Limnological Threat Assessment – Priest Lake Water Release System

FOR: IDAHO DEPARTMENT OF FISH AND GAME

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Executive Summary

The Idaho Department of Fish and Game are investigating the feasibility of installing a subsurface withdrawal structure in the hypolimnion of Priest Lake with the intent to reduce ambient water temperature in Priest River. As considered, the system would withdraw between 45 and 105 cfs from June through September. The purpose of this study was to determine the impact this hypolimnetic withdrawal would have on Priest Lake. To accomplish this, an intensive monitoring program was implemented to assess epilimnion and hypolimnion physical and biological conditions as well as to determine any lake-wide and localized impacts of hypolimnetic withdrawal on the structure on the vertical stratification of the lake. Data were also collected on the Priest River and two reference streams to assess any changes that would potentially occur in the periphyton and macroinvertebrate community structure in Priest River.

The results from the study found that there was no significant difference in the water chemistry between the epilimnion and hypolimnion of the lake. Therefore, the implementation of a hypolimnetic withdrawal program would not result in a measureable change to the nutrient regime within the lake or in Priest River.

The phytoplankton community within Priest Lake was also similar in the epilimnion and hypolimnion. The zooplankton community had fewer individual *Daphnia* sp. present in the hypolimnion; however, the *Daphnia* sp. present in the hypolimnion were larger and therefore the biomass of zooplankton in the epilimnion and hypolimnion were similar.

The periphyton and macroinvertebrate data from Priest River, Yak River and Binarch Creek indicates that all three system have healthy communities that are indicative of nutrient poor but high quality water. The main difference observed between the warmer water of the Priest River when compared to Yak and Binarch is in the number of coldwater taxa. These data suggests there will be a shift toward more obligate cold water taxa if the water temperature in the Priest River is reduced.

Water temperature was measured in a variety of ways in this study. During each sampling event vertical profiles of temperature were collected at each of the main lake monitoring stations. There were two

semi-permanent thermistor chains installed in the lake. One was installed near the proposed intake structure and the second was installed approximately 1 kilometer north of the proposed intake structure in a deeper section of the lake. During July and August five horizontal temperature transects were conducted from the lake mouth to the dam to help ascertain the possible changes in water temperature as a result of hypolimnetic withdrawal. Finally, water temperature was measured using data logging thermistors in Priest River, Lamb Creek, and Binarch Creek.

The horizontal transect data from the lake to the dam consistently showed a decrease in water temperature from the lake to the dam. This finding suggests the outlet area of the lake cools rather than warms as outflow approaches the dam. Based on these data it appears that there is a source of colder water from either Lamb Creek or ground water recharge in the outlet portion of the lake. If the amount of relatively warm epilimnion outflow was reduced the likely result would be for the outlet area to have cooler temperatures than currently exists due to changes in the thermal balance.

The data from the in lake thermistor chains indicate that the lake has a strong thermocline by mid-July. The proposed intake structure depth of 18m would result in water temperature of 8 to 10^{o}C a majority of the time. Under certain weather events the withdrawal temperature can be greater than 10^{o}C higher than the target withdrawal temperature of 8^{o}C.

The data from the thermistor chains as well as hydrologic modeling indicate that there would not be a measureable temperature impact to the epilimnion or hypolimnion of the lake due to a hypolimnetic withdrawal. There is a potential for extremely localized effect deepening the epilimnion by less than 0.4 meters at the point of withdrawal with water being pulled from 3.4 meters above the intake structure to 4.1 meters below the intake structure. Localized effects could be expected to be mitigated with the installation of a more diffused intake structure.

The overall conclusion of this report is that there will no significant impact to the biological or physical characteristics to Priest Lake as a resulting from the implementation of a hypolimnetic withdrawal with a maximum delivery of 105 cfs. Any localized impacts could be expected to eliminated with appropriate design of the intake structure.

It is recommended that if the project is implemented that a monitoring program be established to confirm that there are not impacts to the lake and that there are no adverse changes to the periphyton or macroinvertebrate community within the Priest River.

Introduction

The purpose of this project is to identify and assess the limnological and ecological risks on Priest Lake and Priest River associated with operating a hypolimnetic withdrawal system designed to cool the Priest River downstream of Priest Lake as early as June and as late as early October, depending on environmental conditions of a particular year.

The monitoring and assessment project was designed to address the following questions or concerns of the proposed project:

- Identify and assess the limnological risks of withdrawing up to 105 cubic feet (“cfs”) of hypolimnetic water from June through October on Priest Lake, including the risk of reducing the surface water flow through Outlet Bay;
- Identify and assess the risks of replacing 45-105 cfs of surface water with the same amount of hypolimnetic water on the water quality of Priest River;
- Develop a long-term monitoring plan designed to evaluate the potential impacts of operating a hypolimentic withdrawal system on Priest Lake.

Background

The Priest River downstream of Priest Lake flows approximately 45 miles from the outlet of Priest Lake to its mouth on the Pend Oreille River near the town of Priest River. The Priest River has a low gradient (<1.5%) with a high width to depth ratio resulting in minimal river shading. The mean flow in the period of interest range from 1800 cfs at the beginning of July to 80 cfs by the end of September. Streamflow in the Priest River is regulated by a low head dam located in Outlet Bay, which is operated by the Idaho Water
Resource Board (IWRB).

Priest Lake is approximately 18 miles long running from north to south, and is drained by the Priest River, which is a major tributary of the Pend Oreille River. The dam at Outlet Bay was originally constructed in 1950, and was subsequently replaced in 1978 by a concrete dam. Summer dam operations are controlled to maintain a full summer pool for recreation and minimum instream flows downstream of the dam.

Portland State University (PSU) developed a stream temperature model for the outlet of Priest Lake and the first 30 miles of Priest River downstream of Outlet Bay Dam. The modeling concluded that it was feasible to reduce late summer stream temperatures in the Priest River by adding hypolimnetic water from Priest Lake. PSU considered input flow rates between 30 cfs and 400 cfs and predicted that the upper 30 miles of the Priest River could be cooled between 2^{o} and 10° C. This amount of cooling would be enough to improve native salmonid habitat conditions and meet the Idaho Department of Environmental Quality (IDEQ) criteria for cold-water aquatic life during August and September (<19°C).

The assessment of limnological threats associated with the operation of a cold-water release system at the outlet of Priest Lake was necessary to further investigate the feasibility of developing a coldwater augmentation system at the outlet of the lake to benefit cold-water native salmonids. The goal of the limnology study was to identify and assess the limnological and ecological risks on Priest Lake and the Priest River associated with operating a hypolimneitc withdrawal system. Data obtained over the course of this study can be used to develop a more refined plan for the future.

Methods

Sample Design

The sampling process was designed to provide sufficient data to adequately evaluate the effects of hypolimnetic withdrawal from Outlet Bay and subsequent discharge to Priest River.

Sample Stations

The Priest Lake sample stations were located at the point of the proposed withdrawal structure, as well as north and south of that location (Figure 1).

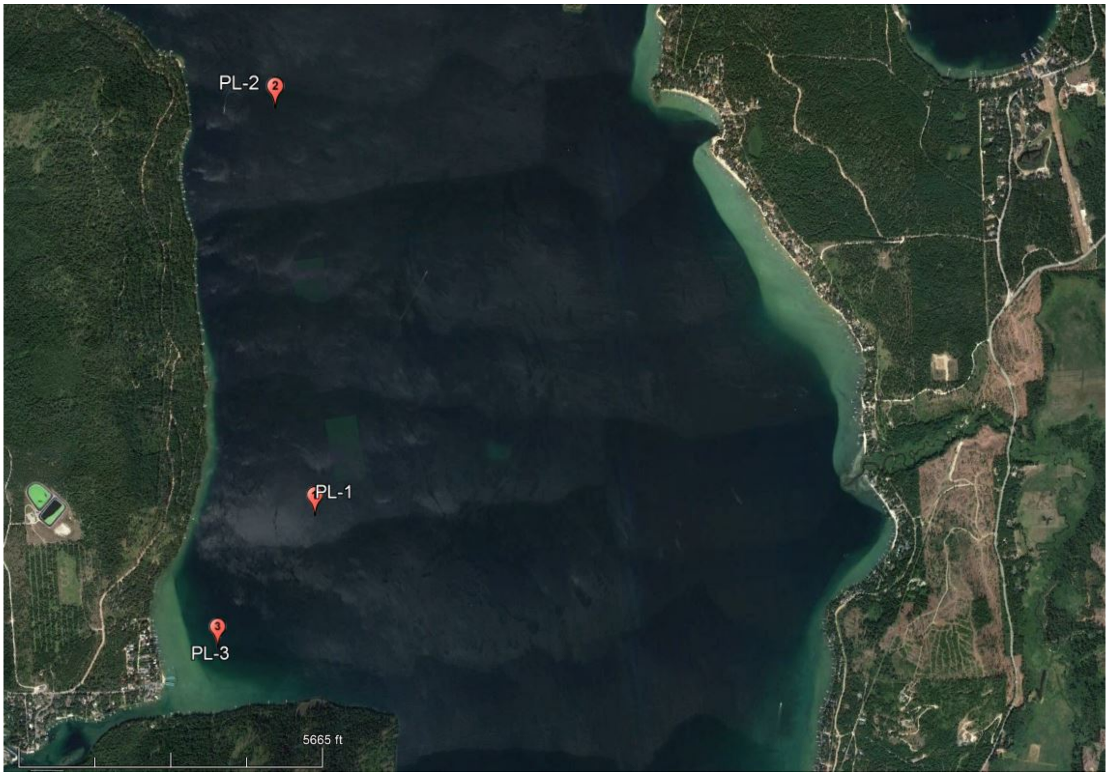


Figure 1. Priest Lake Monitoring Locations
PL-1 is located in the approximate location of the proposed withdrawal structure

Additional stations were located just upstream from the Lamb Creek inflow and in the Priest River, approximately 1.7km downstream from the Priest Lake Dam (Figure 2).

Figure 2. Outlet Bay and River Monitoring Locations

Data Analysis

Project data were stored and organized in Microsoft Office 2010 Excel and Access. Most statistical analyses were conducted using Systat (SYSTAT® 13 Statistics I II III IV, SYSTAT Software Inc., www.systat.com). Nutrient data analyses are further explained in Section 4.3 of this report.

Sample Event Physical Characteristics Measurements

During each sample event and at each station, temperature, dissolved oxygen, pH, specific conductivity, and in situ chlorophyll *a* readings were collected from the surface to the bottom at 0.25 meter or less intervals using a calibrated multi-probe. The dissolved oxygen/temperature probe, pH, and conductivity meters were calibrated according to the manufacturer's instructions (OTT Hydromet, 2014).

Additionally, Secchi readings were recorded as well as reservoir elevation, station depth, weather conditions, and sample date and time. This data is available upon request and will be provided to IDFG; however, due to the data not having direct relevance to the project they have not been included in this report.

Thermistor Chains and Temperature Transects

Moorings consisting of a line with independent temperature recorders and depth sensors spaced 2 meters apart from the surface to the bottom or 50 meters below the surface were installed at PL-2 and north east of PL-1. The data loggers collected temperature data in 15 minute intervals from June to September 2020.

Additional thermistors were installed in the Priest River just downstream from the dam, Lamb Creek 100 meters above its mouth draining into Outlet Bay, Binarch Creek near its mouth and the Yak River 10 km upstream from its confluence with the Kootenai River.

Starting at the end of July, and then every two weeks until the end of September horizontal transects were ran to determine water temperature changes in Outlet Bay from the lake/bay interface to the dam. Temperature data was logged every 2 to 5 seconds with a temperature sensor deployed ½ meter below the water surface. Concurrent with the logging of the water temperature, geographical coordinates were recorded using a GPS device. This data was then used to create a horizontal temperature profile for Outlet Bay.

Meteorological Station

A meterological station (Ambient Weather WS-2902C) was installed on the south end of Priest Lake in Coolin Bay to record wind speed and direction. The data was recorded in five minutes intervals from June 19th, 2020 to December 8th, 2020.

Additional historical metrological data was obtained from the meterological station at the Priest River Ranger Station.

Water Analysis

The water chemistry, physical, and biological sampling began on June 3rd of 2020 and was conducted every two weeks with the final sampling event occurring on September 22nd.

Two samples were collected at each station per event. One sample was a composite of discrete samples from 1, 5, 7, and 10 meters below the water surface. The second sample was a discrete sample taken from 25 meters below the water surface at PL-2, and 17 to 18 meters below the surface at PL-1. There was not a hypolimnetic sample taken at PL-3 due to the depth being less than the thermocline depth. For the outlet station (Out-1) a composite of 1, 3 and 5 meters was collected. At the river station PR-1 a grab sample was collected in the thalweg at mid-depth.

Water samples were analyzed for concentrations of total phosphorus (TP), total dissolved phosphorus (TDP), total Kjedahl nitrogen (TKN), total ammonia, nitrite plus nitrate and total dissolved solids (TDS). Additionally total nitrogen (TN) was calculated by summing TKN and nitrite+nitrate derived from the laboratory analysis.

The laboratory analysis was performed by AmTest Laboratories following approved methods for water analysis (Table 1).

Table 1. Laboratory Analysis Methods for Water Chemistry and Associated Reporting Limits.

Analyte	Analytical Method	Method Detection Limit (Contract Lab)	Practical Quantitation Limit (Contract Lab)
Total Nitrogen	SM 4500 N C	0.010 mg/l	0.050 mg/l
Total Ammonia as Nitrogen	EPA 350.1	0.005 mg/l	0.015 mg/l
Nitrite+Nitrate	EPA 300.0	0.001 mg/l	0.005 mg/l
TP	SM 4500 P E	0.001 mg/l	0.005 mg/l
TDP	SM 4500 P E	0.001 mg/l	0.005 mg/l
TDS	SM 2540 C	1 mg/l	5 mg/l

Chlorophyll *a*

Water samples were collected for chlorophyll *a* analysis from all stations and events using the same depths as the water chemistry sampling protocol. Upon returning to the laboratory 500 ml of sample water was filtered through 0.7um nominal glass fiber filters. The filters were wrapped in foil, labeled and placed in a freezer for later analysis.

Chlorophyll *a* concentrations in the samples was conducted by Advanced Eco-Solutions using a Turner Trilogy Fluorometer and following EPA method 445.0.

Phytoplankton Samples

Phytoplankton samples were taken from the pooled epilimnetic samples. At PL-1 and PL-2 a second sample was taken 18 and 25 meters below the water surface respectively.

A detailed phytoplankton taxa identification and density estimates was performed by AES following the protocols outlined in Utermohl (1958).

Zooplankton

All zooplankton sampling was done using a 50 cm diameter by 200 cm long zooplankton net made with 80 um netting. The net was equipped with a non-tapering Puget Sound closing net collar. Samples were preserved in the field and taken to Aquatic Monitoring and Assessment for analysis. They were analyzed following TWRI B-2501-85. Only macro-zooplankton were identified and enumerated for this project.

Zooplankton samples were collected by doing two discrete vertical tows from each of the three lake stations. At PL-1 and PL-2 a 0-10 meter zooplankton tow was conducted. A second tow from 25 to 10 meters was collected at PL-2 and at PL-1 a second sample from 15 to 10 meters was collected. The shallower depth at PL-1 was done due to shallow water depths. At PL-3 a single 5 meter to surface tow was performed.

Zooplankton density and biomass was determined for Daphnia and Bosmina. The remaining cladocerans and copepods were analyzed for density only. Laboratory methods followed Britton and Greeson, (2005).

Periphyton Samples

Periphyton samples were collected in late July, August, and September at site PR-1, Binarch Creek (near the mouth), and the Yak River in north west Montana 10 km upstream of its confluence with the Kootenai River. Periphyton samples were a composite of 9 discrete samples collected from the natural substrate, in these systems this was primarily cobble and small boulders. The samples were preserved in the field using concentrated Lugol's solution and sent to Rithron Associates out of Missoula, Montana for identification, enumeration and metric calculations.

Each sample was homogenized and a subsample was loaded into a Palmer-Maloney Cell. 300 natural counting units (including diatoms) were enumerated across a known length of transect and identified to the lowest practical taxonomic level. Given the relatively low magnification available while using a P-M cell this was Genus for soft bodied algae, and 'type"(i.e. pennate, centric etc.) for diatoms. Diatoms were also be classified as being 'live' or 'dead'.

The metric calculations were conducted using Rhithron's Laboratory information management system's (LIMS) data base and methodology describe in Bahls, L.L.,1993; Barbour et.al., 1999; Lange-Bertalot, H., 1979; and VanDam et.al, 1999.

Macroinvertebrate Samples

Macroinvertebrate samples were collected in late July, late August, and late September on the Priest River just downstream from the dam (PR-1), Binarch Creek (near the mouth), and the Yak River in northwest Montana (10 km upstream of its confluence with the Kootenai River). The Yak River was selected as surrogate for the Priest River due to its lower temperature regime than the current situation in the Priest River and should provide a good indicator of future conditions in Priest River.

Samples were collected using a Hess sampler. A total of three Hess samples were taken at each location during each event. The location for the Hess sampler was randomly selected using a random number generator and a grid system. The three samples from the station for each event were composited into one sample for analysis. All samples were preserved in the field with 70% ethanol.

The samples were sent to Rhithron Associates out of Missoula, Montana for identification, enumeration and metric calculations. Each sample was homogenized and a subsample of 500 individuals was randomly selected using standard methods (Caton, 1991). Individuals were identified by qualified invertebrate taxonomists to the lowest possible taxonomic level and enumerated. The metric calculations were conducted using Rhithron's (LIMS) data base and methodology describe in Barbour et.al., 1999; Wisseman, 1994; and Fore and Wisseman, 2012.

Priest Lake Results

Water Temperature (Synoptic Surveys)

Vertical profiles of water temperature were performed every 2 weeks from the first of June 2020 to the end of September 2020 at the three Priest Lake stations. Vertical profiles were collected in August and September at the deep pool located within Outlet Bay. The complete dataset of the field collected data can be found in Appendix A.

The water temperature in Priest Lake varied by 7°C in early June (Figure 3) with a bottom temperature of 5°C and a surface temperature of 12°C . By mid-August the bottom temperatures at PL-1 and PL-2 were 6°C, while PL-3 had a bottom temperature of 15°C and the pool in Outlet Bay was 18°C. Surface water temperatures peaked at 21°C to 22°C at PL-1, PL-2 and PL-3, whereas Outlet Bay peak temperatures were 20°C. The resultant change in temperature between the surface and lake bottom was 15°C in the deep stations of the lake and 12°C at PL-3 and only 2°C in Outlet Bay. The strongest thermocline was observed in mid-August with water temperatures declining by 10°C in 6 meters (7 to 13 meters below the water surface). The epilimnion extended down 5 to 6 meters. This depth resulted in a lack of a hypolimnion in PL-3 or Outlet Bay.

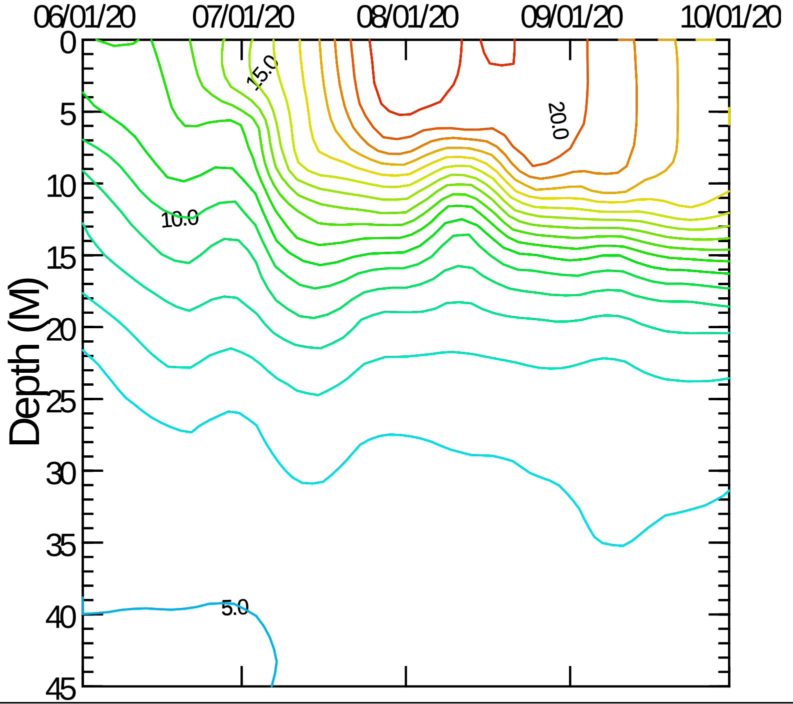
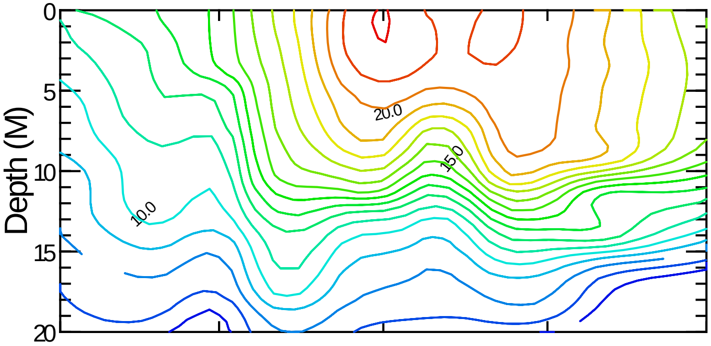
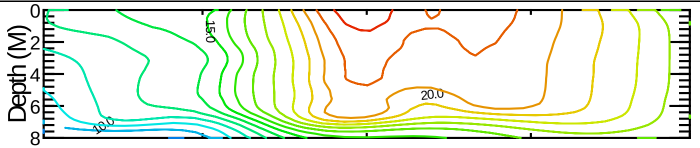
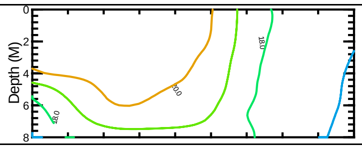
PL-2	
PL-1	
PL-3	
Out-1	

Figure 3. Priest Lake Temperature Isopleth for Synoptic Sampling 2020

Water Temperature (Horizontal Transect- Outlet Bay)

In an effort to ascertain changes in water temperature from Priest Lake to the dam, horizontal temperature transects were conducted every two weeks from July 29th to September 22nd for a total of 5 transects. During each of those events the water temperature at the dam was lower than the water temperature in the lake (Figure 4). On average the water temperature was 0.81°C (1.5°F) lower at the dam than Priest Lake. The smallest reduction in temperature was observed on August 12th (0.53°C/1°F) and the greatest reduction in temperature was observed on September 9th (1.54°C/2.8°F).

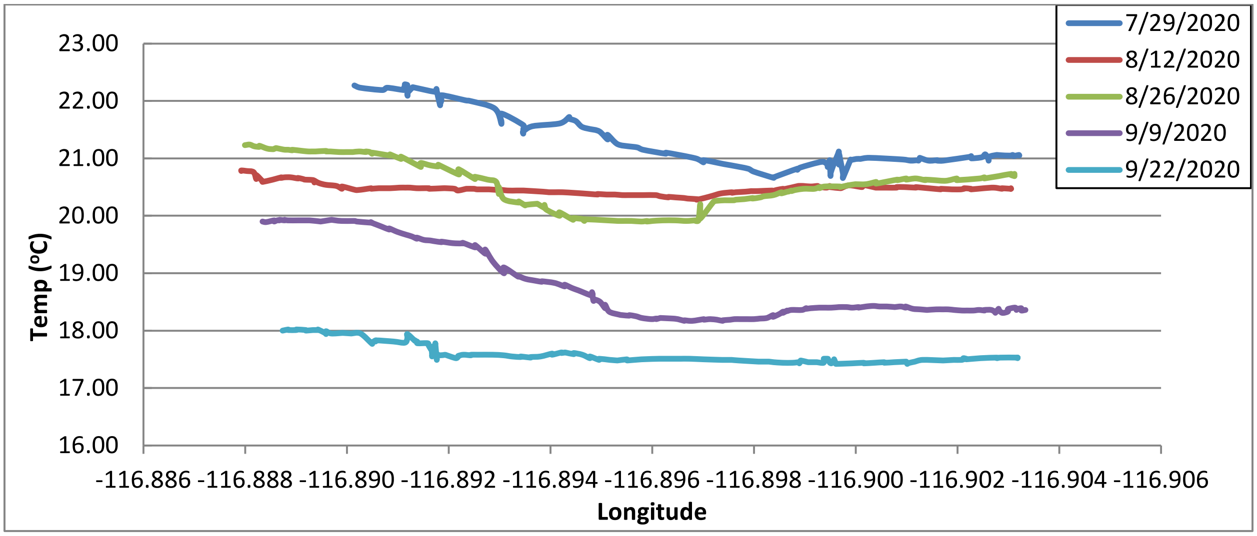


Figure 4. Outlet Bay Water Temperature Transect

Water Temperature (Vertical Thermistor Chains)

We examined whether Priest Lake can deliver water with temperature < 8 °C from 18 m depth at station PL-1 for the period June 1st to October 1st, based on observations in 2020. We begin by summarizing water level, outflow and the wind during this time, and then look at the water temperature in detail.

Water level and outflow

The water level of Priest Lake is measured at USGS station 12393000, located at the south end of Priest Lake (48°30'27" N, 116°53'13" W) near station PL-1. The water level in Priest Lake is shown in Figure 5a. From July 1 to October 8 the water level was maintained close to 3 ft (0.91 m) above datum. In most years, the water level began to drop after October 8, but in 2020 the water level began to decline after October 1 to accommodate maintenance near the dam.

The outflow from Priest Lake to Priest River is measured at USGS Station 12393501, approximately 500 m below the dam (48°29'16.92" N, 116°54'30.9" W). The outflow declines through spring to a minimum which can occur from August to mid-September (Figure 5b). The minimum outflow was generally between 2 and 3 m^3/s with one period of flow near 1 m^3/s from August 22-31, 2019.

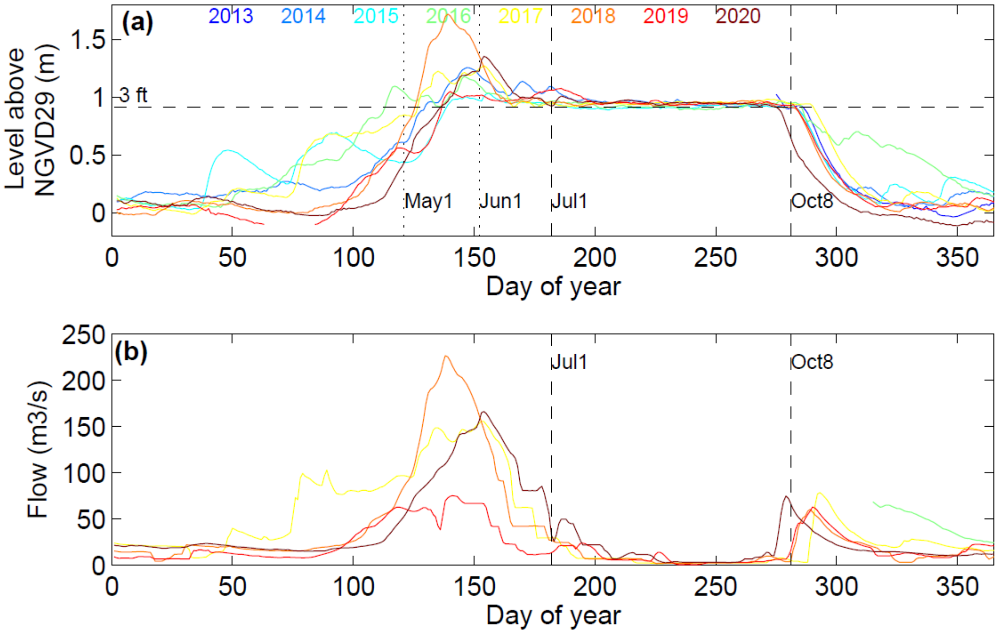


Figure 5. (a) Water level in Priest Lake, 2013-2020. (b) Outflow from Priest Lake, 2017-2020.

Wind at Coolin

Weather data was collected from a station located on a dock at the south end of Priest Lake (48°29'16.92" N, 116°54'30.9" W), near the town of Coolin. Wind speeds were modest with a maximum of 7 m/s (16 mph) and a mean of just 1 m/s (2.2 mph)(Figure 6a). The dominant wind direction was from the south (Figure 6b). The prevailing wind during the study period was diurnal with the highest average wind from the south at 14:00 (2 PM) (Figure 7). A similar pattern of diurnal wind from the south was observed at Priest Lake Ranger Station (see Appendix G) and at the Priest Lake Experimental Forest located 13 km down the valley south of Priest Lake (Finkin 1983).

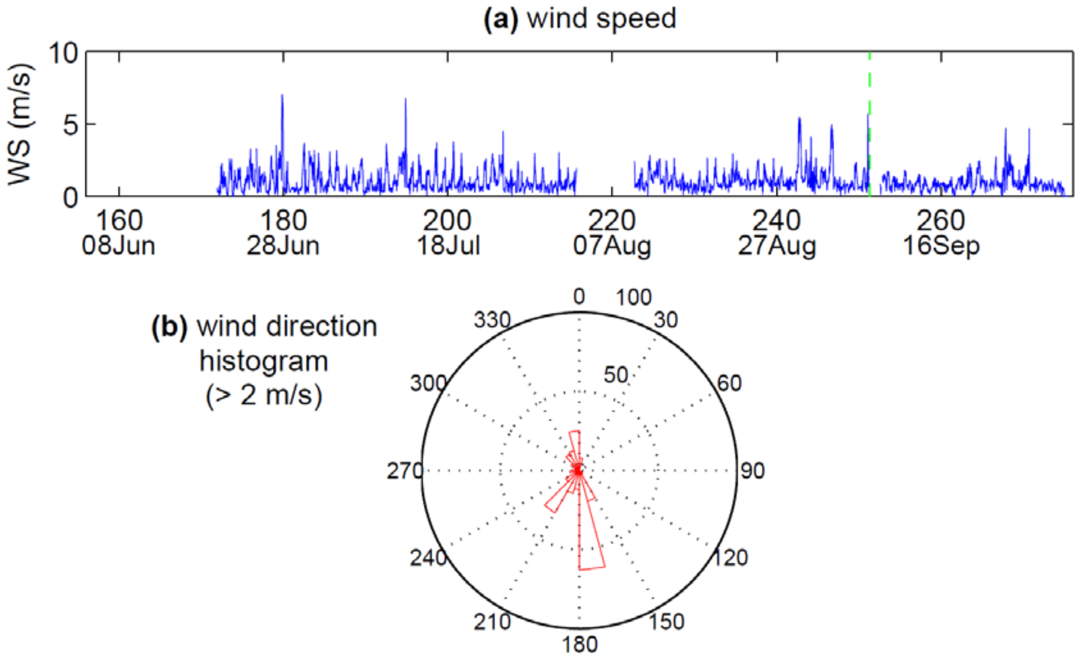


Figure 6. (a) Wind speed, and (b) histogram of wind angle, Coolin station, June 19 (station installed) to October 1, 2020. Vector average hourly data.
Unfortunately the wind data were not available during the storm of September 7, 2020 (green dash) due to power outage.

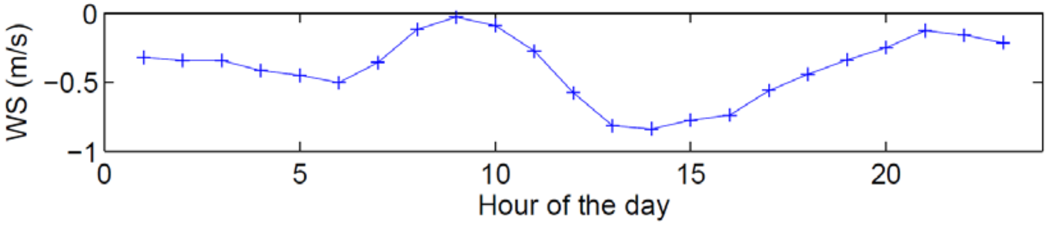


Figure 7. North-south wind averaged for each hour of the day, Coolin station, June 19 to October 1, 2020.
Wind from the south is negative.

