

A Trophic State Analysis of Selected Lakes and
Ponds in Yellowstone National Park

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ABSTRACT

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Beginning in 1998, Dr. A Woodruff Miller of Brigham Young University began sampling different water bodies located in Yellowstone National Park. These samples were collected in order to determine the trophic state of different lakes and ponds. The main focus of this study is to determine the trophic state of each of the water bodies sampled from 2012 through 2016. Three different models used to determine the trophic state are the Carlson Model, The Larsen-Mercier Model, and the Vollenweider Model. The second part of this study was to analyze all of the data collected for each water body beginning from 1998 and identify trends in phosphorus and chlorophyll-a concentrations, the Carlson trophic state index, and any inlet or outlet phosphorus concentrations.

During the span of this study, the trophic state classifications ranged from slightly oligotrophic to hyper-eutrophic. Five lakes averaged a trophic state of strongly eutrophic. These lakes are Feather Lake, Floating Island Lake, Hot Beach Pond, Indian Pond, and Nymph Lake. Eight lakes averaged classifications of slightly eutrophic or eutrophic. These lakes are Buck Lake, Hazel Lake, Lower Basin Lake, North Twin Lake, Pool by Morning Glory Pool, Scaup Lake, Trout Lake East, and Turbid Lake. Lakes that appear to be advancing in the eutrophication process are Hot Lake, Pool by Morning Glory Pool, Scaup Lake, Terrace Springs, Trout Lake West, and Yellowstone Lake at Bridge Bay. Feather Lake and Riddle Lake both have trends that indicate a reversal of the eutrophication process.

Keywords: eutrophication, trophic state analysis, water quality, Yellowstone National Park

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1 INTRODUCTION

Dr. Woodruff Miller, of Brigham Young University, has been sampling lakes and ponds in Yellowstone National Park since 1998. The collected water samples have been tested for total phosphorus and chlorophyll-a concentrations. Transparency, or secchi depth, was also recorded. These parameters were used to determine trophic state classifications for every body of water sampled.

A trophic state indicates the health of a body of water and will be discussed more fully later in this report. Several different models can be used to calculate the trophic state. Dr. Miller has identified the most pertinent models to use in the trophic state analysis. The models used were the Carlson Model, the Larsen-Mercier Model, and the Vollenweider Model. Each model will be discussed later in this report.

There are two purposes of this report. The first is to measure the trophic state for selected water bodies in Yellowstone National Park using the Carlson, Larsen-Mercier, and Vollenweider Models for the years 2012 through 2016. The second is to observe and plot the long term trends that date back to 1998 or when the lakes were first sampled. Trends were observed in each lakes phosphorus concentration, chlorophyll-a concentration, Carlson trophic state index, and inlet and outlet phosphorus concentration if available.

1.1 Eutrophication

Eutrophication is a process not a state (Nixon 2009) that reduces water quality (Dodds 2009). It is a process where lakes become more productive and eventually fill with sediment, become swamps, and ultimately dry land. Eutrophication is naturally a slow process, taking place over thousands of years; however, with anthropogenic influences – pollution caused by human actions – the process can be greatly sped up (Art 1993). Increasing human and animal activities around a lake raise nutrient concentrations in surface waters that leads to greater abundance of aquatic life and eventually to eutrophication.

The most common causes of eutrophication are a greater input of inorganic nutrients, an increase in the turbidity of the water, a change in the lake's hydraulic residence time, or an increase in wildlife grazing pressure (Nixon 2009). “Because of the slow movement of water in a lake, sediments, and pollutants bound to sediments, tend to settle out of the water column rather than being transported downstream” (Vesilind, Peirce, & Weiner, 1994).

The process of eutrophication causes high levels of organic matter, such as algae, that leads to the depletion of aquatic oxygen levels. When the oxygen levels in the water decrease other aquatic organisms, like fish, begin to die. The decomposing organisms also contribute to eutrophication. Eutrophication occurs in three stages: oligotrophic, mesotrophic, and eutrophic.

1.2 Trophic States

A trophic state indicates the overall health of a body of water at a specific time. There are four possible trophic state classifications. These classifications are oligotrophic, mesotrophic, eutrophic, and hyper-eutrophic. Oligotrophic is the healthiest state. It is classified by high water quality and low productivity. Oligotrophic lakes typically have transparent water and a

rocky/sandy shoreline and bottom. Mesotrophic lakes still have good water quality with moderate productivity. Eutrophic lakes have poor water quality. These lakes have high nutrient levels, algal blooms, high turbidity, and warmer temperatures. Hyper-eutrophic classifies lakes that have even worse water quality. They often have high turbidity, an odor, and are unsightly.

1.3 Water Quality Models and Methods

1.3.1 The Carlson Model

The Carlson Model calculates trophic state index based off secchi depth, chlorophyll-a concentration, and total phosphorus concentrations. The major assumption for the model is that suspended particulate material in the water controls secchi depth and algae is the major source of particulates (Lake Access, n.d.). The lakes are assigned a value from 0 to 110 that represents the amount of algal biomass contained within the lake (Carlson 1977). This allows for a more accurate secchi depth measurement.

A plot like the one shown in Figure 1-1 is often used to determine the Carlson Trophic state of a given lake. The total phosphorus and chlorophyll-a concentrations and the secchi depth are plotted on the figure and used to determine the average trophic state classification. Three equations are typically used to define this model. They are presented in Equations 1-1, 1-2, and 1-3.

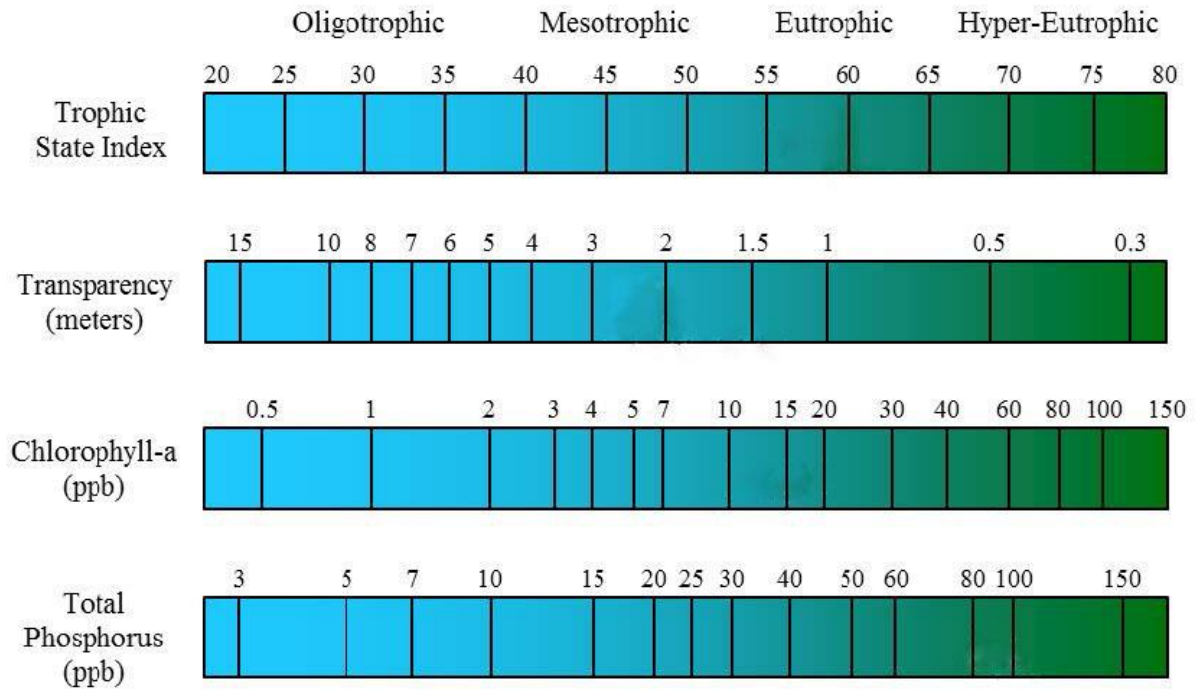


Figure 1-1: Carlson Trophic State Index Model.

$$TSI_{TP} = 14.42 * \ln \left(Total\ Phosphorus\ \frac{\mu g}{L} \right) + 4.15 \quad (1-1)$$

$$TSI_C = 9.81 * \ln \left(Total\ Chlorophyll - a\ \frac{\mu g}{L} \right) + 30.6 \quad (1-2)$$

$$TSI_{SD} = 60 - 14.1 * \ln (Secchi\ Depth\ Meters) \quad (1-3)$$

The trophic state index (TSI) values calculated from each equation are then averaged to determine an overall trophic state. This trophic state corresponds to a specific classification. Table 1-1 shows the scale used to assign trophic state classifications to the average TSI values.

Table 1-1: Correlation between Carlson TSI and Trophic State

Classification	Sub-Classification	Trophic State Index
Oligotrophic	Strongly Oligotrophic	0-25
	Oligotrophic	26-32
	Slightly Oligotrophic	33-37
Mesotrophic	Slightly Mesotrophic	38-42
	Mesotrophic	43-48
	Strongly Mesotrophic	49-53
Eutrophic	Slightly Eutrophic	54-57
	Eutrophci	58-61
	Strongly Eutrophic	62-64
Hyper-Eutrophic	Hyper Eutrophic	65+

1.3.2 The Larsen-Mercier Model

The Larsen-Mercier Model uses the inflowing total phosphorus concentration to the lake and the phosphorus retention coefficient (Larson & Mercier, 1975). The phosphorus retention coefficient can be calculated using Equation 1-4. Since outflowing phosphorus concentrations were not measured in this study, it was assumed that it was equal to the in-lake phosphorus concentration.

$$PRC = \frac{Total\ P\ Inlet - Total\ P\ Outlet}{Total\ P\ Inlet} \quad (1-4)$$

The Larsen-Mercier Model plots the total phosphorus concentration vs the phosphorus retention coefficient. A templet of the Larsen-Mercier Model is shown in Figure 1-2. The chart is divided into three different zones: oligotrophic, mesotrophic, and eutrophic. Where the point falls on the plot determines the Larsen-Mercier trophic state classification. This model was only used when a sample was taken from a lake's inlet.

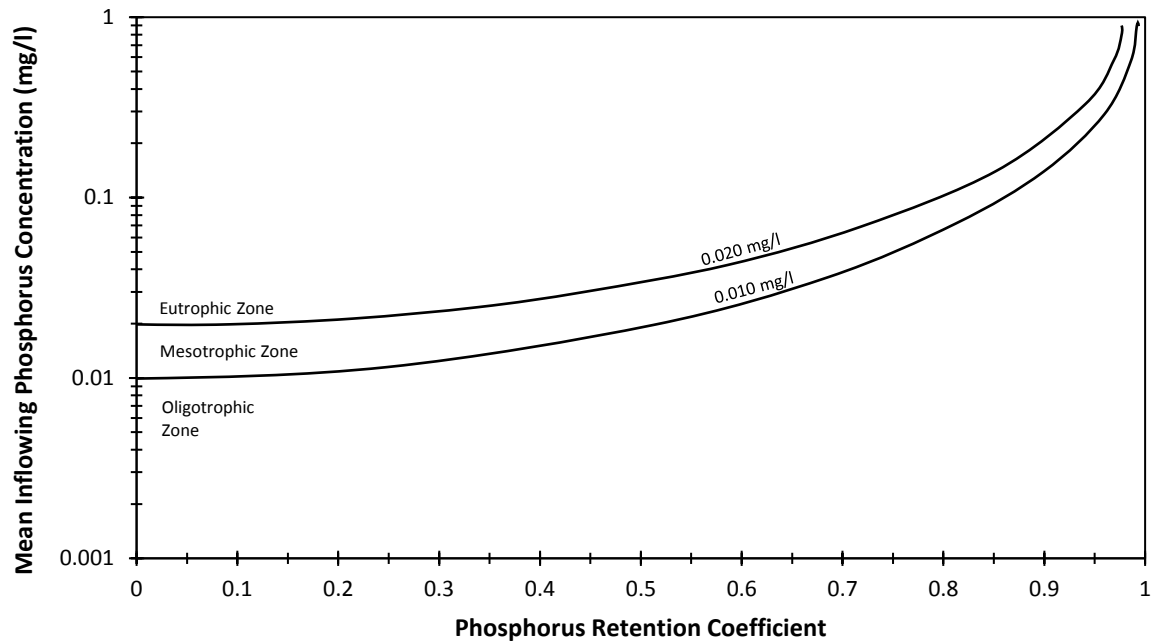


Figure 1-2: Larsen Mercier Model.

1.3.3 The Vollenweider Model

The Vollenweider Model is based on the total phosphorus in the inlet to the lake and the lake's hydraulic residence time (Vollenweider 1968). The hydraulic residence time can be calculated using Equation 1-5.

$$HRT = \frac{\text{Total Volume of the Lake (ft}^3\text{)}}{\text{Total Outlet Flow (ft}^3\text{/yr)}} \quad (1-5)$$

The Vollenweider Model plots the total phosphorus concentration vs the hydraulic residence time. A templet of the Vollenweider Model is shown in Figure 1-3. The chart is divided into four different zones: oligotrophic, mesotrophic, eutrophic, and hyper-eutrophic.

Where the point falls on the plot determines the Vollenweider trophic state classification. This model was only used when a sample was taken from a lake's inlet.

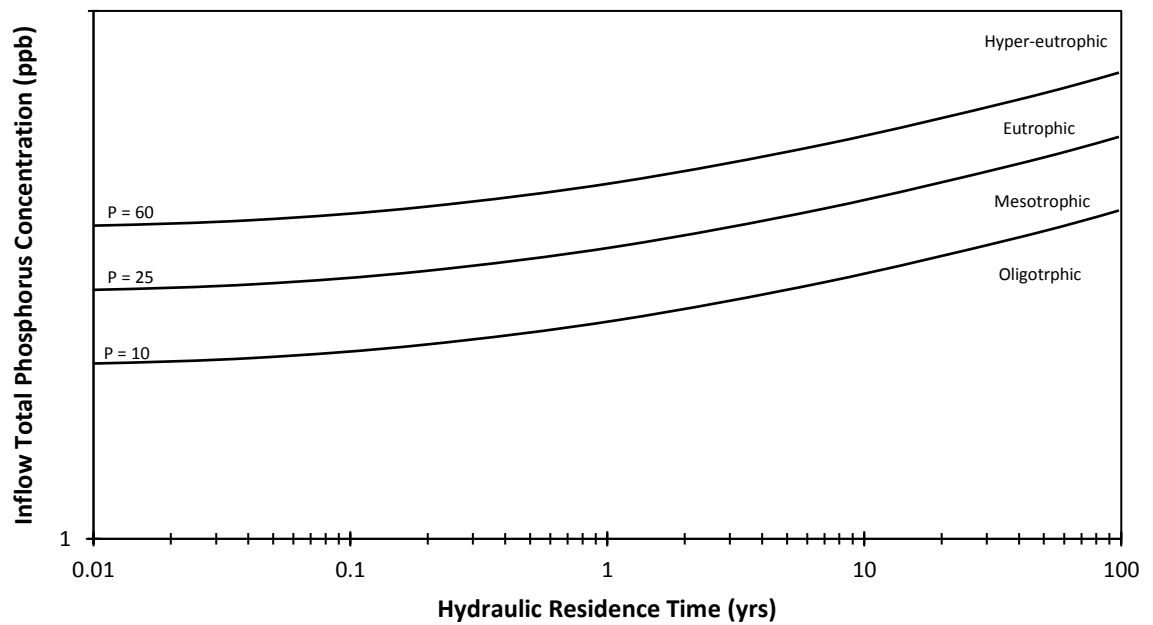


Figure 1-3: Vollenweider Model.

2 TROPHIC STATE ANALYSIS FOR THE YEARS 2012-2016 OF SELECTED LAKES AND PONDS IN YELLOWSTONE NATIONAL PARK

During the years 2012 through 2016, Dr. Miller sampled 41 different lakes and ponds in Yellowstone National Park. Of the water bodies thirty-four were lakes, three were ponds, two were bays on Yellowstone Lake, one was a spring, and one was a pool. In-lake water samples were taken in order to determine the in-lake phosphorus concentration and chlorophyll-a concentration. Inlet water samples were taken when applicable to determine the influent phosphorus concentration. Secchi depth was also recorded for transparency. All samples were taken between the months of June and October.

Two limits in sampling these bodies of water were the secchi depths and the lower limit phosphorus concentration. The secchi depths were determined visually by Dr. Miller and are assumed to be accurate within one meter. The depth was typically reported in a range and the value that better bisected the distance between the phosphorus and chlorophyll-a concentrations on the Carlson plot was used to calculate the trophic state. The phosphorus concentration could be measured in the lab to a lower limit of 10 ppb. Any sample that had a smaller, undetectable, phosphorus concentration was assigned a value of 10 ppb.

For every body of water sampled a Carlson trophic state analysis was completed and the plots can be seen in the following sections of this report. For those lakes that had inlet data

available Larsen-Mercier and Vollenweider Models are also presented. Figure 2-1 shows a map of all the sampled lakes and ponds.

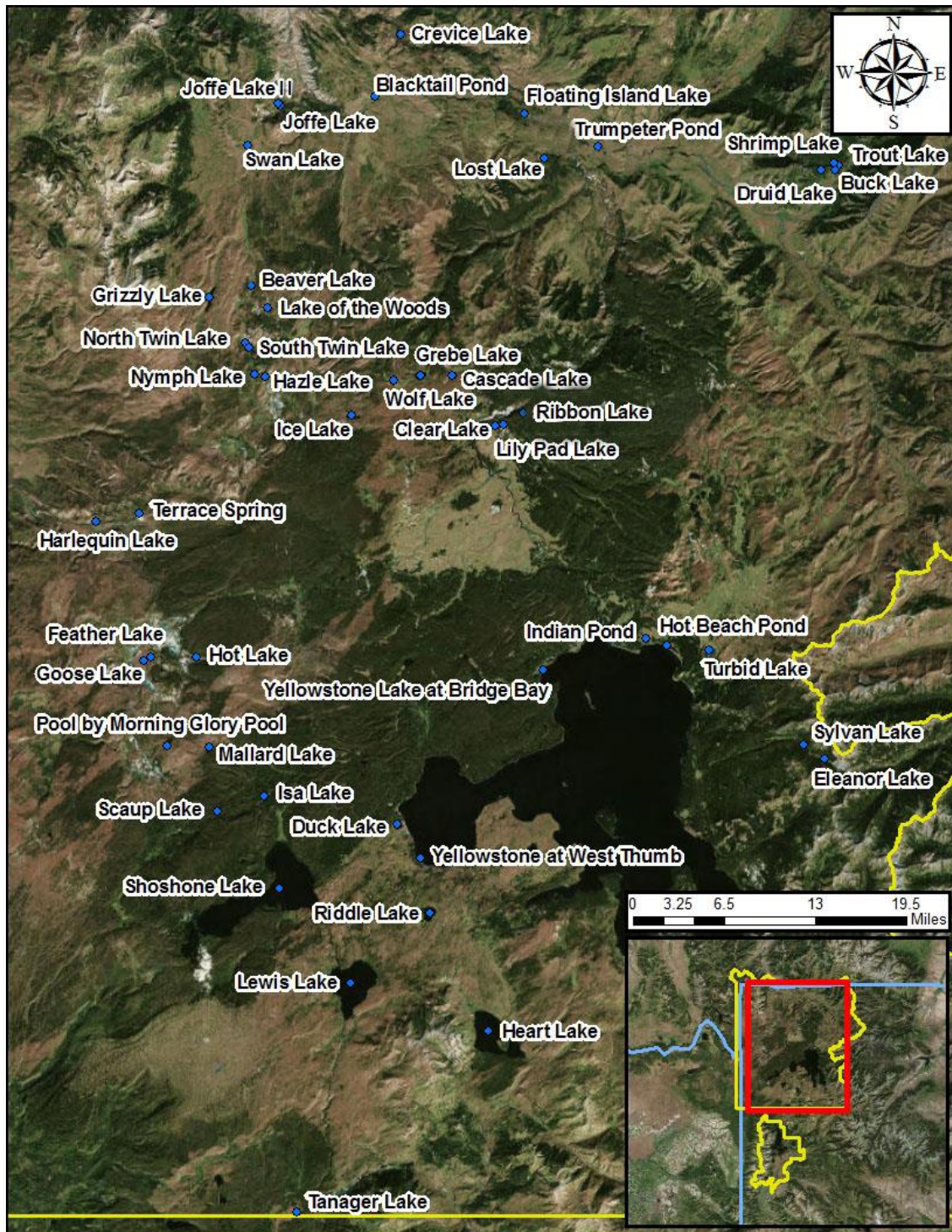


Figure 2-1: Location of Selected Lakes and Ponds in Yellowstone National Park.

2.1 Blacktail Pond

Blacktail Pond was sampled twice during this study. Once in October of 2012 and once during August of 2013. These are the only samples analyzed in this report. However, Blacktail Pond has been sampled many times between 2001 and 2013. The Carlson Model was used to analyze the data collected and is shown in Figure 2-2.

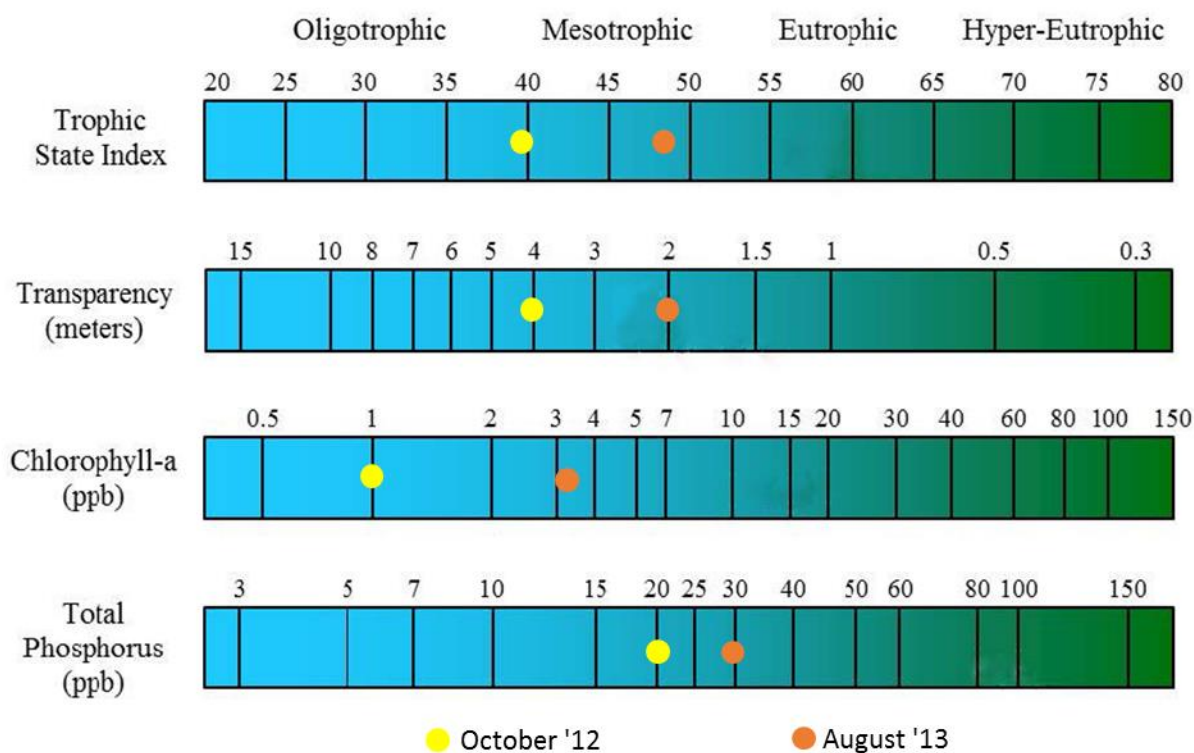


Figure 2-2: Carlson Trophic State Index for Blacktail Pond.

From the Carlson Model it is shown that Blacktail Pond had a trophic state of 39.3 in October 2012 and 48.5 in August of 2013. Table 2-1 compares the models classifications for these two time periods. In 2012, Blacktail Pond was classified as mesotrophic while in 2013 it

was only slightly mesotrophic. For the period of study, Blacktail Pond was classified as mesotrophic.

Table 2-1: Model Comparison for Blacktail Pond

Model	2012	2013	Average
Carlson	Mesotrophic	Slightly Mesotrophic	Mesotrophic

2.2 Buck Lake

Buck Lake was sampled nine times during the period of study. The lake has been periodically sampled since 2004. The Carlson Model was used to analyze the data collected and is shown in Figure 2-3.

The Carlson Model shows the trophic state index during 2012 to be 45.9 in June and 52.3 in August. In 2013, the trophic state index was 40.4 in June, and 48.1 in August. In 2014, the trophic state was 41.2 and 39 during June and August respectively. In 2015, the trophic state was 51.2 in June and 52.4 in September. Lastly, in June of 2016 the trophic state index was 45.1. The Carlson Model for Buck Lake shows a range in trophic state from slightly to strongly mesotrophic with an average of mesotrophic.

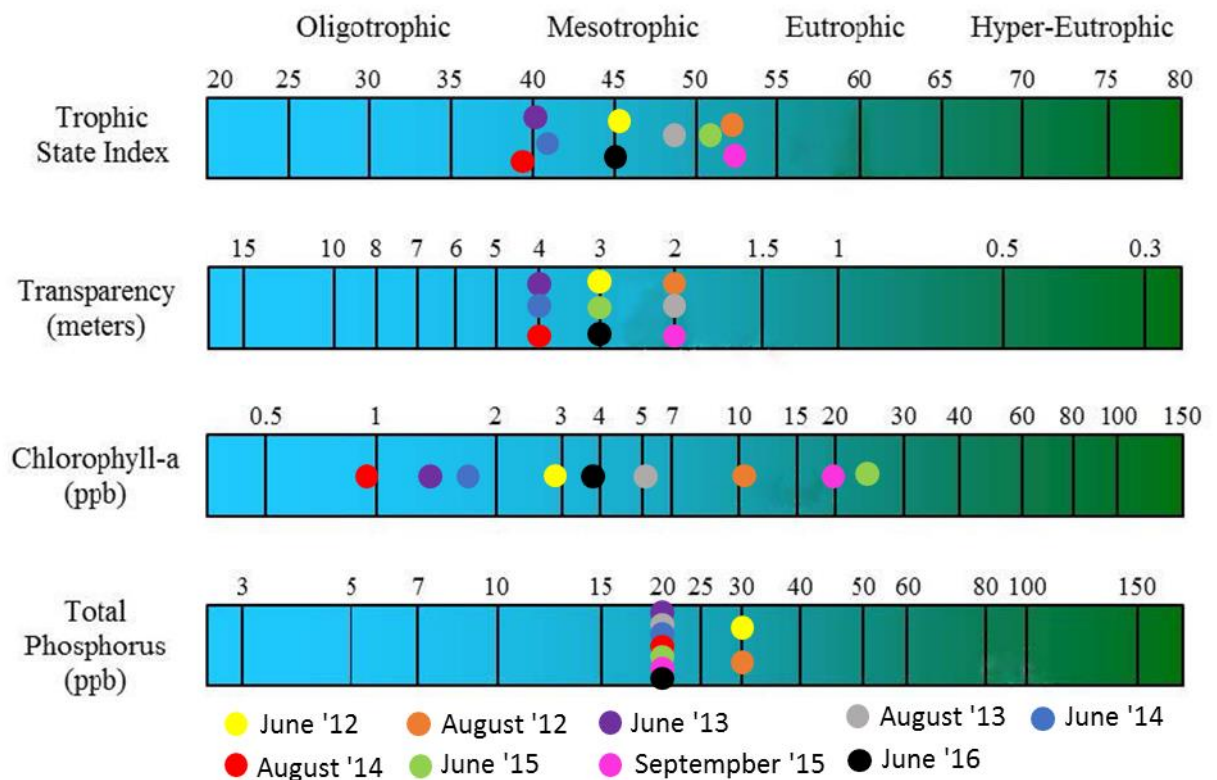


Figure 2-3: Carlson Trophic State Index for Buck Lake.

Buck Lake's inlet was also sampled during the study. The data collected from the inlet were used for trophic state classifications using the Larsen-Mercier Model and the Vollenweider Model. The results from the Larsen-Mercier Model are shown in Figure 2-4. This model classifies Buck Lake as strongly mesotrophic to slightly eutrophic. The results from the Vollenweider Model are shown in Figure 2-5. The hydraulic residence time for Buck Lake was calculated as 0.25 years. The Vollenweider Model classifies Buck Lake as eutrophic to hyper-eutrophic.

A model comparison is shown in Table 2-2. This comparison shows that the Carlson Model gave an average trophic state classification of mesotrophic while the Larsen-Mercier Model and the Vollenweider Model gave higher classifications, slightly eutrophic and strongly

eutrophic respectively. The overall average for this sample period and across all three models is slightly eutrophic.

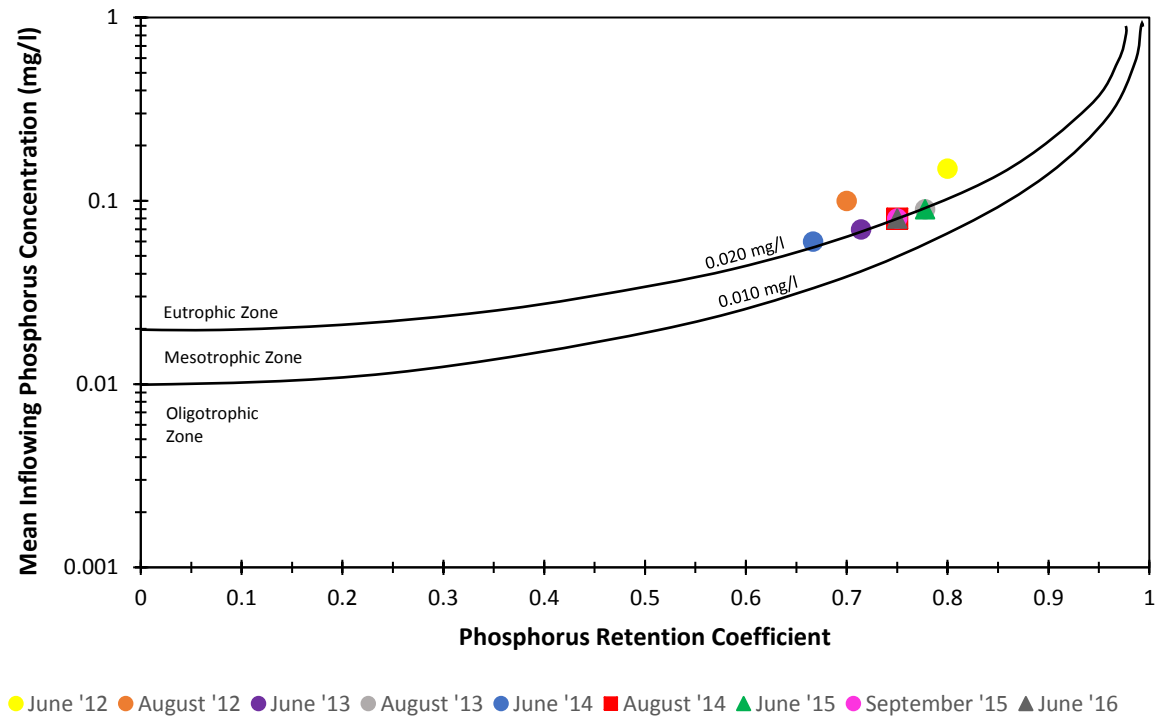


Figure 2-4: Larsen-Mercier Model for Buck Lake.

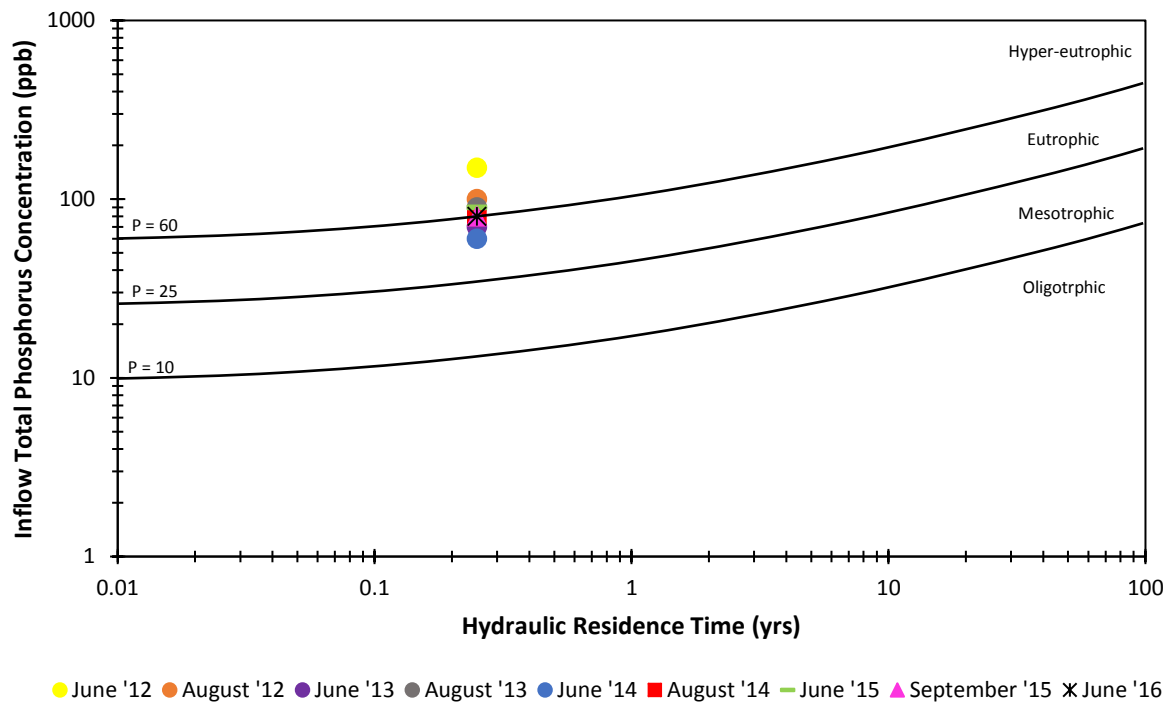


Figure 2-5: Vollenweider Model for Buck Lake.

Table 2-2: Trophic State Model Comparison for Buck Lake

Model	2012	2013	2014	2015	2016	Average
Carlson	Strongly Mesotrophic	Mesotrophic	Slightly Mesotrophic	Strongly Mesotrophic	Mesotrophic	Mesotrophic
Larsen-Mercier	Strongly Eutrophic	Slightly Eutrophic	Slightly Eutrophic	Strongly Mesotrophic	Strongly Mesotrophic	Slightly Eutrophic
Vollenweider	Hyper Eutrophic	Strongly Eutrophic	Strongly Eutrophic	Strongly Eutrophic	Strongly Eutrophic	Strongly Eutrophic
Average	Eutrophic	Slightly Eutrophic	Strongly Mesotrophic	Slightly Eutrophic	Slightly Eutrophic	Slightly Eutrophic

2.3 Cascade Lake

Cascade Lake and its inlet were sampled five times during the period of this study. It was sampled once in August of 2012 and 2013, twice during 2014, and once in June of 2015. The lake has been periodically sampled since 2000. The Carlson Model was used to analyze the data

collected and is shown in Figure 2-6. The Larsen-Mercier and Vollenweider model results are shown in Figure 2-7 and Figure 2-8 respectively.

The Carlson Model shows the trophic state for Cascade Lake to range from mesotrophic to strongly mesotrophic. The Larsen-Mercier Model calculates the trophic state to be slightly eutrophic for all the data samples. The highest classifications come from the Vollenweider Model ranging from strongly mesotrophic to eutrophic. The overall model comparison in Table 2-3 shows an overall average trophic state for Cascade Lake of strongly mesotrophic for the years 2012-2015.

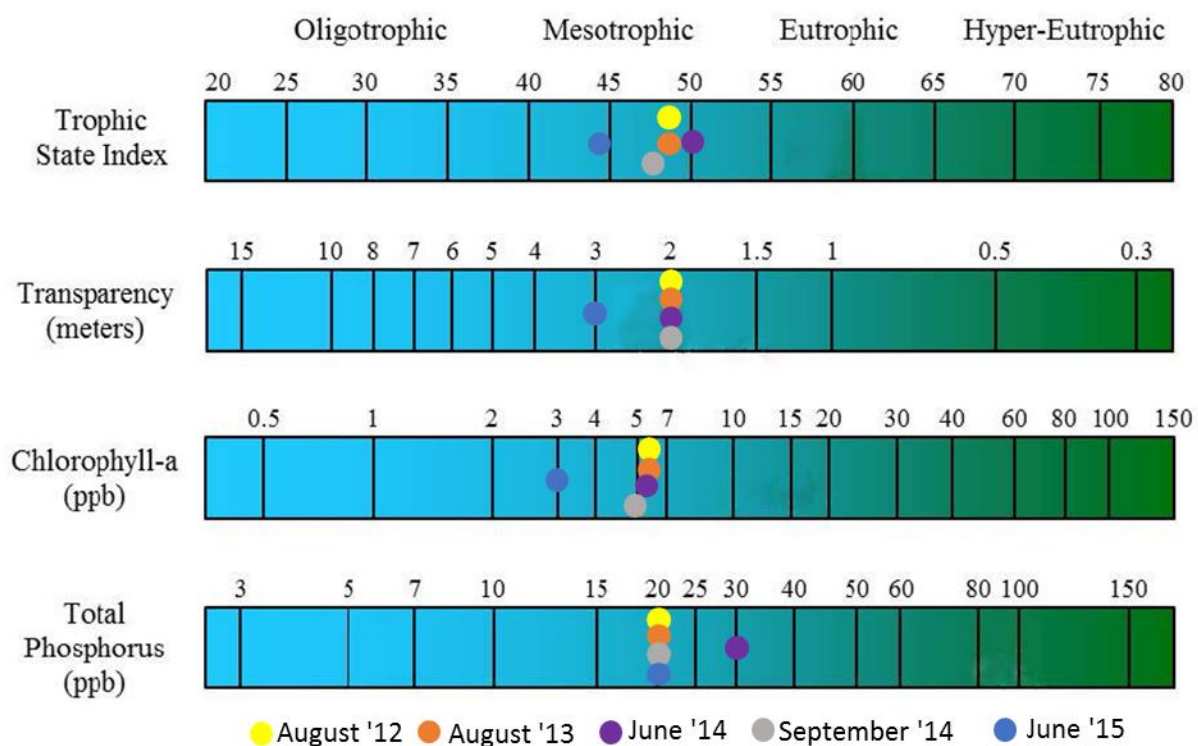


Figure 2-6: Carlson Trophic State Index for Cascade Lake.

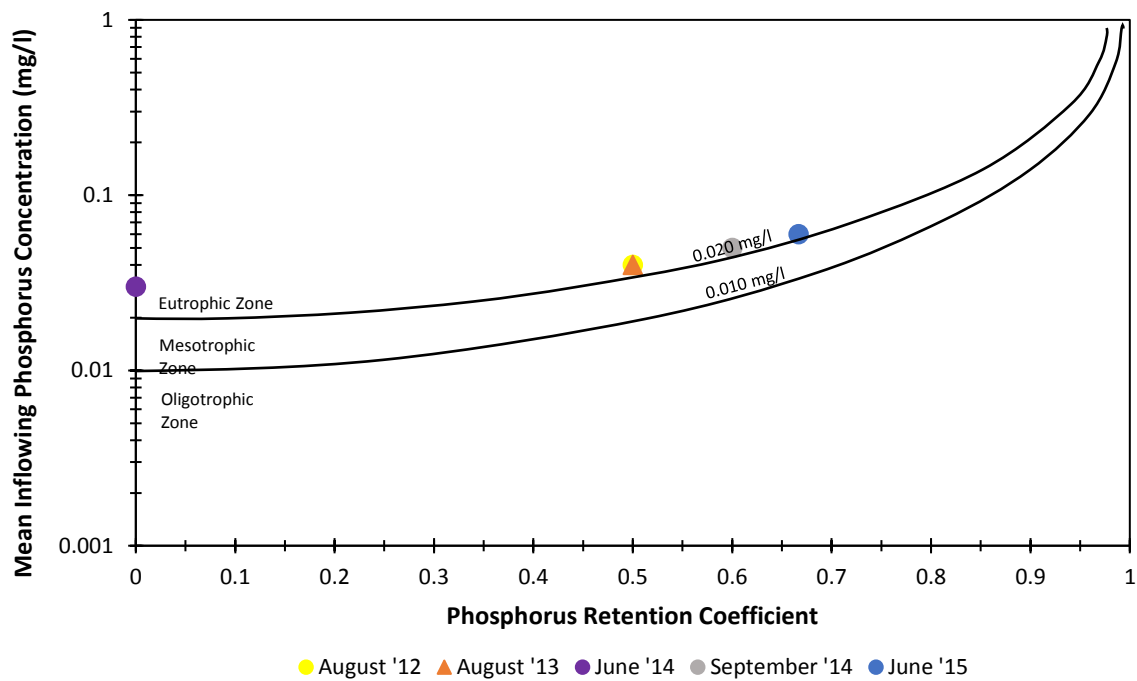


Figure 2-7: Larsen-Mercier Model for Cascade Lake.

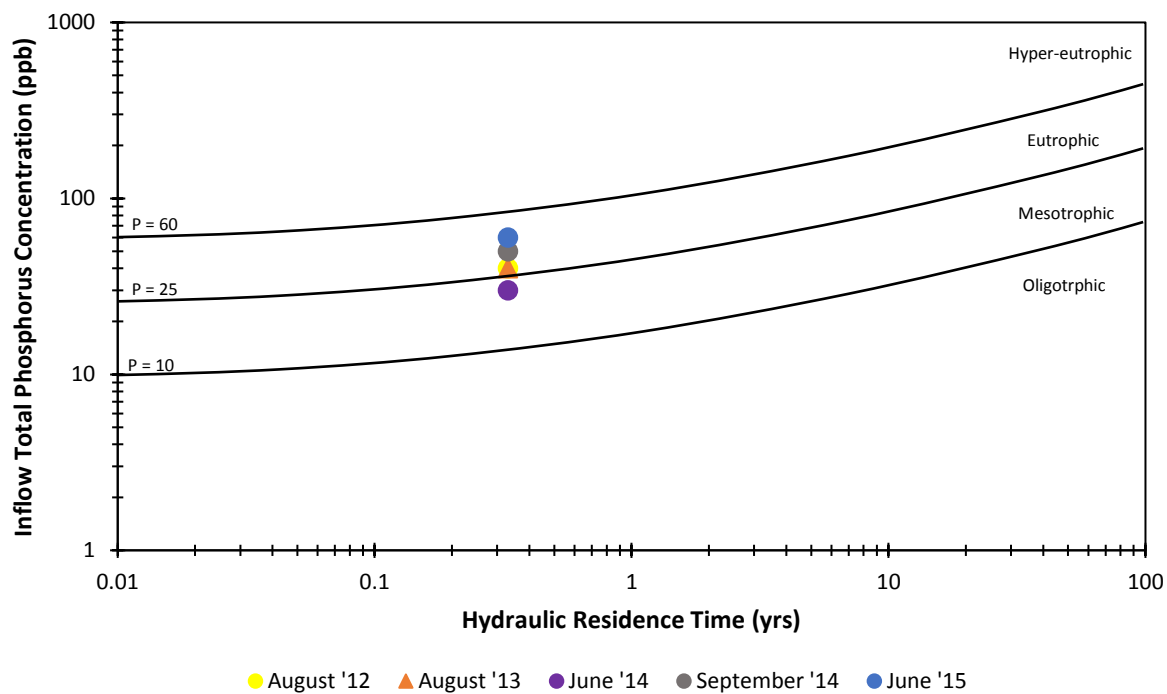


Figure 2-8: Vollenweider Model for Cascade Lake.

Table 2-3: Trophic State Model Comparison for Cascade Lake

Model	2012	2013	2014	2015	Average
Carlson	Mesotrophic	Mesotrophic	Strongly Mesotrophic	Mesotrophic	Mesotrophic
Larsen-Mercier	Slightly Eutrophic	Slightly Eutrophic	Slightly Eutrophic	Slightly Eutrophic	Slightly Eutrophic
Vollenweider	Eutrophic	Eutrophic	Slightly Eutrophic	Eutrophic	Eutrophic
Average	Strongly Mesotrophic	Strongly Mesotrophic	Strongly Mesotrophic	Strongly Mesotrophic	Strongly Mesotrophic

2.4 Clear Lake

Clear Lake was sampled eight times during the period of this study. The lake has been periodically sampled since 2004. The Carlson Model was used to analyze the data collected and is shown in Figure 2-9. The trophic state classifications calculated from the Carlson Model ranged mesotrophic to eutrophic. Overall, the average trophic state for Clear Lake between 2012 and 2016 is strongly mesotrophic as shown in the model comparison from Table 2-4.

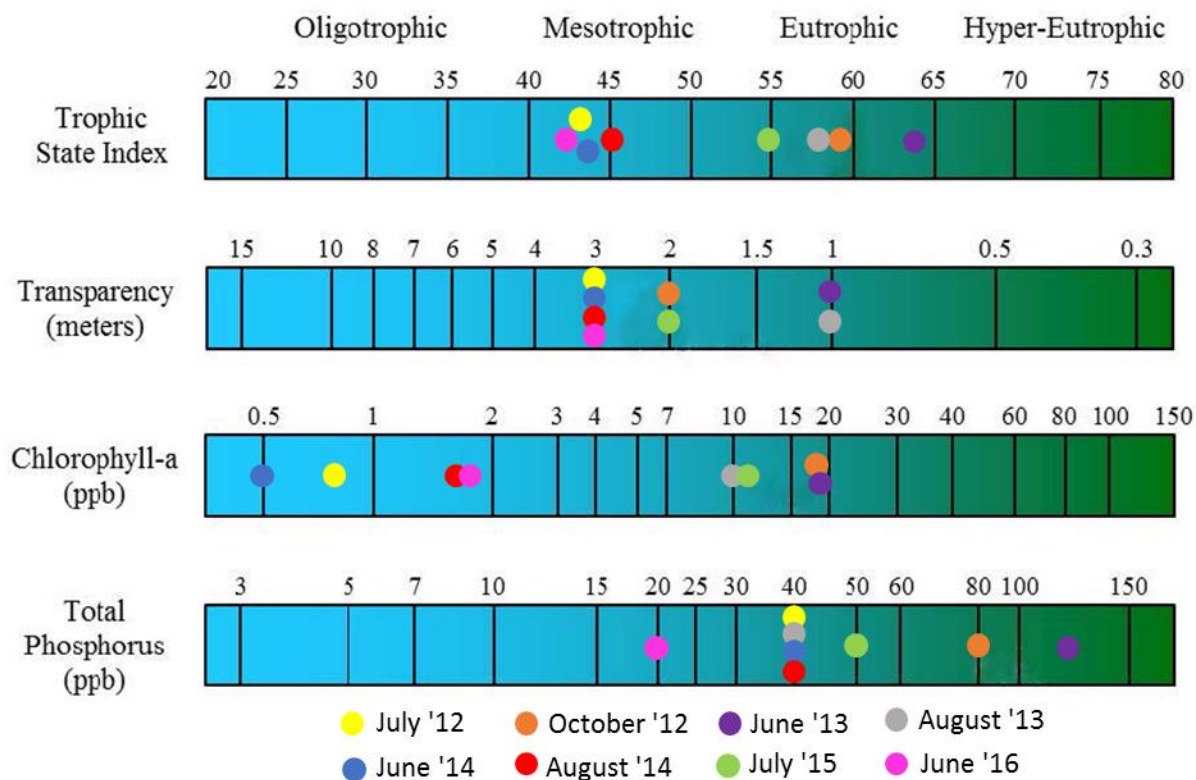


Figure 2-9: Carlson Trophic State Index for Clear Lake.

Table 2-4: Trophic State Model Comparison for Clear Lake

Model	2012	2013	2014	2015	2016	Average
Carlson	Strongly Mesotrophic	Eutrophic	Mesotrophic	Slightly Eutrophic	Mesotrophic	Strongly Mesotrophic

2.5 Divide Lake

Divide Lake was sampled once during September 2015. The Carlson Model was used to analyze the data collected and is shown in Figure 2-10. In September 2015, the trophic state index for Divide Lake was 35.5. This value indicates that the lake is slightly oligotrophic.

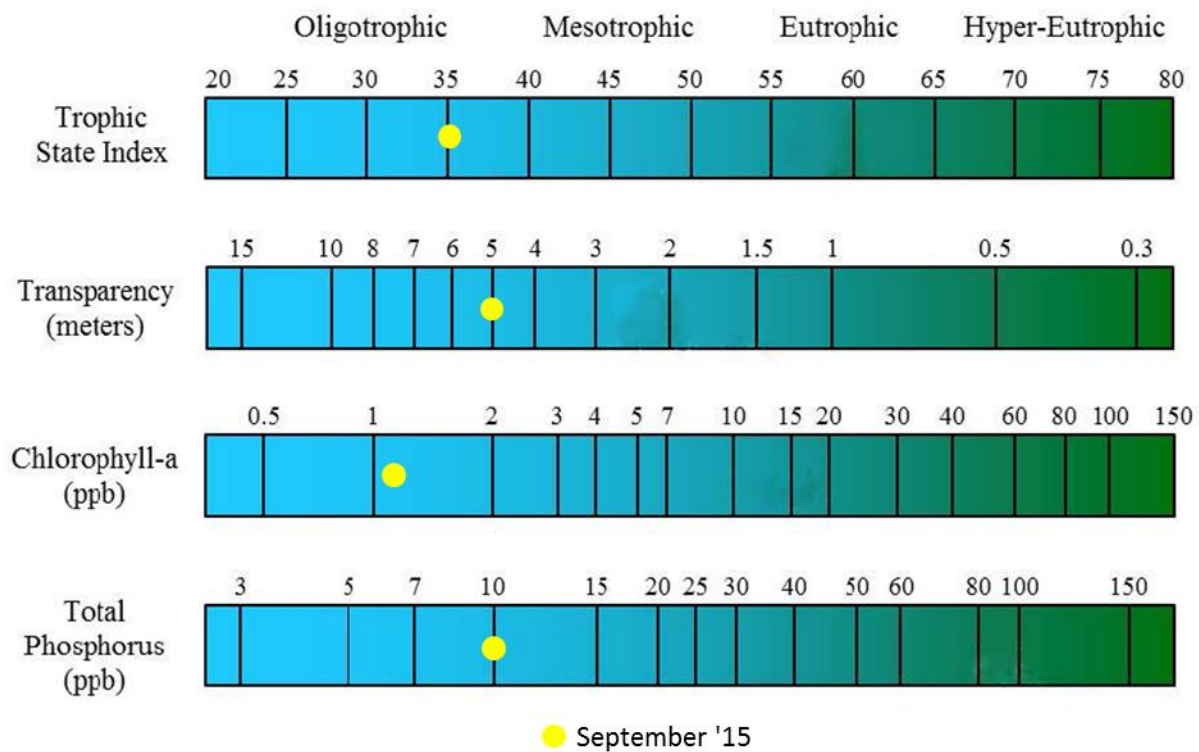


Figure 2-10: Carlson Trophic State Index for Divide Lake.

2.6 Druid Lake

Druid Lake was sampled six times between 2012 and 2014. Three of the samples came in 2012, in June, August, and October. Samples were taken in June and August of 2013. One sample was taken in August of 2014. Druid Lake has been sampled since 2010. The Carlson Model was used to analyze the data collected and is shown in Figure 2-11. A model comparison showing the results from the Carlson Model and the overall average during this time period is shown in Table 2-5. The Carlson Model resulted in trophic states ranging from mesotrophic to strongly mesotrophic. The average trophic state index from June 2012 to August 2014 was mesotrophic.

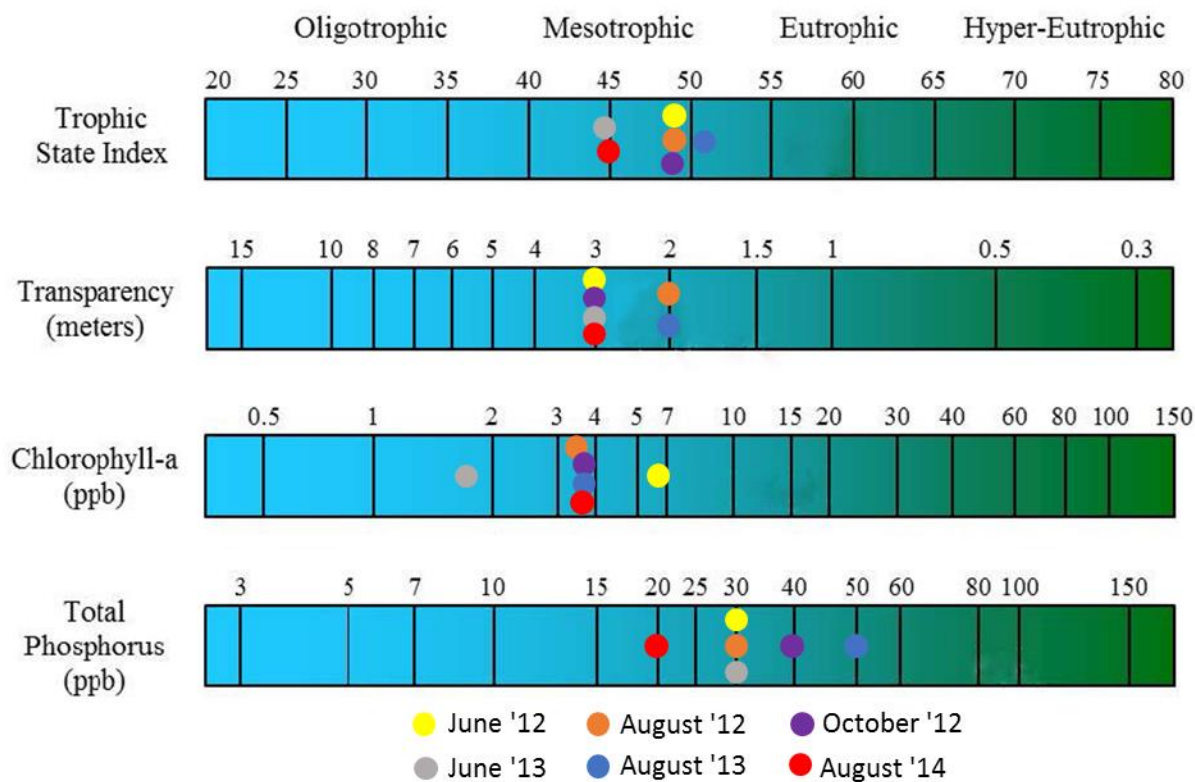


Figure 2-11: Carlson Trophic State Index for Druid Lake.

Table 2-5: Trophic State Model Comparison for Druid Lake

Model	2012	2013	2014	Average
Carlson	Strongly Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic

2.7 Duck Lake

Duck Lake was sampled seven times during the period of study. However, the lake has been sampled periodically since 1999. The Carlson Model was used to analyze the data collected and is shown in Figure 2-12. The Carlson Model calculated trophic state indexes ranging from

slightly oligotrophic to strongly mesotrophic. The trophic state model comparison in Table 2-6 shows an average trophic state index of slightly oligotrophic for Duck Lake from 2012-2016.

