

Bathymetry and Water Quality Monitoring

Fern Lake

Page Lake

Ruth Lake

Monitoring Year 2016

Submitted to:

Long Lake Association

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Prepared by:



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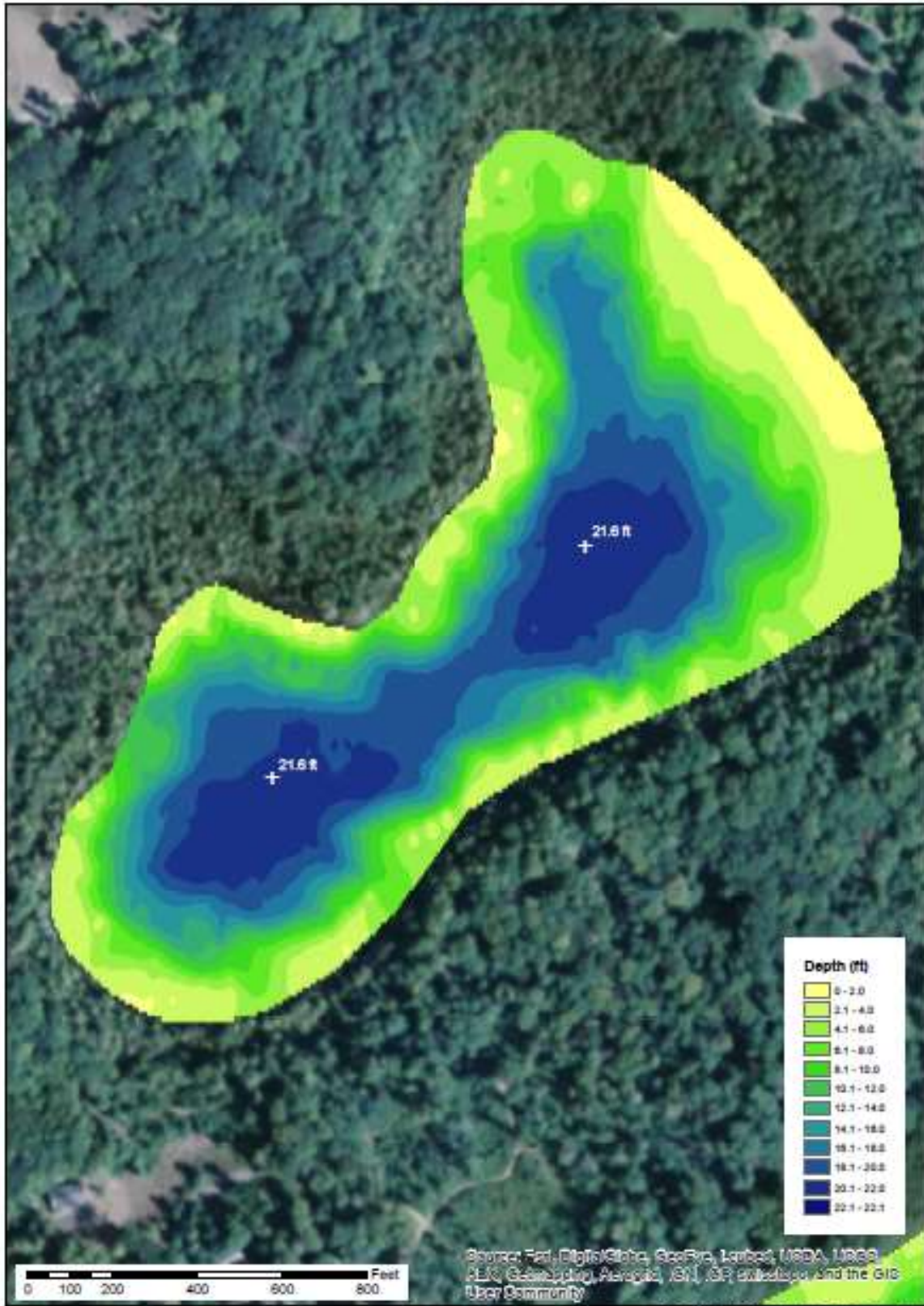
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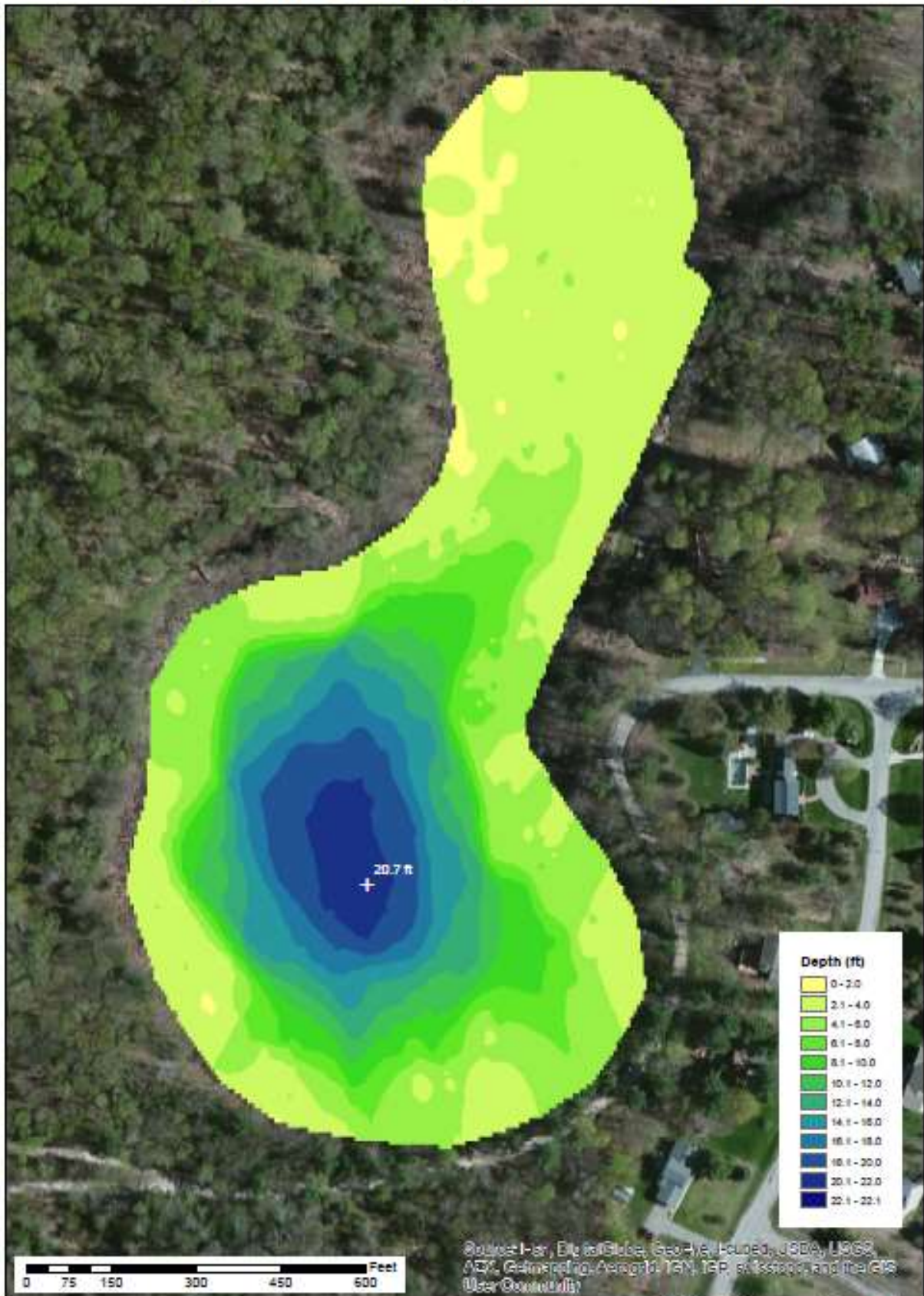
SECTION 1: 2016 Fern, Page and Ruth Lake Bathymetry

