Little Bitterroot Lake
Water Quality Monitoring Program
2016 Annual Report

Prepared For:
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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
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
USGS – United States Geological Survey
WET – Water & Environmental Technologies
WLI – Whitefish Lake Institute

Executive Summary

Little Bitterroot Lake was sampled on August 3, 2016, which was the 17th 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. Depth profiles were recorded at the lake center on August 16. Attached algae was sampled from 2 shoreline locations in 2016. Samples for uranium were collected from the inlet and outlet streams, the lake center, and 3 groundwater wells. The groundwater wells were also sampled for field parameters and nutrients.

Water quality was excellent in Little Bitterroot Lake in 2016. Total nitrogen had the 2nd lowest average concentration for the entire monitoring period, while total phosphorus had the 3rd lowest average on record. Nitrogen concentrations were highest in the southwest portion of the lake, and phosphorus concentrations were highest in the inlet and outlet streams. 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 19.0°C (66°F). The lake was thermally stratified with an epilimnion from 0 to 27 feet, a metalimnion from 25 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 2016 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 40’ below the lake surface. Dissolved oxygen also peaked near this depth, which could be 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 2016, including Lock Bay and the southeast portion of the lake. Benthic algae concentrations were very low and comparable to previous samples collected from typical shoreline conditions.

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.

Uranium samples were collected from the inlet and outlet streams, the lake center, and 3 groundwater wells in 2016. Uranium results were very low, and below state standards for human health. This indicates there is little risk from radioactive elements from the lake or groundwater sources.

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 2016 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 17 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 2016 were 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.			

Depth profiles were measured in Little Bitterroot Lake on August 16, 2016, by the Whitefish Lake Institute, which oversees the Northwest Montana Lakes Volunteer Monitoring Network. Data from Whitefish Lake Institute collected in 2016 are included within this report.

3.0 Field and Analytical Methods

The 2016 sampling events were conducted by WET on August 3 and by Whitefish Lake Institute on August 16 with assistance from members of LBLA. Water quality sampling was conducted at 7 lake locations, the inlet stream (Herrig Creek) and the outlet stream (Little Bitterroot River) (**Figure 1**). Lake and stream sampling includes measurements of field parameters, collection of samples for laboratory analysis, and depth profile monitoring at the lake center. Two near-shore sites were sampled for benthic algae in 2016, and three well samples were collected from around Little Bitterroot Lake for the purpose of comparing groundwater to lake water, and to investigate the potential of radioactive elements in groundwater. 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, 2016) 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 ortho and total).

Samples for uranium were also collected in 2016 from the lake center, the inlet and outlet streams, and from three groundwater wells. Radioactive elements were recently discovered in groundwater wells in the nearby community of Kila, which prompted concern from residents at Little Bitterroot Lake. Radioactive elements in groundwater are a concern because they can increase the risk of cancer or organ damage. Sampling for uranium will not directly measure the amount of harmful radiation (commonly called gross alpha radiation), but results from the uranium samples will indicate whether a greater risk from radioactive elements exists in the area, which may prompt future sampling. All laboratory analyses use 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 2 locations in 2016 to measure the growth of algae on 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 16, 2016, 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.

3.5 Groundwater Sampling

Groundwater samples were collected from three wells surrounding Little Bitterroot Lake, including two wells near Lock Bay, and one well on the southeast portion of the lake. Groundwater was sampled by first purging the wells for several minutes before sample collection. This ensures that standing water in the well casing is removed, and that fresh water from the aquifer is sampled. Samples are filtered or preserved (if necessary) and stored in a cooler on ice for delivery to the laboratory. Groundwater samples were analyzed for uranium and forms of nitrogen (nitrate+nitrite, ammonia, total Kjeldahl, organic, total) and phosphorous (dissolved ortho and total).

4.0 2016 Monitoring Results

Results from 2016 are provided in **Attachment A** and summarized in the following sections below.

