Little Bitterroot Lake
Water Quality Monitoring Program
2017 Annual Report

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Glossary of Terms

Benthic – the bottom region of a lake including the sediment surface

Bloom – a significant increase in algae population triggered by favorable conditions for growth

Chlorophyll-*a* – a green pigment found in photosynthetic plants and algae

Depth profile – a chart showing a water chemistry parameter at various depths within a lake

Epilimnion – the uppermost portion of a stratified lake

Eutrophic – having high biological productivity (meso-eutrophic is moderately high), high productivity is commonly an indicator of high nutrients and poor water quality

Hypolimnion – the bottom layer of a stratified lake

Mesotrophic – having moderate biological productivity

Metalimnion – the middle (transitional) layer of a stratified lake

Oligotrophic – having low biological productivity (meso-oligotrophic is moderately low), low productivity is an indicator of low nutrient concentrations and good water quality

Trophic – relating to available nutrients (ex. trophic status)

Trophic status – a lake's ability to produce and sustain populations of algae in response to available nutrients, also referred to as lake productivity or biological productivity

List of Acronyms

CFS – cubic feet per second
DEQ –Montana Department of Environmental Quality
DO – dissolved oxygen
DOC – dissolved organic carbon
FLBS – Flathead Lake Biological Station
GPM – gallons per minute
LBLA – Little Bitterroot Lake Association
SAP – sampling and analysis plan
SC – specific conductance
TN – total nitrogen
TP – total phosphorus
TSI – trophic state index
TSS – total suspended sediment
USGS – United States Geological Survey
WET – Water & Environmental Technologies
WLI – Whitefish Lake Institute

Executive Summary

Little Bitterroot Lake was sampled on August 2, 2017, which was the 18th sampling event since 1999. Seven lake locations were sampled for field parameters, nutrients, and chlorophyll-a, and 2 stream sites were sampled for field parameters and nutrients. Two additional stream sites were added on Herrig Creek to help evaluate potential effects from recent logging and slash burning within the watershed. Depth profiles were recorded at the lake center on August 7, and attached algae was sampled from 2 shoreline locations in 2017.

Little Bitterroot Lake continued to show excellent water quality in 2017. Total nitrogen in 2017 was slightly higher than 2016, and was near the average concentration for the entire monitoring period. The average total phosphorus concentration was the same as 2016, and was the 3rd lowest average on record. Nitrogen concentrations were similar throughout the lake, ranging from 0.13 to 0.18 mg/L. Total phosphorus concentrations ranged from 0.003 mg/L (below detection) to 0.010 mg/L at the lake center and 0.012 mg/L in Herrig Creek. Little Bitterroot Lake continues to be phosphorus limited, meaning that algae blooms are most likely to occur with inputs of phosphorus.

Near surface lake temperatures in August were around 20.5°C (69°F). The lake was thermally stratified with an epilimnion from 0 to 26 feet, a metalimnion from 26 to 60 feet, and a hypolimnion below 60 feet, which is typical for mid-summer in Little Bitterroot Lake. Measurements of other field parameters in 2017 were consistent with previous years, including specific conductance, pH, and dissolved oxygen.

Algae in the water column (chlorophyll-a) was very low, but one sample was above detection at a depth of 60' below the lake surface. Dissolved oxygen also peaked near this depth, which is expected because algae produce oxygen during daylight hours. Algae concentrations in the water column did not reach nuisance levels, and were comparable to data from previous sample years. Two benthic algae samples were collected in 2017 from Lock Bay and the southeast location. Benthic algae concentrations were very low and comparable to previous samples.

The trophic state index for Little Bitterroot Lake was oligotrophic based on concentrations of chlorophyll-a and phosphorus, meaning the lake has low primary productivity and good water quality. Total nitrogen concentrations indicate the lake has potential to be eutrophic, but the lake is phosphorus limited and the low concentrations of available phosphorus help prevent nuisance algae blooms. When compared to 10 regional large lakes, Little Bitterroot Lake ranks 5th lowest in nitrogen concentration, and 2nd lowest in phosphorus and chlorophyll-a.

Additional samples were collected from the Herrig Creek watershed in 2017 to evaluate effects of logging and slash burning from recent timber sales. The upper Herrig Creek sites showed higher nutrient concentrations than the lake. All samples of total suspended sediment were below the analytical detection limit, which indicates that sedimentation was not an issue in Herrig Creek in 2017. Dissolved organic carbon samples were also collected, which were highest at the upper Herrig Creek site.

In order to improve or maintain water quality in Little Bitterroot Lake, efforts should be made to reduce sources of nutrients, such as limiting application of fertilizer to lawns, maintaining septic systems, keeping a vegetated buffer area, and reducing shoreline erosion. Little Bitterroot Lake is phosphorus limited, meaning that additional inputs of phosphorus are more likely to cause undesirable algae blooms. Fertilizers with little or no phosphorus are recommended to help maintain good water quality. This can be accomplished by selecting fertilizers with a zero as the middle value (i.e. 16-0-0).

1.0 Introduction

Little Bitterroot Lake is the headwaters for the Little Bitterroot River located southwest of Kalispell near the community of Marion at an elevation of approximately 3900 feet (**Attachment A**, **Figure 1**). The lake has a maximum depth of 260 feet, a surface area of approximately 4.6 square miles (2,950 acres) and a drainage area of 34.4 square miles (22,000 acres). The area exists within the Salish Mountains Ecoregion with a humid continental climate (Köppen classification Dfb) and an average annual precipitation of 21 inches. The geology of the watershed is primarily sedimentary rocks of the Belt series. The lake outlet is controlled by an earthen dam built in 1918, and is managed by the Flathead Irrigation Project for downstream irrigators. Herrig Creek is the only perennial stream flowing into the lake, although seven intermittent or ephemeral streams contribute seasonally. Groundwater contributes a substantial portion of water to the lake, especially from the Salish Mountains to the west and northeast. Local uses of the lake include water supply for domestic use, irrigation, fishing and recreation.

The Little Bitterroot Lake Association (LBLA) began in 1988 with the purpose of "preserving the high recreational value of Little Bitterroot Lake, maintaining its aesthetic integrity, and to educate the public and others as to the value of Little Bitterroot Lake as a recreational resource." Water quality monitoring has been conducted on the lake since 1999. The purpose of the monitoring program is to establish a water quality and nutrient baseline for the inflow, outflow, and lake water in conjunction with prior water quality projects. Information from this monitoring program may be used to make management decisions to help maintain the aesthetic and recreational conditions of the lake and surrounding drainages, and to help prioritize future monitoring efforts.

This report outlines the history of the monitoring program and presents water quality results from 2017 and past monitoring events. Long term trends in nutrient concentrations and trophic status are provided for locations that have been sampled consistently since 1999.