Water temperature

Moored temperature data were collected at stations PL-1 and PL-2. The moorings were subsurface, with an anchor at the bottom and a float approximately 2 m below the water surface, see Appendix E for detail. Because the moorings were fixed at the bottom, the temperature sensors remained at one elevation, and did not rise and fall with water level. Here the depths of the temperature sensors are given as the depth below the target summer water level of 3 ft (0.91 m) above datum. At the start of the mooring period, when the water level was 0.4 m above the 3 ft summer level (June 4th, day 156), the nominal 2 m sensor, for example, would have been 2.4 m below the surface. However, the water elevation dropped rapidly through early June to the 3 ft summer level, and remained close to this level for the remainder of the mooring period (Figure 5a).

Contours of temperature at PL-1 are shown for the mooring period in Figure 8. In early June, the near surface temperature remained cool (~11-14 °C), and there was no distinct thermocline. During June 13-14, 2020 (day 165-166), wind was observed from the south, up to 5.7 m/s (13 mph) at the Priest Lake Ranger Station (wind from the Coolin station were not yet available at this time). This resulted in upwelling of cooler water: the wind from the south pushed the warmer surface water to the north, bringing cooler water up from below. Before this time the temperature at 2 m had been 14 °C; during upwelling the temperature at 2 m went below 8 °C. The period of upwelling shows as a blue band on days 165-166 in Figure 8. Upwelling also reduced the temperature at 18 m from just below 8 °C to a low of 5.2 °C.

Through June, the stratification developed rapidly, and by early July there was a distinct surface layer. . On June 2nd, 2020 there was nearly linear stratification from 12 °C at the surface to 5.5 °C just below 20 m. However, by July 1st, 2020, there was a surface mixed layer with a depth of 3.5 m, and a thermocline (temperature gradient) from 3.5 to 6 m. A distinct surface mixed layer (epilimnion) and a thermocline region (metalimnion) overlying cooler deep water (hypolimnion) were observed in all subsequent Hydrolab profiles (Figure 9).

There are variations in the thermocline depth on several timescales (Figure 8). There were variations on a daily time scale, slight upwelling driven by the prevailing afternoon wind from the south. There were also variations on the order of 5 to 15 days, likely reflecting synoptic weather patterns. Finally there were downwelling events, such as that observed on September 7, 2020 (day 251), discussed in detail below (Figure 8).

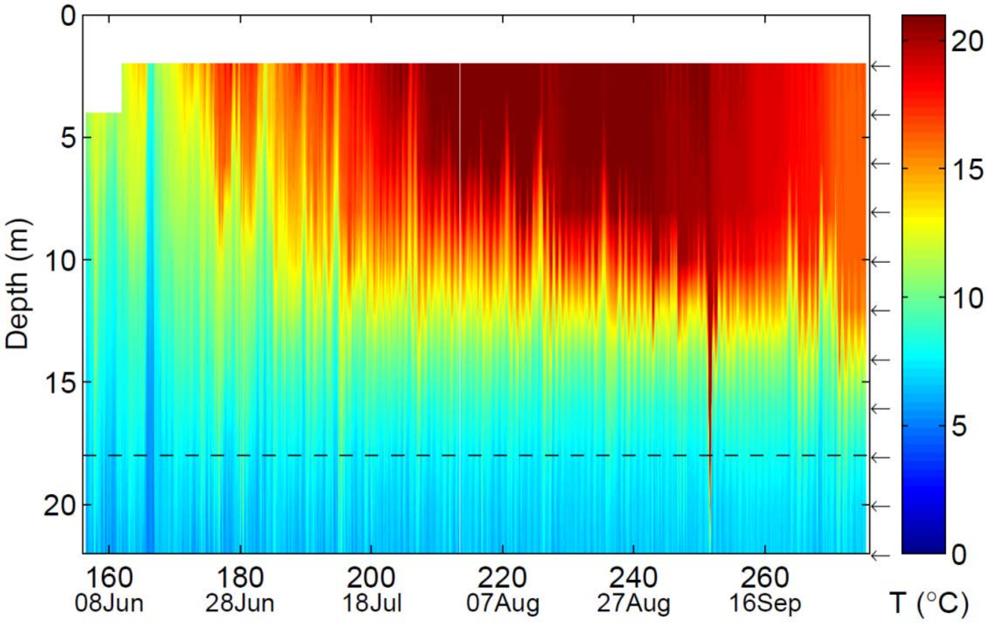


Figure 8. Contours of temperature at station PL-1, June 4 to October 1, 2020.

Arrows on the right mark the depth of the temperature sensors. The dash line marks 18 m. The sensor at 2 m did not begin recording until June 10, 2020 (day 162). A fisherman snagged PL-1 at 10 AM, July 31, 2020 (day 213) and the mooring was restored to its original position at 3 PM that day; data during this time were excluded.

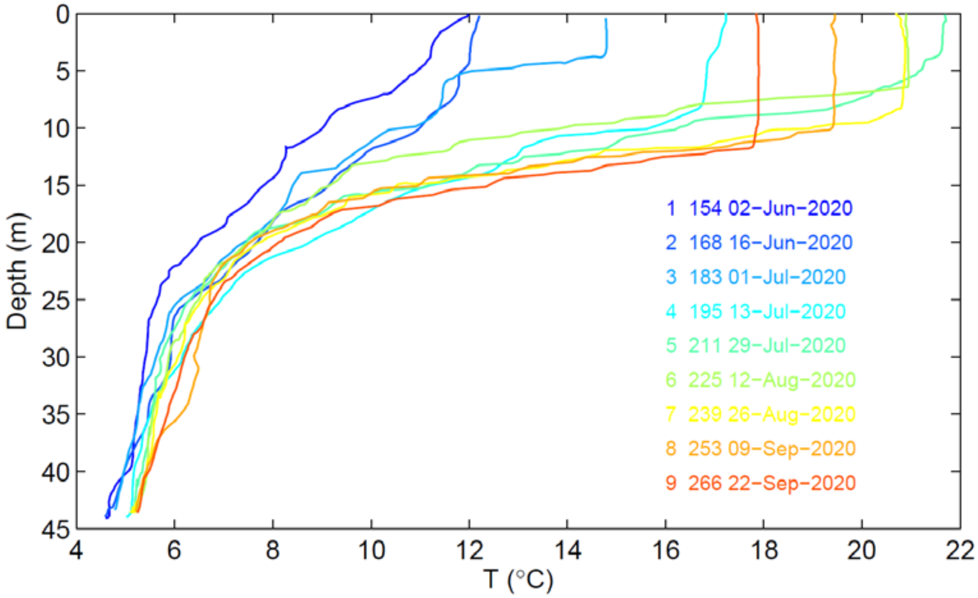


Figure 9. Profiles of temperature at the deep station PL-2 collected using the Hydrolab.

The water temperature at 18 m from both PL-1 and PL-2 are shown in Figure 10. While the temperature at 18 m was generally close to 8 °C, it was above 8 °C for 24.3 days (21%) of the mooring record, while at PL-2 it was above 8 °C for 19.8 days (16%) of the mooring record (118.9 days long).

For the storm of September 7th, 2021, the maximum temperature at 18 m was 20.2 °C at PL-1 and 15.9 °C at PL-2. Note that during this storm, the total time above 10 °C was only 7.3 and 6.5 hours at PL-1 and PL-2, respectively. Excluding September 7 and 8, 2020 (days 251 and 252), then the maximum temperature at PL-1 and PL-2 was 10.8 °C (day 176) and 10.0 °C (day 273), respectively.

A histogram of the temperature at 18 m is shown in Figure 11, and gives the number of observations in each temperature range. The temperature at PL-1 varied more than that at PL-2.

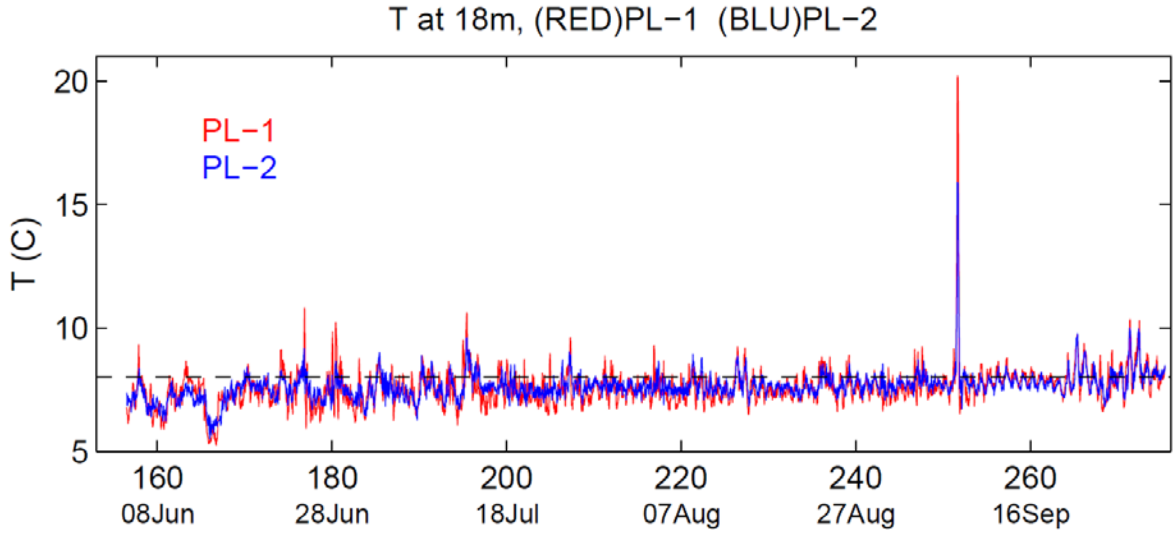


Figure 10. Temperature at PL-1 (RED) and PL-2 (BLU), 18 m below the 3ft summer target water level. The dash line marks 8 °C. The peak resulted from the storm of September 7, 2021 (day 251). The data for PL-1 are from the sensor at 18 m; that for PL-2 are linearly interpolated between the sensors at 17.48 and 19.46 m (Appendix F).

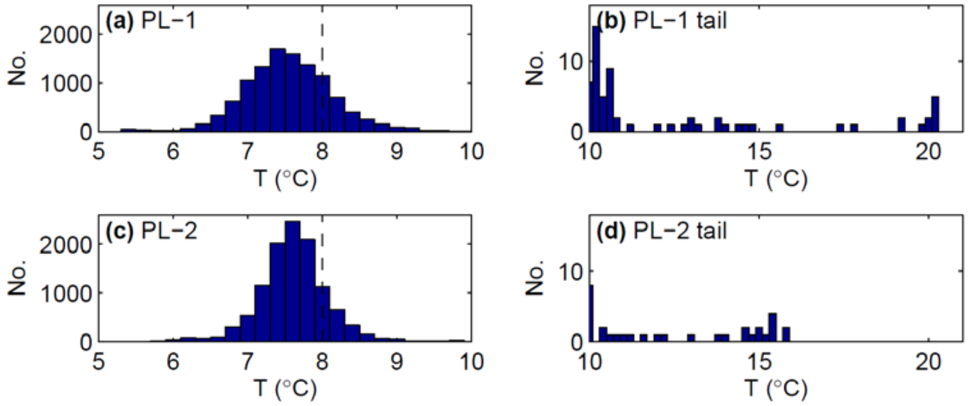


Figure 11. Histogram giving the number of 15 minute readings in each temperature range from 18 m at (a,b) PL-1 and (c,d) PL-2.
Each histogram is shown in two parts (a,c) for 5 to 10 °C, and (b,d) for 10 to 22 °C showing the tail of the histogram on expanded (140X) scale.

The depth of the 8 °C isotherm at both PL-1 and PL-2 are shown in Figure 12. At PL-1, the bottom sensor at 22 m was not deep enough to remain ≤ 8 °C. At PL-2, the 8 °C isotherm reached a depth of 25.3 m during the storm of September 7, 2020 (day 251). Excluding this storm, the next deepest was 22 m on July 13, 2020 (day 195). At 22 m, the maximum temperatures at PL-1 and PL-2 were 9.2 and 9.6 °C, respectively, and the temperature would have exceeded 8 °C for only 0.35 and 0.19 days, respectively.

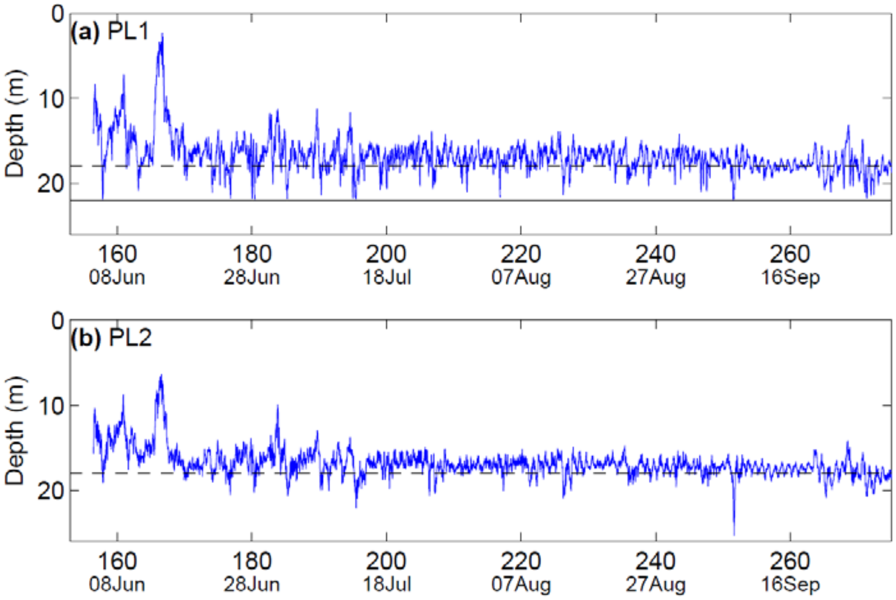


Figure 12. Depth of the 8 °C isotherm at (a) PL-1 and (b) PL-2.
Dash line marks 18 m depth; solid line marks the deepest sensor at PL-1.

The storm of September 7, 2020

On September 7, 2020, a westward tail of the stratospheric polar vortex south of Hudson's Bay, resulted in an unseasonal cold front that swept Alberta and into the US. This cold front crossed northern Idaho causing rapid changes in air pressure and generating sustained high winds.[1]

A contour plot of temperature is shown in Figure 13. At the start of September 7, 2020 (day 251), the epilimnion had a temperature of just over 20 °C extending to 8 m depth. The thermocline, the region of highest temperature gradient (bunched contours), saw a change in temperature from 20 °C to 12 °C, over a depth range of 8 to 13 m. Below the thermocline there was a gradually declining temperature gradient as can be seen in the Hydrolab profile of September 9, 2020 (Figure 9).

In response to the storm, the thermocline deepened, bringing warm water from the epilimnion down to 18 m depth, where a temperature of 20.2 °C was briefly observed. This movement of a gradient accounts for the unusual nature of the 'spike' in temperature shown in Figure 8. Note that the thermocline did not reach 22 m depth, where a maximum temperature of 9.2 °C was observed. After the end of the storm, the thermocline relaxed back, close to the original depth. During the storm the epilimnion cooled slightly, not unexpected given high winds and cooler air temperatures.

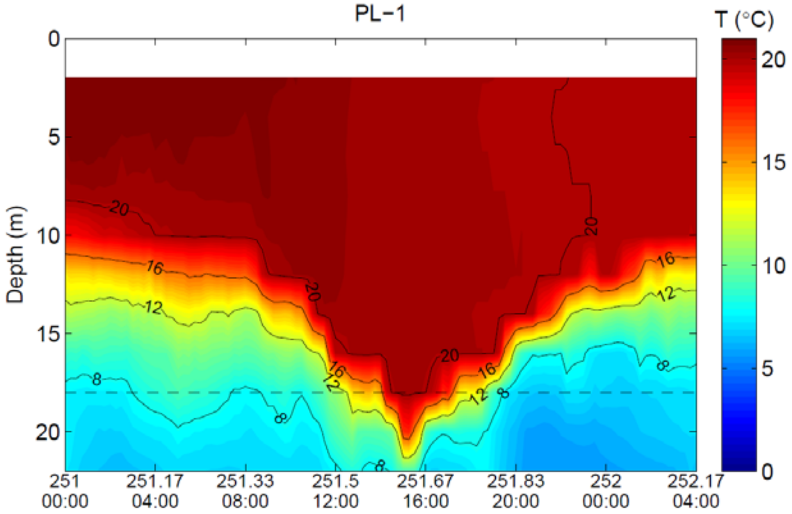


Figure 13. Contour plot of temperature at PL-1, 00:00 September 7 to 04:00 September 8, 2020. The dash line marks 18 m depth.

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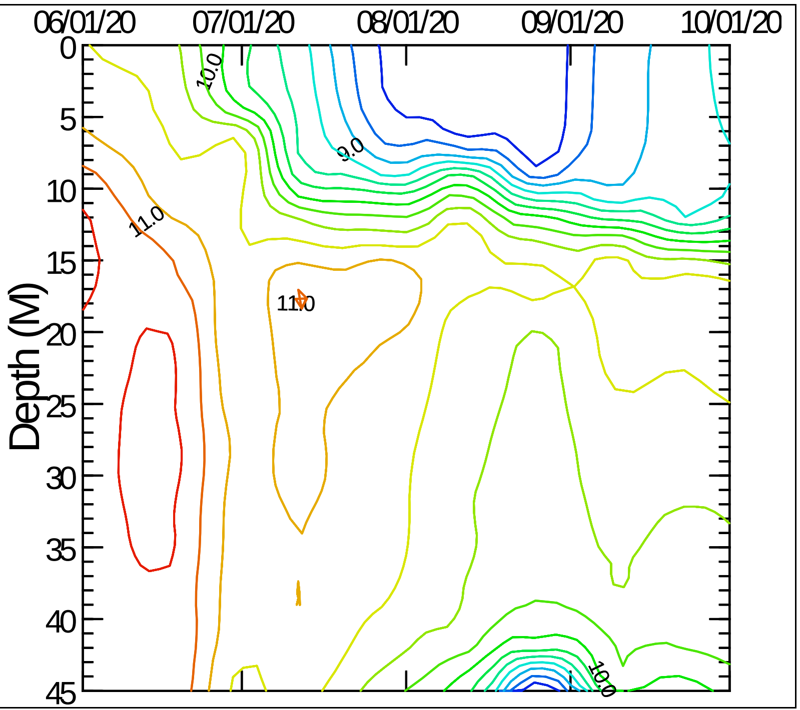
[1] https://www.weather.gov/pih/September_7-8_Damaging_Wind_Event

Dissolved Oxygen

Vertical profiles of the Dissolved Oxygen content in Priest Lake were performed every 2 weeks from the first of June 2020 to the end of September 2020 at the three Priest Lake stations. Vertical profiles were collected in August and September at the deep pool located within Outlet Bay.

The dissolved oxygen concentrations in Priest Lake ranged from a low of 8.03 mg/L to a high of 11.36 mg/L (Figure 14). The lowest dissolved oxygen reading recorded in 2020 was 8.03 mg/L at PL-2 with a number of other measurements close between 8.03 and 8.1 mg/L from the surface to 8 meters below the water surface on August 12th, 2020. The low dissolved oxygen concentrations were a result of the high water temperatures in the epilimnion of Priest Lake. The water was near saturation (>97%) when the lowest dissolved oxygen concentrations were observed. The dissolved oxygen remained near saturation (>90%) for all stations from 25 meters to the surface. For the month of August the percent saturation was reduced to as low as 72% saturation near the lake bottom at PL-2. These levels are indicative of an oligotrophic system with minimal oxygen consumption occurring in the hypolimnion.

PL-2	

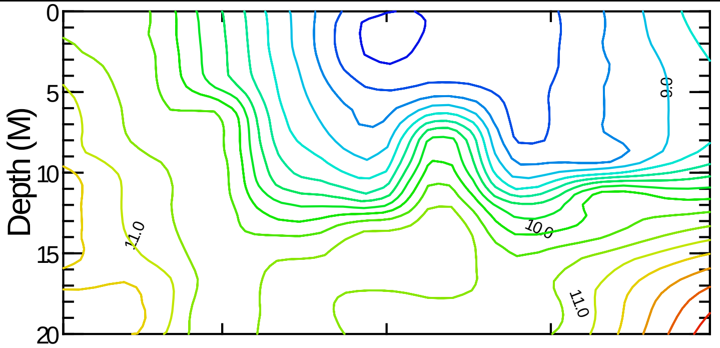
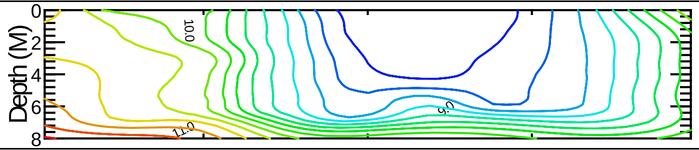
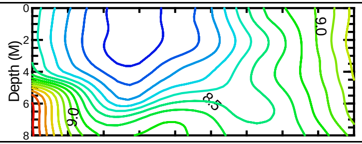
PL-1	
PL-3	
Out-1	

Figure 14. Dissolved Oxygen Isopleths for Priest Lake, Summer of 2020.

Water Chemistry

Water samples were analyzed for nutrients in 2020 (Table 2). One of the concerns that have been expressed is that the withdrawal of hypolimnetic water for supplementing flows in the Priest River is that there will be a change in the nutrient regime of the Priest River. The entire 2020 data set can be found in Appendix B. Due to a significant fraction of the water chemistry values being near or below the laboratory reporting limit (22% to 88%), determination of statistical significant difference was determine using the non-parametric test Kruskal-Wallace.

Phosphorus

The mean and median epilimnetic and hypolimnetic concentrations total phosphorus and total dissolved phosphorus Table 1. Total phosphorus concentrations of epilimnion PL-1, PL-2, PL-3 and Out-1 were not significantly different (Kruskal-Wallis, $p>0.001$) with the means near the method detection limits (Table 1) (Figure 15). Total dissolved phosphorus was also near the method detection limits for the period of study and were not significantly different between any of Priest Lake sampling locations (Kruskal-Wallis, $p>0.001$). Hypolimnetic samples were taken at PL-1 and PL-2. A comparison of the total and dissolved phosphorus data found no difference between the hypolimnion concentrations between the stations (Kruskal-Wallis, p>0.001) and no significant difference between the epilimnion concentrations and the hypolimnion concentrations (Kruskal-Wallis, p>0.001).

Table 2. Priest Lake Phosphorus Statistics

	Total Phosphorus (mg/L)						Total Dissolved Phosphorus (mg/L)					
	PL-1 Epi	PL-1 Hypo	PL-2 Epi	PL-2 Hypo	PL-3 Epi	Out-1 Epi	PL-1 Epi	PL-1 Hypo	PL-2 Epi	PL-2 Hypo	PL-3 Epi	Out-1 Epi
N of Cases	9	9	9	9	9	7	9	9	9	9	9	7
Minimum	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Maximum	0.004	0.006	0.004	0.007	0.014	0.005	0.003	0.004	0.003	0.005	0.003	0.003
Median	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Mean	0.002	0.002	0.001	0.002	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.001
St. Dev	0.001	0.002	0.001	0.002	0.004	0.002	0.001	0.001	0.001	0.002	0.001	0.001

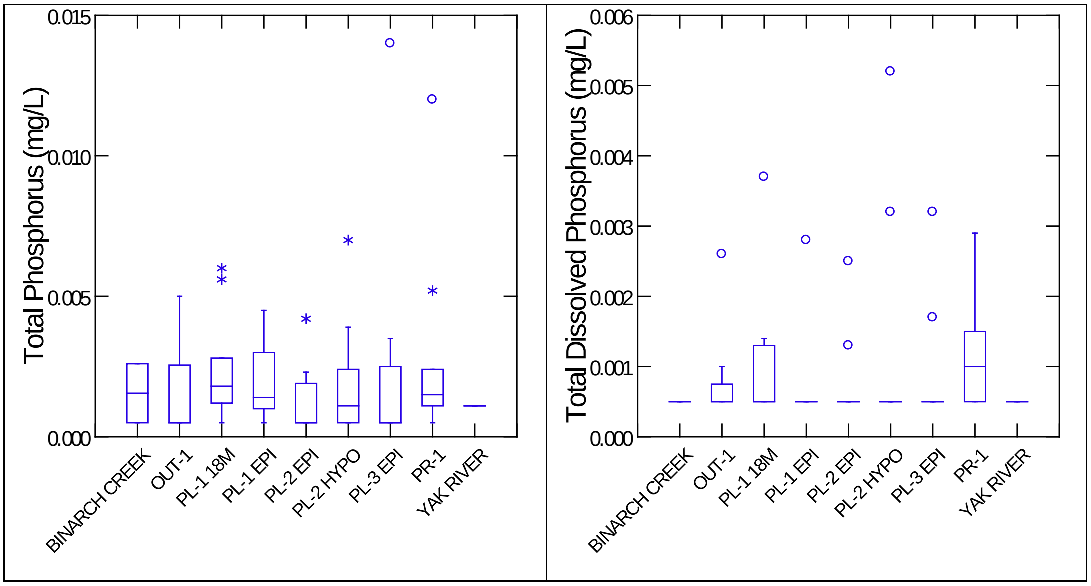


Figure 15. Box Plots of Total and Dissolved Phosphorus Concentrations During 2020

* are indicative or potential mild outliers and ^{o} or indicators of potential large outliers. The horizontal lines indicate the median and the box represents the 25 and75% range of the samples. The error bars are 1 standard deviation from the mean.

Nitrogen

The mean and median epilimnetic concentrations for nitrite+nitrate, and ammonia can be found in Table 2. The actual concentrations for nitrite+nitrate and ammonia are likely lower than the data results and statistics would indicate due to the high percentage of the results being below the laboratory detection limits (NO_2+NO_3, 34% <MDL; NH_3, 83%<MDL). It should be noted that these high percentage of values being below the MDL is not unusual for north Idaho lakes. The nitrogen concentration is Priest Lake is exceptionally low and is often below detection of the best commercial labs. The ammonia concentrations were all lower than Idaho's water quality criteria for both chronic and acute exposure. There was no statistical difference between stations or depth in Priest Lake in 2020 (KW, p>0.1) (Figure 16).

Table 3. Priest Lake Nitrogen Statistics

	Nitrite+Nitrate (mg/L)						Total Ammonia (mg/L)					
	PL-1 Epi	PL-1 Hypo	PL-2 Epi	PL-2 Hypo	PL-3 Epi	Out-1 Epi	PL-1 Epi	PL-1 Hypo	PL-2 Epi	PL-2 Hypo	PL-3 Epi	Out-1 Epi
N of Cases	9	9	9	9	9	7	9	9	9	9	9	7
Minimum	0.001	0.001	0.001	0.001	0.001	0.002	0.003	0.003	0.003	0.003	0.003	0.003
Maximum	0.006	0.022	0.014	0.013	0.010	0.01	0.006	0.007	0.006	0.030	0.011	0.007
Median	0.005	0.002	0.003	0.001	0.004	0.007	0.003	0.003	0.003	0.003	0.003	0.003
Mean	0.003	0.005	0.004	0.004	0.005	0.007	0.003	0.003	0.003	0.006	0.004	0.003
St. Dev	0.003	0.007	0.005	0.005	0.003	0.003	0.001	0.002	0.001	0.009	0.003	0.002

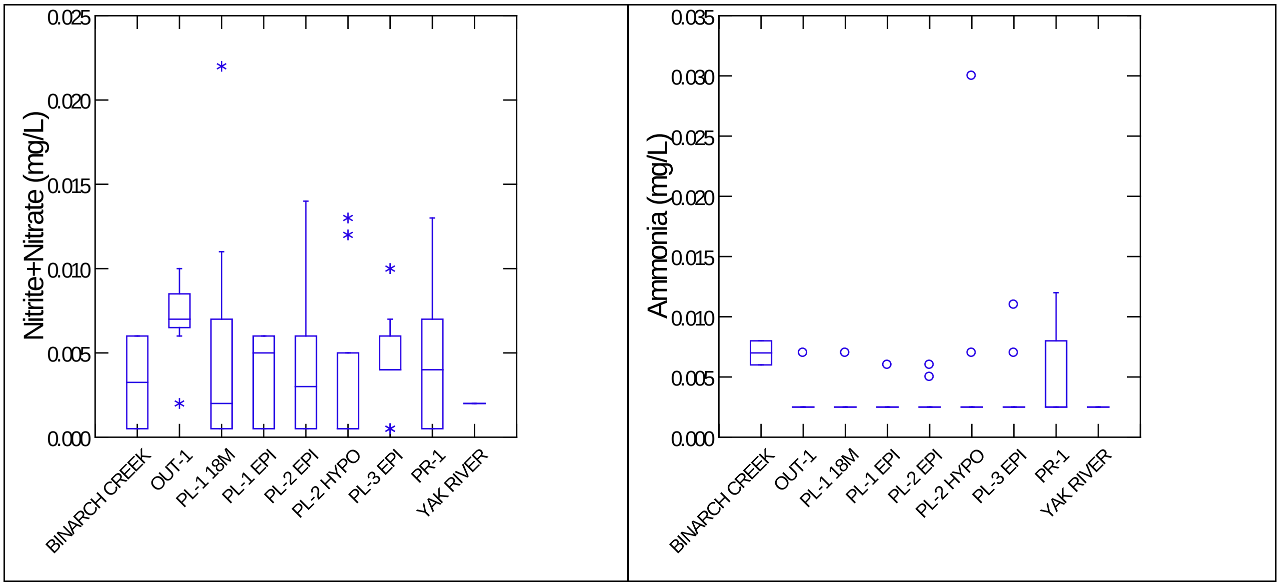


Figure 16. Priest Lake Nitrogen Box Plots

Chlorophyll *a*

Epilimnetic chlorophyll *a* concentrations were determined for the Priest Lake stations in 2020. PL-1 and PL-2 also had samples collected for determination hypolimnetic chlorophyll *a* concentrations. Chlorophyll *a* is a surrogate for determination of the algal productivity and densities in aquatic systems, the higher the chlorophyll *a* concentrations the higher the phytoplankton density. Most of the phytoplankton growth occurs within the photic zone; however, typical phytoplankton taxa are immotile and therefore unable to control their depth. This results in the phytoplankton concentrations being affected by wind, gravity and density gradients as well as solar radiation.

The chlorophyll *a* concentrations in the epilimnion of Priest Lake ranged from a high of 2.15 ug/L to a low of 0.13 ug/L (Figure 17). These concentrations are indicative of an oligotrophic system. The highest epilimnion concentrations of chlorophyll *a* were observed on July 1st.

Over time individual phytoplankton cells begin to settle into deeper depths and tend to accumulate at the metalimnion/hypolimnion interface due to the change in the water density gradients. This was observed in Priest Lake during the July 13th sampling event (Figure 18). In early July there was a bloom in the epilimnion of Priest Lake. In the subsequent sample event, two weeks later, there was an accumulation of chlorophyll *a* within the hypolimnion. After mid-July chlorophyll *a* concentrations fell to less than

1ug/L in both the epilimnion and hypolimnion and remained <1ug/L for the remainder of the sampling season.

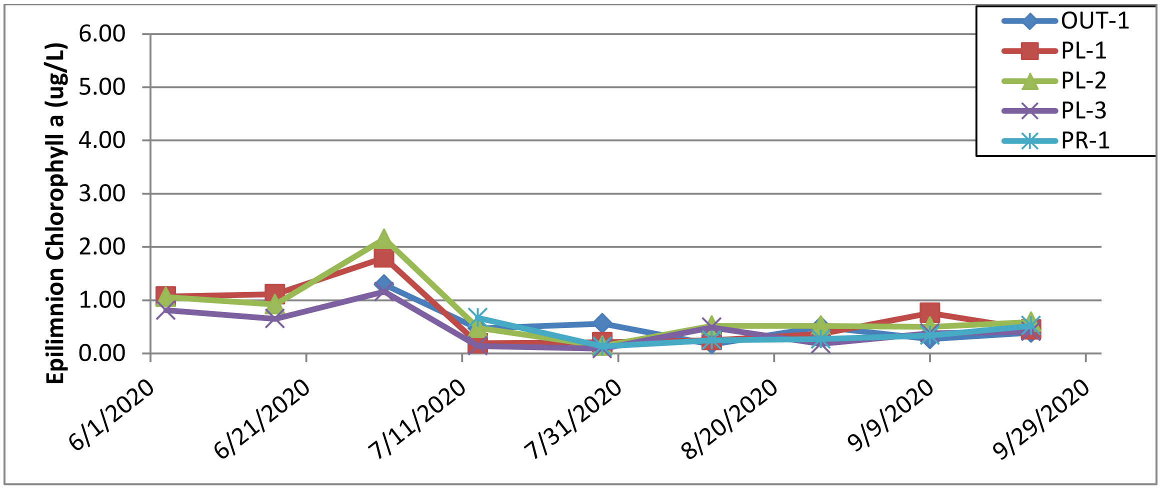


Figure 17. Priest Lake Epilimnetic Chlorophyll *a* Concentrations.