4.1 2016 Field Parameter Results

Field parameter results from 2016 are provided in **Table 1** in **Appendix A**. Weather during lake and stream sampling was cool (~60°F) and overcast with periods of light rain. In August 2016, the lake had a uniform surface temperature around 19.0°C (66°F). Herrig Creek was contributing cooler water around 11.2°C (52°F) at a flow of approximately 2.5 CFS (1100 gallons per minute, GPM). The Little Bitterroot River at the outlet had a temperature of 14.4°C (58°F) and a flow of 2.0 CFS (900 GPM). The pH at lake sites varied between 7.9 and 8.3, while the inlet and outlet streams measured 6.3 and 7.3, 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 stream sites. Dissolved oxygen (DO) varied from 8.7 to 10.3 mg/L in the lake, while DO measured 10.8 mg/L in the inlet stream and 3.9 mg/L in the outlet stream. Specific conductance was quite low in the inlet stream (56 µS/cm) but uniformly around 120 µS/cm at the lake sites. Specific conductance at the outlet stream was slightly higher than lake sites, measuring 131 µS/cm.

These results are comparable to field parameters measured during previous sample years, and are indicative of good water quality and oligotrophic conditions. Very little water was passing through the spillway at the lake outlet at the time of sampling, and much of the water may have been coming from groundwater sources, which could contribute to the lower temperature and DO exhibited in 2016. During August 2015, the outlet stream had significantly higher flow (25 CFS), which suggests the lake had more water in 2015 compared to 2016.

Field parameters were also recorded during groundwater sampling. Groundwater temperature varied from 10.4°C (51°F) to 17.7°C (64°F), dissolved oxygen ranged from 1.9 to 7.2 mg/L, specific conductance ranged from 227 to 554 µS/cm, and pH varied from 7.4 to 8.2. These results are typical for groundwater, which is generally lower in temperature and dissolved oxygen, but higher in specific conductance when compared to the lake sites. The well depths varied from 266’ to 390’ below ground surface.

4.2 2016 Nutrient Results

Results from August 2016 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 2016, total nitrogen concentrations were comparable throughout the lake. The highest values were recorded in the southwest portion of the lake (0.12 mg/L), the inlet stream (0.11 mg/L), and Lock Bay (0.11 mg/L). Total nitrogen was lowest in Herrig Creek Bay, the lake center, and the outlet stream, which all measured 0.08 mg/L.

Total phosphorus measurements were also low throughout the lake in 2016. The highest TP readings were at the lake outlet (0.015 mg/L) and the inlet stream (0.011 mg/L). 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.

Total nitrogen concentrations in groundwater samples varied from 0.04 mg/L in the wells near Lock Bay to 0.36 mg/L in the southeast portion of the lake. Total phosphorus concentrations were below detection (<0.003 mg/L) in the Lock Bay wells, while the well in the southeast measured 0.015 mg/L.

4.3 2016 Chlorophyll-a Results

In August 2016, algae growth in the water column was very low, with most samples being below the analytical detection limit. The highest measurement of chlorophyll-a occurred 40' below the lake surface (1.7 mg/L). The highest concentration of dissolved oxygen occurred approximately 46' below the lake surface, which could be expected because algae produce oxygen during daytime hours. Depth profile measurements from the Hydrolab measured a peak concentration of 2.6 mg/L at a depth of 65'.

In recent years, homeowners around the lake have commented about algae on shoreline rocks, typically referred to as "green slime". Attached algae, also called benthic algae, were sampled at two locations in August 2016, including Lock Bay and the southeast corner. Sampling results showed fairly low chlorophyll-a concentrations (2.3 and 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 are quite low and not at nuisance levels, although additional inputs of nutrients could increase algae growth around Little Bitterroot Lake.

4.4 2016 Depth Profile Results

Depth profile sampling was conducted on August 16, 2016, 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 August 2014 and 2015 are also shown for comparison. In August 2016 the lake was thermally stratified with an epilimnion (upper layer) from 0 to 27 feet, a metalimnion (transitional layer) from 27 to 60 feet, and a hypolimnion 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 8.4 mg/L in the epilimnion in August 2016, with a peak occurring around 46' below the lake surface (12.8 mg/L). Dissolved oxygen typically peaks in the area with the highest algae growth. 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 2016 are shown for all sample locations in **Figure 4,** and **Figure 5** shows minimum, maximum, and average results from 2004-2016. Nutrient concentrations have generally shown a decreasing trend since consistent yearly monitoring began in 2004. In August 2016, total nitrogen concentrations in Little Bitterroot Lake had the second lowest average for the entire sampling period, and total phosphorus concentrations exhibited the third lowest average on record. Nutrient concentrations were higher in 2015 when compared to 2016. Precipitation in the area was higher in 2015 compared to 2016, which may have caused additional nutrients to enter the lake from the surrounding watershed. This pattern has been shown in previous sample years, especially 2011 which was a high precipitation year with elevated nutrient concentrations.