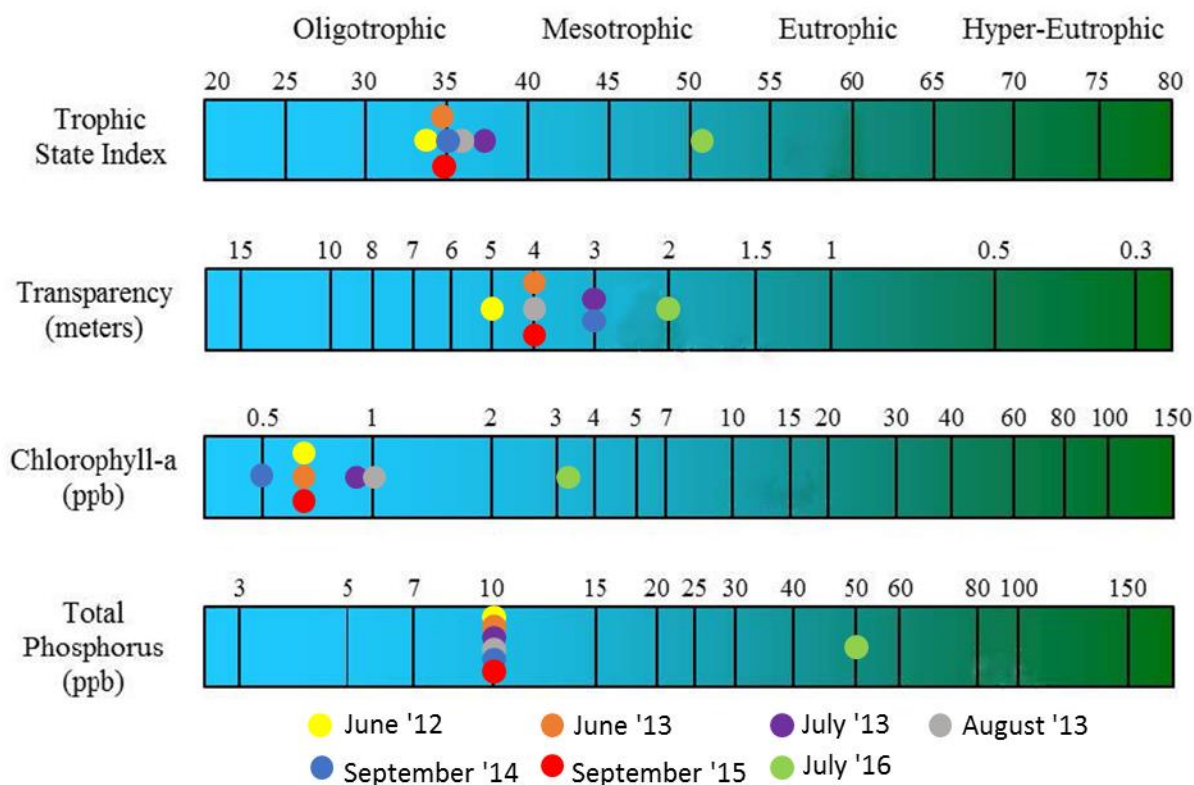


Figure 2-12: Carlson Trophic State Index for Duck Lake.

Table 2-6: Trophic State Model Comparison for Duck Lake

Model	2012	2013	2014	2015	2016	Average
Carlson	Slightly Oligotrophic	Slightly Oligotrophic	Slightly Oligotrophic	Slightly Oligotrophic	Strongly Mesotrophic	Slightly Oligotrophic

2.8 Feather Lake

Feather Lake was sampled six times during the period of this study. It has also been sampled as early as 2010. The Carlson Model was used to analyze the data collected and is

shown in Figure 2-13. Values of total phosphorus being depicted to the far right on the Carlson Model indicate that the observed values were high enough to be off the chart. This did not affect the calculation of the Carlson trophic state index. The Carlson Model calculated trophic state indexes ranging from slightly eutrophic to eutrophic. The trophic state model comparison in Table 2-7 shows an average trophic state index of slightly eutrophic for Feather Lake from 2012-2015.

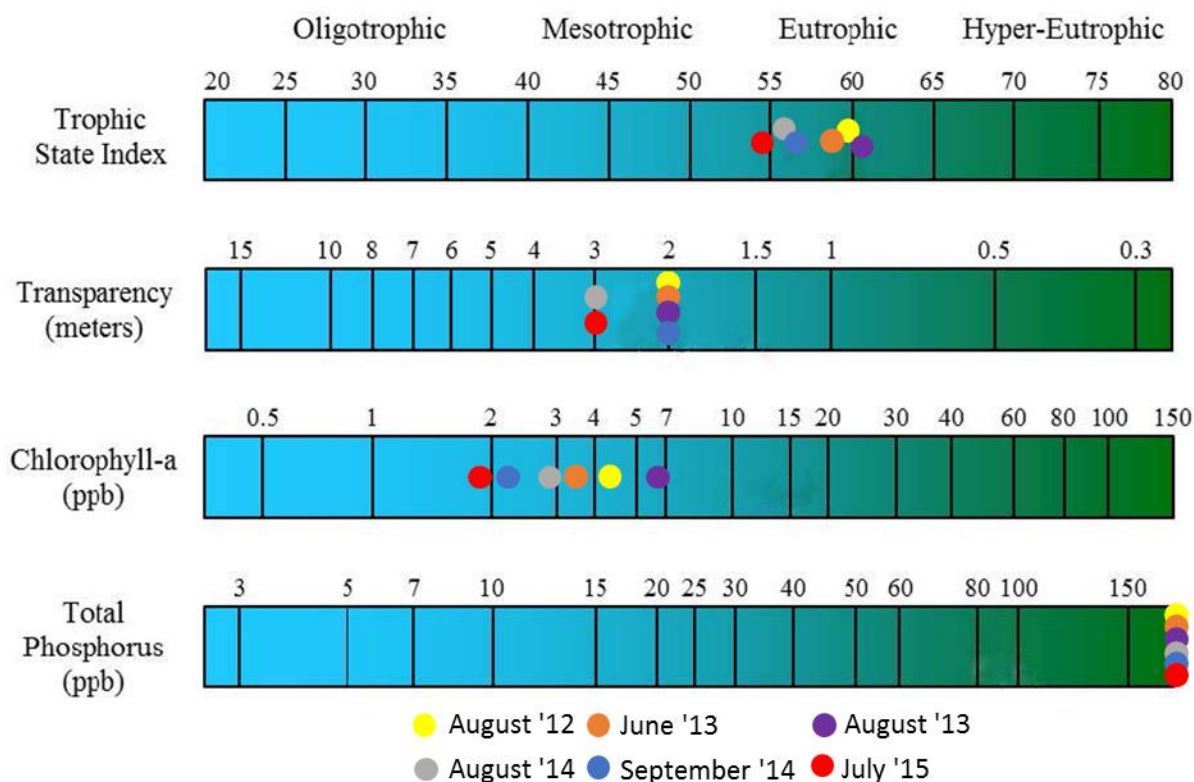


Figure 2-13: Carlson Trophic State Index for Feather Lake.

Table 2-7: Trophic State Model Comparison for Feather Lake

Model	2012	2013	2014	2015	Average
Carlson	Eutrophic	Eutrophic	Slightly Eutrophic	Slightly Eutrophic	Slightly Eutrophic

2.9 Floating Island Lake

Floating Island Lake was sampled once during October 2012. Values of total phosphorus being depicted to the far right on the Carlson Model indicate that the observed values were high enough to be off the chart. This did not affect the calculation of the Carlson trophic state index. The Carlson Model was used to analyze the data collected and is shown in Figure 2-14. In October 2012, the trophic state index for Floating Island Lake was 64.4. This value indicates that the lake is strongly eutrophic.

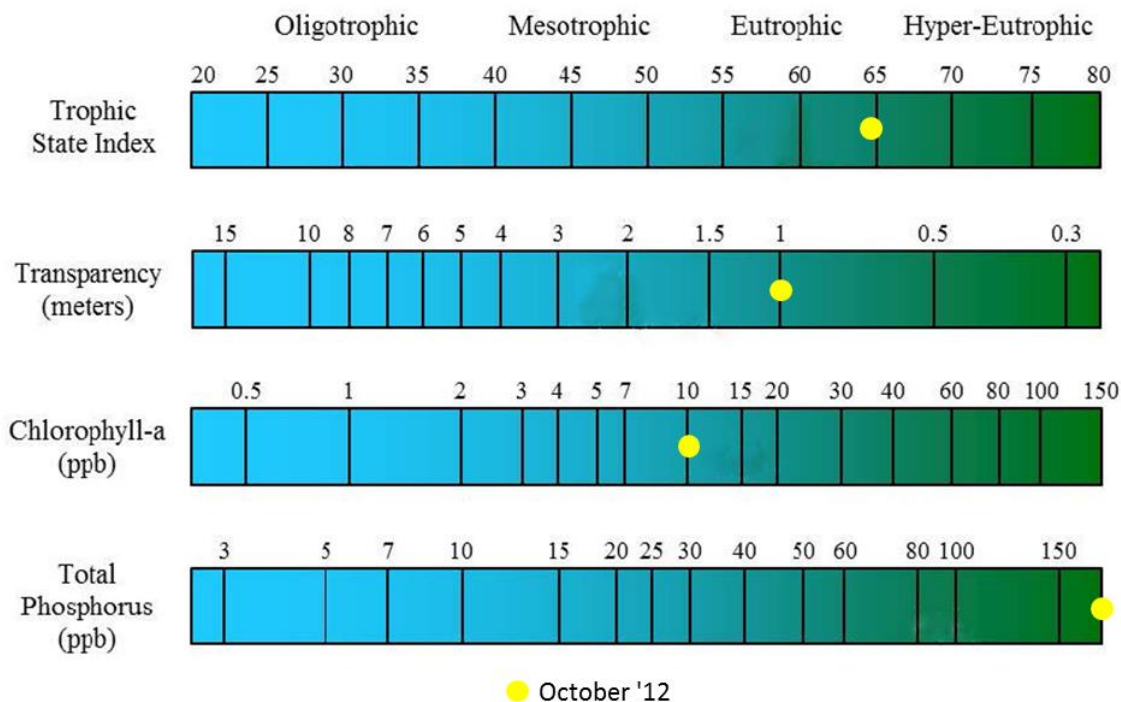


Figure 2-14: Carlson Trophic State Index for Floating Island Lake.

2.10 Goose Lake

Goose Lake and its inlet were sampled six times during this study. The lake has been periodically sampled since 2001. The Carlson Model was used to analyze the data collected and

is shown in Figure 2-15. The Larsen-Mercier and Vollenweider model results are shown in Figure 2-16 and Figure 2-17 respectively.

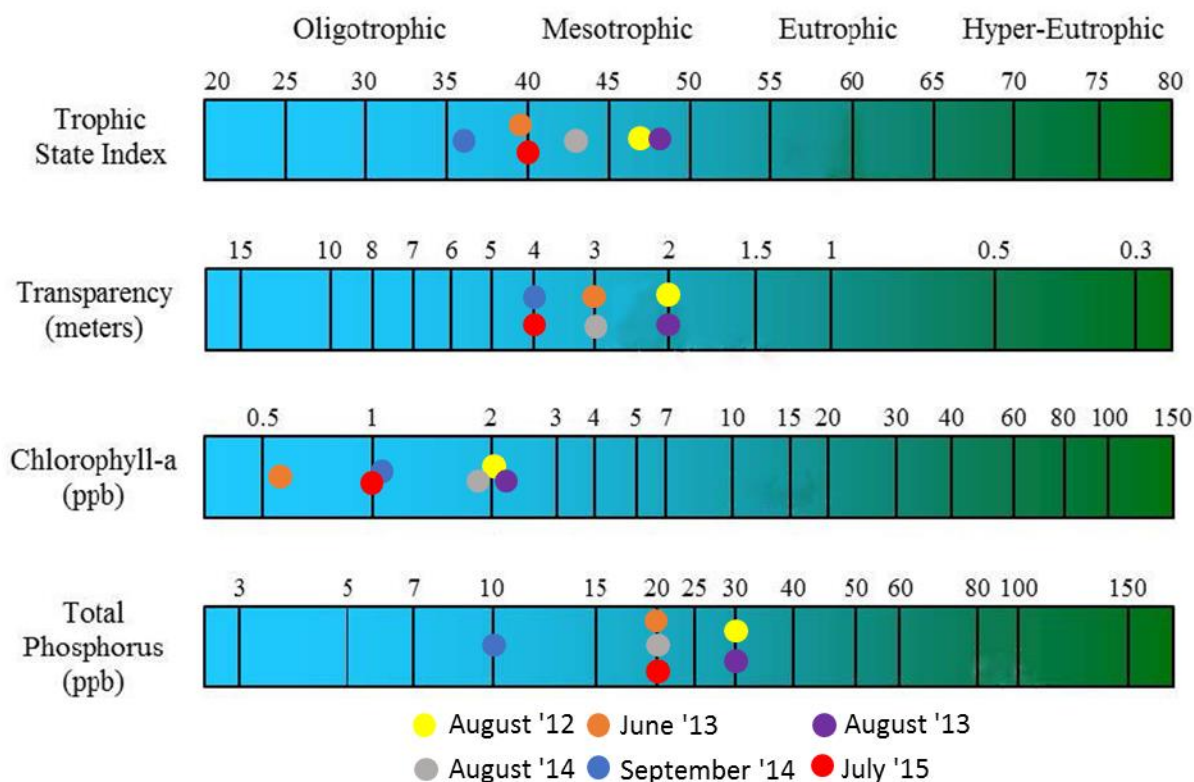


Figure 2-15: Carlson Trophic State Index for Goose Lake.

The Carlson Model shows the trophic state of Goose Lake to range from slightly mesotrophic to mesotrophic. The Larsen-Mercier Model calculates the trophic state to be slightly mesotrophic to eutrophic. The Vollenweider Model shows the trophic state classification to be mesotrophic to strongly mesotrophic. The model comparison shown in Table 2-8 shows an overall average trophic state for Goose Lake of strongly mesotrophic for the years 2012-2015.

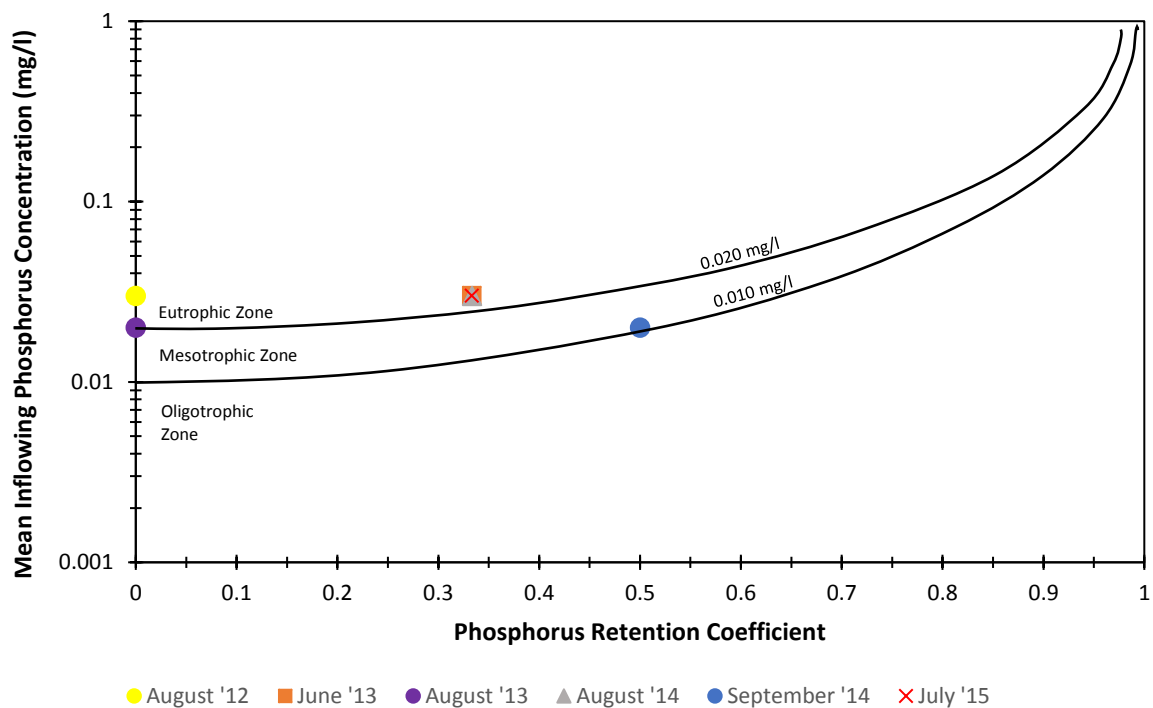


Figure 2-16: Larsen-Mercier Model for Goose Lake.

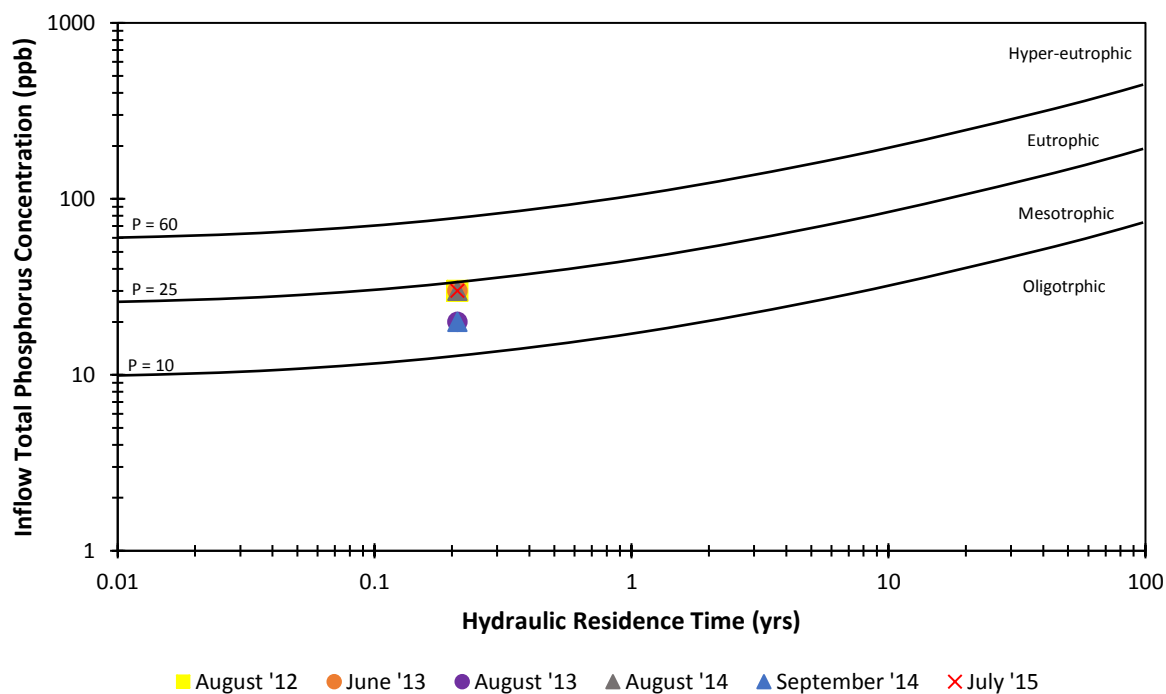


Figure 2-17: Vollenweider Model for Goose Lake.

Table 2-8: Trophic State Model Comparison for Goose Lake

Model	2012	2013	2014	2015	Average
Carlson	Mesotrophic	Mesotrophic	Slightly Mesotrophic	Slightly Mesotrophic	Slightly Mesotrophic
Larsen-Mercier	Eutrophic	Slightly Eutrophic	Strongly Mesotrophic	Eutrophic	Slightly Eutrophic
Vollenweider	Strongly Mesotrophic	Strongly Mesotrophic	Strongly Mesotrophic	Strongly Mesotrophic	Strongly Mesotrophic
Average	Strongly Mesotrophic	Strongly Mesotrophic	Mesotrophic	Strongly Mesotrophic	Strongly Mesotrophic

2.11 Grebe Lake

Grebe Lake and its inlet were sampled once during August 2012. The lake has also been sampled during the year 2000. The Carlson Model was used to analyze the data collected and is shown in Figure 2-18. In August 2012, the Carlson trophic state index for Grebe Lake was 45.6. This value indicates that the lake is mesotrophic.

The Larsen-Mercier and Vollenweider model results are shown in Figure 2-19 and Figure 2-20 respectively. The Larsen-Mercier Model calculates the trophic state to be slightly eutrophic while the Vollenweider model is similar to the Carlson Model at slightly mesotrophic. The trophic state model comparison in Table 2-9 shows an average trophic state index of mesotrophic for Grebe Lake in August 2012.

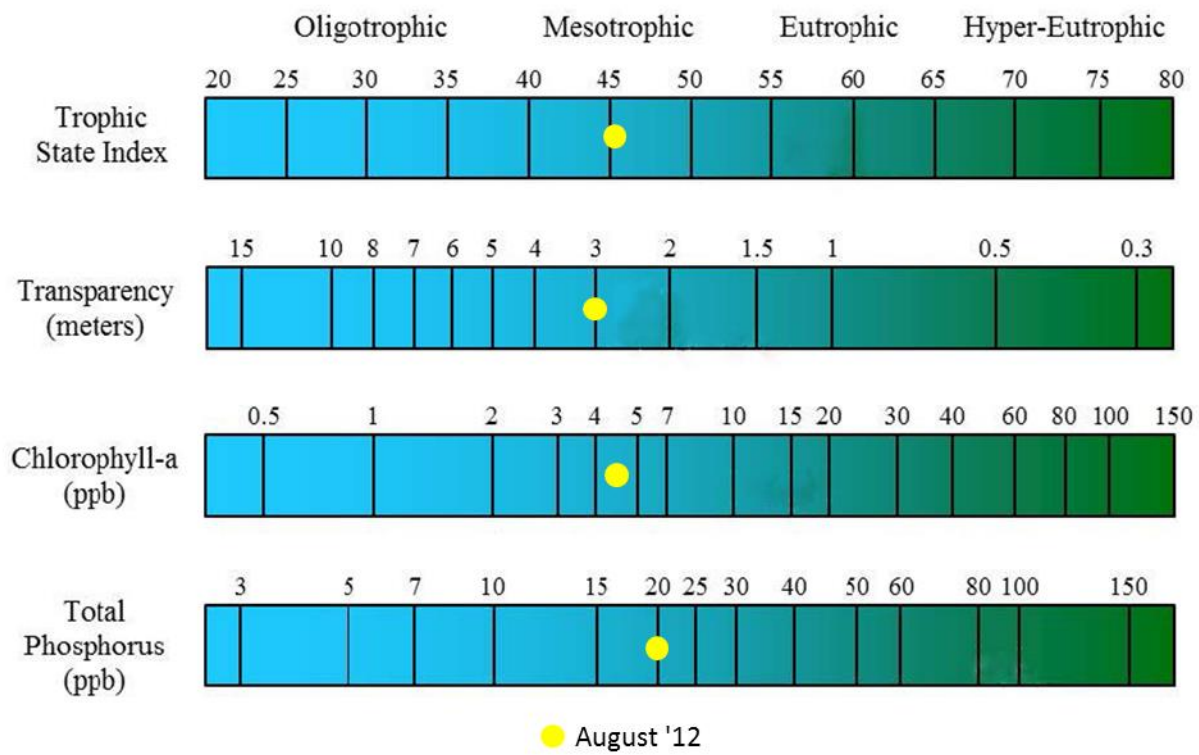


Figure 2-18: Carlson Trophic State Index for Grebe Lake.

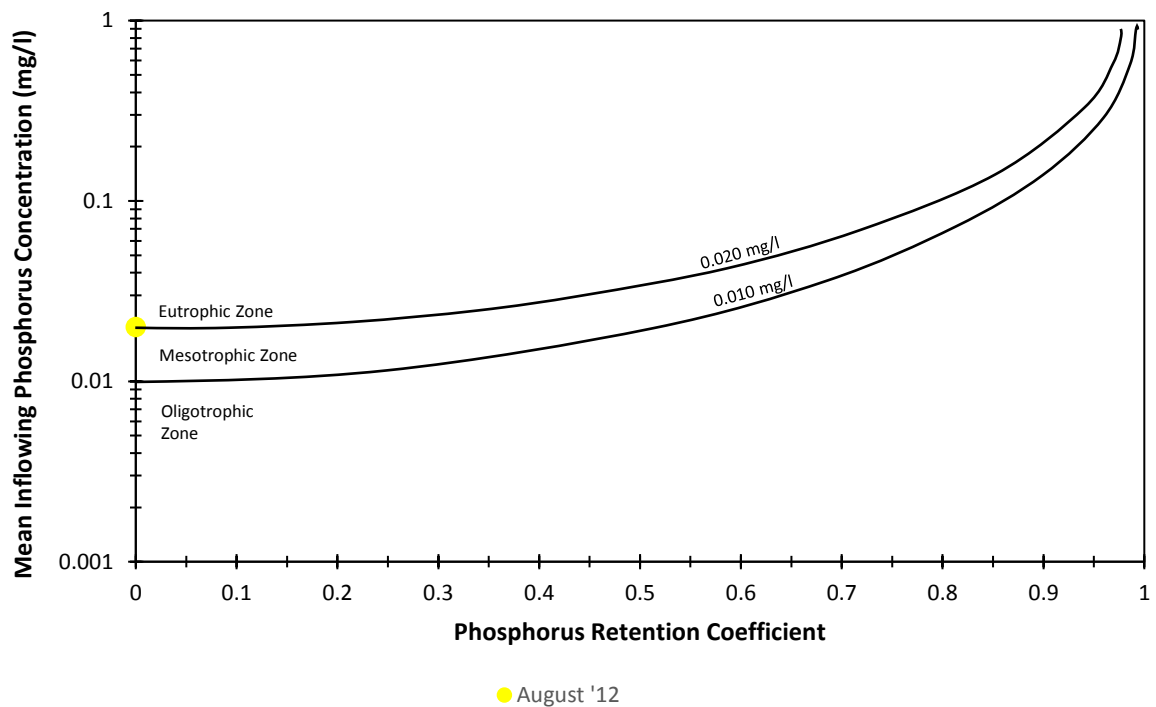


Figure 2-19: Larsen-Mercier Model for Grebe Lake.

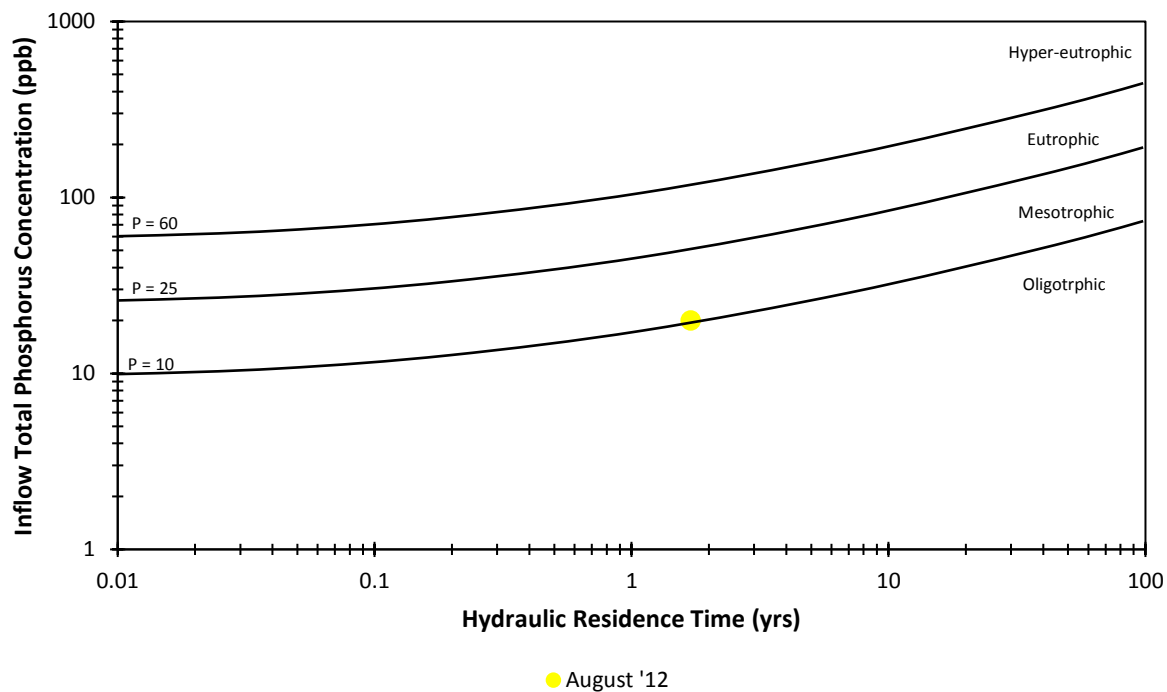


Figure 2-20: Vollenweider Model for Grebe Lake.

Table 2-9: Trophic State Model Comparison for Grebe Lake

Model	2012	Average
Carlson	Mesotrophic	Mesotrophic
Larsen-Mercier	Slightly Eutrophic	Slightly Eutrophic
Vollenweider	Mesotrophic	Mesotrophic
Average	Mesotrophic	Mesotrophic

2.12 Grizzly Lake

Grizzly Lake was sampled once during August 2012. The Carlson Model was used to analyze the data collected and is shown in Figure 2-21. In August 2012, the trophic state index for Grizzly Lake was 32.9. This value indicates that the lake is slightly oligotrophic.

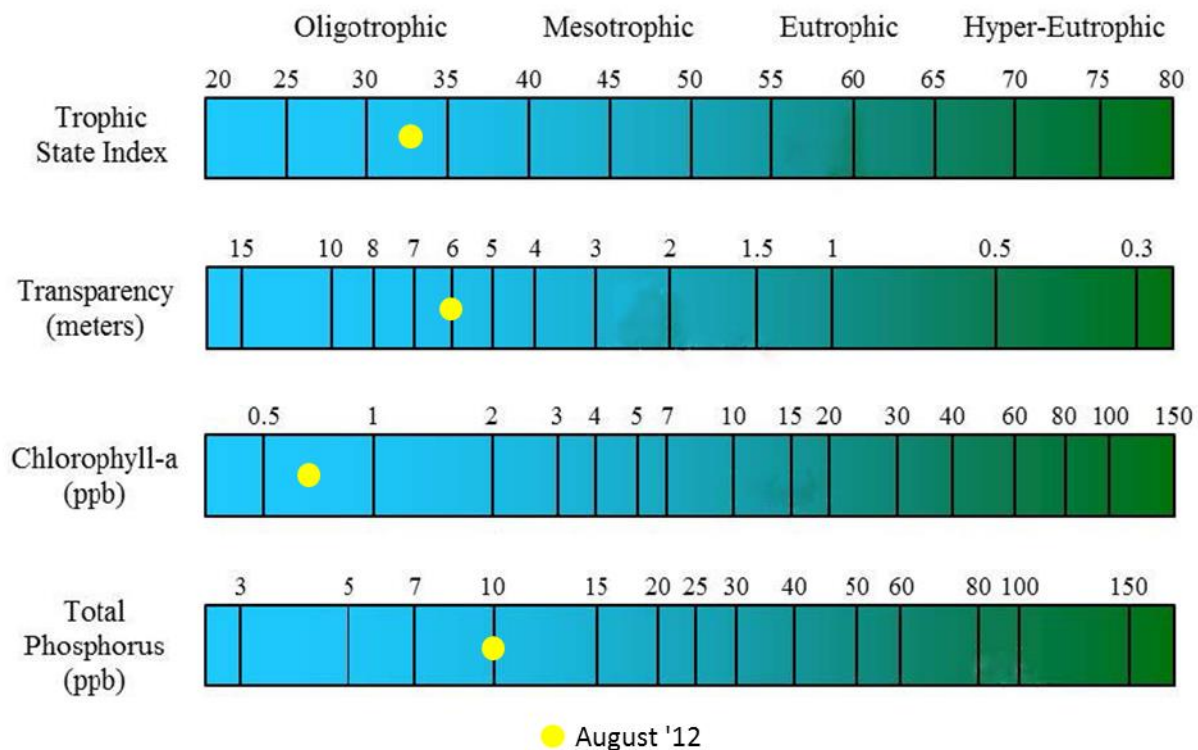


Figure 2-21: Carlson Trophic State Index for Grizzly Lake.

2.13 Harlequin Lake

Harlequin Lake was sampled three times during the period of this study. Once in July of 2012, October 2012, and once during June 2015. These are the only samples analyzed in this report. However, Harlequin Lake has been sampled many times since 2001. The Carlson Model was used to analyze the data collected and is shown in Figure 2-22.

From the Carlson Model it is shown that Harlequin Lake had a Trophic State of 48.2 in July 2012, 59.1 in October 2012, and 49.7 in June 2015. Table 2-10 compares the models classifications for these two years. Harlequin Lake ranged from strongly mesotrophic to slightly eutrophic from 2012 to 2015. For the period of study, Harlequin Lake had an average classification of strongly mesotrophic.

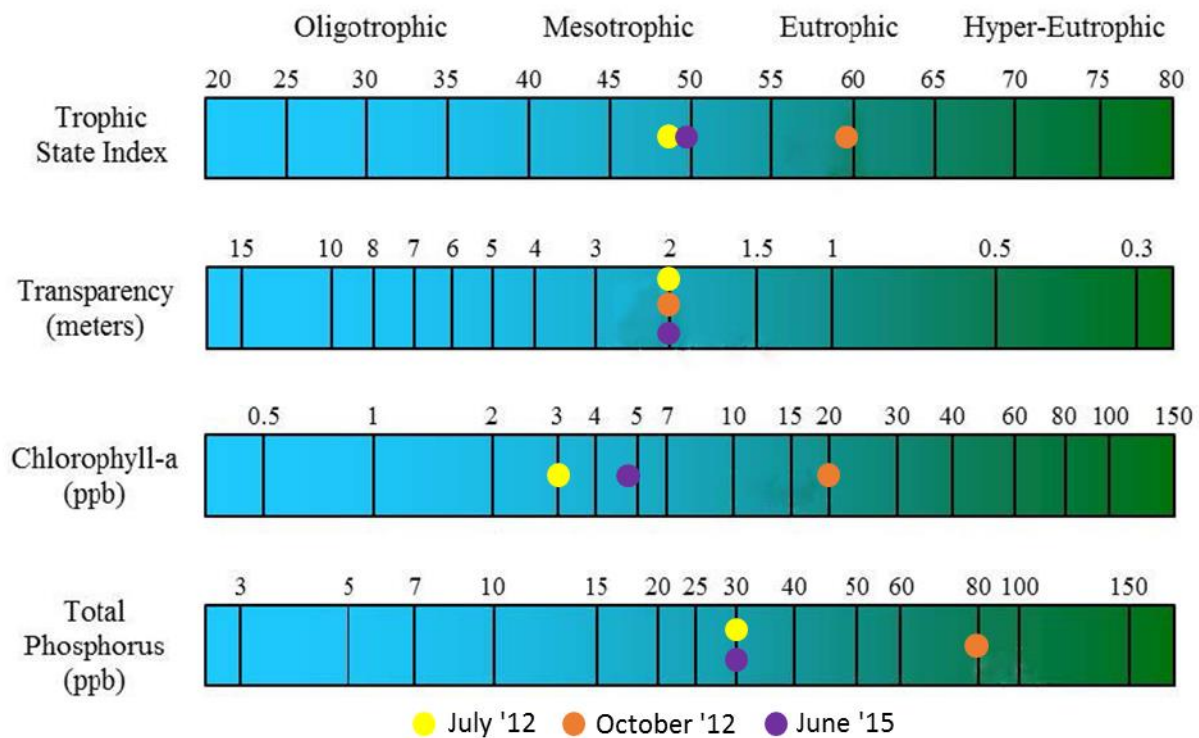


Figure 2-22: Carlson Trophic State Index for Harlequin Lake.

Table 2-10: Trophic State Model Comparison for Harlequin Lake.

Model	2012	2015	Average
Carlson	Slightly Eutrophic	Strongly Mesotrophic	Strongly Mesotrophic

2.14 Hazel Lake

Hazel Lake and its inlet were sampled four times during the period of this study. It was sampled once in June and August of 2012, once in June 2013, and once in June of 2016. The lake has been periodically sampled since 2001. The Carlson Model was used to analyze the data

collected and is shown in Figure 2-23. The Larsen-Mercier and Vollenweider model results are shown in Figure 2-24 and Figure 2-25 respectively.

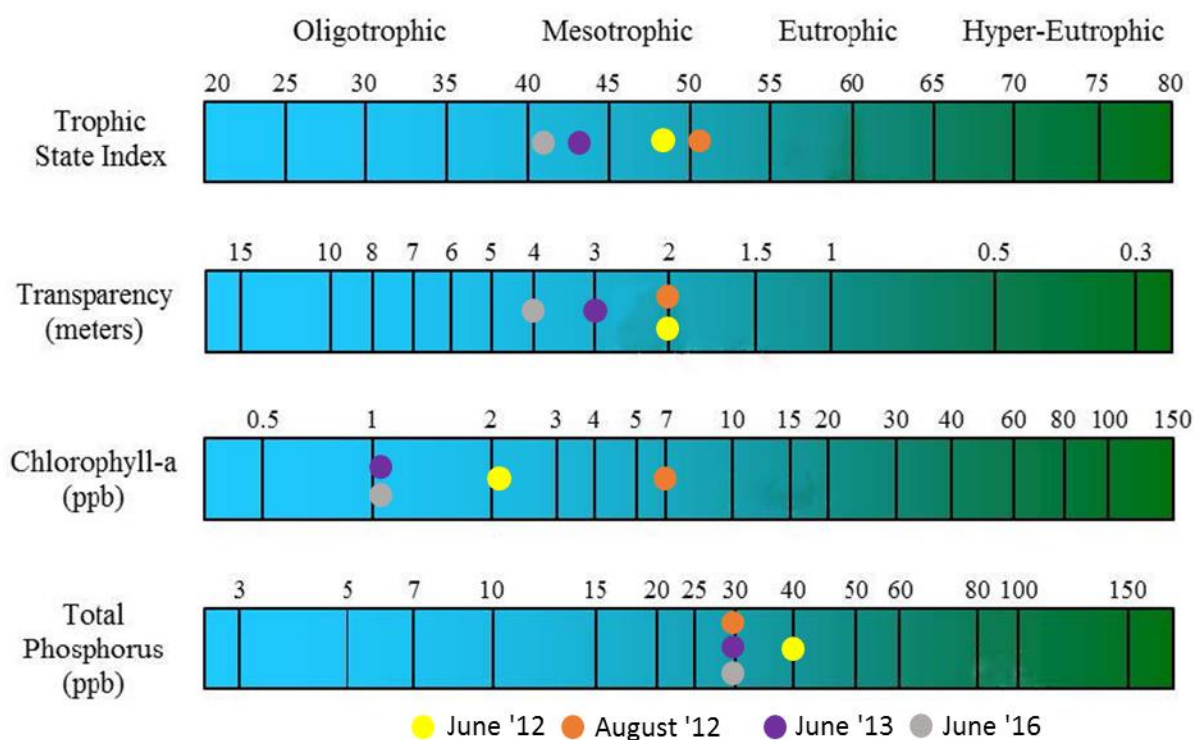


Figure 2-23: Carlson Trophic State Index for Hazel Lake.

The Carlson Model shows the trophic state for Hazel Lake to range from slightly mesotrophic to strongly mesotrophic. The Larsen-Mercier Model calculates the trophic state to be eutrophic for all the data samples. The highest classifications come from the Vollenweider Model ranging from eutrophic to hyper-eutrophic. The model comparison shown in Table 2-11 shows an overall average trophic state for Hazel Lake of slightly eutrophic for the years 2012-2016.

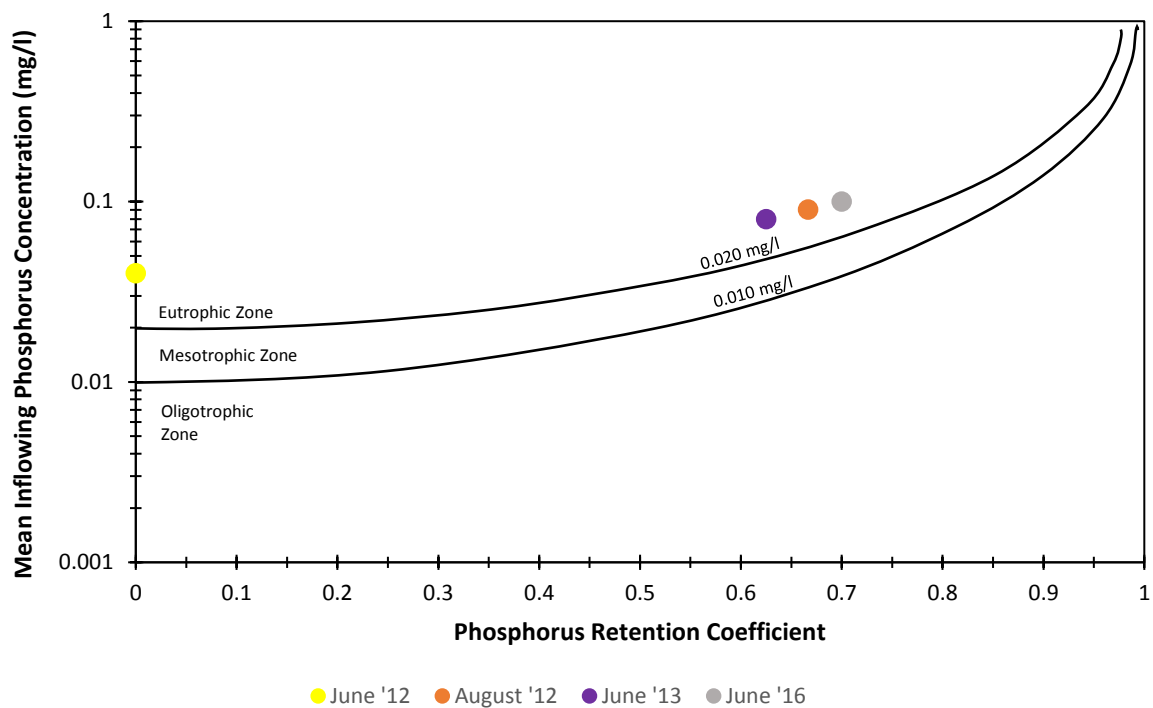


Figure 2-24: Larsen-Mercier Model for Hazel Lake.

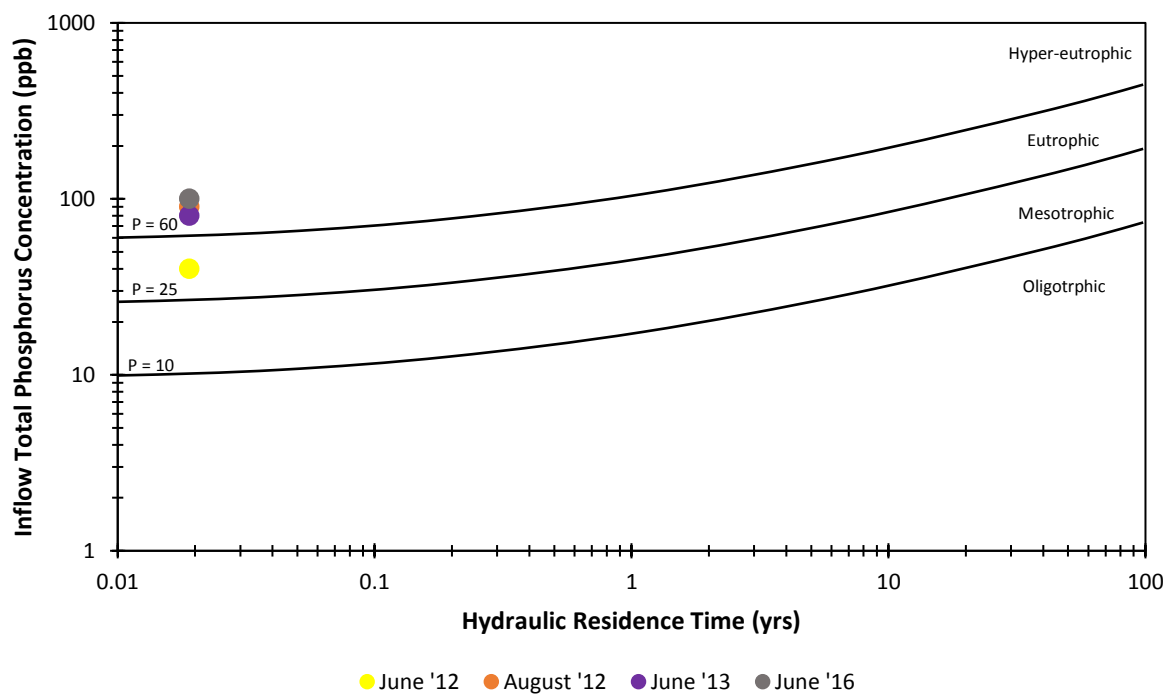


Figure 2-25: Vollenweider Model for Hazel Lake.

Table 2-11: Trophic State Model Comparison for Hazel Lake

Model	2012	2013	2016	Average
Carlson	Strongly Mesotrophic	Mesotrophic	Slightly Mesotrophic	Mesotrophic
Larsen-Mercier	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Vollenweider	Strongly Eutrophic	Hyper Eutrophic	Hyper Eutrophic	Strongly Eutrophic
Average	Slightly Eutrophic	Slightly Eutrophic	Slightly Eutrophic	Slightly Eutrophic

2.15 Hot Beach Pond

Hot beach Pond was sampled three times during the period of this study. Once in August of 2012, August 2013, and once during October 2016. These are the only samples analyzed in this report. However, Hot Beach Pond has been sampled periodically since 2004. Values of total phosphorus being depicted to the far right on the Carlson Model indicate that the observed values were high enough to be off the chart. This did not affect the calculation of the Carlson trophic state index. The Carlson Model was used to analyze the data collected and is shown in Figure 2-26.

From the Carlson Model it is shown that Hot Beach Pond had a trophic state of 73.7 in August 2012, 49.0 in August 2013, and 63.4 in October 2016. Table 2-12 compares the models classifications for these three time periods. Hot Beach Pond ranged from strongly mesotrophic to hyper-eutrophic from 2012 to 2016. For the period of study, Hot Beach Pond had an average classification of strongly eutrophic.

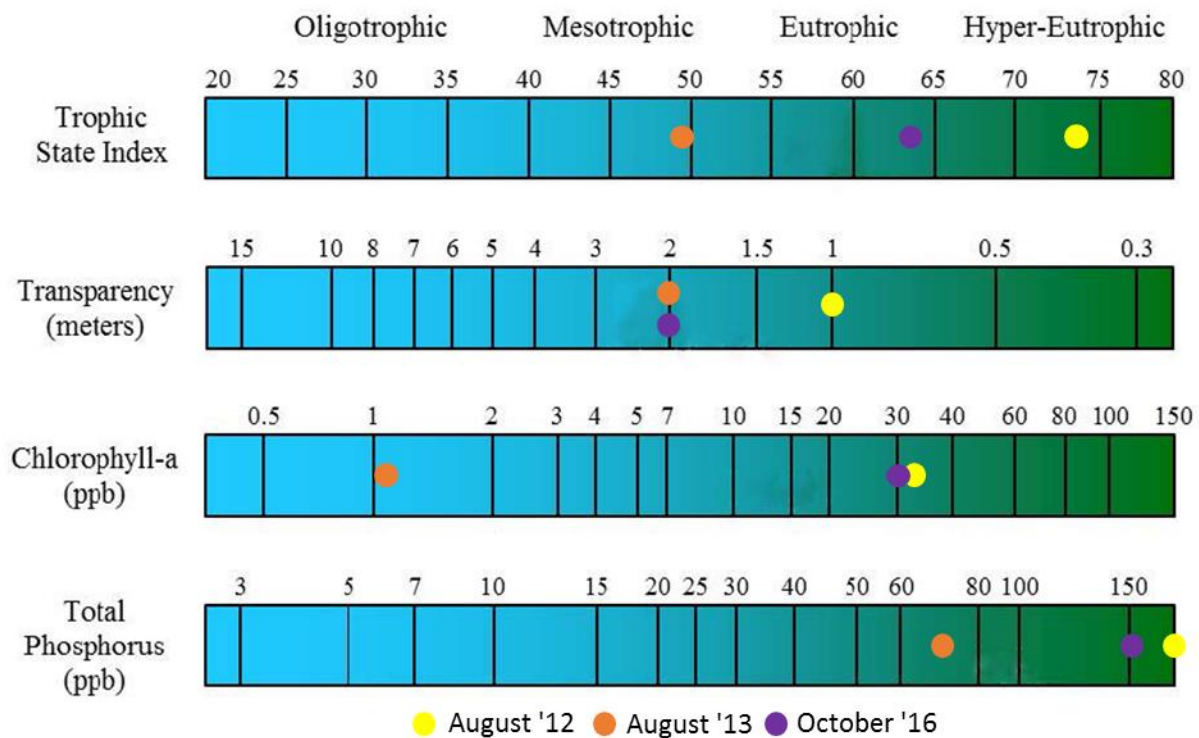


Figure 2-26: Carlson Trophic State Index for Hot Beach Pond.

Table 2-12: Trophic State Model Comparison for Hot Beach Pond

Model	2012	2013	2016	Average
Carlson	Hyper Eutrophic	Strongly Mesotrophic	Strongly Eutrophic	Strongly Eutrophic

2.16 Hot Lake

Hot Lake was sampled once during this study in July 2016. It has also been sampled a couple times since 2001. The Carlson Model was used to analyze the data collected and is shown in Figure 2-27. In July 2016, the trophic state index for Hot Lake was 44.9. This value indicates that the lake is mesotrophic.

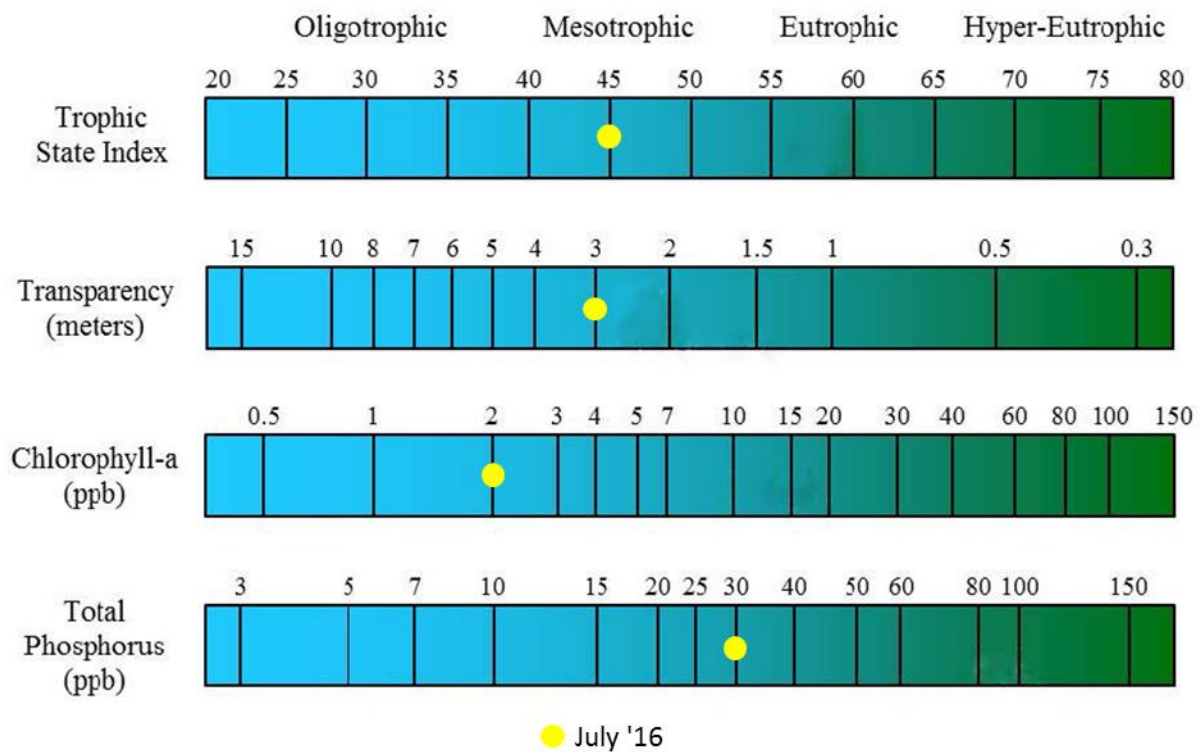


Figure 2-27: Carlson Trophic State Index for Hot Lake.

2.17 Ice Lake

Ice Lake was sampled five times during the period of study. The lake has been periodically sampled since 2000. The Carlson Model was used to analyze the data collected and is shown in Figure 2-28. The trophic state classifications calculated from the Carlson Model ranged from slightly oligotrophic to mesotrophic. Overall, the average trophic state for Ice Lake between 2012 and 2016 is slightly mesotrophic as shown in the model comparison in Table 2-13.

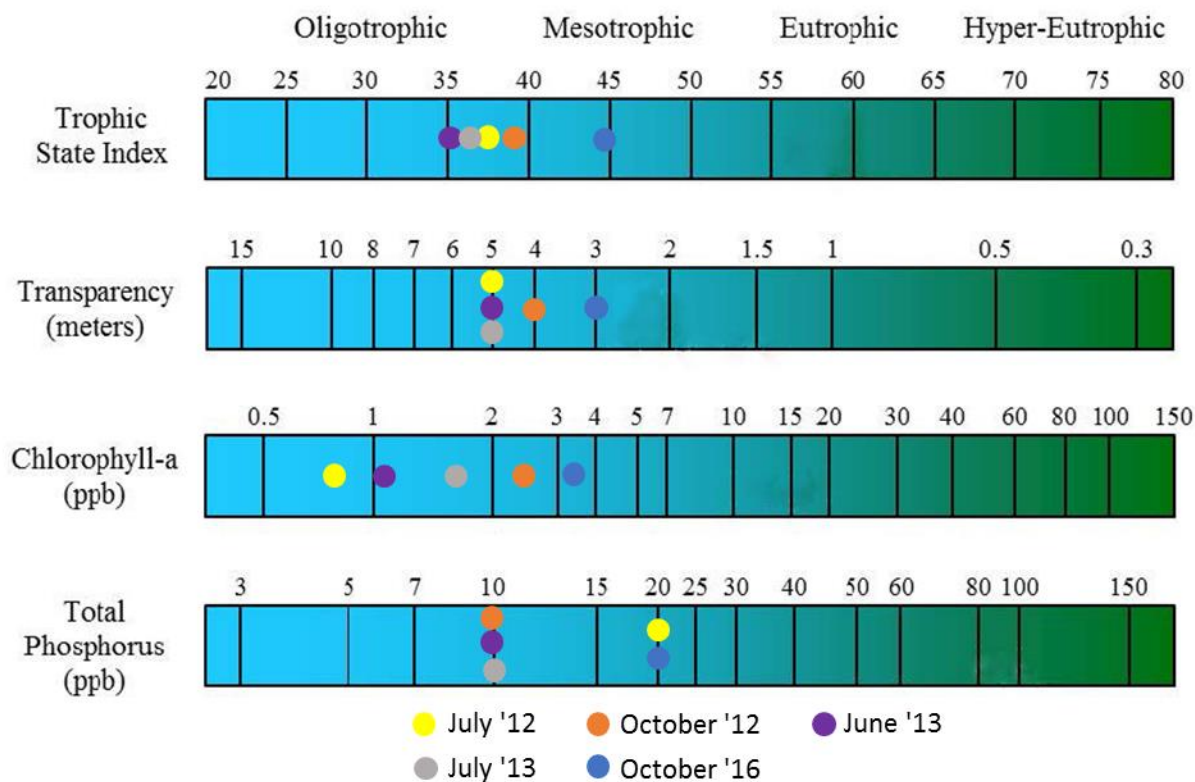


Figure 2-28: Carlson Trophic State Index for Ice Lake.