Previous to 2016 no bathymetric data had been collected on Fern, Page or Ruth Lakes and lake depths were unknown. Depth and contour data was collected using a Garmin GPS depth finder with transducer attached to a 10 ft jon boat. A depth profile of the lakes was collected by rowing around the lakes in transects and filling in the areas of the lakes on the device. The device recorded a log file of latitude, longitude and depth coordinates along the path of the boat. Bathymetric maps were created using ArcGIS. The log file containing the coordinates from the Garmin was uploaded as a Microsoft Word file and then copied and pasted into Microsoft Excel. The “text to columns” tool was then used to prepare the data to be modified into “text format” for the GIS program. Decimal degrees were converted into XY latitude/longitude coordinates and then put into a table that ArcGIS could read. Depth profiles are essential for basis comparisons for past, present and future status of the lakes. This data can be used as a baseline for future data collected and to continue monitoring the life cycles of the lakes.

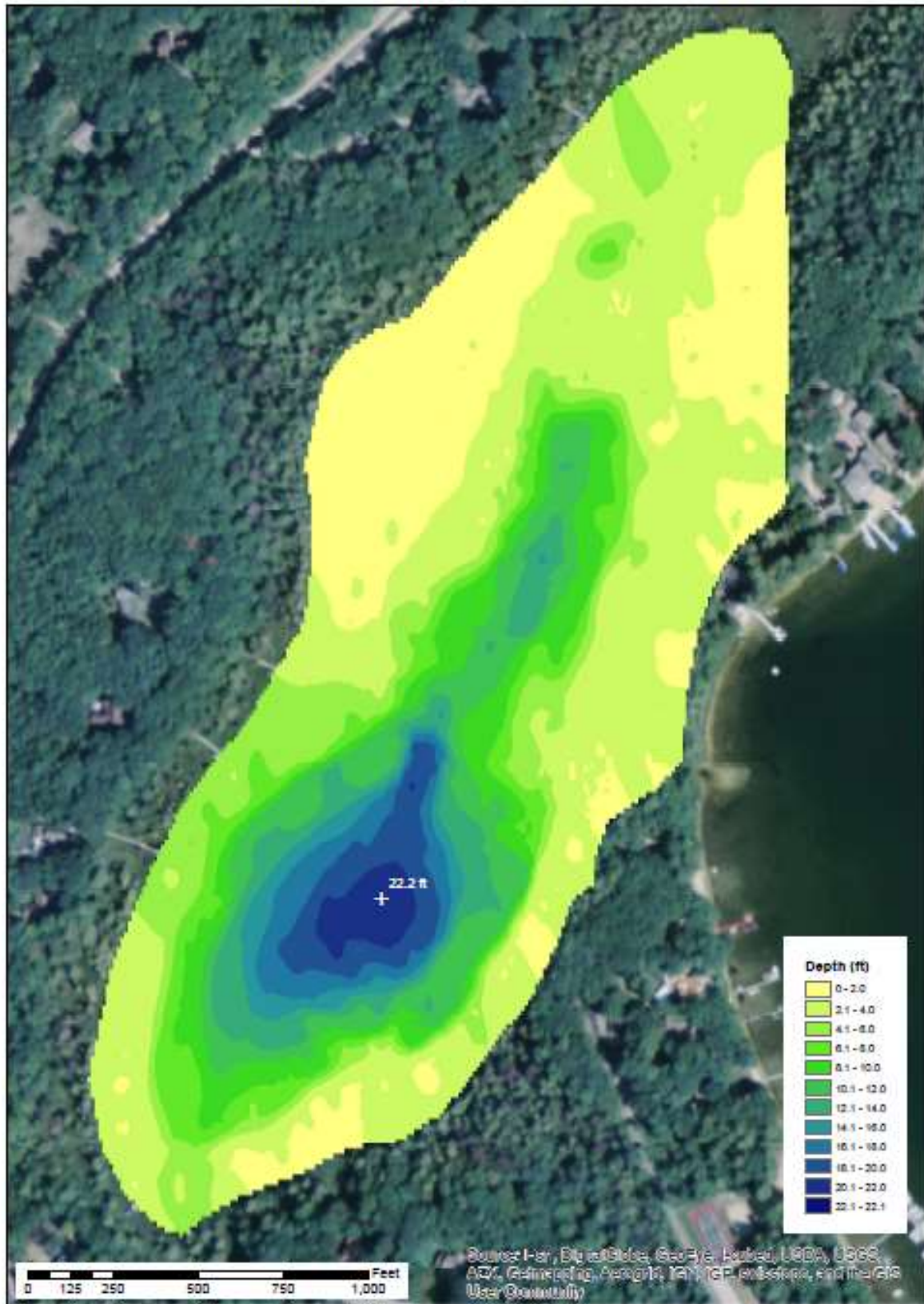
Fern Lake - Long Lake Association



Page Lake - Long Lake Association



Ruth Lake - Long Lake Association



SECTION 2: 2016 Fern and Page Lake Water Quality Assessment

Fern and Page Lakes monitoring was initiated in 2016 by the Long Lake Association in partnership with Great Lakes Environmental Center (GLEC) and Great Lakes Water Studies Institute (GLWSI). Monitoring was initiated to provide an initial assessment of lake water quality. This introductory assessment will establish a baseline from which future monitoring can be compared and will allow any important emerging trends in water quality to become apparent. Any concerns demonstrated by this monitoring effort will provide the opportunity for appropriate action to be taken in a timely manner.