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 2016) 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 2016.

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 2016 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 2016. 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 Uranium Results

Uranium was added to the sampling protocol in 2016, with samples collected from the inlet and outlet streams, the lake center, and from three groundwater wells around the lake. Uranium in the lake sites varied from below the analytical detection limit in the inlet stream (<0.0002 mg/L) to 0.002 mg/L at the lake center. The groundwater samples varied from 0.0003 mg/L to 0.0005 mg/L. These results are well below human health standards for surface water and groundwater (0.03 mg/L), and indicate that there is little risk of radioactive elements in both the lake and groundwater (DEQ, 2012). These results are comparable to data collected in 1976 during the National Uranium Resource Evaluation (NURE) program, which reported a concentration of 0.0001 mg/L for uranium in the Little Bitterroot River downstream of Little Bitterroot Lake (USGS, 2017).

5.0 Discussion and Conclusions

Water quality in Little Bitterroot Lake was very good in 2016, 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 in 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.

Uranium samples collected from Little Bitterroot Lake and neighboring wells were well below the state standards for human health, indicating that there is little risk of radioactive elements occurring in both the lake and groundwater.

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 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, 2016). Among the large lakes monitored through NWMTLVMN, Little Bitterroot Lakes is the 5^{th} lowest in nitrogen concentration, and 2^{nd} 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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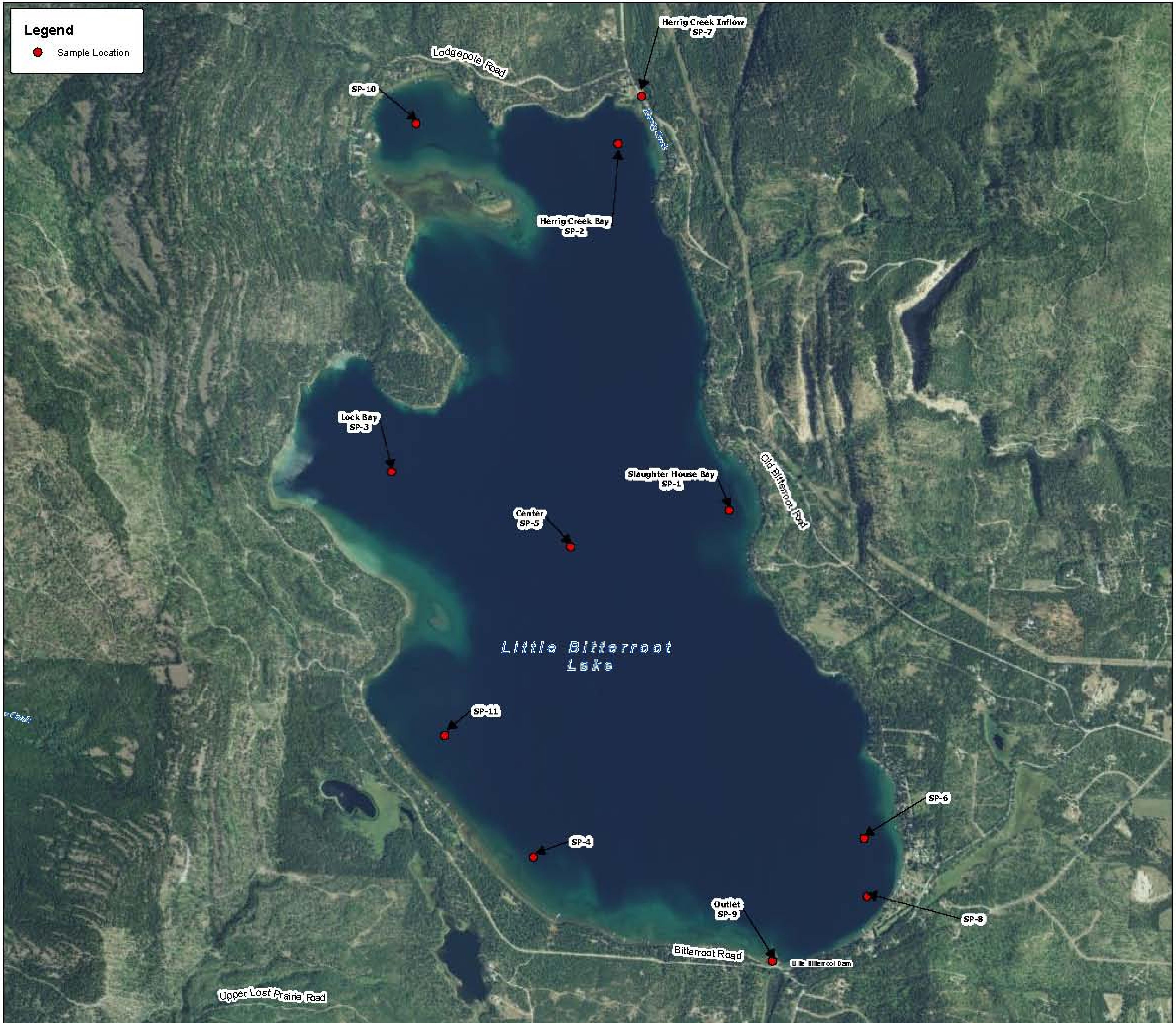
Attachment A – Tables and Figures