Table 2-13: Trophic State Model Comparison for Ice Lake.

Model	2012	2013	2016	Average
Carlson	Slightly Mesotrophic	Slightly Oligotrophic	Mesotrophic	Slightly Mesotrophic

2.18 Indian Pond

Indian Pond was sampled thirteen times during the period of this study. Its inlet was also sampled eight times during the study. The pond has been periodically sampled since 2004. The Carlson Model was used to analyze the data collected and is shown in Figure 2-29. The Larsen-Mercier and Vollenweider model results are shown in Figure 2-30 and Figure 2-31 respectively.

The Carlson Model shows the trophic state for Indian Pond to range from eutrophic to hyper-eutrophic. The Larsen-Mercier Model calculates the trophic state to be eutrophic to

strongly eutrophic. The highest classifications come from the Vollenweider Model, which calculates hyper-eutrophic for all the data samples. The overall model comparison in Table 2-14 shows an average trophic state for Indian Pond of strongly eutrophic for the years 2012-2016.

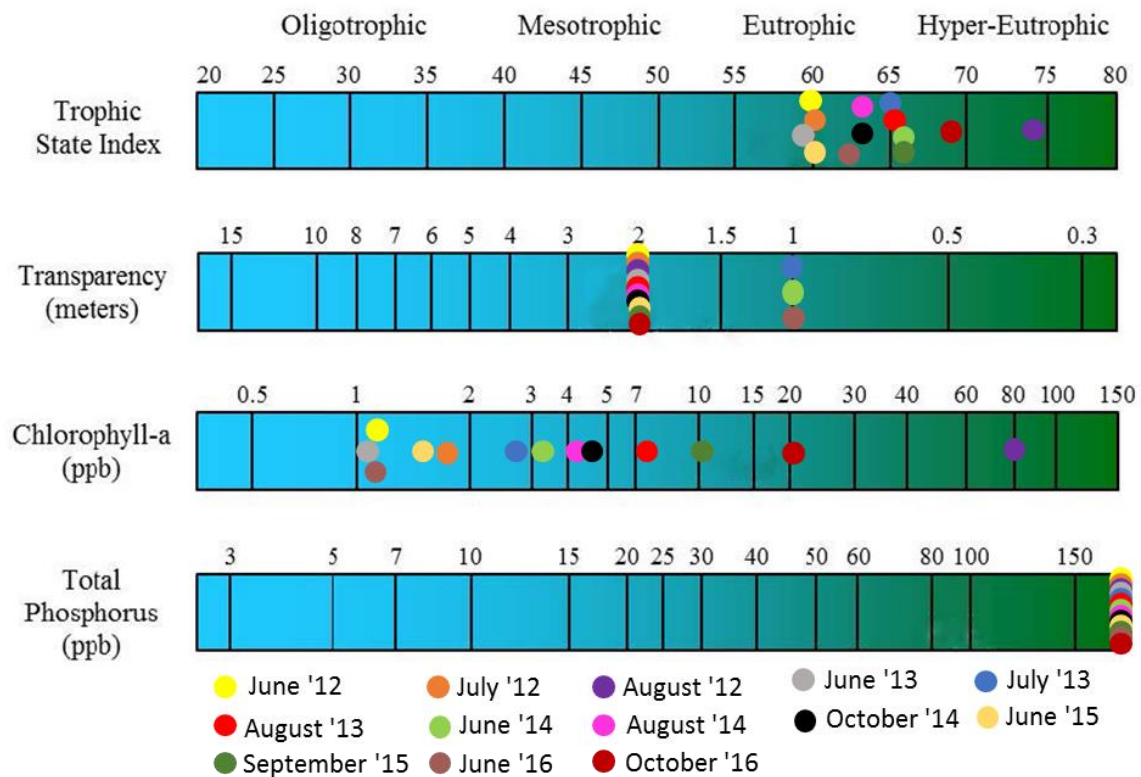


Figure 2-29: Carlson Trophic State Index for Indian Pond.

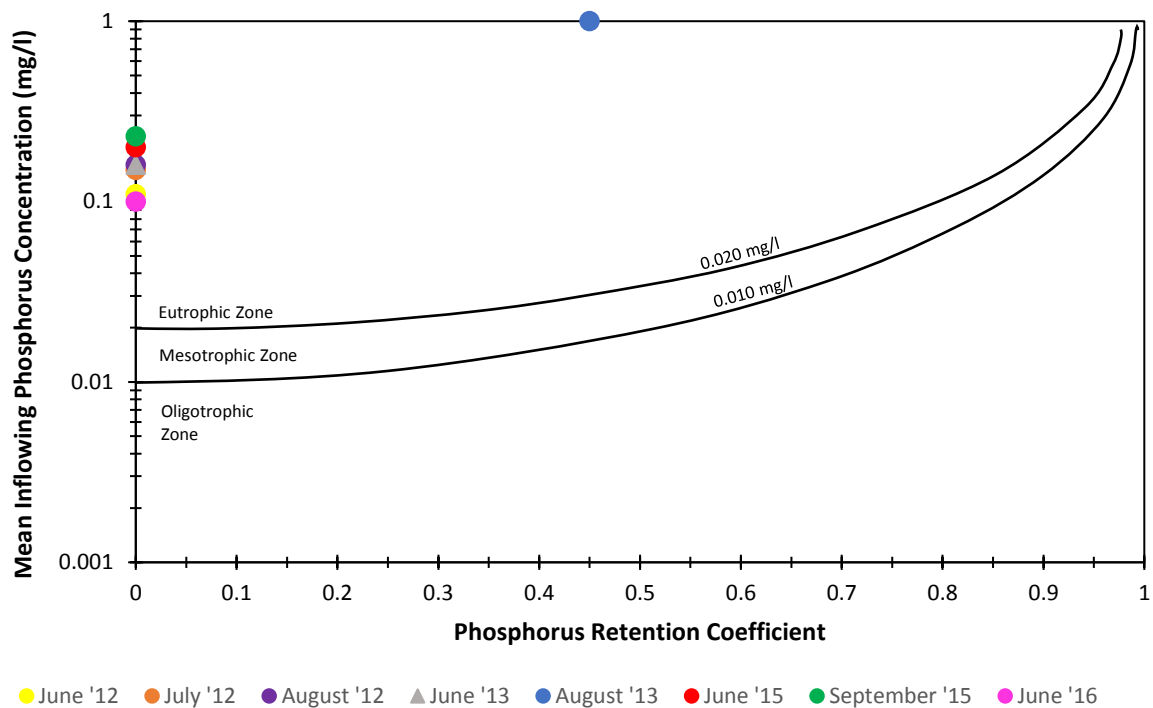


Figure 2-30: Larsen-Mercier Model for Indian Pond.

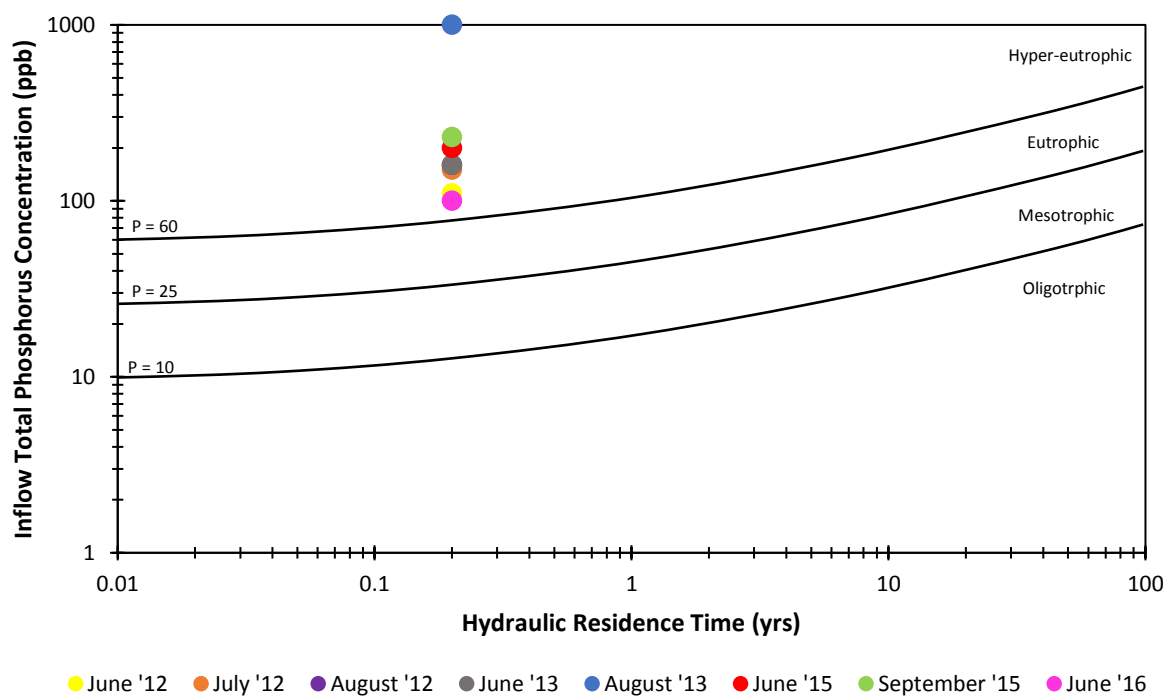


Figure 2-31: Vollenweider Model for Indian Pond.

Table 2-14: Model Comparison for Indian Pond

Model	2012	2013	2014	2015	2016	Average
Carlson	Strongly Eutrophic	Strongly Eutrophic	Strongly Eutrophic	Strongly Eutrophic	Hyper Eutrophic	Strongly Eutrophic
Larsen-Mercier	Strongly Eutrophic	Strongly Eutrophic	-	Strongly Eutrophic	Eutrophic	Strongly Eutrophic
Vollenweider	Hyper Eutrophic	Hyper Eutrophic	-	Hyper Eutrophic	Hyper Eutrophic	Hyper Eutrophic
Average	Strongly Eutrophic	Strongly Eutrophic	Slightly Eutrophic	Strongly Eutrophic	Strongly Eutrophic	Strongly Eutrophic

2.19 Isa Lake

Isa Lake was sampled twice during this study, once in August 2012 and once in July 2016. It has also been sampled a couple times since 1999. The Carlson Model was used to analyze the data collected and is shown in Figure 2-32. In August 2012, the trophic state index for Isa Lake was 47.9 and in July 2016 it was 44.9. The model comparison in Table 2-15 shows an overall average trophic state for Isa Lake of Mesotrophic.

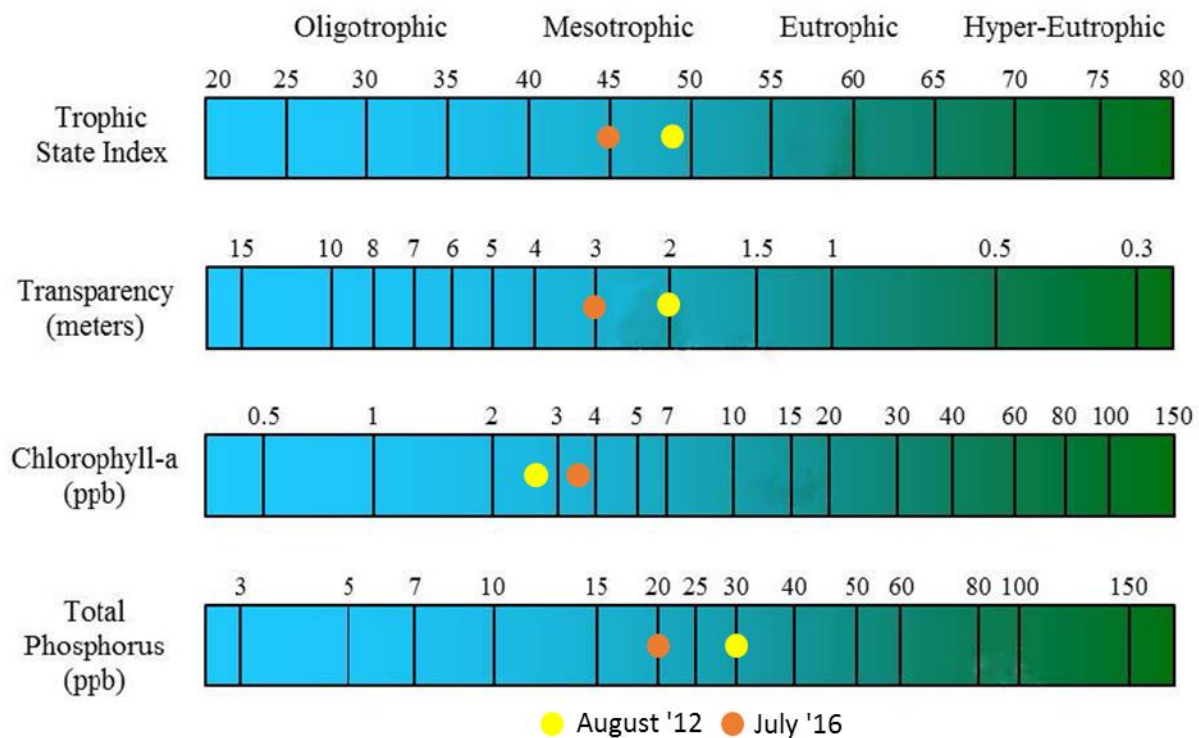


Figure 2-32: Carlson Trophic State Index for Isa Lake.

Table 2-15: Model Comparison for Isa Lake

Model	2012	2016	Average
Carlson	Mesotrophic	Mesotrophic	Mesotrophic

2.20 Joffee Lake

Joffee Lake was sampled twice during the year 2012. The Carlson Model was used to analyze the data collected and is shown in Figure 2-33. In August and October of 2012, the trophic state index for Joffee Lake was 33.7. This value indicates that the lake is slightly oligotrophic.

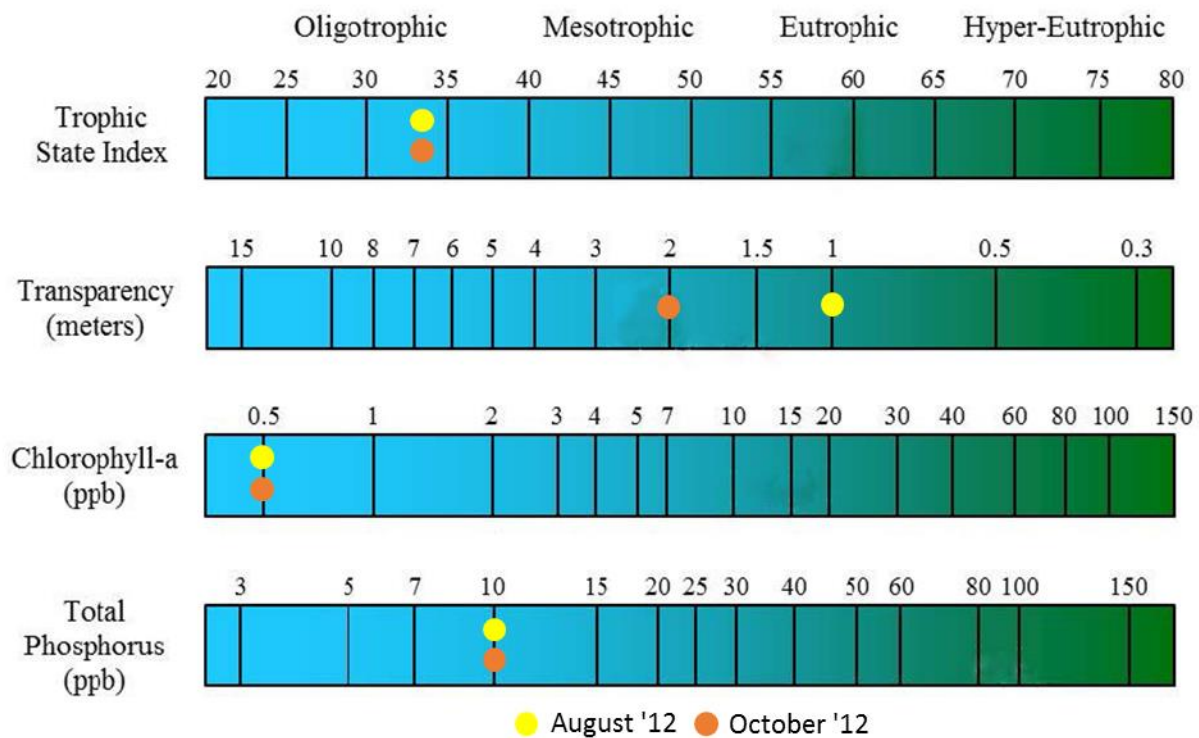


Figure 2-33: Carlson Trophic State Index for Joffee Lake.

2.21 Joffee Lake II

Joffee Lake II was sampled once during August 2013. The Carlson Model was used to analyze the data collected and is shown in Figure 2-34. The trophic state index for Joffee Lake II was 33.7. This value indicates that the lake is slightly oligotrophic.

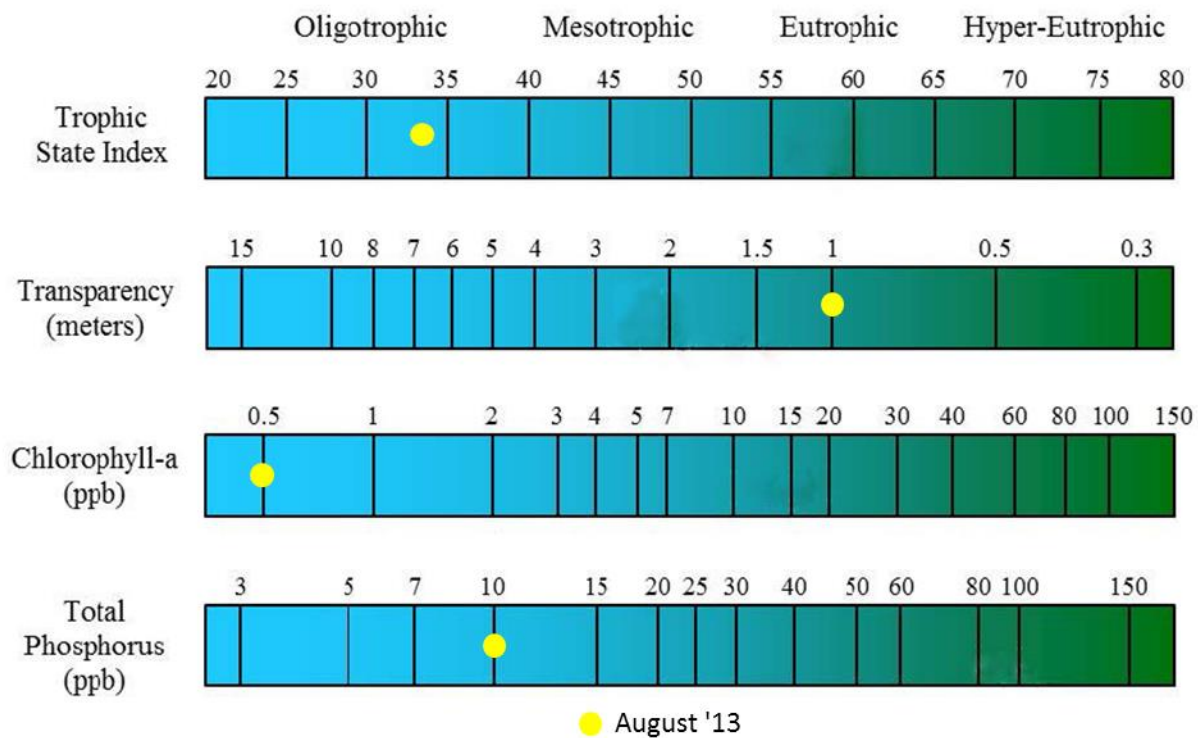


Figure 2-34: Carlson Trophic State Index for Joffee Lake II.

2.22 Lewis Lake

Lewis Lake was sampled twice during the period of this study. Its inlet was also sampled during the study. The lake has been periodically sampled since 1998. The Carlson Model was used to analyze the data collected and is shown in Figure 2-35. The Larsen-Mercier and Vollenweider model results are shown in Figure 2-36 and Figure 2-37 respectively.

The Carlson Model shows the trophic state for Lewis Lake to range from oligotrophic to slightly oligotrophic. The Larsen-Mercier Model calculates the trophic state to be eutrophic. The Vollenweider Model calculates slightly mesotrophic. The overall model comparison in Table 2-16 shows an overall average trophic state for Lewis Lake of slightly mesotrophic for the years 2012-2013.

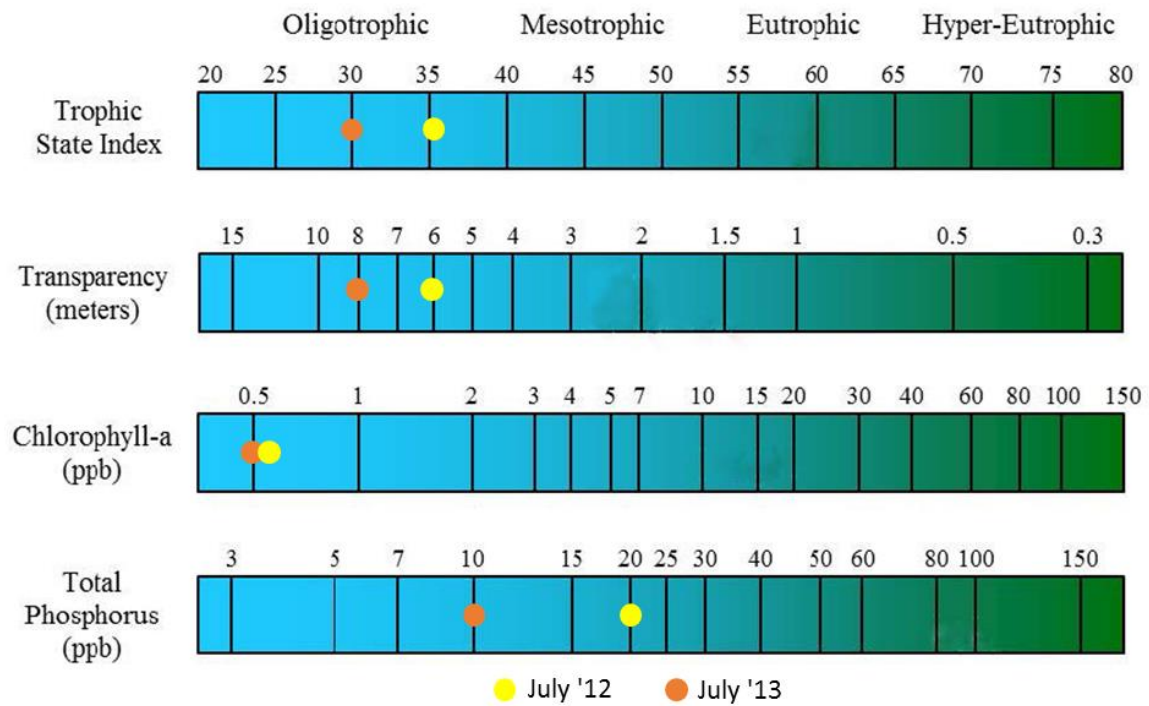


Figure 2-35: Carlson Trophic State Index for Lewis Lake.

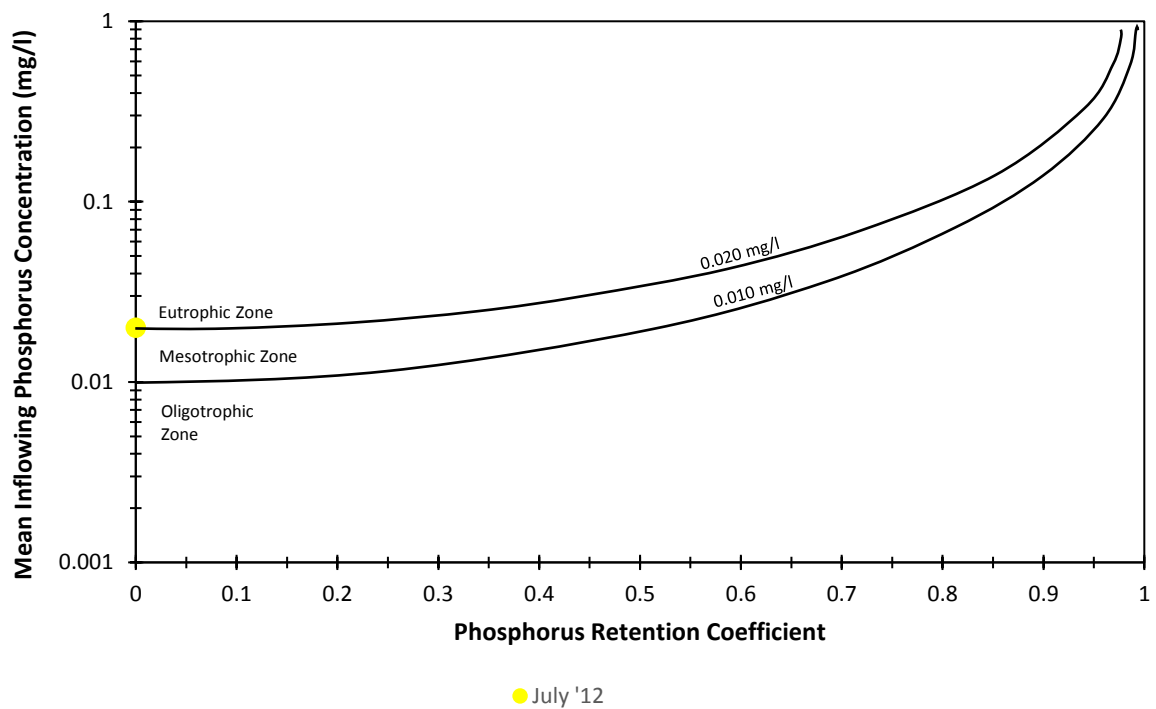


Figure 2-36: Larsen-Mercier Model for Lewis Lake.

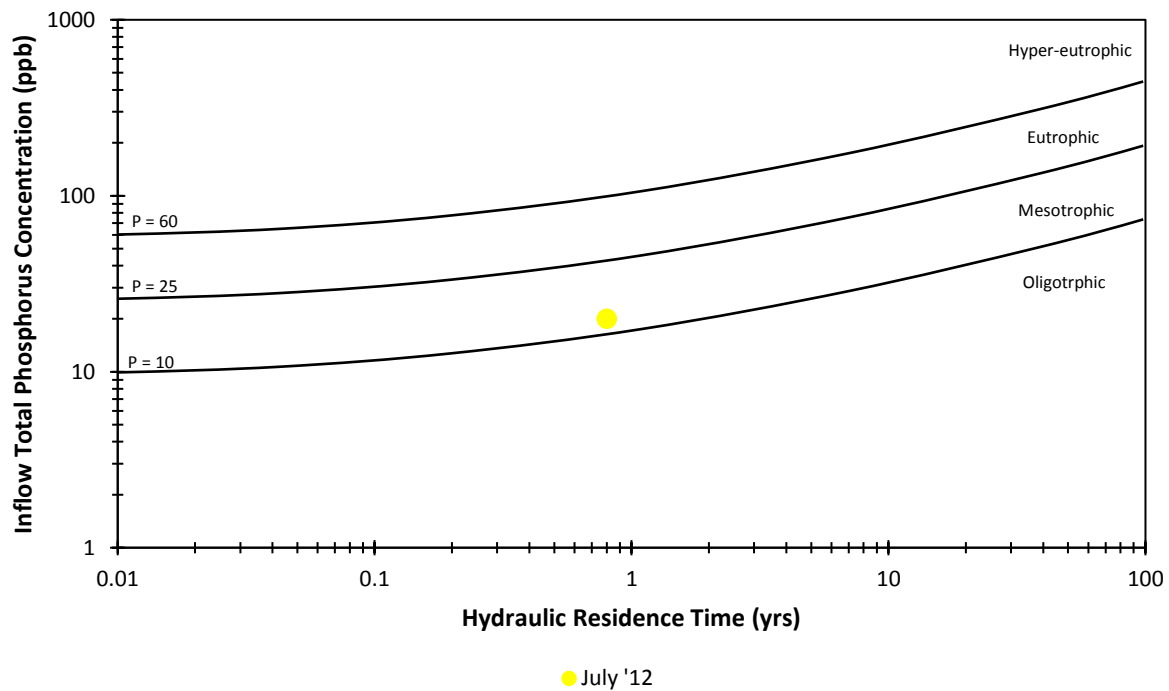


Figure 2-37: Vollenweider Model for Lewis Lake.

Table 2-16: Model Comparison for Lewis Lake

Model	2012	2013	Average
Carlson	Slightly Oligotrophic	Oligotrophic	Slightly Oligotrophic
Larsen-Mercier	Eutrophic	-	Eutrophic
Vollenweider	Mesotrophic	-	Mesotrophic
Average	Mesotrophic	Oligotrophic	Slightly Mesotrophic

2.23 Lily Pad Lake

Lily Pad Lake was sampled eight times between 2012 and 2016. Two of the samples came in 2012, in July and October. Two more samples were taken in June and August of 2013. Two samples were also taken in June and August of 2014. It was also sampled in July of 2015 and June of 2016. Lily Pad Lake has been sampled since 2004. The Carlson Model was used to

analyze the data collected and is shown in Figure 2-38. A model comparison showing the results from the Carlson Model and the overall average during this time period is shown in Table 2-17. The Carlson Model resulted in trophic states ranging from slightly oligotrophic to eutrophic. The average trophic state index from 2012-2016 was mesotrophic.

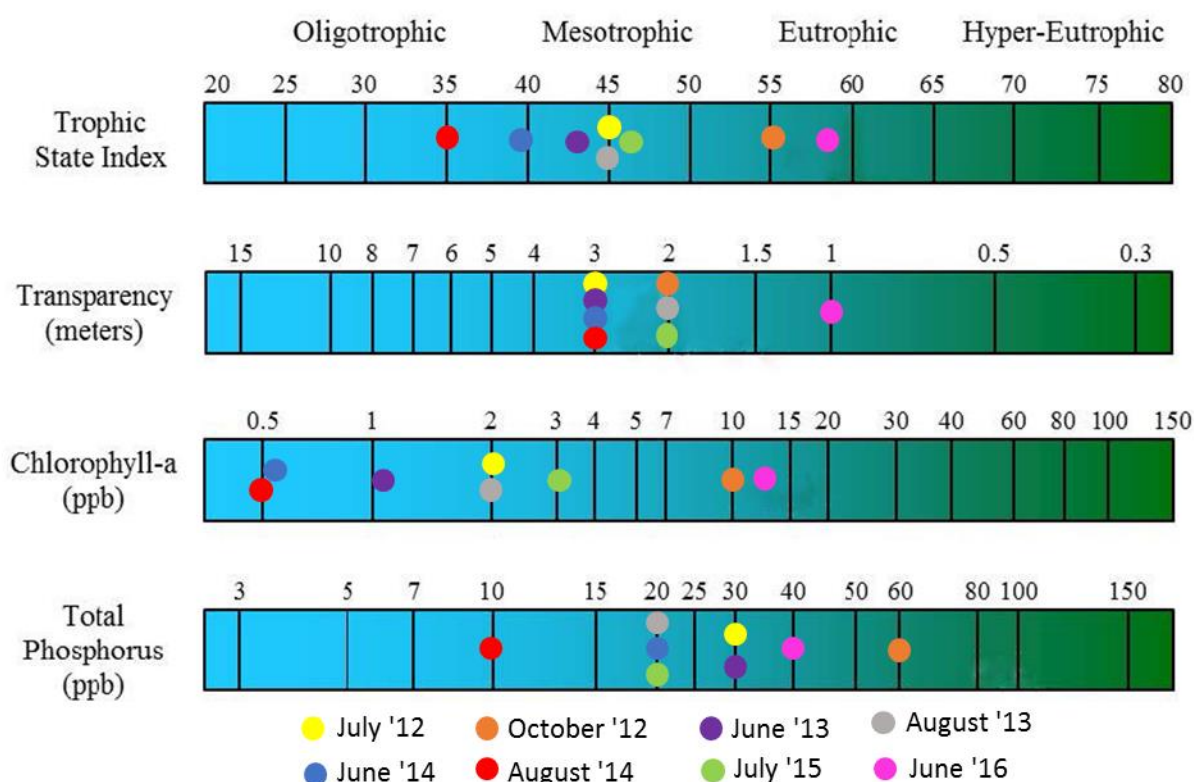


Figure 2-38: Carlson Trophic State Index for Lily Pad Lake.

Table 2-17: Model Comparison for Lily Pad Lake

Model	2012	2013	2014	2015	2016	Average
Carlson	Strongly Mesotrophic	Mesotrophic	Slightly Oligotrophic	Mesotrophic	Eutrophic	Mesotrophic

2.24 Lost Lake

Lost Lake was sampled eleven times between 2012 and 2016. Lost Lake has been sampled periodically since 20004. The Carlson Model was used to analyze the data collected and is shown in Figure 2-39. A model comparison showing the results from the Carlson Model and the overall average during this time period is shown in Table 2-18. The Carlson Model resulted in trophic states ranging from slightly mesotrophic to strongly mesotrophic. The average trophic state index from 2012-2016 was mesotrophic.

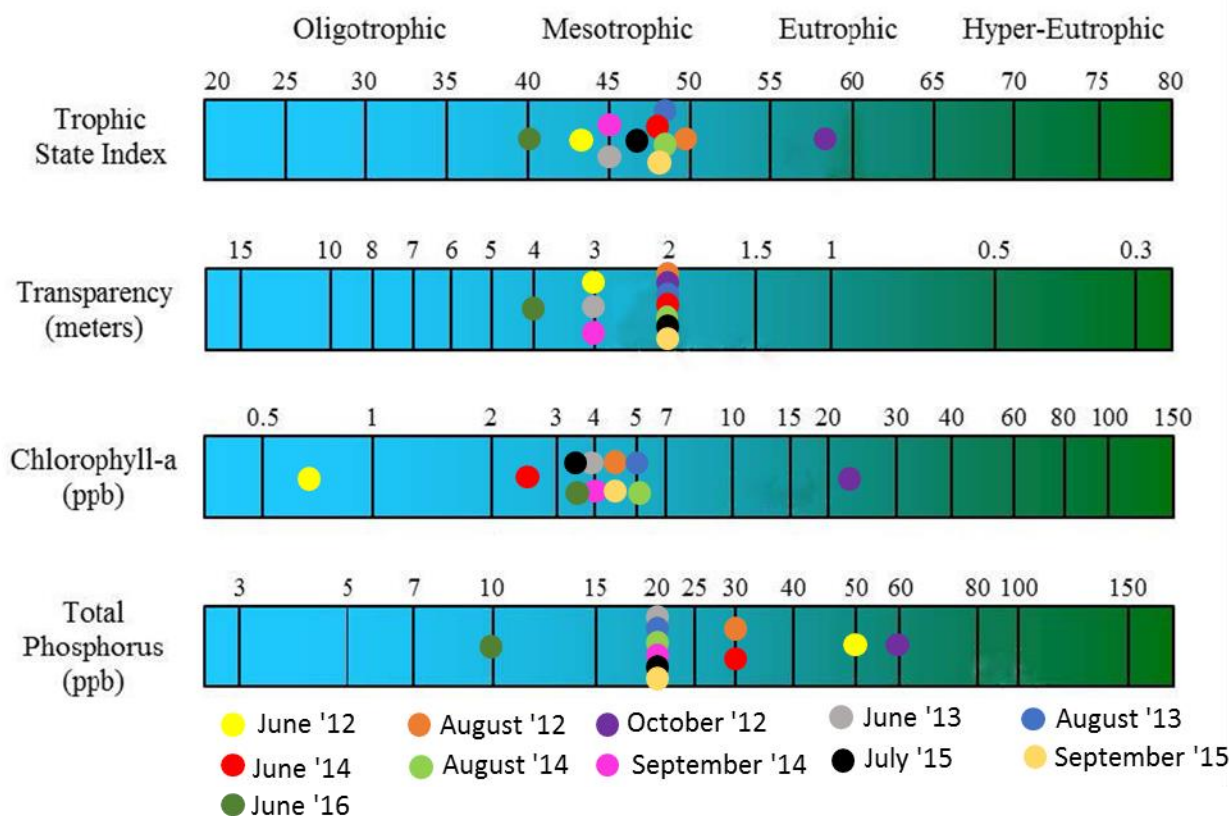


Figure 2-39: Carlson Trophic State Index for Lost Lake.

Table 2-18: Model Comparison for Lost Lake

Model	2012	2013	2014	2015	2016	Average
Carlson	Strongly Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic	Slightly Mesotrophic	Mesotrophic

2.25 Lower Basin Lake

Lower Basin Lake was sampled ten times between 2012 and 2016. The Carlson Model was used to analyze the data collected and is shown in Figure 2-40. Values of total phosphorus being depicted to the far right on the Carlson Model indicate that the observed values were high enough to be off the chart. This did not affect the calculation of the Carlson trophic state index. A model comparison showing the results from the Carlson Model and the overall average during this time period is shown in Table 2-19. The Carlson Model resulted in trophic states ranging from slightly eutrophic to strongly eutrophic. The average trophic state index from 2012-2016 was eutrophic.

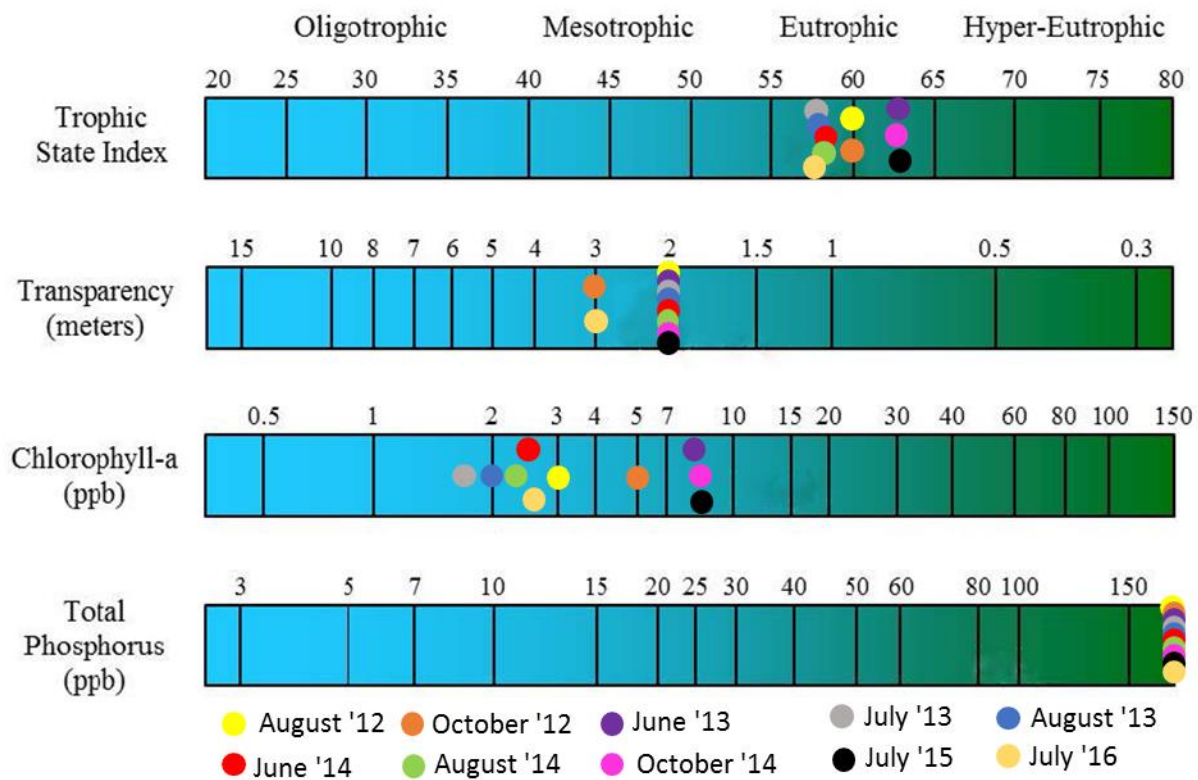


Figure 2-40: Carlson Trophic State Index for Lower Basin Lake.

Table 2-19: Model Comparison for Lower Basin Lake

Model	2012	2013	2014	2015	2016	Average
Carlson	Eutrophic	Eutrophic	Eutrophic	Strongly Eutrophic	Slightly Eutrophic	Eutrophic

2.26 North Twin Lake

North Twin Lake and its inlet were sampled five times during the period of this study. It was sampled once in June and October of 2012, June and August of 2013, and once in September of 2014. The lake has been periodically sampled since 2001. The Carlson Model was used to analyze the data collected and is shown in Figure 2-41. The Larsen-Mercier and Vollenweider model results are shown in Figure 2-42 and Figure 2-43 respectively.

The Carlson Model shows the trophic state for North Twin Lake to range from slightly mesotrophic to strongly mesotrophic. The Larsen-Mercier Model calculates the trophic state to be eutrophic for all the data samples. The highest classifications came from the Vollenweider Model, which calculated hyper-eutrophic for all the data samples. The overall model comparison in Table 2-20 shows an average trophic state for North Twin Lake of slightly eutrophic.

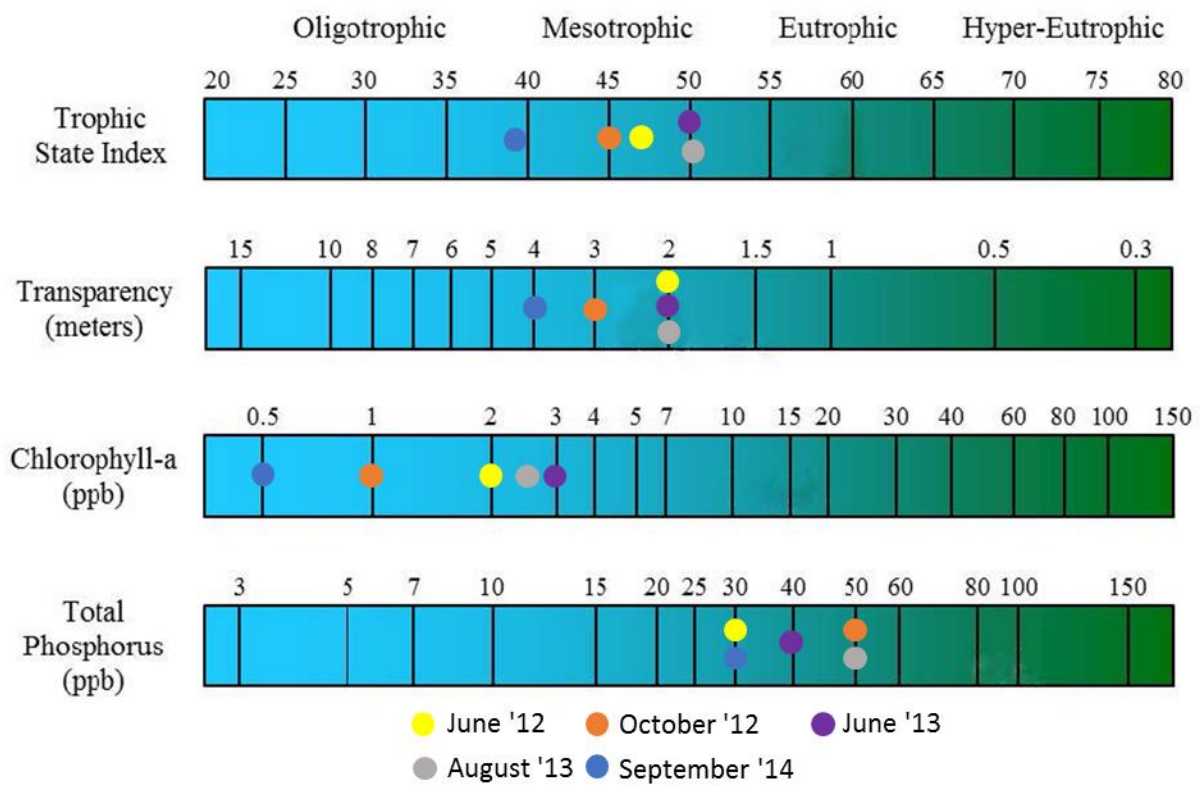


Figure 2-41: Carlson Trophic State Index for North Twin Lake.

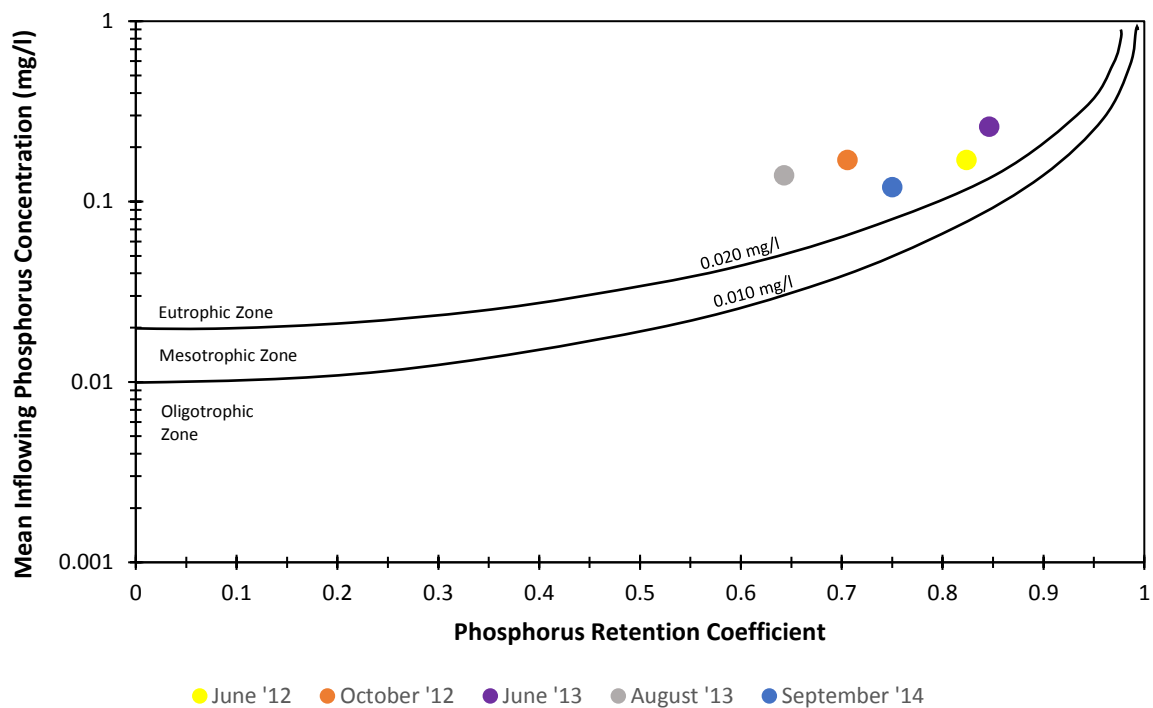


Figure 2-42: Larsen-Mercier Model for North Twin Lake.

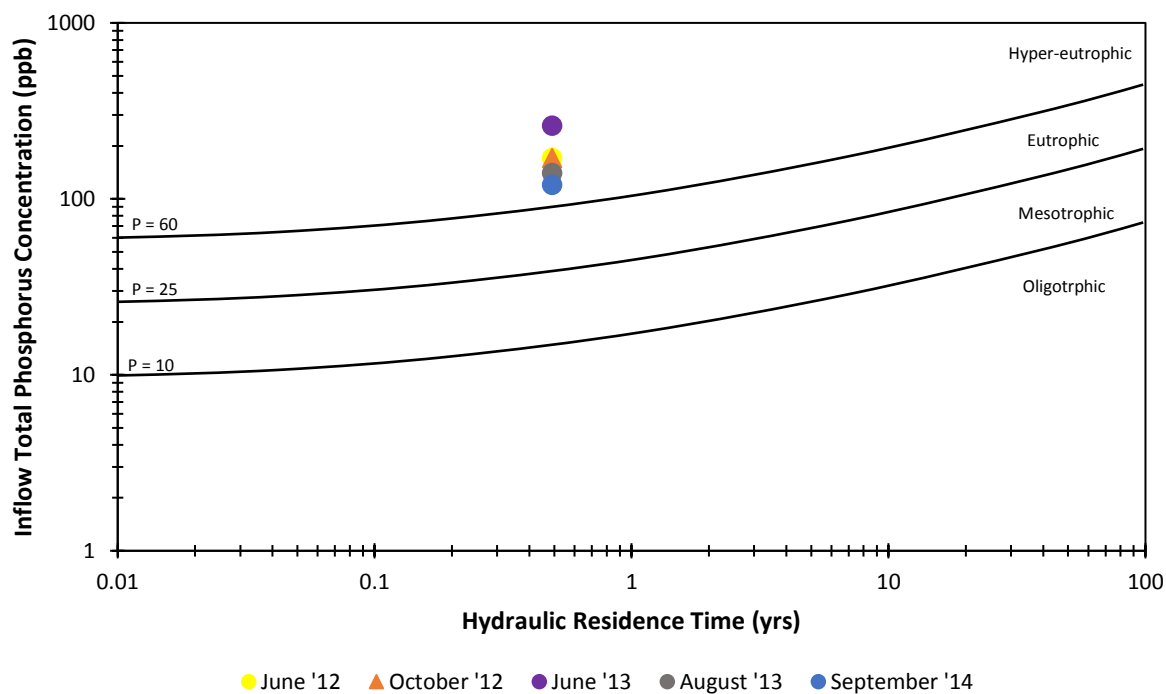


Figure 2-43: Vollenweider Model for North Twin Lake.

Table 2-20: Model Comparison for North Twin Lake

Model	2012	2013	2014	Average
Carlson	Mesotrophic	Strongly Mesotrophic	Slightly Mesotrophic	Mesotrophic
Larsen-Mercier	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Vollenweider	Hyper Eutrophic	Hyper Eutrophic	Hyper Eutrophic	Hyper Eutrophic
Average	Slightly Eutrophic	Eutrophic	Slightly Eutrophic	Slightly Eutrophic

2.27 Nymph Lake

Nymph Lake and its inlet were sampled four times during the period of this study. The lake has been periodically sampled since 2001. The Carlson Model was used to analyze the data collected and is shown in Figure 2-44. The Larsen-Mercier and Vollenweider model results are shown in Figure 2-45 and Figure 2-46 respectively.

The Carlson Model shows the trophic state for Nymph Lake to range from slightly eutrophic to hyper-eutrophic. The Larsen-Mercier Model calculates the trophic state to range between eutrophic and strongly eutrophic. The highest classification come from the Vollenweider Model, which calculate hyper-eutrophic for all the data samples. The overall model comparison in Table 2-21 shows an overall average trophic state for Nymph Lake of strongly eutrophic.

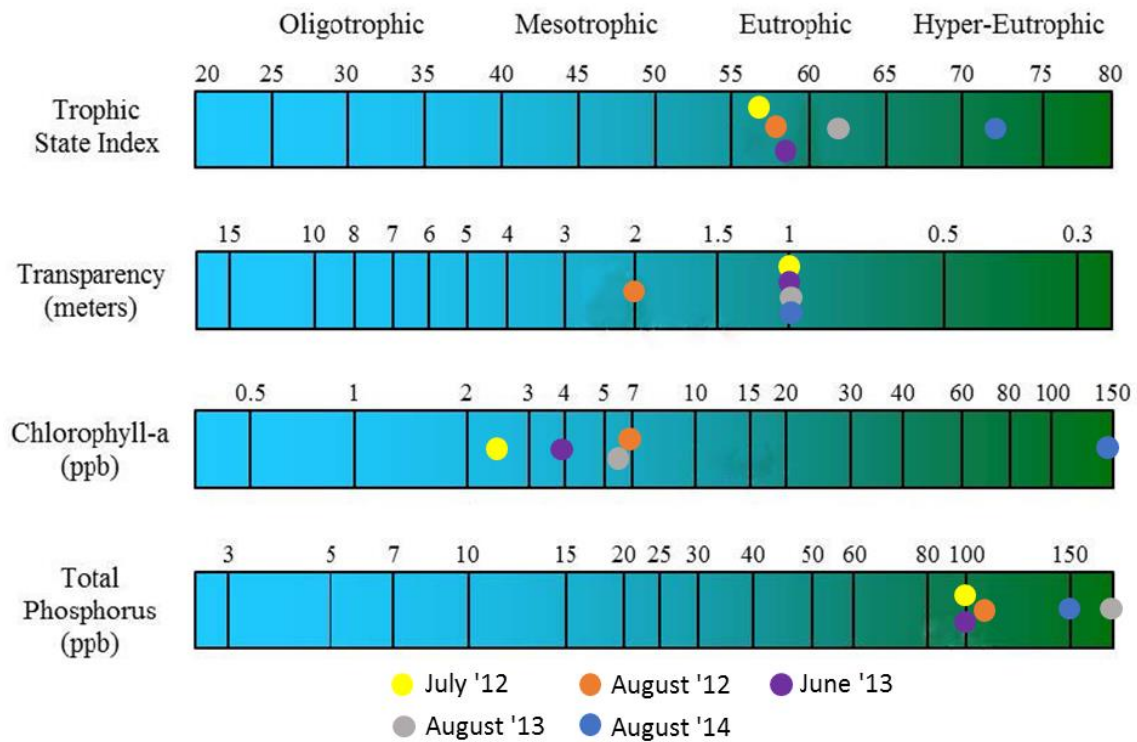


Figure 2-44: Carlson Trophic State Index for Nymph Lake.

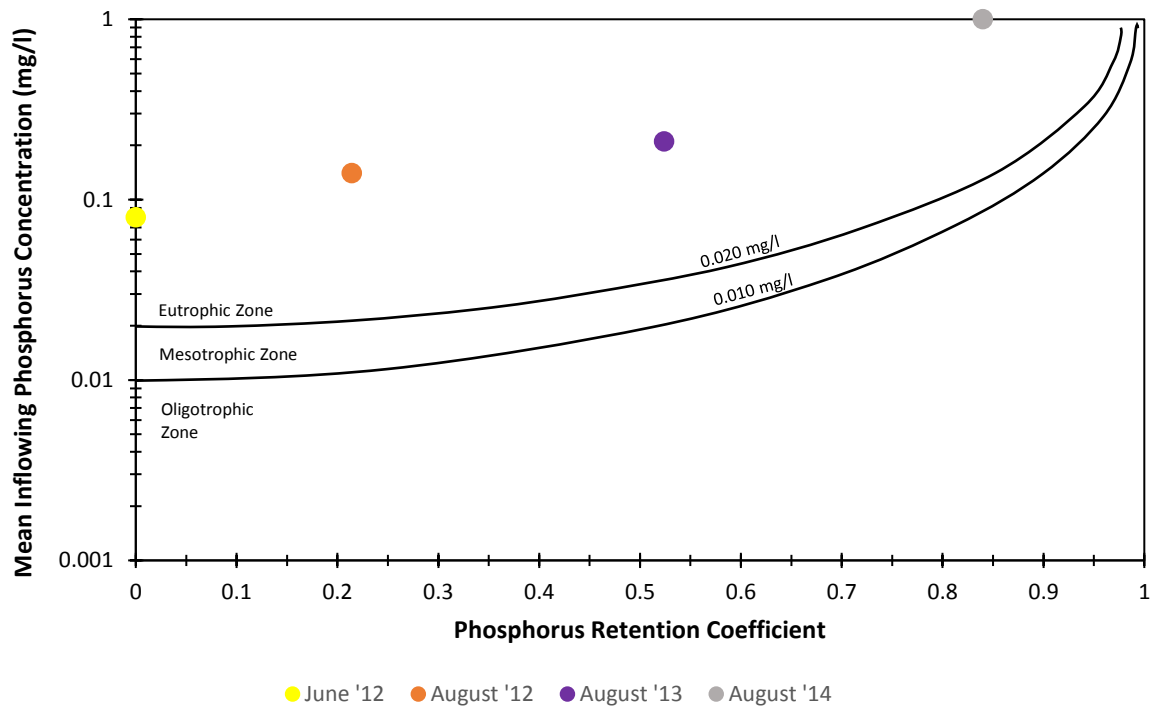


Figure 2-45: Larsen-Mercier Model for Nymph Lake.

