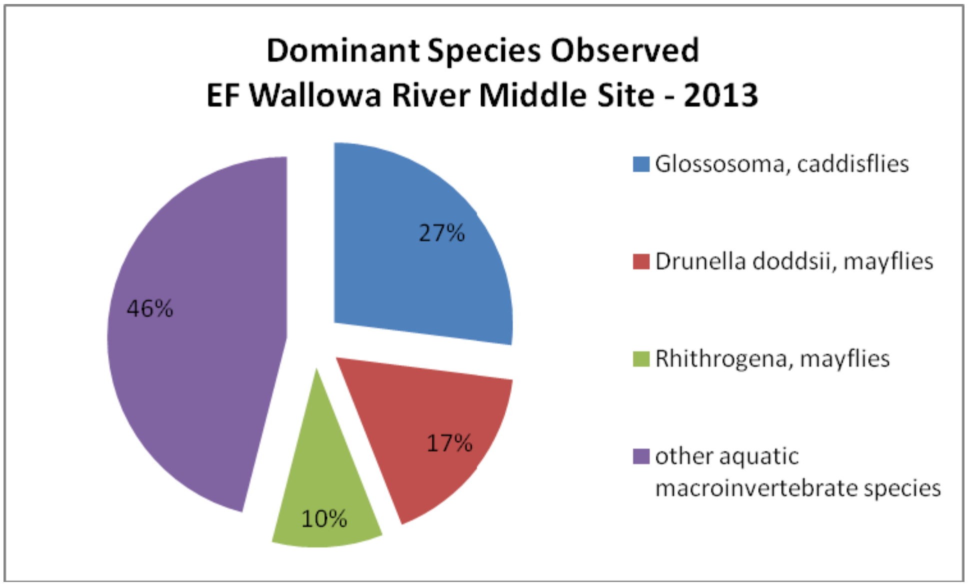
Figure 5.3.1. The three most dominant aquatic macroinvertebrate species observed within the sample taken from above the Project forebay.



The sample taken from the East Fork Wallowa River natural channel in the indentified 500 m stream section during 2013 data collection activities was dominated by mayflies and caddisflies.

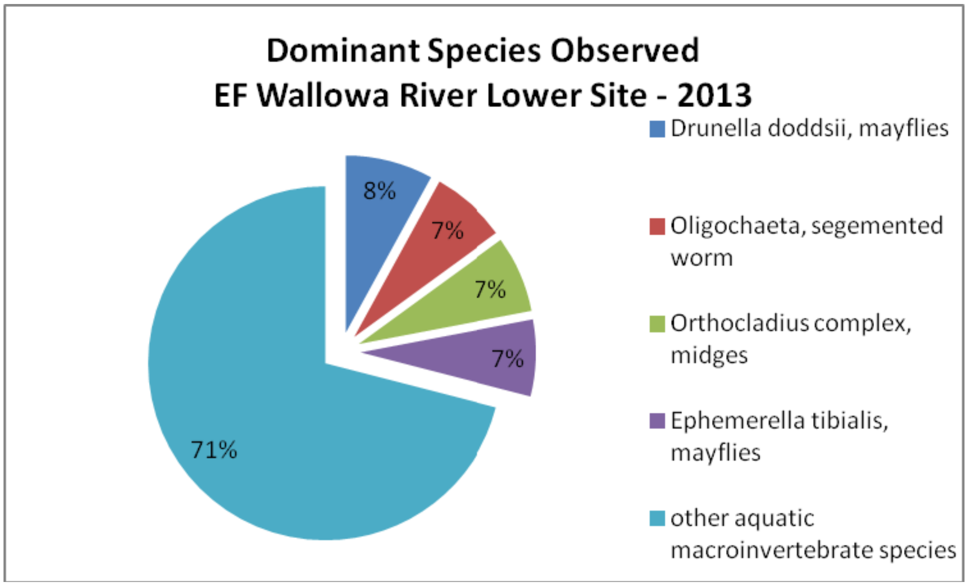
In all 50 different species were identified from within this sample. The three most dominant species observed are identified within Figure 5.3.2.