Table 1. 2016 Water Quality Data.

Sample Info			Field Water Quality				Nutrients					Chlorophyll-a		Metals
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)**	**Uranium (mg/L)**
							0.01	**0.05**	**0.04**	**0.001**	**0.003**	**0.1**	**0.1**	**0.0002**
SP-7	8/3/16	Inlet - Herrig Cr.	11.22	10.8	56	6.29	<0.01	<0.05	**0.11**	**0.002**	**0.011**			0.0002
SP-2	8/3/16	North - Herrig Cr. Bay	18.92	9.4	120	8.32	<0.01	<0.05	**0.08**	**0.002**	<0.003	<0.1		
SP-10	8/3/16	Northwest - Northwest Bay	18.90	9.7	121	7.90	<0.01	<0.05	**0.10**	**0.001**	**0.004**	<0.1		
SP-1	8/3/16	East - Slaughter House Bay	19.30	8.7	123	8.15	<0.01	<0.05	**0.09**	**0.002**	<0.003	<0.1		
SP-3	8/3/16	West - Lock Bay	18.90	9.7	121	7.90	<0.01	<0.05	**0.11**	**0.002**	<0.003	<0.1	**3.6**	
SP-5	8/3/16	Center - 0' Depth	19.11	9.8	116	8.21	<0.01	<0.05	**0.08**	**0.002**	<0.003	<0.1		**0.002**
SP-5-20	8/3/16	Center - 20' Depth	Field parameters at depth are shown with depth profile data in Figure 3.				<0.01	<0.05	**0.11**	**0.002**	**0.010**	<0.1		
SP-5-40	8/3/16	Center - 40' Depth					<0.01	<0.05	**0.10**	**0.002**	<0.003	**1.70**		
SP-4	8/3/16	Southwest	19.08	10.3	123	8.00	<0.01	<0.05	**0.12**	**0.002**	<0.003	<0.1		
SP-6	8/3/16	Southeast	19.42	10.2	121	8.10	<0.01	<0.05	**0.09**	**0.002**	**0.003**	<0.1	**2.3**	
SP-9	8/3/16	Outlet - Ltl. Bitterroot River	14.44	3.9	131	7.28	<0.01	<0.05	**0.08**	**0.005**	**0.015**			**0.0004**
GW-1	8/4/16	Well - Hill	10.43	1.9	554	7.40	<0.01	<0.05	**0.04**	**0.004**	<0.003			**0.0005**
GW-2	8/4/16	Well - Conlan	14.15	7.2	367	7.44	<0.01	<0.05	**0.04**	**0.005**	<0.003			**0.0003**
GW-3	8/4/16	Well - Bailey	17.69	6.9	227	8.20	<0.01	<0.05	**0.36**	**0.004**	**0.015**			**0.0003**

The analytical detection limit for water quality parameters are provided below the constituent name.
Values in **BOLD** are above the analytical detection limit.