2.0 Monitoring Program History

Water & Environmental Technologies (WET) have conducted 18 sampling events on Little Bitterroot Lake since 1999 with assistance from the Little Bitterroot Lake Association. Data collected during sampling helps document existing water quality, track changes in nutrient concentrations over time, and to characterize the lake's productivity and trophic status. Additional data have been collected by the Flathead Lake Biological Station, Flathead Basin Commission, Flathead High School, Montana DEQ, University of Montana, and Whitefish Lake Institute. Laboratory analyses in 2017 were provided by Energy Laboratories in Helena, MT, and funded by a grant from the Volunteer Monitoring Support Program administered by Montana DEQ.

Past monitoring events conducted by WET on Little Bitterroot Lake include:

November 30, 1999	May 24, 2000	September 27, 2004	September 1, 2005
September 25, 2006	October 8, 2007	October 13, 2008	October 5, 2009
June 3, 2010	August 23, 2010	September 20, 2011	September 10, 2012
May 20, 2013	August 29, 2013	August 11, 2014	August 11, 2015
August 3, 2016	August 2, 2017.		

Depth profiles were measured in Little Bitterroot Lake on August 7, 2017, by the Whitefish Lake Institute, which oversees the Northwest Montana Lakes Volunteer Monitoring Network. Data from Whitefish Lake Institute collected in 2017 are included within this report.

3.0 Field and Analytical Methods

The 2017 sampling events were conducted by WET on August 2 and by Whitefish Lake Institute on August 7 with assistance from members of LBLA. Water quality sampling was conducted at 7 lake locations and 4 stream locations, including 3 sites on the inlet stream (Herrig Creek) and one site on the outlet stream (Little Bitterroot River) (**Figure 1**). Two sites were included in the upper watershed of Herrig Creek to help evaluate potential effects from recent logging and slash burning. This is the second year of sampling at these locations.

Lake and stream sampling includes measurements of field parameters (temperature, dissolved oxygen, specific conductance, and pH), collection of nutrient samples for laboratory analysis, and depth profile monitoring at the lake center. Two near-shore sites were also sampled for benthic algae in 2017. Methods of each component of the monitoring program are summarized in the following sections. A complete description of field and analytical methods are provided in the project Sampling and Analysis Plan (SAP) (WET, 2017) which is provided to Montana DEQ to procure funding from the grant program.

3.1 Field Parameters

Field parameters including water temperature, dissolved oxygen, specific conductance and pH are monitored using a portable water quality meter at each sample location. The instrument is calibrated during the day of sampling. Water clarity is evaluated at the lake center using a Secchi disc, and stream flow is measured at the inlet and outlet streams using an electronic flow meter.

3.2 Water Chemistry Samples

Samples are collected for laboratory analysis of nutrients at each lake and stream location. Bottles are filled from moving water at the inlet and outlet streams, and from just below the surface at lake sites. At the lake center, samples are collected at various depths using a Van Dorn type sampler. Samples are filtered or preserved if necessary, and stored in a cooler on ice for delivery to the laboratory. Nutrient parameters analyzed at the laboratory include various forms of nitrogen (nitrate+nitrite, ammonia, total Kjeldahl, organic, total) and phosphorous (dissolved and total).

Samples for total suspended solids (TSS) and dissolved organic carbon (DOC) were also collected in 2017 from the lake center, the inlet and outlet streams, and from two additional sites on Herrig Creek. The purpose of these samples was to provide baseline data for in-stream sediment and carbon in response to recent logging and slash burning within the Herrig Creek watershed.

All laboratory analyses were performed by Energy Laboratories in Helena, MT, using standard analytical methods, which are described in detail in the project SAP.

3.3 Algae Samples

Samples are collected from lake sites to analyze the concentration of chlorophyll-a, which provides a measurement of algae growth in water. Chlorophyll-a samples are collected in amber glass bottles, and are wrapped in aluminum foil to prevent exposure to sunlight, which can degrade break down the chlorophyll and degrade sample integrity. Chlorophyll-a samples are collected from near the surface at 7 lake sites, and 2 samples are collected from various depths at the lake center.

Samples were collected from two locations in 2017 to measure the algae growth on shoreline rocks, also called attached algae or benthic algae. For benthic algae collection, large rocks are selected from the wadeable portion of the lake with typical algae growth for the area. A template is placed on the rock, and algae are removed from inside the template by scraping and brushing. The removed algae are filtered on a glass filter, placed in a centrifuge tube, wrapped in aluminum foil, and stored on dry ice for delivery to the laboratory. The algae sample is then analyzed for concentration of chlorophyll-a.

3.4 Depth Profile Sampling

Depth profile sampling was conducted at the lake center to evaluate changes in field and nutrient parameters at depth, which indicate whether or not the lake is stratified during sampling. Depth profile sampling was conducted by Whitefish Lake Institute on August 7, 2017, using a portable Hydrolab water quality meter which measures depth, chlorophyll-a, temperature, specific conductance, dissolved oxygen, and pH. The Hydrolab has a maximum sampling depth of 140 feet, which is sufficient to monitor for stratification in Little Bitterroot Lake.

4.0 2017 Monitoring Results

Results from 2017 are provided in **Attachment A** and summarized in the following sections below.

4.1 2017 Field Parameter Results

Field parameter results from 2017 are provided in **Table 1** in **Appendix A**. Weather during lake and stream sampling was warm (~80°F) with partly cloudy skies and light wind. There was also considerable smoke in the air from recent forest fires. In August 2017, the lake had a uniform surface temperature around 20°C (68°F). Herrig Creek was contributing cooler water around 16.9°C (62°F) at a flow of approximately 2.5 CFS (1100 gallons per minute, GPM). The Little Bitterroot River at the outlet had a relatively warm temperature of 21.4°C (70.5°F) and a flow of 7 CFS (3100 GPM).

The pH at lake sites varied between 8.2 and 8.5, while the inlet and outlet streams measured 6.7 and 8.9, respectively. Biological activity by plants and algae raise pH during daytime hours when photosynthesis is occurring, which may attribute to the higher pH measurements in the lake when compared to the inlet stream.

Dissolved oxygen (DO) varied from 8.8 to 9.3 mg/L in the lake, while DO measured 9.9 mg/L in the inlet stream and 8.7 mg/L in the outlet stream. Specific conductance was quite low in the inlet stream (47 µS/cm) but uniformly around 101 µS/cm at the lake sites. Specific conductance at the outlet stream was slightly higher than lake sites, measuring 108 µS/cm.