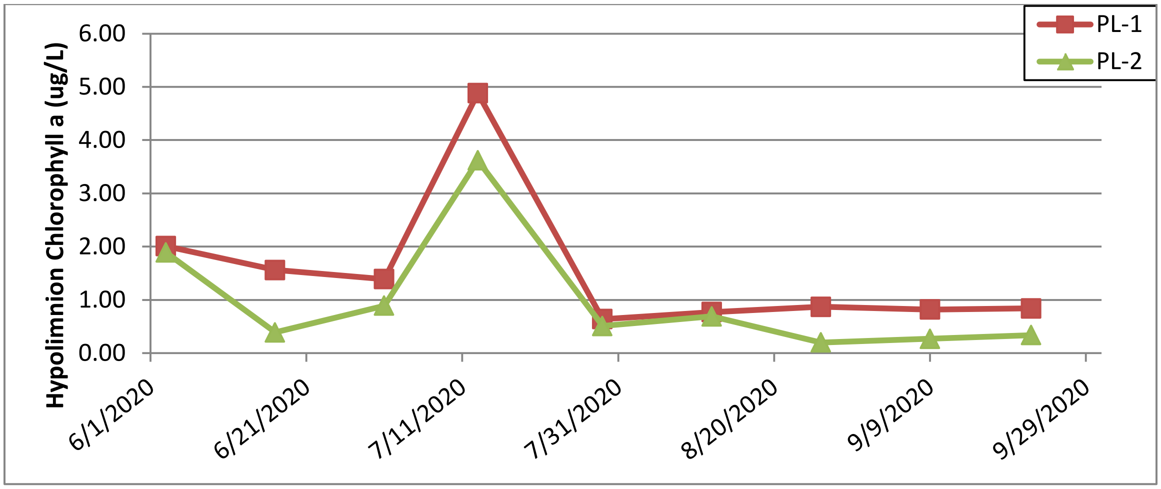


Figure 18. Priest Lake Hypolmnetic Chlorophyll *a* Concentrations.

Phytoplankton

The Priest Lake phytoplankton community was assessed concurrently with the physical and chemical samples at PL-1, PL-2 and PL-3. At PL-1 and PL-2 there were two samples taken during each sample event to assess the epilimnion and hypolimnion phytoplankton communities.

The results from the phytoplankton identification and enumeration were combined into five major taxonomic groups (Blue-green, Coccoid Greens, Diatoms, Dinoflagellates and Flagellates). For each sample a total phytoplankton density and biovolume for each taxonomic group was calculated. In terms of abundance the predominant group was the blue-green (Figure 19). It should be noted that the taxa that made up the majority of this group were *Synechococcus sp*. This is a common taxa in lake ecosystems; however, it should not be confused with other blue-green algae taxa that are considered to be indicators of poor water quality and may produce toxins. *Synechococcus sp.* is a non-bloom forming, non-toxic blue-green algae taxa. The second most abundant taxonomic group were small microflagellates. These two taxonomic groups tend to dominate the phytoplankton taxa in terms of abundance in most oligotrophic lakes.

The dominance by biovolume shows, that while still important, the dominance of the blue-green group is significantly reduced by the increased importance of green and diatom taxa as well as flagellates (Figure 20). This is due to the larger size of green and diatom taxa.

All stations exhibited a peak in July in terms of both density and biovolume with a general decline as the season progressed. This matches the findings of the chlorophyll *a* results previously reported.

One final thing of note is the slight but not significantly different reduction of phytoplankton density and biovolume in the hypolimnion samples. This is not uncommon in systems with good water clarity that allows light penetration deeper than the thermocline.

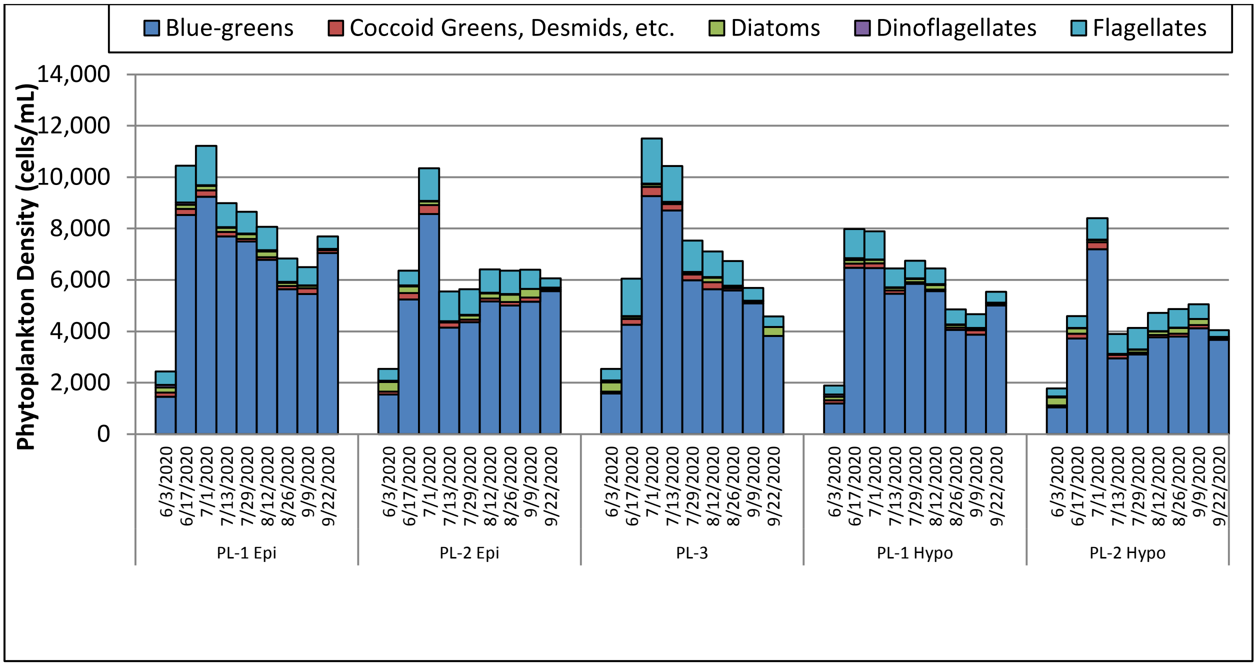


Figure 19. Phytoplankton Density by Major Taxonomic Group by Station and Date.

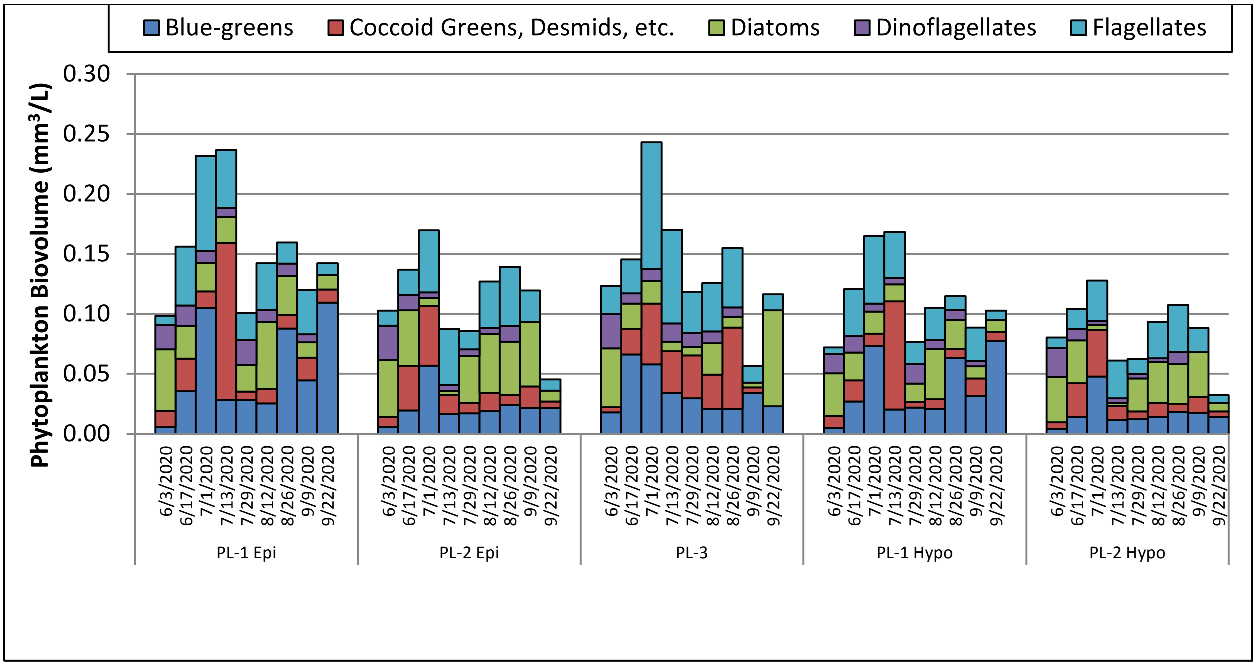


Figure 20. Phytoplankton Biovolume by Major Taxonomic Group by Station and Date.

Zooplankton

The Priest Lake zooplankton community was assessed concurrently with the physical and chemical samples at PL-1, PL-2 and PL-3. At PL-1 and PL-2 there were two samples taken during each sample event to assess the epilimnion and hypolimnion zooplankton communities. The Bosmina sp. densities peaked in early to mid-July (Figure 21). Daphnia sp. densities peaked in August in 2020. Zooplankton biomass didn’t peak until late August and into late September (Figure 22). In terms of density and biomass, Daphnia were the dominant taxa in 2020.

The hypolimnion densities were considerably lower than the epilimnion; however, the biomasses were similar. This is due to larger individuals being located in the hypolimnion even though they are less total individuals in the hypolimnion.

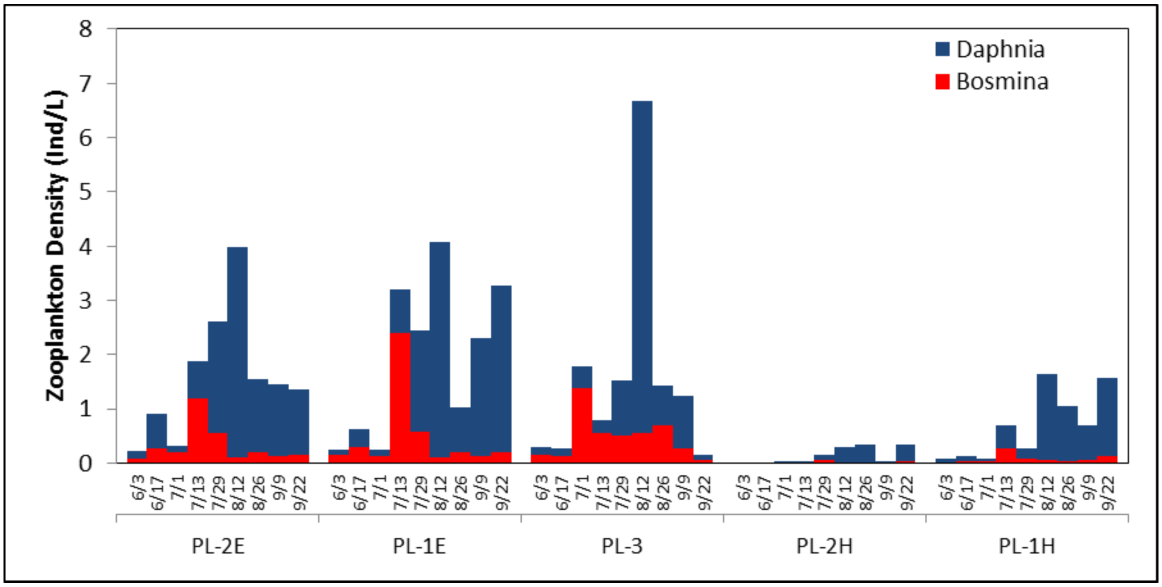


Figure 21. Zooplankton Density by Station, Date, and Depth

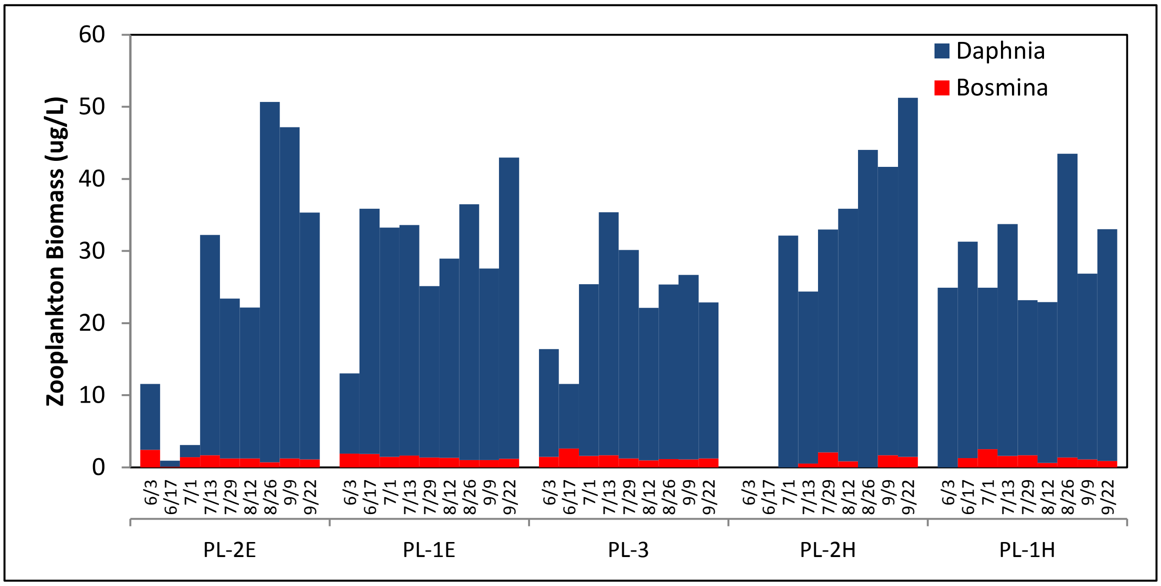


Figure 22. Zooplankton Biomass by Station, Date, and Depth.
The suffix E indicates epilimnion samples and the H indicates hypolimnion samples

River and Tributary Results

Water Temperature

Data logging thermistors were deployed in the Priest River (1.7 km downstream of Priest Lake Dam), Lamb Creek, and Binarch Creek. Data was collected every 15 minutes from July 23rd to September 22nd 2020. Each location had a distinct daily temperature pattern (Figure 23). The Priest River had the highest average water temperature (20.16°C) as well as the greatest average daily variation (4.25°C). Lamb Creek had a daily average water temperature of 11.49°C, with an average range of 2.68°C. Binarch Creek, which is a spring fed creek, had the lowest average temperatures (7.51°C) as well as the lowest average daily range in temperatures (1.4°C). Data loggers were not installed in the Yak River but the instantaneous data collected during macroinvertebrate sampling events indicates that its temperature regime is likely similar to that found in Lamb Creek.

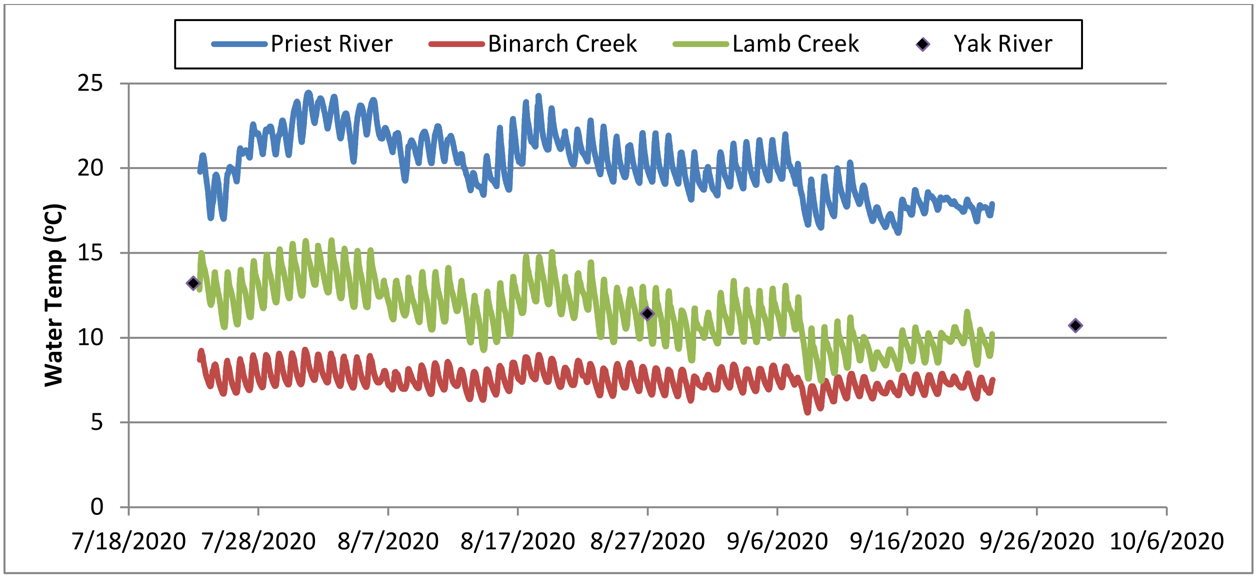


Figure 23. Thermistor Data for Priest River, Binarch Creek, and Lamb Creek and Event Temperatures for Yak River

The temperatures observed in the Priest River closely mimic the water temperatures observed in the upper meter of Priest Lake (Figure 24). This would be expected since Priest Lake water is the source water for the majority of the Priest River in the upper sections. The water temperatures observed in Priest Lake at 18 meters below the water surface are similar to those observed in Binarch Creek. There was one day that was an outlier in the water temperature at 18 meters that was due to the September storm event and has been discussed previously in this report.

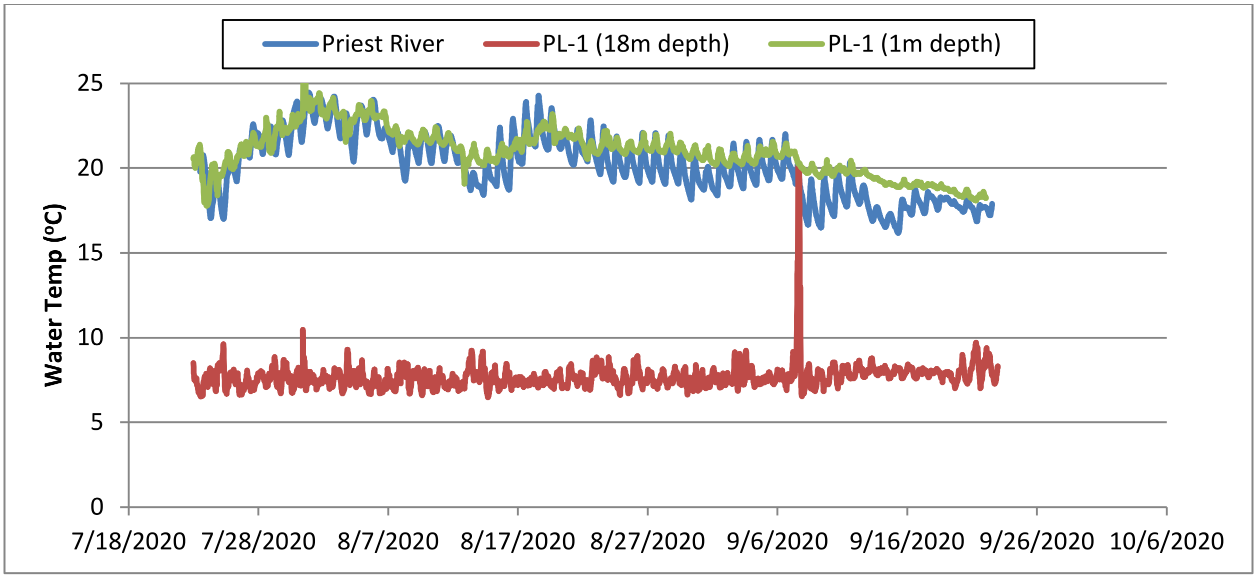


Figure 24. Thermistor Data from Priest River, 1 Meter and 18 Meters Below Water Surface in Priest Lake

Water Chemistry

Nutrient samples were collected from the Priest River site during each lake sampling event. Binarch Creek had water chemistry collected twice and Yak River once. The goal was not to characterize the nutrient status of Binarch Creek or Yak River but to confirm that they had similar water chemistry to aid in interpretation of macroinvertebrate and periphyton data.

The nitrogen and phosphorus data from the Priest River was not significantly different from the results found in the Priest Lake samples (KW, $p>0.01$) (Table 3and Table 4). The number of samples collected from Binarch Creek and Yak River were too few to be able to run statistical analysis on, but the limited results indicate that they are both nutrient poor systems.

Table 4. Lotic Phosphorus Concentrations

	Total Phosphorus (mg/L)			Total Dissolved Phosphorus (mg/L)		
	PR-1	Binarch	Yak	PR-1	Binarch	Yak
N of Cases	9	2	1	9	2	1
Minimum	0.001	0.001	0.001	0.001	0.001	0.001
Maximum	0.012	0.003	0.001	0.003	0.001	0.001
Median	0.002	0.002	0.001	0.001	0.001	0.001
Mean	0.003	0.002	0.001	0.001	0.001	0.001
St. Dev	0.004	0.001	.	0.001	0	.

Table 5. Lotic Nitrogen Concentrations

	Nitrite+Nitrate (mg/L)			Total Ammonia (mg/L)		
	PR-1	Binarch	Yak	PR-1	Binarch	Yak
N of Cases	9	2	1	9	2	1
Minimum	0.001	0.001	0.002	0.003	0.006	0.003
Maximum	0.013	0.006	0.002	0.012	0.008	0.003
Median	0.004	0.003	0.002	0.003	0.007	0.003
Mean	0.004	0.003	0.002	0.005	0.007	0.003
St. Dev	0.004	0.004	.	0.004	0.001	.

Periphyton

There were three sampling events on the Priest River, Binarch Creek and the Yak River. During each of those events 9 periphyton scrapes were composited into a single sample. The samples were identified and enumerated by Rithron and Associates out of Missoula, MT. This information was used to determine a number of indicator metrics to compare the systems. Metrics are a way to numerically characterize a biological system in regards to different environmental or stressor variables. The ones selected for this study were developed to observe changes in community structure due to nutrient and water temperature changes that are anticipated as a result of the project. The full analysis with all the metrics that were calculated for each sample can be found in Appendix C.

Binarch Creek and the Yak River were selected for sampling because their potential to provide insight into the potential changes that may be observed in the Priest River if water temperatures are reduced. The Priest River and Yak River are similar in size and have a similar climatic regime; however, the Yak River is several degrees colder than Priest River. The metric scores for each of the waterbodies and compared to each other are found in Figure 25.

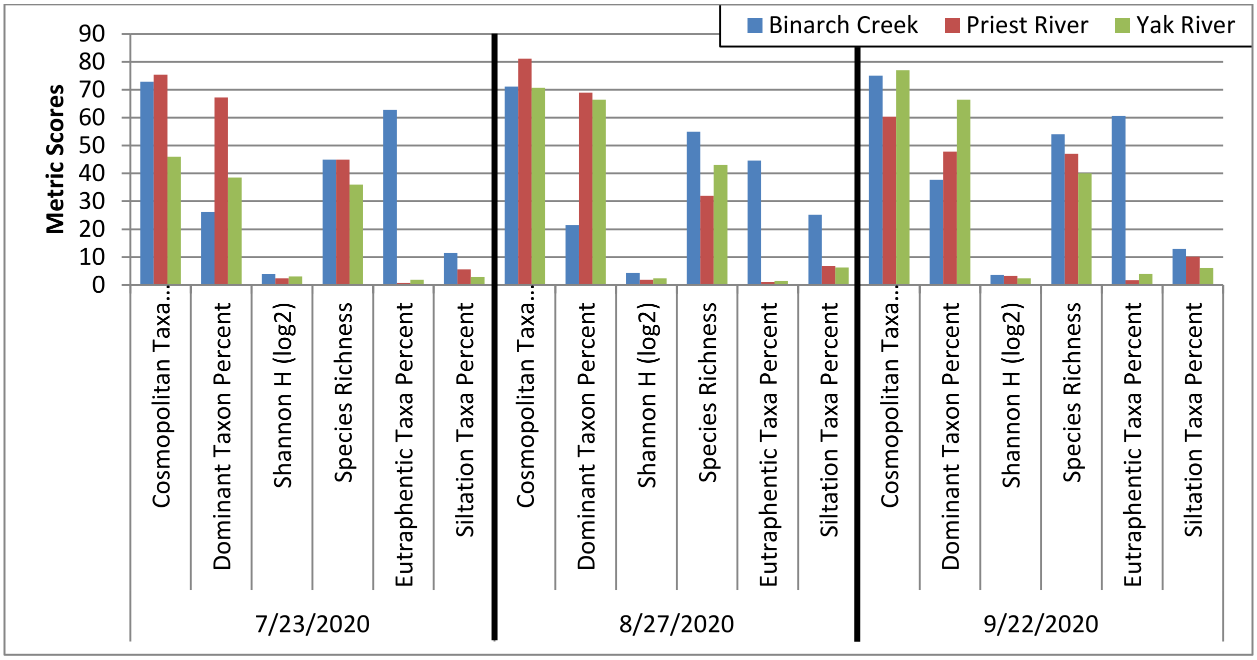


Figure 25. Periphyton Community Metrics

Macroinvertebrates

Macroinvertebrate samples were taken concurrently with the periphyton samples and at the same locations. The rationale for this is the same as the reasons we selected these sites for the periphyton analysis.

Priest River, Binarch Creek, and Yak River had very similar metric scores with a few exceptions. Binarch Creek had a higher percent of cold stenotherms present in the samples as well as a lower temperature preference score. Both of these indicate that there was a temperature driven community shift. The Yak River had a temperature preference score lower than Priest River and higher than Binarch Creek. It is likely that colder temperature in Priest River will shift the macroinvertebrate system with a higher percentage of cold water obligate taxa.

The remaining metrics indicate that all three systems have a healthy macroinvertebrate community.

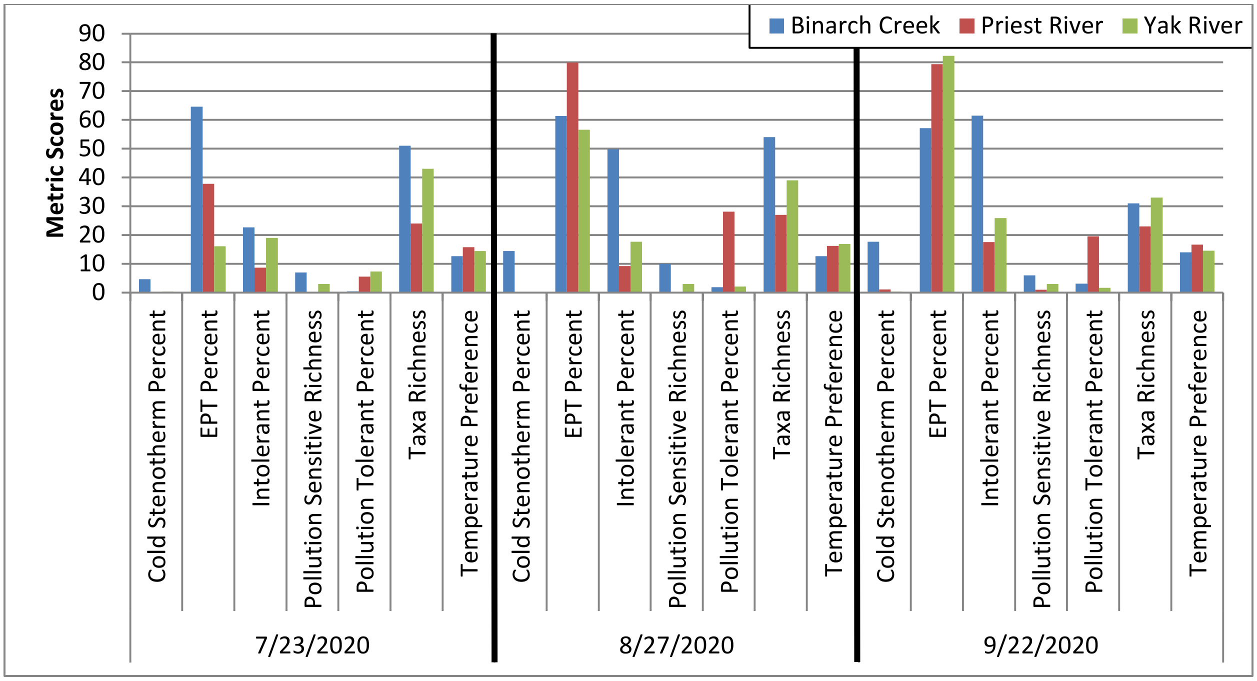


Figure 26. Macroinvertebrate Community Metrics

Discussion

There were 5 main objectives for this project. They included:

- Determine if there was a difference in water quality between the epilimnion and hypolimnion of Priest Lake.
- Determine the potential impact of a hypolimnetic withdrawal structure on Priest Lake on hypolimnion and epilimnion conditions.
- Determine what changes may occur within Outlet Bay due to hypolimnetic diversion.
- Determine the impact of hypolimnetic water on Priest River
- Determine if 18 meters below the water surface is an appropriate depth for meeting the goals of withdrawal of 8 ^{o}C hypolimnetic water.

The discussion regarding these five objectives has been divided up into potential changes in physical conditions, nutrients, and biological communities.

Dissolved Oxygen Discussion

One of the primary drivers to determine the capacity of water to contain dissolved oxygen is water temperature. As water warms its ability to absorb oxygen is reduced. Therefore when examining dissolved oxygen conditions within lakes both concentrations of dissolved oxygen as well as percent saturation levels should be evaluated. The data collected in 2020 did not indicate there were any significant reduction in dissolved oxygen by depth. Due to the higher dissolved oxygen carrying capacity in cold water a hypolimnetic withdrawal may increase dissolved oxygen levels in Priest River.

The Idaho water quality standard for water designated as a cold water fishery requires that dissolved oxygen levels be above 6 mg/L. The bottom seven meters of deep lakes are exempt from this criteria. The data collected in 2020 in the Priest Lake system did not record any dissolved oxygen reading that violated the Idaho water quality criteria.

Nutrient Discussion

The nutrient concentrations observed within Priest Lake are very low and often at the level of detection for approved analysis methods. These nutrient concentrations are indicative of an oligotrophic system. When we examined the data from the epilimnion we found no statistically significant difference in any of the nutrient concentrations between PL-1, PL-2, PL-3, or OUT-1. A comparison of the nutrient concentrations between the epilimnion and hypolimnion at PL-1 and PL-2 were also not significantly different. This is not unexpected in oligotrophic systems. The biological community is often what causes differences between the epilimnion and hypolimnion nutrient concentrations; however, in oligotrophic systems there is not enough biological productivity to modify the nutrient regime between water layers.

When the nutrient concentrations from the Priest River were compared to the nutrient concentrations in the epilimnion and hypolimnion of Priest Lake there was no significant difference. This data would suggest that use of hypolimnetic water would not have a significant impact on nutrient concentrations within Priest River.

Biological Community Discussion

Phytoplankton samples taken from the three Priest Lake stations do not indicate that there is a measureable difference in the phytoplankton community in terms of density or biovolume between the three Priest Lake stations or between the epilimnion and hypolimnion. This would suggest that there would be little change to the phytoplankton community to the lake or to the amount received by Priest River due to supplementing surface water with hypolimnetic water.