Figure 5.3.2. The three most dominant aquatic macroinvertebrate species observed in 2013 within the sample taken from the mid East Fork Wallowa River bypassed reach.



The sample taken from the lower East Fork Wallowa River natural channel was dominated by mayflies, midges, and Oligochaeta (segmented worms). In all 57 different species were identified from within this sample. The most dominant species observed are identified within Figure 5.3.3.

Figure 5.3.3. The three most dominant aquatic macroinvertebrate species observed in 2013 within the sample taken from the lower East Fork Wallowa River bypassed reach site.



5.4 Discussion

In 2013, taxon richness and diversity increased within the three samples collected the further downstream the sample location. Percent composition of species intolerant to higher water temperatures and lower dissolved oxygen levels also increased in the downstream sample in 2013 when compared to the sample taken from upstream.

Though tolerant taxon increased in samples taken from lower in the stream reach, all three samples collected had high levels of moderate to highly intolerant aquatic macroinvertebrate species, indicative of high water quality. 60 percent of the upper sample, 83 percent of the middle sample, and 48 percent of the lower sample consisted of caddisflies, mayflies, or stoneflies known to have stringent habitat requirements in terms of low water temperatures and high dissolved oxygen content (Lillehammer 1988 and Whitney 1939).

Additional analysis and discussion can be found in the short memo from Robert Wisseman at Aquatic Biology Associates to Jeremiah Doyle, dated December 20, 2013 and located in Appendix B.

6.0 REFERENCES

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's Bull trout. Oregon Department of Fish and Wildlife, Portland, OR.

Cramer, S.P. and K.L. Witty. 1998. Feasibility for reintroducing sockeye and coho salmon in the Grande Ronde basin. Report to Bonneville Power Administration. Project No. 1998-05301.

Dunham, J. B., and B. E. Rieman. 1999. Metapopulation Structure of Bull Trout: Influences of Physical, Biotic, and Geometrical Landscape Characteristics. Ecological Applications 9:642–655

Federal Register, Vol. 75, No. 200 – October 2010 pgs. 63,898-64,070.

Fraley, J. J., and B. B. Shepard. 1989. Life history, ecology, and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River System, Montana. Northwest Science 63: 133–143

Goodson, K., B. McIntosh, M. Chilcote, and C. Corrarino. 2005. Oregon Native Fish Status Report. Oregon Department of Fish and Wildlife, Fish Division, Salem, OR.

Lillehammer, A. (1988) Stoneflies (Plecoptera) of Fennoscandia and Denmark. Fauna Entomologica Scandinavica 21: 1–165.

MEMO: Robert Wisseman, Aquatic Biology Associates, Inc., Corvallis, OR to Jeremiah Doyle, PacifiCorp Energy. December 19, 2013

MEMO: Pat DeHaan, USFWS Abernathy Fish Conservation Genetics Lab, Abernathy, WA to Jeremiah Doyle, PacifiCorp Energy. May 9, 2013

NMFS. 2000. National Marine Fisheries Service Backpack Electrofishing Guidelines.

NOAA. 2008. Fisheries Off West Coast States; West Coast Salmon Fisheries; Amendment 14; Essential Fish Habitat Descriptions for Pacific Salmon, 73 FR 60987, 60991 (October 15, 2008)

Smith, B., and C. Knox. 1992. Report of Findings; Bull Trout Density Sampling. Oregon Department of Fish and Wildlife, Wallowa Fish District.

Surber, E. W. 1936. Rainbow trout and bottom fauna production in one mile of stream. American Fisheries Society 66: 193-202.

USFWS. 2002. Bull Trout Draft Recovery Plan. Chapter 11 Grande Ronde River. Region 1, United States Fish and Wildlife Service, Portland, OR. October 2002.

7.0 APPENDICES

APPENDIX A

MEMO: Pat DeHaan, USFWS Abernathy Fish Conservation Genetics Lab, Abernathy, WA to Jeremiah Doyle, PacifiCorp Energy. May 9, 2013

Genetic Species ID of putative bull trout collected in the Wallowa River System, OR.