N W E S

1 inch = 2,000 feet

Feet

0 1,000 2,000

WATER & ENVIRONMENTAL TECHNOLOGIES, PC

Little Bitterroot Lake Site Location

LBHHM01	FIGURE 1
10/30/09	

Image Source: 2009 NAIP 1m Natural Color Imagery for Montana acquired between June 23, 2009 and September 2, 2009.

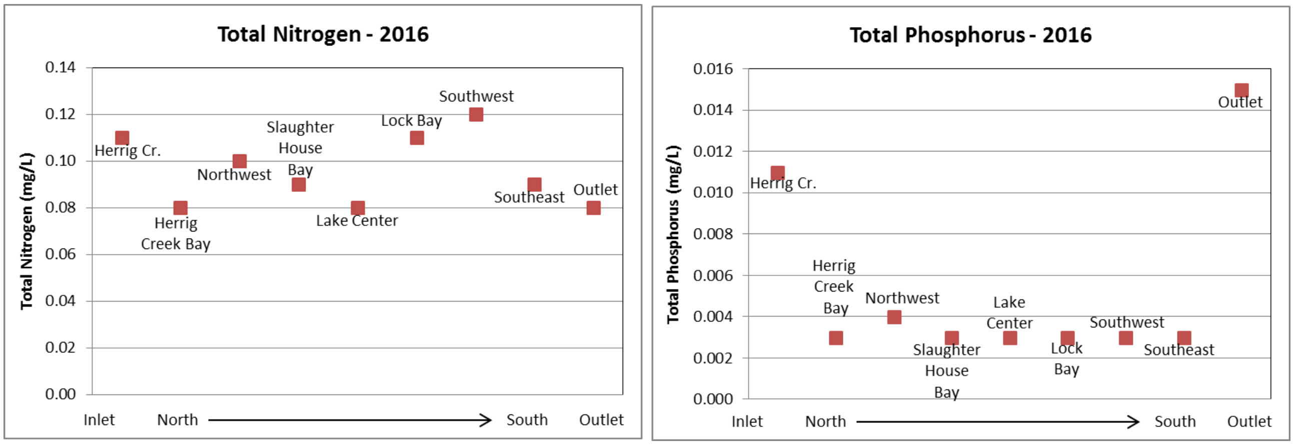


Figure 2. Total Nitrogen and Total Phosphorus Results for 2016.