Zooplankton samples were also taken from the three Priest Lake Stations. There was no difference in the density or biomass of the Cladocerans in the epilimnion of these three stations. There was a difference between the epilimnion and hypolimnion samples taken at PL-1 and PL-2. The density of the zooplankton taxa was considerably lower in the hypolimnion compared to the epilimnion. Even though there were fewer individual zooplankton in the hypolimnion the ones present had a larger body size. This resulted in the biomass in the epilimnion and hypolimnion being similar.

The installation of a hypolimnetic withdrawal structure will likely result in a small decrease in the large bodied zooplankton species in the localized area of the withdrawal point; however, due to the zone of impact compared to the overall lake size this difference will be negligible. The Priest River will likely receive less small bodied zooplankton but little change in the total biomass received from the lake. Since planktivorous fish such as trout prefer large bodied zooplankton this may be a net positive to the fishery in Priest River but due to the low total biomass being delivered to the Priest River it is not likely to have a measurable impact to the fishery.

Macroinvertebrate and periphyton samples were collected in the Priest River, Yak River and Binarch Creek to provide insight to the likely changes that may occur within these communities as a result of reduced summer water temperatures. For most metrics examined all three stations had similar macroinvertebrate and periphyton communities. They are all healthy and indicative of low sediment and nutrient conditions. The primary difference observed was in the cold water indicator metrics. The metrics calculated indicates that the water temperature in Priest River was higher and this impacting the taxa present in the macroinvertebrate and periphyton communities. It is likely that with the reduction of water temperature within the Priest River that that macroinvertebrate and periphyton communities would shift to a community similar to those found in the Yak River.

Outlet Discussion

One of the principal concerns that has been expressed about the project is the impact the project would have on water quality within Outlet Bay. The nutrient and chlorophyll *a* samples collected in 2020 indicate that the concentrations of nutrients in Outlet Bay are similar to those found in the epilimnion samples of Priest Lake. This is expected since the surface layer of the lake is a major source of water for Outlet Bay. Furthermore, since the epilimnion and hypolimnion have very similar nutrient and chlorophyll a concentrations there should be no measureable change in the nutrient concentrations of Outlet Bay with the implementation of this project.

It is reasonable to assume that a decrease in water flowing over the dam at Priest Lake would result in lower water velocity, longer transit times for a given amount of water and these factors would result in an increase in water temperature. The increase in water temperature could then result in a number of secondary effects such as increased occurrence of blue-green algae blooms. The data in 2020 call this assumption into question. During each of the temperature transects, from Priest Lake to the dam, a measurable decrease in water temperature was observed as one moved downstream.

The cause of this temperature reduction was not determined in this study but there are two likely scenarios that resulted in the observed temperature reduction. The first involves the intrusion of cold water from Lamb Creek. The water velocity in Outlet Bay is slow enough that the intrusion could move upstream to a limited degree with the majority of the colder water mixing with the warmer lake water causing the temperature reduction.

A second potential source of the cooling could be from ground water upwelling occurring in Outlet Bay. There is a shelf at the mouth of Priest Lake as it transitions into Outlet Bay. This shelf limits colder water from deeper in the lake from entering Outlet Bay directly. The Outlet Bay and surrounding geology consists of sandy deposits. Some of the lake water could diffuse through the sand and thereby cool the water to the natural ground temperature. This water could then upwell into the Outlet Bay area causing a reduction in water temperature.

The mechanism of the cooling is less important than the likely impact this cooling will have on Outlet Bay. A reduction in the amount of warm lake water entering Outlet Bay without a reduction of cool water, either from Lamb Creek or ground water upwelling, will likely result in a minimal amount of cooling in Outlet Bay or no change at all.

Blue-green algal blooms are primarily controlled by solar radiation, nutrient concentration, and water temperature. The project will not result in a change in the solar radiation or nutrient concentrations in the outlet. Based on the monitoring data there is a cold-water supply of water entering the Outlet area. This will likely become more pronounced if less epilimnetic lake water is discharged over the dam. With the water temperature reduction, the risk of blue-green algal blooms should not increase as a result of the project. One concern that has been expressed is the impact of increased residency time of the water within the outlet and this resulting in an increase in the chance of blue-green algal blooms. As has been previously discussed the residency time of the epilimnion of Priest Lake is relatively long. Based on this, it is unlikely that the outlet will have a different risk of blue-green algal blooms than the main lake and with the lower water temperature may have a lower risk than the main lake.

Vertical Temperature within Priest Lake Discussion

As described above, the water temperature at 18 m at PL-1 did not remain less than 8 °C during the mooring period. The temperature rose above 8 °C with slight exceedances (< 2 °C) of 8 °C occurring for a significant fraction of the time, and with larger exceedances (> 10 °C) of 8 °C occurring for a short period of time.

Eighteen meters occurs near the bottom of the thermocline region (metalimnion). It is not unexpected that any motion of the thermocline – whether driven by the usual diurnal winds, or by exceptional storms – would then affect the temperature at 18 m, as was observed.

The results shown here are based on observations from one year only, and therefore, some variation in the stratification would be expected for subsequent years. For example, in some years, the summer thermocline may be slightly deeper or slightly shallower, depending on the weather through spring and summer for the given year, and this would result in slightly more or slightly less exceedance of 8 °C, respectively.

There remain a number of interesting questions that are more fully discussed in Appendix H. The items discussed in Appendix H include:

- What factors controlled the downwelling event observed on September 7, 2020?
- How unusual was the storm of September 7, 2020?
- Would the proposed withdrawal of 45 - 103 cfs (1.3 – 3.0 m^3/s) affect the stratification in the lake?

Likelyhood of storms similar to the one observed on September 7th, 2020.

Seven hour average winds > 3.5 m/s (7.8 mph) in June to September occurred on 14 occasions over the last 19 years. The storms occur throughout the June to September period, with slightly more events in

August and September. Of the 47 storms, at total of 5 events had atmospheric pressure changes similar to that seen on September 7, 2020.

Temperature of water withdrawn by the intake

Because of the temperature stratification, water will be withdrawn from a horizontal layer at the depth of the intake. The temperature stratification inhibits the withdrawal of water from above or below the level of the intake because of the energy needed to either bring warmer (buoyant) water down from above, or bring colder (denser) water up from below.

The withdrawal of water on average becomes negligible 3.4 m above depth of the intake and 4.1 m below the depth of the intake.

Excluding day 251, the estimated outlet temperature is within 0.6 °C of the temperature observed at 18 m, and the average difference is 0.1 °C. This suggests that the inclusion of cooler water from below is approximately balanced by the inclusion of warmer water from above, and that the measured temperature is a good approximation to the temperature of the water that will be withdrawn.

Effect of the proposed withdrawal on the stratification in the lake

The proposed intake would withdraw 45 - 103 cfs (1.3 – 2.9 m^3/s). This is generally less than the outflow rate except for periods of low flow, see Figure 5. During low flow, the withdrawal would need to be reduced to maintain the target summer water level.

For comparison, the monthly average outflow from Priest Lake averaged from 75 m^3/s in June to 4.1 m^3/s in September (Table 6). Outflow from Priest Lake is from the surface. For example, the average inflow of 17 m^3/s in July corresponds to adding a layer of water with depth of 0.47 m over the surface area of the lake. Inflows either mix into the epilimnion itself, or plunge into the metalimnion; in either case the inflow causes the outflow of surface water at the dam. If the average epilimnion depth in July was approximately 5 m (Figure 9), July inflow would on average replace about 10% of the epilimnion.

Similarly, the average inflow of 4 m^3/s in September corresponds to a layer of 0.11 m and, out of a typical epilimnion depth of 10 m, only about 1% would be replaced. This suggests that the summer residence time of the epilimnion in Priest Lake is relatively long.

Table 6. Average and minimum outflow from Priest Lake, 2017-2020

	June	July	August	September
Average (m^3/s)	75	17	4.6	4.1

The proposed intake would withdraw a maximum of 2.9 m^3/s, which corresponds to a layer thickness of approximately 0.08 m/month (3 inches/month). The proposed intake would withdraw this layer of water from 18 m (see previous section), which would deepen the thermocline slightly. In effect, rather than all outflow from the epilimnion that is warmer, a fraction of water will be withdrawn from below that is cooler, resulting in a small increase in the residence time of the epilimnion.

Conclusions and Recommendations

The examination of the data in Priest Lake, Priest River, as well as colder water surrogate rivers indicates that there would be little adverse impacts to the cooling of the Priest River by hypolimnetic flow supplementation.

- The water chemistry in the epilimnion and hypolimnion are similar and are not significantly different and therefore would not result in a significant change in the nutrient conditions within Priest River.
- The zooplankton community is composed of fewer but larger individuals in the hypolimnion; however, the impact of the withdrawal structure would be minimal when examined in the context of the entire water body.
- The phytoplankton community is similar between the epilimnion and hypolimnion and therefore no change to the phytoplankton community would be expected.
- Outlet Bay's water temperature declines as one approaches the dam. This is either due to ground water inflow or the cooling effect of Lamb Creek. Regardless of the source of this temperature reduction the reduction of warm lake surface water entering the Bay due to hypolimnetic diversion will not result in an increase in water temperature in Outlet Bay and may result in additional cooling due to an increase in the ratio of cool water to warm water.
- The macroinvertebrate community in the Priest River will likely change to a community similar to the Yak River with an increase in cold water taxa.
- The periphyton community in the Priest River will remain similar to those currently observed. A potential issue that will need to be considered is that with the colder water there may be an increased presence of *Didymosphenia geminata*.
- Water temperatures at 18 meters of water depth exceeded the target temperature approximately 16% of the time, however, the majority of the increase was less than 1^{o}C. IDFG may want to consider deepening the withdrawal point 1 to 2 meters if this increase is a concern.
- Large storm events like the one observed in September of 2020 can result in epilimnetic water reaching the proposed withdrawal depth and a rapid increase in water temperature within the pipe and thereby delivered to the Priest River. IDFG may want to evaluate if a rapid, short term change in water temperature will adversely impact the fish in Priest River.

- A single discrete point withdrawal 18 meters has the potential to bring in water from no more than 3.4 meters above and 4.1 meters below the intake. IDFG may want to consider having an engineered analysis done to create and intake structure that occurs over a larger horizontal area to reduce the vertical impact of the withdrawal structure. The withdrawal area of impact should also be taken into account when determining the depth from the lake bottom to place the structure to ensure no entrainment of lake bottom sediment.

Based on this study's findings and with the development of a diffused withdrawal structure there should not be a significant impact on water quality or water temperature in Priest Lake and no adverse impact to the biological community of the lake or river system.

The conclusions reached in this report are supported by the data and peer reviewed scientific models; however, there is the possibility that there are conditions within Priest Lake that were not accounted for. In an effort to ensure that the conclusion of this study are correct we are recommending a monitoring program be established in Priest Lake and Priest River.

The monitoring program should include, summer bi-weekly temperature and dissolved oxygen vertical profiles be conducted adjacent to the intake structure as well as a second station outside of the immediate vicinity of the intake structure. This would provide the data needed to ensure that no adverse impacts were being caused by the hypolimnetic withdrawal.

A horizontal temperature transect of the area from the lake outlet to the dam should be collected concurrently with the vertical profiles in the lake. This data would allow confirmation that the water temperature in the outlet area of the lake is not adversely impacted by the reduction of surface overflow across the dam.

We also recommend that annual periphyton and macroivertebrate samples be taken downstream of the outlet structure to monitor changes in the community structure of these two trophic levels as well as ensuring that no nuisance taxa become dominant.

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Appendix A- Nutrient Data

Project Name	Sample ID	Date Sampled	Time	Analyte Name	Results	Units	Method
PRIEST LAKE	PL-1 EPI	6/3/2020	11:15:00	Total Phosphorus	0.003	mg/l	4500PF
PRIEST LAKE	PL-1 EPI	6/3/2020	11:15:00	Temperature on receipt	4	degrees C	170.1
PRIEST LAKE	PL-1 EPI	6/3/2020	11:15:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-1 EPI	6/3/2020	11:15:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 EPI	6/3/2020	11:15:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-1 EPI	6/3/2020	11:15:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-1 18M	6/3/2020	10:45:00	Total Phosphorus	0.0056	mg/l	4500PF
PRIEST LAKE	PL-1 18M	6/3/2020	10:45:00	Total Nitrogen (TKN)	2.86	mg/l	351.2
PRIEST LAKE	PL-1 18M	6/3/2020	10:45:00	Temperature on receipt	4	degrees C	170.1
PRIEST LAKE	PL-1 18M	6/3/2020	10:45:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-1 18M	6/3/2020	10:45:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 18M	6/3/2020	10:45:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-1 EPI (DUP)	6/3/2020	11:15:00	Total Phosphorus	0.0058	mg/l	4500PF
PRIEST LAKE	PL-1 EPI (DUP)	6/3/2020	11:15:00	Total Nitrogen (TKN)	0.13	mg/l	351.2
PRIEST LAKE	PL-1 EPI (DUP)	6/3/2020	11:15:00	Temperature on receipt	4	degrees C	170.1
PRIEST LAKE	PL-1 EPI (DUP)	6/3/2020	11:15:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-1 EPI (DUP)	6/3/2020	11:15:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 EPI (DUP)	6/3/2020	11:15:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI	6/3/2020	10:30:00	Total Phosphorus	0.0019	mg/l	4500PF
PRIEST LAKE	PL-2 EPI	6/3/2020	10:30:00	Ammonia Nitrogen	0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI	6/3/2020	10:30:00	Total Nitrogen (TKN)	1.4	mg/l	351.2
PRIEST LAKE	PL-2 EPI	6/3/2020	10:30:00	Temperature on receipt	4	degrees C	170.1
PRIEST LAKE	PL-2 EPI	6/3/2020	10:30:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 EPI	6/3/2020	10:30:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO	6/3/2020	10:00:00	Total Phosphorus	0.0039	mg/l	4500PF
PRIEST LAKE	PL-2 HYPO	6/3/2020	10:00:00	Total Nitrogen (TKN)	0.14	mg/l	351.2
PRIEST LAKE	PL-2 HYPO	6/3/2020	10:00:00	Temperature on receipt	4	degrees C	170.1
PRIEST LAKE	PL-2 HYPO	6/3/2020	10:00:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 HYPO	6/3/2020	10:00:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO	6/3/2020	10:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-3	6/3/2020	12:00:00	Tot-Diss Phosphorus	0.0017	mg/l	4500-P E
PRIEST LAKE	PL-3	6/3/2020	12:00:00	Total Phosphorus	0.0025	mg/l	4500PF
PRIEST LAKE	PL-3	6/3/2020	12:00:00	Total Nitrogen (TKN)	0.17	mg/l	351.2
PRIEST LAKE	PL-3	6/3/2020	12:00:00	Temperature on receipt	4	degrees C	170.1
PRIEST LAKE	PL-3	6/3/2020	12:00:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-3	6/3/2020	12:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PR-1	6/3/2020	14:00:00	Tot-Diss Phosphorus	0.0012	mg/l	4500-P E
PRIEST LAKE	PR-1	6/3/2020	14:00:00	Total Phosphorus	0.0024	mg/l	4500PF
PRIEST LAKE	PR-1	6/3/2020	14:00:00	Total Nitrogen (TKN)	0.12	mg/l	351.2
PRIEST LAKE	PR-1	6/3/2020	14:00:00	Temperature on receipt	4	degrees C	170.1
PRIEST LAKE	PR-1	6/3/2020	14:00:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PR-1	6/3/2020	14:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	6/3/2020		Tot-Diss Phosphorus	0.0031	mg/l	4500-P E
PRIEST LAKE	BLANK	6/3/2020		Temperature on receipt	4	degrees C	170.1
PRIEST LAKE	BLANK	6/3/2020		Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	BLANK	6/3/2020		Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	BLANK	6/3/2020		Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	6/3/2020		Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-1 EPI	6/17/2020	10:30:00	Total Phosphorus	0.0014	mg/l	4500PF
PRIEST LAKE	PL-1 EPI	6/17/2020	10:30:00	Total Nitrogen (TKN)	0.19	mg/l	351.2

Project Name	Sample ID	Date Sampled	Time	Analyte Name	Results	Units	Method
PRIEST LAKE	PL-1 EPI	6/17/2020	10:30:00	Temperature on receipt	5.5	degrees C	170.1
PRIEST LAKE	PL-1 EPI	6/17/2020	10:30:00	Total Dissolved Solids	38	mg/l	2540C
PRIEST LAKE	PL-1 EPI	6/17/2020	10:30:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-1 EPI	6/17/2020	10:30:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 EPI	6/17/2020	10:30:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-1 18M	6/17/2020	10:10:00	Tot-Diss Phosphorus	0.0014	mg/l	4500-P E
PRIEST LAKE	PL-1 18M	6/17/2020	10:10:00	Total Nitrogen (TKN)	0.17	mg/l	351.2
PRIEST LAKE	PL-1 18M	6/17/2020	10:10:00	Temperature on receipt	5.5	degrees C	170.1
PRIEST LAKE	PL-1 18M	6/17/2020	10:10:00	Total Dissolved Solids	32	mg/l	2540C
PRIEST LAKE	PL-1 18M	6/17/2020	10:10:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-1 18M	6/17/2020	10:10:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-1 18M	6/17/2020	10:10:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI	6/17/2020	9:30:00	Total Nitrogen (TKN)	0.19	mg/l	351.2
PRIEST LAKE	PL-2 EPI	6/17/2020	9:30:00	Temperature on receipt	5.5	degrees C	170.1
PRIEST LAKE	PL-2 EPI	6/17/2020	9:30:00	Total Dissolved Solids	33	mg/l	2540C
PRIEST LAKE	PL-2 EPI	6/17/2020	9:30:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 EPI	6/17/2020	9:30:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-2 EPI	6/17/2020	9:30:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 EPI	6/17/2020	9:30:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO	6/17/2020	9:00:00	Total Nitrogen (TKN)	0.18	mg/l	351.2
PRIEST LAKE	PL-2 HYPO	6/17/2020	9:00:00	Temperature on receipt	5.5	degrees C	170.1
PRIEST LAKE	PL-2 HYPO	6/17/2020	9:00:00	Total Dissolved Solids	37	mg/l	2540C
PRIEST LAKE	PL-2 HYPO	6/17/2020	9:00:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 HYPO	6/17/2020	9:00:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-2 HYPO	6/17/2020	9:00:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO	6/17/2020	9:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-3	6/17/2020	11:20:00	Total Nitrogen (TKN)	0.12	mg/l	351.2
PRIEST LAKE	PL-3	6/17/2020	11:20:00	Temperature on receipt	5.5	degrees C	170.1
PRIEST LAKE	PL-3	6/17/2020	11:20:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-3	6/17/2020	11:20:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-3	6/17/2020	11:20:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-3	6/17/2020	11:20:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI (DUP)	6/17/2020	9:30:00	Total Nitrogen (TKN)	0.19	mg/l	351.2
PRIEST LAKE	PL-2 EPI (DUP)	6/17/2020	9:30:00	Temperature on receipt	5.5	degrees C	170.1
PRIEST LAKE	PL-2 EPI (DUP)	6/17/2020	9:30:00	Total Dissolved Solids	34	mg/l	2540C
PRIEST LAKE	PL-2 EPI (DUP)	6/17/2020	9:30:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 EPI (DUP)	6/17/2020	9:30:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-2 EPI (DUP)	6/17/2020	9:30:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 EPI (DUP)	6/17/2020	9:30:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PR-1	6/17/2020	8:00:00	Total Phosphorus	0.0011	mg/l	4500PF
PRIEST LAKE	PR-1	6/17/2020	8:00:00	Tot-Diss Phosphorus	0.0015	mg/l	4500-P E
PRIEST LAKE	PR-1	6/17/2020	8:00:00	Ammonia Nitrogen	0.008	mg/l	350.1
PRIEST LAKE	PR-1	6/17/2020	8:00:00	Total Nitrogen (TKN)	0.18	mg/l	351.2
PRIEST LAKE	PR-1	6/17/2020	8:00:00	Temperature on receipt	5.5	degrees C	170.1
PRIEST LAKE	PR-1	6/17/2020	8:00:00	Total Dissolved Solids	41	mg/l	2540C
PRIEST LAKE	PR-1	6/17/2020	8:00:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	BLANK	6/17/2020		Temperature on receipt	5.5	degrees C	170.1
PRIEST LAKE	BLANK	6/17/2020		Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	BLANK	6/17/2020		Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	BLANK	6/17/2020		Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E

Project Name	Sample ID	Date Sampled	Time	Analyte Name	Results	Units	Method
PRIEST LAKE	BLANK	6/17/2020		Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	6/17/2020		Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	BLANK	6/17/2020		Total Dissolved Solids	< 1	mg/l	2540C
PRIEST LAKE	PL-1 EPI	7/1/2020	10:00:00	Tot-Diss Phosphorus	0.0028	mg/l	4500-P E
PRIEST LAKE	PL-1 EPI	7/1/2020	10:00:00	Total Phosphorus	0.0045	mg/l	4500PF
PRIEST LAKE	PL-1 EPI	7/1/2020	10:00:00	Total Nitrate + Nitrite	0.006	mg/l	300
PRIEST LAKE	PL-1 EPI	7/1/2020	10:00:00	Total Nitrogen (TKN)	0.15	mg/l	351.2
PRIEST LAKE	PL-1 EPI	7/1/2020	10:00:00	Temperature on receipt	6.2	degrees C	170.1
PRIEST LAKE	PL-1 EPI	7/1/2020	10:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-1 18M	7/1/2020	9:30:00	Total Phosphorus	0.0028	mg/l	4500PF
PRIEST LAKE	PL-1 18M	7/1/2020	9:30:00	Tot-Diss Phosphorus	0.0037	mg/l	4500-P E
PRIEST LAKE	PL-1 18M	7/1/2020	9:30:00	Total Nitrate + Nitrite	0.011	mg/l	300
PRIEST LAKE	PL-1 18M	7/1/2020	9:30:00	Total Nitrogen (TKN)	0.11	mg/l	351.2
PRIEST LAKE	PL-1 18M	7/1/2020	9:30:00	Temperature on receipt	6.2	degrees C	170.1
PRIEST LAKE	PL-1 18M	7/1/2020	9:30:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI	7/1/2020	12:00:00	Tot-Diss Phosphorus	0.0025	mg/l	4500-P E
PRIEST LAKE	PL-2 EPI	7/1/2020	12:00:00	Total Phosphorus	0.0042	mg/l	4500PF
PRIEST LAKE	PL-2 EPI	7/1/2020	12:00:00	Total Nitrate + Nitrite	0.006	mg/l	300
PRIEST LAKE	PL-2 EPI	7/1/2020	12:00:00	Total Nitrogen (TKN)	0.13	mg/l	351.2
PRIEST LAKE	PL-2 EPI	7/1/2020	12:00:00	Temperature on receipt	6.2	degrees C	170.1
PRIEST LAKE	PL-2 EPI	7/1/2020	12:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO	7/1/2020	11:40:00	Total Phosphorus	0.0024	mg/l	4500PF
PRIEST LAKE	PL-2 HYPO	7/1/2020	11:40:00	Tot-Diss Phosphorus	0.0032	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO	7/1/2020	11:40:00	Total Nitrate + Nitrite	0.012	mg/l	300
PRIEST LAKE	PL-2 HYPO	7/1/2020	11:40:00	Temperature on receipt	6.2	degrees C	170.1
PRIEST LAKE	PL-2 HYPO	7/1/2020	11:40:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO	7/1/2020	11:40:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-3	7/1/2020	10:30:00	Tot-Diss Phosphorus	0.0032	mg/l	4500-P E
PRIEST LAKE	PL-3	7/1/2020	10:30:00	Total Phosphorus	0.0035	mg/l	4500PF
PRIEST LAKE	PL-3	7/1/2020	10:30:00	Total Nitrate + Nitrite	0.007	mg/l	300
PRIEST LAKE	PL-3	7/1/2020	10:30:00	Total Nitrogen (TKN)	0.13	mg/l	351.2
PRIEST LAKE	PL-3	7/1/2020	10:30:00	Temperature on receipt	6.2	degrees C	170.1
PRIEST LAKE	PL-3	7/1/2020	10:30:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	OUT-1	7/1/2020	11:05:00	Total Phosphorus	0.0025	mg/l	4500PF
PRIEST LAKE	OUT-1	7/1/2020	11:05:00	Tot-Diss Phosphorus	0.0026	mg/l	4500-P E
PRIEST LAKE	OUT-1	7/1/2020	11:05:00	Total Nitrate + Nitrite	0.009	mg/l	300
PRIEST LAKE	OUT-1	7/1/2020	11:05:00	Total Nitrogen (TKN)	0.14	mg/l	351.2
PRIEST LAKE	OUT-1	7/1/2020	11:05:00	Temperature on receipt	6.2	degrees C	170.1
PRIEST LAKE	OUT-1	7/1/2020	11:05:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PR-1	7/1/2020	8:20:00	Tot-Diss Phosphorus	0.0029	mg/l	4500-P E
PRIEST LAKE	PR-1	7/1/2020	8:20:00	Total Phosphorus	0.0052	mg/l	4500PF
PRIEST LAKE	PR-1	7/1/2020	8:20:00	Total Nitrate + Nitrite	0.013	mg/l	300
PRIEST LAKE	PR-1	7/1/2020	8:20:00	Total Nitrogen (TKN)	0.15	mg/l	351.2
PRIEST LAKE	PR-1	7/1/2020	8:20:00	Temperature on receipt	6.2	degrees C	170.1
PRIEST LAKE	PR-1	7/1/2020	8:20:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-3 EPI (DUP)	7/1/2020	10:30:00	Tot-Diss Phosphorus	0.004	mg/l	4500-P E
PRIEST LAKE	PL-3 EPI (DUP)	7/1/2020	10:30:00	Total Phosphorus	0.0052	mg/l	4500PF
PRIEST LAKE	PL-3 EPI (DUP)	7/1/2020	10:30:00	Total Nitrate + Nitrite	0.006	mg/l	300
PRIEST LAKE	PL-3 EPI (DUP)	7/1/2020	10:30:00	Total Nitrogen (TKN)	0.1	mg/l	351.2
PRIEST LAKE	PL-3 EPI (DUP)	7/1/2020	10:30:00	Temperature on receipt	6.2	degrees C	170.1

Project Name	Sample ID	Date Sampled	Time	Analyte Name	Results	Units	Method
PRIEST LAKE	PL-3 EPI (DUP)	7/1/2020	10:30:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	7/1/2020		Tot-Diss Phosphorus	0.0022	mg/l	4500-P E
PRIEST LAKE	BLANK	7/1/2020		Total Nitrate + Nitrite	0.012	mg/l	300
PRIEST LAKE	BLANK	7/1/2020		Temperature on receipt	6.2	degrees C	170.1
PRIEST LAKE	BLANK	7/1/2020		Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	BLANK	7/1/2020		Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	7/1/2020		Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-1 EPI	7/13/2020	10:45:00	Total Phosphorus	0.003	mg/l	4500PF
PRIEST LAKE	PL-1 EPI	7/13/2020	10:45:00	Total Nitrate + Nitrite	0.006	mg/l	300
PRIEST LAKE	PL-1 EPI	7/13/2020	10:45:00	Total Nitrogen (TKN)	0.34	mg/l	351.2
PRIEST LAKE	PL-1 EPI	7/13/2020	10:45:00	Temperature on receipt	10	degrees C	170.1
PRIEST LAKE	PL-1 EPI	7/13/2020	10:45:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 EPI	7/13/2020	10:45:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-1 18M	7/13/2020	10:40:00	Total Phosphorus	0.006	mg/l	4500PF
PRIEST LAKE	PL-1 18M	7/13/2020	10:40:00	Total Nitrate + Nitrite	0.007	mg/l	300
PRIEST LAKE	PL-1 18M	7/13/2020	10:40:00	Total Nitrogen (TKN)	0.12	mg/l	351.2
PRIEST LAKE	PL-1 18M	7/13/2020	10:40:00	Temperature on receipt	10	degrees C	170.1
PRIEST LAKE	PL-1 18M	7/13/2020	10:40:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 18M	7/13/2020	10:40:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI	7/13/2020	9:35:00	Total Nitrate + Nitrite	0.008	mg/l	300
PRIEST LAKE	PL-2 EPI	7/13/2020	9:35:00	Total Nitrogen (TKN)	0.17	mg/l	351.2
PRIEST LAKE	PL-2 EPI	7/13/2020	9:35:00	Temperature on receipt	10	degrees C	170.1
PRIEST LAKE	PL-2 EPI	7/13/2020	9:35:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-2 EPI	7/13/2020	9:35:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 EPI	7/13/2020	9:35:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO	7/13/2020	9:00:00	Total Phosphorus	0.007	mg/l	4500PF
PRIEST LAKE	PL-2 HYPO	7/13/2020	9:00:00	Total Nitrate + Nitrite	0.013	mg/l	300
PRIEST LAKE	PL-2 HYPO	7/13/2020	9:00:00	Total Nitrogen (TKN)	0.18	mg/l	351.2
PRIEST LAKE	PL-2 HYPO	7/13/2020	9:00:00	Temperature on receipt	10	degrees C	170.1
PRIEST LAKE	PL-2 HYPO	7/13/2020	9:00:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO	7/13/2020	9:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-3	7/13/2020	11:05:00	Total Nitrate + Nitrite	0.01	mg/l	300
PRIEST LAKE	PL-3	7/13/2020	11:05:00	Total Phosphorus	0.014	mg/l	4500PF
PRIEST LAKE	PL-3	7/13/2020	11:05:00	Total Nitrogen (TKN)	0.21	mg/l	351.2
PRIEST LAKE	PL-3	7/13/2020	11:05:00	Temperature on receipt	10	degrees C	170.1
PRIEST LAKE	PL-3	7/13/2020	11:05:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-3	7/13/2020	11:05:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	OUT-1	7/13/2020	11:55:00	Total Phosphorus	0.005	mg/l	4500PF
PRIEST LAKE	OUT-1	7/13/2020	11:55:00	Total Nitrate + Nitrite	0.01	mg/l	300
PRIEST LAKE	OUT-1	7/13/2020	11:55:00	Total Nitrogen (TKN)	4.41	mg/l	351.2
PRIEST LAKE	OUT-1	7/13/2020	11:55:00	Temperature on receipt	10	degrees C	170.1
PRIEST LAKE	OUT-1	7/13/2020	11:55:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	OUT-1	7/13/2020	11:55:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PR-1	7/13/2020	7:55:00	Total Phosphorus	0.012	mg/l	4500PF
PRIEST LAKE	PR-1	7/13/2020	7:55:00	Total Nitrogen (TKN)	0.39	mg/l	351.2
PRIEST LAKE	PR-1	7/13/2020	7:55:00	Temperature on receipt	10	degrees C	170.1
PRIEST LAKE	PR-1	7/13/2020	7:55:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PR-1	7/13/2020	7:55:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PR-1	7/13/2020	7:55:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-1 -18M (DUP)	7/13/2020	10:40:00	Total Phosphorus	0.005	mg/l	4500PF