Field parameters were also recorded at the additional sites on Herrig Creek (HC-1 and HC-2). Water temperature at Herrig Creek sites increased from 14.0°C (57°F) at the upper site to 15.6°C (60°F) at the middle site, and 16.9°C (62°F) at the mouth. Dissolved oxygen was highest at the middle sample sites (HC-2) with a concentration of 11.2 mg/L, although all sites had relatively high concentrations of dissolved oxygen sufficient to support aquatic life. Specific conductance measured 63 µS/cm at the upper site, and 43 and 47 µS/cm at the middle and lower sites, respectively. Readings of pH were lowest at the upper Herrig Creek site (6.3), and measured 7.7 and 6.7 at the middle and lower sites, respectively. Stream flow was quite low at the upper site, and was measured at 2 GPM using a stopwatch and bucket. The middle and lower Herrig Creek sites were flowing at approximately 2.5 CFS (1100 GPM). These field parameter results are typical for a healthy mountain stream.

These results are comparable to field parameters measured during previous sample years, and are indicative of good water quality and oligotrophic conditions. Nearly three times the volume of water was leaving the lake at the outlet when compared to the inflow stream, which suggests the lake level was relatively high at the time of sampling.

4.2 2017 Nutrient Results

Results from August 2017 are provided in **Table 1**, and data for total nitrogen (TN) and total phosphorus

(TP) are shown spatially in **Figure 2**, organized left to right from the lake inlet (Herrig Creek) to the lake outlet (Little Bitterroot River).

In 2017, total nitrogen concentrations were comparable throughout the lake. The highest values were recorded at the lake center at a depth of 60' (0.018 mg/L) and at the inlet and outlet streams (0.017 mg/L). Total nitrogen was lowest at several lake sites, which all measured 0.13 mg/L. The additional sites on Herrig Creek displayed higher concentrations of TN than the lake sites, with the upper site measuring 0.34 mg/L and the middle site measuring 0.18 mg/L.

Total phosphorus measurements were also low throughout the lake in 2017. The highest TP readings in the lake were at the lake center at a depth of 60' (0.010 mg/L). Herrig Creek also had higher TP readings than the lake sites, measuring 0.023 mg/L at the upper sites, and 0.012 mg/L at the middle and lower sites of Herrig Creek. The lowest measurements were below the analytical detection limit (0.003 mg/L) at 5 lake sites. Little Bitterroot Lake has typically been described as "phosphorus-limited", so it's likely that inputs of phosphorus from the inlet stream are consumed by algae and aquatic plants within the lake, resulting in lower measurements of total phosphorus in the lake samples.

4.3 2017 Chlorophyll-a Results

In August 2017, algae growth in the water column was very low, with most samples being below the analytical detection limit. The only detectable sample of chlorophyll-a occurred at 60' below the lake surface at the lake center (1.0 mg/L). The highest concentration of dissolved oxygen occurred approximately 53' below the lake surface, which is expected because algae produce oxygen during daytime hours. Depth profile measurements from the Hydrolab measured a peak algae concentration of 3.3 mg/L at a depth of 92'.

Attached algae, also called benthic algae, were sampled at two shoreline locations in August 2017, including Lock Bay and the southeast corner. Sampling results showed very low chlorophyll-a concentrations (0.7 mg/m^2) at both locations. Previous benthic algae concentrations have ranged from 2.3 to 3.6 mg/m^2. Prolific algae growth can be a problem because it consumes oxygen from the water column during the night, which can cause low oxygen levels for fish and other aquatic organisms. Algae can also be a physical nuisance to homeowners and recreationists due to prolific growth. Concentrations of algae in the water column and on shoreline rocks at Little Bitterroot Lake are quite low and not at nuisance levels, although additional inputs of nutrients could increase algae growth around the lake.

4.4 2017 Depth Profile Results

Depth profile sampling was conducted on August 7, 2017, to show changes in water chemistry at depth. Results from the depth profile sampling are shown in **Figure 3**, including charts for water temperature, dissolved oxygen, pH, and chlorophyll-a. Results from 2014 to 2017 are shown for comparison.

In August 2017 the lake was thermally stratified with an epilimnion (upper layer) from 0 to 26 feet, a metalimnion (transitional layer) from 26 to 60 feet, and a hypolimnion (bottom layer) from approximately 60 feet to the lake bottom. These results are comparable to previous years, although 2014 exhibited higher measurements of chlorophyll-a and dissolved oxygen. Surface water temperatures were also slightly higher in August 2014.

Dissolved oxygen was near 7.9 mg/L in the epilimnion in August 2017, with a peak occurring around 53' below the lake surface (12.2 mg/L). Dissolved oxygen typically peaks in the area with the highest algae growth because the algae produce oxygen during photosynthesis. Dissolved oxygen concentrations are well above the threshold for aquatic life (5 mg/L) throughout the water column, which is typical of an oligotrophic lake with good water quality and low biological productivity.

4.5 Long Term Trends

Results from 2004 to 2017 are shown for all sample locations in **Figure 4,** and **Figure 5** shows minimum, maximum, and average results from 2004-2017. Nutrient concentrations have generally shown a decreasing trend since consistent yearly monitoring began in 2004. In August 2017, total nitrogen concentrations in Little Bitterroot Lake were slightly higher than those measured in 2016, but results were comparable to samples collected since 2012. Concentrations of total phosphorus were also very low and comparable to data collected since 2012. Higher concentrations of nutrients have occurred in years with relatively high precipitation such as 2011, which can cause inputs of additional nutrients to enter the lake from the surrounding watershed.

The downward trends in nutrient concentrations are encouraging from the standpoint of improving water quality, but should be interpreted with caution because of the limited temporal data available for Little Bitterroot Lake. Nutrient concentrations can vary between seasons or change rapidly due to episodic events such as runoff or lake turnover, so sample events may not coincide with periods of peak nutrient concentrations. Data and trends become more robust as future measurements are added to the dataset, and continuity and consistency are maintained within the monitoring program.

Data from the entire sampling period (1999 to 2017) were analyzed spatially by combining all data for each sample location shown in **Figure 6**. These charts show the minimum, maximum, and average nutrient concentrations for each sample site for the period of record. Sample locations are organized from left to right in the general direction of flow through the lake, from the inlet (Herrig Creek) to the outlet (Little Bitterroot River). Average concentrations of total nitrogen are lowest at the lake center and highest at the lake outlet. Concentrations of total phosphorus are lowest at the inlet and at Slaughter House Bay, and are highest at the center of the lake. However, results for total nitrogen and phosphorus are quite variable at each location and differences between sample locations may not be statistically significant.