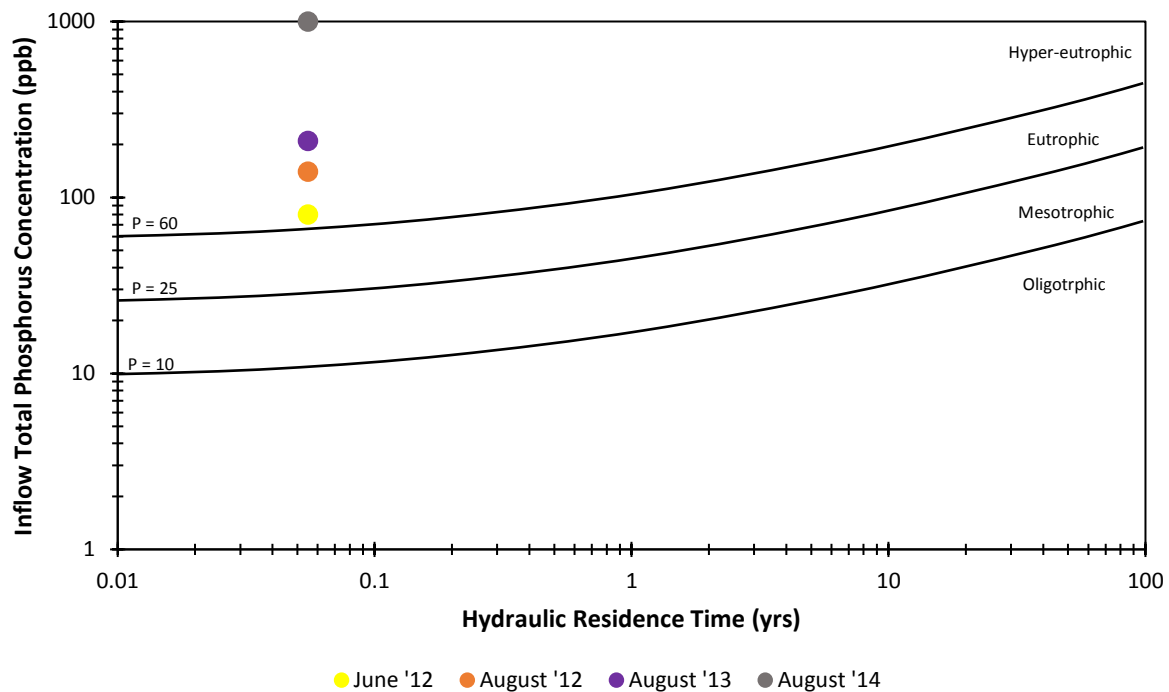


Figure 2-46: Vollenweider Model for Nymph Lake.

Table 2-21: Model Comparison for Nymph Lake

Model	2012	2013	2014	Average
Carlson	Slightly Eutrophic	Eutrophic	Hyper Eutrophic	Strongly Eutrophic
Larsen-Mercier	Eutrophic	Eutrophic	Strongly Eutrophic	Strongly Eutrophic
Vollenweider	Hyper Eutrophic	Hyper Eutrophic	Hyper Eutrophic	Hyper Eutrophic
Average	Eutrophic	Strongly Eutrophic	Hyper Eutrophic	Strongly Eutrophic

2.28 Pool by Morning Glory Pool

Pool by Morning Glory Pool was sampled once during August of 2012. This pool has been sampled a couple times since 2001. The value of total phosphorus being depicted to the far right

on the Carlson Model indicates that the observed value was high enough to be off the chart. This did not affect the calculation of the Carlson trophic state index. The Carlson Model was used to analyze the data collected and is shown in Figure 2-47. In August 2012, the trophic state index for Pool by Morning Glory Pool was 58.0. This value indicates that the lake is eutrophic.

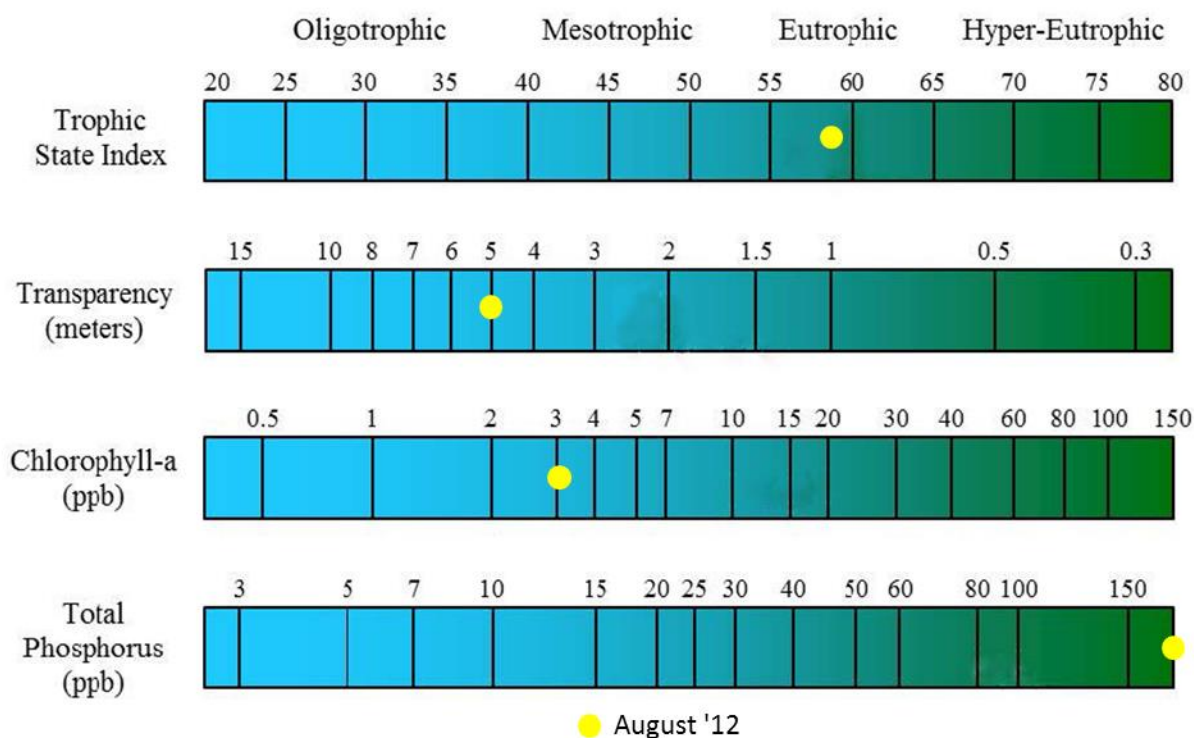


Figure 2-47: Carlson Trophic State Index for Pool by Morning Glory Pool.

2.29 Ribbon Lake

Ribbon Lake was sampled once during August 2013. The Carlson Model was used to analyze the data collected and is shown in Figure 2-48. In August 2013, the trophic state index for Ribbon Lake was 44.4. This value indicates that the lake is mesotrophic.

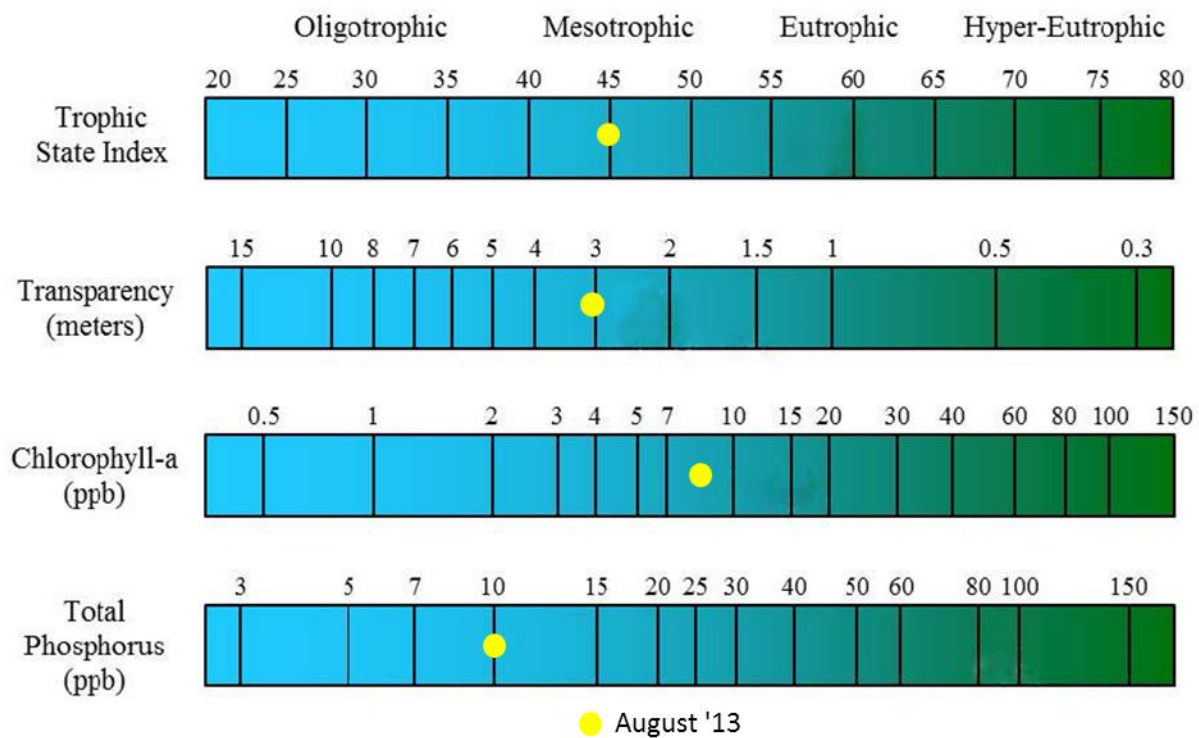


Figure 2-48: Carlson Trophic State Index for Ribbon Lake.

2.30 Scaup Lake

Scaup Lake was sampled three times during the period of study. However, the lake has been sampled since 2002. The Carlson Model was used to analyze the data collected and is shown in Figure 2-49. The Carlson Model calculated trophic state indexes ranging from strongly mesotrophic to strongly eutrophic. The trophic state model comparison in Table 2-22 shows an average trophic state index of slightly eutrophic for Scaup Lake.

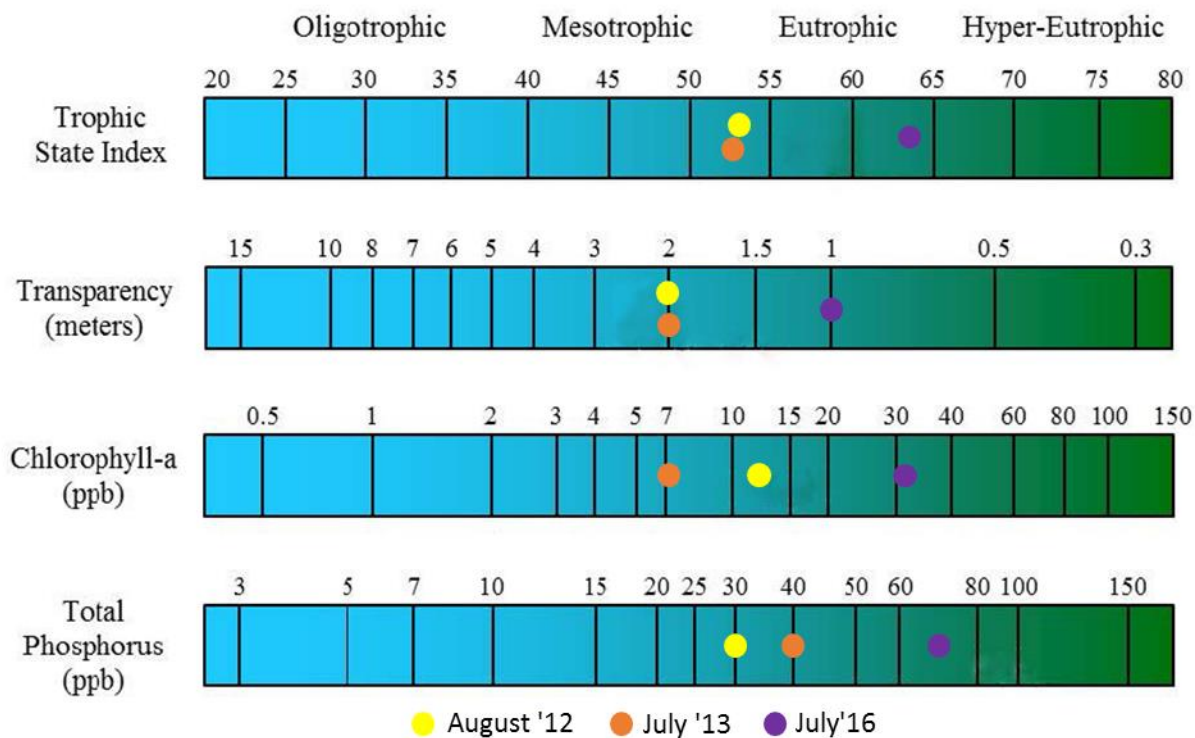


Figure 2-49: Carlson Trophic State Index for Scaup Lake.

Table 2-22: Model Comparison for Scaup Lake

Model	2012	2013	2016	Average
Carlson	Strongly Mesotrophic	Strongly Mesotrophic	Strongly Eutrophic	Slightly Eutrophic

2.31 Shrimp Lake

Shrimp Lake was sampled two times during the period of study. It was sampled in August of 2012 and 2013. However, the lake has been sampled since 2004. The Carlson Model was used to analyze the data collected and is shown in Figure 2-50. The trophic state model comparison in Table 2-23 shows an average trophic state index of strongly mesotrophic for Shrimp Lake.

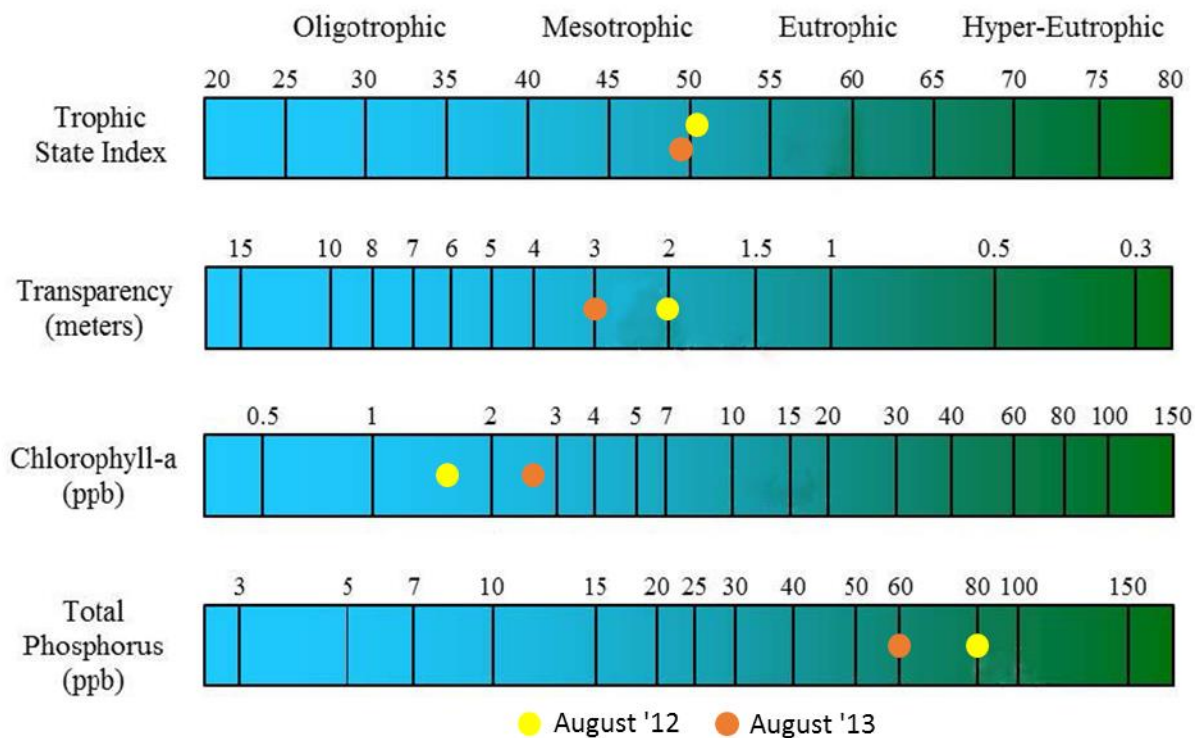


Figure 2-50: Carlson Trophic State Index for Shrimp Lake.

Table 2-23: Model Comparison for Shrimp Lake

Model	2012	2013	Average
Carlson	Strongly Mesotrophic	Strongly Mesotrophic	Strongly Mesotrophic

2.32 South Twin Lake

South Twin Lake was sampled five times during the period of this study. Its inlet was also sampled three times during the study. The lake has been periodically sampled since 2001. The Carlson Model was used to analyze the data collected and is shown in Figure 2-51. The Larsen-Mercier and Vollenweider model results are shown in Figure 2-52 and Figure 2-53 respectively.

The Carlson Model shows the trophic state for South Twin Lake to range from slightly mesotrophic to mesotrophic. The Larsen-Mercier Model calculates the trophic state to be eutrophic for all the data samples. The Vollenweider Model calculates mesotrophic for all the data samples. The overall model comparison in Table 2-24 shows an average trophic state for South Twin Lake of strongly mesotrophic.

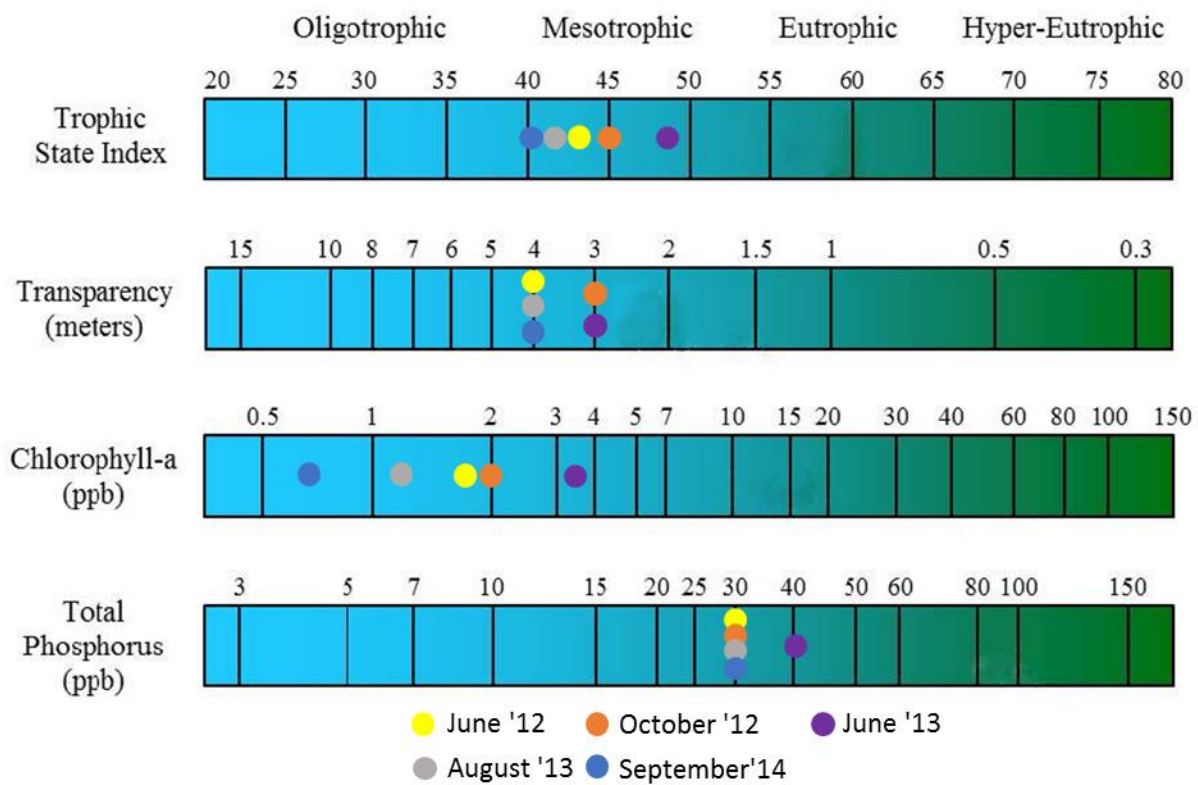


Figure 2-51: Carlson Trophic State Index for South Twin Lake.

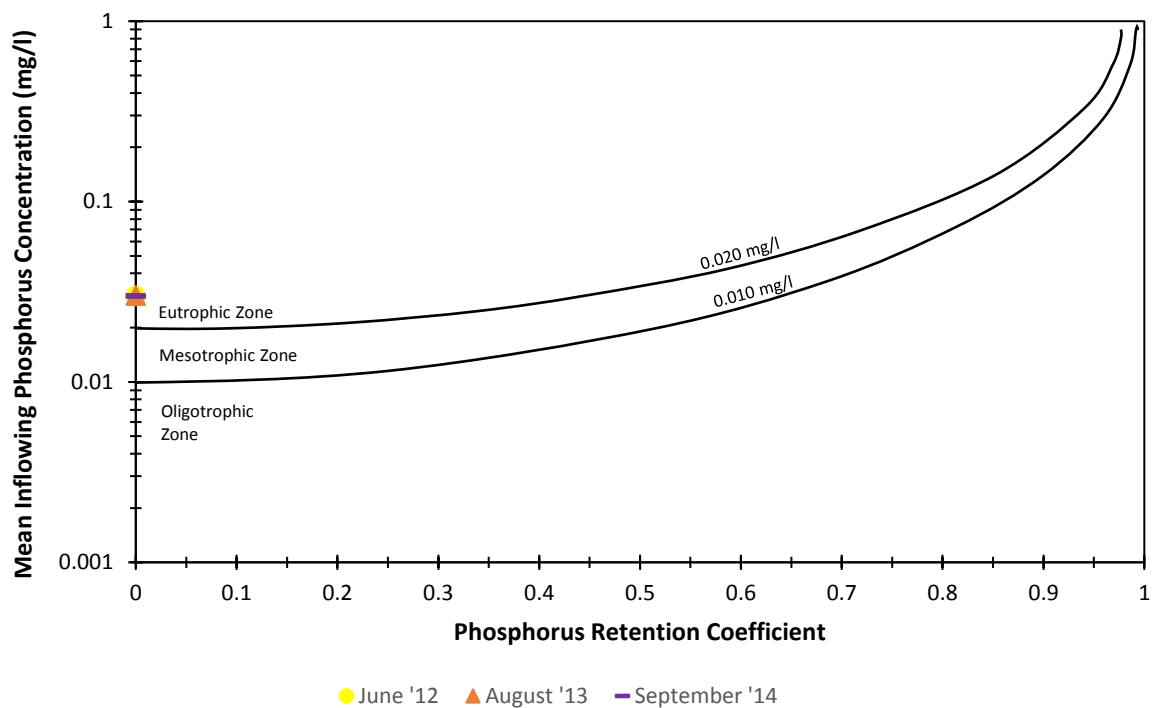


Figure 2-52: Larsen-Mercier Model for South Twin Lake.

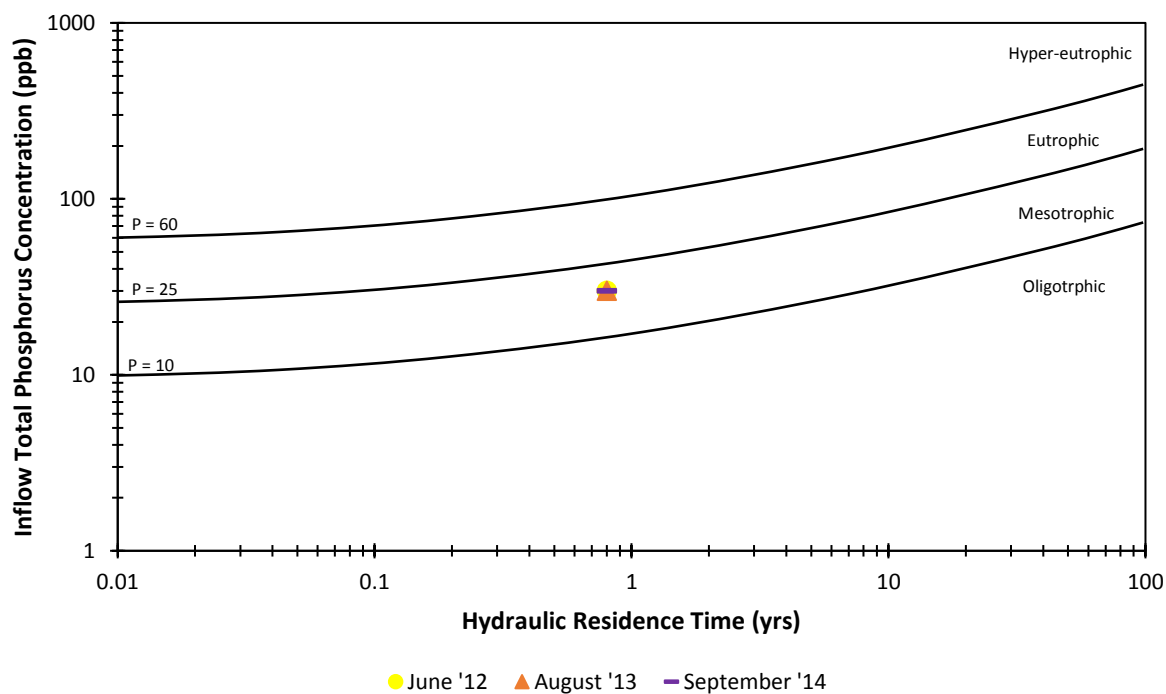


Figure 2-53: Vollenweider Model for South Twin Lake.

Table 2-24: Model Comparison for South Twin Lake

Model	2012	2013	2014	Average
Carlson	Mesotrophic	Mesotrophic	Slightly Mesotrophic	Mesotrophic
Larsen-Mercier	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Vollenweider	Mesotrophic	Mesotrophic	Mesotrophic	Mesotrophic
Average	Strongly Mesotrophic	Strongly Mesotrophic	Mesotrophic	Strongly Mesotrophic

2.33 Swan Lake

Swan Lake was sampled eight times during the period of study. However, the lake has been sampled since 2001. The Carlson Model was used to analyze the data collected and is shown in Figure 2-54. The Carlson Model calculated trophic state indexes ranging from slightly mesotrophic to strongly eutrophic. The trophic state model comparison in Table 2-25 shows an average trophic state index of strongly mesotrophic for Swan Lake.

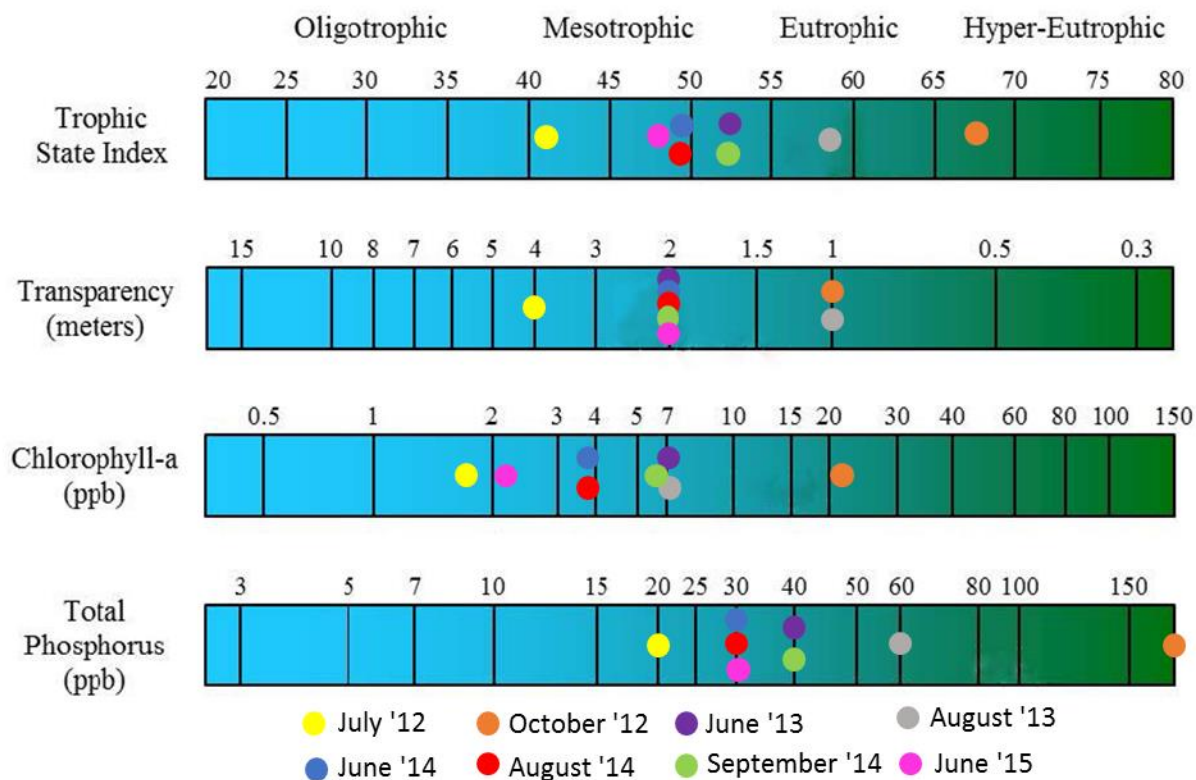


Figure 2-54: Carlson Trophic State Index for Swan Lake.

Table 2-25: Model Comparison for Swan Lake

Model	2012	2013	2014	2015	Average
Carlson	Slightly Eutrophic	Slightly Eutrophic	Strongly Mesotrophic	Mesotrophic	Strongly Mesotrophic

2.34 Sylvan Lake

Sylvan Lake and its inlet were sampled four times during the period of this study. It was sampled twice in 2012 during June and July, once during June of 2013, and once in October of 2016. The lake has been periodically sampled since 2004. The Carlson Model was used to analyze the data collected and is shown in Figure 2-55. The Larsen-Mercier and Vollenweider model results are shown in Figure 2-56 and Figure 2-57 respectively.

The Carlson Model shows the trophic state for Sylvan Lake to range from slightly oligotrophic to slightly mesotrophic. The Larsen-Mercier Model calculates the trophic state to be slightly mesotrophic to eutrophic. The Vollenweider Model ranges from slightly oligotrophic to strongly mesotrophic. The overall model comparison in Table 2-26 shows an overall average trophic state for Sylvan Lake of slightly mesotrophic.

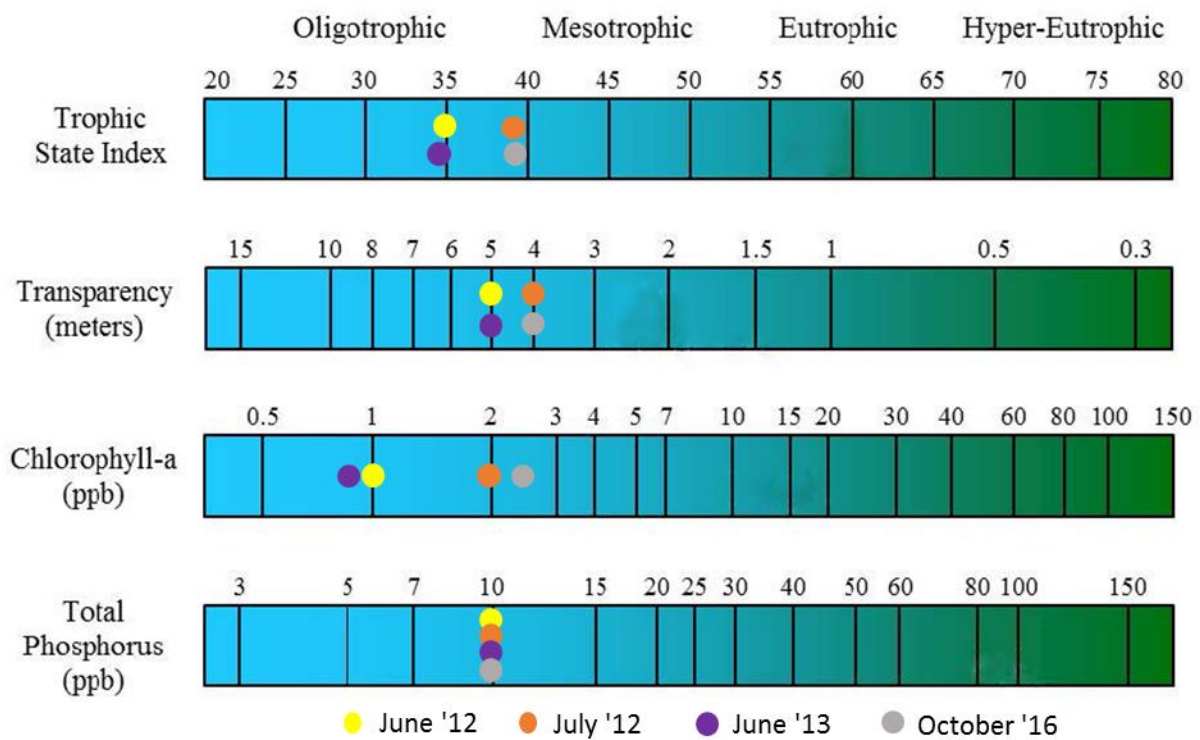


Figure 2-55: Carlson Trophic State Index for Sylvan Lake.

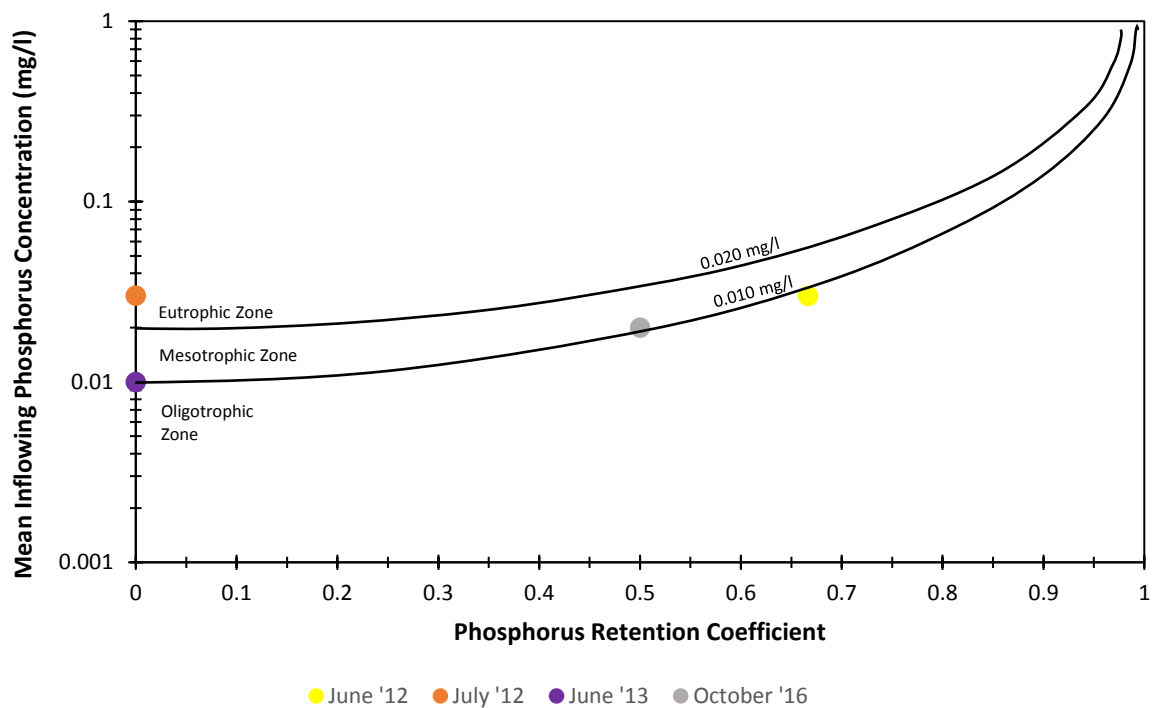


Figure 2-56: Larsen-Mercier Model for Sylvan Lake.

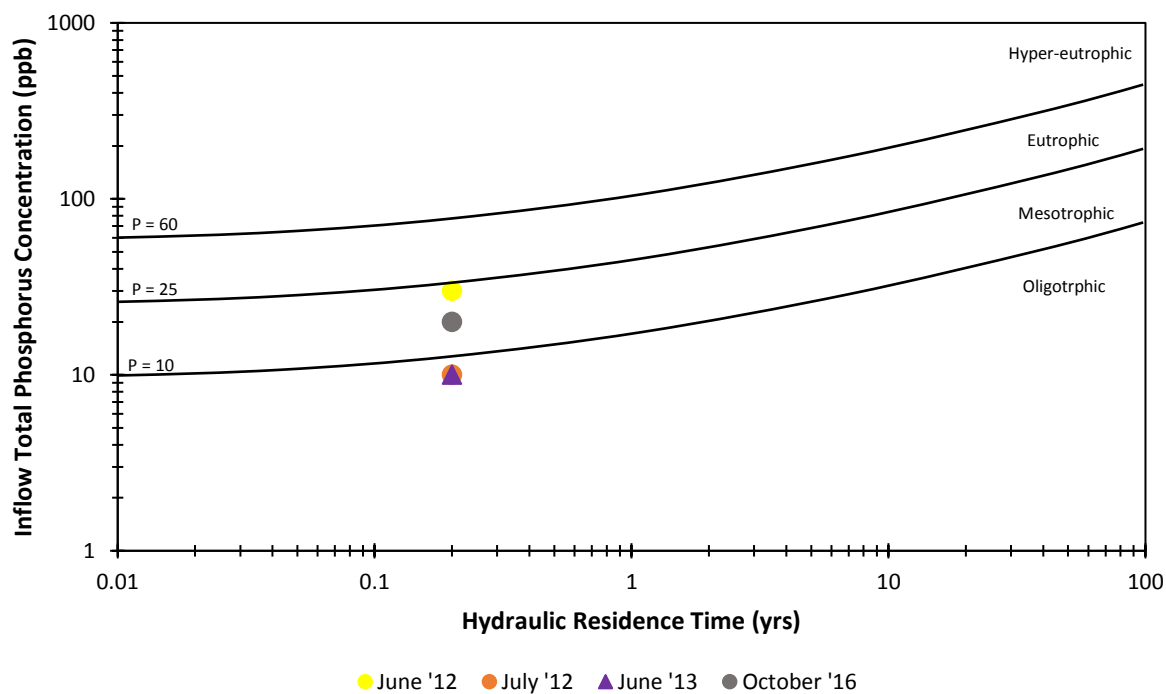


Figure 2-57: Vollenweider Model for Sylvan Lake.

Table 2-26: Model Comparison for Sylvan Lake

Model	2012	2013	2016	Average
Carlson	Slightly Oligotrophic	Slightly Oligotrophic	Slightly Mesotrophic	Slightly Oligotrophic
Larsen-Mercier	Mesotrophic	Slightly Mesotrophic	Slightly Mesotrophic	Slightly Mesotrophic
Vollenweider	Mesotrophic	Slightly Oligotrophic	Mesotrophic	Mesotrophic
Average	Mesotrophic	Slightly Oligotrophic	Slightly Mesotrophic	Slightly Mesotrophic

2.35 Tanager Lake

Tanager Lake was sampled two times during the period of study. It was sampled once in July of 2012 and once in August of 2013. However, the lake has been sampled since 2004. The Carlson Model was used to analyze the data collected and is shown in Figure 2-58. The trophic state model comparison in Table 2-27 shows an average trophic state index of mesotrophic for Tanager Lake.

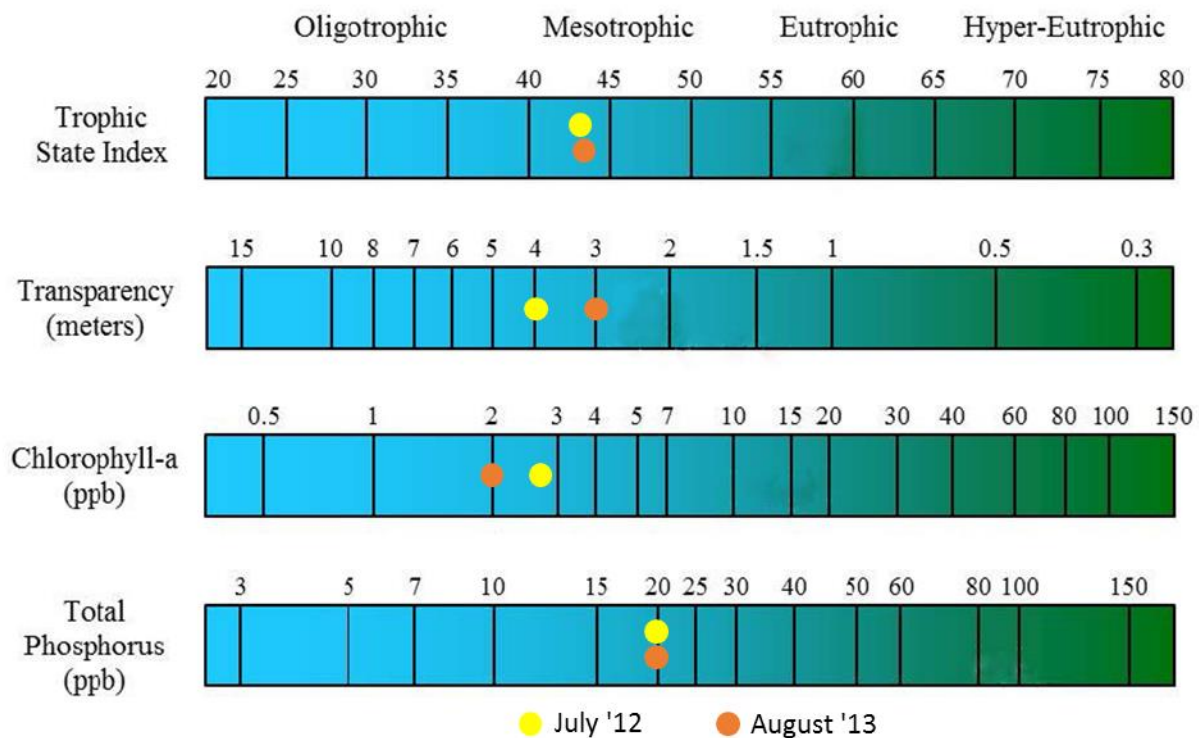


Figure 2-58: Carlson Trophic State Index for Tanager Lake.

Table 2-27: Model Comparison for Tanager Lake

Model	2012	2013	Average
Carlson	Mesotrophic	Mesotrophic	Mesotrophic

2.36 Terrace Spring

Terrace Spring was sampled two times during the period of study. It was sampled once in October of 2014 and once in September of 2016. However, the lake has been sampled a couple of times since 2007. The Carlson Model was used to analyze the data collected and is shown in Figure 2-59. In October 2014, it had a trophic state of 54.3 and in September 2016 it was 51.5. The trophic state model comparison in Table 2-28 shows an average trophic state index of strongly mesotrophic for Terrace Spring.

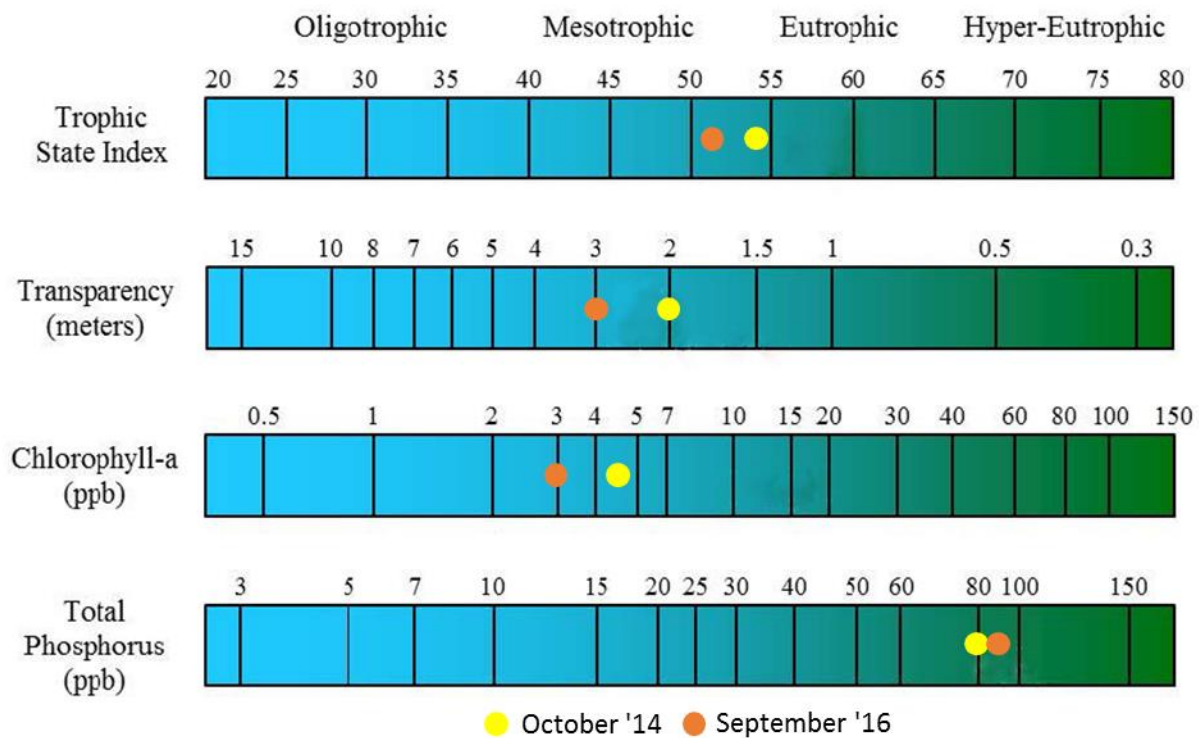


Figure 2-59: Carlson Trophic State Index for Terrace Spring.

Table 2-28: Model Comparison for Terrace Spring

Model	2012	2013	Average
Carlson	Slightly Eutrophic	Strongly Mesotrophic	Strongly Mesotrophic

2.37 Trout Lake East

Trout Lake East and its inlet were sampled nine times during the period of this study. The east side of the lake has been sampled periodically since 2004. The Carlson Model was used to analyze the data collected and is shown in Figure 2-60. The Larsen-Mercier and Vollenweider Model results are shown in Figure 2-61 and Figure 2-62 respectively.

The Carlson Model shows the trophic state for Trout Lake East to range from mesotrophic to eutrophic. The Larsen-Mercier Model calculates the trophic state to be eutrophic for all the data samples. The highest classification came from the Vollenweider Model at strongly eutrophic. The overall model comparison in Table 2-29 shows an overall average trophic state for Trout Lake East of eutrophic.

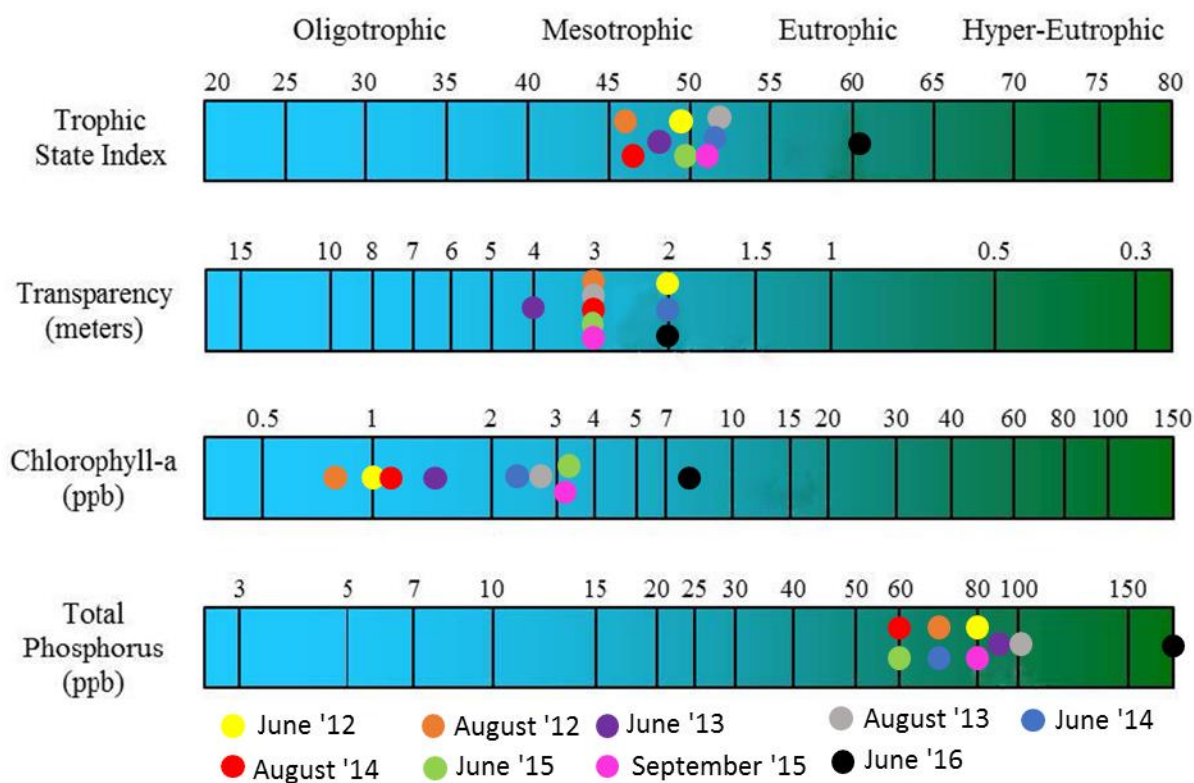


Figure 2-60: Carlson Trophic State Index for Trout Lake East.

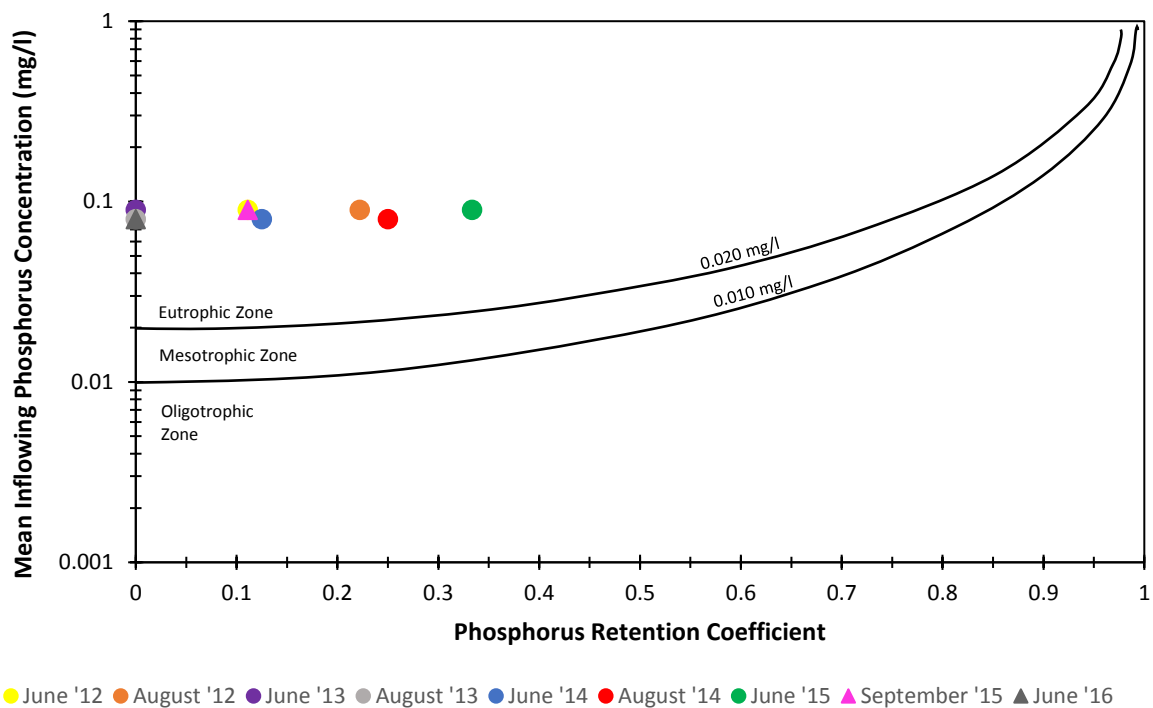


Figure 2-61: Larsen-Mercier Model for Trout Lake East.

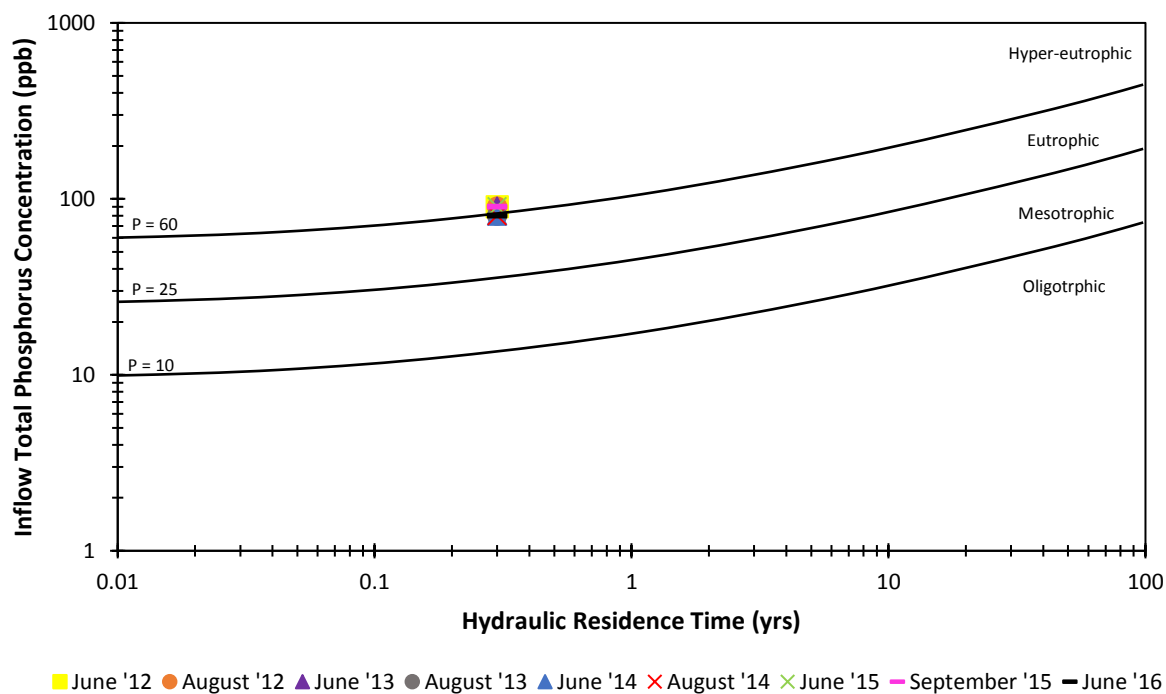


Figure 2-62: Vollenweider Model for Trout Lake East.