Project Name	Sample ID	Date Sampled	Time	Analyte Name	Results	Units	Method
PRIEST LAKE	PL-1 -18M (DUP)	7/13/2020	10:40:00	Total Nitrogen (TKN)	0.12	mg/l	351.2
PRIEST LAKE	PL-1 -18M (DUP)	7/13/2020	10:40:00	Temperature on receipt	10	degrees C	170.1
PRIEST LAKE	PL-1 -18M (DUP)	7/13/2020	10:40:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-1 -18M (DUP)	7/13/2020	10:40:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 -18M (DUP)	7/13/2020	10:40:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	7/13/2020		Ammonia Nitrogen	0.005	mg/l	350.1
PRIEST LAKE	BLANK	7/13/2020		Total Nitrate + Nitrite	0.014	mg/l	300
PRIEST LAKE	BLANK	7/13/2020		Temperature on receipt	10	degrees C	170.1
PRIEST LAKE	BLANK	7/13/2020		Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	BLANK	7/13/2020		Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	BLANK	7/13/2020		Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-1 EPI	7/29/2020	10:15:00	Total Phosphorus	0.0013	mg/l	4500PF
PRIEST LAKE	PL-1 EPI	7/29/2020	10:15:00	Total Nitrate + Nitrite	0.005	mg/l	300
PRIEST LAKE	PL-1 EPI	7/29/2020	10:15:00	Total Nitrogen (TKN)	0.13	mg/l	351.2
PRIEST LAKE	PL-1 EPI	7/29/2020	10:15:00	Temperature on receipt	15.8	degrees C	170.1
PRIEST LAKE	PL-1 EPI	7/29/2020	10:15:00	Total Dissolved Solids	29	mg/l	2540C
PRIEST LAKE	PL-1 EPI	7/29/2020	10:15:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 EPI	7/29/2020	10:15:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-1 18M	7/29/2020	10:00:00	Total Nitrate + Nitrite	0.001	mg/l	300
PRIEST LAKE	PL-1 18M	7/29/2020	10:00:00	Total Phosphorus	0.0016	mg/l	4500PF
PRIEST LAKE	PL-1 18M	7/29/2020	10:00:00	Total Nitrogen (TKN)	0.12	mg/l	351.2
PRIEST LAKE	PL-1 18M	7/29/2020	10:00:00	Temperature on receipt	15.8	degrees C	170.1
PRIEST LAKE	PL-1 18M	7/29/2020	10:00:00	Total Dissolved Solids	23	mg/l	2540C
PRIEST LAKE	PL-1 18M	7/29/2020	10:00:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 18M	7/29/2020	10:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI	7/29/2020	9:30:00	Total Phosphorus	0.0023	mg/l	4500PF
PRIEST LAKE	PL-2 EPI	7/29/2020	9:30:00	Total Nitrate + Nitrite	0.003	mg/l	300
PRIEST LAKE	PL-2 EPI	7/29/2020	9:30:00	Total Nitrogen (TKN)	0.16	mg/l	351.2
PRIEST LAKE	PL-2 EPI	7/29/2020	9:30:00	Temperature on receipt	15.8	degrees C	170.1
PRIEST LAKE	PL-2 EPI	7/29/2020	9:30:00	Total Dissolved Solids	17	mg/l	2540C
PRIEST LAKE	PL-2 EPI	7/29/2020	9:30:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 EPI	7/29/2020	9:30:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO	7/29/2020	9:20:00	Total Phosphorus	0.0012	mg/l	4500PF
PRIEST LAKE	PL-2 HYPO	7/29/2020	9:20:00	Total Nitrogen (TKN)	0.13	mg/l	351.2
PRIEST LAKE	PL-2 HYPO	7/29/2020	9:20:00	Temperature on receipt	15.8	degrees C	170.1
PRIEST LAKE	PL-2 HYPO	7/29/2020	9:20:00	Total Dissolved Solids	27	mg/l	2540C
PRIEST LAKE	PL-2 HYPO	7/29/2020	9:20:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 HYPO	7/29/2020	9:20:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO	7/29/2020	9:20:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-3	7/29/2020	10:30:00	Total Nitrate + Nitrite	0.004	mg/l	300
PRIEST LAKE	PL-3	7/29/2020	10:30:00	Temperature on receipt	15.8	degrees C	170.1
PRIEST LAKE	PL-3	7/29/2020	10:30:00	Total Dissolved Solids	29	mg/l	2540C
PRIEST LAKE	PL-3	7/29/2020	10:30:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-3	7/29/2020	10:30:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-3	7/29/2020	10:30:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-3	7/29/2020	10:30:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	OUT-1	7/29/2020	11:10:00	Tot-Diss Phosphorus	0.001	mg/l	4500-P E
PRIEST LAKE	OUT-1	7/29/2020	11:10:00	Total Nitrate + Nitrite	0.007	mg/l	300
PRIEST LAKE	OUT-1	7/29/2020	11:10:00	Temperature on receipt	15.8	degrees C	170.1
PRIEST LAKE	OUT-1	7/29/2020	11:10:00	Total Dissolved Solids	26	mg/l	2540C

Project Name	Sample ID	Date Sampled	Time	Analyte Name	Results	Units	Method
PRIEST LAKE	OUT-1	7/29/2020	11:10:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	OUT-1	7/29/2020	11:10:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	OUT-1	7/29/2020	11:10:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PR-1	7/29/2020	8:10:00	Total Phosphorus	0.0015	mg/l	4500PF
PRIEST LAKE	PR-1	7/29/2020	8:10:00	Total Nitrate + Nitrite	0.007	mg/l	300
PRIEST LAKE	PR-1	7/29/2020	8:10:00	Total Nitrogen (TKN)	0.16	mg/l	351.2
PRIEST LAKE	PR-1	7/29/2020	8:10:00	Temperature on receipt	15.8	degrees C	170.1
PRIEST LAKE	PR-1	7/29/2020	8:10:00	Total Dissolved Solids	30	mg/l	2540C
PRIEST LAKE	PR-1	7/29/2020	8:10:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PR-1	7/29/2020	8:10:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO (DUP)	7/29/2020	9:20:00	Total Phosphorus	0.0013	mg/l	4500PF
PRIEST LAKE	PL-2 HYPO (DUP)	7/29/2020	9:20:00	Temperature on receipt	15.8	degrees C	170.1
PRIEST LAKE	PL-2 HYPO (DUP)	7/29/2020	9:20:00	Total Dissolved Solids	24	mg/l	2540C
PRIEST LAKE	PL-2 HYPO (DUP)	7/29/2020	9:20:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 HYPO (DUP)	7/29/2020	9:20:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO (DUP)	7/29/2020	9:20:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO (DUP)	7/29/2020	9:20:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	BLANK	7/29/2020		Total Nitrate + Nitrite	0.011	mg/l	300
PRIEST LAKE	BLANK	7/29/2020		Total Dissolved Solids	2	mg/l	2540C
PRIEST LAKE	BLANK	7/29/2020		Temperature on receipt	15.8	degrees C	170.1
PRIEST LAKE	BLANK	7/29/2020		Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	BLANK	7/29/2020		Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	BLANK	7/29/2020		Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	7/29/2020		Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-1 EPI	8/12/2020	10:35:00	Total Phosphorus	0.0033	mg/l	4500PF
PRIEST LAKE	PL-1 EPI	8/12/2020	10:35:00	Total Nitrate + Nitrite	0.006	mg/l	300
PRIEST LAKE	PL-1 EPI	8/12/2020	10:35:00	Total Nitrogen (TKN)	0.12	mg/l	351.2
PRIEST LAKE	PL-1 EPI	8/12/2020	10:35:00	Temperature on receipt	20.2	degrees C	170.1
PRIEST LAKE	PL-1 EPI	8/12/2020	10:35:00	Total Dissolved Solids	37	mg/l	2540C
PRIEST LAKE	PL-1 EPI	8/12/2020	10:35:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 EPI	8/12/2020	10:35:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-1 18M	8/12/2020	10:25:00	Tot-Diss Phosphorus	0.0013	mg/l	4500-P E
PRIEST LAKE	PL-1 18M	8/12/2020	10:25:00	Total Phosphorus	0.0018	mg/l	4500PF
PRIEST LAKE	PL-1 18M	8/12/2020	10:25:00	Total Nitrogen (TKN)	0.12	mg/l	351.2
PRIEST LAKE	PL-1 18M	8/12/2020	10:25:00	Temperature on receipt	20.2	degrees C	170.1
PRIEST LAKE	PL-1 18M	8/12/2020	10:25:00	Total Dissolved Solids	37	mg/l	2540C
PRIEST LAKE	PL-1 18M	8/12/2020	10:25:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-1 18M	8/12/2020	10:25:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI	8/12/2020	9:45:00	Total Nitrate + Nitrite	0.004	mg/l	300
PRIEST LAKE	PL-2 EPI	8/12/2020	9:45:00	Temperature on receipt	20.2	degrees C	170.1
PRIEST LAKE	PL-2 EPI	8/12/2020	9:45:00	Total Dissolved Solids	37	mg/l	2540C
PRIEST LAKE	PL-2 EPI	8/12/2020	9:45:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-2 EPI	8/12/2020	9:45:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 EPI	8/12/2020	9:45:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI	8/12/2020	9:45:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-2 HYPO	8/12/2020	9:25:00	Total Nitrate + Nitrite	0.005	mg/l	300
PRIEST LAKE	PL-2 HYPO	8/12/2020	9:25:00	Total Nitrogen (TKN)	0.14	mg/l	351.2
PRIEST LAKE	PL-2 HYPO	8/12/2020	9:25:00	Temperature on receipt	20.2	degrees C	170.1
PRIEST LAKE	PL-2 HYPO	8/12/2020	9:25:00	Total Dissolved Solids	43	mg/l	2540C
PRIEST LAKE	PL-2 HYPO	8/12/2020	9:25:00	Total Phosphorus	< 0.001	mg/l	4500PF

Project Name	Sample ID	Date Sampled	Time	Analyte Name	Results	Units	Method
PRIEST LAKE	PL-2 HYPO	8/12/2020	9:25:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO	8/12/2020	9:25:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-3	8/12/2020	11:00:00	Total Nitrate + Nitrite	0.005	mg/l	300
PRIEST LAKE	PL-3	8/12/2020	11:00:00	Total Nitrogen (TKN)	0.13	mg/l	351.2
PRIEST LAKE	PL-3	8/12/2020	11:00:00	Temperature on receipt	20.2	degrees C	170.1
PRIEST LAKE	PL-3	8/12/2020	11:00:00	Total Dissolved Solids	32	mg/l	2540C
PRIEST LAKE	PL-3	8/12/2020	11:00:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-3	8/12/2020	11:00:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-3	8/12/2020	11:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	OUT-1	8/12/2020	11:40:00	Total Nitrate + Nitrite	0.008	mg/l	300
PRIEST LAKE	OUT-1	8/12/2020	11:40:00	Total Nitrogen (TKN)	0.23	mg/l	351.2
PRIEST LAKE	OUT-1	8/12/2020	11:40:00	Temperature on receipt	20.2	degrees C	170.1
PRIEST LAKE	OUT-1	8/12/2020	11:40:00	Total Dissolved Solids	40	mg/l	2540C
PRIEST LAKE	OUT-1	8/12/2020	11:40:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	OUT-1	8/12/2020	11:40:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	OUT-1	8/12/2020	11:40:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PR-1	8/12/2020	8:00:00	Total Phosphorus	0.0014	mg/l	4500PF
PRIEST LAKE	PR-1	8/12/2020	8:00:00	Total Nitrate + Nitrite	0.004	mg/l	300
PRIEST LAKE	PR-1	8/12/2020	8:00:00	Total Nitrogen (TKN)	0.24	mg/l	351.2
PRIEST LAKE	PR-1	8/12/2020	8:00:00	Temperature on receipt	20.2	degrees C	170.1
PRIEST LAKE	PR-1	8/12/2020	8:00:00	Total Dissolved Solids	38	mg/l	2540C
PRIEST LAKE	PR-1	8/12/2020	8:00:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PR-1	8/12/2020	8:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO (DUP)	8/12/2020	9:25:00	Total Phosphorus	0.0034	mg/l	4500PF
PRIEST LAKE	PL-2 HYPO (DUP)	8/12/2020	9:25:00	Total Nitrate + Nitrite	0.005	mg/l	300
PRIEST LAKE	PL-2 HYPO (DUP)	8/12/2020	9:25:00	Temperature on receipt	20.2	degrees C	170.1
PRIEST LAKE	PL-2 HYPO (DUP)	8/12/2020	9:25:00	Total Dissolved Solids	39	mg/l	2540C
PRIEST LAKE	PL-2 HYPO (DUP)	8/12/2020	9:25:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO (DUP)	8/12/2020	9:25:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO (DUP)	8/12/2020	9:25:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	BLANK	8/12/2020		Total Dissolved Solids	1	mg/l	2540C
PRIEST LAKE	BLANK	8/12/2020		Temperature on receipt	20.2	degrees C	170.1
PRIEST LAKE	BLANK	8/12/2020		Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	BLANK	8/12/2020		Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	BLANK	8/12/2020		Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	BLANK	8/12/2020		Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	8/12/2020		Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-1 EPI	8/26/2020	10:15:00	Total Phosphorus	0.001	mg/l	4500PF
PRIEST LAKE	PL-1 EPI	8/26/2020	10:15:00	Temperature on receipt	3.3	degrees C	170.1
PRIEST LAKE	PL-1 EPI	8/26/2020	10:15:00	Total Dissolved Solids	29	mg/l	2540C
PRIEST LAKE	PL-1 EPI	8/26/2020	10:15:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-1 EPI	8/26/2020	10:15:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 EPI	8/26/2020	10:15:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-1 EPI	8/26/2020	10:15:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-1 18M	8/26/2020	10:00:00	Total Nitrate + Nitrite	0.002	mg/l	300
PRIEST LAKE	PL-1 18M	8/26/2020	10:00:00	Total Phosphorus	0.0024	mg/l	4500PF
PRIEST LAKE	PL-1 18M	8/26/2020	10:00:00	Total Nitrogen (TKN)	0.13	mg/l	351.2
PRIEST LAKE	PL-1 18M	8/26/2020	10:00:00	Temperature on receipt	3.3	degrees C	170.1
PRIEST LAKE	PL-1 18M	8/26/2020	10:00:00	Total Dissolved Solids	31	mg/l	2540C
PRIEST LAKE	PL-1 18M	8/26/2020	10:00:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E

Project Name	Sample ID	Date Sampled	Time	Analyte Name	Results	Units	Method
PRIEST LAKE	PL-1 18M	8/26/2020	10:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI	8/26/2020	9:50:00	Total Nitrogen (TKN)	0.11	mg/l	351.2
PRIEST LAKE	PL-2 EPI	8/26/2020	9:50:00	Temperature on receipt	3.3	degrees C	170.1
PRIEST LAKE	PL-2 EPI	8/26/2020	9:50:00	Total Dissolved Solids	33	mg/l	2540C
PRIEST LAKE	PL-2 EPI	8/26/2020	9:50:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 EPI	8/26/2020	9:50:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-2 EPI	8/26/2020	9:50:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 EPI	8/26/2020	9:50:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO	8/26/2020	9:15:00	Total Phosphorus	0.0011	mg/l	4500PF
PRIEST LAKE	PL-2 HYPO	8/26/2020	9:15:00	Temperature on receipt	3.3	degrees C	170.1
PRIEST LAKE	PL-2 HYPO	8/26/2020	9:15:00	Total Dissolved Solids	33	mg/l	2540C
PRIEST LAKE	PL-2 HYPO	8/26/2020	9:15:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 HYPO	8/26/2020	9:15:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO	8/26/2020	9:15:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO	8/26/2020	9:15:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-3	8/26/2020	11:00:00	Total Nitrate + Nitrite	0.004	mg/l	300
PRIEST LAKE	PL-3	8/26/2020	11:00:00	Ammonia Nitrogen	0.007	mg/l	350.1
PRIEST LAKE	PL-3	8/26/2020	11:00:00	Total Nitrogen (TKN)	0.28	mg/l	351.2
PRIEST LAKE	PL-3	8/26/2020	11:00:00	Temperature on receipt	3.3	degrees C	170.1
PRIEST LAKE	PL-3	8/26/2020	11:00:00	Total Dissolved Solids	41	mg/l	2540C
PRIEST LAKE	PL-3	8/26/2020	11:00:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-3	8/26/2020	11:00:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	OUT-1	8/26/2020	11:35:00	Total Nitrate + Nitrite	0.002	mg/l	300
PRIEST LAKE	OUT-1	8/26/2020	11:35:00	Total Phosphorus	0.0026	mg/l	4500PF
PRIEST LAKE	OUT-1	8/26/2020	11:35:00	Total Nitrogen (TKN)	0.29	mg/l	351.2
PRIEST LAKE	OUT-1	8/26/2020	11:35:00	Temperature on receipt	3.3	degrees C	170.1
PRIEST LAKE	OUT-1	8/26/2020	11:35:00	Total Dissolved Solids	25	mg/l	2540C
PRIEST LAKE	OUT-1	8/26/2020	11:35:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	OUT-1	8/26/2020	11:35:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PR-1	8/26/2020	8:15:00	Tot-Diss Phosphorus	0.001	mg/l	4500-P E
PRIEST LAKE	PR-1	8/26/2020	8:15:00	Total Phosphorus	0.0018	mg/l	4500PF
PRIEST LAKE	PR-1	8/26/2020	8:15:00	Total Nitrogen (TKN)	0.22	mg/l	351.2
PRIEST LAKE	PR-1	8/26/2020	8:15:00	Temperature on receipt	3.3	degrees C	170.1
PRIEST LAKE	PR-1	8/26/2020	8:15:00	Total Dissolved Solids	29	mg/l	2540C
PRIEST LAKE	PR-1	8/26/2020	8:15:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PR-1	8/26/2020	8:15:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	OUT-1 (DUP)	8/26/2020	11:35:00	Total Phosphorus	0.0017	mg/l	4500PF
PRIEST LAKE	OUT-1 (DUP)	8/26/2020	11:35:00	Total Nitrate + Nitrite	0.003	mg/l	300
PRIEST LAKE	OUT-1 (DUP)	8/26/2020	11:35:00	Total Nitrogen (TKN)	0.31	mg/l	351.2
PRIEST LAKE	OUT-1 (DUP)	8/26/2020	11:35:00	Temperature on receipt	3.3	degrees C	170.1
PRIEST LAKE	OUT-1 (DUP)	8/26/2020	11:35:00	Total Dissolved Solids	24	mg/l	2540C
PRIEST LAKE	OUT-1 (DUP)	8/26/2020	11:35:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	OUT-1 (DUP)	8/26/2020	11:35:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	8/26/2020		Temperature on receipt	3.3	degrees C	170.1
PRIEST LAKE	BLANK	8/26/2020		Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	BLANK	8/26/2020		Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	BLANK	8/26/2020		Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	BLANK	8/26/2020		Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	8/26/2020		Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	BLANK	8/26/2020		Total Dissolved Solids	< 1	mg/l	2540C

Project Name	Sample ID	Date Sampled	Time	Analyte Name	Results	Units	Method
PRIEST LAKE	PL-1 EPI	9/9/2020	11:15:00	Total Nitrogen (TKN)	0.12	mg/l	351.2
PRIEST LAKE	PL-1 EPI	9/9/2020	11:15:00	Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	PL-1 EPI	9/9/2020	11:15:00	Total Dissolved Solids	24	mg/l	2540C
PRIEST LAKE	PL-1 EPI	9/9/2020	11:15:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-1 EPI	9/9/2020	11:15:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-1 EPI	9/9/2020	11:15:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 EPI	9/9/2020	11:15:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-1 18M	9/9/2020	11:00:00	Tot-Diss Phosphorus	0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 18M	9/9/2020	11:00:00	Total Nitrate + Nitrite	0.022	mg/l	300
PRIEST LAKE	PL-1 18M	9/9/2020	11:00:00	Total Nitrogen (TKN)	0.32	mg/l	351.2
PRIEST LAKE	PL-1 18M	9/9/2020	11:00:00	Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	PL-1 18M	9/9/2020	11:00:00	Total Dissolved Solids	27	mg/l	2540C
PRIEST LAKE	PL-1 18M	9/9/2020	11:00:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-1 18M	9/9/2020	11:00:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 EPI	9/9/2020	10:08:00	Tot-Diss Phosphorus	0.0013	mg/l	4500-P E
PRIEST LAKE	PL-2 EPI	9/9/2020	10:08:00	Ammonia Nitrogen	0.006	mg/l	350.1
PRIEST LAKE	PL-2 EPI	9/9/2020	10:08:00	Total Nitrate + Nitrite	0.014	mg/l	300
PRIEST LAKE	PL-2 EPI	9/9/2020	10:08:00	Total Nitrogen (TKN)	0.19	mg/l	351.2
PRIEST LAKE	PL-2 EPI	9/9/2020	10:08:00	Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	PL-2 EPI	9/9/2020	10:08:00	Total Dissolved Solids	26	mg/l	2540C
PRIEST LAKE	PL-2 EPI	9/9/2020	10:08:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-2 HYPO	9/9/2020	10:00:00	Tot-Diss Phosphorus	0.0052	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO	9/9/2020	10:00:00	Ammonia Nitrogen	0.03	mg/l	350.1
PRIEST LAKE	PL-2 HYPO	9/9/2020	10:00:00	Total Nitrogen (TKN)	0.18	mg/l	351.2
PRIEST LAKE	PL-2 HYPO	9/9/2020	10:00:00	Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	PL-2 HYPO	9/9/2020	10:00:00	Total Dissolved Solids	26	mg/l	2540C
PRIEST LAKE	PL-2 HYPO	9/9/2020	10:00:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 HYPO	9/9/2020	10:00:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-3	9/9/2020	11:50:00	Total Nitrate + Nitrite	0.004	mg/l	300
PRIEST LAKE	PL-3	9/9/2020	11:50:00	Total Nitrogen (TKN)	0.1	mg/l	351.2
PRIEST LAKE	PL-3	9/9/2020	11:50:00	Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	PL-3	9/9/2020	11:50:00	Total Dissolved Solids	28	mg/l	2540C
PRIEST LAKE	PL-3	9/9/2020	11:50:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-3	9/9/2020	11:50:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-3	9/9/2020	11:50:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	OUT-1	9/9/2020	12:20:00	Total Nitrate + Nitrite	0.007	mg/l	300
PRIEST LAKE	OUT-1	9/9/2020	12:20:00	Total Nitrogen (TKN)	0.22	mg/l	351.2
PRIEST LAKE	OUT-1	9/9/2020	12:20:00	Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	OUT-1	9/9/2020	12:20:00	Total Dissolved Solids	24	mg/l	2540C
PRIEST LAKE	OUT-1	9/9/2020	12:20:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	OUT-1	9/9/2020	12:20:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	OUT-1	9/9/2020	12:20:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PR-1	9/10/2020	12:30:00	Tot-Diss Phosphorus	0.0016	mg/l	4500-P E
PRIEST LAKE	PR-1	9/10/2020	12:30:00	Total Nitrate + Nitrite	0.006	mg/l	300
PRIEST LAKE	PR-1	9/10/2020	12:30:00	Ammonia Nitrogen	0.008	mg/l	350.1
PRIEST LAKE	PR-1	9/10/2020	12:30:00	Total Nitrogen (TKN)	0.1	mg/l	351.2
PRIEST LAKE	PR-1	9/10/2020	12:30:00	Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	PR-1	9/10/2020	12:30:00	Total Dissolved Solids	22	mg/l	2540C
PRIEST LAKE	PR-1	9/10/2020	12:30:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PR-1 (DUP)	9/10/2020	12:30:00	Total Nitrate + Nitrite	0.003	mg/l	300

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PRIEST LAKE	PR-1 (DUP)	9/10/2020	12:30:00	Total Nitrogen (TKN)	0.19	mg/l	351.2
PRIEST LAKE	PR-1 (DUP)	9/10/2020	12:30:00	Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	PR-1 (DUP)	9/10/2020	12:30:00	Total Dissolved Solids	26	mg/l	2540C
PRIEST LAKE	PR-1 (DUP)	9/10/2020	12:30:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PR-1 (DUP)	9/10/2020	12:30:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PR-1 (DUP)	9/10/2020	12:30:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	9/9/2020		Total Nitrate + Nitrite	0.012	mg/l	300
PRIEST LAKE	BLANK	9/9/2020		Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	BLANK	9/9/2020		Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	BLANK	9/9/2020		Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	BLANK	9/9/2020		Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	9/9/2020		Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	BLANK	9/9/2020		Total Dissolved Solids	< 1	mg/l	2540C
PRIEST LAKE	YAK RIVER	9/10/2020	9:30:00	Total Phosphorus	0.0011	mg/l	4500PF
PRIEST LAKE	YAK RIVER	9/10/2020	9:30:00	Total Nitrate + Nitrite	0.002	mg/l	300
PRIEST LAKE	YAK RIVER	9/10/2020	9:30:00	Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	YAK RIVER	9/10/2020	9:30:00	Total Dissolved Solids	84	mg/l	2540C
PRIEST LAKE	YAK RIVER	9/10/2020	9:30:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	YAK RIVER	9/10/2020	9:30:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	YAK RIVER	9/10/2020	9:30:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	BINARCH CREEK	9/10/2020	11:00:00	Total Phosphorus	0.0026	mg/l	4500PF
PRIEST LAKE	BINARCH CREEK	9/10/2020	11:00:00	Ammonia Nitrogen	0.006	mg/l	350.1
PRIEST LAKE	BINARCH CREEK	9/10/2020	11:00:00	Total Nitrogen (TKN)	0.16	mg/l	351.2
PRIEST LAKE	BINARCH CREEK	9/10/2020	11:00:00	Temperature on receipt	11	degrees C	170.1
PRIEST LAKE	BINARCH CREEK	9/10/2020	11:00:00	Total Dissolved Solids	20	mg/l	2540C
PRIEST LAKE	BINARCH CREEK	9/10/2020	11:00:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	BINARCH CREEK	9/10/2020	11:00:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 EPI	9/22/2020	10:55:00	Ammonia Nitrogen	0.006	mg/l	350.1
PRIEST LAKE	PL-1 EPI	9/22/2020	10:55:00	Total Nitrate + Nitrite	0.006	mg/l	300
PRIEST LAKE	PL-1 EPI	9/22/2020	10:55:00	Total Nitrogen (TKN)	0.15	mg/l	351.2
PRIEST LAKE	PL-1 EPI	9/22/2020	10:55:00	Temperature on receipt	2.2	degrees C	170.1
PRIEST LAKE	PL-1 EPI	9/22/2020	10:55:00	Total Dissolved Solids	28	mg/l	2540C
PRIEST LAKE	PL-1 EPI	9/22/2020	10:55:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-1 EPI	9/22/2020	10:55:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 18M	9/22/2020	10:30:00	Total Phosphorus	0.0012	mg/l	4500PF
PRIEST LAKE	PL-1 18M	9/22/2020	10:30:00	Total Nitrate + Nitrite	0.004	mg/l	300
PRIEST LAKE	PL-1 18M	9/22/2020	10:30:00	Ammonia Nitrogen	0.007	mg/l	350.1
PRIEST LAKE	PL-1 18M	9/22/2020	10:30:00	Temperature on receipt	2.2	degrees C	170.1
PRIEST LAKE	PL-1 18M	9/22/2020	10:30:00	Total Dissolved Solids	22	mg/l	2540C
PRIEST LAKE	PL-1 18M	9/22/2020	10:30:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-1 18M	9/22/2020	10:30:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-2 EPI	9/22/2020	9:50:00	Total Nitrogen (TKN)	0.11	mg/l	351.2
PRIEST LAKE	PL-2 EPI	9/22/2020	9:50:00	Temperature on receipt	2.2	degrees C	170.1
PRIEST LAKE	PL-2 EPI	9/22/2020	9:50:00	Total Dissolved Solids	20	mg/l	2540C
PRIEST LAKE	PL-2 EPI	9/22/2020	9:50:00	Total Nitrate + Nitrite	< 0.001	mg/l	300
PRIEST LAKE	PL-2 EPI	9/22/2020	9:50:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-2 EPI	9/22/2020	9:50:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 EPI	9/22/2020	9:50:00	Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	PL-2 HYPO	9/22/2020	9:35:00	Total Nitrate + Nitrite	0.003	mg/l	300
PRIEST LAKE	PL-2 HYPO	9/22/2020	9:35:00	Ammonia Nitrogen	0.007	mg/l	350.1

Project Name	Sample ID	Date Sampled	Time	Analyte Name	Results	Units	Method
PRIEST LAKE	PL-2 HYPO	9/22/2020	9:35:00	Temperature on receipt	2.2	degrees C	170.1
PRIEST LAKE	PL-2 HYPO	9/22/2020	9:35:00	Total Dissolved Solids	23	mg/l	2540C
PRIEST LAKE	PL-2 HYPO	9/22/2020	9:35:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-2 HYPO	9/22/2020	9:35:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 HYPO	9/22/2020	9:35:00	Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	PL-3	9/22/2020	11:20:00	Total Nitrate + Nitrite	0.006	mg/l	300
PRIEST LAKE	PL-3	9/22/2020	11:20:00	Ammonia Nitrogen	0.011	mg/l	350.1
PRIEST LAKE	PL-3	9/22/2020	11:20:00	Total Nitrogen (TKN)	0.13	mg/l	351.2
PRIEST LAKE	PL-3	9/22/2020	11:20:00	Temperature on receipt	2.2	degrees C	170.1
PRIEST LAKE	PL-3	9/22/2020	11:20:00	Total Dissolved Solids	25	mg/l	2540C
PRIEST LAKE	PL-3	9/22/2020	11:20:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-3	9/22/2020	11:20:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	OUT-1	9/22/2020	12:05:00	Total Nitrate + Nitrite	0.006	mg/l	300
PRIEST LAKE	OUT-1	9/22/2020	12:05:00	Ammonia Nitrogen	0.007	mg/l	350.1
PRIEST LAKE	OUT-1	9/22/2020	12:05:00	Total Nitrogen (TKN)	0.14	mg/l	351.2
PRIEST LAKE	OUT-1	9/22/2020	12:05:00	Temperature on receipt	2.2	degrees C	170.1
PRIEST LAKE	OUT-1	9/22/2020	12:05:00	Total Dissolved Solids	20	mg/l	2540C
PRIEST LAKE	OUT-1	9/22/2020	12:05:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	OUT-1	9/22/2020	12:05:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PR-1	9/22/2020	13:30:00	Total Nitrate + Nitrite	0.007	mg/l	300
PRIEST LAKE	PR-1	9/22/2020	13:30:00	Ammonia Nitrogen	0.012	mg/l	350.1
PRIEST LAKE	PR-1	9/22/2020	13:30:00	Total Nitrogen (TKN)	0.14	mg/l	351.2
PRIEST LAKE	PR-1	9/22/2020	13:30:00	Temperature on receipt	2.2	degrees C	170.1
PRIEST LAKE	PR-1	9/22/2020	13:30:00	Total Dissolved Solids	21	mg/l	2540C
PRIEST LAKE	PR-1	9/22/2020	13:30:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PR-1	9/22/2020	13:30:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	PL-2 EPI DUP	9/22/2020	9:50:00	Total Nitrate + Nitrite	0.003	mg/l	300
PRIEST LAKE	PL-2 EPI DUP	9/22/2020	9:50:00	Ammonia Nitrogen	0.009	mg/l	350.1
PRIEST LAKE	PL-2 EPI DUP	9/22/2020	9:50:00	Total Nitrogen (TKN)	0.21	mg/l	351.2
PRIEST LAKE	PL-2 EPI DUP	9/22/2020	9:50:00	Temperature on receipt	2.2	degrees C	170.1
PRIEST LAKE	PL-2 EPI DUP	9/22/2020	9:50:00	Total Dissolved Solids	42	mg/l	2540C
PRIEST LAKE	PL-2 EPI DUP	9/22/2020	9:50:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	PL-2 EPI DUP	9/22/2020	9:50:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	BLANK	9/22/2020		Total Nitrate + Nitrite	0.011	mg/l	300
PRIEST LAKE	BLANK	9/22/2020		Temperature on receipt	2.2	degrees C	170.1
PRIEST LAKE	BLANK	9/22/2020		Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	BLANK	9/22/2020		Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E
PRIEST LAKE	BLANK	9/22/2020		Ammonia Nitrogen	< 0.005	mg/l	350.1
PRIEST LAKE	BLANK	9/22/2020		Total Nitrogen (TKN)	< 0.1	mg/l	351.2
PRIEST LAKE	BLANK	9/22/2020		Total Dissolved Solids	< 1	mg/l	2540C
PRIEST LAKE	BINARCH CREEK	9/22/2020	12:45:00	Total Nitrate + Nitrite	0.006	mg/l	300
PRIEST LAKE	BINARCH CREEK	9/22/2020	12:45:00	Ammonia Nitrogen	0.008	mg/l	350.1
PRIEST LAKE	BINARCH CREEK	9/22/2020	12:45:00	Temperature on receipt	2.2	degrees C	170.1
PRIEST LAKE	BINARCH CREEK	9/22/2020	12:45:00	Total Dissolved Solids	36	mg/l	2540C
PRIEST LAKE	BINARCH CREEK	9/22/2020	12:45:00	Total Phosphorus	< 0.001	mg/l	4500PF
PRIEST LAKE	BINARCH CREEK	9/22/2020	12:45:00	Tot-Diss Phosphorus	< 0.001	mg/l	4500-P E