May 9, 2013

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Presently little information exists regarding the status of bull trout (*Salvelinus confluentus*) in the Wallowa River system, Oregon. Bull trout were presumed to be extirpated from the Wallowa River in the 1950s and there have been two attempts to reintroduce bull trout to the Wallowa River system since then (USFWS 2002). Currently it is unknown how successful these reintroduction efforts were at re-establishing spawning population of bull trout in the system. Given the uncertainty associated with bull trout status in the Wallowa River, it is important to document the species presence as well as any potential threat of hybridization with non-native brook trout (*S. fontinalis*). Putative bull trout have been collected in the Wallowa River system by PacifiCorp biologists during fish surveys. In 2013, Abernathy Fish Technology Center received genetic samples from 38 putative bull trout collected in the Wallowa River system for species ID analysis.

Putative bull trout were genotyped at 16 microsatellite loci following genotyping methods outlined in DeHaan and Adams (2012). Several of these 16 loci have fixed allelic differences between bull trout and brook trout and previous studies have shown these loci can be used for species ID and hybrid detection (DeHaan et al. 2010). Genotypes for the 38 putative bull trout were compared to allele frequency distributions of known bull trout and brook trout to determine species ID. Of the 38 putative bull trout collected in the Wallowa River system, 30 fish had genotypes consistent with pure bull trout and eight fish had genotypes consistent with F1 bull trout x brook trout hybrids (Table 1). These data provide evidence that bull trout are currently present in the Wallowa system and that non-native brook trout represent a potential threat to bull trout in the system. We are in the process of establishing a new study between the U.S. Fish and Wildlife Service and PacifiCorp to use genetic data to explore the origins of Wallowa Bull trout (i.e. remnant native population vs. introduced population). We anticipate this analysis will begin in late 2013 or early 2014.

References

DeHaan, P. W., and B. Adams. 2012. Rapid response genetic analysis of bull trout collected in the Lewis River, WA. U.S. Fish and Wildlife Serivce, Longview, WA.

DeHaan, P. W., L. T. Schwabe, and W. R. Ardren. 2010. Spatial patterns of hybridization between bull trout, *Salvelinus confluentus*, and brook trout, *Salvelinus fontinalis,* in an Oregon stream network. Conservation Genetics 11(3):935-949.

USFWS. 2002. Bull trout draft recovery plan. U.S. Fish and Wildlife Service, Portland, OR. available online at: http://www.fws.gov/pacific/bulltrout/Recovery.html

APPENDIX B

MEMO: Robert Wisseman, Aquatic Biology Associates, Inc., Corvallis, OR to Jeremiah Doyle, PacifiCorp Energy. December 19, 2013

Wallowa Falls Hydroelectric Project
Benthic Macroinvertebrate Biomonitoring, August 2013

Introduction and Methods

PacifiCorp Energy (PacifiCorp) operates the Wallowa Falls Hydroelectric Project on the East Fork Wallowa River in northeast Oregon. As part of this operation, sediment accumulation in the 0.2 acre forebay at 5800' elevation is periodically flushed downstream to prevent damage to the penstock and generating unit. Scheduled maintenance flushed 314 cubic yards of sediment from the forebay into the bypassed reach on August 13, 2012. No sediment was flushed downstream in 2013, however the sediment released in 2012 continued to work its way down the bypass reach.

To determine potential impacts to the benthic macroinvertebrate (BMI) community, BMI samples were taken at three stations on August 13-14, 2013, using the prevalent protocol in the Pacific Northwest that combines 8 Surber samples into a single composite BMI sample, from which a 500 minimum subsample is extracted to characterize populations. Samples were analyzed by Aquatic Biology Associates, Inc., Corvallis, OR, following standard laboratory protocols. At each BMI station a 500 organism minimum subsample of macroinvertebrates was acquired and identified to the Pacific Northwest Aquatic Monitoring Partnership Standard Taxonomic Effort Level 2 (in preparation).