Table 2-29: Model Comparison for Trout Lake East

Model	2012	2013	2014	2015	2016	Average
Carlson	Mesotrophic	Strongly Mesotrophic	Strongly Mesotrophic	Strongly Mesotrophic	Eutrophic	Strongly Mesotrophic
Larsen-Mercier	Eutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic	Eutrophic
Vollenweider	Strongly Eutrophic	Strongly Eutrophic	Strongly Eutrophic	Strongly Eutrophic	Strongly Eutrophic	Strongly Eutrophic
Average	Slightly Eutrophic	Eutrophic	Slightly Eutrophic	Eutrophic	Eutrophic	Eutrophic

2.38 Turbid Lake

Turbid Lake and its inlet were sampled once during the period of this study. It was sampled in June 2012. The lake was also sampled in 2004. The Carlson Model was used to analyze the data collected and is shown in Figure 2-63. The Larsen-Mercier and Vollenweider Model results are shown in Figure 2-64 and Figure 2-65 respectively.

The Carlson Model shows the trophic state to 58.3 or eutrophic. The Larsen-Mercier Model and the Vollenweider Model also calculate the trophic state of Turbid Lake to be eutrophic. Not surprisingly, the model comparison in Table 2-30 shows an average trophic state for Turbid Lake of eutrophic.

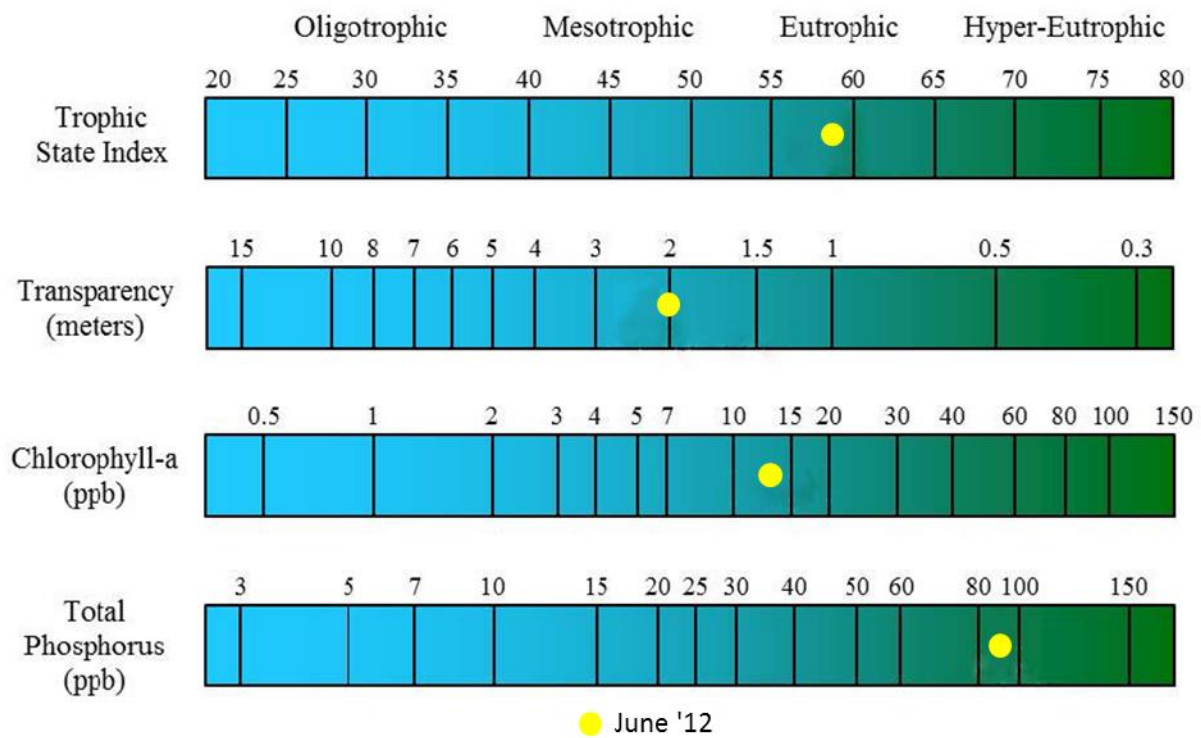


Figure 2-63: Carlson Trophic State Index for Turbid Lake.

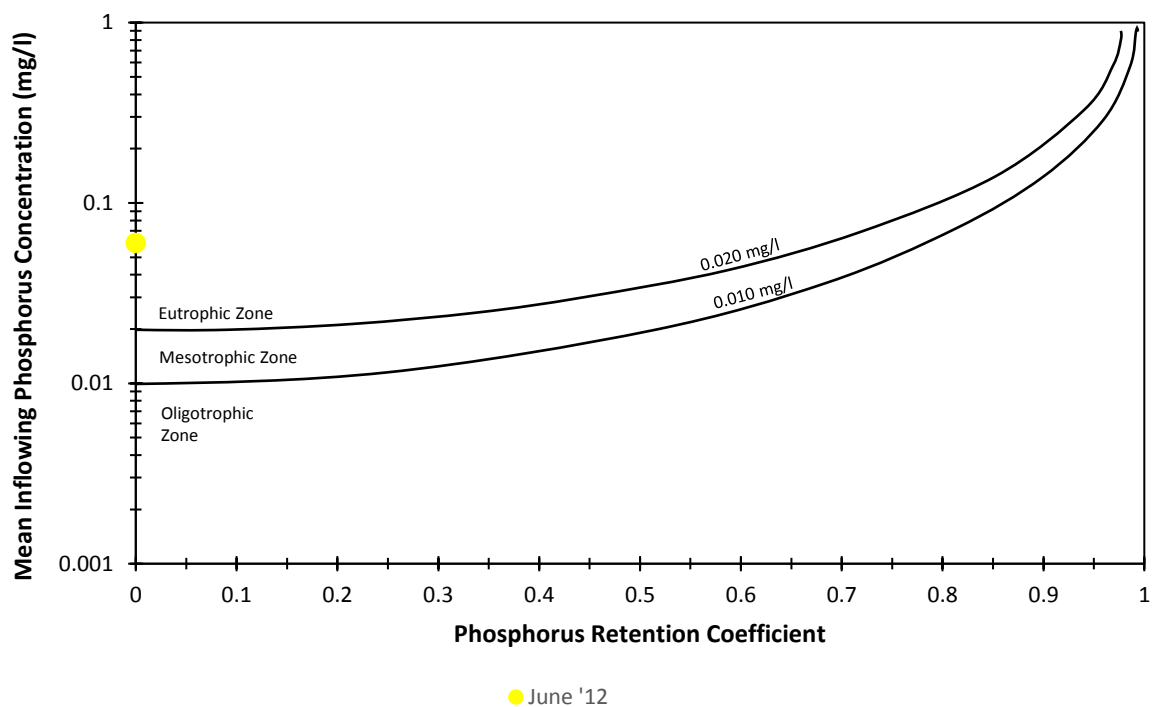


Figure 2-64: Larsen-Mercier Model for Turbid Lake.

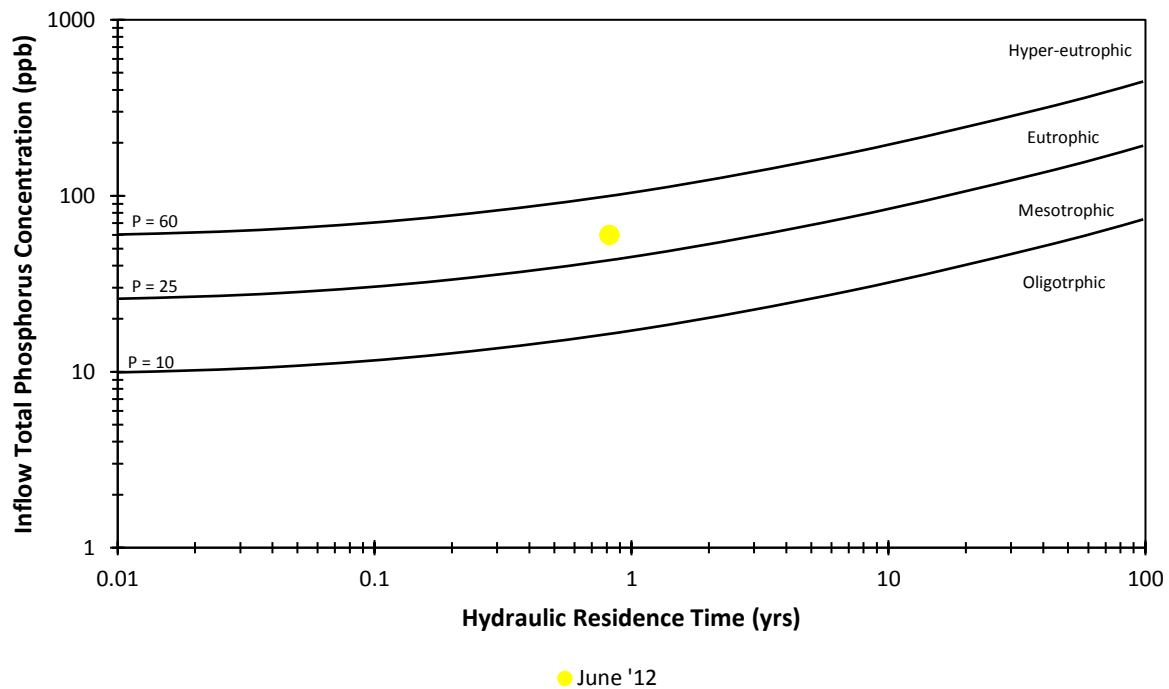


Figure 2-65: Vollenweider Model for Turbid Lake.

Table 2-30: Model Comparison for Turbid Lake

Model	2012	Average
Carlson	Eutrophic	Eutrophic
Larsen-Mercier	Eutrophic	Eutrophic
Vollenweider	Eutrophic	Eutrophic
Average	Eutrophic	Eutrophic

2.39 Wolf Lake

Wolf Lake and its inlet were sampled once during the period of this study. It was sampled in August 2012. The lake was also sampled in 2000. The Carlson Model was used to analyze the data collected and is shown in Figure 2-66. The Larsen-Mercier and Vollenweider Model results are shown in Figure 2-67 and Figure 2-68 respectively.

The Carlson Model shows the trophic state to 45.1 or mesotrophic. The Larsen-Mercier Model calculates the trophic state to be slightly eutrophic. The Vollenweider Model calculates the trophic state of Wolf Lake to be mesotrophic. The model comparison in Table 2-31 shows an overall average trophic state for Wolf Lake of mesotrophic.

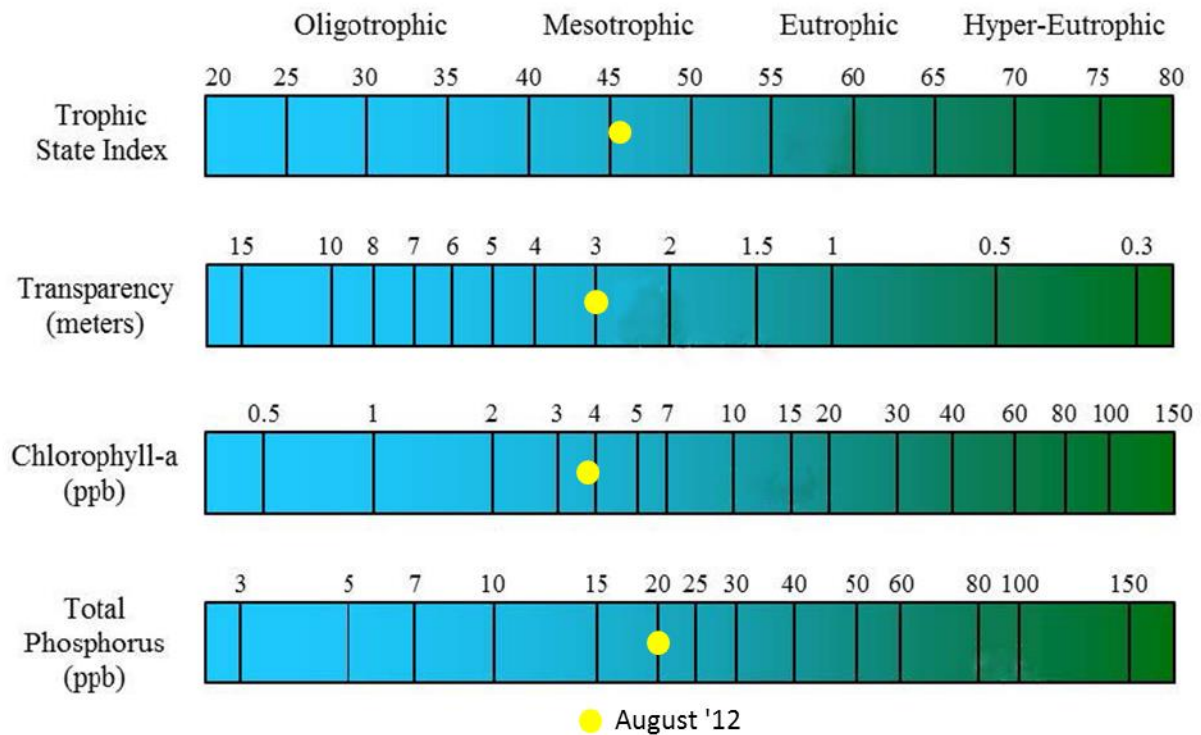


Figure 2-66: Carlson Trophic State Index for Wolf Lake.

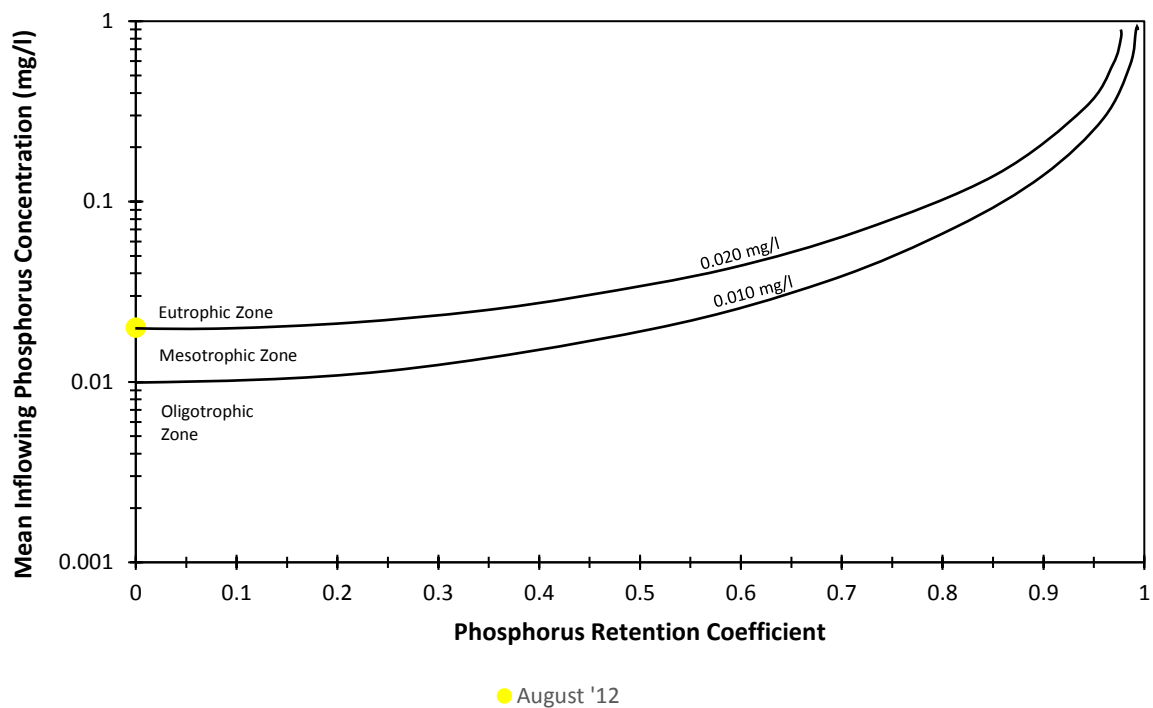


Figure 2-67: Larsen-Mercier Model for Wolf Lake.

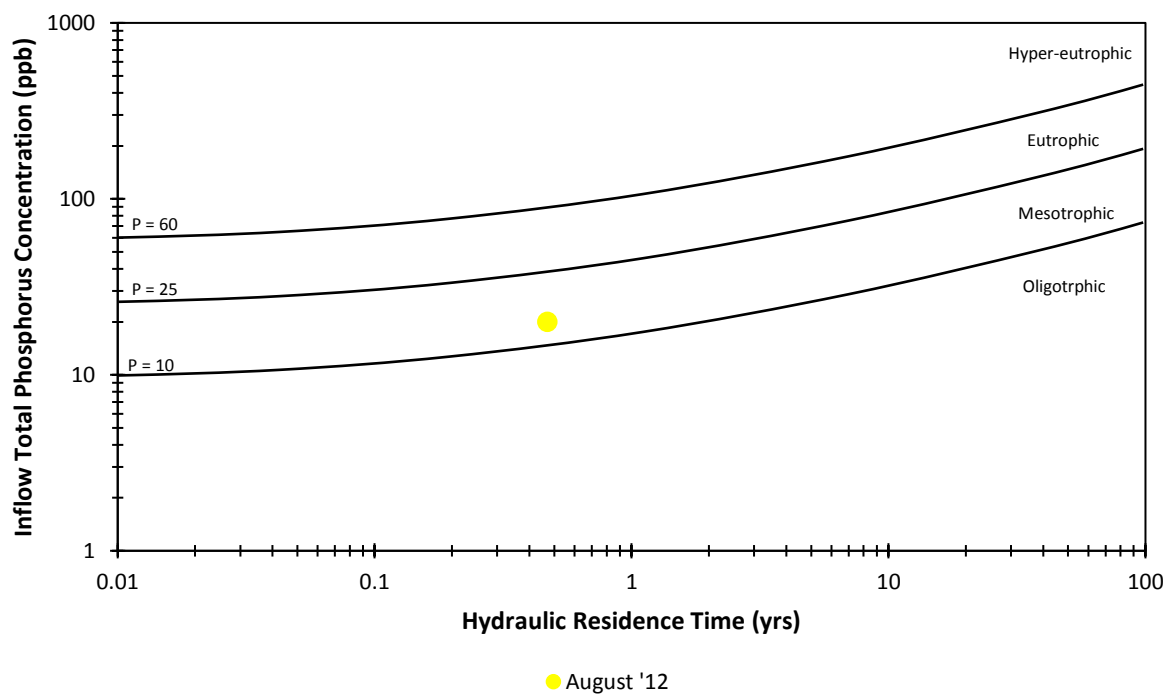


Figure 2-68: Vollenweider Model for Wolf Lake.

Table 2-31: Model Comparison for Wolf Lake

Model	2012	Average
Carlson	Mesotrophic	Mesotrophic
Larsen-Mercier	Slightly Eutrophic	Slightly Eutrophic
Vollenweider	Mesotrophic	Mesotrophic
Average	Mesotrophic	Mesotrophic

2.40 Yellowstone Lake at Bridge Bay

Yellowstone Lake at Bridge Bay was sampled twice during the period of study. It was sampled once in August of 2013 and once in October of 2016. The Carlson Model was used to analyze the data collected and is shown in Figure 2-69. In August 2013, the trophic state was 41.6 and in October of 2016 it was 46.6. The model comparison in Table 2-32 shows that the average trophic state during this time was mesotrophic.

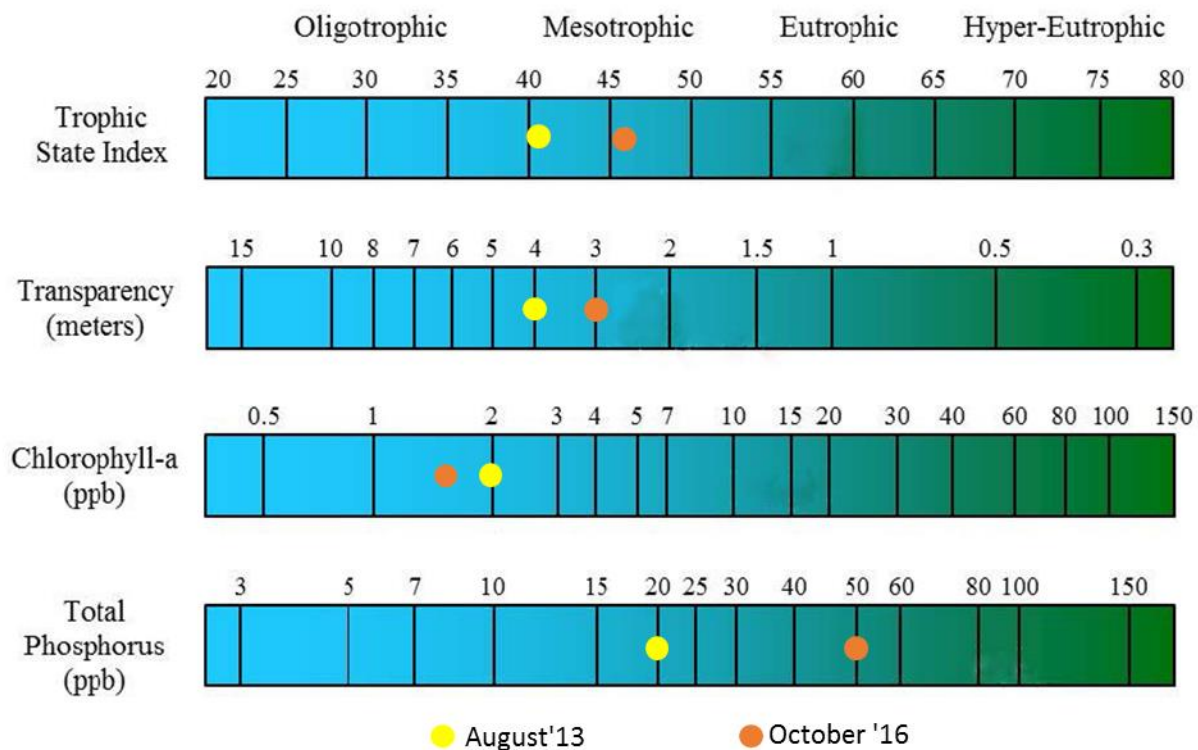


Figure 2-69: Carlson Trophic State Index for Yellowstone Lake at Bridge Bay.

Table 2-32: Model Comparison for Yellowstone Lake at Bridge Bay

Model	2012	2013	Average
Carlson	Slightly Mesotrophic	Mesotrophic	Mesotrophic

2.41 Yellowstone Lake at Grant Marina (West Thumb)

Yellowstone Lake at Grant Marina was sampled twice during the period of study. It was sampled once in July of 2013 and once in October of 2016. The Carlson Model was used to analyze the data collected and is shown in Figure 2-70. In July 2013, the trophic state was 36.0 and in October of 2016 it was 30.6. The model comparison in Table 2-33 shows that the average trophic state during this time was slightly oligotrophic.

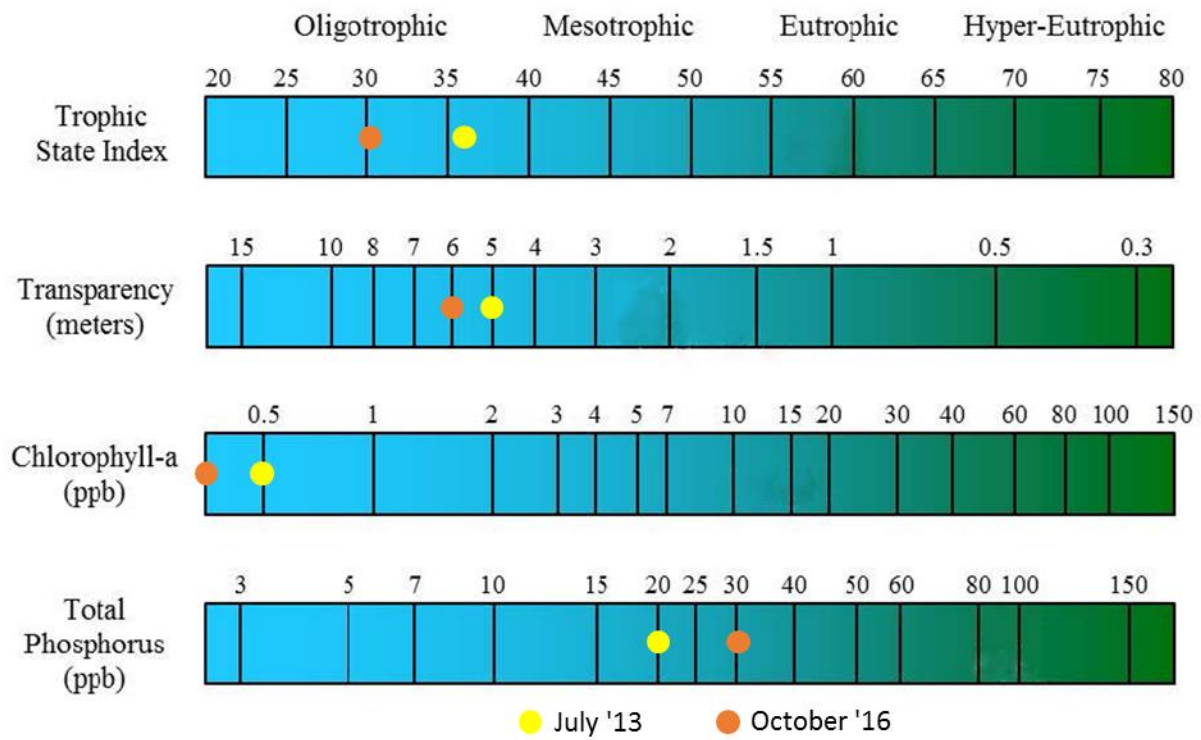


Figure 2-70: Carlson Trophic State Index for Yellowstone Lake at Grant Marina.

Table 2-33: Model Comparison for Yellowstone Lake at Grant Marina

Model	2012	2013	Average
Carlson	Slightly Oligotrophic	Oligotrophic	Slightly Oligotrophic

3 LONG-TERM TRENDS OF PHOSPHOROUS, CHLOROPHYLL-A, AND CARLSON TROPHIC STATE IN SELECTED WATER BODIES IN YELLOWSTONE NATIONAL PARK

Dr. Miller has been sampling different lakes and ponds since 1998. Since many of these lakes have been sampled multiple times, trends can be analyzed within each lake and inlet. The trends that were analyzed in this report were the in-lake phosphorus concentration, the chlorophyll-a concentration, and the Carlson trophic state index. When available, inlet and outlet phosphorus concentration trends were also examined. Trends were only plotted and analyzed for those lakes that have been sampled two or more times.

Each trend plot displays all of the data that have been collected along with a trend line. R^2 values were also calculated to determine the statistical correlation between the data and the change in time. The R^2 values range from zero to one. An R^2 value of zero indicates no correlation while a value of one shows perfect correlation.

3.1 Beaver Lake

Beaver Lake has been sampled ten times since 2001. Its inlet has also been sampled eight times. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus,

chlorophyll-a, Carlson trophic state index, and the inlet phosphorus trends are presented in Figure 3-1, Figure 3-2, Figure 3-3, and Figure 3-4 respectively.

The in-lake phosphorus concentration for Beaver Lake shows a trend that is increasing. However, it has a low R^2 value of 0.115. This suggests the data may not be correlated. The in-lake chlorophyll-a concentration also shows an increasing trend over time. It has an R^2 value of 0.2231 that suggest the data may not be correlated. The data also appear to have an outlier that many account for the increasing trend. The Carlson trophic state index shows a slight increase over time with an R^2 value of 0.1129. Again indicating that there is not a strong correlation between the trophic state index and the passing of time. The inlet phosphorus concentration also shows an increase over time. It had an R^2 value of 0.123. The data have an outlier that may account for the increase.

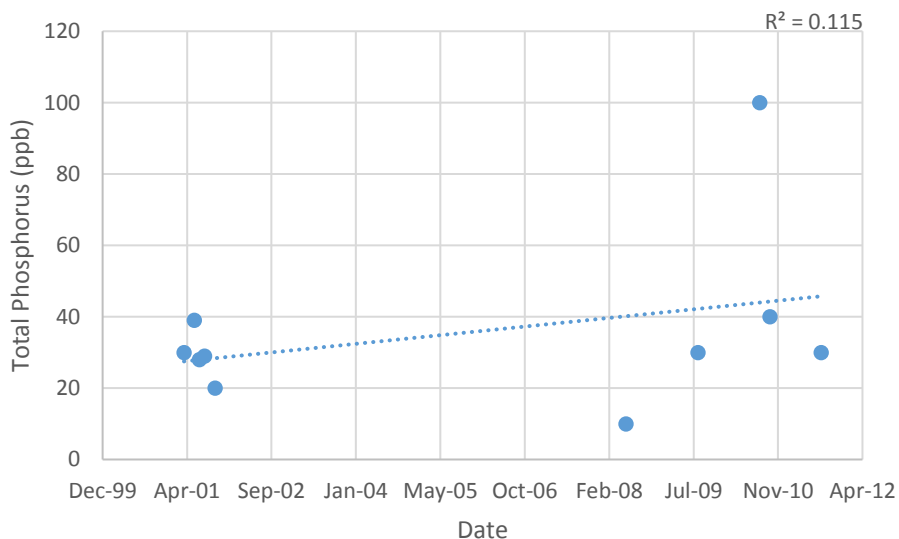


Figure 3-1: In-lake Phosphorus Concentration Trend for Beaver Lake.



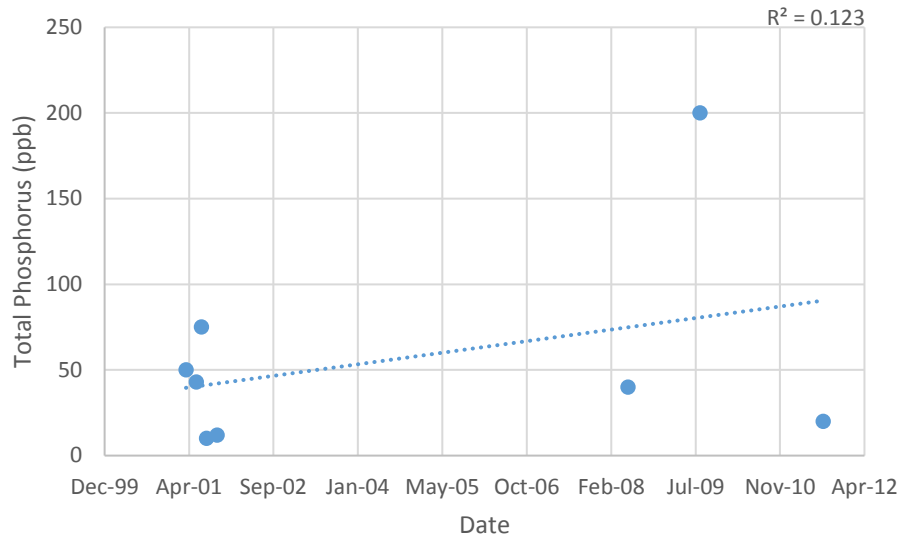


Figure 3-4: Phosphorus Concentration Trend for the Inlet of Beaver Lake.

3.2 Blacktail Pond

Blacktail Pond has been sampled thirteen times since 2001. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-5, Figure 3-6, and Figure 3-7 respectively.

The in-lake phosphorus concentration for Blacktail Pond shows a trend that is increasing. However, it has a low R^2 value of 0.2659. This suggests the data may not be correlated. The data also appear to have an outlier that many account for the increasing trend. The in-lake chlorophyll-a concentration also shows an increasing trend over time. It has an R^2 value of 0.1149 that suggest the data may not be correlated. The Carlson trophic state index shows an increase over time with an R^2 value of 0.2357. Again indicating that there is not a strong correlation between the TIS and the passing of time.

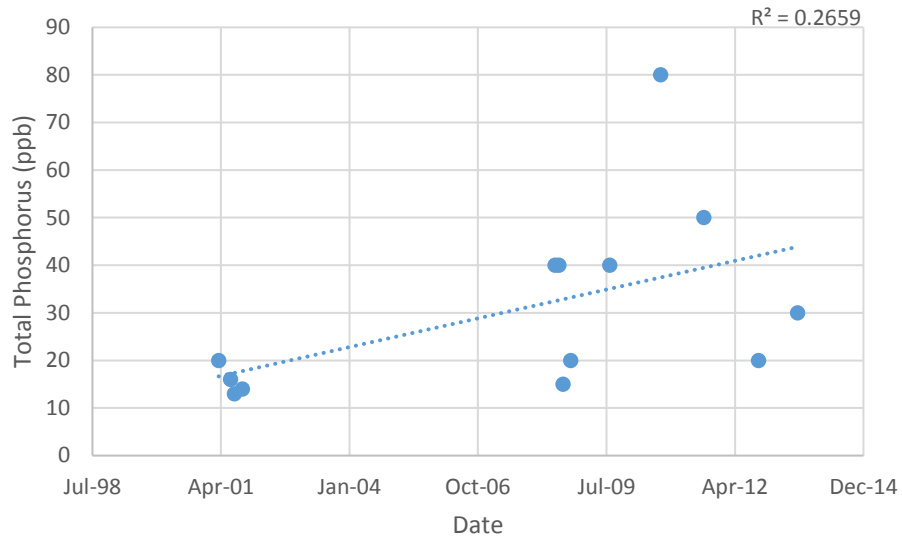


Figure 3-5: In-lake Phosphorus Concentration Trend for Blacktail Pond.

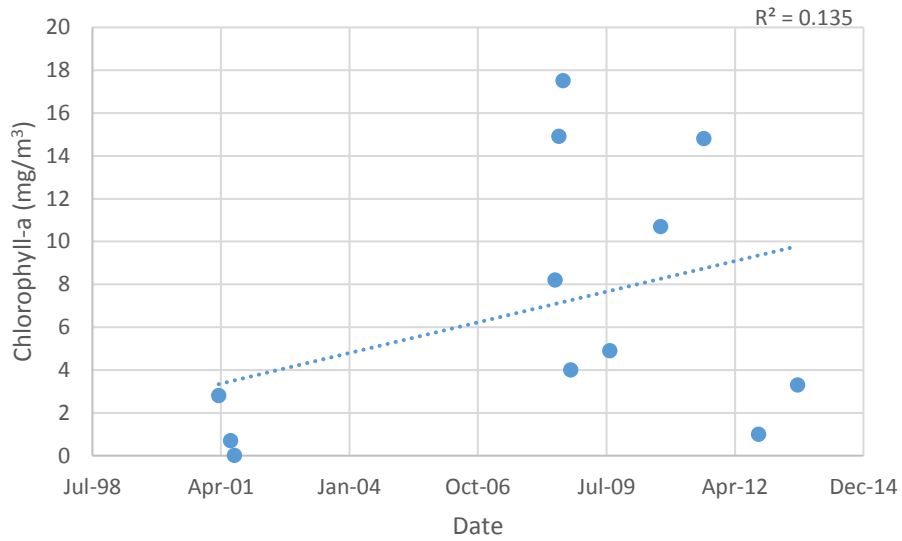


Figure 3-6: In-lake Chlorophyll-a Concentration Trend for Blacktail Pond.

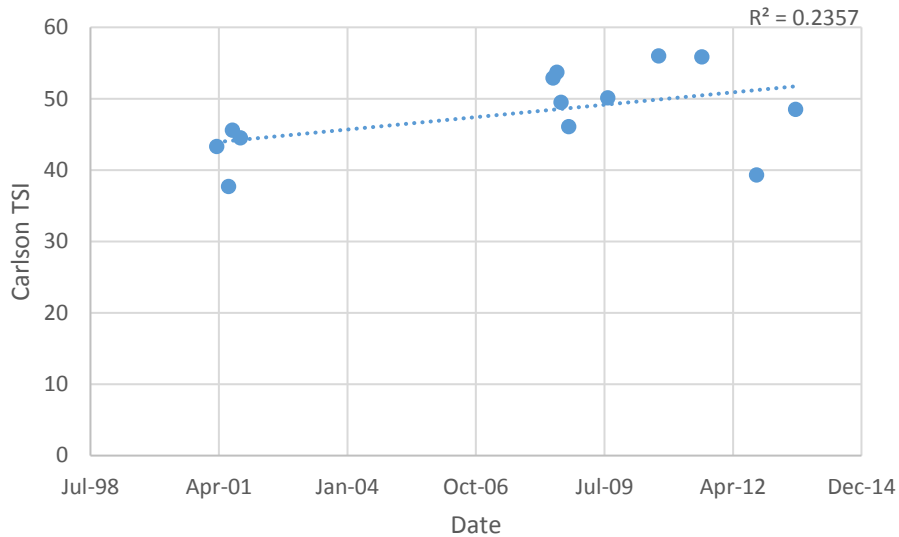


Figure 3-7: Carlson Trophic State Index Trend for Blacktail Pond.

3.3 Buck Lake

Buck Lake and its inlet have been sampled thirty-four times since 2004. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and the inlet phosphorus trends are presented in Figure 3-8, Figure 3-9, Figure 3-10, and Figure 3-11 respectively.

The in-lake phosphorus concentration for Buck Lake shows a trend that is decreasing. However, it has a low R^2 value of 0.1397. This suggests the data may not be correlated. The in-lake chlorophyll-a concentration and the Carlson trophic state index also show a slightly decreasing trend over time. They both have R^2 values less than 0.1 that suggest the data are not correlated. The inlet phosphorus concentration shows a very slight increase over time. It had an R^2 value of 0.0014 indicating that there is almost no correlation.

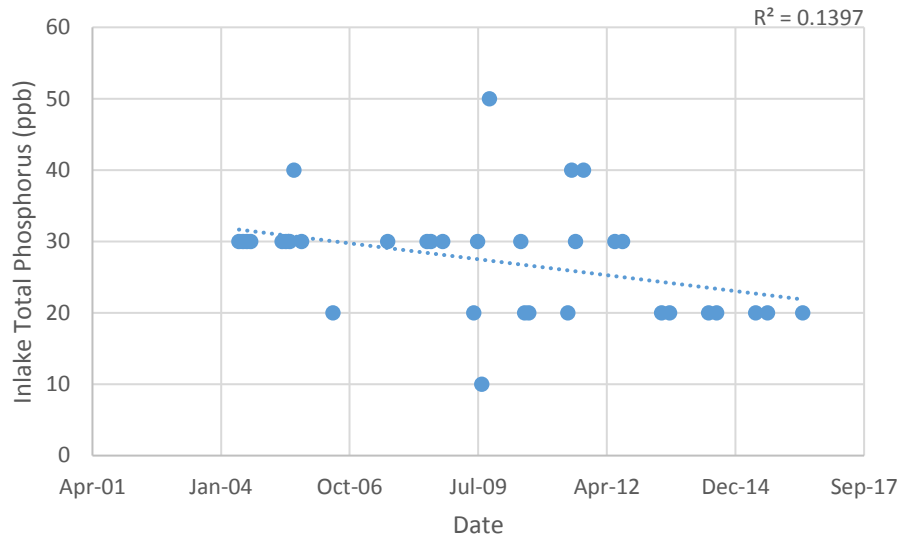


Figure 3-8: In-lake Phosphorus Concentration Trend for Buck Lake.

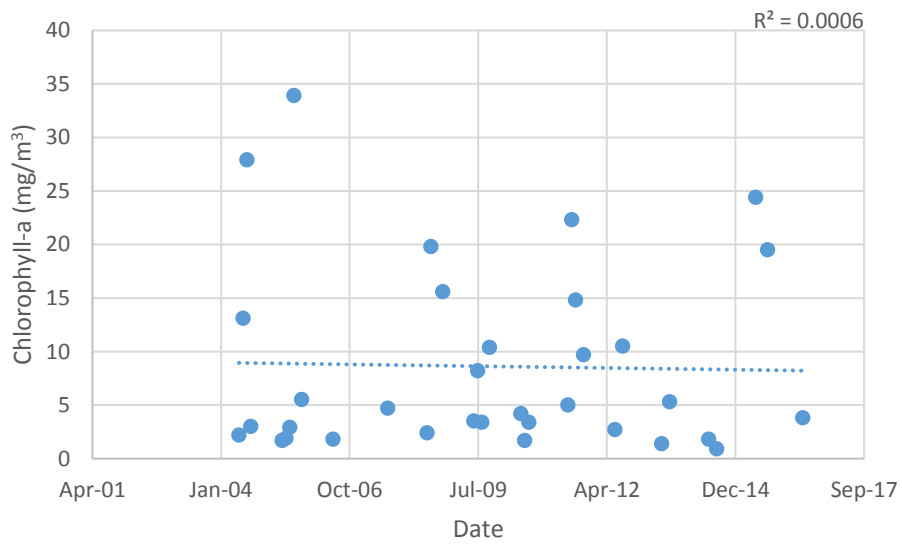


Figure 3-9: In-lake Chlorophyll-a Concentration Trend for Buck Lake.

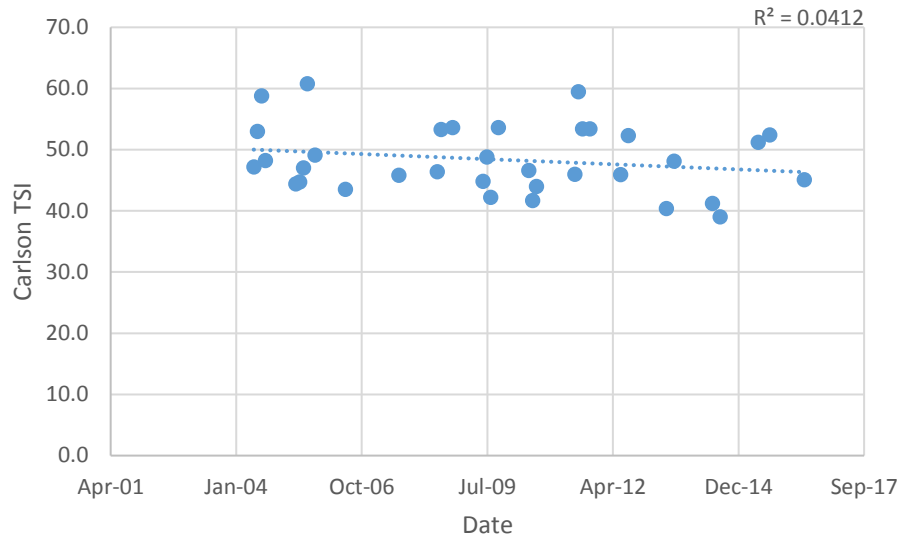


Figure 3-10: Carlson Trophic State Index Trend for Buck Lake.

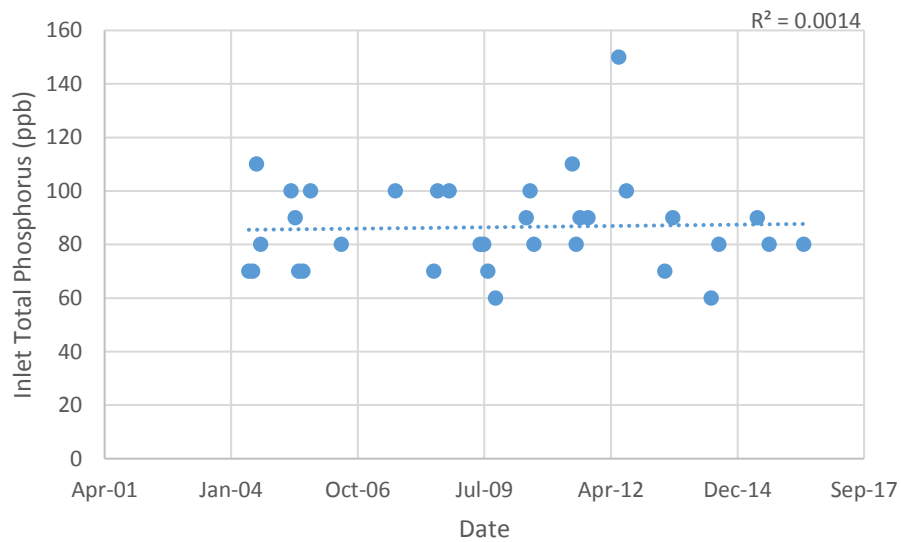


Figure 3-11: Phosphorus Concentration Trend for the Inlet of Buck Lake.

3.4 Cascade Lake

Cascade Lake has been sampled fourteen times since 2004. Its inlet has been sampled eleven times, and its outlet has been sampled twice. The data for in-lake, inlet, and outlet

phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, the inlet phosphorus trends, and outlet phosphorus trends are presented in Figure 3-12, Figure 3-13, Figure 3-14, Figure 3-15, and Figure 3-16 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Cascade Lake all trend upward. However, they all have low R^2 values suggesting the data may not be correlated. The inlet phosphorus concentration shows an increase over time. It has an R^2 value of 0.5774 indicating that there is a correlation between the phosphorus concentration and the passing of time. The outlet phosphorus concentration shows a decreasing trend; however, because only two data points are available no conclusions can be made regarding the trends significance.

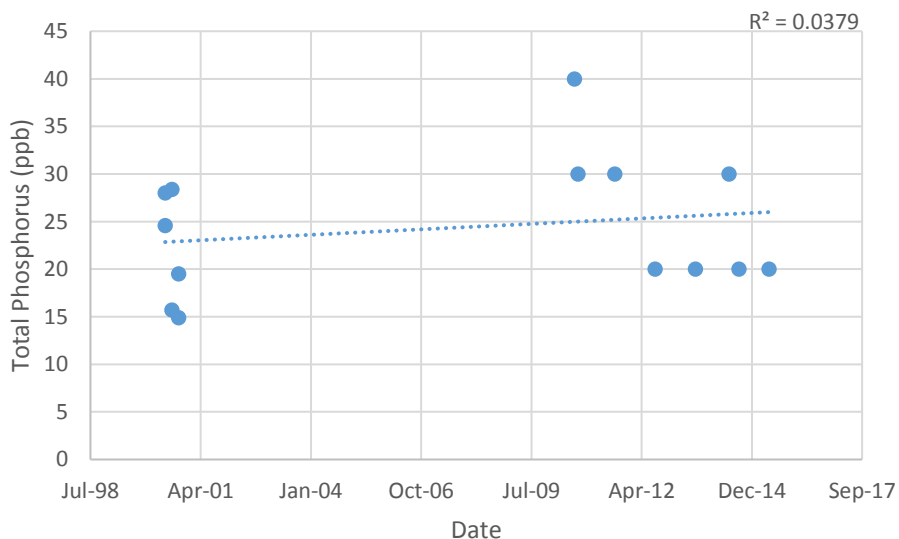


Figure 3-12: In-lake Phosphorus Concentration Trend for Cascade Lake.

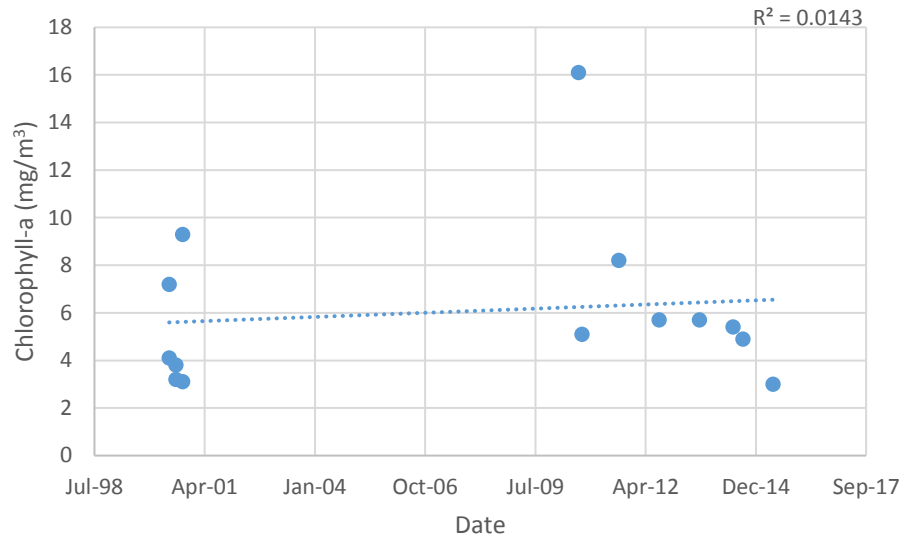


Figure 3-13: In-lake Chlorophyll-a Concentration Trend for Cascade Lake.

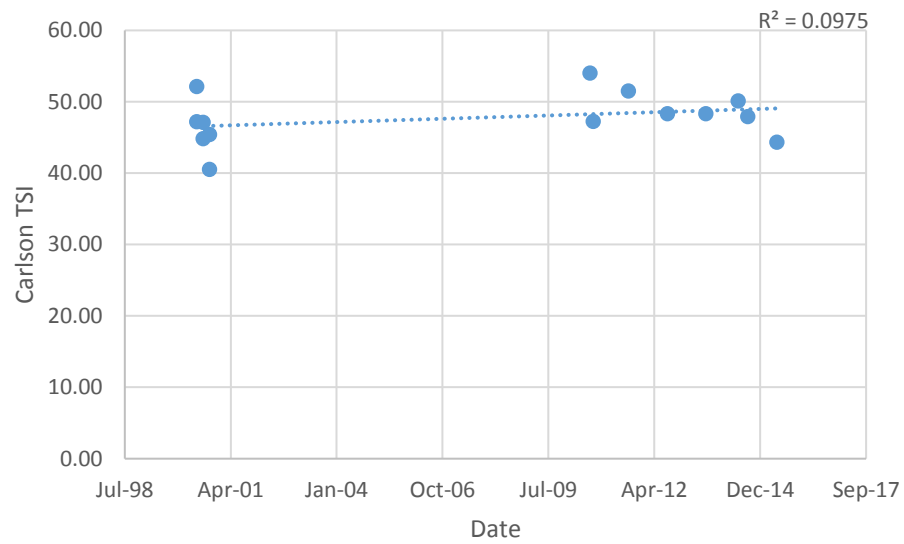


Figure 3-14: Carlson Trophic State Index Trend for Cascade Lake.

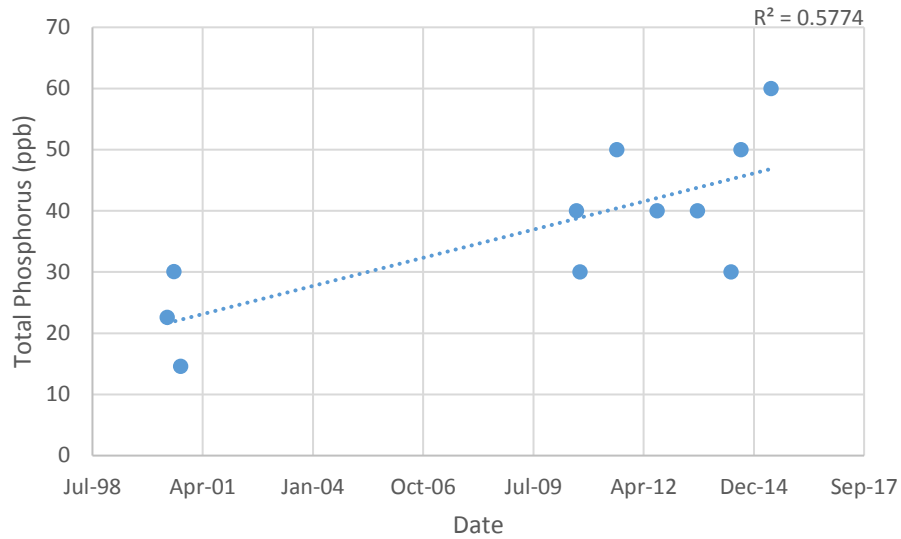


Figure 3-15: Phosphorus Concentration Trend for the Inlet of Cascade Lake.

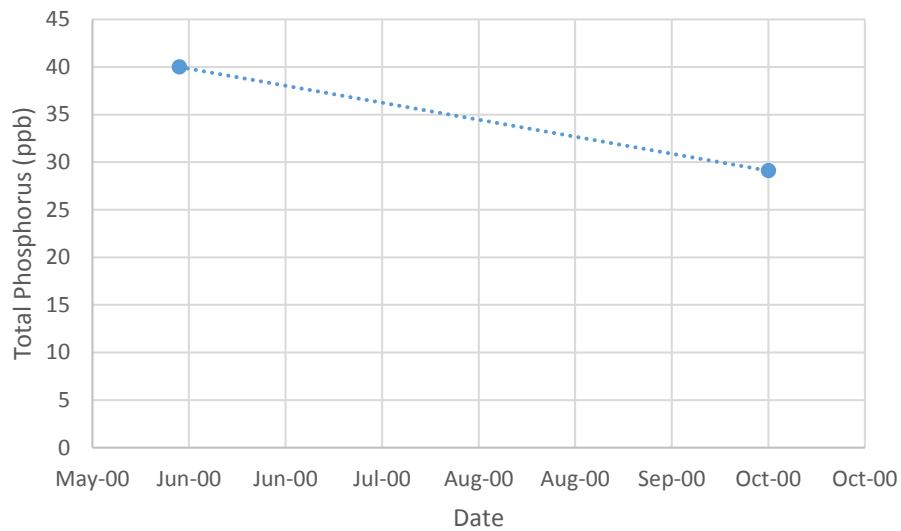


Figure 3-16: Phosphorus Concentration Trend for the Outlet of Cascade Lake.

3.5 Clear Lake

Clear Lake has been sampled twenty-three times since 2004. Its inlet has been sampled twice. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and

Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and the inlet phosphorus trends are presented in Figure 3-17, Figure 3-18, Figure 3-19, and Figure 3-20 respectively.

The in-lake phosphorus concentration and Carlson trophic state index for Clear Lake trend downward, while the chlorophyll-a and inlet phosphorus concentrations trend upward. However, they all have a low R^2 value suggesting little or no correlation. The inlet phosphorus concentration has only two data points available so no conclusions can be made regarding the trends significance.

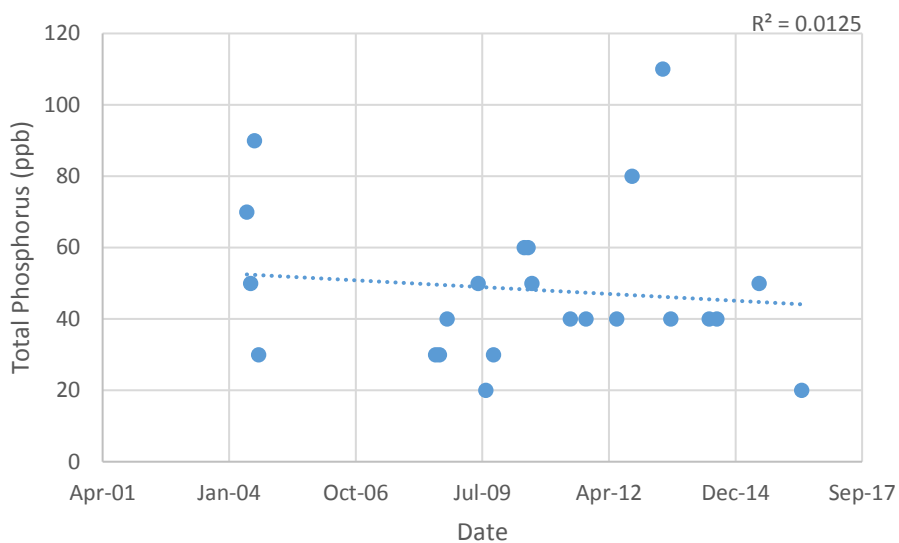


Figure 3-17: In-lake Phosphorus Concentration Trend for Clear Lake.