Appendix B- Zooplankton Data

		Density (#/L)											Biomass (ug/L)	
Station	**Date**	**Bosmina**	**Calanoid**	**Chydorid**	**Cyclopoid**	**Daphnia**	**Diaphanosoma**	**Epishura**	**Holopedium**	**Leptadora**	**Macrothrix**	**Nauplii**	**Bosmina**	**Daphnia**
PL-1E	6/3/2020	0.15	15.18		5.86	0.10		0.05				14.82	1.90	11.12
PL-1E	6/17/2020	0.30	5.54		1.99	0.32		0.02				7.16	1.88	33.98
PL-1E	7/1/2020	0.11	3.15		3.06	0.13						14.82	1.45	31.79
PL-1E	7/13/2020	2.39	15.58		6.57	0.81		0.10				20.42	1.62	31.98
PL-1E	7/29/2020	0.59	2.55		5.76	1.86						2.67	1.36	23.76
PL-1E	8/12/2020	0.10	3.09		8.05	3.97			0.03			1.83	1.34	27.61
PL-1E	8/26/2020	0.19	4.36		2.26	0.85						0.48	1.03	35.43
PL-1E	9/9/2020	0.13	1.20		1.85	2.18			0.01			1.51	1.00	26.56
PL-1E	9/22/2020	0.19	0.59		2.22	3.09	0.05		0.02			0.75	1.19	41.79
PL-1H	6/3/2020		8.15		5.20	0.07						20.01	0.00	24.91
PL-1H	6/17/2020	0.03	4.01		2.38	0.10		0.03				24.75	1.26	30.03
PL-1H	7/1/2020	0.04	6.80		0.90	0.04						5.61	2.52	22.40
PL-1H	7/13/2020	0.27	4.24		4.28	0.42						6.19	1.58	32.15
PL-1H	7/29/2020	0.07	3.55		1.46	0.20						1.80	1.69	21.48
PL-1H	8/12/2020	0.06	2.76		2.31	1.57						1.59	0.62	22.31
PL-1H	8/26/2020	0.03	0.78		2.04	1.02						1.17	1.35	42.16
PL-1H	9/9/2020	0.05	2.63		1.91	0.66						1.15	1.11	25.77
PL-1H	9/22/2020	0.13	0.73		1.74	1.44						0.73	0.90	32.14
PL-2E	6/3/2020	0.08	18.03		3.67	0.15						22.08	2.45	9.13
PL-2E	6/17/2020	0.27	11.38		4.16	0.65		0.08				15.13	0.09	0.81
PL-2E	7/1/2020	0.19	3.38		3.40	0.11						21.24	1.40	305.08
PL-2E	7/13/2020	1.18	10.77		5.12	0.69						13.18	1.67	30.53
PL-2E	7/29/2020	0.56	3.31		5.30	2.04						2.67	1.24	22.18
PL-2E	8/12/2020	0.10	3.57		5.33	3.87			0.17			2.11	1.23	20.92
PL-2E	8/26/2020	0.20	3.87		2.47	1.35	0.03					0.66	0.71	49.98
PL-2E	9/9/2020	0.13	0.80		1.39	1.32	0.03					0.46	1.23	135.38
PL-2E	9/22/2020	0.15	0.70		2.28	1.20						1.20	1.12	34.23
PL-2H	6/3/2020		6.26		1.41							21.72	0.00	0.00
PL-2H	6/17/2020		2.55		0.65							12.50	0.00	0.00
PL-2H	7/1/2020		3.74		0.26	0.02						2.74	0.00	32.14
PL-2H	7/13/2020	0.01	3.96	0.01	0.56	0.03						2.57	0.51	23.88
PL-2H	7/29/2020	0.06	4.30		0.58	0.10						1.14	2.07	30.92
PL-2H	8/12/2020	0.01	2.65		0.54	0.28							0.85	35.02
PL-2H	8/26/2020		2.72		1.59	0.34						0.38	0.00	44.00
PL-2H	9/9/2020	0.00	0.11		0.02	0.00						0.02	1.67	39.99
PL-2H	9/22/2020	0.03	2.02		1.16	0.32						0.50	1.45	49.77
PL-3	6/3/2020	0.15	10.24		1.81	0.13		0.03				6.34	1.46	14.92
PL-3	6/17/2020	0.13	4.58		0.84	0.13		0.06				3.15	2.59	8.97
PL-3	7/1/2020	1.38	4.84		7.13	0.41						17.57	1.60	23.82
PL-3	7/13/2020	0.56	2.01		1.35	0.23						29.79	1.70	33.70

		Density (#/L)											Biomass (ug/L)	
Station	**Date**	**Bosmina**	**Calanoid**	**Chydorid**	**Cyclopoid**	**Daphnia**	**Diaphanosoma**	**Epishura**	**Holopedium**	**Leptadora**	**Macrothrix**	**Nauplii**	**Bosmina**	**Daphnia**
PL-3	7/29/2020	0.50	1.80		1.57	1.03			0.02	0.02		1.28	1.24	28.92
PL-3	8/12/2020	0.56	5.50		6.16	6.11			0.51			1.17	0.95	21.18
PL-3	8/26/2020	0.70	0.69		1.09	0.73						1.12	1.14	24.21
PL-3	9/9/2020	0.27	0.22		0.46	0.98						0.83	1.11	25.58
PL-3	9/22/2020	0.05	0.14		0.19	0.09					0.00	0.31	1.24	21.65

Appendix C- Periphyton Data

Sample_Station_Name	Sample_Date_Collected	Heading	Group	Metric	Value
Priest River	7/23/2020	Community Structure	Distribution	Cosmopolitan Taxa Percent	75.37%
Priest River	7/23/2020	Community Structure	Distribution	Native Taxa Percent	0.00%
Priest River	7/23/2020	Community Structure	Diversity	Shannon H (log2)	2.43
Priest River	7/23/2020	Community Structure	Diversity	Species Richness	45
Priest River	7/23/2020	Community Structure	Dominance	Dominant Taxon Percent	67.22%
Priest River	7/23/2020	Community Structure	Rare Taxa	Mountains Rare Taxa Percent	0.00%
Priest River	7/23/2020	Community Structure	Rare Taxa	Plains Rare Taxa Percent	0.00%
Priest River	7/23/2020	Inorgainc Nutrients	Rhopalodiales	Rhopalodiales Percent	0.00%
Priest River	7/23/2020	Inorganic Nutrients	Autotrophism	Nitrogen Autotroph Taxa Percent	84.69%
Priest River	7/23/2020	Inorganic Nutrients	Trophic State	Eutraphentic Taxa Percent	0.83%
Priest River	7/23/2020	Metals	Abnormality	Abnormal Cells Percent	0.00%
Priest River	7/23/2020	Metals	Acid Tolerance	Acidophilous Taxa Percent	3.83%
Priest River	7/23/2020	Metals	Disturbance	Disturbance Taxa Percent	67.22%
Priest River	7/23/2020	Metals	Metals Tolerance	Metals Tolerant Taxa Percent	1.83%
Priest River	7/23/2020	Organic Nutrients	Heterotrophism	Nitrogen Heterotroph Taxa Percent	0.17%
Priest River	7/23/2020	Organic Nutrients	Oxidation	Low DO Taxa Percent	0.17%
Priest River	7/23/2020	Organic Nutrients	Pollution	Pollution Index	2.90
Priest River	7/23/2020	Organic Nutrients	Saprobity	Polysaprobous Taxa Percent	1.00%
Priest River	7/23/2020	Sediment	Brackishness	Mountains Brackish Taxa Percent	85.02%
Priest River	7/23/2020	Sediment	Brackishness	Plains Brackish Taxa Percent	5.66%
Priest River	7/23/2020	Sediment	Motility	Motile Taxa Percent	6.49%
Priest River	7/23/2020	Sediment	Siltation	Siltation Taxa Percent	5.66%
Binarch Creek	7/23/2020	Community Structure	Distribution	Cosmopolitan Taxa Percent	72.85%
Binarch Creek	7/23/2020	Community Structure	Distribution	Native Taxa Percent	0.83%
Binarch Creek	7/23/2020	Community Structure	Diversity	Shannon H (log2)	3.84
Binarch Creek	7/23/2020	Community Structure	Diversity	Species Richness	45
Binarch Creek	7/23/2020	Community Structure	Dominance	Dominant Taxon Percent	26.16%
Binarch Creek	7/23/2020	Community Structure	Rare Taxa	Mountains Rare Taxa Percent	0.00%
Binarch Creek	7/23/2020	Community Structure	Rare Taxa	Plains Rare Taxa Percent	0.33%
Binarch Creek	7/23/2020	Inorgainc Nutrients	Rhopalodiales	Rhopalodiales Percent	0.00%
Binarch Creek	7/23/2020	Inorganic Nutrients	Autotrophism	Nitrogen Autotroph Taxa Percent	83.28%
Binarch Creek	7/23/2020	Inorganic Nutrients	Trophic State	Eutraphentic Taxa Percent	62.75%
Binarch Creek	7/23/2020	Metals	Abnormality	Abnormal Cells Percent	0.00%
Binarch Creek	7/23/2020	Metals	Acid Tolerance	Acidophilous Taxa Percent	1.49%
Binarch Creek	7/23/2020	Metals	Disturbance	Disturbance Taxa Percent	3.81%
Binarch Creek	7/23/2020	Metals	Metals Tolerance	Metals Tolerant Taxa Percent	28.15%
Binarch Creek	7/23/2020	Organic Nutrients	Heterotrophism	Nitrogen Heterotroph Taxa Percent	1.66%
Binarch Creek	7/23/2020	Organic Nutrients	Oxidation	Low DO Taxa Percent	1.66%
Binarch Creek	7/23/2020	Organic Nutrients	Pollution	Pollution Index	2.53
Binarch Creek	7/23/2020	Organic Nutrients	Saprobity	Polysaprobous Taxa Percent	30.96%
Binarch Creek	7/23/2020	Sediment	Brackishness	Mountains Brackish Taxa Percent	87.25%
Binarch Creek	7/23/2020	Sediment	Brackishness	Plains Brackish Taxa Percent	6.62%
Binarch Creek	7/23/2020	Sediment	Motility	Motile Taxa Percent	19.70%
Binarch Creek	7/23/2020	Sediment	Siltation	Siltation Taxa Percent	11.42%
Yak River	7/23/2020	Community Structure	Distribution	Cosmopolitan Taxa Percent	46.03%
Yak River	7/23/2020	Community Structure	Distribution	Native Taxa Percent	0.00%
Yak River	7/23/2020	Community Structure	Diversity	Shannon H (log2)	3.04
Yak River	7/23/2020	Community Structure	Diversity	Species Richness	36
Yak River	7/23/2020	Community Structure	Dominance	Dominant Taxon Percent	38.58%
Yak River	7/23/2020	Community Structure	Rare Taxa	Mountains Rare Taxa Percent	0.00%
Yak River	7/23/2020	Community Structure	Rare Taxa	Plains Rare Taxa Percent	0.00%
Yak River	7/23/2020	Inorgainc Nutrients	Rhopalodiales	Rhopalodiales Percent	0.00%
Yak River	7/23/2020	Inorganic Nutrients	Autotrophism	Nitrogen Autotroph Taxa Percent	54.30%
Yak River	7/23/2020	Inorganic Nutrients	Trophic State	Eutraphentic Taxa Percent	1.99%
Yak River	7/23/2020	Metals	Abnormality	Abnormal Cells Percent	0.00%
Yak River	7/23/2020	Metals	Acid Tolerance	Acidophilous Taxa Percent	0.17%
Yak River	7/23/2020	Metals	Disturbance	Disturbance Taxa Percent	39.40%
Yak River	7/23/2020	Metals	Metals Tolerance	Metals Tolerant Taxa Percent	12.09%
Yak River	7/23/2020	Organic Nutrients	Heterotrophism	Nitrogen Heterotroph Taxa Percent	0.00%
Yak River	7/23/2020	Organic Nutrients	Oxidation	Low DO Taxa Percent	0.00%
Yak River	7/23/2020	Organic Nutrients	Pollution	Pollution Index	2.78
Yak River	7/23/2020	Organic Nutrients	Saprobity	Polysaprobous Taxa Percent	5.30%
Yak River	7/23/2020	Sediment	Brackishness	Mountains Brackish Taxa Percent	53.97%
Yak River	7/23/2020	Sediment	Brackishness	Plains Brackish Taxa Percent	0.17%
Yak River	7/23/2020	Sediment	Motility	Motile Taxa Percent	2.65%
Yak River	7/23/2020	Sediment	Siltation	Siltation Taxa Percent	2.81%
Priest River	8/27/2020	Community Structure	Distribution	Cosmopolitan Taxa Percent	81.09%

Sample_Station_Name	Sample_Date_Collected	Heading	Group	Metric	Value
Priest River	8/27/2020	Community Structure	Distribution	Native Taxa Percent	0.00%
Priest River	8/27/2020	Community Structure	Diversity	Shannon H (log2)	1.97
Priest River	8/27/2020	Community Structure	Diversity	Species Richness	32
Priest River	8/27/2020	Community Structure	Dominance	Dominant Taxon Percent	68.99%
Priest River	8/27/2020	Community Structure	Rare Taxa	Mountains Rare Taxa Percent	0.00%
Priest River	8/27/2020	Community Structure	Rare Taxa	Plains Rare Taxa Percent	0.00%
Priest River	8/27/2020	Inorgainc Nutrients	Rhopalodiales	Rhopalodiales Percent	0.00%
Priest River	8/27/2020	Inorganic Nutrients	Autotrophism	Nitrogen Autotroph Taxa Percent	95.02%
Priest River	8/27/2020	Inorganic Nutrients	Trophic State	Eutraphentic Taxa Percent	1.00%
Priest River	8/27/2020	Metals	Abnormality	Abnormal Cells Percent	0.00%
Priest River	8/27/2020	Metals	Acid Tolerance	Acidophilous Taxa Percent	12.44%
Priest River	8/27/2020	Metals	Disturbance	Disturbance Taxa Percent	68.99%
Priest River	8/27/2020	Metals	Metals Tolerance	Metals Tolerant Taxa Percent	2.65%
Priest River	8/27/2020	Organic Nutrients	Heterotrophism	Nitrogen Heterotroph Taxa Percent	0.33%
Priest River	8/27/2020	Organic Nutrients	Oxidation	Low DO Taxa Percent	0.33%
Priest River	8/27/2020	Organic Nutrients	Pollution	Pollution Index	2.94
Priest River	8/27/2020	Organic Nutrients	Saprobity	Polysaprobous Taxa Percent	1.49%
Priest River	8/27/2020	Sediment	Brackishness	Mountains Brackish Taxa Percent	95.02%
Priest River	8/27/2020	Sediment	Brackishness	Plains Brackish Taxa Percent	12.77%
Priest River	8/27/2020	Sediment	Motility	Motile Taxa Percent	6.63%
Priest River	8/27/2020	Sediment	Siltation	Siltation Taxa Percent	6.80%
Binarch Creek	8/27/2020	Community Structure	Distribution	Cosmopolitan Taxa Percent	71.14%
Binarch Creek	8/27/2020	Community Structure	Distribution	Native Taxa Percent	1.16%
Binarch Creek	8/27/2020	Community Structure	Diversity	Shannon H (log2)	4.30
Binarch Creek	8/27/2020	Community Structure	Diversity	Species Richness	55
Binarch Creek	8/27/2020	Community Structure	Dominance	Dominant Taxon Percent	21.39%
Binarch Creek	8/27/2020	Community Structure	Rare Taxa	Mountains Rare Taxa Percent	0.00%
Binarch Creek	8/27/2020	Community Structure	Rare Taxa	Plains Rare Taxa Percent	1.00%
Binarch Creek	8/27/2020	Inorgainc Nutrients	Rhopalodiales	Rhopalodiales Percent	0.17%
Binarch Creek	8/27/2020	Inorganic Nutrients	Autotrophism	Nitrogen Autotroph Taxa Percent	80.10%
Binarch Creek	8/27/2020	Inorganic Nutrients	Trophic State	Eutraphentic Taxa Percent	44.61%
Binarch Creek	8/27/2020	Metals	Abnormality	Abnormal Cells Percent	0.00%
Binarch Creek	8/27/2020	Metals	Acid Tolerance	Acidophilous Taxa Percent	3.65%
Binarch Creek	8/27/2020	Metals	Disturbance	Disturbance Taxa Percent	9.29%
Binarch Creek	8/27/2020	Metals	Metals Tolerance	Metals Tolerant Taxa Percent	23.05%
Binarch Creek	8/27/2020	Organic Nutrients	Heterotrophism	Nitrogen Heterotroph Taxa Percent	0.83%
Binarch Creek	8/27/2020	Organic Nutrients	Oxidation	Low DO Taxa Percent	0.66%
Binarch Creek	8/27/2020	Organic Nutrients	Pollution	Pollution Index	2.60
Binarch Creek	8/27/2020	Organic Nutrients	Saprobity	Polysaprobous Taxa Percent	25.04%
Binarch Creek	8/27/2020	Sediment	Brackishness	Mountains Brackish Taxa Percent	84.41%
Binarch Creek	8/27/2020	Sediment	Brackishness	Plains Brackish Taxa Percent	4.15%
Binarch Creek	8/27/2020	Sediment	Motility	Motile Taxa Percent	29.02%
Binarch Creek	8/27/2020	Sediment	Siltation	Siltation Taxa Percent	25.21%
Yak River	8/27/2020	Community Structure	Distribution	Cosmopolitan Taxa Percent	70.72%
Yak River	8/27/2020	Community Structure	Distribution	Native Taxa Percent	0.00%
Yak River	8/27/2020	Community Structure	Diversity	Shannon H (log2)	2.36
Yak River	8/27/2020	Community Structure	Diversity	Species Richness	43
Yak River	8/27/2020	Community Structure	Dominance	Dominant Taxon Percent	66.39%
Yak River	8/27/2020	Community Structure	Rare Taxa	Mountains Rare Taxa Percent	0.00%
Yak River	8/27/2020	Community Structure	Rare Taxa	Plains Rare Taxa Percent	0.00%
Yak River	8/27/2020	Inorgainc Nutrients	Rhopalodiales	Rhopalodiales Percent	0.67%
Yak River	8/27/2020	Inorganic Nutrients	Autotrophism	Nitrogen Autotroph Taxa Percent	80.03%
Yak River	8/27/2020	Inorganic Nutrients	Trophic State	Eutraphentic Taxa Percent	1.50%
Yak River	8/27/2020	Metals	Abnormality	Abnormal Cells Percent	0.00%
Yak River	8/27/2020	Metals	Acid Tolerance	Acidophilous Taxa Percent	0.17%
Yak River	8/27/2020	Metals	Disturbance	Disturbance Taxa Percent	67.22%
Yak River	8/27/2020	Metals	Metals Tolerance	Metals Tolerant Taxa Percent	2.83%
Yak River	8/27/2020	Organic Nutrients	Heterotrophism	Nitrogen Heterotroph Taxa Percent	0.17%
Yak River	8/27/2020	Organic Nutrients	Oxidation	Low DO Taxa Percent	0.17%
Yak River	8/27/2020	Organic Nutrients	Pollution	Pollution Index	2.88
Yak River	8/27/2020	Organic Nutrients	Saprobity	Polysaprobous Taxa Percent	1.16%
Yak River	8/27/2020	Sediment	Brackishness	Mountains Brackish Taxa Percent	81.70%
Yak River	8/27/2020	Sediment	Brackishness	Plains Brackish Taxa Percent	1.00%
Yak River	8/27/2020	Sediment	Motility	Motile Taxa Percent	7.65%
Yak River	8/27/2020	Sediment	Siltation	Siltation Taxa Percent	6.32%
Priest River	9/22/2020	Community Structure	Distribution	Cosmopolitan Taxa Percent	60.33%
Priest River	9/22/2020	Community Structure	Distribution	Native Taxa Percent	0.50%

Sample_Station_Name	Sample_Date_Collected	Heading	Group	Metric	Value
Priest River	9/22/2020	Community Structure	Diversity	Shannon H (log2)	3.28
Priest River	9/22/2020	Community Structure	Diversity	Species Richness	47
Priest River	9/22/2020	Community Structure	Dominance	Dominant Taxon Percent	47.83%
Priest River	9/22/2020	Community Structure	Rare Taxa	Mountains Rare Taxa Percent	0.00%
Priest River	9/22/2020	Community Structure	Rare Taxa	Plains Rare Taxa Percent	0.50%
Priest River	9/22/2020	Inorgainc Nutrients	Rhopalodiales	Rhopalodiales Percent	0.67%
Priest River	9/22/2020	Inorganic Nutrients	Autotrophism	Nitrogen Autotroph Taxa Percent	72.00%
Priest River	9/22/2020	Inorganic Nutrients	Trophic State	Eutraphentic Taxa Percent	1.67%
Priest River	9/22/2020	Metals	Abnormality	Abnormal Cells Percent	0.00%
Priest River	9/22/2020	Metals	Acid Tolerance	Acidophilous Taxa Percent	11.67%
Priest River	9/22/2020	Metals	Disturbance	Disturbance Taxa Percent	47.83%
Priest River	9/22/2020	Metals	Metals Tolerance	Metals Tolerant Taxa Percent	2.83%
Priest River	9/22/2020	Organic Nutrients	Heterotrophism	Nitrogen Heterotroph Taxa Percent	0.17%
Priest River	9/22/2020	Organic Nutrients	Oxidation	Low DO Taxa Percent	0.17%
Priest River	9/22/2020	Organic Nutrients	Pollution	Pollution Index	2.86
Priest River	9/22/2020	Organic Nutrients	Saprobity	Polysaprobous Taxa Percent	1.00%
Priest River	9/22/2020	Sediment	Brackishness	Mountains Brackish Taxa Percent	75.50%
Priest River	9/22/2020	Sediment	Brackishness	Plains Brackish Taxa Percent	13.17%
Priest River	9/22/2020	Sediment	Motility	Motile Taxa Percent	11.00%
Priest River	9/22/2020	Sediment	Siltation	Siltation Taxa Percent	10.17%
Binarch Creek	9/22/2020	Community Structure	Distribution	Cosmopolitan Taxa Percent	75.04%
Binarch Creek	9/22/2020	Community Structure	Distribution	Native Taxa Percent	1.33%
Binarch Creek	9/22/2020	Community Structure	Diversity	Shannon H (log2)	3.72
Binarch Creek	9/22/2020	Community Structure	Diversity	Species Richness	54
Binarch Creek	9/22/2020	Community Structure	Dominance	Dominant Taxon Percent	37.77%
Binarch Creek	9/22/2020	Community Structure	Rare Taxa	Mountains Rare Taxa Percent	0.00%
Binarch Creek	9/22/2020	Community Structure	Rare Taxa	Plains Rare Taxa Percent	1.00%
Binarch Creek	9/22/2020	Inorgainc Nutrients	Rhopalodiales	Rhopalodiales Percent	0.00%
Binarch Creek	9/22/2020	Inorganic Nutrients	Autotrophism	Nitrogen Autotroph Taxa Percent	83.69%
Binarch Creek	9/22/2020	Inorganic Nutrients	Trophic State	Eutraphentic Taxa Percent	60.57%
Binarch Creek	9/22/2020	Metals	Abnormality	Abnormal Cells Percent	0.00%
Binarch Creek	9/22/2020	Metals	Acid Tolerance	Acidophilous Taxa Percent	5.16%
Binarch Creek	9/22/2020	Metals	Disturbance	Disturbance Taxa Percent	7.82%
Binarch Creek	9/22/2020	Metals	Metals Tolerance	Metals Tolerant Taxa Percent	38.77%
Binarch Creek	9/22/2020	Organic Nutrients	Heterotrophism	Nitrogen Heterotroph Taxa Percent	0.33%
Binarch Creek	9/22/2020	Organic Nutrients	Oxidation	Low DO Taxa Percent	0.00%
Binarch Creek	9/22/2020	Organic Nutrients	Pollution	Pollution Index	2.42
Binarch Creek	9/22/2020	Organic Nutrients	Saprobity	Polysaprobous Taxa Percent	40.27%
Binarch Creek	9/22/2020	Sediment	Brackishness	Mountains Brackish Taxa Percent	88.69%
Binarch Creek	9/22/2020	Sediment	Brackishness	Plains Brackish Taxa Percent	7.49%
Binarch Creek	9/22/2020	Sediment	Motility	Motile Taxa Percent	18.80%
Binarch Creek	9/22/2020	Sediment	Siltation	Siltation Taxa Percent	12.98%
Yak River	9/29/2020	Community Structure	Distribution	Cosmopolitan Taxa Percent	77.02%
Yak River	9/29/2020	Community Structure	Distribution	Native Taxa Percent	0.00%
Yak River	9/29/2020	Community Structure	Diversity	Shannon H (log2)	2.44
Yak River	9/29/2020	Community Structure	Diversity	Species Richness	40
Yak River	9/29/2020	Community Structure	Dominance	Dominant Taxon Percent	66.45%
Yak River	9/29/2020	Community Structure	Rare Taxa	Mountains Rare Taxa Percent	0.00%
Yak River	9/29/2020	Community Structure	Rare Taxa	Plains Rare Taxa Percent	0.00%
Yak River	9/29/2020	Inorgainc Nutrients	Rhopalodiales	Rhopalodiales Percent	1.98%
Yak River	9/29/2020	Inorganic Nutrients	Autotrophism	Nitrogen Autotroph Taxa Percent	82.81%
Yak River	9/29/2020	Inorganic Nutrients	Trophic State	Eutraphentic Taxa Percent	3.97%
Yak River	9/29/2020	Metals	Abnormality	Abnormal Cells Percent	0.00%
Yak River	9/29/2020	Metals	Acid Tolerance	Acidophilous Taxa Percent	0.00%
Yak River	9/29/2020	Metals	Disturbance	Disturbance Taxa Percent	67.27%
Yak River	9/29/2020	Metals	Metals Tolerance	Metals Tolerant Taxa Percent	3.64%
Yak River	9/29/2020	Organic Nutrients	Heterotrophism	Nitrogen Heterotroph Taxa Percent	0.00%
Yak River	9/29/2020	Organic Nutrients	Oxidation	Low DO Taxa Percent	0.00%
Yak River	9/29/2020	Organic Nutrients	Pollution	Pollution Index	2.85
Yak River	9/29/2020	Organic Nutrients	Saprobity	Polysaprobous Taxa Percent	3.80%
Yak River	9/29/2020	Sediment	Brackishness	Mountains Brackish Taxa Percent	83.31%
Yak River	9/29/2020	Sediment	Brackishness	Plains Brackish Taxa Percent	0.33%
Yak River	9/29/2020	Sediment	Motility	Motile Taxa Percent	8.76%
Yak River	9/29/2020	Sediment	Siltation	Siltation Taxa Percent	6.12%

Appendix D- Macroinvertebrate Data

Metrics Report

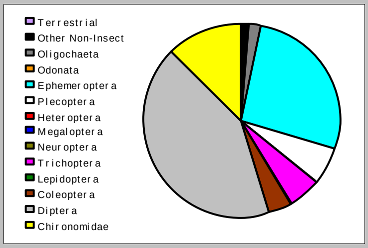
Project ID: AESI20DB
RAI No.: AESI20DB001
Sta. Name: Priest River
Client ID: Priest River_07232020
STORET ID
Coll. Date: 7/23/2020
Latitude: **Longitude:**

Abundance Measures

Sample Count: 254
Sample Abundance: 254.00 100.00% of sample used
Coll. Procedure: 3 Hess Comp
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	1	4	1.57%
Oligochaeta	2	5	1.97%
Odonata			
Ephemeroptera	4	66	25.98%
Plecoptera	3	16	6.30%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	5	14	5.51%
Lepidoptera			
Coleoptera	1	9	3.54%
Diptera	1	108	42.52%
Chironomidae	7	32	12.60%

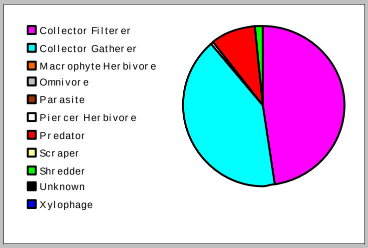


Dominant Taxa

Category	A	PRA
Simulium	108	42.52%
Baetis tricaudatus complex	61	24.02%
Tvetenia tshernovskii	17	6.69%
Zaitzevia	9	3.54%
Sweltsa	9	3.54%
Hesperoperla pacifica	6	2.36%
Torrenticola	4	1.57%
Lumbriculidae	4	1.57%
Hydropsychidae	4	1.57%
Eukiefferiella Brehmi Gr.	4	1.57%
Cricotopus / Orthocladius	3	1.18%
Cheumatopsyche	3	1.18%
Brachycentrus americanus	3	1.18%
Thienemannimyia Gr.	2	0.79%
Hydropsyche	2	0.79%

Functional Composition

Category	R	A	PRA
Predator	6	23	9.06%
Parasite			
Collector Gatherer	11	105	41.34%
Collector Filterer	5	121	47.64%
Macrophyte Herbivore			
Piercer Herbivore	1	1	0.39%
Xylophage			
Scraper			
Shredder	1	4	1.57%
Omnivore			
Unknown			

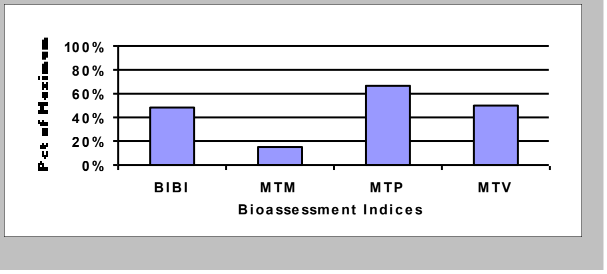


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	24
E Richness	4
P Richness	3
T Richness	5
EPT Richness	12
EPT Percent	37.80%
All Non-Insect Abundance	9
All Non-Insect Richness	3
All Non-Insect Percent	3.54%
Oligochaeta+Hirudinea Percent	1.97%
Baetidae/Ephemeroptera	0.924
Hydropsychidae/Trichoptera	0.643
Dominance	
Dominant Taxon Percent	42.52%
Dominant Taxa (2) Percent	66.54%
Dominant Taxa (3) Percent	73.23%
Dominant Taxa (10) Percent	88.98%
Diversity	
Shannon H (loge)	1.933
Shannon H (log2)	2.789
Margalef D	4.216
Simpson D	0.250
Evenness	0.608
Function	
Predator Richness	6
Predator Percent	9.06%
Filterer Richness	5
Filterer Percent	47.64%
Collector Percent	88.98%
Scraper+Shredder Percent	1.57%
Scraper/Filterer	0.000
Scraper/Scraper+Filterer	0.000
Habit	
Burrower Richness	1
Burrower Percent	1.57%
Swimmer Richness	1
Swimmer Percent	24.02%
Clinger Richness	14
Clinger Percent	61.42%
Characteristics	
Cold Stenotherm Richness	0
Cold Stenotherm Percent	0.00%
Hemoglobin Bearer Richness	0
Hemoglobin Bearer Percent	0.00%
Air Breather Richness	0
Air Breather Percent	0.00%
Voltinism	
Univoltine Richness	11
Semivoltine Richness	3
Multivoltine Percent	38.58%
Tolerance	
Sediment Tolerant Richness	1
Sediment Tolerant Percent	1.57%
Sediment Sensitive Richness	0
Sediment Sensitive Percent	0.00%
Metals Tolerance Index	4.870
Pollution Sensitive Richness	0
Pollution Tolerant Percent	5.51%
RAI Hilsenhoff Biotic Index	5.209
Intolerant Percent	8.66%
Supertolerant Percent	5.12%
CTQa	78.947

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	24	48.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	20	66.67%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	9	50.00%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	3	14.29%	Severe



Monday, February 08, 2021

Metrics Report

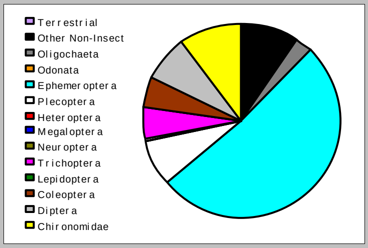
Project ID:	AESI20DB
RAI No.:	AESI20DB002
Sta. Name:	Binarch Creek
Client ID:	Binarch Creek_07232020
STORET ID	
Coll. Date:	7/23/2020
Latitude:	**Longitude:**

Abundance Measures

Sample Count:	477		
Sample Abundance:	477.00	100.00%	of sample used
Coll. Procedure:	3 Hess Comp		
Sample Notes:			