4.6 Trophic Status

Trophic status refers to a lake's ability to produce and sustain populations of algae in response to available nutrients, also referred to as biological productivity. High biological productivity is an indicator of high nutrients and poor water quality, whereas low biological productivity is an indicator of low nutrient concentrations and good water quality. The trophic status of Little Bitterroot Lake was determined by calculating the Carlson's Trophic State Index (TSI) from measurements of total nitrogen, total phosphorus and chlorophyll-a (Carlson, 1977). The TSI for Little Bitterroot Lake is shown in **Figure 7** for data from 2004 to 2017.

TSI data suggest that Little Bitterroot Lake is classified as eutrophic based on concentrations of total nitrogen; however, measurements of total phosphorus and chlorophyll-a indicate that the lake is oligotrophic with low biological productivity. Total phosphorus concentrations in 2017 were very low, indicating oligotrophic conditions.

Despite having relatively high concentrations of total nitrogen, Little Bitterroot Lake typically does not experience large blooms of nuisance algae and has shown low concentrations of chlorophyll-a during sample events conducted from 2010 to 2017. The low biological productivity is likely because the lake's morphology is favorable to oligotrophic conditions and limited by low phosphorus concentrations. Little Bitterroot Lake has steep sides, limited littoral (shallow shoreline) habitat, and a low watershed/lake ratio of 4.8 (Ellis et al, 1998). The lake appears to be phosphorus-limited, meaning that it has an adequate amount of nitrogen compared to the amount of phosphorus needed to support algae growth. Lakes that are phosphorus-limited often show increased algae growth when phosphorus concentrations increase, but not necessarily when nitrogen concentrations increase. Total phosphorus is commonly associated with sediment, so high concentrations often occur in years following land disturbance (such as road building or logging) or increased precipitation and runoff.

4.7 Additional Sample Results from Herrig Creek

Additional samples were collected from two sites on Herrig Creek in 2017 in response to recent logging and slash burning in the watershed. Baseline samples for nutrient parameters were collected, along with dissolved organic carbon and total suspended sediment, which can increase due to land disturbance such as logging, burning, or road building. Dissolved organic carbon (DOC) is an important food source for algae, and total suspended sediment (TSS) is a measure of the amount of sediment that is carried in the stream. For comparison, samples of DOC and TSS were also collected at the lake center and in the outlet stream.

Concentrations of DOC were lowest at the lake center (3.2 mg/L) and highest at the upper Herrig Creek site (6.0 mg/L). It's expected to see lower concentrations of DOC in the lake because it is consumed by algae during photosynthesis. These concentrations are considered typical for undisturbed watersheds, and serve as a baseline that can be evaluated against future results.

Concentrations of TSS were below the analytical detection limit at all sites in 2017, which indicates that stream water quality does not contain measureable concentrations of sediment. Stream flows were relatively low at the time of sampling, so detectable concentrations could be expected during spring runoff.

Nutrient concentrations were higher in the additional Herrig Creek sites than all lake sites, which indicates that Herrig Creek is a source of both nitrogen and phosphorus to Little Bitterroot Lake. Concentrations were highest at the upper Herrig Creek site and decrease downstream.

5.0 Discussion and Conclusions

Water quality in Little Bitterroot Lake was very good in 2017, with low concentrations of nutrients and chlorophyll-a. Total nutrient concentrations (nitrogen and phosphorus) have generally been decreasing since the inception of the monitoring program in 1999. The highest concentrations of total nitrogen have typically occurred at Herrig Creek Bay and the lake outlet, while the highest concentrations of total phosphorus have occurred at the lake center. The highest concentrations of both nutrients were exhibited in 2011, which was a high precipitation year during which excess nutrients may have been flushed into Little Bitterroot Lake from the surrounding watershed. Past sampling events indicate that lake water quality is strongly influenced by ground water with less input from Herrig Creek and other intermittent streams.

The trophic state index for Little Bitterroot Lake suggests eutrophic conditions exist due to elevated concentrations of total nitrogen, but measurements of total phosphorus and chlorophyll-a indicate oligotrophic conditions with low biological productivity and very good water quality. Little Bitterroot Lake has typically been phosphorus-limited, meaning it has an inadequate amount of phosphorus compared to the amount of nitrogen needed to support algae growth. Based on this observation, Little Bitterroot Lake is more likely to experience algae blooms with the addition of phosphorus since concentrations of nitrogen are already relatively elevated. However, nutrient concentrations can vary significantly, and efforts to reduce inputs of both phosphorus and nitrogen should be encouraged to help maintain the water quality of Little Bitterroot Lake and limit algae growth.

Overall, Little Bitterroot Lake has shown excellent water quality throughout its monitoring history. Nutrient and chlorophyll-a concentrations are low, algae blooms are rare, and field data indicate suitable ranges of temperature, dissolved oxygen and pH to support a viable fishery. Little Bitterroot Lake also displays excellent water quality when compared to other regional lakes. 41 lakes are presently monitored annually through the Northwest Montana Lakes Volunteer Monitoring Network (NWMTLVMN), including 10 lakes classified as large lakes with surface areas greater than 500 acres (WLI, 2018). Among the large lakes monitored through NWMTLVMN, Little Bitterroot Lakes is the 5th lowest in nitrogen concentration, and 2nd lowest in phosphorus and chlorophyll-a concentrations. These results are consistent with our monitoring program, which indicate that Little Bitterroot Lake is phosphorus limited and has a trophic status of oligotrophic.

6.0 References

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Attachment A – Tables and Figures


Legend
2017 Sample Locations
HC-2
Herrig Creek-Middle
Lodgepole Road
SP-10
Northwest Bay
SP-7
Inlet-Herrig Creek
SP-2
Herrig Cr. Bay
SP-3
Lock Bay
Old Bitterroot Road
SP-1
Slaughter House Bay
SP-5
Lake Center
Little Bitterroot
Lake
SP-4
Southwest
SP-6
Southeast
Bitterroot Road
Little Bitterroot Dam
SP-9
Outlet-Little Bitterroot River
Upper Lost Prairie Road
N
W
E
S
1 inch = 2,000 feet
Feet
0
1,000
2,000
Water & Environmental
TECHNOLOGIES
Little Bitterroot Lake
2017 Sample Locations
Flathead County, Montana
Job#: LHBHHM01
Date: 3/28/2017
FIGURE 1

Table 1. 2017 Water Quality Data.