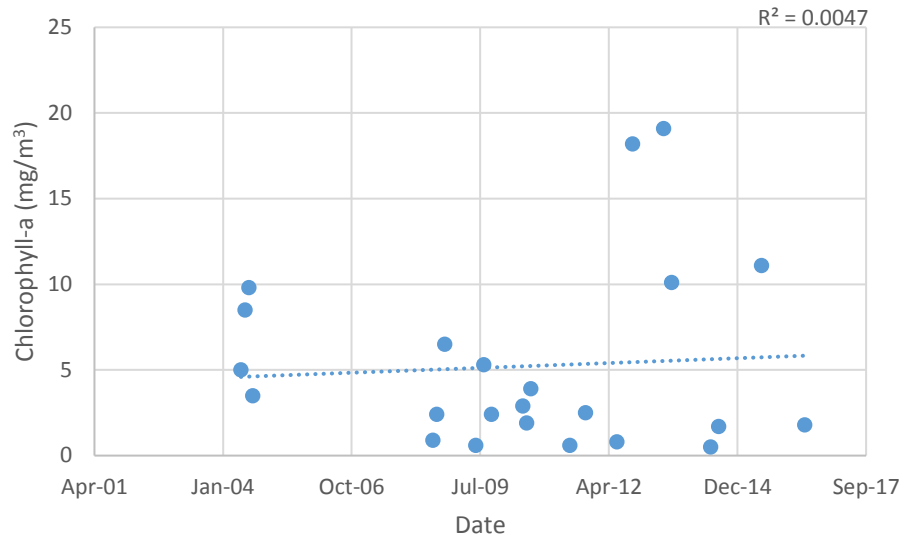


Figure 3-18: In-lake Chlorophyll-a Concentration Trend for Clear Lake.

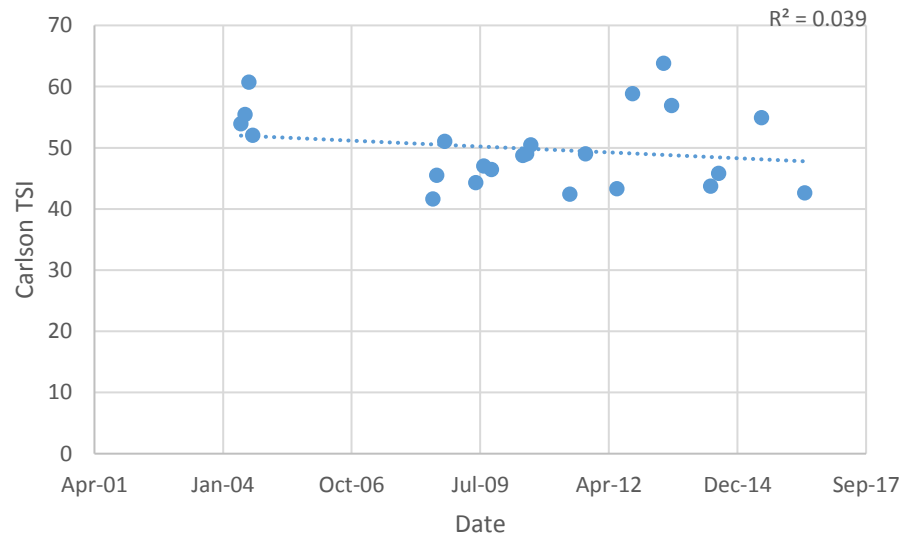


Figure 3-19: Carlson Trophic State Index Trend for Clear Lake.

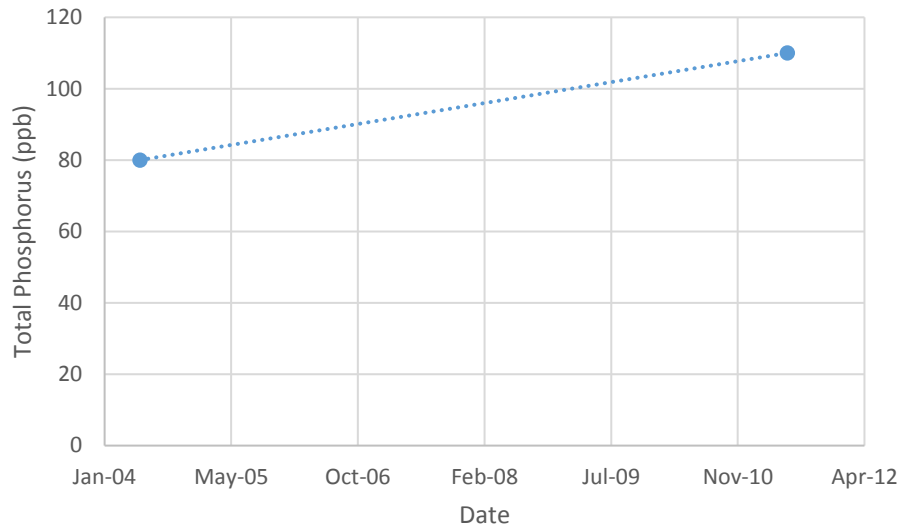


Figure 3-20: Phosphorus Concentration Trend for the Inlet of Clear Lake.

3.6 Druid Lake

Druid Lake has been sampled nine times since 2010. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-21, Figure 3-22, and Figure 3-23 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Druid Lake all trend downward. They all have a low R^2 value suggesting there may be no correlation between the data and the change of time.

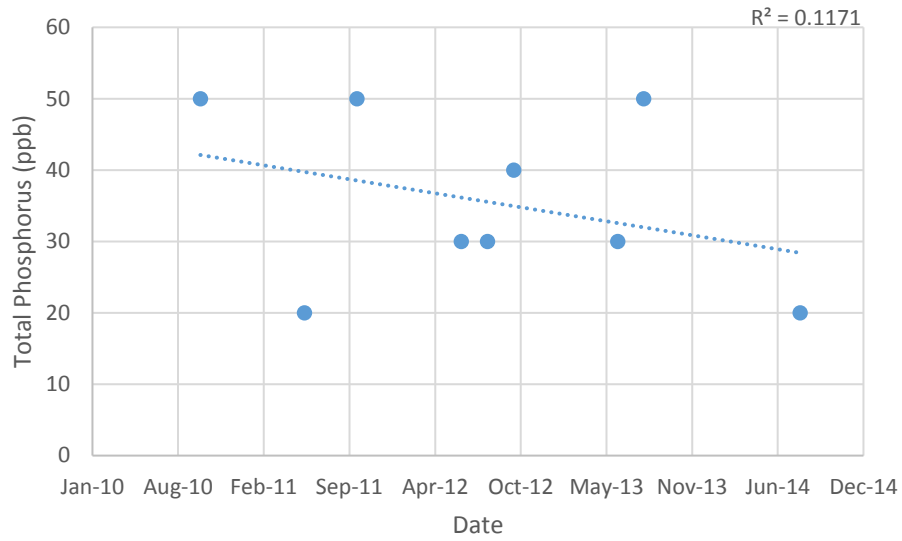


Figure 3-21: In-Lake Phosphorus Concentration Trend for Druid Lake.

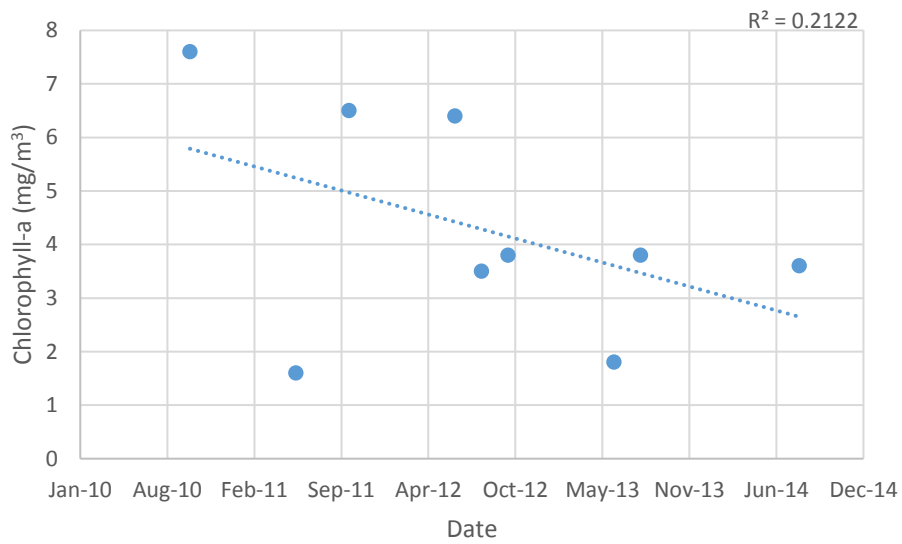


Figure 3-22: In-Lake Chlorophyll-a Concentration Trend for Druid Lake.

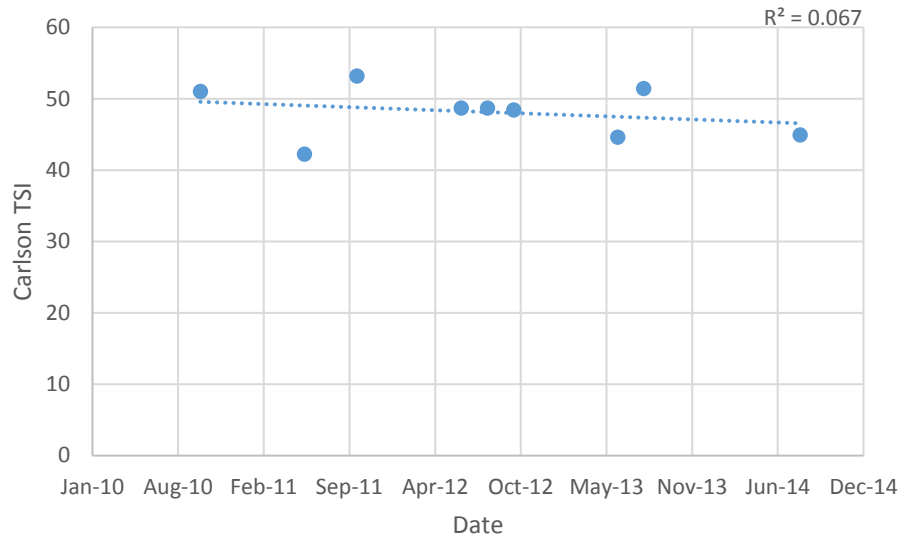


Figure 3-23: Carlson Trophic State Index Trend for Druid Lake.

3.7 Duck Lake

Duck Lake has been sampled seventeen times since 1999. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-24, Figure 3-25, and Figure 3-26 respectively.

The in-lake phosphorus concentration shows an increasing trend, while the Carlson trophic state index for Duck Lake remains constant, and the chlorophyll-a concentration trends downward. However, all three have a low R^2 value suggesting there may be no correlation between the data and the change of time.

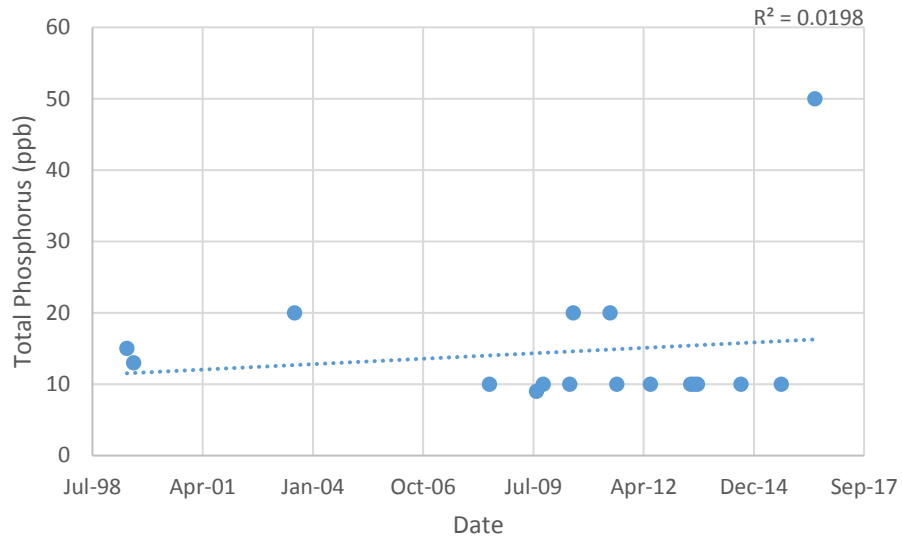


Figure 3-24: In-lake Phosphorus Concentration Trend for Duck Lake.

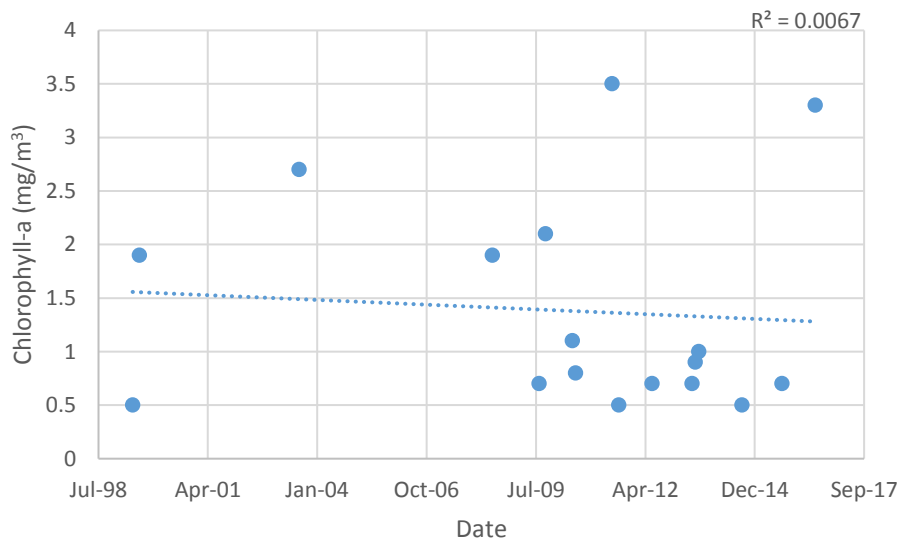


Figure 3-25: In-lake Chlorophyll-a Concentration Trend for Duck Lake.

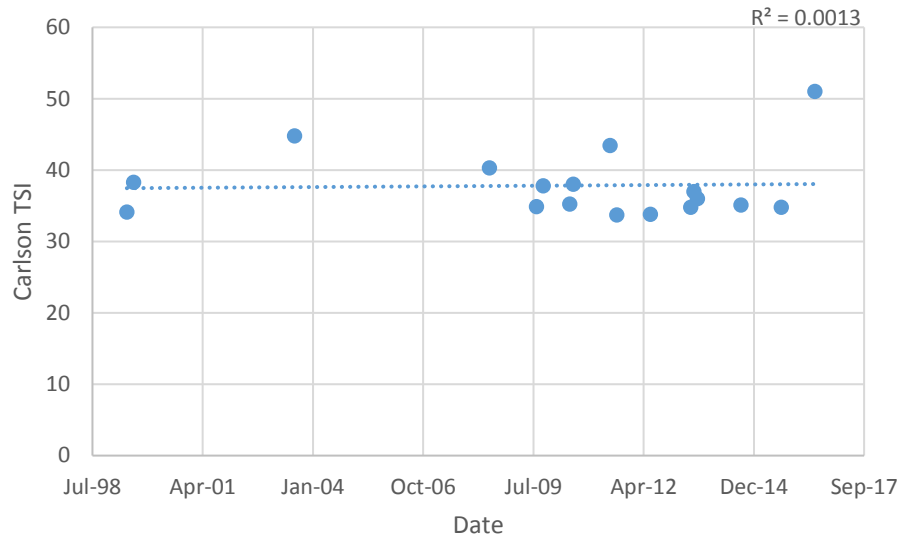


Figure 3-26: Carlson Trophic State Index Trend for Duck Lake.

3.8 Eleanor Lake

Eleanor Lake has been sampled twelve times since 2004. Its inlet has been sampled five times. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and the inlet phosphorus trends are presented in Figure 3-27, Figure 3-28, Figure 3-29, and Figure 3-30 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Druid Lake all trend downward. They all have a low R^2 value suggesting there may be no correlation between the data and the change of time. The inlet phosphorus concentration trend is increasing and it has a R^2 value of 0.3614 suggesting that there could be some correlation between the inlet phosphorus concentration and time.

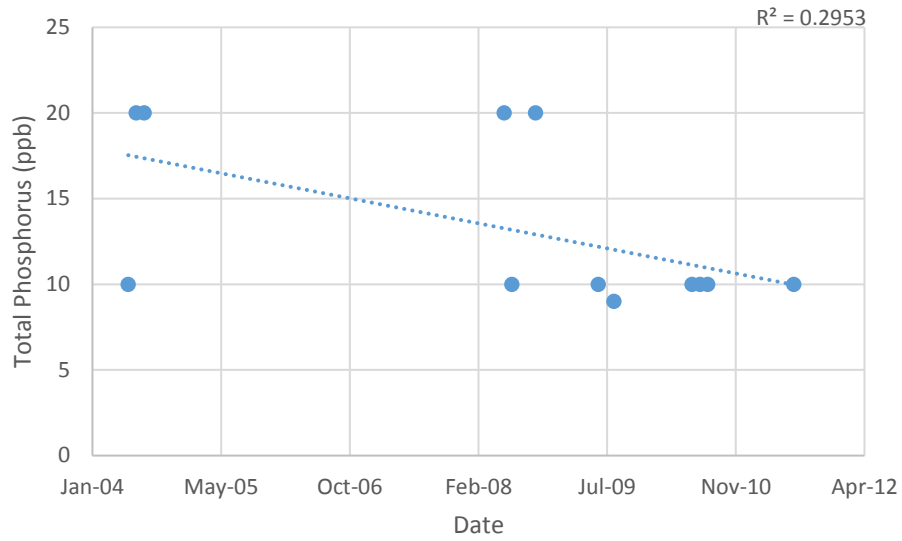


Figure 3-27: In-lake Phosphorus Concentration Trend for Eleanor Lake.

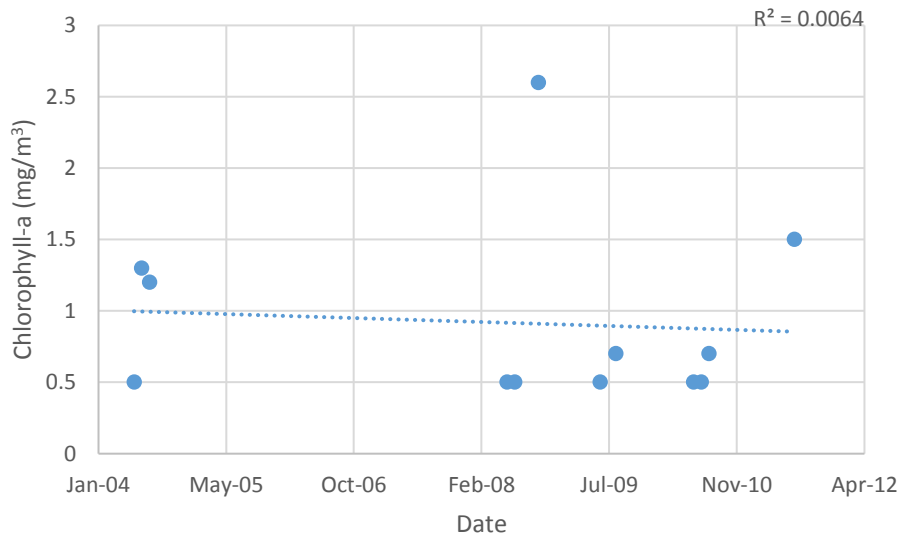


Figure 3-28: In-lake Chlorophyll-a Concentration Trend for Eleanor Lake.

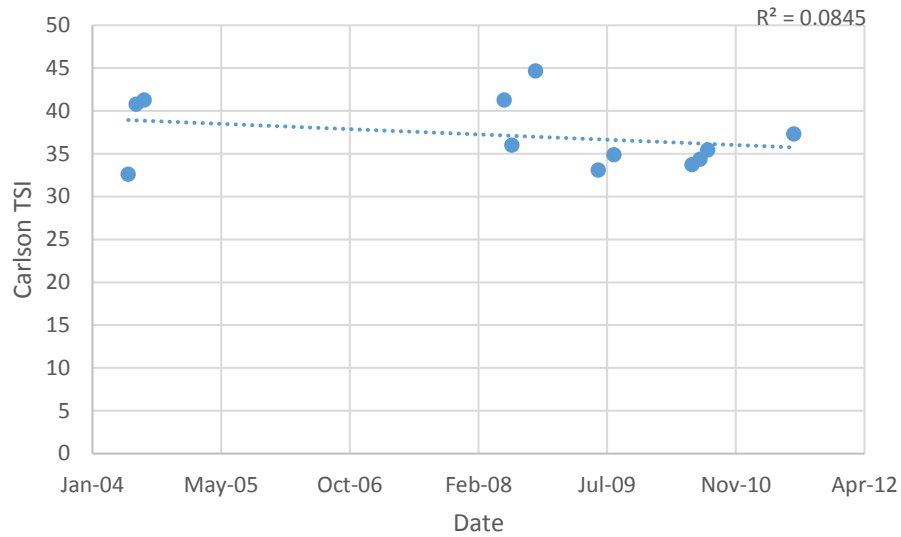


Figure 3-29: Carlson Trophic State Index Trend for Eleanor Lake.

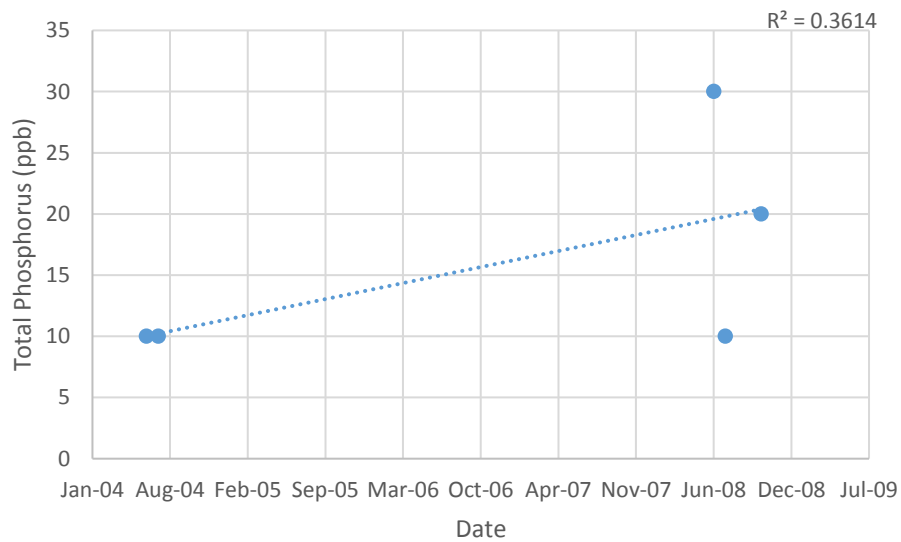


Figure 3-30: Phosphorus Concentration Trend for the Inlet of Eleanor Lake.

3.9 Feather Lake

Feather Lake has been sampled eight times since 2010. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order

to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-31, Figure 3-32, and Figure 3-33 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Feather Lake all decrease with time. They all have high R^2 values, of 0.7 or larger, suggesting there is correlation between the data and the change of time. With all of these constituents decreasing, the lake may be experiencing a reversal of the eutrophication process.

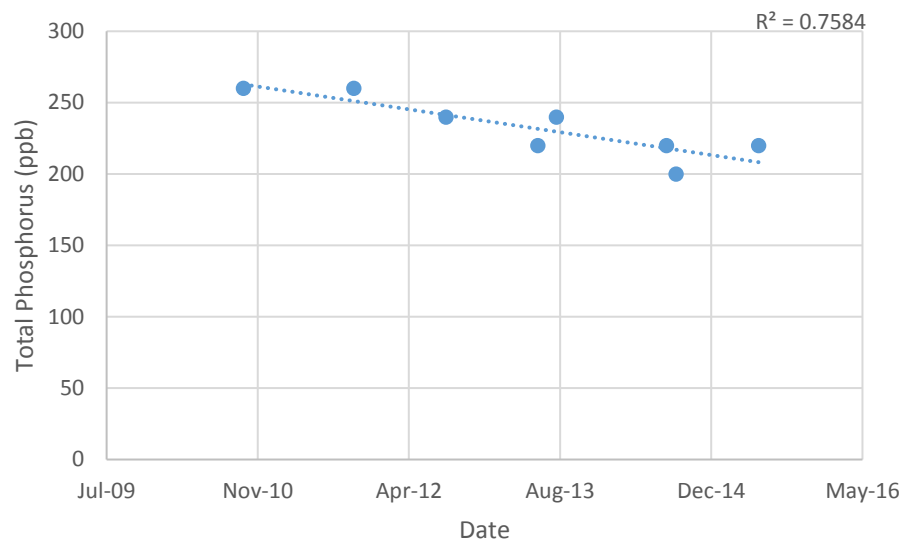


Figure 3-31: In-lake Phosphorus Concentration Trend for Feather Lake.

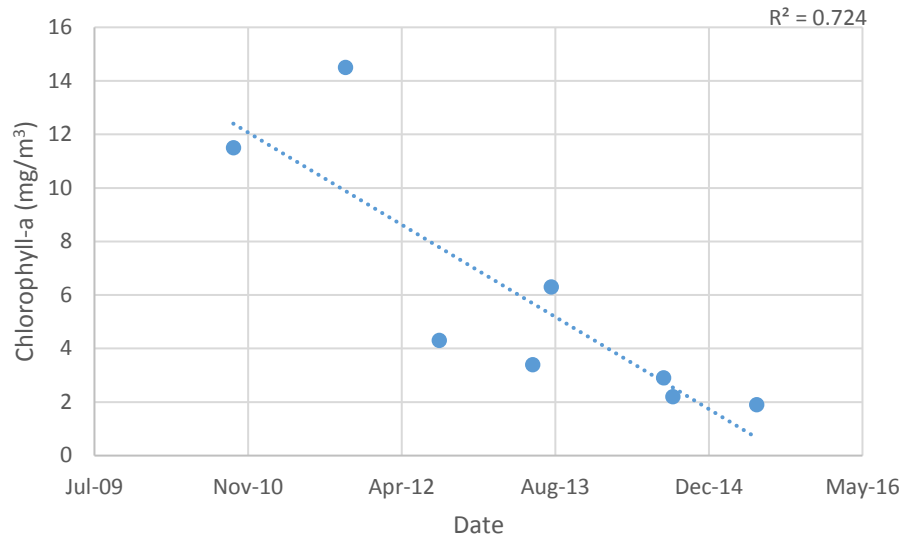


Figure 3-32: In-lake Chlorophyll-a Concentration Trend for Feather Lake.

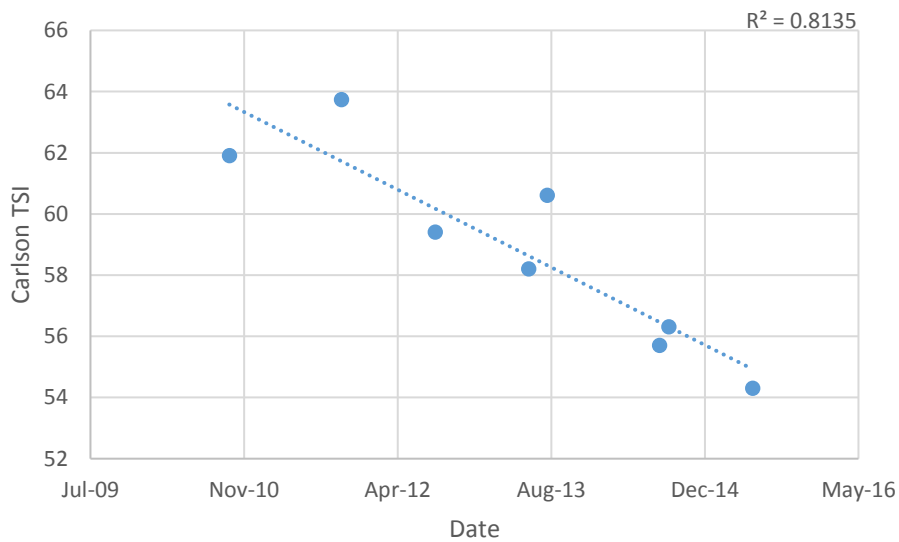


Figure 3-33: Carlson Trophic State Index for Feather Lake.

3.10 Floating Island Lake

Floating Island Lake has been sampled four times since 2010. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were

plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-34, Figure 3-35, and Figure 3-36 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Floating Island Lake all decrease with time. Total phosphorus and chlorophyll-a concentrations have low R^2 values suggesting there is little or no correlation between the data and the change of time. However, the Carlson trophic state index trend has a higher R^2 value of 0.3689 indicating a possible correlation.

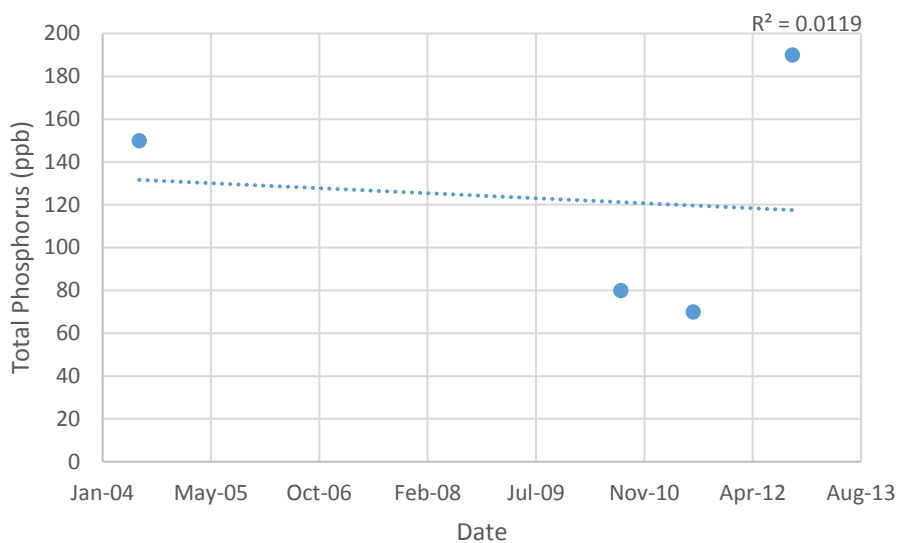


Figure 3-34: In-lake Phosphorus Concentration Trend for Floating Island Lake.

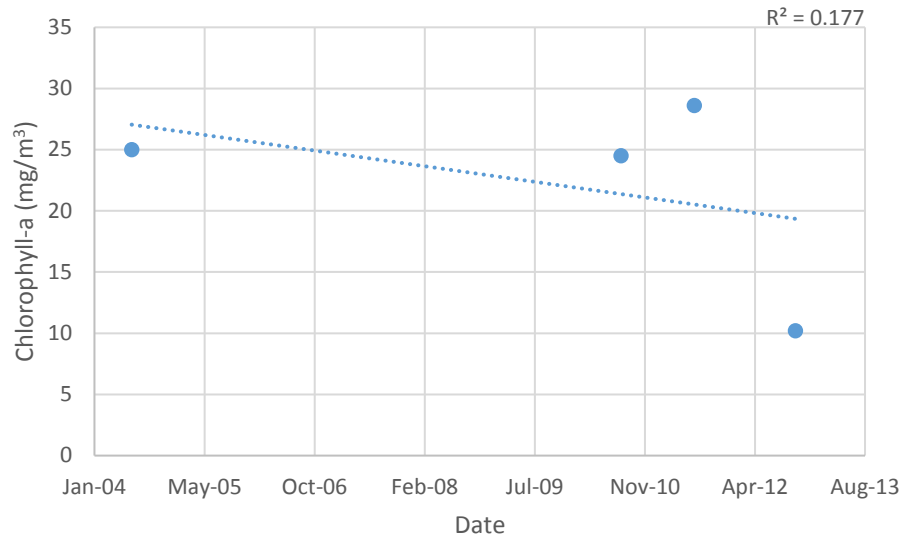


Figure 3-35: In-lake Chlorophyll-a Concentration Trend for Floating Island Lake.

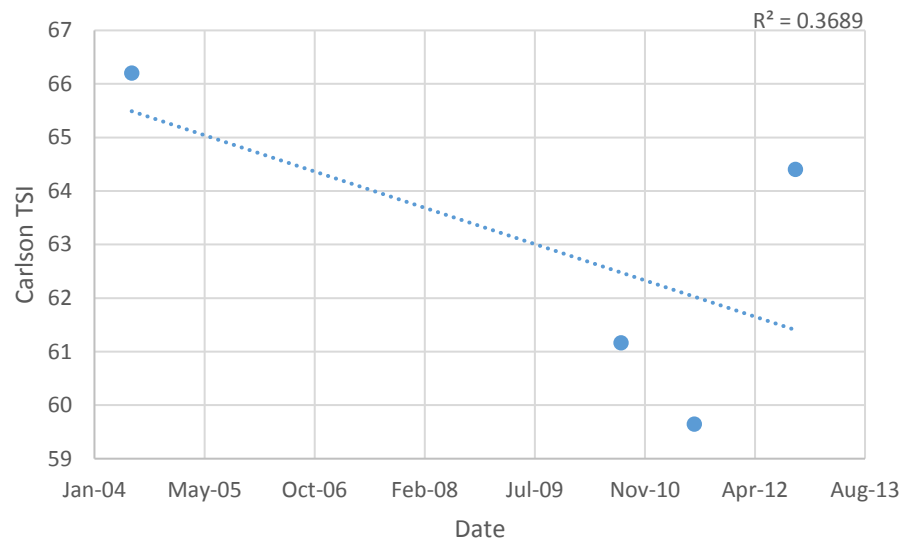


Figure 3-36: Carlson Trophic State Index Trend for Floating Island Lake.

3.11 Goose Lake

Goose Lake and its inlet has been sampled thirteen times since 2001. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index

were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and inlet phosphorus trends are presented in Figure 3-37, Figure 3-38, Figure 3-39, and Figure 3-40 respectively.

The in-lake and inlet phosphorus concentrations show an increasing trend. The chlorophyll-a concentration and Carlson trophic state index for Goose Lake show no change in trend with time. All of these constituents have low R^2 values that suggests the data may not be correlated.

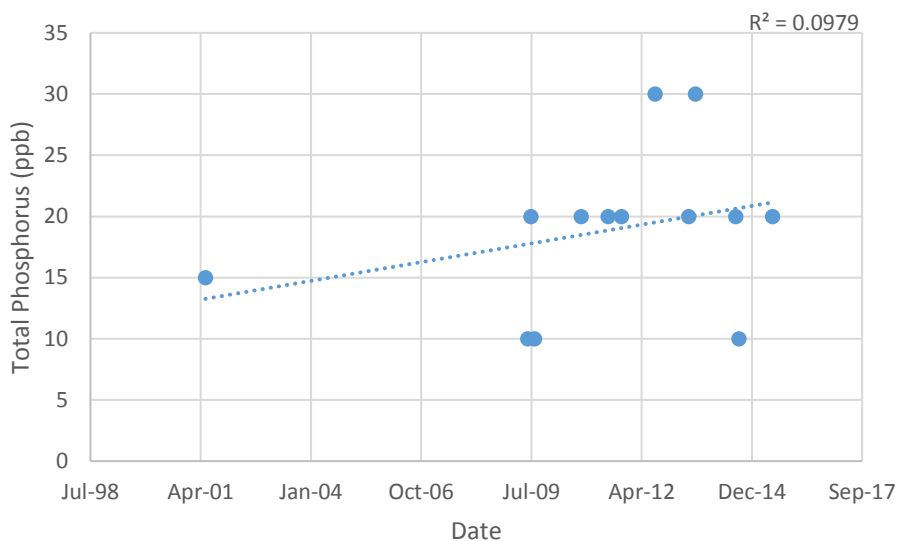


Figure 3-37: In-lake Phosphorus Concentration Trend for Goose Lake.

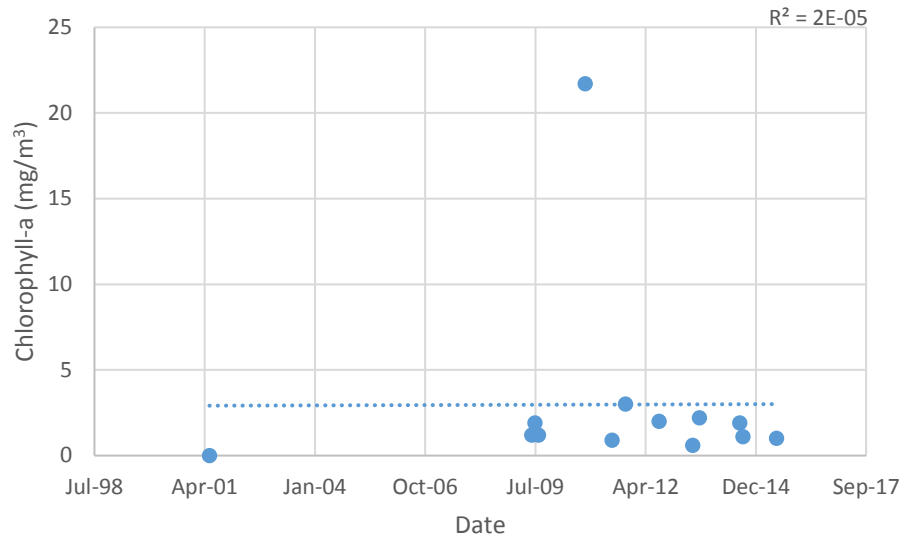


Figure 3-38: In-lake Chlorophyll-a Concentration Trend for Goose Lake.

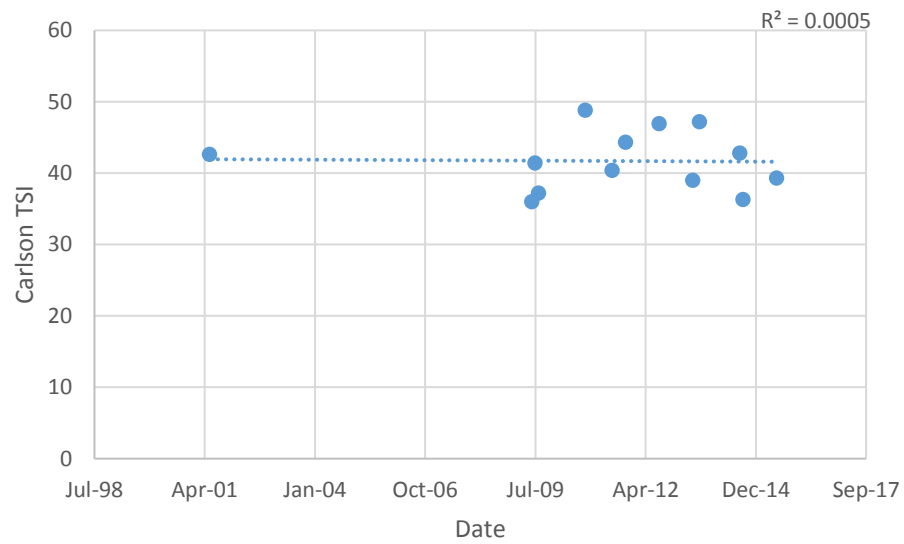


Figure 3-39: Carlson Trophic State Index Trend for Goose Lake.

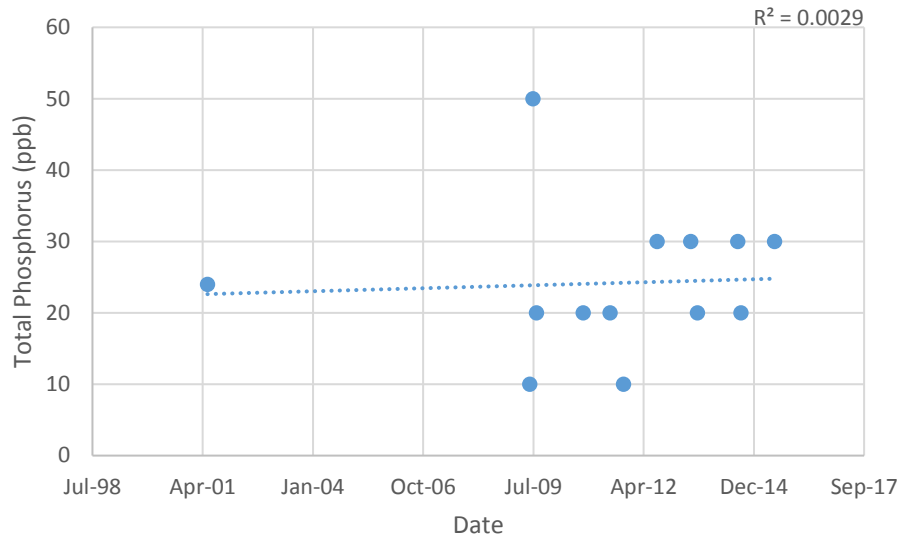


Figure 3-40: Phosphorus Concentration Trend for the Inlet of Goose Lake.

3.12 Grebe Lake

Grebe Lake has been sampled five times since 2000. Its inlet has been sampled three times, and its outlet has been sampled twice. The data for in-lake, inlet, and outlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, the inlet phosphorus, and outlet phosphorus trends are presented in Figure 3-41, Figure 3-42, Figure 3-43, Figure 3-44, and Figure 3-45 respectively.

The in-lake and inlet phosphorus concentrations have a decreasing trend. The chlorophyll-a concentration, Carlson trophic state index, and outlet phosphorus concentration for Grebe Lake all trend upward. However, all trends have a low R^2 value suggesting the data may not be correlated. There are only two data points available for the outlet phosphorus concentration so no conclusions can be made regarding the trends significance.

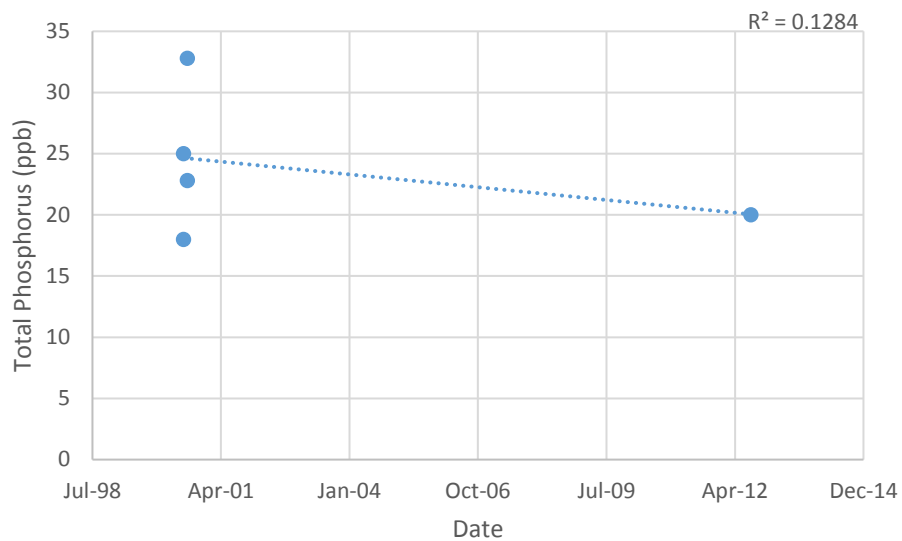


Figure 3-41: In-lake Phosphorus concentration Trend for Grebe Lake.

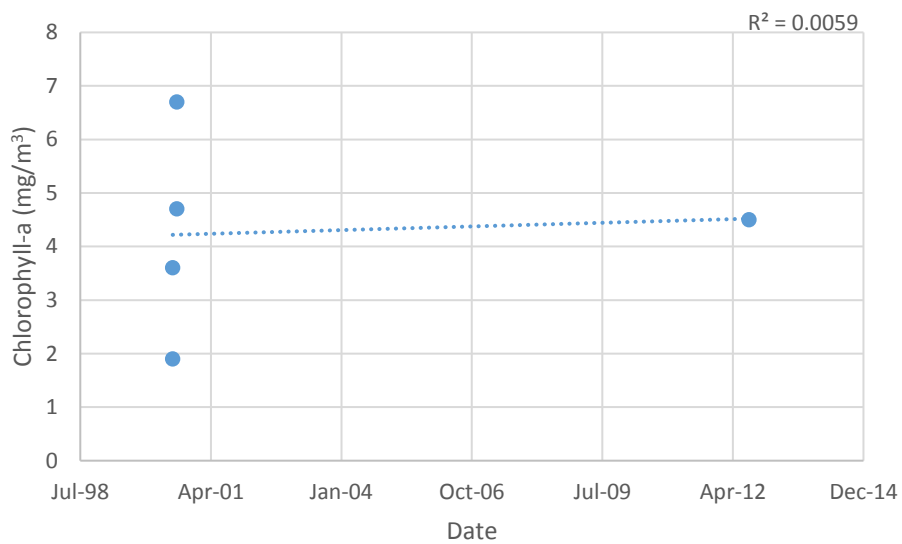


Figure 3-42: In-lake Chlorophyll-a Concentration Trend for Grebe Lake.

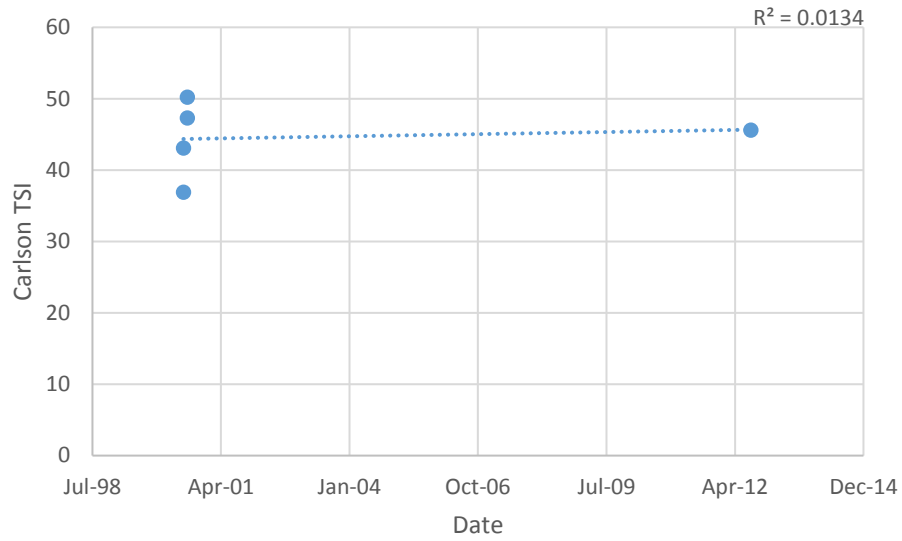


Figure 3-43: Carlson Trophic State Index Trend for Grebe Lake.

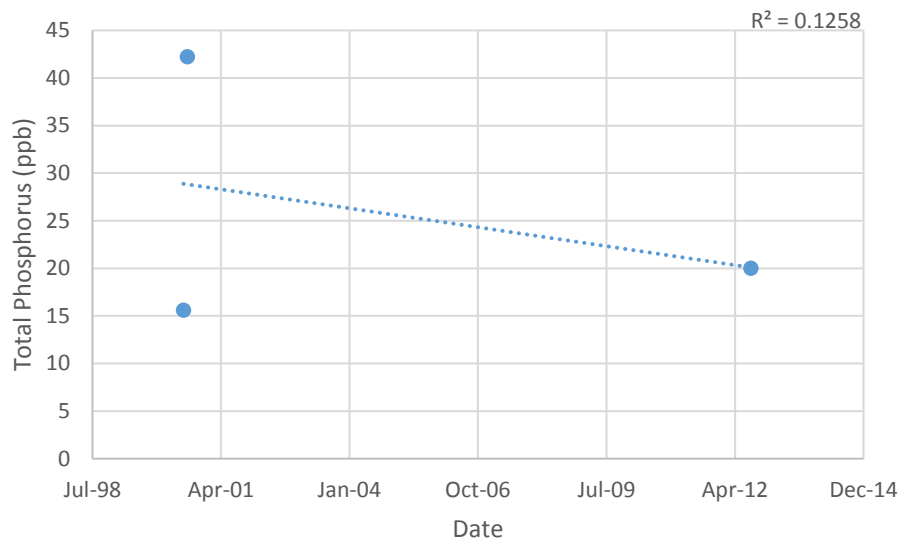


Figure 3-44: Phosphorus Concentration Trend for the Inlet of Grebe Lake.

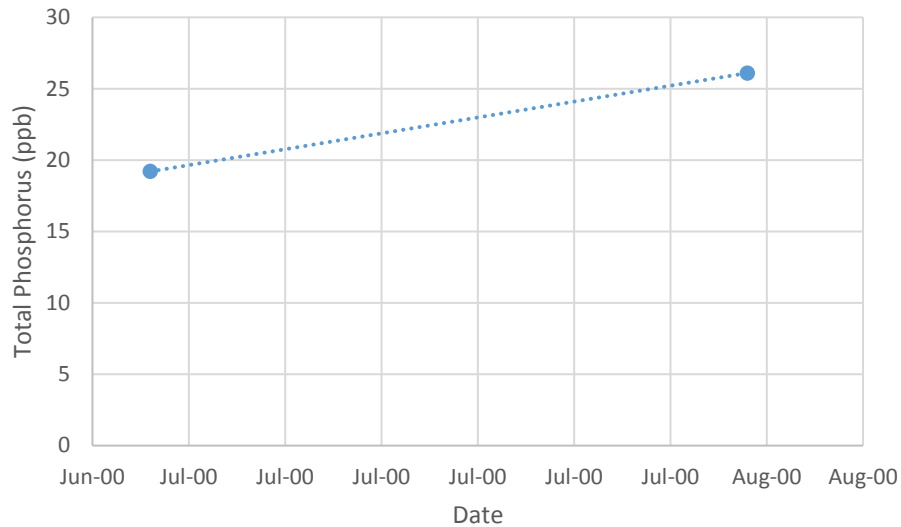


Figure 3-45: Phosphorus Concentration Trend for the Outlet of Grebe Lake.

3.13 Grizzly Lake

Grizzly Lake has been sampled twice since 2000. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-46, Figure 3-47, and Figure 3-48 respectively.

The in-lake phosphorus concentration remains constant. The chlorophyll-a concentration, and Carlson trophic state index for Grizzly Lake trend downward. Since there are only two data points available for each constituent, no conclusions can be made regarding the trends' significance.

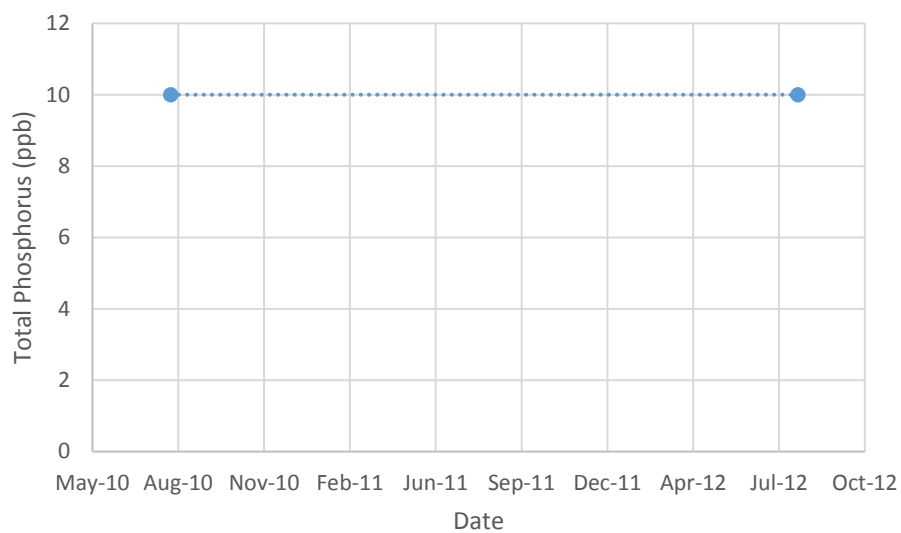


Figure 3-46: In-lake Phosphorus Concentration for Grizzly Lake.

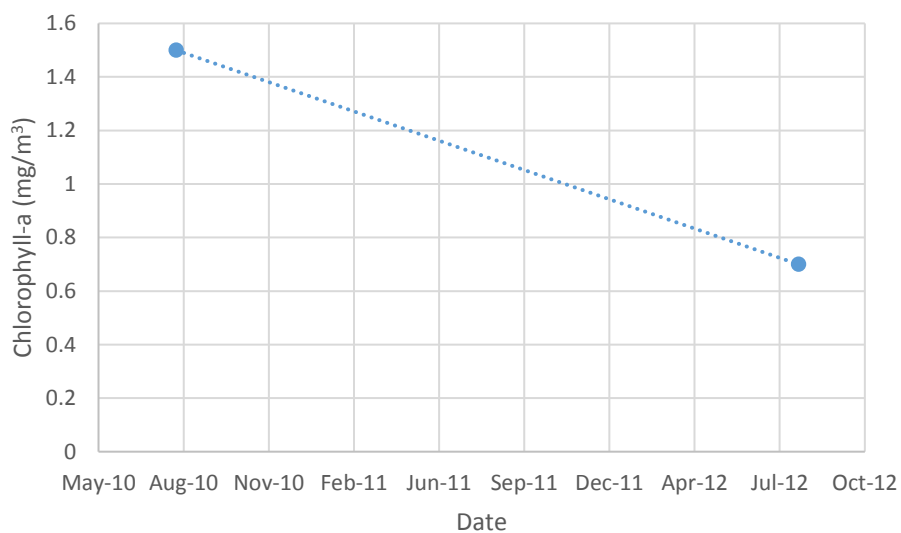


Figure 3-47: In-lake Chlorophyll-a Concentration Trend for Grizzly Lake.

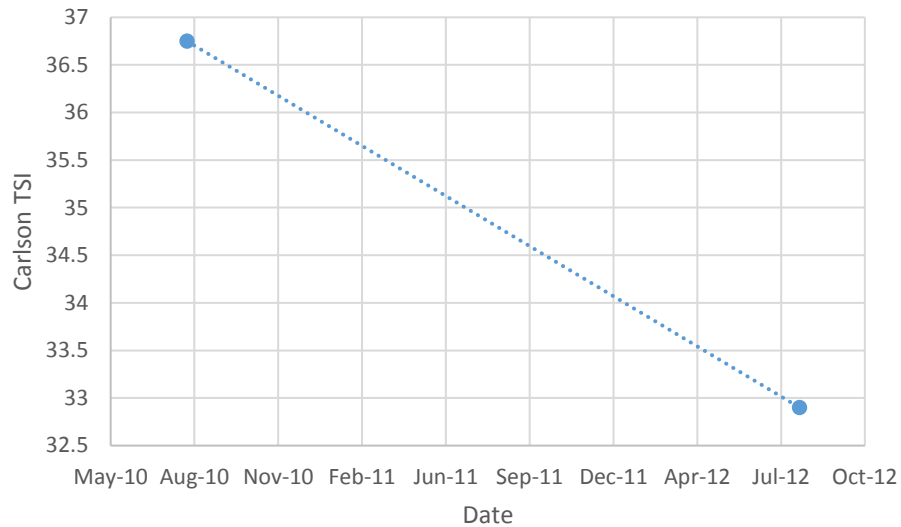


Figure 3-48: Carlson Trophic State Index Trend for Grizzly Lake.