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	5	46	9.64%
Oligochaeta	2	14	2.94%
Odonata			
Ephemeroptera	12	243	50.94%
Plecoptera	9	39	8.18%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	10	26	5.45%
Lepidoptera			
Coleoptera	1	24	5.03%
Diptera	2	36	7.55%
Chironomidae	10	49	10.27%

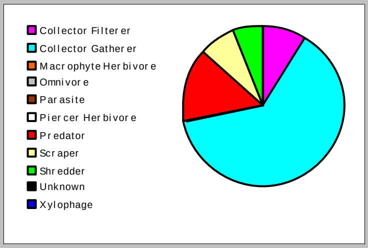


Dominant Taxa

Category	A	PRA
Baetis tricaudatus complex	200	41.93%
Simulium	34	7.13%
Heterlimnius corpulentus	24	5.03%
Trepaxonemata	21	4.40%
Sweltsa	19	3.98%
Cinygmula	19	3.98%
Micropsectra	16	3.35%
Lebertia	16	3.35%
Pagastia	14	2.94%
Enchytraeidae	13	2.73%
Micrasema	7	1.47%
Leuctridae	6	1.26%
Eukiefferiella Gracei Gr.	6	1.26%
Caudatella	5	1.05%
Cricotopus / Orthocladius	4	0.84%

Functional Composition

Category	R	A	PRA
Predator	13	72	15.09%
Parasite			
Collector Gatherer	19	298	62.47%
Collector Filterer	5	44	9.22%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	6	35	7.34%
Shredder	8	28	5.87%
Omnivore			
Unknown			

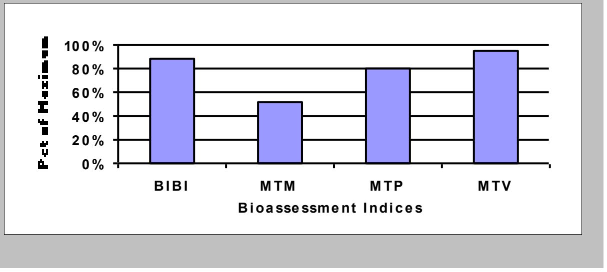


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	51
E Richness	12
P Richness	9
T Richness	10
EPT Richness	31
EPT Percent	64.57%
All Non-Insect Abundance	60
All Non-Insect Richness	7
All Non-Insect Percent	12.58%
Oligochaeta+Hirudinea Percent	2.94%
Baetidae/Ephemeroptera	0.831
Hydropsychidae/Trichoptera	0.269
Dominance	
Dominant Taxon Percent	41.93%
Dominant Taxa (2) Percent	49.06%
Dominant Taxa (3) Percent	54.09%
Dominant Taxa (10) Percent	78.83%
Diversity	
Shannon H (loge)	2.512
Shannon H (log2)	3.624
Margalef D	8.184
Simpson D	0.213
Evenness	0.639
Function	
Predator Richness	13
Predator Percent	15.09%
Filterer Richness	5
Filterer Percent	9.22%
Collector Percent	71.70%
Scraper+Shredder Percent	13.21%
Scraper/Filterer	0.795
Scraper/Scraper+Filterer	0.443
Habit	
Burrower Richness	1
Burrower Percent	0.21%
Swimmer Richness	2
Swimmer Percent	42.35%
Clinger Richness	30
Clinger Percent	34.38%
Characteristics	
Cold Stenotherm Richness	7
Cold Stenotherm Percent	4.61%
Hemoglobin Bearer Richness	0
Hemoglobin Bearer Percent	0.00%
Air Breather Richness	1
Air Breather Percent	0.42%
Voltinism	
Univoltine Richness	31
Semivoltine Richness	3
Multivoltine Percent	61.43%
Tolerance	
Sediment Tolerant Richness	2
Sediment Tolerant Percent	0.63%
Sediment Sensitive Richness	2
Sediment Sensitive Percent	1.05%
Metals Tolerance Index	4.062
Pollution Sensitive Richness	7
Pollution Tolerant Percent	0.42%
RAI Hilsenhoff Biotic Index	4.021
Intolerant Percent	22.64%
Supertolerant Percent	6.71%
CTQa	63.442

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	44	88.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	24	80.00%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	17	94.44%	None
MTM	Montana DEQ Mountains (Bukantis 1998)	11	52.38%	Moderate



Monday, February 08, 2021

Metrics Report

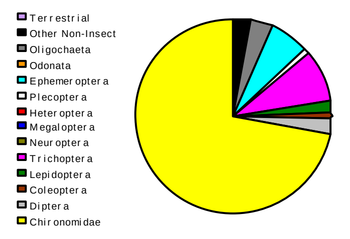
Project ID: AESI20DB
RAI No.: AESI20DB003
Sta. Name: Yak River
Client ID: Yak River_07232020
STORET ID
Coll. Date: 7/23/2020
Latitude: **Longitude:**

Abundance Measures

Sample Count: 316
Sample Abundance: 316.00 100.00% of sample used
Coll. Procedure: 3 Hess Comp
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	2	9	2.85%
Oligochaeta	2	12	3.80%
Odonata			
Ephemeroptera	7	21	6.65%
Plecoptera	3	3	0.95%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	8	27	8.54%
Lepidoptera	1	6	1.90%
Coleoptera	2	2	0.63%
Diptera	2	8	2.53%
Chironomidae	16	228	72.15%

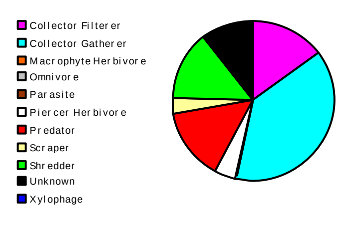


Dominant Taxa

Category	A	PRA
Sublettea coffmani	33	10.44%
Thienemannimyia Gr.	28	8.86%
Cricotopus / Orthocladius	21	6.65%
Pagastia	18	5.70%
Cricotopus (Cricotopus)	18	5.70%
Potthastia Gaedii Gr.	17	5.38%
Microtendipes	15	4.75%
Hydroptila	14	4.43%
Tanytarsini	12	3.80%
Parakiefferiella	12	3.80%
Orthocladiinae	12	3.80%
Eukiefferiella	12	3.80%
Nais	11	3.48%
Tanytarsus	10	3.16%
Baetis tricaudatus complex	10	3.16%

Functional Composition

Category	R	A	PRA
Predator	8	46	14.56%
Parasite			
Collector Gatherer	17	120	37.97%
Collector Filterer	5	48	15.19%
Macrophyte Herbivore			
Piercer Herbivore	1	14	4.43%
Xylophage			
Scraper	4	10	3.16%
Shredder	7	45	14.24%
Omnivore			
Unknown	1	33	10.44%

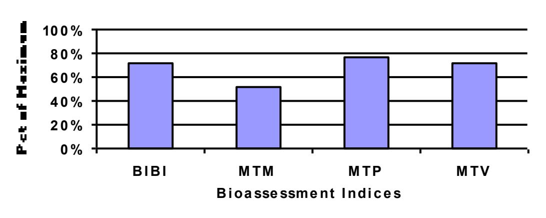


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	43
E Richness	7
P Richness	3
T Richness	8
EPT Richness	18
EPT Percent	16.14%
All Non-Insect Abundance	21
All Non-Insect Richness	4
All Non-Insect Percent	6.65%
Oligochaeta+Hirudinea Percent	3.80%
Baetidae/Ephemeroptera	0.476
Hydropsychidae/Trichoptera	0.333
Dominance	
Dominant Taxon Percent	10.44%
Dominant Taxa (2) Percent	19.30%
Dominant Taxa (3) Percent	25.95%
Dominant Taxa (10) Percent	59.49%
Diversity	
Shannon H (loge)	3.139
Shannon H (log2)	4.528
Margalef D	7.596
Simpson D	0.057
Evenness	0.834
Function	
Predator Richness	8
Predator Percent	14.56%
Filterer Richness	5
Filterer Percent	15.19%
Collector Percent	53.16%
Scraper+Shredder Percent	17.41%
Scraper/Filterer	0.208
Scraper/Scraper+Filterer	0.172
Habit	
Burrower Richness	1
Burrower Percent	0.32%
Swimmer Richness	1
Swimmer Percent	3.16%
Clinger Richness	21
Clinger Percent	33.54%
Characteristics	
Cold Stenotherm Richness	1
Cold Stenotherm Percent	0.32%
Hemoglobin Bearer Richness	3
Hemoglobin Bearer Percent	5.38%
Air Breather Richness	0
Air Breather Percent	0.00%
Voltinism	
Univoltine Richness	19
Semivoltine Richness	3
Multivoltine Percent	82.59%
Tolerance	
Sediment Tolerant Richness	1
Sediment Tolerant Percent	0.32%
Sediment Sensitive Richness	1
Sediment Sensitive Percent	0.95%
Metals Tolerance Index	5.538
Pollution Sensitive Richness	3
Pollution Tolerant Percent	7.28%
RAI Hilsenhoff Biotic Index	5.133
Intolerant Percent	18.99%
Supertolerant Percent	12.66%
CTQa	80.611

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	36	72.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	23	76.67%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	13	72.22%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	11	52.38%	Moderate



Monday, February 08, 2021

Metrics Report

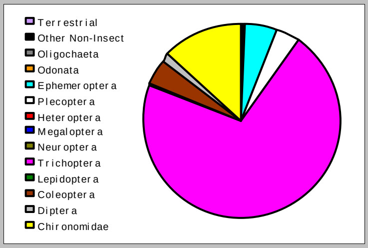
Project ID: AESI20DB
RAI No.: AESI20DB004
Sta. Name: Priest River
Client ID: Priest River_08272020
STORET ID
Coll. Date: 8/27/2020
Latitude: **Longitude:**

Abundance Measures

Sample Count: 502
Sample Abundance: 502.00 100.00% of sample used
Coll. Procedure: 3 Hess Comp
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	2	4	0.80%
Oligochaeta	1	1	0.20%
Odonata			
Ephemeroptera	4	25	4.98%
Plecoptera	4	20	3.98%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	7	356	70.92%
Lepidoptera	1	1	0.20%
Coleoptera	2	23	4.58%
Diptera	1	5	1.00%
Chironomidae	5	67	13.35%

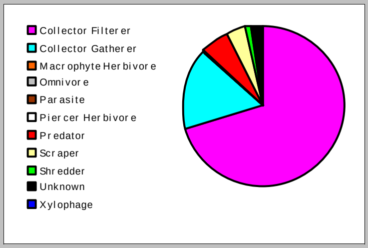


Dominant Taxa

Category	A	PRA
Hydropsyche	205	40.84%
Cheumatopsyche	116	23.11%
Tvetenia tshernovskii	49	9.76%
Zaitzevia	21	4.18%
Hydropsychidae	19	3.78%
Rhithrogena	13	2.59%
Sublettea coffmani	12	2.39%
Hesperoperla pacifica	11	2.19%
Brachycentridae	11	2.19%
Sweltsa	7	1.39%
Hemerodromia	5	1.00%
Ephemerella Excrucians Gr.	4	0.80%
Baetis tricaudatus complex	4	0.80%
Heptageniidae	3	0.60%
Sperchon	2	0.40%

Functional Composition

Category	R	A	PRA
Predator	7	30	5.98%
Parasite			
Collector Gatherer	7	82	16.33%
Collector Filterer	4	353	70.32%
Macrophyte Herbivore			
Piercer Herbivore	1	1	0.20%
Xylophage			
Scraper	3	19	3.78%
Shredder	4	5	1.00%
Omnivore			
Unknown	1	12	2.39%

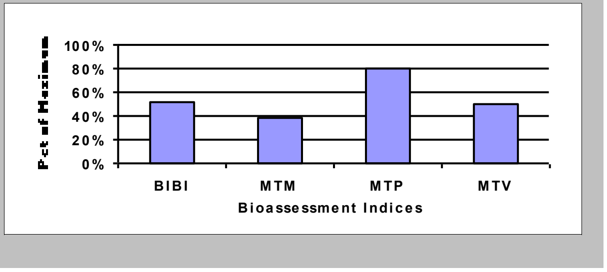


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	27
E Richness	4
P Richness	4
T Richness	7
EPT Richness	15
EPT Percent	79.88%
All Non-Insect Abundance	5
All Non-Insect Richness	3
All Non-Insect Percent	1.00%
Oligochaeta+Hirudinea Percent	0.20%
Baetidae/Ephemeroptera	0.200
Hydropsychidae/Trichoptera	0.955
Dominance	
Dominant Taxon Percent	40.84%
Dominant Taxa (2) Percent	63.94%
Dominant Taxa (3) Percent	73.71%
Dominant Taxa (10) Percent	92.43%
Diversity	
Shannon H (loge)	1.790
Shannon H (log2)	2.583
Margalef D	4.239
Simpson D	0.275
Evenness	0.543
Function	
Predator Richness	7
Predator Percent	5.98%
Filterer Richness	4
Filterer Percent	70.32%
Collector Percent	86.65%
Scraper+Shredder Percent	4.78%
Scraper/Filterer	0.054
Scraper/Scraper+Filterer	0.051
Habit	
Burrower Richness	1
Burrower Percent	0.20%
Swimmer Richness	2
Swimmer Percent	1.00%
Clinger Richness	15
Clinger Percent	83.67%
Characteristics	
Cold Stenotherm Richness	0
Cold Stenotherm Percent	0.00%
Hemoglobin Bearer Richness	0
Hemoglobin Bearer Percent	0.00%
Air Breather Richness	0
Air Breather Percent	0.00%
Voltinism	
Univoltine Richness	12
Semivoltine Richness	5
Multivoltine Percent	15.34%
Tolerance	
Sediment Tolerant Richness	1
Sediment Tolerant Percent	0.20%
Sediment Sensitive Richness	0
Sediment Sensitive Percent	0.00%
Metals Tolerance Index	4.751
Pollution Sensitive Richness	0
Pollution Tolerant Percent	28.09%
RAI Hilsenhoff Biotic Index	4.538
Intolerant Percent	9.16%
Supertolerant Percent	0.20%
CTQa	70.083

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	26	52.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	24	80.00%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	9	50.00%	Moderate
MTM	Montana DEQ Mountains (Bukantis 1998)	8	38.10%	Moderate



Monday, February 08, 2021

Metrics Report

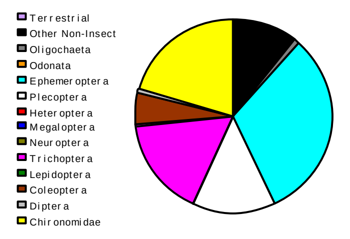
Project ID: AESI20DB
RAI No.: AESI20DB005
Sta. Name: Binarch Creek
Client ID: Binarch Creek_08272020
STORET ID
Coll. Date: 8/27/2020
Latitude: **Longitude:**

Abundance Measures

Sample Count: 526
Sample Abundance: 526.00 100.00% of sample used
Coll. Procedure: 3 Hess Comp
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	7	57	10.84%
Oligochaeta	1	6	1.14%
Odonata			
Ephemeroptera	12	164	31.18%
Plecoptera	9	71	13.50%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	9	88	16.73%
Lepidoptera			
Coleoptera	2	29	5.51%
Diptera	1	4	0.76%
Chironomidae	13	107	20.34%

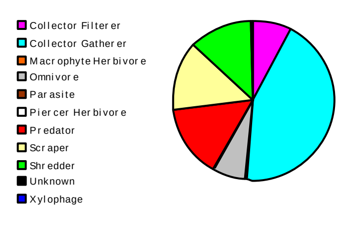


Dominant Taxa

Category	A	PRA
Baetis tricaudatus complex	55	10.46%
Eukiefferiella Gracei Gr.	38	7.22%
Cinygmula	35	6.65%
Caudatella	35	6.65%
Sweltsa	33	6.27%
Polycelis	33	6.27%
Heterlimnius corpulentus	27	5.13%
Micrasema	22	4.18%
Hydropsyche	17	3.23%
Cinygma	17	3.23%
Eukiefferiella	13	2.47%
Pagastia	12	2.28%
Limnephilidae	11	2.09%
Kogotus	10	1.90%
Cheumatopsyche	9	1.71%

Functional Composition

Category	R	A	PRA
Predator	12	78	14.83%
Parasite			
Collector Gatherer	20	230	43.73%
Collector Filterer	5	41	7.79%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	8	76	14.45%
Shredder	7	65	12.36%
Omnivore	1	33	6.27%
Unknown	1	3	0.57%

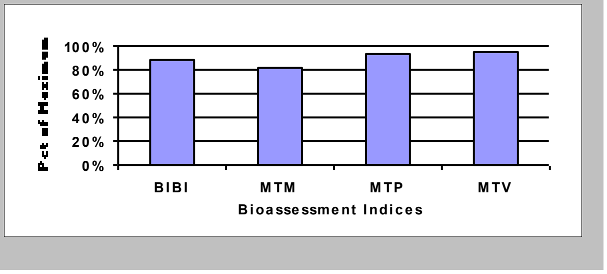


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	54
E Richness	12
P Richness	9
T Richness	9
EPT Richness	30
EPT Percent	61.41%
All Non-Insect Abundance	63
All Non-Insect Richness	8
All Non-Insect Percent	11.98%
Oligochaeta+Hirudinea Percent	1.14%
Baetidae/Ephemeroptera	0.360
Hydropsychidae/Trichoptera	0.398
Dominance	
Dominant Taxon Percent	10.46%
Dominant Taxa (2) Percent	17.68%
Dominant Taxa (3) Percent	24.33%
Dominant Taxa (10) Percent	59.32%
Diversity	
Shannon H (loge)	3.282
Shannon H (log2)	4.735
Margalef D	8.685
Simpson D	0.054
Evenness	0.823
Function	
Predator Richness	12
Predator Percent	14.83%
Filterer Richness	5
Filterer Percent	7.79%
Collector Percent	51.52%
Scraper+Shredder Percent	26.81%
Scraper/Filterer	1.854
Scraper/Scraper+Filterer	0.650
Habit	
Burrower Richness	0
Burrower Percent	0.00%
Swimmer Richness	2
Swimmer Percent	11.22%
Clinger Richness	30
Clinger Percent	55.32%
Characteristics	
Cold Stenotherm Richness	10
Cold Stenotherm Percent	14.45%
Hemoglobin Bearer Richness	0
Hemoglobin Bearer Percent	0.00%
Air Breather Richness	0
Air Breather Percent	0.00%
Voltinism	
Univoltine Richness	28
Semivoltine Richness	3
Multivoltine Percent	40.30%
Tolerance	
Sediment Tolerant Richness	0
Sediment Tolerant Percent	0.00%
Sediment Sensitive Richness	2
Sediment Sensitive Percent	2.09%
Metals Tolerance Index	3.512
Pollution Sensitive Richness	10
Pollution Tolerant Percent	1.90%
RAI Hilsenhoff Biotic Index	3.015
Intolerant Percent	49.81%
Supertolerant Percent	15.21%
CTQa	67.619

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	44	88.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	28	93.33%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	17	94.44%	None
MTM	Montana DEQ Mountains (Bukantis 1998)	17	80.95%	Slight



Metrics Report

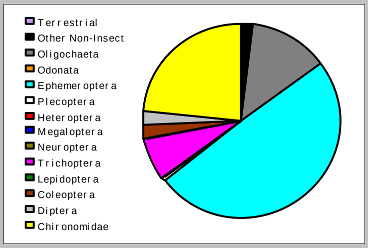
Project ID: AESI20DB
RAI No.: AESI20DB006
Sta. Name: Yak River
Client ID: Yak River_08272020
STORET ID
Coll. Date: 8/27/2020
Latitude: **Longitude:**

Abundance Measures

Sample Count: 543
Sample Abundance: 1,629.00 33.33% of sample used
Coll. Procedure: 3 Hess Comp
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	5	12	2.21%
Oligochaeta	1	71	13.08%
Odonata			
Ephemeroptera	7	265	48.80%
Plecoptera	1	4	0.74%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	4	38	7.00%
Lepidoptera			
Coleoptera	3	12	2.21%
Diptera	3	14	2.58%
Chironomidae	15	127	23.39%

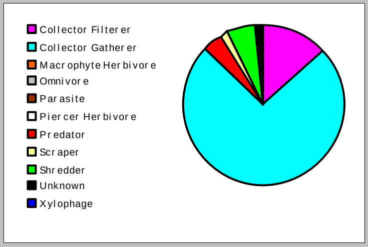


Dominant Taxa

Category	A	PRA
Ephemerella Excrucians Gr.	237	43.65%
Nais	71	13.08%
Microtendipes	46	8.47%
Brachycentrus americanus	21	3.87%
Pagastia	18	3.31%
Lepidostoma	15	2.76%
Epeorus	15	2.76%
Potthastia Gaedii Gr.	11	2.03%
Cricotopus / Orthocladius	9	1.66%
Antocha monticola	9	1.66%
Orthocladiinae	8	1.47%
Optioservus	8	1.47%
Potthastia Longimanus Gr.	7	1.29%
Thienemannimyia Gr.	6	1.10%
Sublettea coffmani	5	0.92%

Functional Composition

Category	R	A	PRA
Predator	7	22	4.05%
Parasite			
Collector Gatherer	17	400	73.66%
Collector Filterer	6	74	13.63%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	2	9	1.66%
Shredder	5	29	5.34%
Omnivore			
Unknown	2	9	1.66%

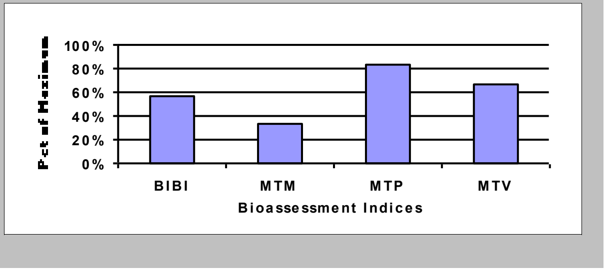


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	39
E Richness	7
P Richness	1
T Richness	4
EPT Richness	12
EPT Percent	56.54%
All Non-Insect Abundance	83
All Non-Insect Richness	6
All Non-Insect Percent	15.29%
Oligochaeta+Hirudinea Percent	13.08%
Baetidae/Ephemeroptera	0.034
Hydropsychidae/Trichoptera	0.026
Dominance	
Dominant Taxon Percent	43.65%
Dominant Taxa (2) Percent	56.72%
Dominant Taxa (3) Percent	65.19%
Dominant Taxa (10) Percent	83.24%
Diversity	
Shannon H (loge)	2.169
Shannon H (log2)	3.130
Margalef D	6.084
Simpson D	0.243
Evenness	0.592
Function	
Predator Richness	7
Predator Percent	4.05%
Filterer Richness	6
Filterer Percent	13.63%
Collector Percent	87.29%
Scraper+Shredder Percent	7.00%
Scraper/Filterer	0.122
Scraper/Scraper+Filterer	0.108
Habit	
Burrower Richness	1
Burrower Percent	0.18%
Swimmer Richness	3
Swimmer Percent	1.84%
Clinger Richness	15
Clinger Percent	66.30%
Characteristics	
Cold Stenotherm Richness	0
Cold Stenotherm Percent	0.00%
Hemoglobin Bearer Richness	3
Hemoglobin Bearer Percent	8.84%
Air Breather Richness	1
Air Breather Percent	1.66%
Voltinism	
Univoltine Richness	13
Semivoltine Richness	5
Multivoltine Percent	26.15%
Tolerance	
Sediment Tolerant Richness	1
Sediment Tolerant Percent	1.66%
Sediment Sensitive Richness	0
Sediment Sensitive Percent	0.00%
Metals Tolerance Index	3.557
Pollution Sensitive Richness	3
Pollution Tolerant Percent	2.03%
RAI Hilsenhoff Biotic Index	4.478
Intolerant Percent	17.68%
Supertolerant Percent	14.73%
CTQa	82.625

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	28	56.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	25	83.33%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	12	66.67%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	7	33.33%	Moderate



Monday, February 08, 2021

Metrics Report

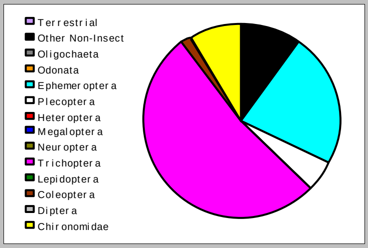
Project ID: AESI20DB
RAI No.: AESI20DB007
Sta. Name: Priest River
Client ID: Priest River_09222020
STORET ID
Coll. Date: 9/22/2020
Latitude: **Longitude:**

Abundance Measures

Sample Count:	97		
Sample Abundance:	97.00	100.00%	of sample used
Coll. Procedure:	3 Hess Comp		
Sample Notes:			

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	4	10	10.31%
Oligochaeta			
Odonata			
Ephemeroptera	7	21	21.65%
Plecoptera	2	5	5.15%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	5	51	52.58%
Lepidoptera			
Coleoptera	2	2	2.06%
Diptera			
Chironomidae	3	8	8.25%

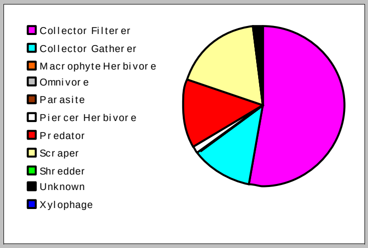


Dominant Taxa

Category	A	PRA
Hydropsyche	24	24.74%
Cheumatopsyche	14	14.43%
Neureclipsis	11	11.34%
Ephemerella	9	9.28%
Sperchon	5	5.15%
Tvetenia tshernovskii	3	3.09%
Trepaxonemata	3	3.09%
Sweltsa	3	3.09%
Rhithrogena	3	3.09%
Heptagenia	3	3.09%
Baetis tricaudatus complex	3	3.09%
Sublettea coffmani	2	2.06%
Skwala	2	2.06%
Ceraclea	1	1.03%
Caudatella	1	1.03%

Functional Composition

Category	R	A	PRA
Predator	5	14	14.43%
Parasite			
Collector Gatherer	7	12	12.37%
Collector Filterer	4	51	52.58%
Macrophyte Herbivore			
Piercer Herbivore	1	1	1.03%
Xylophage			
Scraper	5	17	17.53%
Shredder			
Omnivore			
Unknown	1	2	2.06%

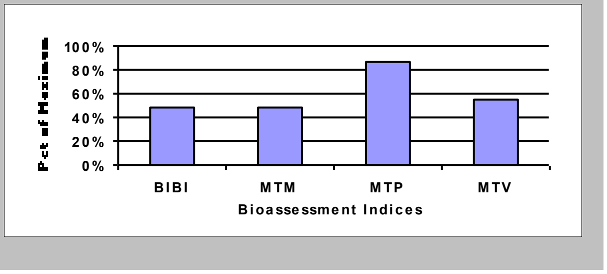


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	23
E Richness	7
P Richness	2
T Richness	5
EPT Richness	14
EPT Percent	79.38%
All Non-Insect Abundance	10
All Non-Insect Richness	4
All Non-Insect Percent	10.31%
Oligochaeta+Hirudinea Percent	0.00%
Baetidae/Ephemeroptera	0.143
Hydropsychidae/Trichoptera	0.745
Dominance	
Dominant Taxon Percent	24.74%
Dominant Taxa (2) Percent	39.18%
Dominant Taxa (3) Percent	50.52%
Dominant Taxa (10) Percent	80.41%
Diversity	
Shannon H (loge)	2.554
Shannon H (log2)	3.685
Margalef D	4.831
Simpson D	0.109
Evenness	0.815
Function	
Predator Richness	5
Predator Percent	14.43%
Filterer Richness	4
Filterer Percent	52.58%
Collector Percent	64.95%
Scraper+Shredder Percent	17.53%
Scraper/Filterer	0.333
Scraper/Scraper+Filterer	0.250
Habit	
Burrower Richness	0
Burrower Percent	0.00%
Swimmer Richness	1
Swimmer Percent	3.09%
Clinger Richness	12
Clinger Percent	64.95%
Characteristics	
Cold Stenotherm Richness	1
Cold Stenotherm Percent	1.03%
Hemoglobin Bearer Richness	0
Hemoglobin Bearer Percent	0.00%
Air Breather Richness	0
Air Breather Percent	0.00%
Voltinism	
Univoltine Richness	13
Semivoltine Richness	2
Multivoltine Percent	21.65%
Tolerance	
Sediment Tolerant Richness	2
Sediment Tolerant Percent	2.06%
Sediment Sensitive Richness	0
Sediment Sensitive Percent	0.00%
Metals Tolerance Index	4.283
Pollution Sensitive Richness	1
Pollution Tolerant Percent	19.59%
RAI Hilsenhoff Biotic Index	4.418
Intolerant Percent	17.53%
Supertolerant Percent	2.06%
CTQa	76.857

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	24	48.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	26	86.67%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	10	55.56%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	10	47.62%	Moderate



Monday, February 08, 2021

Metrics Report

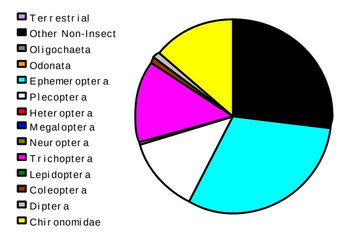
Project ID: AESI20DB
RAI No.: AESI20DB008
Sta. Name: Binarch Creek
Client ID: Binarch Creek_09222020
STORET ID
Coll. Date: 9/22/2020
Latitude: **Longitude:**

Abundance Measures

Sample Count: 392
Sample Abundance: 392.00 100.00% of sample used
Coll. Procedure: 3 Hess Comp
Sample Notes:

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	2	106	27.04%
Oligochaeta			
Odonata			
Ephemeroptera	8	119	30.36%
Plecoptera	5	50	12.76%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	7	55	14.03%
Lepidoptera			
Coleoptera	2	4	1.02%
Diptera	1	5	1.28%
Chironomidae	6	53	13.52%

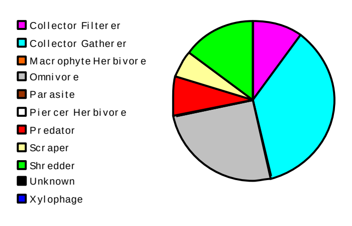


Dominant Taxa

Category	A	PRA
Polycelis	100	25.51%
Baetis tricaudatus complex	59	15.05%
Caudatella	34	8.67%
Zapada columbiana	27	6.89%
Micrasema	25	6.38%
Eukiefferiella	14	3.57%
Eukiefferiella Gracei Gr.	12	3.06%
Hydropsyche	11	2.81%
Cheumatopsyche	11	2.81%
Pagastia	10	2.55%
Sweltsa	9	2.30%
Tanytarsus	7	1.79%
Zapada cinctipes	6	1.53%
Lebertia	6	1.53%
Ironodes	6	1.53%

Functional Composition

Category	R	A	PRA
Predator	7	29	7.40%
Parasite			
Collector Gatherer	9	143	36.48%
Collector Filterer	5	39	9.95%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	5	22	5.61%
Shredder	4	59	15.05%
Omnivore	1	100	25.51%
Unknown			

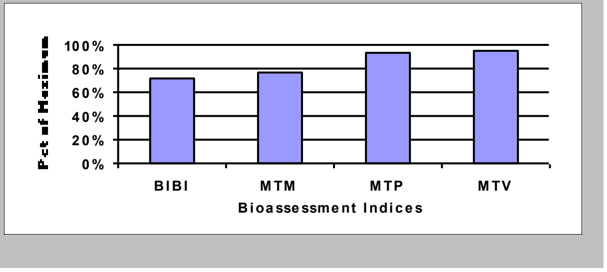


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	31
E Richness	8
P Richness	5
T Richness	7
EPT Richness	20
EPT Percent	57.14%
All Non-Insect Abundance	106
All Non-Insect Richness	2
All Non-Insect Percent	27.04%
Oligochaeta+Hirudinea Percent	0.00%
Baetidae/Ephemeroptera	0.496
Hydropsychidae/Trichoptera	0.418
Dominance	
Dominant Taxon Percent	25.51%
Dominant Taxa (2) Percent	40.56%
Dominant Taxa (3) Percent	49.23%
Dominant Taxa (10) Percent	77.30%
Diversity	
Shannon H (loge)	2.614
Shannon H (log2)	3.771
Margalef D	5.075
Simpson D	0.122
Evenness	0.761
Function	
Predator Richness	7
Predator Percent	7.40%
Filterer Richness	5
Filterer Percent	9.95%
Collector Percent	46.43%
Scraper+Shredder Percent	20.66%
Scraper/Filterer	0.564
Scraper/Scraper+Filterer	0.361
Habit	
Burrower Richness	0
Burrower Percent	0.00%
Swimmer Richness	1
Swimmer Percent	15.05%
Clinger Richness	22
Clinger Percent	43.62%
Characteristics	
Cold Stenotherm Richness	5
Cold Stenotherm Percent	17.60%
Hemoglobin Bearer Richness	0
Hemoglobin Bearer Percent	0.00%
Air Breather Richness	0
Air Breather Percent	0.00%
Voltinism	
Univoltine Richness	18
Semivoltine Richness	3
Multivoltine Percent	55.61%
Tolerance	
Sediment Tolerant Richness	0
Sediment Tolerant Percent	0.00%
Sediment Sensitive Richness	1
Sediment Sensitive Percent	0.26%
Metals Tolerance Index	3.885
Pollution Sensitive Richness	6
Pollution Tolerant Percent	3.06%
RAI Hilsenhoff Biotic Index	2.741
Intolerant Percent	61.48%
Supertolerant Percent	8.16%
CTQa	64.720