The bypassed reach on the East Fork Wallowa River is approximately 1.75 miles long and extends from the forebay at 5800' elevation downstream to the confluence with the West Fork Wallowa River. The minimum in-stream flow released at the forebay dam is 0.5 cfs. The bypassed reach has a steep gradient, with the upper mile at 18.9% and the lower 0.75 mile at 8.5%. The channel is a combination of steep bedrock sections, waterfalls, and large boulders with high quantities of large woody debris. BMI stations are:

> **Lower**: East Fork Wallowa River bypass reach just upstream of the confluence with West Fork Wallowa River.
>
> **Middle**: East Fork Wallowa River bypass reach 500 meters upstream of the confluence with the West Fork Wallowa River.
>
> **Upper**: Unregulated control reach just upstream of the Project forebay and upstream of forebay sediment releases.

Results

Table 1 summarizes key metrics that characterize the BMI communities found at the three stations in August 2013.

Benthic macroinvertebrate communities in montane streams typically display considerable changes in community structure along an altitudinal and longitudinal gradient. This trend is quite evident at the three stations sampled on the East Fork Wallowa River. Overall abundance and richness is greatest at the Lower elevation station and declines progressively upstream and at higher elevations at the Middle and Upper stations. A more limited benthic community consisting primarily of cold water taxa is found at the Upper/Control station.

Reference to low, moderate or high metric values for Pacific Northwest montane streams given below is based on the best professional judgment of Robert Wisseman. As of yet, there are no published references that address this topic.

Total taxa richness is highest at the Lower station and declines progressively upstream at the Middle and Upper stations. This is due to a loss of taxa progressing up the altitudinal and longitudinal gradient into colder headwater reaches.

Total abundance: Standing crops of 1112 to 3976 per square meter as seen at the East Fork Wallowa River stations in 2013 are typical for oligotrophic montane streams of this size in the Pacific Northwest. Highest invertebrate densities are found near the mouth where water temperature is higher, flows more moderate and primary productivity higher. In 2013 total abundance at the Middle station was 1112 invertebrates/m^2, about half that found at the Upper station (2148/m^2) and significantly less than the Lower station (3976/m^2). A fine sediment pulse working its way through the steep gradient reach where the Middle station is located may have depressed invertebrate densities in 2013.

EPT taxa richness: EPT (Ephemeroptera+Plecoptera+Trichoptera) taxa are some of the most sensitive macroinvertebrates to stressors such as fine sediment. EPT richness of 23-32 taxa as found at the three stations in 2013 is in the moderate range. EPT taxa richness mirrors the longitudinal trend for total taxa richness, with the colder headwater reaches having the fewest taxa.

% Top 3 taxa is the percent contribution of the 3 dominant taxa at a station, a more easily understood measure of the community diversity. Dominance <50% is low, 50-74% is moderate, and >75% is high. Dominance was low at the Lower (28%) and Upper (41%) stations in 2013, and moderate at the Middle station (53%), perhaps indicating some stress to the benthic community at the Middle station.

% Tolerant taxa and tolerant taxa richness (warm water biota) was low at all three stations in 2013, with 1-2 taxa accounting for 0.6-1.5 % of the community. This is as expected in a high gradient, cold montane stream.

Intolerant taxa (cold-water biota) richness was very high (20-22 taxa) and comprised a high proportion of the benthic community at all three stations (27-52%) in 2012. Dominance at the Lower & Middle stations (27 & 28%) was substantially less than found at the Upper control station (52%). Many of these cold-water biota taxa are sensitive to substrate scouring and fine sediment accumulation in and on stream bottom substrates. Fine sediment working its way down the bypass channel in 2013 may have depressed intolerant taxa populations.

Semivoltine taxa require more than one year to complete their life cycle and are often sensitive to physical disturbance of substrates. The % semivoltine taxa was low basin wide in 2013 (2.3-4%), including the Upper control, than is typical for forested montane streams in the Pacific Northwest. This appears to be due more to natural annual variation than from sediment release impacts.

Ephemeroptera (mayfly) abundance in western montane streams normally increases in a downstream direction as stream water warms more and the channel opens up, increasing algal production. Highest abundance of mayflies in 2013 was found at the Lower station (1360/m^2). The Middle station had substantially fewer mayflies (578/m^2), than either the Lower or Upper station (984/m^2), possibly indicating impacts from the sediment release.