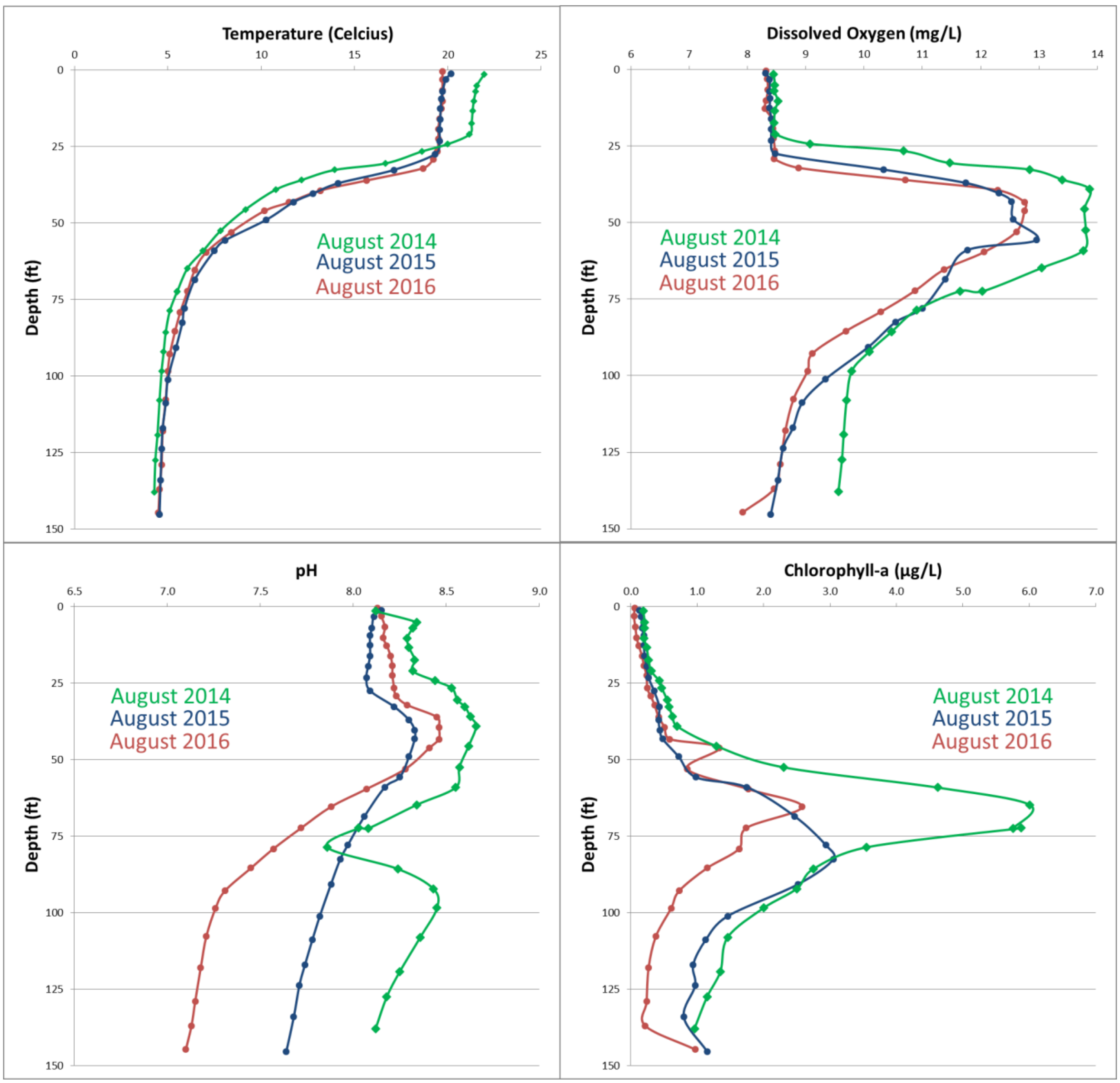


Figure 3. Depth Profile Results for 2016.

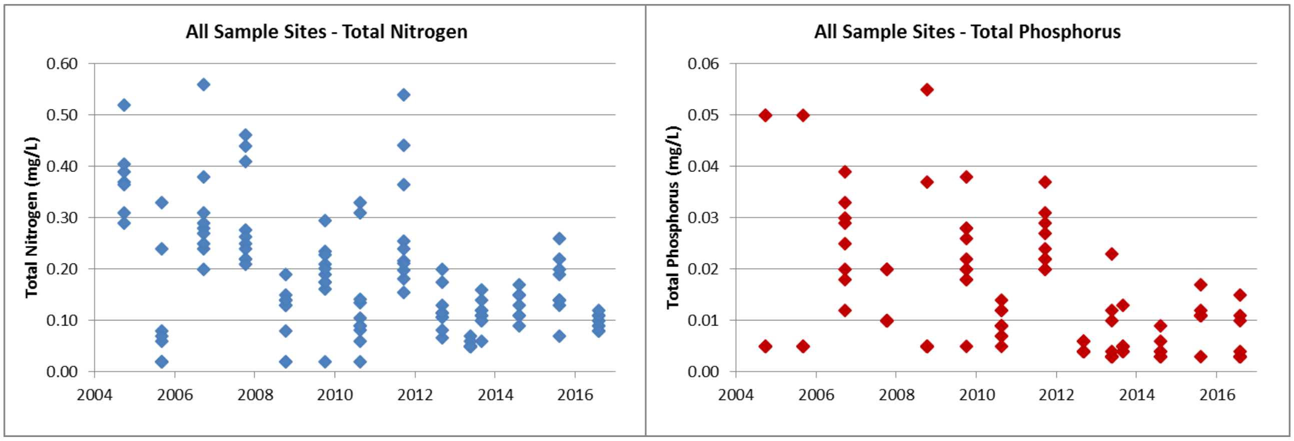


Figure 4. Total Nitrogen and Total Phosphorus Results for 2004-2016.