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	36	72.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	28	93.33%	None
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	17	94.44%	None
MTM	Montana DEQ Mountains (Bukantis 1998)	16	76.19%	Slight



Monday, February 08, 2021

Metrics Report

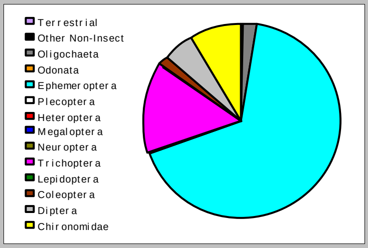
Project ID: AESI20DB
RAI No.: AESI20DB009
Sta. Name: Yak River
Client ID: Yak River_09292020
STORET ID
Coll. Date: 9/29/2020
Latitude: **Longitude:**

Abundance Measures

Sample Count:	379		
Sample Abundance:	379.00	100.00%	of sample used
Coll. Procedure:	3 Hess Comp		
Sample Notes:			

Taxonomic Composition

Category	R	A	PRA
Terrestrial			
Other Non-Insect	2	2	0.53%
Oligochaeta	1	7	1.85%
Odonata			
Ephemeroptera	8	254	67.02%
Plecoptera	1	1	0.26%
Heteroptera			
Megaloptera			
Neuroptera			
Trichoptera	7	57	15.04%
Lepidoptera			
Coleoptera	1	6	1.58%
Diptera	3	19	5.01%
Chironomidae	10	33	8.71%

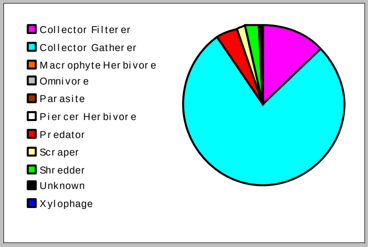


Dominant Taxa

Category	A	PRA
Ephemerella Excrucians Gr.	223	58.84%
Brachycentrus americanus	44	11.61%
Epeorus	20	5.28%
Antocha monticola	13	3.43%
Pagastia	9	2.37%
Potthastia Longimanus Gr.	8	2.11%
Nais	7	1.85%
Optioservus	6	1.58%
Roederiodes	4	1.06%
Lepidostoma	4	1.06%
Drunella grandis	4	1.06%
Sublettea coffmani	3	0.79%
Micrasema	3	0.79%
Hydropsyche	3	0.79%
Baetis tricaudatus complex	3	0.79%

Functional Composition

Category	R	A	PRA
Predator	9	16	4.22%
Parasite			
Collector Gatherer	14	294	77.57%
Collector Filterer	4	49	12.93%
Macrophyte Herbivore			
Piercer Herbivore			
Xylophage			
Scraper	3	8	2.11%
Shredder	2	9	2.37%
Omnivore			
Unknown	1	3	0.79%

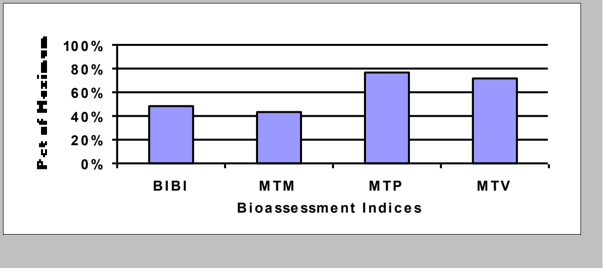


Metric Values and Scores

Metric	Value
Composition	
Taxa Richness	33
E Richness	8
P Richness	1
T Richness	7
EPT Richness	16
EPT Percent	82.32%
All Non-Insect Abundance	9
All Non-Insect Richness	3
All Non-Insect Percent	2.37%
Oligochaeta+Hirudinea Percent	1.85%
Baetidae/Ephemeroptera	0.016
Hydropsychidae/Trichoptera	0.053
Dominance	
Dominant Taxon Percent	58.84%
Dominant Taxa (2) Percent	70.45%
Dominant Taxa (3) Percent	75.73%
Dominant Taxa (10) Percent	89.18%
Diversity	
Shannon H (loge)	1.766
Shannon H (log2)	2.548
Margalef D	5.399
Simpson D	0.372
Evenness	0.505
Function	
Predator Richness	9
Predator Percent	4.22%
Filterer Richness	4
Filterer Percent	12.93%
Collector Percent	90.50%
Scraper+Shredder Percent	4.49%
Scraper/Filterer	0.163
Scraper/Scraper+Filterer	0.140
Habit	
Burrower Richness	0
Burrower Percent	0.00%
Swimmer Richness	2
Swimmer Percent	1.06%
Clinger Richness	14
Clinger Percent	85.49%
Characteristics	
Cold Stenotherm Richness	1
Cold Stenotherm Percent	0.26%
Hemoglobin Bearer Richness	1
Hemoglobin Bearer Percent	0.26%
Air Breather Richness	1
Air Breather Percent	3.43%
Voltinism	
Univoltine Richness	15
Semivoltine Richness	2
Multivoltine Percent	10.29%
Tolerance	
Sediment Tolerant Richness	1
Sediment Tolerant Percent	3.43%
Sediment Sensitive Richness	0
Sediment Sensitive Percent	0.00%
Metals Tolerance Index	3.245
Pollution Sensitive Richness	3
Pollution Tolerant Percent	1.58%
RAI Hilsenhoff Biotic Index	3.475
Intolerant Percent	25.86%
Supertolerant Percent	2.90%
CTQa	69.333

Bioassessment Indices

BioIndex	Description	Score	Pct	Rating
BIBI	B-IBI (Karr et al.)	24	48.00%	
MTP	Montana DEQ Plains (Bukantis 1998)	23	76.67%	Slight
MTV	Montana Revised Valleys/Foothills (Bollman 1998)	13	72.22%	Slight
MTM	Montana DEQ Mountains (Bukantis 1998)	9	42.86%	Moderate



Monday, February 08, 2021

Appendix E-Moorings

Stn.	No.	Nominal Depth (m)	Actual Depth* (m)	HWTP Serial	RBR Solo D Serial
PL-1	1	2	2	20847505	78506
PL-1	2	4	4	20847506	
PL-1	3	6	6	20847507	
PL-1	4	8	8	20847508	
PL-1	5	10	10	20847509	
PL-1	6	12	12	20847510	
PL-1	7	14	14	20847511	
PL-1	8	16	16	20847512	
PL-1	9	18	18	20847513	
PL-1	10	20	20	20847514	
PL-1	11	22	22	20847515	
PL-2	1	2	3.62	20847516	78510
PL-2	2	4	5.6	20847517	
PL-2	3	6	7.58	20847518	
PL-2	4	8	9.56	20847519	
PL-2	5	10	11.54	20847520	
PL-2	6	12	13.52	20847521	
PL-2	7	14	15.5	20847522	
PL-2	8	16	17.48	20847523	
PL-2	9	18	19.46	20847524	
PL-2	10	20	21.44	20847525	
PL-2	11	22	23.42	20847526	
PL-2	12	24	25.4	20847527	
PL-2	13	26	27.38	20847528	
PL-2	14	28	29.36	20847529	
PL-2	15	30	31.34	20847530	
PL-2	16	32	33.32	20847531	
PL-2	17	34	35.3	20847532	
PL-2	18	36	37.28	20847533	
PL-2	19	38	39.26	20847534	
PL-2	20	42	43.22	20847536	78474

* from 3ft summer level

Appendix F- Comparison of wind at Coolin and Priest Lake Ranger Station

RAWS (remote automatic weather station) data were used from Priest Lake Ranger Station (48.574181 N, 116.957869W) located approximately 10 km northwest of the study area. Data were courtesy of Matt Butler (USFS, Priest River, ID), and downloaded from the Mesowest archive at the University of Utah (station PLKI1, https://mesowest.utah.edu/).

Wind at Priest Lake Ranger Station (PLRS) showed a similar diurnal pattern as observed at Coolin. A comparison of the Coolin and PLRS data is given in Figure A-2. Our particular interest is wind from the north. There were times when Coolin observed light wind from the north, while PLRS showed light wind from the south. However, above a wind speed of 3.2 m/s (7 mph), winds were consistently from the north at both stations. Using only wind speed > 3.2 m/s, gives a slope of 1.02 (not shown); for the work here we use the PLRS wind data without adjustment.

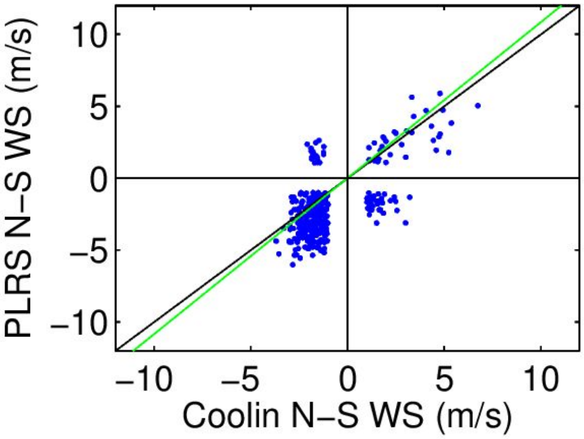


Figure G-1 Comparison of north-south wind at Coolin and the Priest Lake Ranger Station (PLRS), hourly data, June 19 to October 1, 2020. Wind < 1 m/s were excluded. The black line is 1:1, and the green line is best fit through the origin with slope of m=1.08.

Appendix G-Atmospheric pressure

The effect of the atmospheric pressure can be seen just above the noise level of the sensitive 15-minute water level data available from USGS, Figure 5a. At the onset of the storm on day 251.3 the water level rose by approximately 0.01 m (0.4 inch), and oscillated about this new equilibrium position. Note the water level increase was only a few mutiples of the apparent resolution of the data, 0.003 m. This behaviour is the classic (but rarely observed) response to a step increase in wind. The observed period of the oscillations was 50.6 minutes.

The expected period of the surface seiche (oscillation) is,

$$T_s = \frac{2\,L}{\sqrt{g\,h_{mn}}}$$

where L is the length of the lake (30 km), h_{mn} is the mean depth of the lake (39 m) and g is gravity (9.81 m/s$_2$), giving T_s = 51.1 minutes. The close agreement between the observed and expected surface seiche periods is probably fortuitous.

Appendix H-Vertical Temperature Discussion

Factors controlling the downwelling, September 7, 2020

To explore the first question, consider the two storms of September 2 and 7, 2020 shown in Figure Figure 27a. Both storms give strong wind from the north, they are the largest wind events during the 2020 study period, and they are separated by a period of relatively low wind. Note the Coolin wind speed data were not available during the storm of September 7, 2020 due to power outage, but the PLRS data is expected to provide a reasonable estimate of the wind given the elevated wind speeds (Appendix F).

In addition to wind, there was a strong gradient of air pressure across the length of the lake during the second storm, Figure 27b. From pressure data at nearby airports, it was possible to determine the speed of the front to be approximately 30 km/hr, from north to south. As Priest Lake is approximately 30 km long, this means that the slope of the air pressure per hour (Figure 27c) gives the atmospheric pressure difference across the length of Priest Lake. Based on data shown from Sandpoint Airport, the pressure gradient rose to 0.01 dbar/hr for a duration of 2 hours. Estimates suggest that this pressure gradient does not have long enough duration to significantly affect the first mode horizontal internal seiche in the lake, however it did have an effect on the surface level, see Figure 27d and Appendix G for more detail.

The thermocline depth was estimated from the maximum temperature gradient between the temperature sensors, Figure 27e. This depth has 2 m steps, reflecting the 2 m distance between the sensors, and a step occurred when the maximum gradient crossed a sensor. Another way to estimate the thermocline depth would be to choose an isotherm to represent the thermocline (e.g. the 16 °C isotherm in Figure 13). Regardless of this choice, it is clear that the thermocline deflected at most 2 m as a result of the storm of September 2, but deflected 10 m during the storm of September 7th. The large deflection on September 7 resulted in the spike in temperature at 18 m, Figure 27f.

Overall the results are puzzling. On the one hand the storm of September 2, 2020 is slightly stronger than that of September 7, 2020, based on wind speed squared which is proportional to the wind forcing on the surface of the lake (not shown). On the other hand the barometric pressure gradient across the lake does not appear to act for long enough to significantly affect the first mode internal motion.

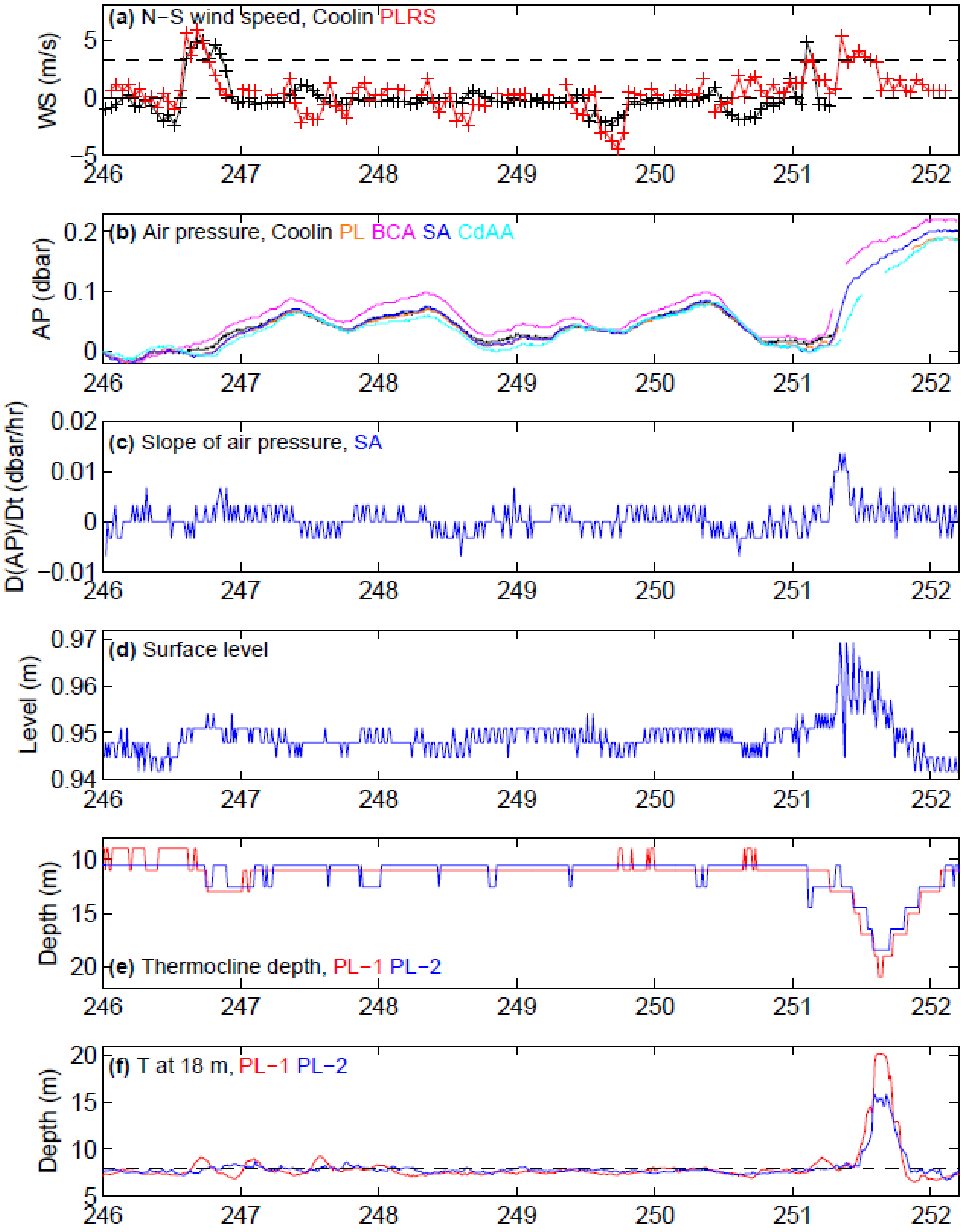


Figure 27. (a) North-south wind speed at Coolin and PLRS (hourly), (b) atmospheric pressure, (c) rate of change of atmospheric pressure, (d) water surface level (15 min.), (e) thermocline depth (maximum temperature gradient), and (f) temperature at 18 m, September 2 - 8, 2020 (day 246-252).

Stations: PLRS - Priest Lake Ranger Station; PL – Idaho Transportation Department Station ITD66 (Priest Lake) near PLRS; BCA – Boundary County Airport; SA – Sandpoint Airport; CdAA – Coeur d'Alene Airport.

There has been considerable recent interest in atmospheric pressure effects on surface water level in coastal oceans and large lakes. Under special circumstances, when the speed of the surface wave matches the speed of the atmospheric pressure front, resonant amplification can results in what are referred to as meteotsunamis (Pattiaratchi and Wijeranne 2015, Pattiaratchi 2020). In Priest Lake the average velocity of the surface wave can be estimated as $c = \sqrt{g\ h_{mn}}$, where h_{mn} is the mean depth (39 m), and g is gravity (9.81 m/s2), giving $c \sim$ 60 km/hr. For comparison the velocity the front was $u \sim$ 30 km/hr. The amplification is proportional to $1/(1-(u/c)^2)$ (eq. 2.3 Pattiaratchi and Wijeratne 2015), which for Priest Lake is a factor of only 1.3. This suggests that significant amplification did not occur, which is confirmed by the water level where the south end of the lake experienced an increase in water level of only 1 cm. While this rules out significant surface (external) waves, this leaves the question of the influence on thermocline (internal) waves. We are not aware of any work that has looked at the effect of atmospheric pressure gradients on internal wave activity.

There are variety of uncertainties that should be borne in mind:

Variations in wind We have used a limited record of wind data consisting of one station on the shore of the lake. Wind on a lake is generally higher than that measured at shore. In addition, variation of wind from location to location, while a common experience for boaters, is a source of significant uncertainty in characterizing lake behaviour. There are expected to be significant variations in the wind along the length of the Priest Lake particularly in the narrow straits and around islands. Maps of the expected winds prepared by USFS also show significant variation of wind speed *across* the south end of the lake. It is altogether possible that the wind forcing experienced on September 7, 2020 was significantly higher than that on September 2, 2020, the observations at PLRS notwithstanding.

Bathymetry The complex bathymetry of Priest Lake, with both islands and narrows, makes the usual estimates based on a rectangular lake particularly unsuitable. It is likely that smaller sections of the lake may act independently in regard to internal wave motion (c.f. Imam et al. 2013, 2020).

Higher vertical and horizontal modes. We have focused on the simplest vertical and horizontal mode (V1H1). However, higher vertical modes may be possible during periods when the metalimnion is relatively broad, as observed in Priest Lake. Higher horizontal modes may, for example, result from variation in the wind along the length of the lake.

Non-linear effects Non-linear effects, such as surges and bores have long been recognized in lakes (e.g. Farmer 1978, Horn et al 2001). In these cases, the long wave internal seiche begins to sharpen to form fronts that propagate as solitary-like waves (solitons).

Effect of rotation The internal Rossby radius, $R = \sqrt{g'h_1}/f$ where g' is the reduced gravity, h_1 is the epilimnion depth and f is the Coriolis parameter (1.08×10^{-4} rad/s at a latitude of 48 °). In early September with $g' = 0.019$ m/s^2, $h_1 = 10$ m, the internal Rossby radius was $R = 4$ km. This is wider than the mean width of Priest Lake (3 km) and suggests that the effects of rotation are unlikely to be of primary importance.

Potential for events like that of September 7, 2020

As discussed above there are a number of uncertainties regarding the forcing that generated the storm of September 7, 2020, both the degree to which wind and atmospheric pressure changes contributed to the internal wave response, and the degree to which the observed winds at PLRS were representative of the forcing on the lake. Regardless of these uncertainties we will attempt to assess the potential for events like that of September 7, 2020 in two ways:

- determine the occurrence of wind storms from the north, and
- examine pressure changes during these winds events.

To assess storms, we used the hourly data at PLRS for 2002 to 2020, calculated the north-south wind, and binned this wind into 7 hr averages, which was the approximate duration of the storm on September 7, 2020. There were a total of 47 storms with a 7 hr average wind speed from the north greater than 2.5 m/s (Table 5). Of these, storms with speed > 4 m/s (9 mph) were rare, occurring only 6 times in the last 19 years (Table 5). For comparison, the storms of September 2 and 7, 2020 (Figure 27) had a mean speed of 4.1 and 3.8 m/s, respectively.

The highest wind from the north was observed on August 14, 2002 with a 7 hr average of 6.2 m/s (14 mph), but little change in air pressure was observed during this event. The second highest wind from the north was on September 28, 2019 with a 7 hr average of 4.3 m/s (10 mph), also without significant pressure change.

The atmospheric pressure changes were examined during each of the 47 storms (Table 5). There were 9 storms during which the pressure change rose by 0.1 dbar (1000 Pa) with a front moving from north to south. Of these, 4 storms had a rate of increase of pressure similar to that observed on September 7, 2020: July 10, 2008; August 21, 2015; and two in one year, August 18 and September 11, 2016.

Several of these corresponded to notable wind events crossing northern Idaho. For example, on July 10, 2008, high winds and dry conditions resulted from a strong, dry, cold front moving across eastern

Washington and northern Idaho, with estimated wind gusts to 60 mph[2]. In another example, wind on August 21, 2015 was noted to have affected forest fires in the region.

In summary, 7 hr average winds > 3.5 m/s (7.8 mph) in June to September occurred on 14 occasions over the last 19 years. The storms occur throughout the June to September period, with slightly more events in August and September. Of the 47 storms, at total of 5 events had atmospheric pressure changes similar to that seen on September 7, 2020.

Table 7. Number of north wind storms with a 7 hr average wind speed from the north for June to September of each year, 2002-2020.

Year	2.5 to 3 m/s 2.5-5.6 mph	3 to 3.5 m/s 6.7-7.8 mph	3.5 to 4 m/s 7.8-9.0 mph	> 4 m/s >9.0 mph
2002:	2	3		1
2003:		1	1	
2004:				
2005:	1	1		
2006:	1			
2007:		3	1	
2008:	1			1
2009:	1	2		1
2010:				1
2011:		1	1	
2012:	1	1		
2013:				
2014:	1	1	1	
2015:	1	1	2	
2016:	2	1	1	
2017:	2			
2018:	2			
2019:		2		1
2020:		1	1	1
TOTAL	15	18	8	6

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[2] https://www.weather.gov/otx/July-WeatherHistory

Temperature of water withdrawn by the intake

Because of the temperature stratification, water will be withdrawn from a horizontal layer at the depth of the intake. The temperature stratification inhibits the withdrawal of water from above or below the level of the intake because of the energy needed to either bring warmer (buoyant) water down from above, or bring colder (denser) water up from below. The study of how inflow interacts with stratification is referred to as selective withdrawal (cf. Imberger et al. 1976, Fischer et al. 1979).

For linear stratification it is possible to estimate the vertical distance, δ, over which withdrawal will occur as

$$\delta \approx 0.7 \left(\frac{Q}{N}\right)^{1/3}$$

where Q is the inflow and $N = \sqrt{\frac{g}{\rho}\frac{d\rho}{dz}}$ is the Brunt–Väisälä frequency, ρ is density, g is gravity and z is depth downward (Lawrence 1980, Ivey and Blake 1985). When the stratification, N, is higher, the range depth range from which water is withdrawn, 2δ, is smaller. Note , δ is the half-thickness as shown in Figure 28b. Figure 28b is an idealization of the relative contribution of water over the depth, δ, being maximum at the level of the intake and going to zero at $\pm\delta$ from the depth of the intake (here we use a cosine function, the dominant term in the exact solution).

For Priest Lake, we use a piecewise linear stratification to approximate the density in the region of the potential intake at 18 m (Figure 28c). The stratification is higher above the level of the intake (δ^+ is smaller) and the stratification is lower below the level of the intake (δ^- is larger). For the upper stratification we approximate N using the difference in temperature between 14 to 18 m, and for the lower stratification we use the difference between 18 to 22 m; these depth ranges are comparable to δ, where δ^+ averaged 3.4 ± 0.4 m, and δ^- averaged 4.1 ± 0.4 m. Using this approximation, the withdrawal of water on average becomes negligible 3.4 m above depth of the intake and 4.1 m below the depth of the intake.

Excluding day 251, the estimated outlet temperature is within 0.6 °C of the temperature observed at 18 m, and the average difference is 0.1 °C. This suggests that the inclusion of cooler water from below is approximately balanced by the inclusion of warmer water from above, and that the measured temperature is a good approximation to the temperature of the water that will be withdrawn.

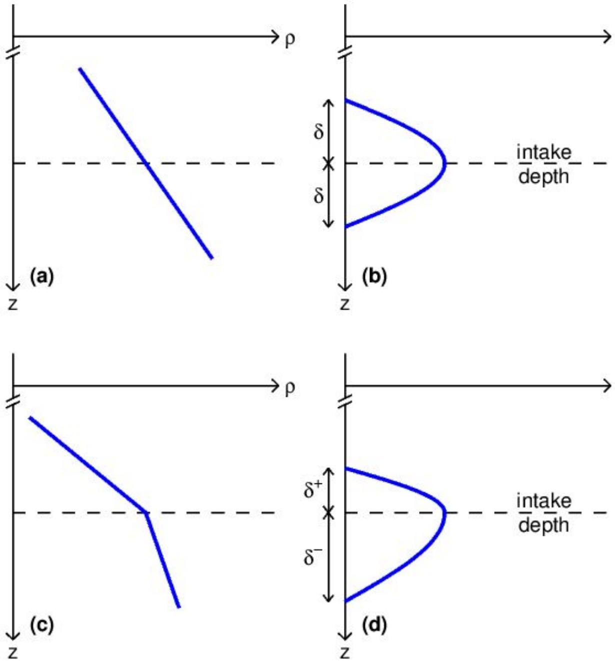

Figure 28 Schematic illustrating selective withdrawal from (a,b) linear stratification and (c,d) piece-wise linear stratification.

ρ is density, z is depth downward, u is velocity of water withdrawn (far from the intake), and δ is the half-thickness of the withdrawal layer.

Effect of the proposed withdrawal on the stratification in the lake

The proposed intake would withdraw 45 - 103 cfs (1.3 – 2.9 m^3/s). This is generally less than the outflow rate except for periods of low flow, see Figure 5. During low flow, the withdrawal would need to be reduced to maintain the target summer water level.

For comparison, the monthly average outflow from Priest Lake averaged from 75 m^3/s in June to 4.1 m^3/s in September (Table 6). Outflow from Priest Lake is from the surface. For example, the average inflow of 17 m^3/s in July corresponds to adding a layer of water with depth of 0.47 m over the surface area of the lake. Inflows either mix into the epilimnion itself, or plunge into the metalimnion; in either case the inflow causes the outflow of surface water at the dam. If the average epilimnion depth in July was approximately 5 m (Figure 9), July inflow would on average replace about 10% of the epilimnion. Similarly, the average inflow of 4 m^3/s in September corresponds to a layer of 0.11 m and, out of a typical epilimnion depth of 10 m, only about 1% would be replaced. This suggests that the summer residence time of the epilimnion in Priest Lake is relatively long.

Table 8. Average and minimum outflow from Priest Lake, 2017-2020

	June	July	August	September
Average (m^3/s)	75	17	4.6	4.1

The proposed intake would withdraw a maximum of 2.9 m^3/s, which corresponds to a layer thickness of approximately 0.08 m/month (3 inches/month). The proposed intake would withdraw this layer of water from 18 m (see previous section), which would deepen the thermocline slightly. In effect, rather than all outflow from the epilimnion that is warmer, a fraction of water will be withdrawn from below that is cooler, resulting in a small increase in the residence time of the epilimnion. This could also result in a small increase in the heat content of the epilimnion (all else being equal) and could potentially result in a slight increase the strength of the temperature stratification. However, the effect of these small changes would be not be significant. For example, the slight increase in heat content of the epilimnion due to the withdrawal would be small compared to the natural variation in the surface heat fluxes, andthe deepening of the epilimnion due to the withdrawal would be small compared to the natural deepening of the epilimnion over the course of the summer due to wind and convective cooling.

Another way of assessing the influence of the withdrawal on the stratification is to consider drawdown in an idealized two-layer system; we estimate whether the water from the thermocline could be drawn into the intake. Lubin and Springer (1967) give the critical separation for a sharp density interface as,

$$h = 0.69\left(\frac{Q^2}{g'}\right)^{\frac{1}{5}}$$

where Q is the flow and g' is the reduced gravity across the density interface, $g' = (\rho_2 - \rho_1)g/\rho_2$, ρ_1 is the density of upper layer (epilimnion), ρ_2 is the density of the lower layer (hypolimnion), and g is gravity (9.8 m/s^2). For the maximum inflow, $Q = 2.9$ m^3/s, the value of h is shown in Figure 29a from

July to September, the period when a distinct epilimnion and thermocline have developed. Figure 29b compares the estimated separation between the critical depth above the 18 m intake (red line) to the depth of the 16 °C isotherm (blue line) which approximates the depth of the thermocline. With the exception of the storm on September 7, 2020 (day 251), the thermocline lies above the critical separation suggesting that entrainment of the epilimnion into the intake will not occur. Note that in Priest Lake the thermocline is not sharp and the intake may entrain the lower part of the metalimnion as discussed in the previous section.

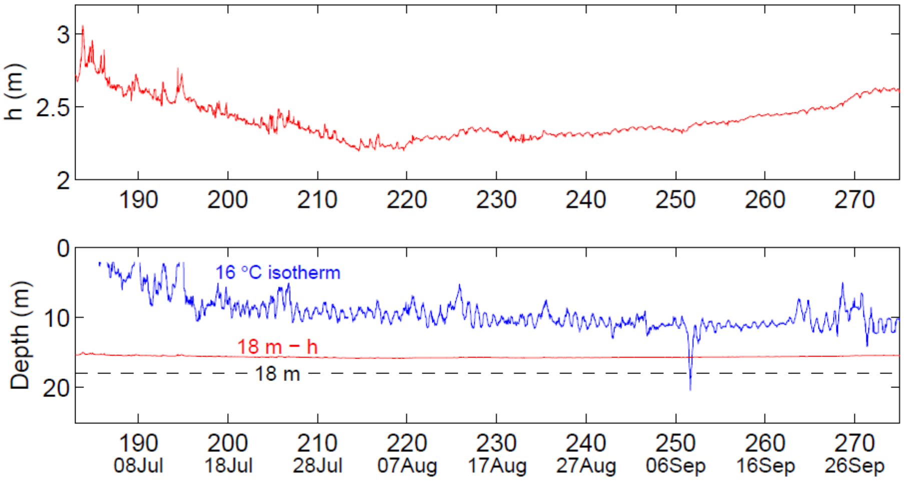

Figure 29. (a) Critical depth and (b) 18 m minus the critical depth compared to the 16 °C isotherm representing the thermocline, July to September, 2020.

We can also estimate the potential for a dip in the water surface using the results of Lubin and Springer (1967). Because of the large density difference between air and water the reduced gravity $g' = (\rho_2 - \rho_1)g/\rho_2$ becomes g, and the critical separation becomes

$$h = 0.69\left(\frac{Q^2}{g}\right)^{\frac{1}{5}}$$

For $Q = 2.9$ m^3/s and $g = 9.8$ m/s^2, then $h = 0.7$ m; a dip in the water surface would only occur if the intake point was less that one meter below the lake surface.