For 2016 the monitoring of Fern and Page Lake's water quality and bathymetric (depth) data were collected using the following equipment: 1) Fern and Page Lake water quality and measurement of water chemistry used a YSI multiparameter water quality probe (supplied by GLEC), as well as collecting water samples for analysis of total phosphorus and nitrate/nitrite nitrogen at the surface and near bottom, and a single calcium sample at each sampling site; 2) collection of Bathymetry data for Fern, Page and Ruth using a Garmin sonar/GPS with attached transducer and boat provided by the Long Lake Associate (LLA); 3) levels of Chlorophyll *a* at each sampling site (an indirect indicator of algae in the water column); and 4) measurement of secchi disk depth at each of the sampling points.

Fern Lake HydroLab Data

Chlorophyll a (ug/L)

2016	Site #1	Site #2
Fern Lake	5.3**	5.8

** Mean of 2 Samples

Total Phosphorus (ug/L)

2016	Site #1	Site #2
Surface	7	6.5
Near Bottom	13.6	8.8

Sediment Phosphorus (mg/kg)

2016	Site #1	Site #2
Fern Lake	791	770

Nitrate/Nitrite Nitrogen (NOx) (ug/L)

2016	Site #1	Site #2
Surface	<1.1	<1.1
Near Bottom	5.4	<1.1

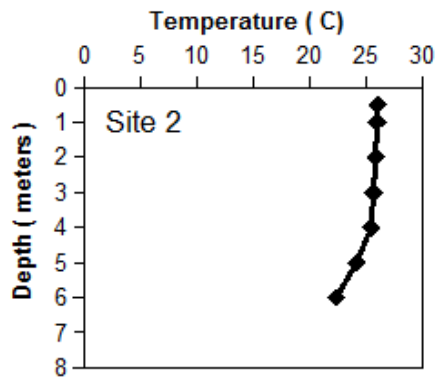
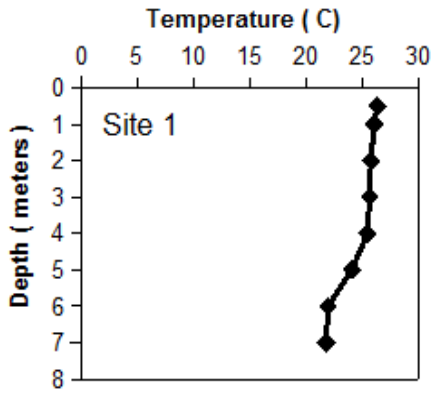
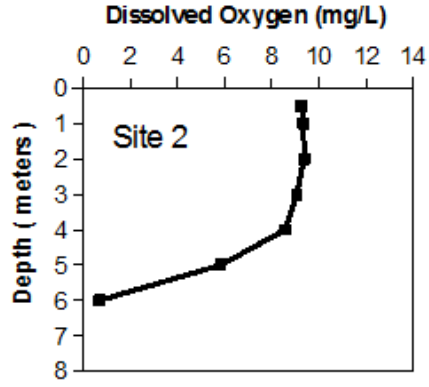
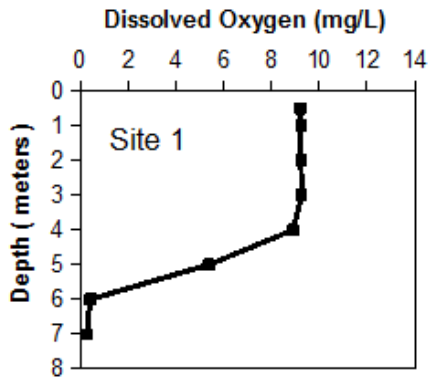
Calcium (mg/L)

2016	Site #1	Site #2
Fern Lake	32.2	30.9

Secchi Depth (ft)

Site #1	Site #2
14.4	14.6

Figure XX. YSI ProDDS Multiparameter Probe Profiles for Fern Lake Sampling Sites 1 and 2 on August 18, 2016.