Sample Info			Field Water Quality				Nutrients					Chlorophyll-a		Additional Samples	
Site	**Date**	**Site Description**	**Temperature (°C)**	**Dissolved Oxygen (mg/L)**	**Specific Conductance (uS/cm)**	**pH**	**Nitrate + Nitrite Nitrogen (mg/L)**	**Ammonia Nitrogen (mg/L)**	**Total Nitrogen (mg/L)**	**Ortho Phosphorus (mg/L)**	**Total Phosphorus (mg/L)**	**Algae in Water (mg/L)**	**Benthic Algae (mg/m^2)**	**Total Suspended Solids (mg/L)**	**Dissolved Organic Carbon (mg/L)**
							0.01	**0.05**	**0.04**	**0.001**	**0.003**	**0.1**	**0.1**	**4**	**0.5**
SP-2	8/2/17	North - Herrig Cr. Bay	20.04	9.3	102	8.44	0.010	0.050	**0.13**	**0.006**	0.003	0.10			
SP-10	8/2/17	Northwest - Northwest Bay	20.41	9.3	100	8.43	0.010	0.050	**0.13**	**0.008**	**0.005**	0.10			
SP-1	8/2/17	East - Slaughter House Bay	20.67	9.0	102	8.42	0.010	0.050	**0.13**	**0.007**	0.003	0.10			
SP-3	8/2/17	West - Lock Bay	20.28	9.0	102	8.39	0.010	0.050	**0.13**	**0.007**	0.003	0.10	**0.7**		
SP-5	8/2/17	Lake Center - surface	20.29	9.2	101	8.51	0.010	0.050	**0.14**	**0.007**	0.003	0.10		ND	**3.2**
SP-5-30	8/2/17	Lake Center - 30' depth	field data shown with depth profile				0.010	0.050	**0.15**	**0.008**	**0.006**	0.10			
SP-5-60	8/2/17	Lake Center - 60' depth					0.010	0.050	**0.18**	**0.007**	**0.010**	**1.00**			
SP-4	8/2/17	Southwest	20.69	8.8	100	8.17	0.010	0.050	**0.15**	**0.006**	0.003	0.10			
SP-6	8/2/17	Southeast	20.35	9.0	102	8.22	0.010	0.050	**0.14**	**0.009**	**0.005**	0.10	**0.7**		
HC-1	8/2/17	Herrig Creek - upper site	13.96	8.9	63	6.31	**0.150**	0.050	**0.34**	**0.021**	**0.023**			ND	**6.0**
HC-2	8/2/17	Herrig Creek - middle site	15.57	11.2	43	7.72	**0.040**	0.050	**0.18**	**0.011**	**0.012**			ND	**3.5**
SP-7	8/2/17	Herrig Creek - at mouth	16.88	9.9	47	6.73	0.010	**0.100**	**0.17**	**0.009**	**0.012**			ND	**3.9**
SP-9	8/2/17	Ltl. Bitterroot River - at outlet	21.36	8.7	108	8.89	0.010	0.050	**0.17**	**0.008**	**0.007**			ND	**3.4**

The analytical detection limit for water quality parameters are provided below the constituent name.
Values in **BOLD** are above the analytical detection limit.
ND indicates "no detection", value is below the analytical detection limit.

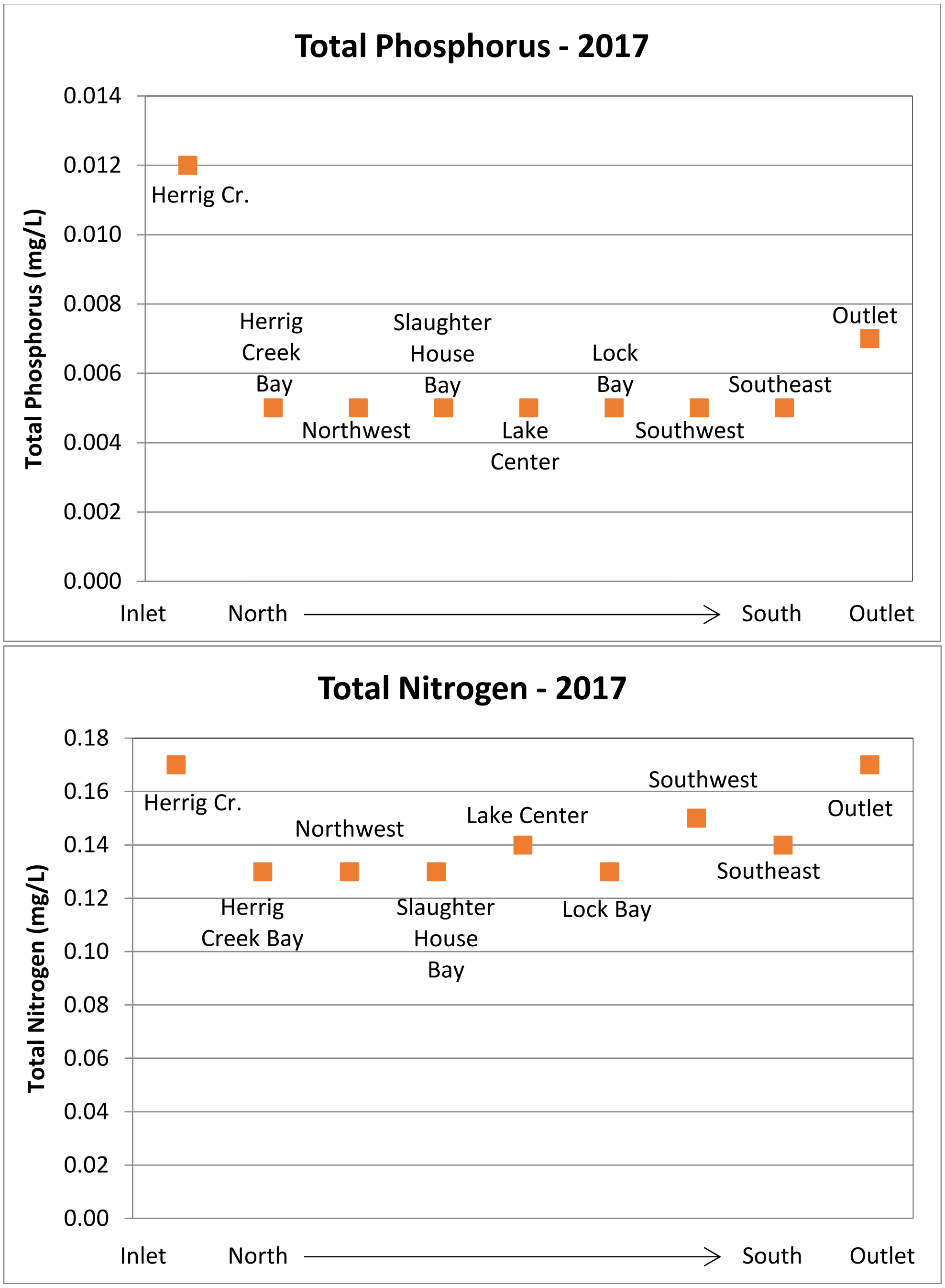


Figure 2. Total Nitrogen and Total Phosphorus Results for 2017.