3.14 Harlequin Lake

Harlequin Lake has been sampled seventeen times since 2001. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-49, Figure 3-50, and Figure 3-51 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Harlequin Lake all increase with time. The phosphorus and chlorophyll-a concentrations have low R^2 values suggesting no correlation among the data points. The Carlson trophic state index has a slightly higher R^2 value indicating a possible correlation.

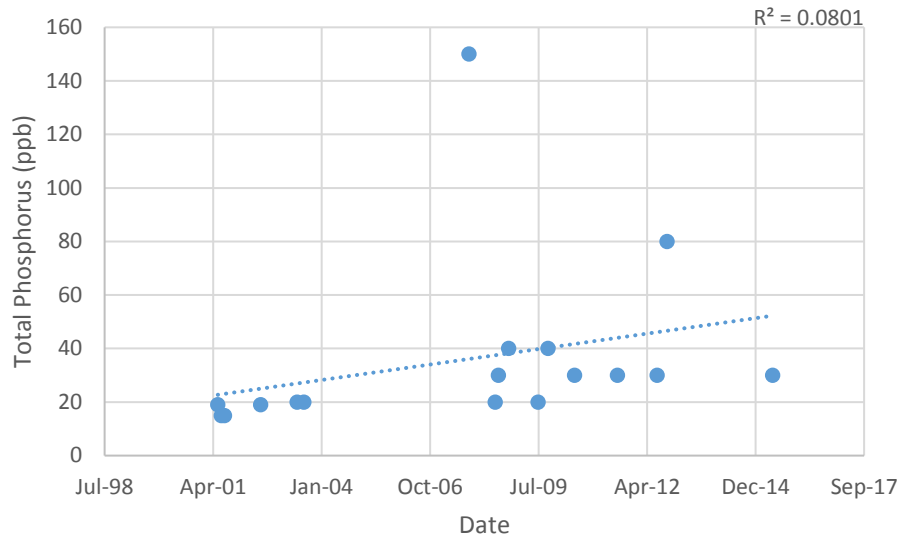


Figure 3-49: In-lake Phosphorus Concentration Trend for Harlequin Lake.

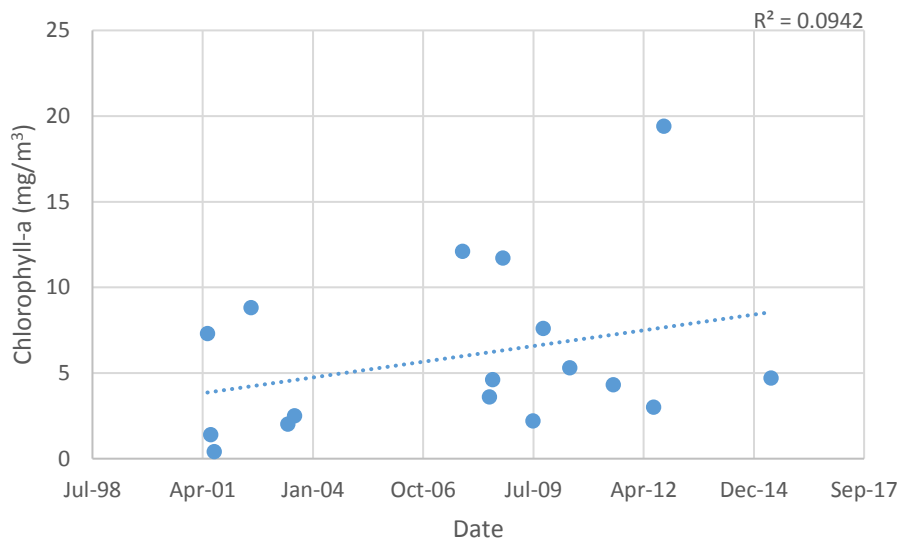


Figure 3-50: In-lake Chlorophyll-a Concentration Trend for Harlequin Lake.

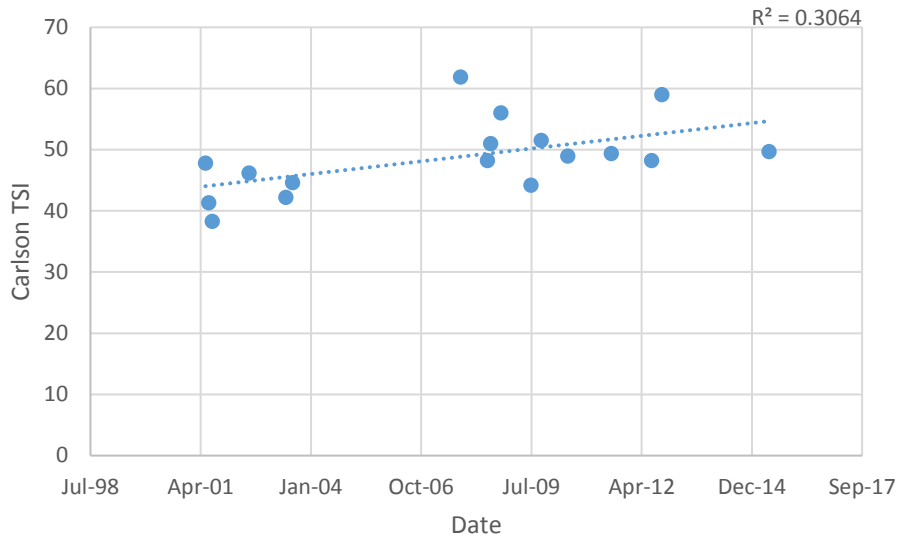


Figure 3-51: Carlson Trophic State Index Trend for Harlequin Lake.

3.15 Hazel Lake

Hazel Lake has been sampled thirteen times since 2001. Its inlet has been sampled twelve times. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and the inlet phosphorus trends are presented in Figure 3-52, Figure 3-53, Figure 3-54, and Figure 3-55 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, Carlson trophic state index, and inlet phosphorus concentration for Hazel Lake all increase with time. The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index have a low R^2 value suggesting the data may not be correlated. The inlet phosphorus concentration trend has an R^2 value of 0.4121. This shows for Hazel Lake, there is a higher correlation for the inlet phosphorus concentration then for the other constituents.

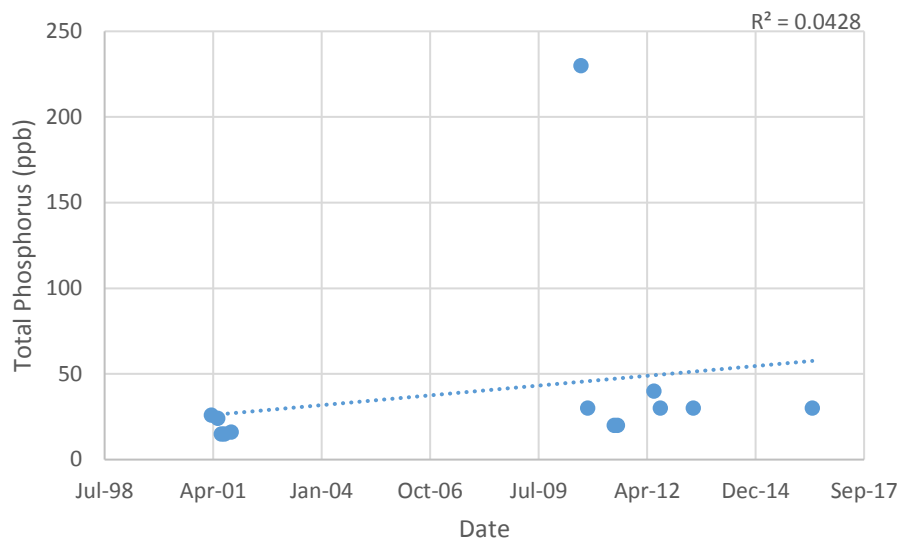


Figure 3-52: In-lake Phosphorus Concentration Trend for Hazel Lake.

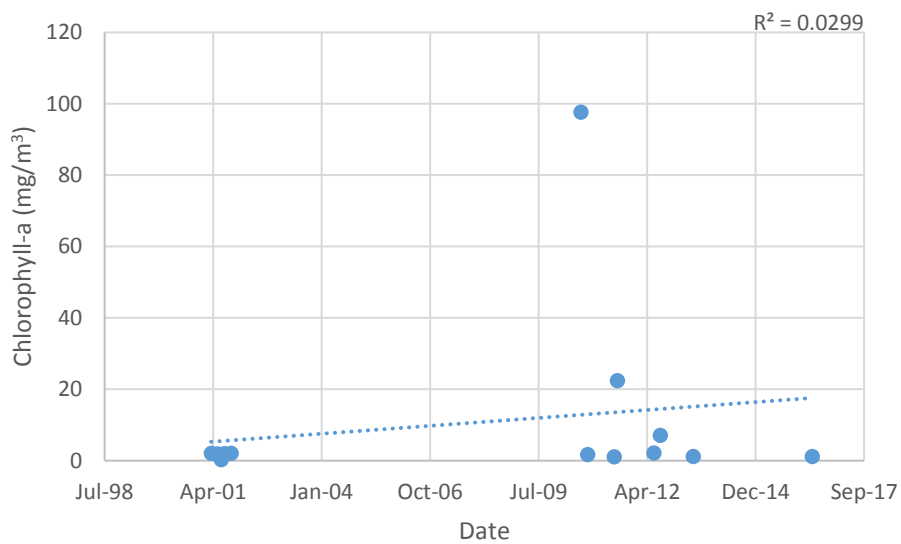


Figure 3-53: In-lake Chlorophyll-a Concentration Trend for Hazel Lake.

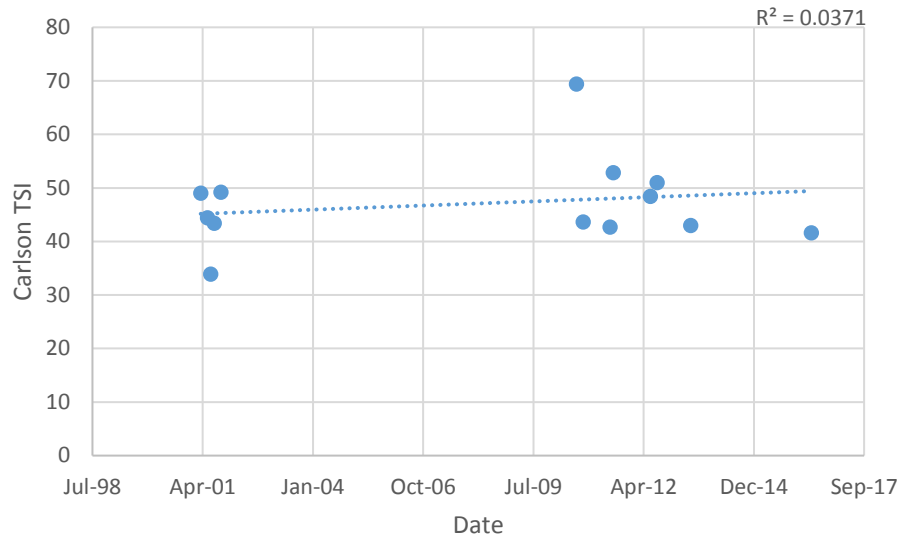


Figure 3-54: Carlson Trophic State Index Trend for Hazel Lake.

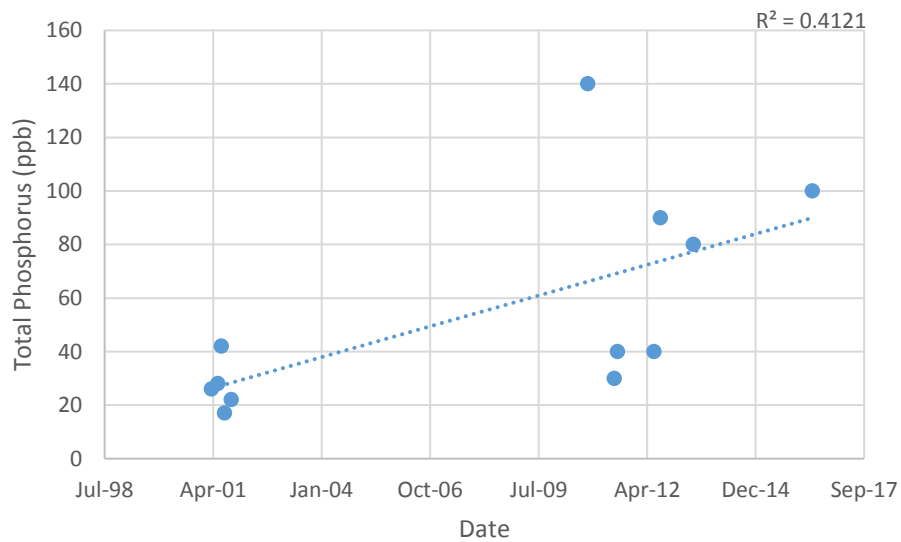


Figure 3-55: Phosphorus Concentration Trend for the Inlet of Hazel Lake.

3.16 Heart Lake

Heart Lake has been sampled four times since 2001. Its inlet has been sampled twice. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson

trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and the inlet phosphorus trends are presented in Figure 3-56, Figure 3-57, Figure 3-58, and Figure 3-59 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, Carlson trophic state index, and inlet phosphorus concentration for Heart Lake increase with time. The in-lake phosphorus concentration has a low R^2 value of 0.0286 indicating little or no correlation. The chlorophyll-a concentration and Carlson trophic state index have higher R^2 values, of 0.4 or larger, suggesting the correlation might be significant. The inlet phosphorus concentration only had two samples taken so no conclusions can be made regarding the trends significance.

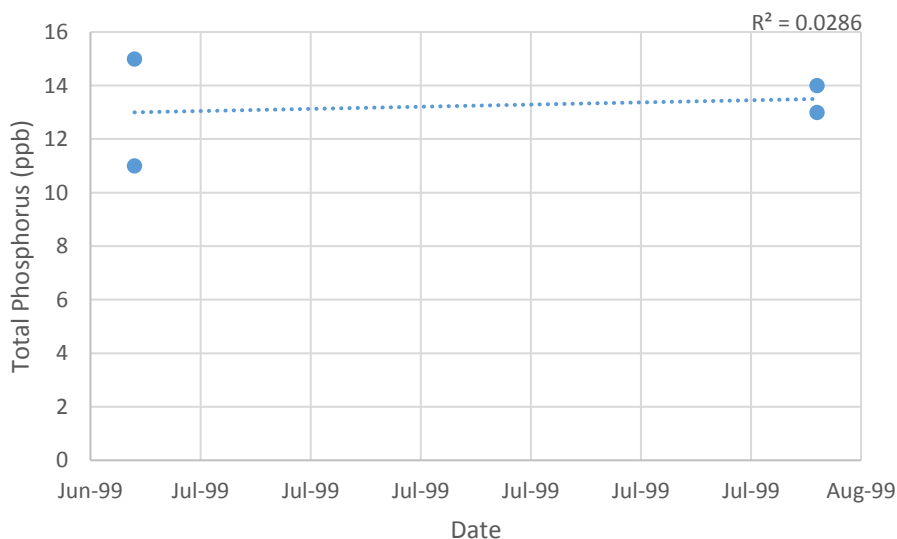


Figure 3-56: In-lake Phosphorus Concentration Trend for Heart Lake.

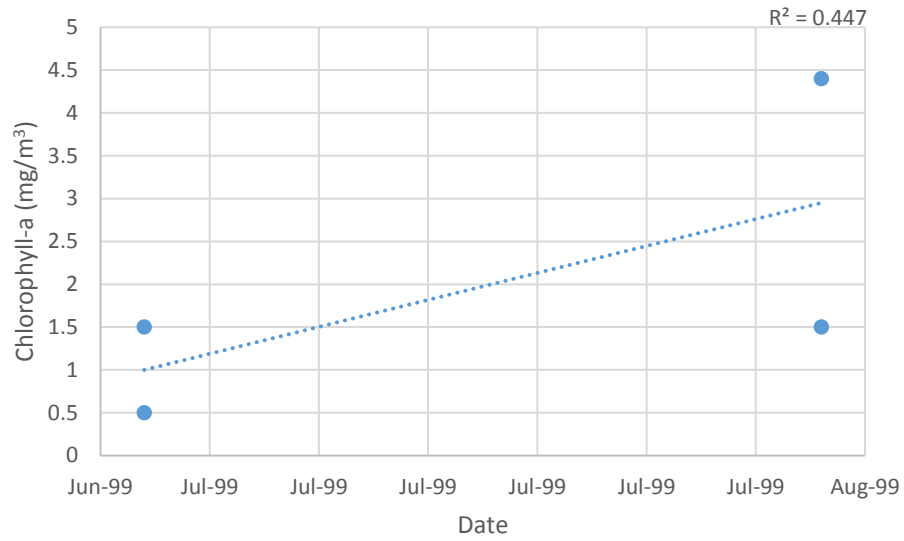


Figure 3-57: In-lake Chlorophyll-a Concentration Trend for Heart Lake.

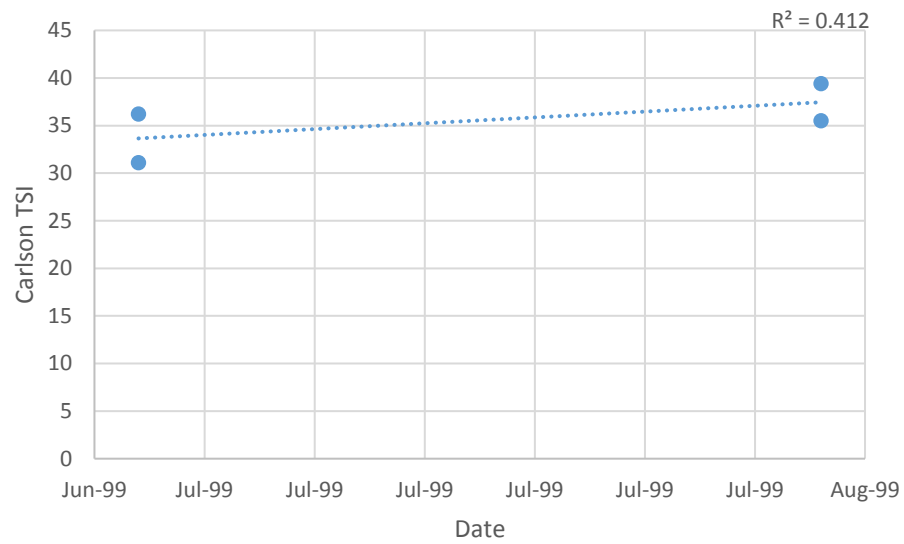


Figure 3-58: Carlson Trophic State Index Trend for Heart Lake.

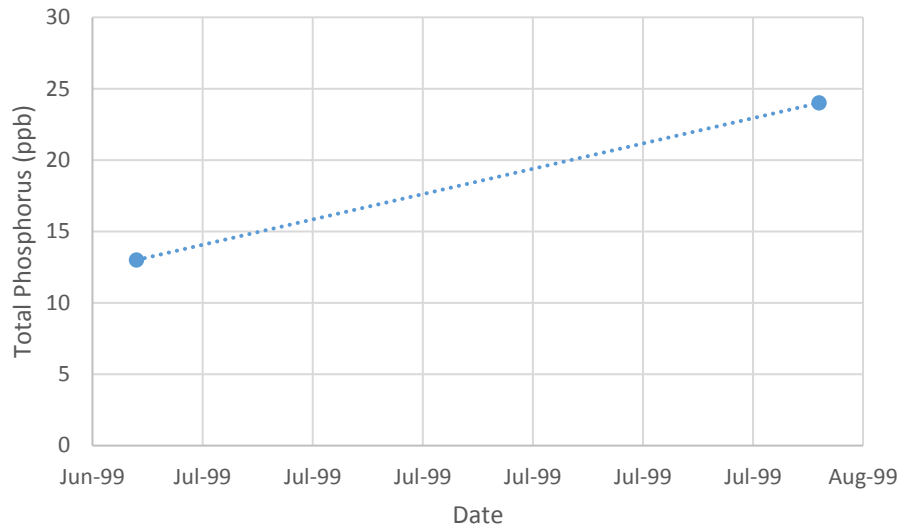


Figure 3-59: Phosphorus Concentration Trend of the Inlet of Heart Lake.

3.17 Hot Beach Pond

Hot Beach Pond has been sampled ten times since 2004. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-60, Figure 3-61, and Figure 3-62 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Hot Beach Pond all increase with time. They have low R^2 values suggesting there may be no correlation among the data points.

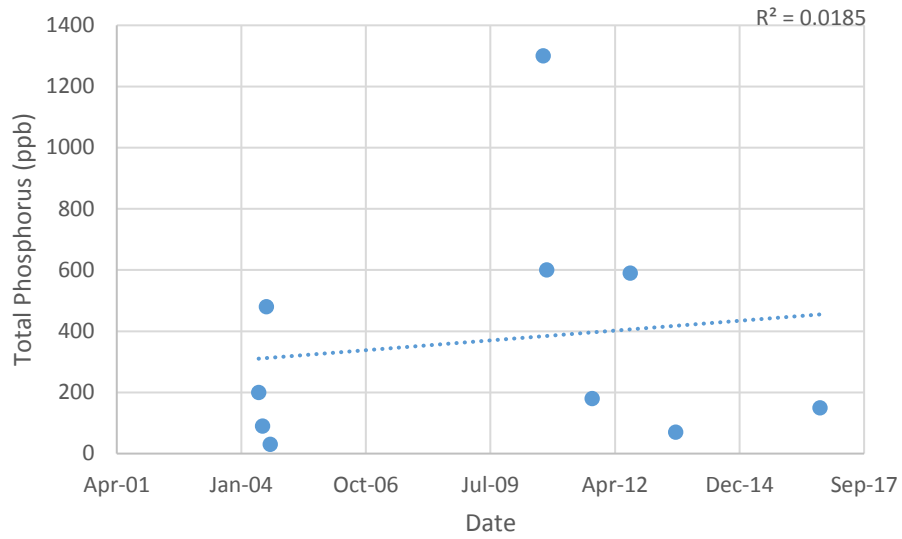


Figure 3-60: In-lake Phosphorus Concentration Trend for Hot Beach Pond.

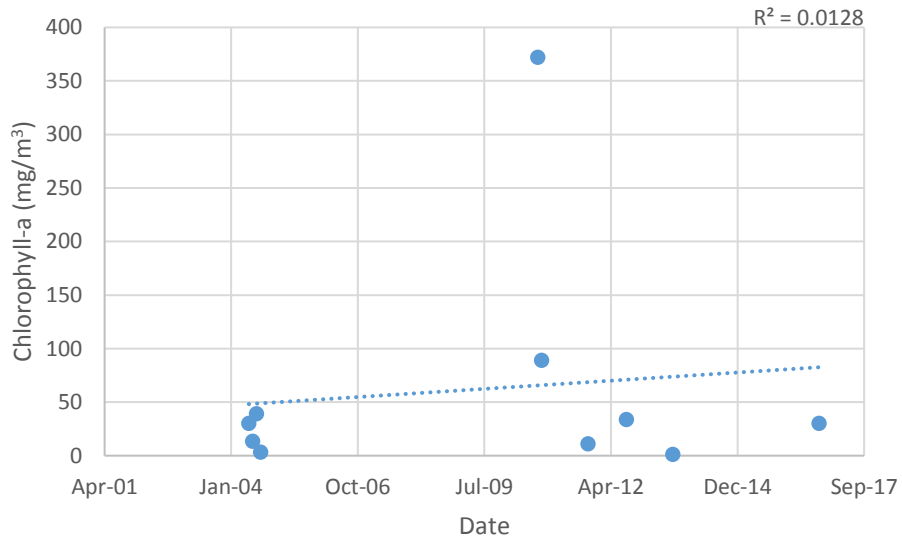


Figure 3-61: In-lake Chlorophyll-a Concentration Trend for Hot Beach Pond.

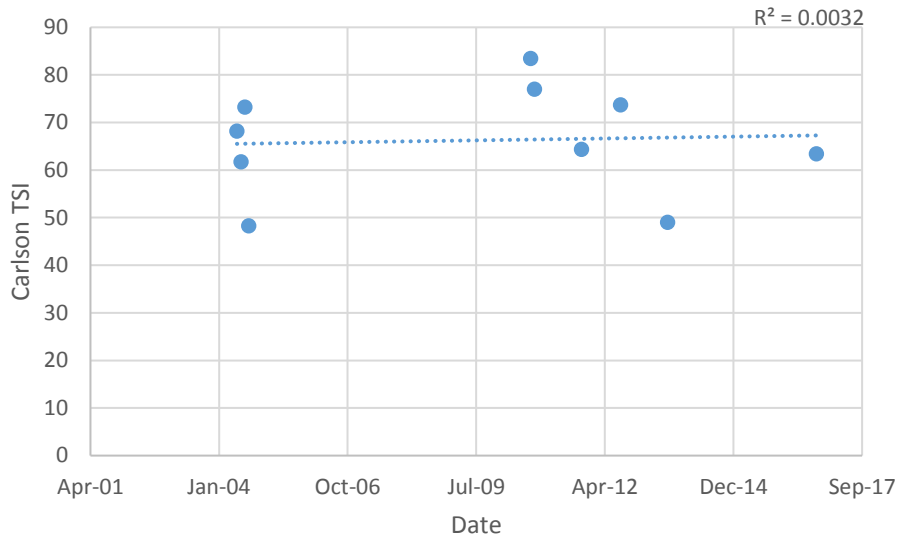


Figure 3-62: Carlson Trophic State Index Trend for Hot Beach Pond.

3.18 Hot Lake

Hot Lake has been sampled three times since 2001. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-63, Figure 3-64, and Figure 3-65 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Hot Lake increase with time. They have high R^2 values. The R^2 values for the in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index are 0.8574, 0.6242, and 0.6157 respectively. This shows correlation among the data points.

However, because there are only three data samples for Hot Lake the correlation must be looked at with some degree of skepticism. Continued sampling of the lake must be done in the coming years to confirm the correlation.

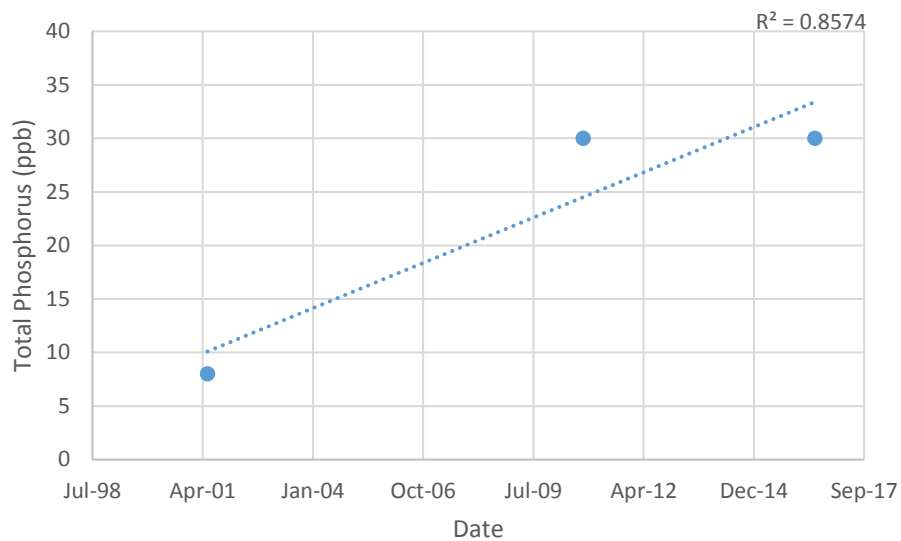


Figure 3-63: In-lake Phosphorus Concentration Trend for Hot Lake.

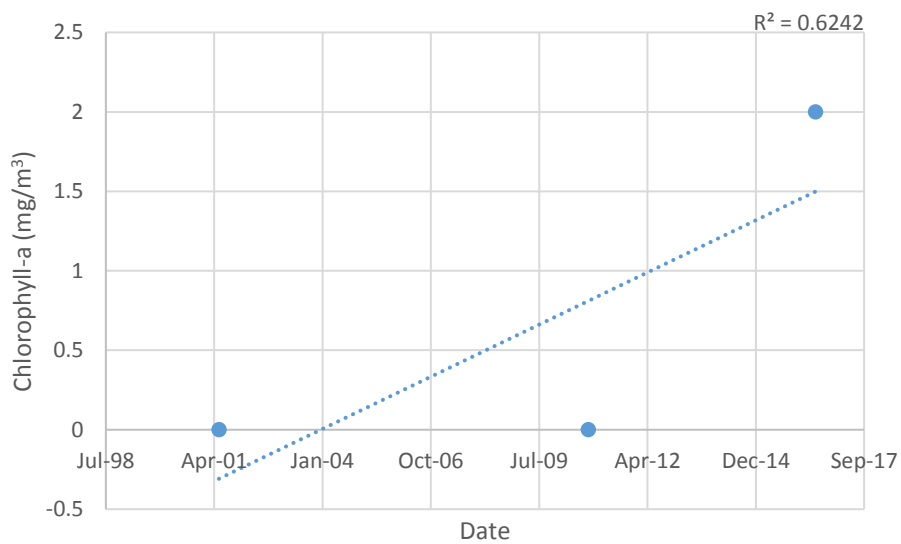


Figure 3-64: In-lake Chlorophyll-a Concentration Trend for Hot Lake.

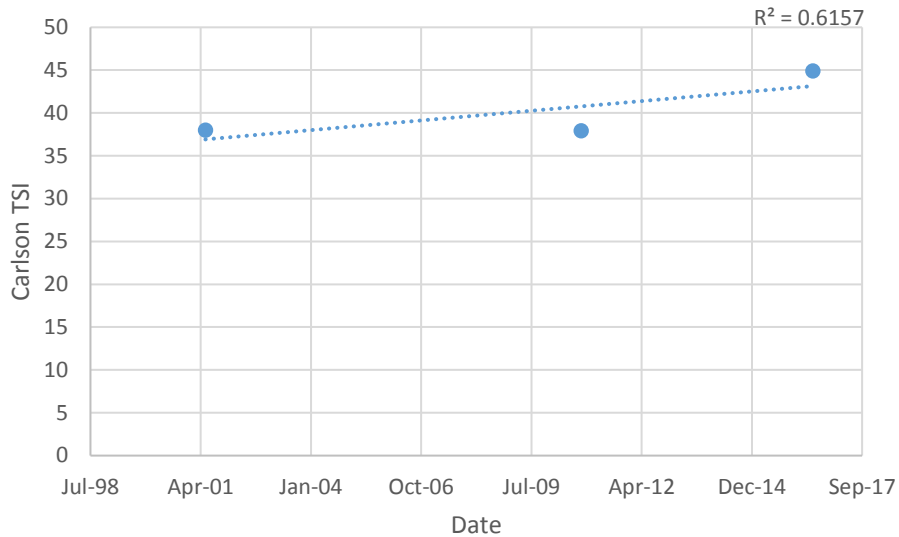


Figure 3-65: Carlson Trophic State Index Trend for Hot Lake.

3.19 Ice Lake

Ice Lake has been sampled sixteen times since 2000. Its inlet has been sampled four times, and its outlet has been sampled twice. The data for in-lake, inlet, and outlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, the inlet phosphorus, and outlet phosphorus trends are presented in Figure 3-66, Figure 3-67, Figure 3-68, Figure 3-69, and Figure 3-70 respectively.

The in-lake phosphorus concentration and Carlson trophic state index for Ice Lake both decrease with time and have low R^2 values. The chlorophyll-a concentration, and the inlet phosphorus concentration increase over time. The chlorophyll-a concentration has a low R^2 value suggesting the data may not be correlated. However, the inlet phosphorus concentration has a very high R^2 value of 0.9 indicating almost perfect correlation. This may affect the in-lake phosphorus concentration given enough time. The outlet phosphorus concentration shows a

decreasing trend; however, because only two data points are available no conclusions can be made regarding the trends significance.

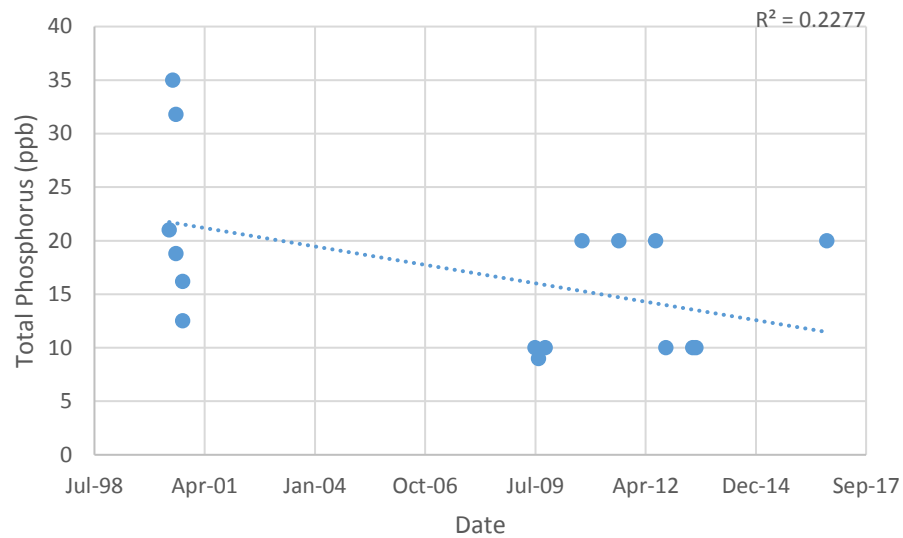


Figure 3-66: In-lake Phosphorus Concentration Trend for Ice Lake.

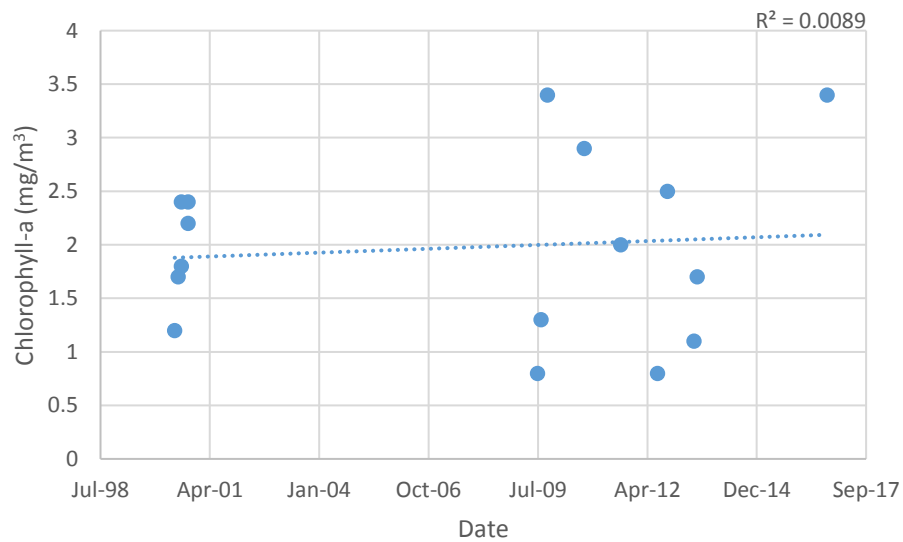


Figure 3-67: In-lake Chlorophyll-a Concentration for Ice Lake.

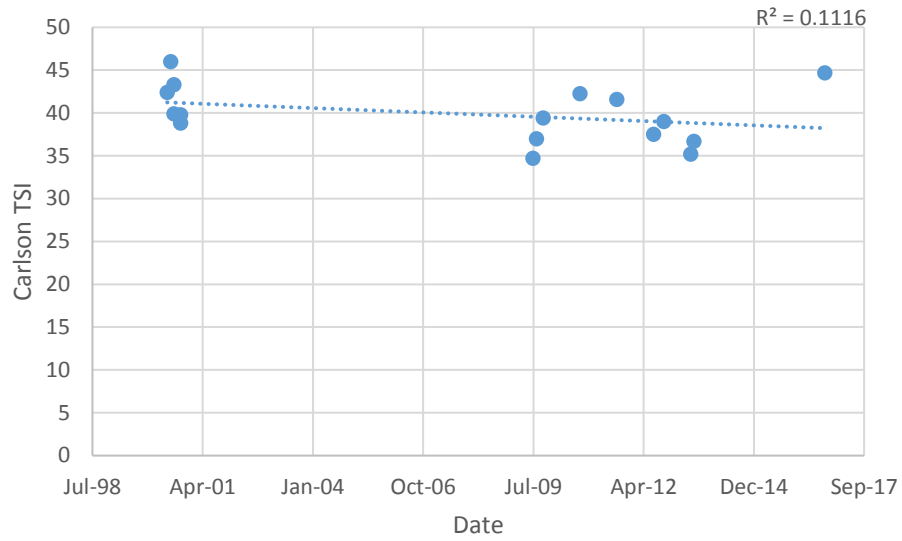


Figure 3-68: Carlson Trophic State Index Trend for Ice Lake.

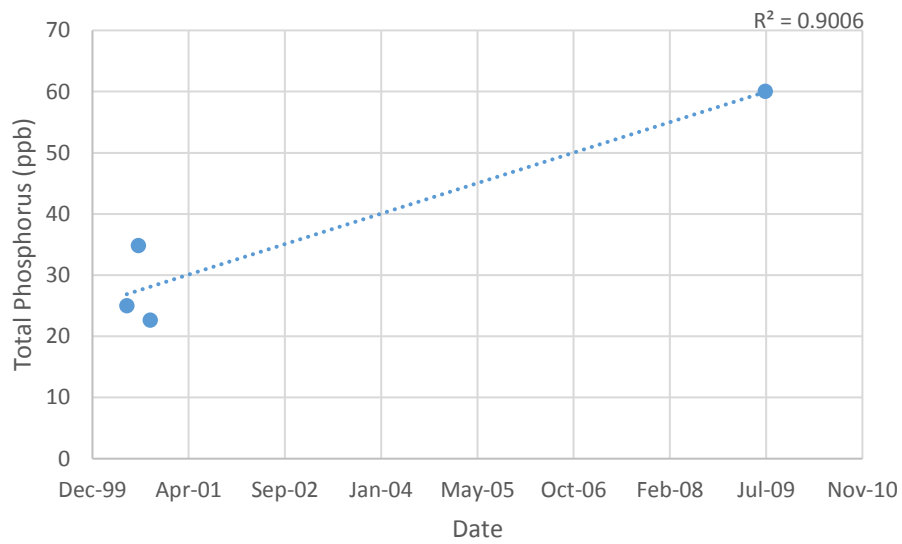


Figure 3-69: Phosphorus Concentration Trend for the Inlet of Ice Lake.

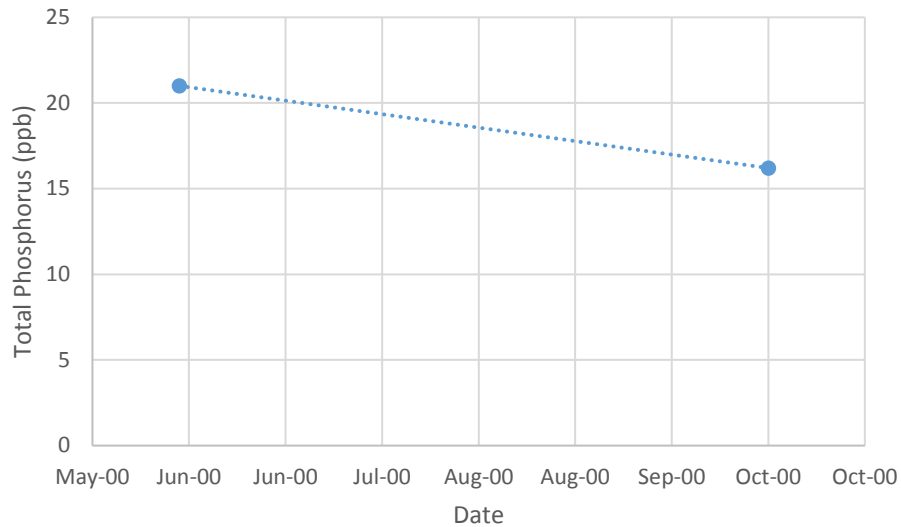


Figure 3-70: Phosphorus Concentration Trend for the Outlet of Ice Lake.

3.20 Indian Pond

Indian Pond has been sampled thirty-eight times since 2004. Its inlet has been sampled twenty-three times. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-71, Figure 3-72, Figure 3-73, and Figure 3-74 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index are fairly constant with time. The inlet phosphorus concentration for Indian Pond increases with time. They have low R^2 values suggesting there may be no correlation among the data points.

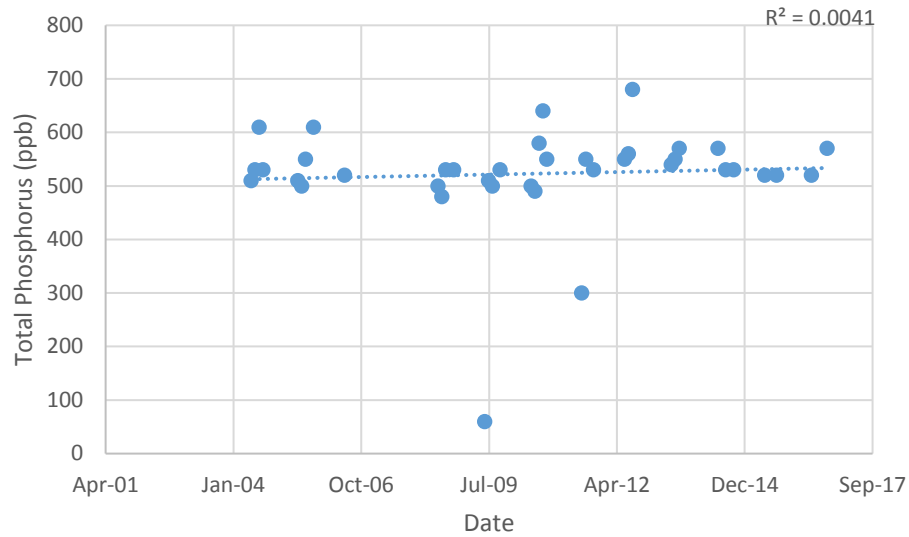


Figure 3-71: In-lake Phosphorus Concentration Trend for Indian Pond.

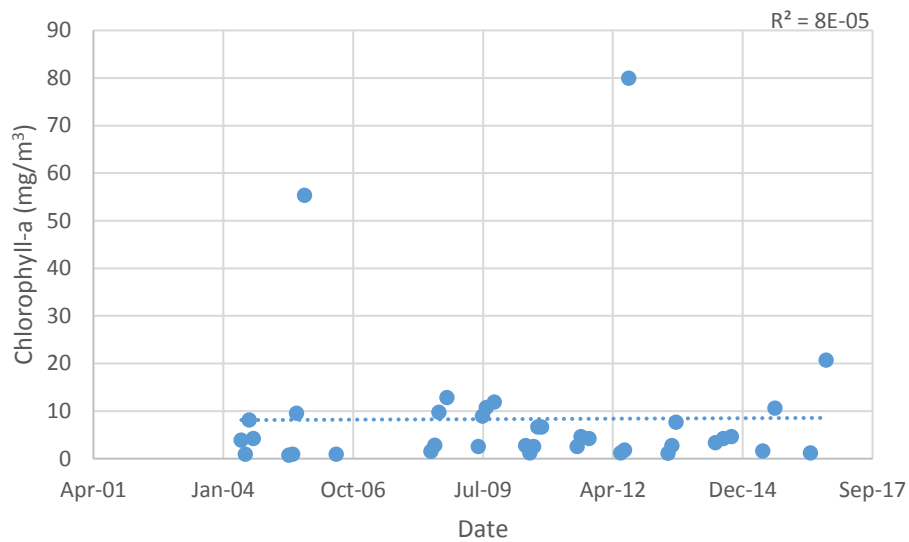


Figure 3-72: In-lake Chlorophyll-a Concentration Trend for Indian Pond.

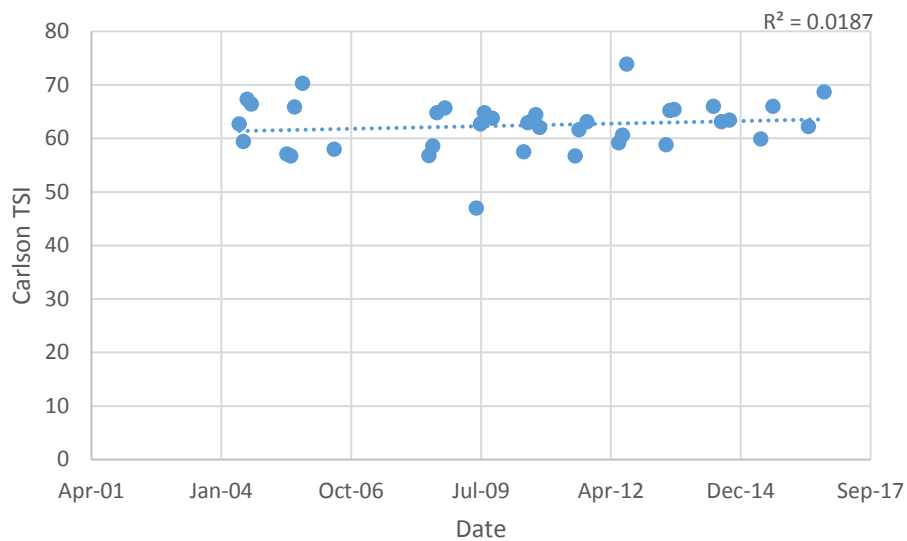


Figure 3-73: Carlson Trophic State Index Trend for Indian Pond.

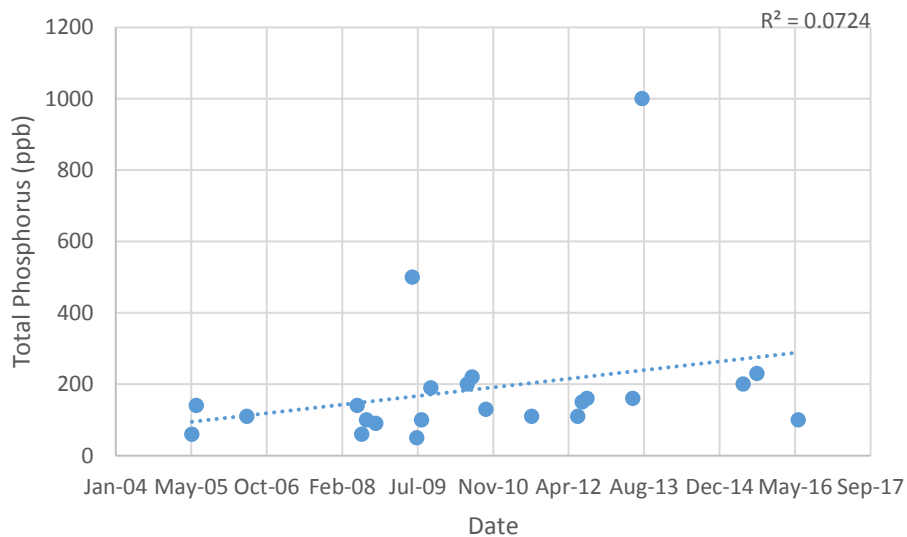


Figure 3-74: Phosphorus Concentration for the Inlet of Indian Pond.

3.21 Isa Lake

Isa Lake has been sampled six times since 1999. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order

to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-75, Figure 3-76, and Figure 3-77 respectively.

The in-lake phosphorus and chlorophyll-a concentrations decrease with time. The Carlson trophic state index for Isa Lake increases with time. All the constituents have low R^2 values suggesting there may be no correlation among the data points.

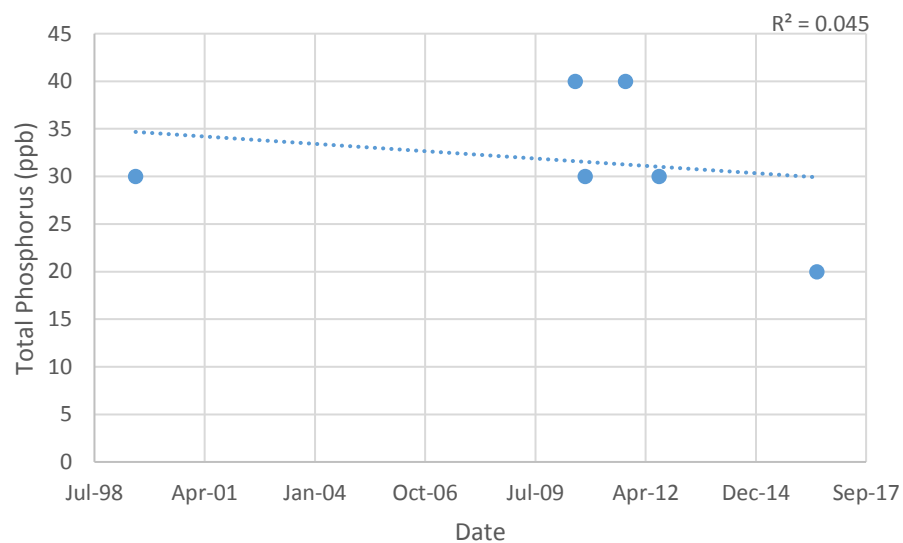


Figure 3-75: In-lake Phosphorus Concentration Trend for Isa Lake.

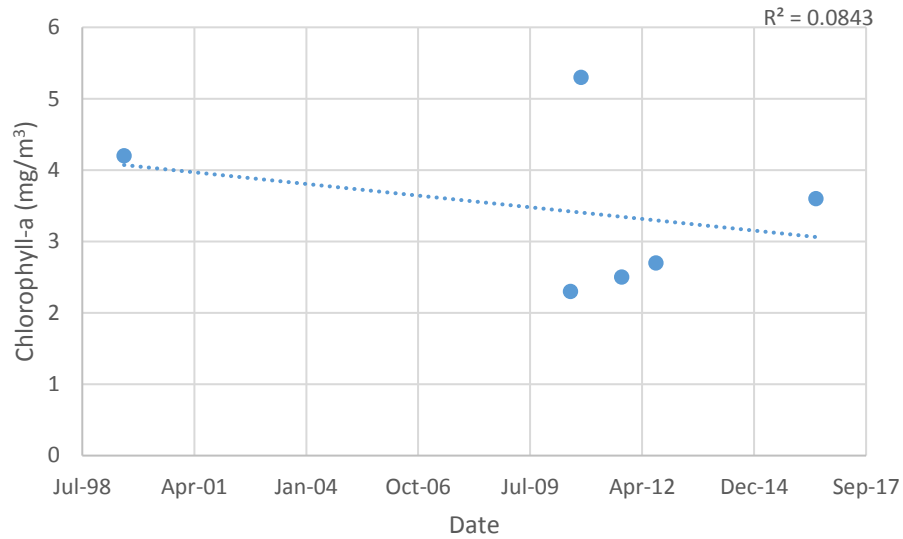


Figure 3-76: In-lake Chlorophyll-a Concentration Trend for Isa Lake.

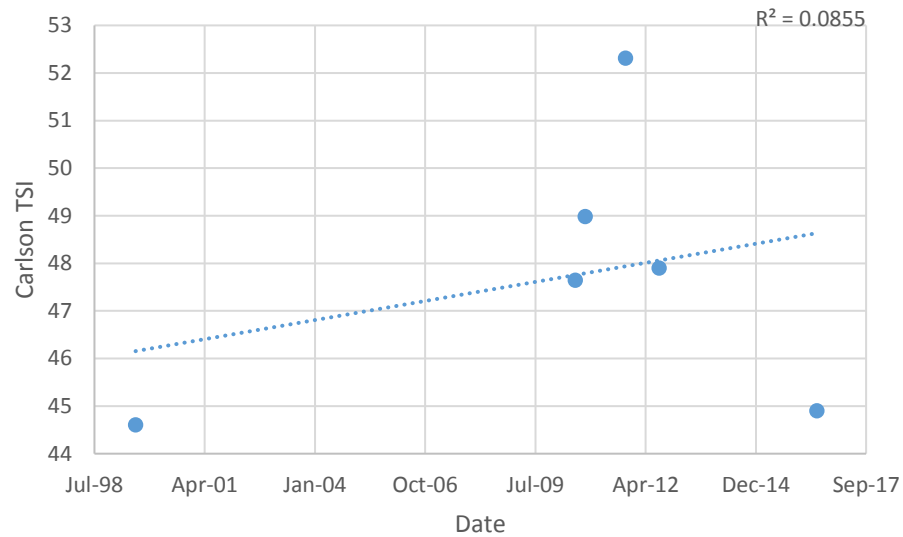


Figure 3-77: Carlson Trophic State Index Trend for Isa Lake.

3.22 Joffee Lake

Joffee Lake has been sampled twice since 2012. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order

to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-78, Figure 3-79, and Figure 3-80 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Joffee Lake show a constant trend with time. There are only two data points available for Joffee Lake so no conclusions can be made regarding the trends significance.

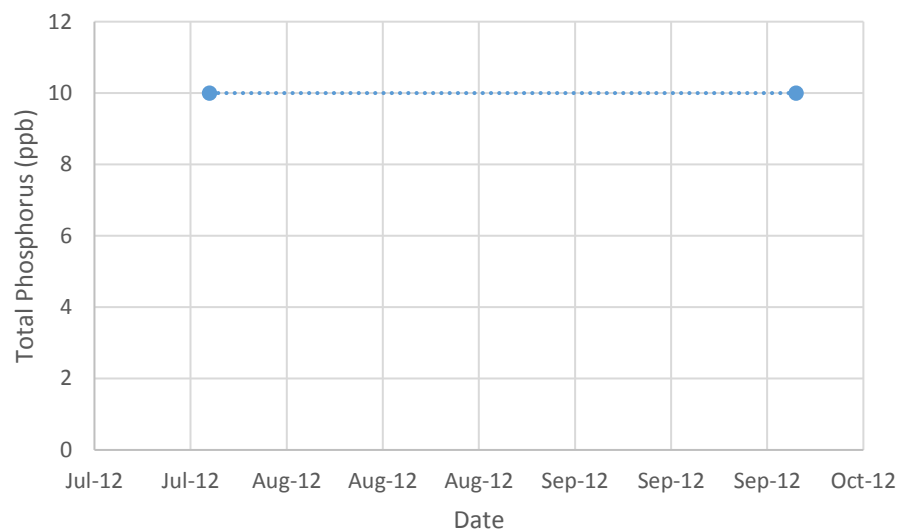


Figure 3-78: In-lake Phosphorus Concentration Trend for Joffee Lake.