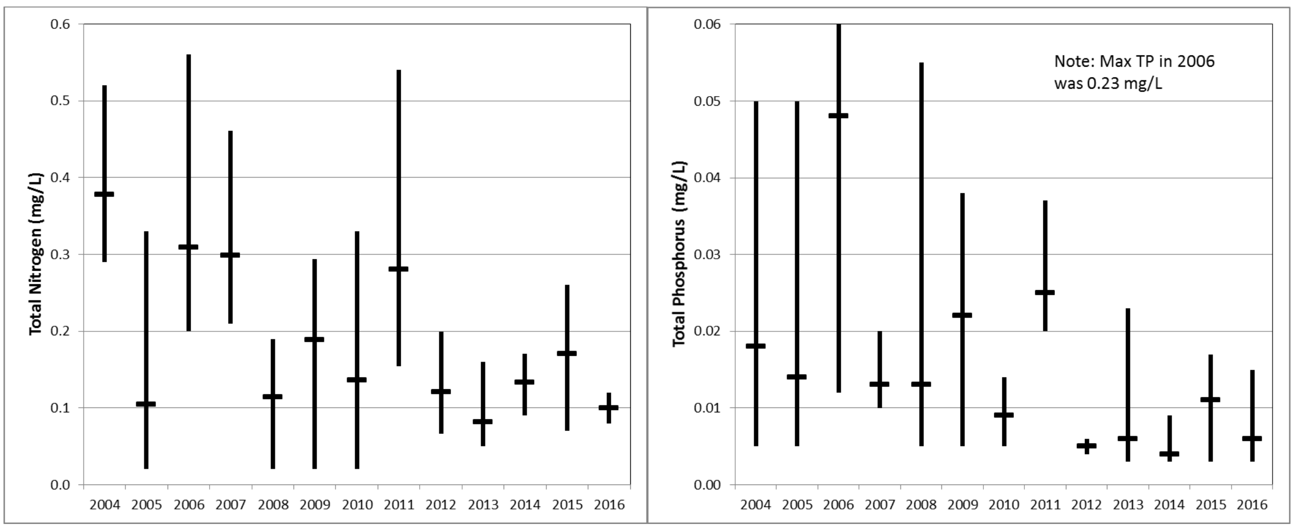


Figure 5. Yearly Nutrient Statistics (Minimum, Maximum, Average) from 2004-2016.

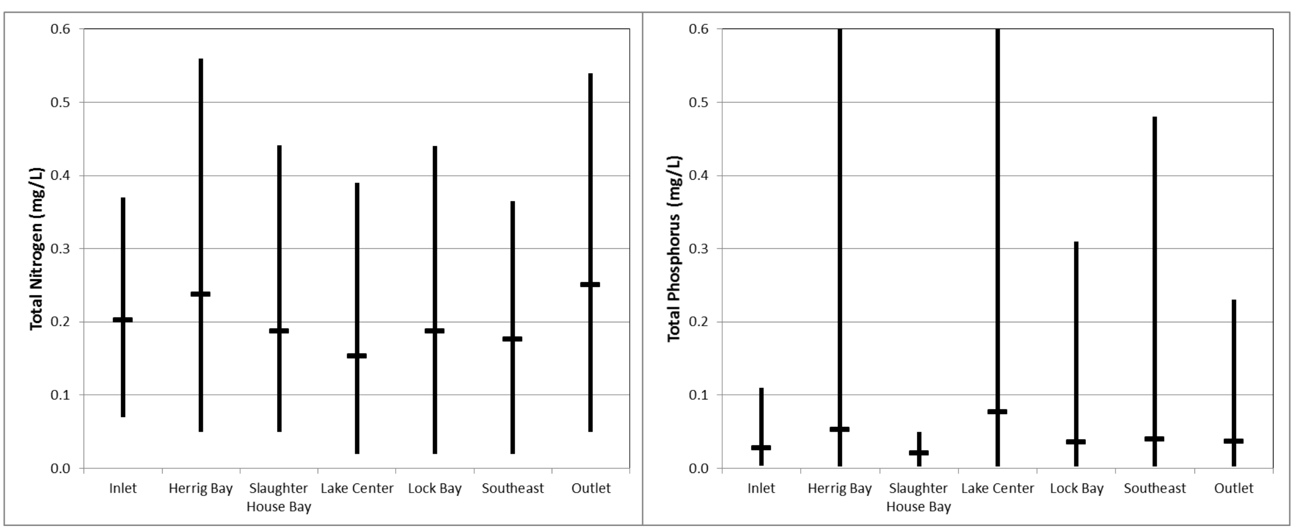


Figure 6. Spatial Nutrient Statistics (Minimum, Maximum, Average) from 1999-2016.