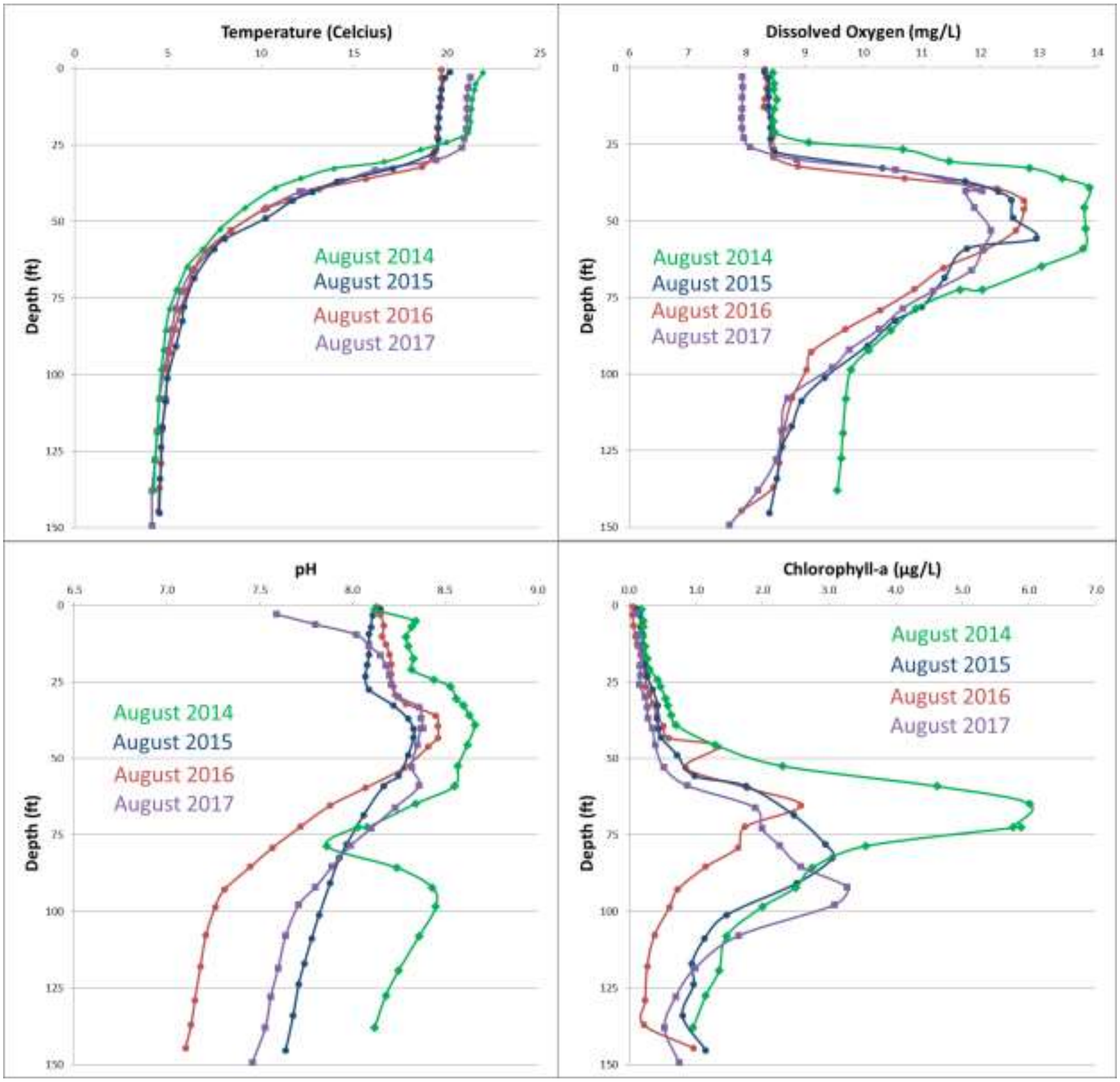
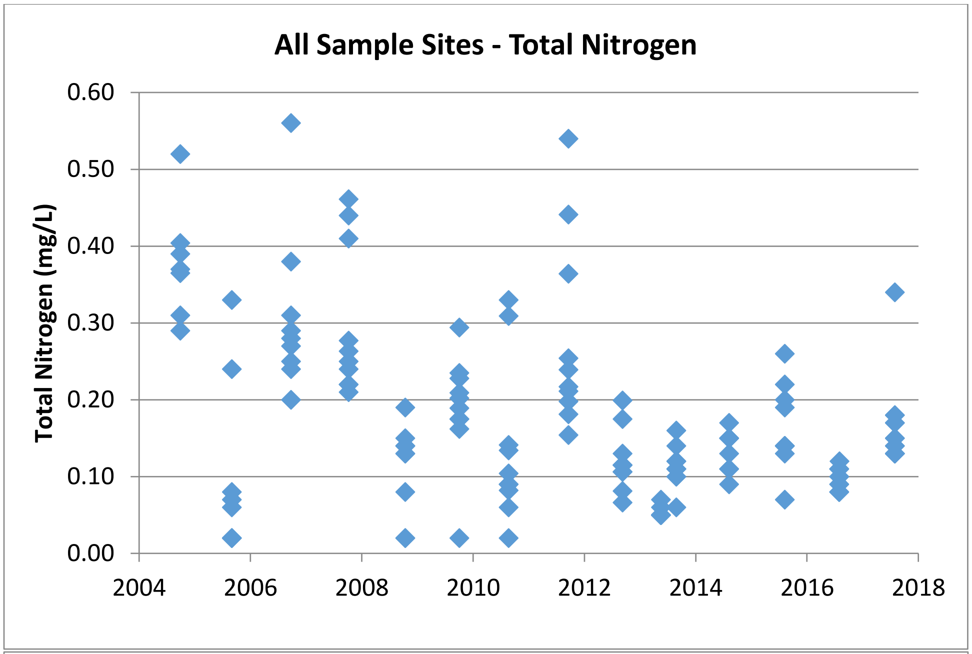


Figure 3. Depth Profile Results for 2017.