Page Lake HydroLab Data

Chlorophyll a (ug/L)

2016	Site #1
Page Lake	12.7

Total Phosphorus (ug/L)

2016	Site #1
Surface	20.8
Near Bottom	63.7

Sediment Phosphorus (mg/kg)

Page Lake	700
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Nitrate/Nitrite Nitrogen (NOx) (ug/L)

2016	Site #1
Surface	<1.1
Near Bottom	5.7

Calcium (mg/L)

2016	Site #1
Page Lake	8.9

Secchi Depth (ft)

Site #1
8.5

Figure XY. YSI ProDDS Multiparameter Probe Profiles for Page Lake Sampling Site 1 on August 18, 2016.

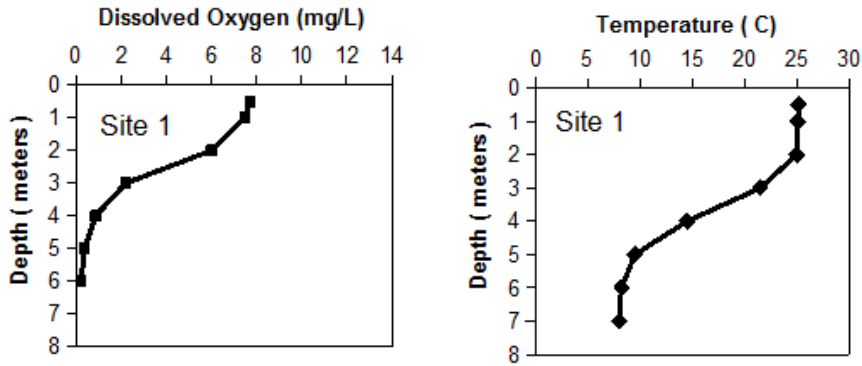


Table 1. Trophic State Classification (Chapra, 1997)

Variable	Oligotrophic	Mesotrophic	Eutrophic
Total Phosphorus ($\mu\text{g/L}$)	<10	10-20	>20
Chlorophyll a ($\mu\text{g/L}$)	<4	4-10	>10
Secchi depth (ft)	>13	6.6-13	>6.6

Table 4. Phosphorus Data for Area Lakes and Sediments

Lake	Water Total Phosphorus ($\mu\text{g/L}$)	Sediment Phosphorus (mg TP/kg DW)
Torch	1.7	86
Burt	2.2	119
Lime	4.4	200
Crystal	4.8	332
North Leelanau	4.8	489
South Leelanau	4.9	398
Glen	5.1	326
Little Traverse	5.1	401
Cedar	5.3	396
Platte	7.7	620
Mickey Site 1	11.5(top) 19.1(bottom)	1625
Mickey Site 2	7.6(top) 7.3(bottom)	879

Conclusions of Fern and Page Lake Water Quality Assessment:

Based on table 1 guidelines for Secchi depth, total phosphorus and chlorophyll a, both lakes are on the edge of Oligotrophic, or just barely mesotrophic. This is not bad for these lakes as they are small and shallow, so they have fairly good water quality based on our data results. In comparison they are very similar to Ruth, but not as good as Long Lake.

Water and Sediment phosphorus levels in these lakes were slightly higher than surrounding lakes. Mickey Lake being the closest had higher sediment phosphorus levels in 2014 possibly due to low dissolved oxygen levels. Looking at past data from Long Lake there was higher phosphorus levels in 1999-2000 samples compared to all other years. Fern and Page lakes are smaller and shallower and the accumulation of biomass decomposition over the years could be contributing to these high levels as they did in Long Lake, as well as input of other sources of phosphorus.

In Fern and Page lakes both graphs of dissolved oxygen vs depth and temperature help to explain the increase in Total Phosphorus at the lower depths. For Page, the dissolved oxygen was below 4 mg/L starting at about 3 meters which is fairly shallow, and is essentially close to zero at the bottom. Perfect conditions for the release of phosphorus which could explain the 63.7 ug/L readings near the bottom and the elevated readings near the surface. The temperature also drops in half by about 5 meters (indicating a "thermocline"), which prevents mixing. Similarly, for Fern Lake the dissolved oxygen is also close to zero, but not until it is nearly at the bottom. There was an elevation of phosphorus at the bottom as well, but not the same from top to bottom, which does allow for the vertical mixing of the water column.

REFERENCES

Chapra, S. C., 1997 , Surface Water Quality Modeling, McGraw-Hill, New York.

GLEC 2014 Long Lake Water Quality Assessment, 2014 Document