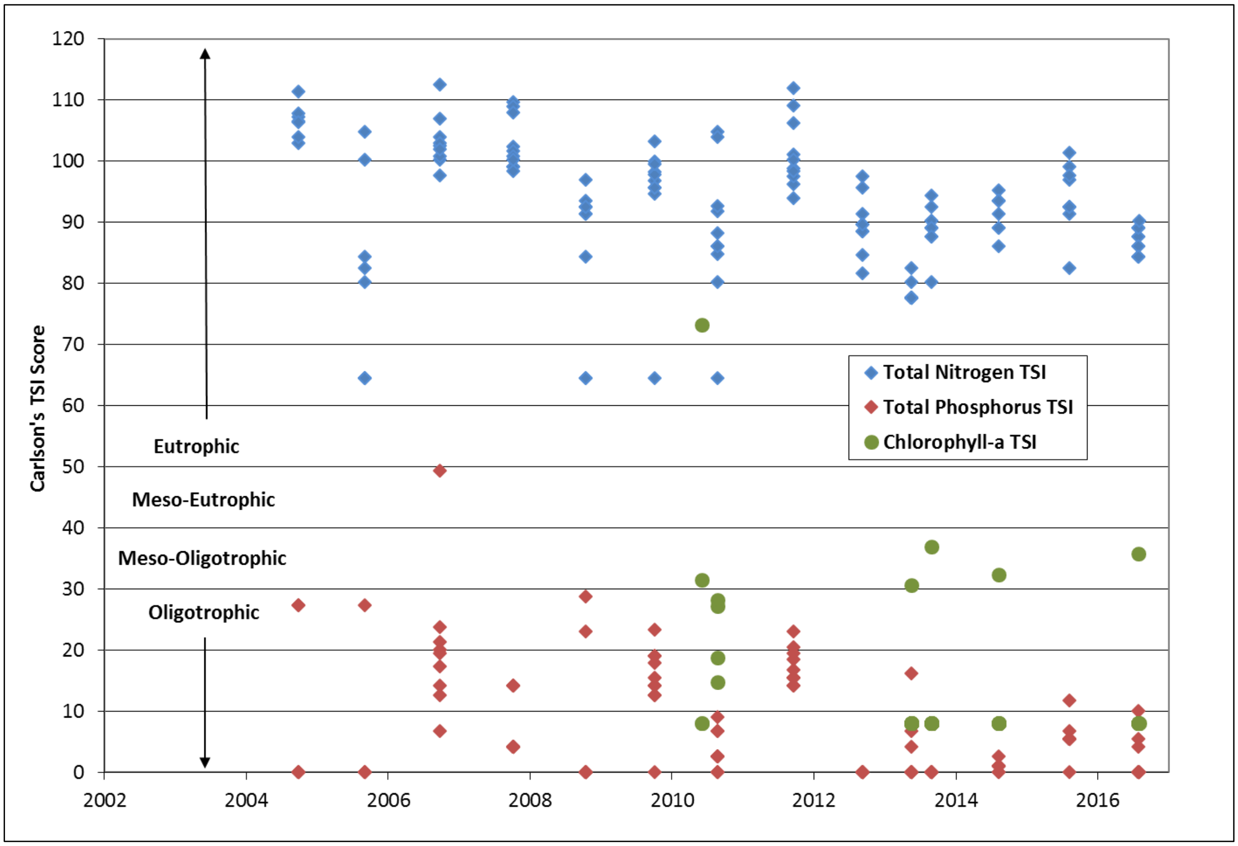


Figure 7. Trophic Status of Little Bitterroot Lake from 2004-2016.