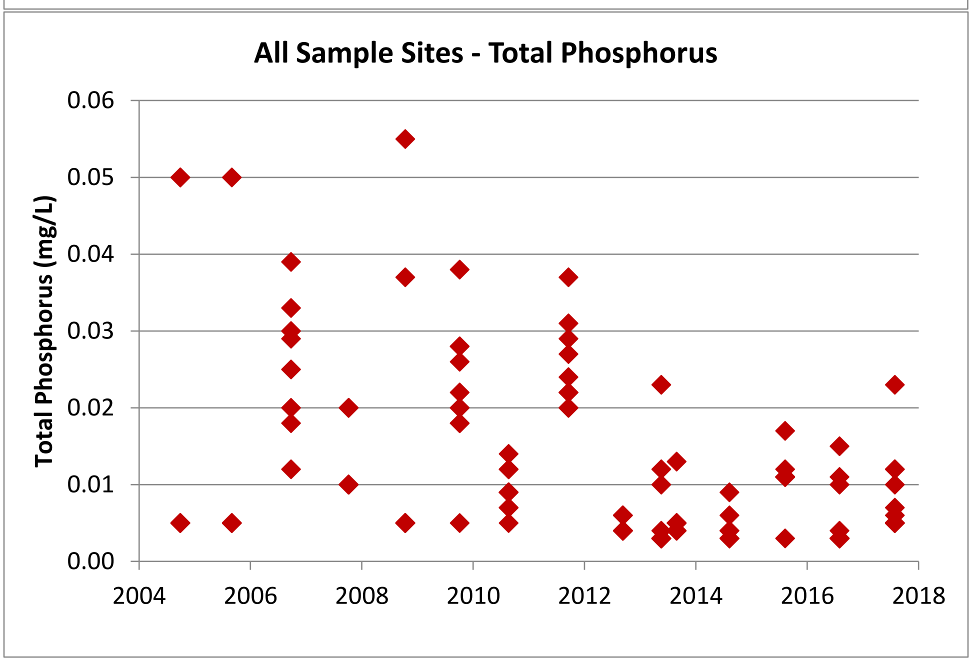


Figure 4. Total Nitrogen and Total Phosphorus Results for 2004-2017.

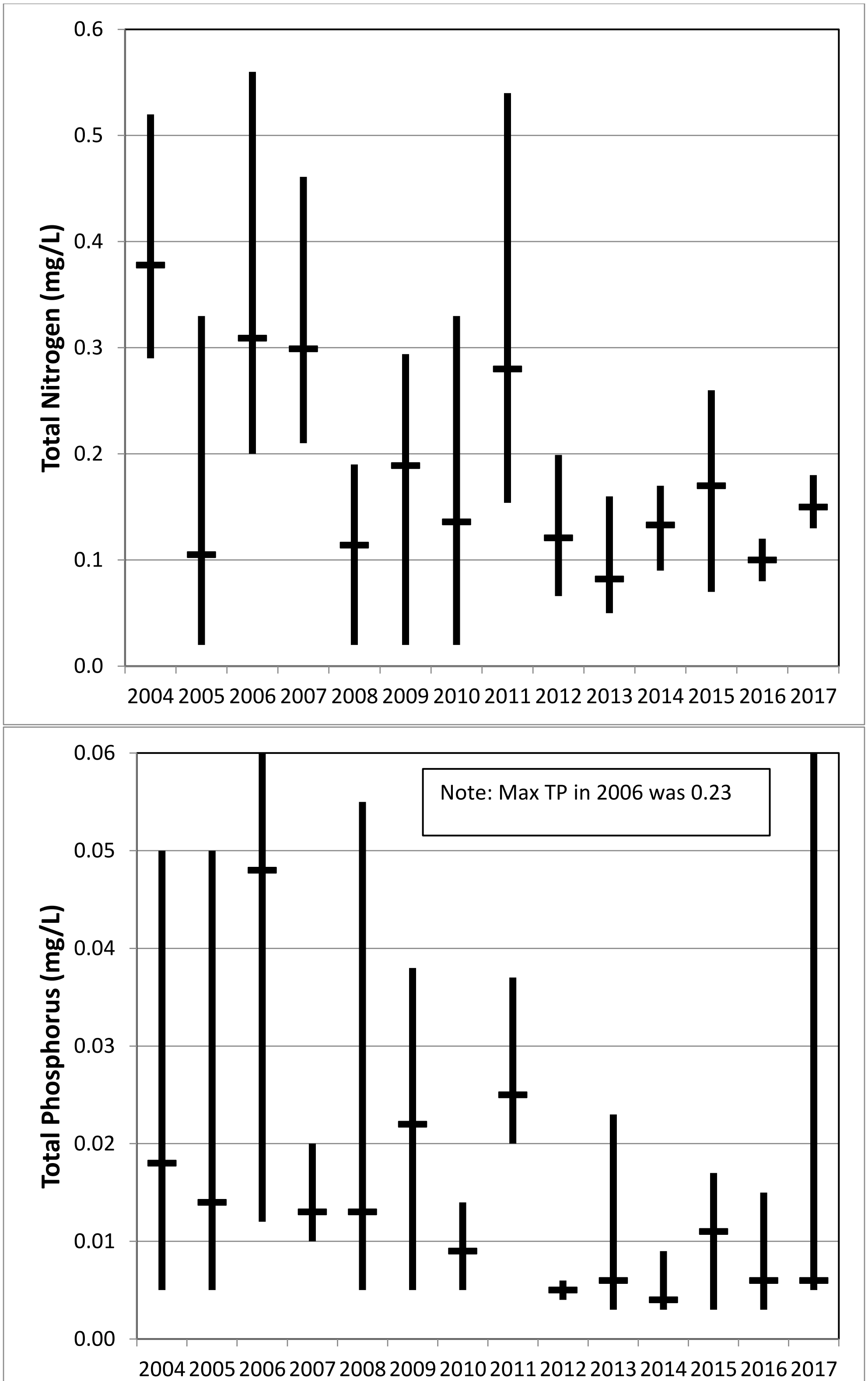


Figure 5. Yearly Nutrient Statistics (Minimum, Maximum, Average) from 2004-2017.