Plecoptera (stonefly) abundance at all three stations in 2013 was low (31-72/m^2), with the lowest density found at the middle station, possibly indicating impacts from the sediment release.

Trichoptera (caddisfly) abundance in 2013 at all three stations was roughly similar (228-364/m^2).

Chironomidae (midges) are a diverse family of true flies that are ubiquitous and common in freshwater ecosystems. Many species are tolerant of fine sediment. Dominant midges at the Lower station were *Eukiefferiella species groups*, *Orthocladius species groups*, *Pagastia* and *Tvetenia bavarica group*, which are all taxa common in urban and suburban streams with fine sediment problems. These taxa were rare or absent at the Middle and Upper stations. Midge abundance at the Middle station in 2013 (78/m^2), was an order of magnitude less than found at the Lower (1564/m^2) and Upper (740/m^2) stations. Scour from fine sediment moving down through the steep middle reaches of the bypass reach may be impacting populations.

Scrapers have mouthparts specialized for "scraping" algae off hard rock or wood surfaces. They are sensitive to fine sediment that buries hard surfaces on which they feed or pulses of fine sediment in bed-load transport that scour their algal food source from these hard surfaces. In 2013 scraper densities at all three stations had a relatively narrow range (576-828/m^2). Impacts from the sediment release to the scraper community were not catastrophic.

Conclusions

Jeremiah Doyle of PacifiCorp indicated there were no unusual flood or drought events that occurred in the East Fork Wallowa River watershed in 2013.

1. Taxa richness based metrics, such as Total taxa, EPT taxa, Tolerant taxa, Intolerant taxa, and Semivoltine taxa display typical longitudinal/altitudinal changes along the stream axis. The suite of taxa present in the regulated and unregulated reaches of the watershed is typical for the region, with no apparent loss of taxa in the Middle reaches from the 2012 sediment release.

2. Taxa abundance based metrics, such as Total abundance, Semivoltine taxa abundance; Ephemeroptera abundance, Plecoptera abundance, and Chironomidae abundance are all considerably lower in the steep Middle reaches, than at the Lower station or Upper control station. This depression in abundance is likely due to a combination of natural habitat factors (e.g. steeper gradient), and the 2012 sediment release.

3. Fine sediment may be accumulating in pockets between boulders and cobbles at the Lower station where fine sediment related taxa can thrive. The development of fine sediment dwelling taxa would occur over years, and not between the August 13, 2012 release of sediment from the forebay and the 2013 sampling.

4. Where stream gradient progresses from steeper mid- and headwater reaches to lower gradient reaches near the mouth, an increase in sediment tolerant taxa as seen in the East Fork Wallowa River is typical. Sediment being released from the forebay is derived from "natural" additions to the stream channel above the forebay. Hydroelectric Project operations may be influencing the competence of the stream to move fine sediment in the lower reaches of the East Fork Wallowa River.

Table 1. Summary of the benthic macroinvertebrate community in the East Fork Wallowa River in August 2013. Abundances are per one square meter.

Station	**Lower** Near mouth	**Middle** Mid reaches	**Upper** Above Forebay
Total taxa richness	56	47	39
Total abundance	3976	1112	2148
EPT taxa richness	32	30	23
% Top 3 taxa	28	53	41
% Tolerant taxa (warm-water biota)	1.5	1	0.6

Tolerant taxa richness	2	2	1
% Intolerant taxa (cold-water biota)	27	28	52
Intolerant taxa richness	22	21	20
% Semivoltine taxa (>1 year life cycle)	4.0	2.3	3.7
Semivoltine taxa abundance	160	26	80
Semivoltine taxa richness	8	8	6
Ephemeroptera abundance (mayflies)	1360	578	984
Plecoptera abundance (stoneflies)	152	31	72
Trichoptera abundance (caddisflies)	364	310	228
Chironomidae abundance (midges)	1564	78	740
Oligochaeta abundance (worms)	292	68	0
Scraper feeding group abundance	828	692	576

APPENDIX C

	Water body Station	E.F. Wallowa River Lower	E.F. Wallowa River Middle	E.F. Wallowa River Above Forebay
Taxon	Common name	Abundance	Abundance	Abundance
Turbellaria	flat worms	24	28	12
Nemata	round worms	12	8	8
Oligochaeta	segmented worms	292	68	
Acari	mites	8		32
Ameletus	mayflies	4	3	
Acentrella turbida	mayflies	8	1	
Baetis bicaudatus	mayflies	184	56	372
Baetis tricaudatus	mayflies	184	56	
Caudatella hystrix	mayflies	88	7	128
Drunella coloradensis	mayflies	48	6	20
Drunella doddsii	mayflies	332	184	216
Drunella spinifera	mayflies	24	10	76
Ephemerella dorothea infrequens	mayflies	12		16
Ephemerella tibialis	mayflies	280	53	
Cinygmula	mayflies	12	15	4
Epeorus albertae group	mayflies	76	72	24
Epeorus grandis group	mayflies	52	2	112
Rhithrogena	mayflies	56	113	16
Capniidae	stoneflies	4	6	4

Taxon	Water body / Station / Common name	E.F. Wallowa River Lower Abundance	E.F. Wallowa River Middle Abundance	E.F. Wallowa River Above Forebay Abundance
Chloroperlidae	stoneflies		1	
Sweltsa	stoneflies		1	
Malenka	stoneflies	4		
Visoka cataractae	stoneflies	8		
Zapada cinctipes	stoneflies	24	1	
Zapada columbiana	stoneflies	72	1	12
Zapada oregonensis group	stoneflies	4	8	28
Doroneuria	stoneflies	16	7	
Isoperla	stoneflies	8	2	4
Megarcys	stoneflies	8	3	8
Yoraperla brevis	stoneflies		1	16
Taeniopterygidae	stoneflies	4		
Micrasema	caddisflies			24
Glossosoma	caddisflies	204	297	148
Parapsyche elsis	caddisflies	16	6	28
Ecclisomyia	caddisflies		1	
Dolophilodes	caddisflies	80	1	
Rhyacophila atrata group	caddisflies	4		
Rhyacophila betteni group	caddisflies	12	1	
Rhyacophila brunnea/vemna group	caddisflies	24		4

	Water body Station	E.F. Wallowa River Lower	E.F. Wallowa River Middle	E.F. Wallowa River Above Forebay
Taxon	Common name	Abundance	Abundance	Abundance
Rhyacophila hyalinata group	caddisflies	12		12
Rhyacophila nevadensis group	caddisflies		1	8
Rhyacophila vagrita	caddisflies	12	2	4
Rhyacophila vagrita	caddisflies		1	
Deuterophlebia	mountain midges	4		32
Deuterophlebia	mountain midges			4
Chelifera/Metachela	dance flies	8		
Clinocera	dance flies	20		4
Wiedemannia	dance flies			8
Glutops	higher flies	4	6	
Prosimulium	black flies	112	2	24
Simulium	black flies	44		
Dicranota	crane flies	8	2	
Rhabdomastix setigera group	crane flies		1	
Chironomidae	midges	72	7	52
Brillia	midges	144	6	4
Chaetocladius	midges		1	
Cricotopus (Nostococladius)	midges			8
Diamesa	midges	32	1	
Eukiefferiella brehmi group	midges	192	22	292

	Water body Station	E.F. Wallowa River Lower Abundance	E.F. Wallowa River Middle Abundance	E.F. Wallowa River Above Forebay Abundance
Taxon	Common name			
Eukiefferiella claripennis group	midges	20	10	12
Eukiefferiella devonica group	midges	52		60
Hydrobaenus	midges	40		
Krenosmittia	midges			4
Micropsectra	midges	12	5	
Orthocladius	midges	52		
Orthocladius complex	midges	284	4	60
Orthocladius (Euorthocladius)	midges	20		
Pagastia	midges	124	10	112
Stempellinella	midges	20	1	
Tvetenia bavarica group	midges	500	11	136