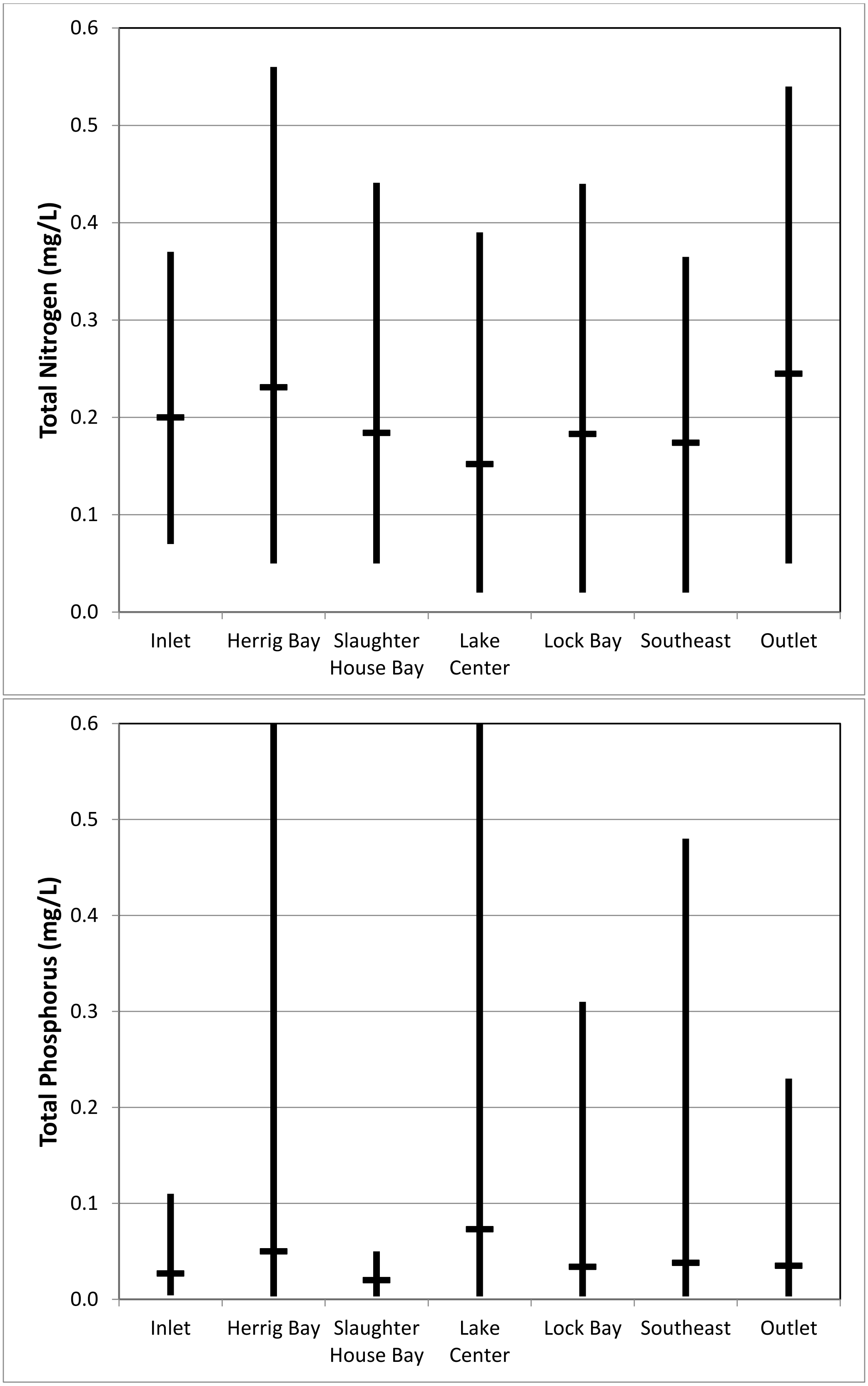


Figure 6. Spatial Nutrient Statistics (Minimum, Maximum, Average) from 1999-2017.

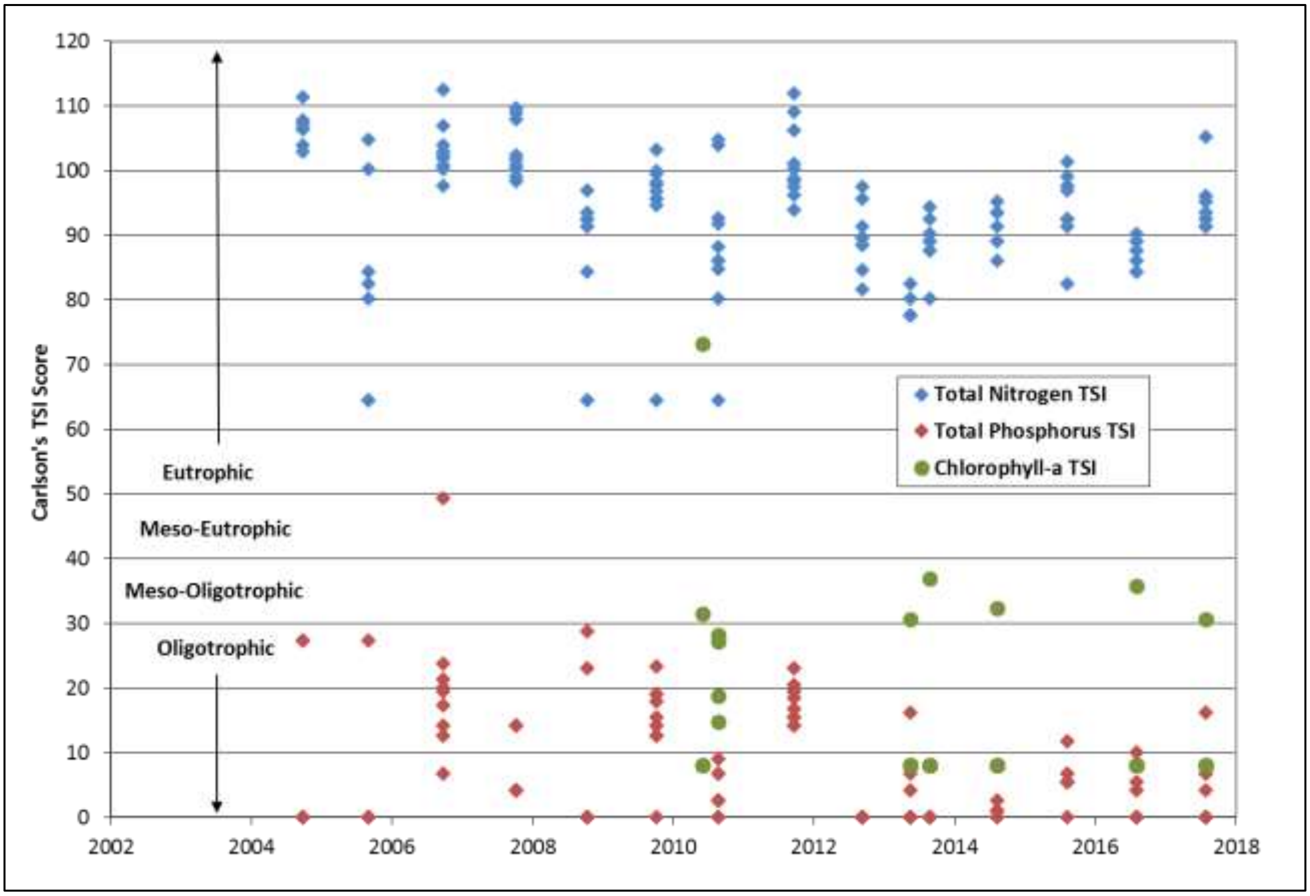


Figure 7. Trophic Status of Little Bitterroot Lake from 2004-2017.