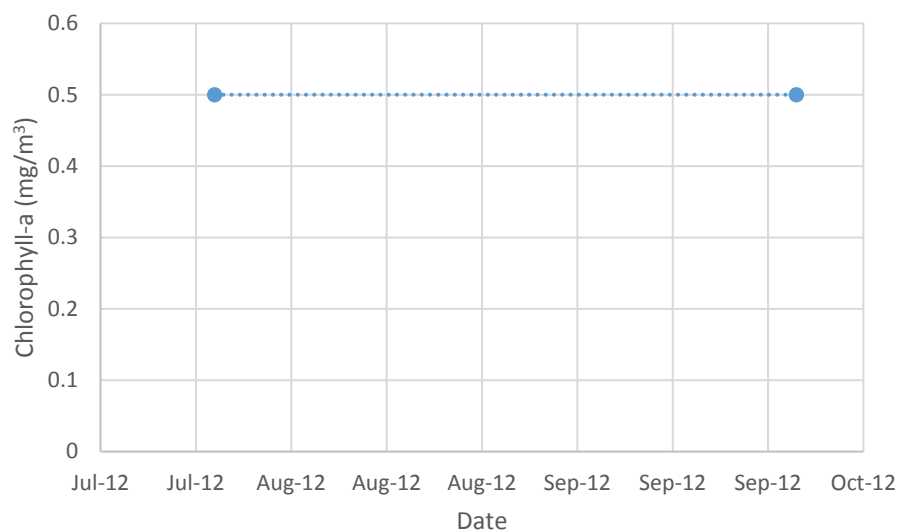


Figure 3-79: In-lake Chlorophyll-a Concentration Trend for Joffee Lake.

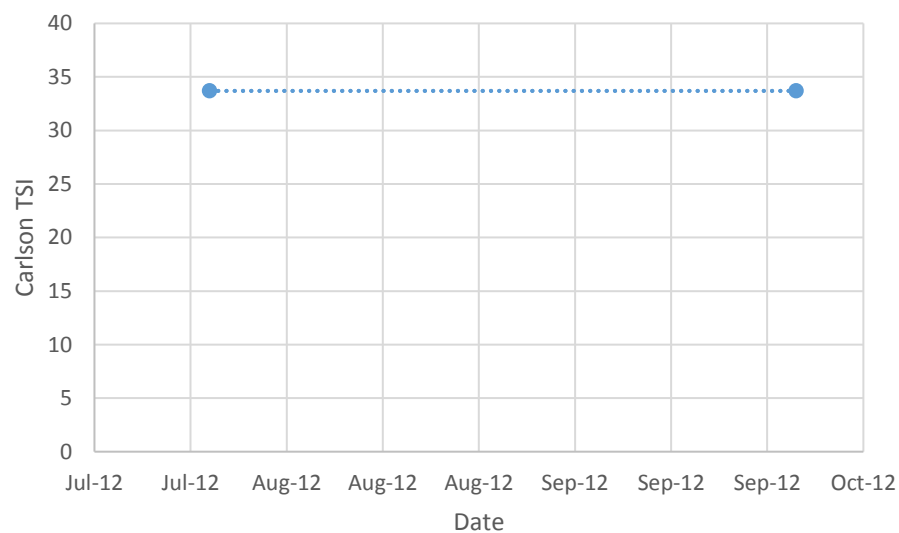


Figure 3-80: Carlson Trophic State Index Trend for Joffee Lake.

3.23 Lake of the Woods

Lake of the Woods has been sampled twice since 2012. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order

to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-81, Figure 3-82, and Figure 3-83 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Lake of the Woods show an increase with time. There are only two data points available for Lake of the Woods so no conclusions can be made regarding the trends significance.

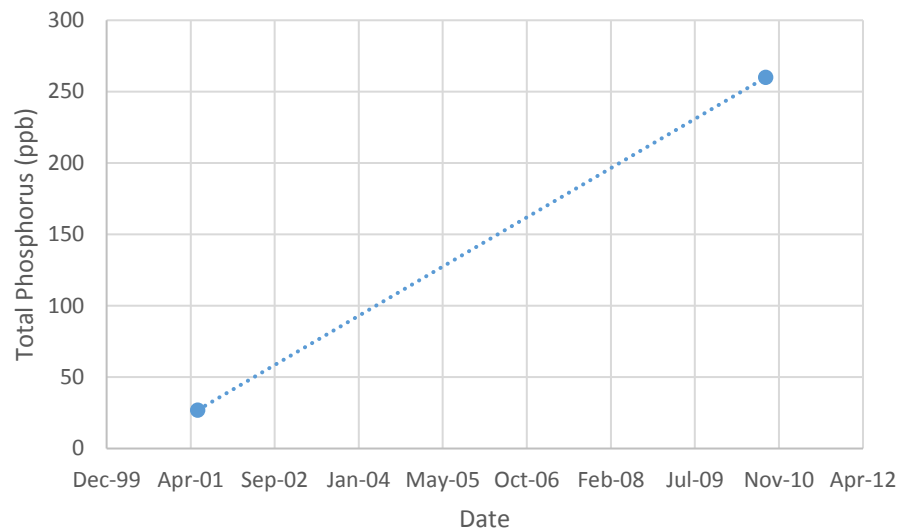


Figure 3-81: In-lake Phosphorus Concentration Trend for Lake of the Woods.

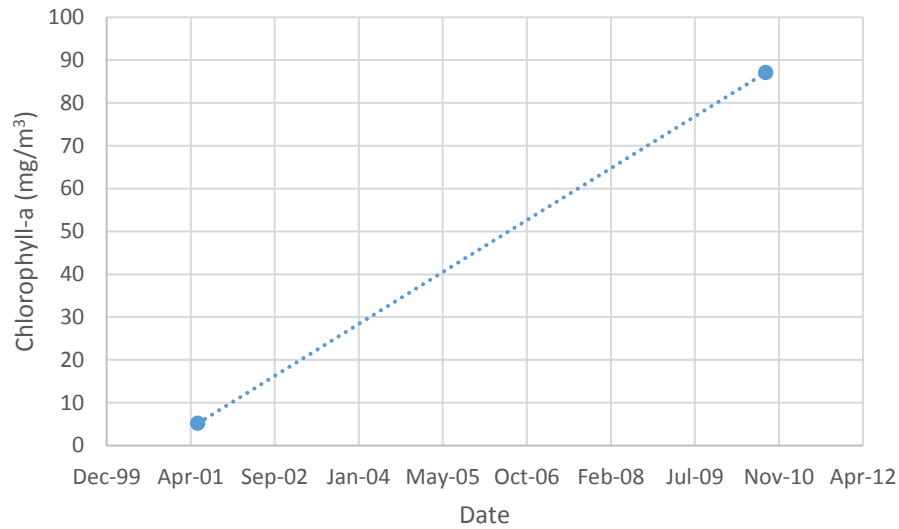


Figure 3-82: In-lake Chlorophyll-a Concentration Trend for Lake of the Woods.

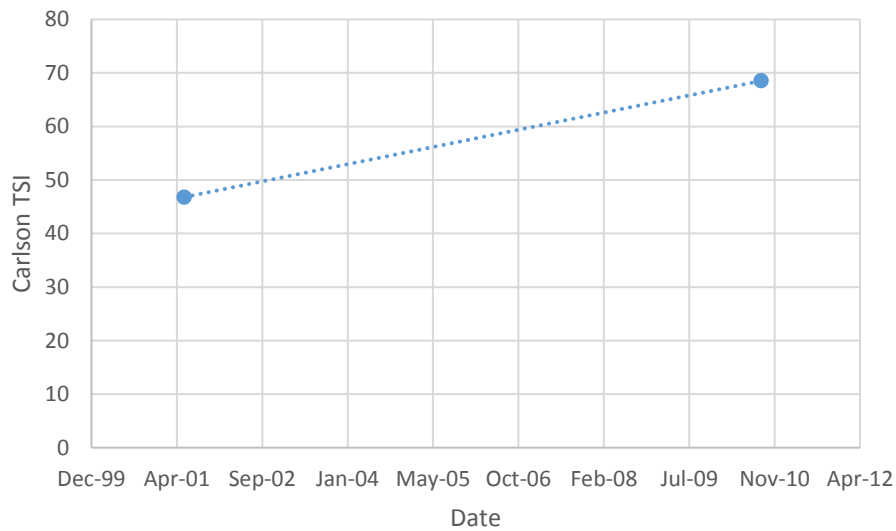


Figure 3-83: Carlson Trophic State Index Trend for Lake of the Woods.

3.24 Lewis Lake

Lewis Lake has been sampled sixteen times since 1998. Its inlet has been sampled five times. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and

Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index, and inlet phosphorus concentration trends are presented in Figure 3-84, Figure 3-85, Figure 3-86, and Figure 3-87 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index decrease with time. The inlet phosphorus concentration for Lewis Lake is constant over time. They have low R^2 values suggesting there may be no correlation among the data points.

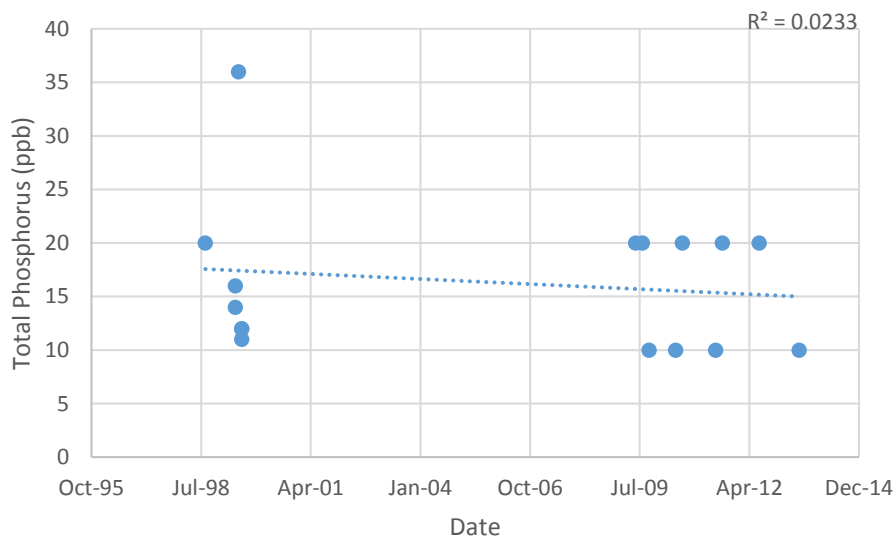


Figure 3-84: In-lake Phosphorus Concentration Trend for Lewis Lake.

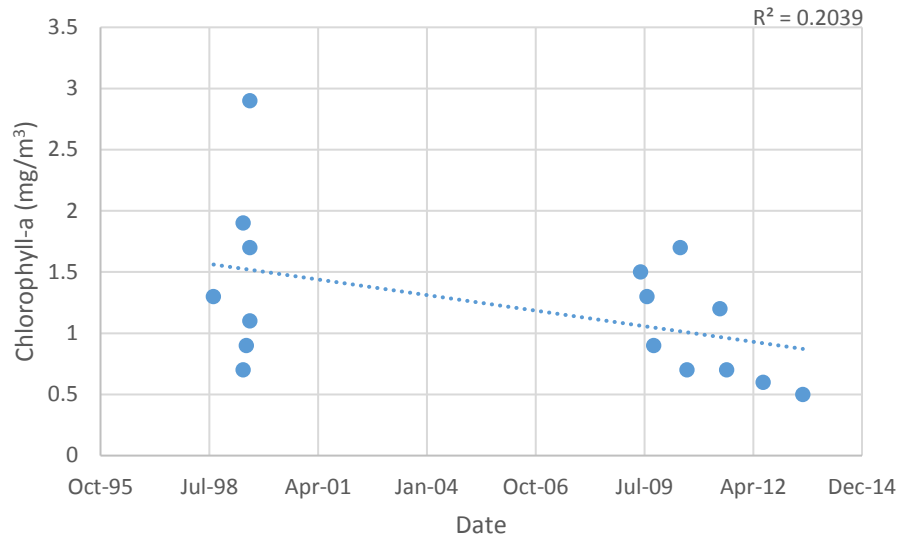


Figure 3-85: In-lake Chlorophyll-a Concentration Trend for Lewis Lake.

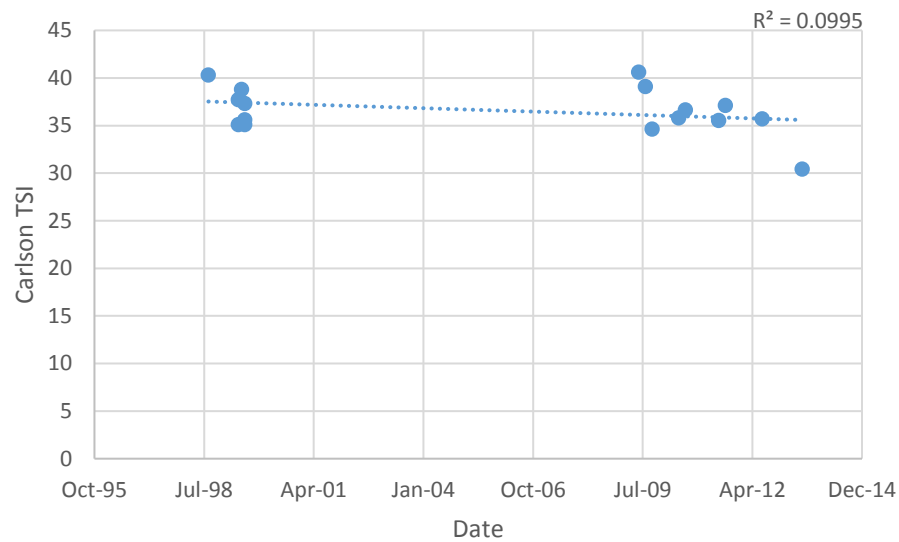


Figure 3-86: Carlson Trophic State Index Trend for Lewis Lake.

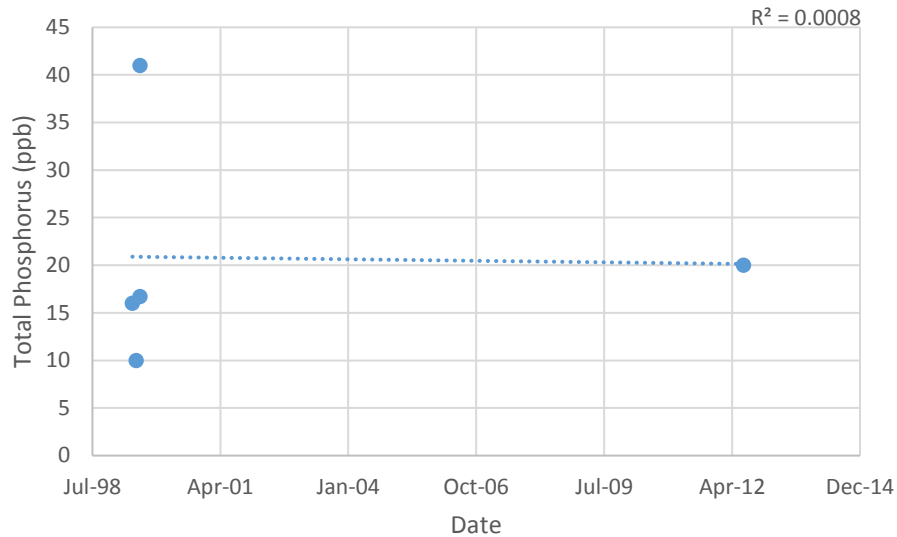


Figure 3-87: Phosphorus Concentration Trend for the Inlet of Lewis Lake.

3.25 Lily Pad Lake

Lily Pad Lake has been sampled twenty-five times since 1998. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-88, Figure 3-89, and Figure 3-90 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Lily Pad Lake increase with time. They have low R^2 values suggesting there may be no correlation among the data points.



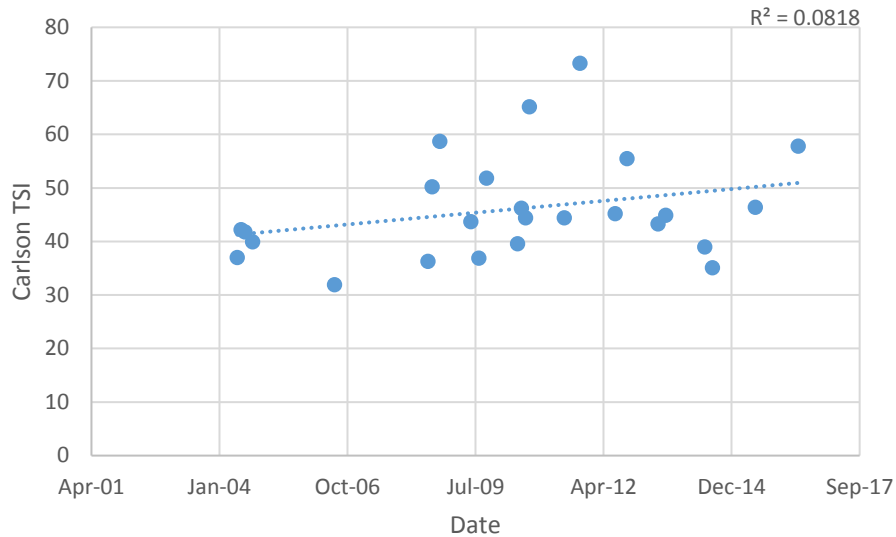


Figure 3-90: Carlson Trophic State Index Trend for Lily Pad Lake.

3.26 Lost Lake

Lost Lake has been sampled thirty-six times since 2004. Its inlet has been sampled sixteen times. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and inlet phosphorus concentration trends are presented in Figure 3-91, Figure 3-92, Figure 3-93, and Figure 3-94 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, Carlson trophic state index, and inlet phosphorus concentration for Lost Lake decrease with time. They have low R^2 values suggesting there may be no correlation among the data points.



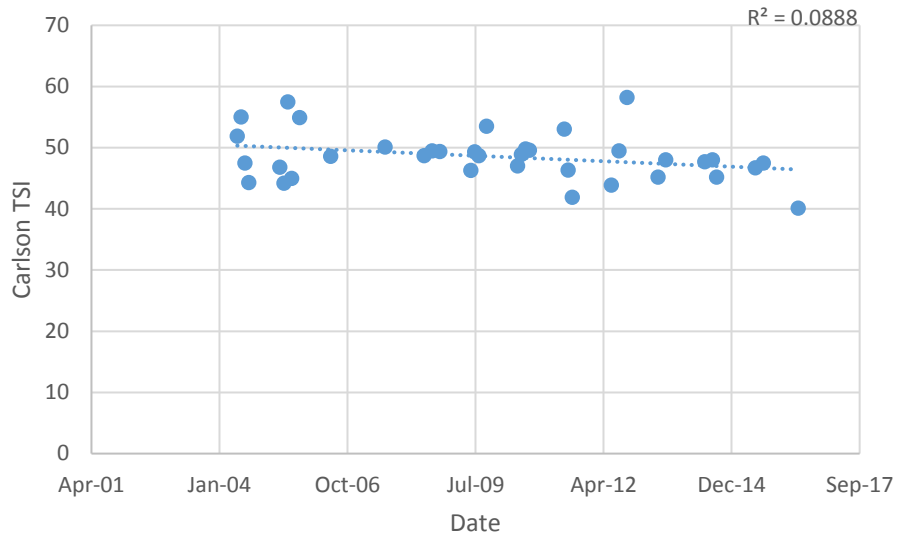


Figure 3-93: Carlson Trophic State Index Trend for Lost Lake.

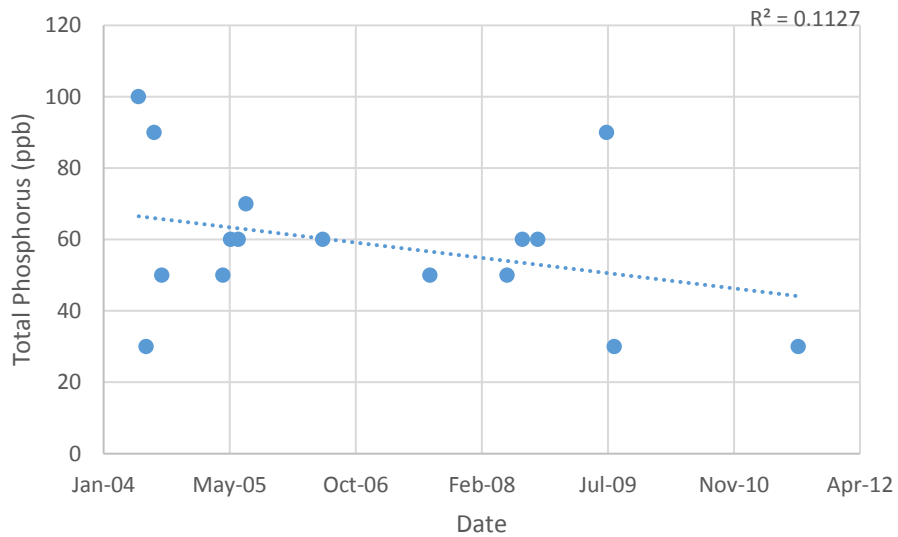


Figure 3-94: Phosphorus Concentration Trend for the Inlet of Lost Lake.

3.27 Lower Basin Lake

Lower Basin Lake has been sampled ten times since 2012. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order

to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-95, Figure 3-96, and Figure 3-97 respectively.

The in-lake phosphorus concentration and Carlson trophic state index trend for Lower Basin Lake decrease with time while the chlorophyll-a concentration increases. All of the constituents have low R^2 values suggesting there may be no correlation among the data points.

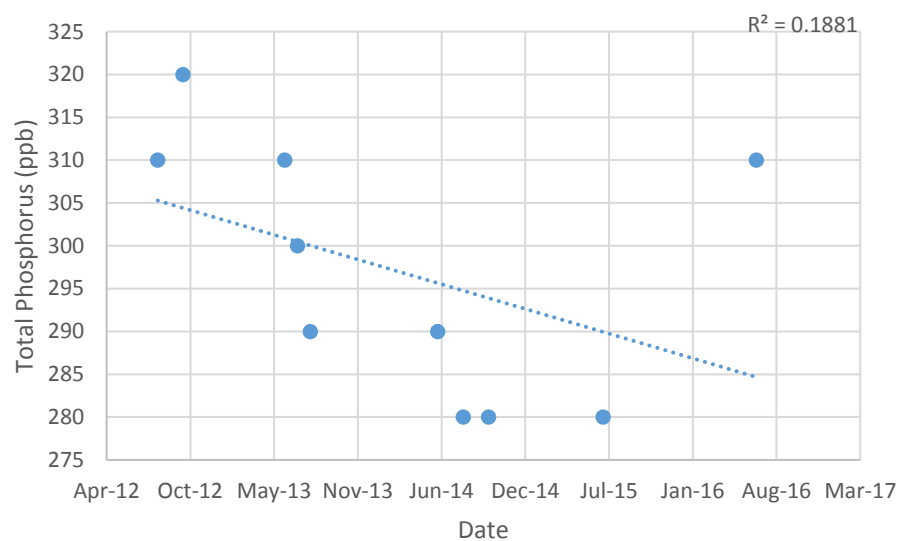


Figure 3-95: In-lake Phosphorus Concentration Trend for Lower Basin Lake.

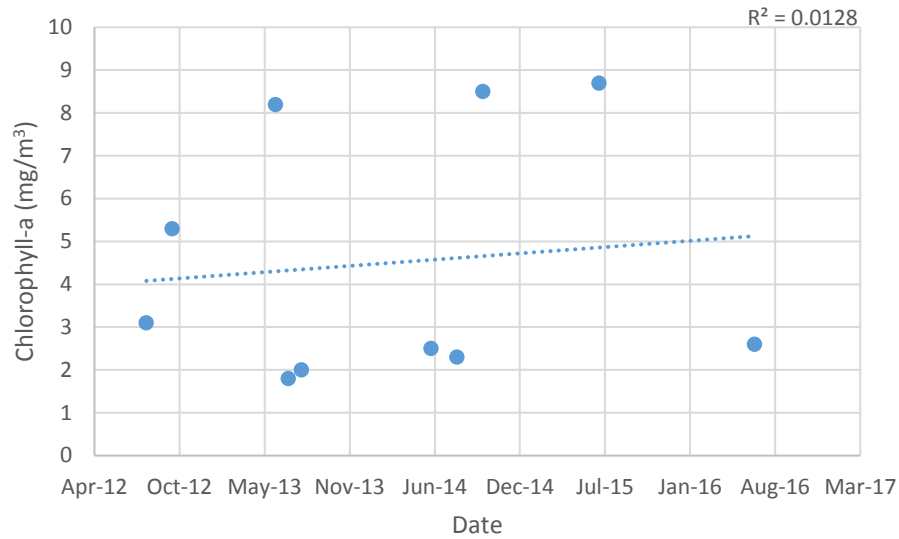


Figure 3-96: In-lake Chlorophyll-a Concentration Trend for Lower Basin Lake.

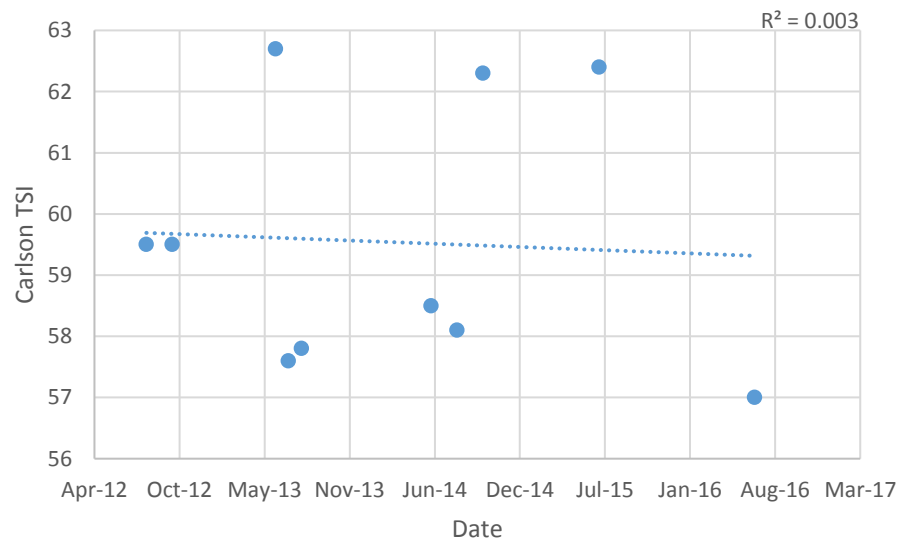


Figure 3-97: Carlson Trophic State Index Trend for Lower Basin Lake.

3.28 North Twin Lake

North Twin Lake and its inlet have been sampled twenty-three times since 2001. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic

The in-lake phosphorus concentration, Carlson trophic state index, and inlet phosphorus concentration for North Twin Lake increase with time. The chlorophyll-a concentration remains constant with time. All the constituents have low R^2 values suggesting there may be no correlation among the data points.





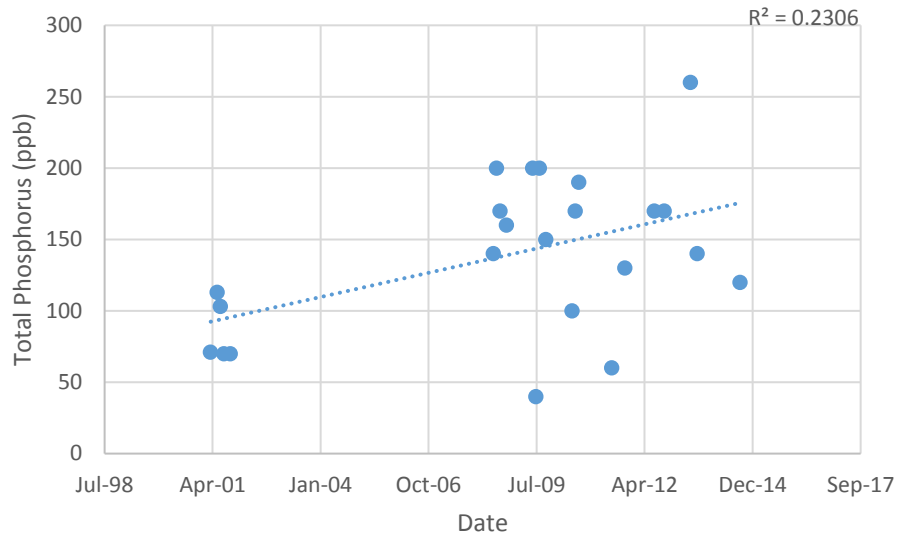


Figure 3-101: Phosphorus Concentration Trend for the Inlet of North Twin Lake.

3.29 Nymph Lake

Nymph Lake and its inlet have been sampled nineteen times since 2001. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and inlet phosphorus concentration trends are presented in Figure 3-102, Figure 3-103, Figure 3-104, and Figure 3-105 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and inlet phosphorus concentration for Nymph Lake all increase with time. The Carlson trophic state index trend appears to remain constant with time. All the constituents have low R^2 values suggesting there may be no correlation among the data points.

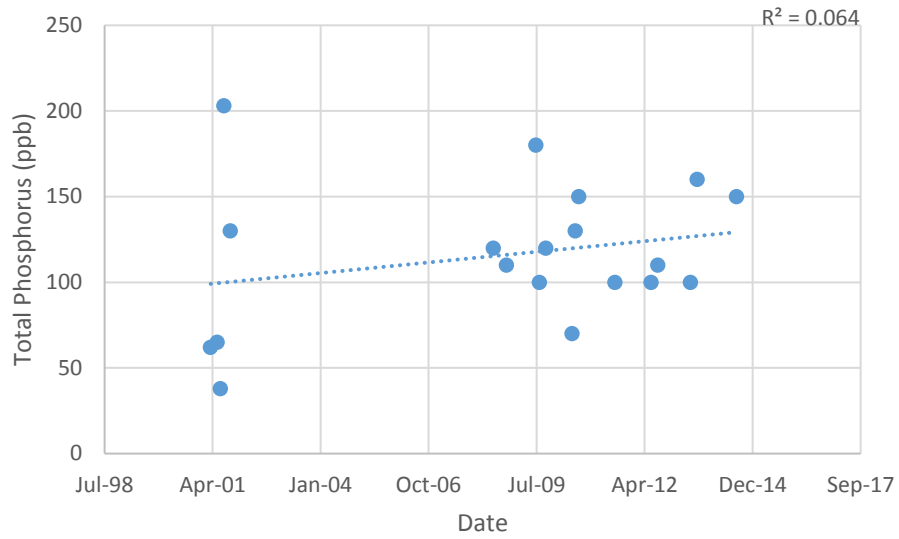


Figure 3-102: In-lake Phosphorus Concentration Trend for Nymph Lake.

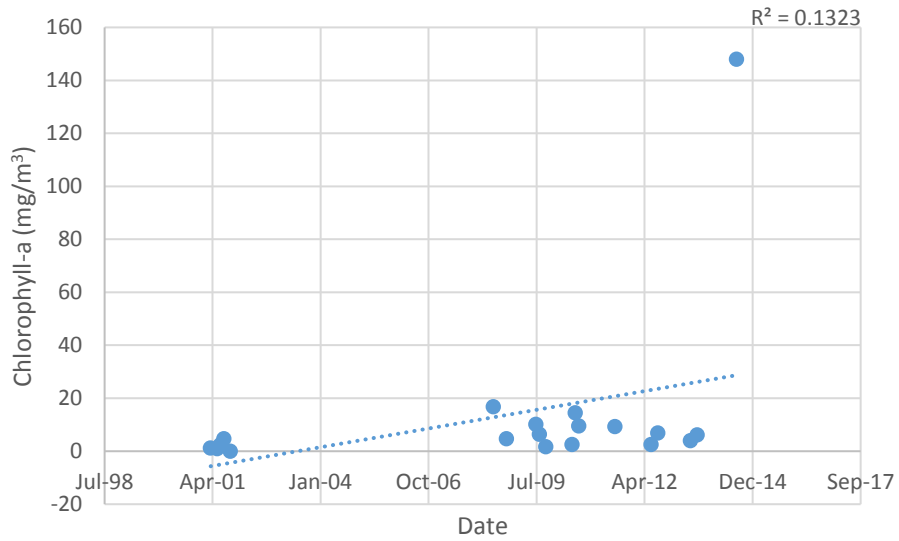


Figure 3-103: In-lake Chlorophyll-a Concentration Trend for Nymph Lake.

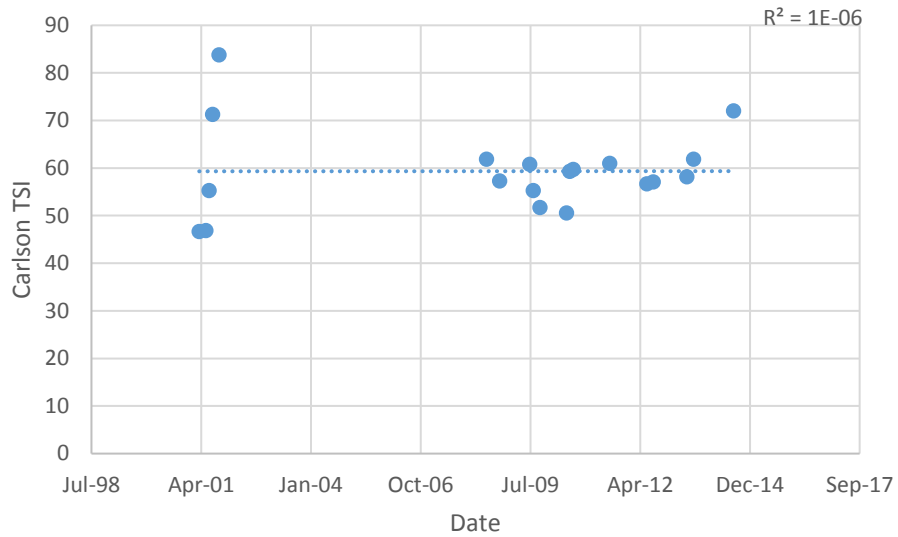


Figure 3-104: Carlson Trophic State Index Trend for Nymph Lake.

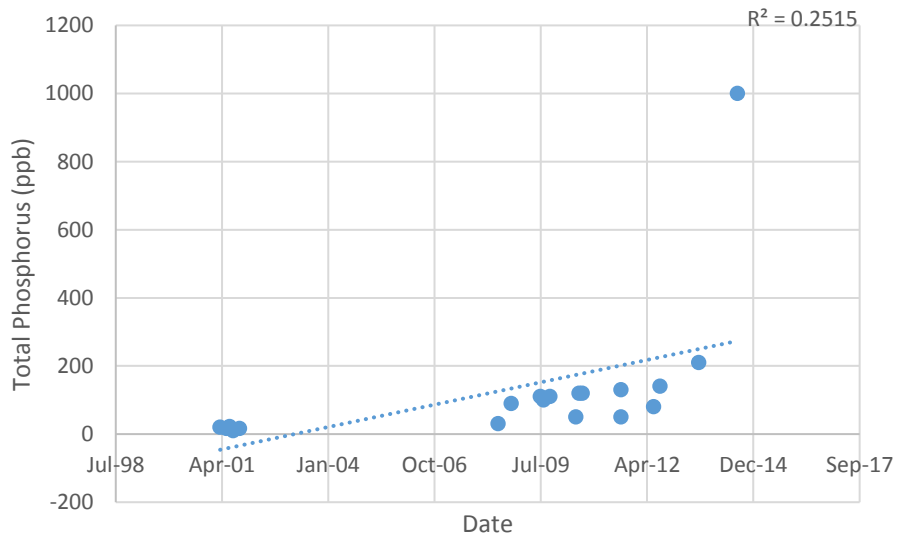


Figure 3-105: Phosphorus Concentration Trend for the Inlet of Nymph Lake.

3.30 Petrified Tree Stream

Petrified Tree Stream has been sampled three times since 2012. Since this body of water was a stream and not a lake or pond it was only sampled for phosphorus concentration. The data

for Petrified Tree Stream were plotted in order to determine the trend. The phosphorus concentration trend is presented in Figure 3-106.

The phosphorus concentration for Petrified Tree Stream decreases with time. It has an R^2 value of 0.2503 suggesting there may be no correlation among the data points. However, because of the small amount of data available no conclusions can be made regarding the trends significance.

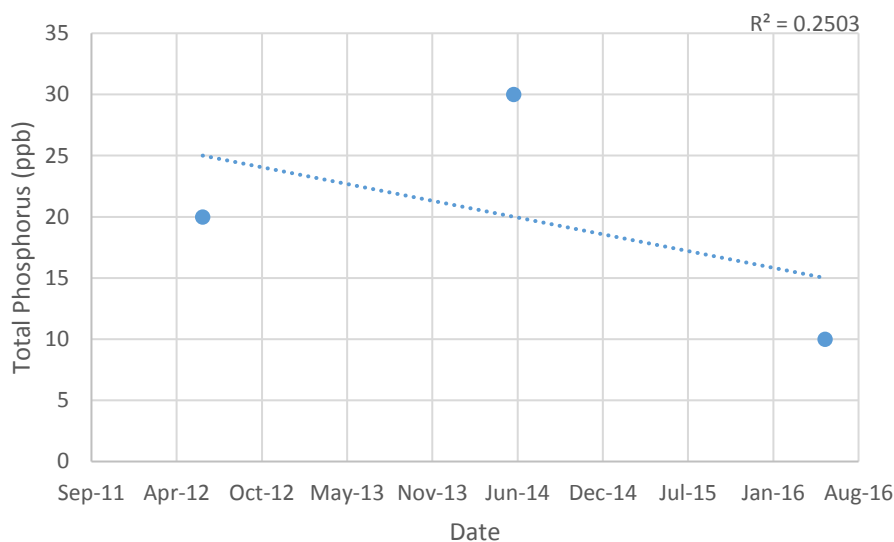


Figure 3-106: Phosphorus Concentration for Petrified Tree Stream.

3.31 Pool by Morning Glory Pool

Pool by Morning Glory Pool has been sampled three times since 2001. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-107, Figure 3-108, and Figure 3-109 respectively.

The in-lake phosphorus concentration and Carlson trophic state index for the Pool show an increase with time. The R^2 values for in-lake phosphorus and Carlson trophic state index are both very high. Each is over 0.9. This shows almost perfect correlation. With these constituents increasing, the lake may be progressing in the eutrophication process. The chlorophyll-a concentration decreases over time and has an R^2 value of 0.496. This shows some correlation but it is not as significant as the phosphorus and Carlson trophic state.

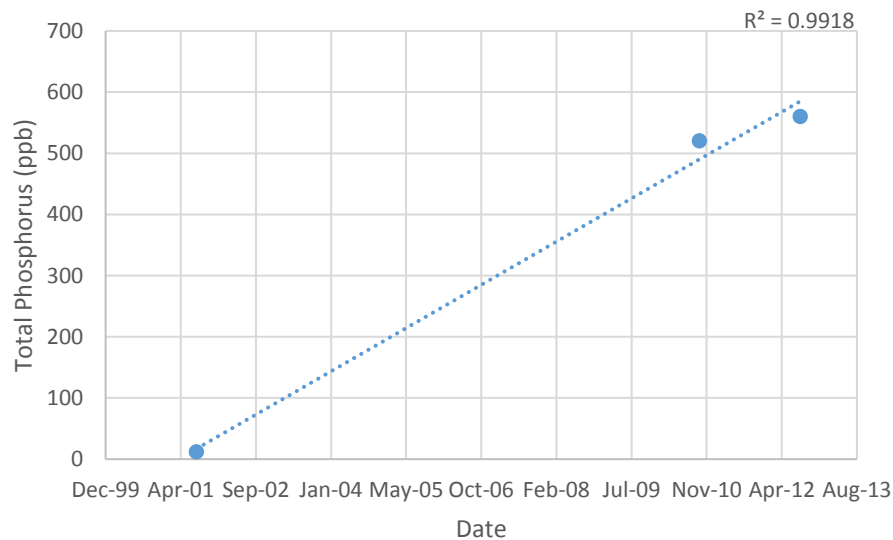


Figure 3-107: In-lake Phosphorus Concentration Trend for Pool by Morning Glory Pool.

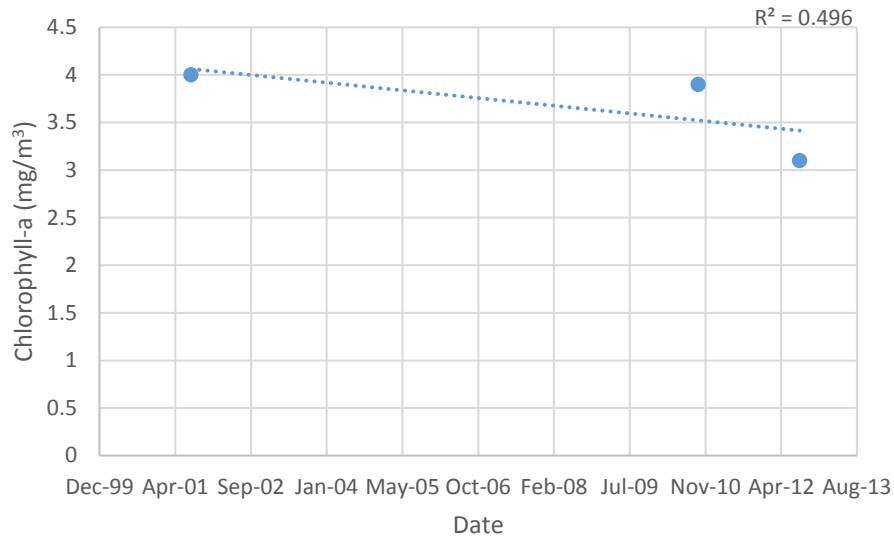


Figure 3-108: In-lake Chlorophyll-a Concentration Trend for Pool by Morning Glory Pool.

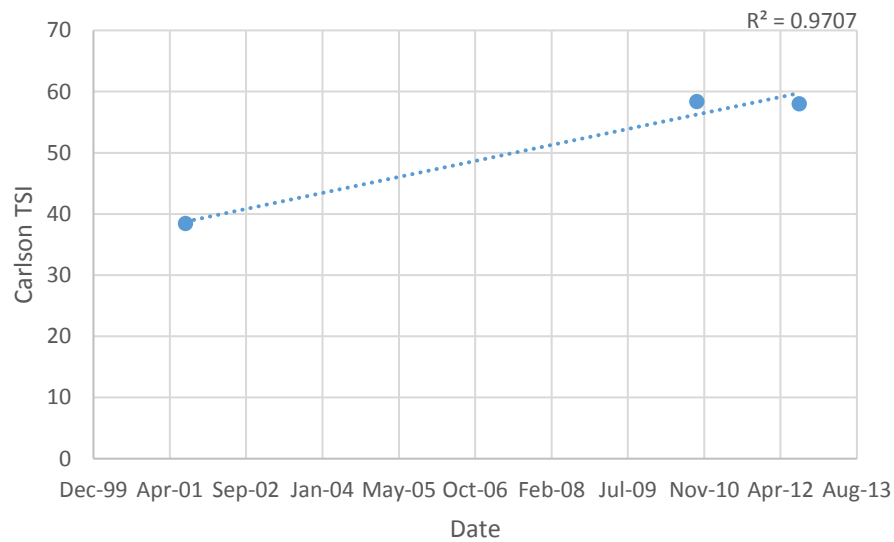


Figure 3-109: Carlson Trophic State Index Trend for Pool by Morning Glory Pool.

3.32 Ribbon Lake

Ribbon Lake has been sampled four times since 2006. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order

to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-110, Figure 3-111, and Figure 3-112 respectively.

The in-lake phosphorus concentration shows a downward trend with an R^2 value of 0.752. This shows good correlation between the data and time. The chlorophyll-a concentration has an upward trend and a R^2 value of 0.2621. This indicates that there is not much correlation between the chlorophyll-a concentration and the change in time. The Carlson trophic state index trend for Ribbon Lake also decreases with time. It has a R^2 value of 0.4161 suggesting a slight correlation among the data points. However, because of the small amount of data available no conclusions can be made regarding the trends significance.

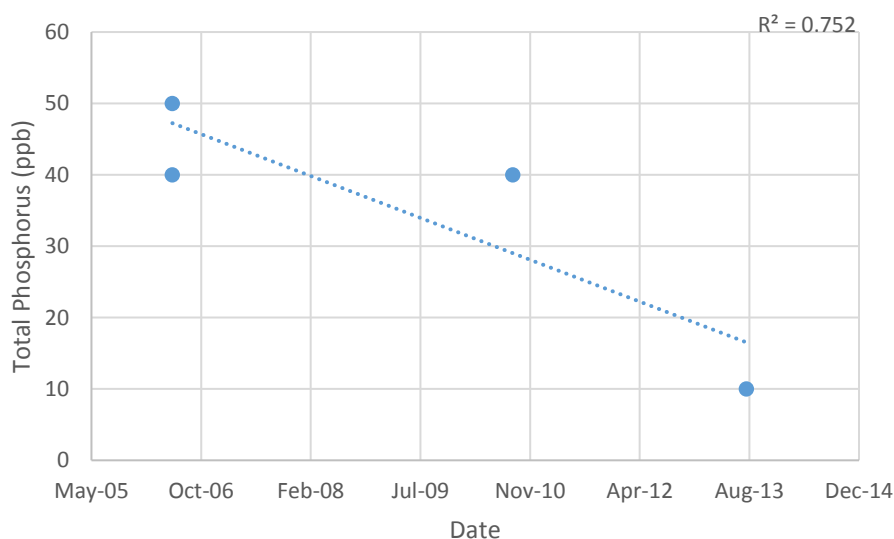


Figure 3-110: In-lake Phosphorus Concentration Trend for Ribbon Lake.

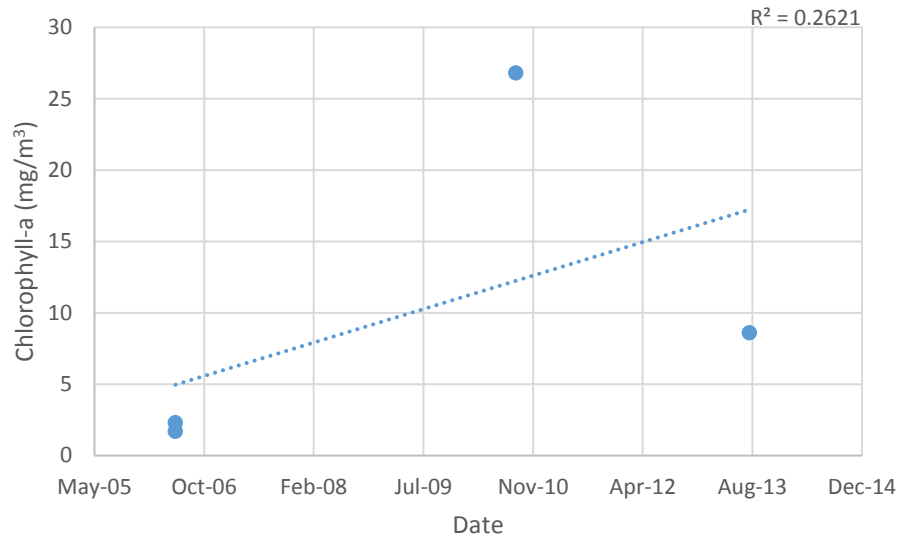


Figure 3-111: In-lake Chlorophyll-a Concentration Trend for Ribbon Lake.

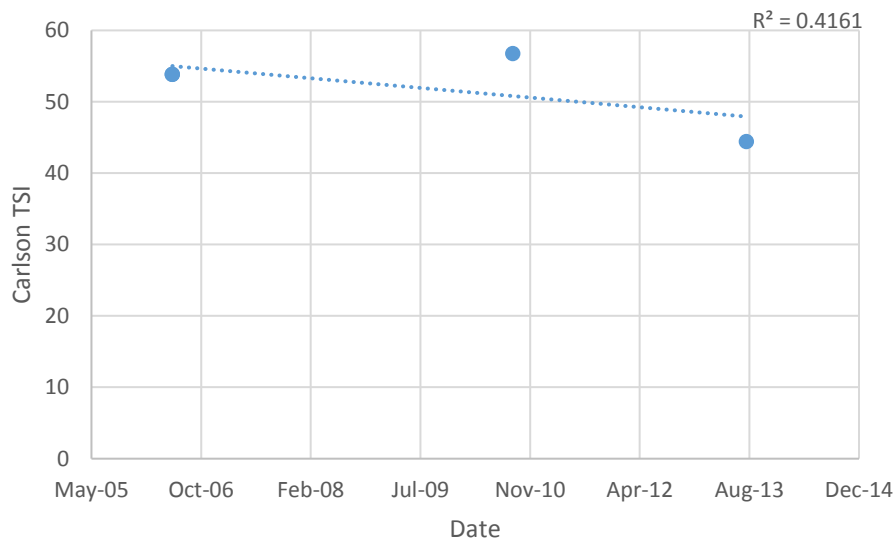


Figure 3-112: Carlson Trophic State Index Trend for Ribbon Lake.

3.33 Riddle Lake

Riddle Lake has been sampled four times since 1999. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order

to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-113, Figure 3-114, and Figure 3-115 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Riddle Lake increase with time. They have high R^2 values suggesting correlation among the data points. This indicates that Riddle Lake could be advancing in the eutrophication process.

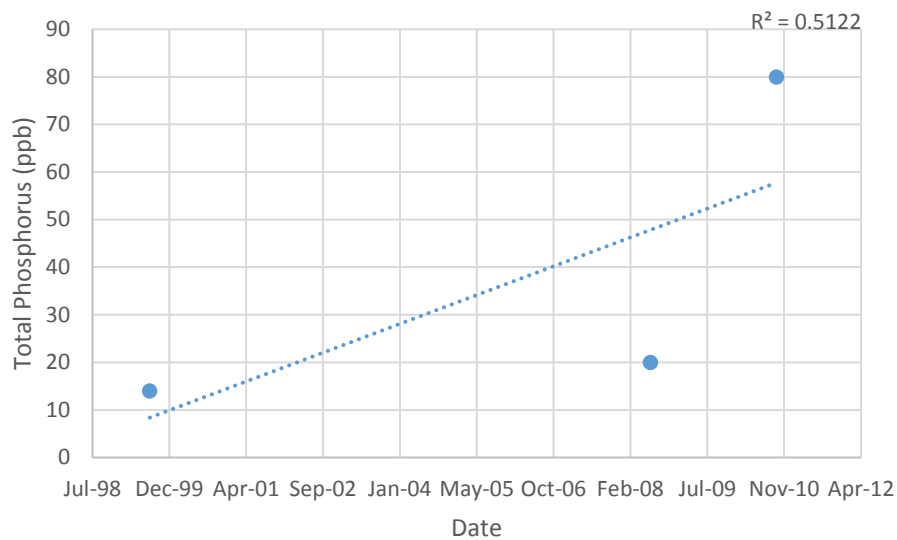


Figure 3-113: In-lake Phosphorus Concentration Trend for Riddle Lake.

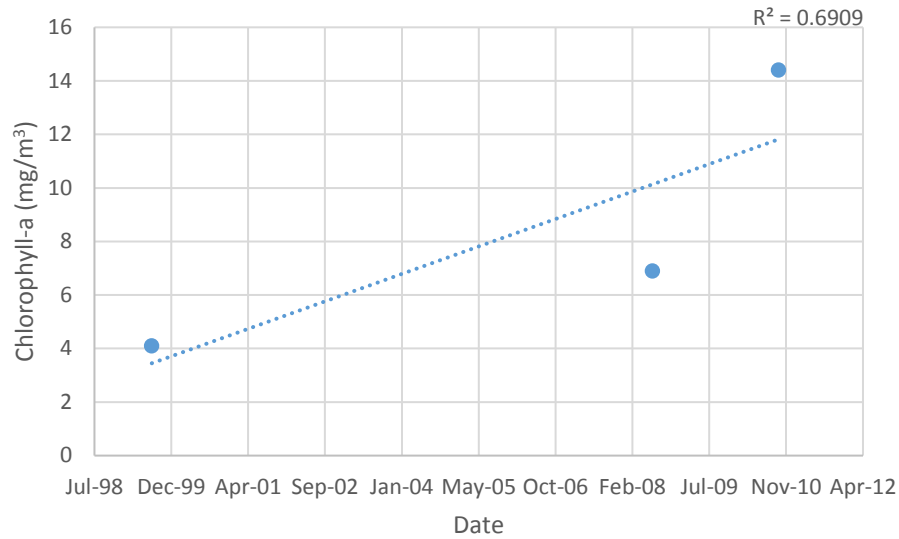


Figure 3-114: In-lake Chlorophyll-a Concentration Trend for Riddle Lake.

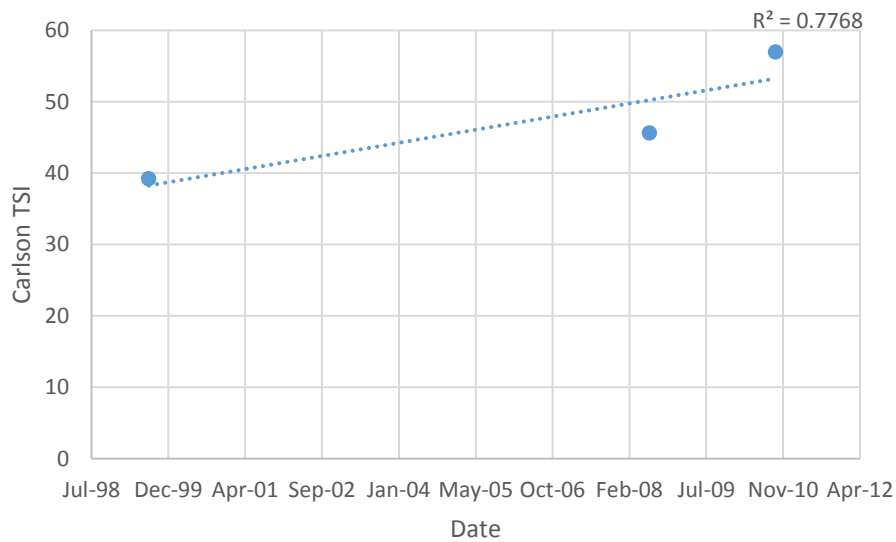


Figure 3-115: Carlson Trophic State Index Trend for Riddle Lake.

3.34 Scaup Lake

Scaup Lake has been sampled six times since 2002. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order

to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-116, Figure 3-117, and Figure 3-118 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Scaup Lake increase with time. They have R^2 values of roughly 0.4 suggesting some correlation among the data points. This indicates that Scaup Lake could be advancing in the eutrophication process.

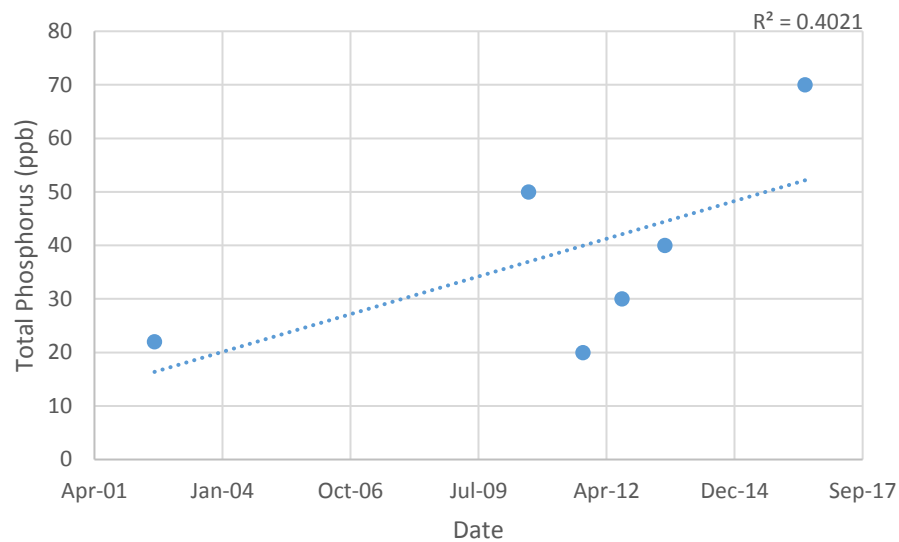


Figure 3-116: In-lake Phosphorus Concentration Trend for Scaup Lake.

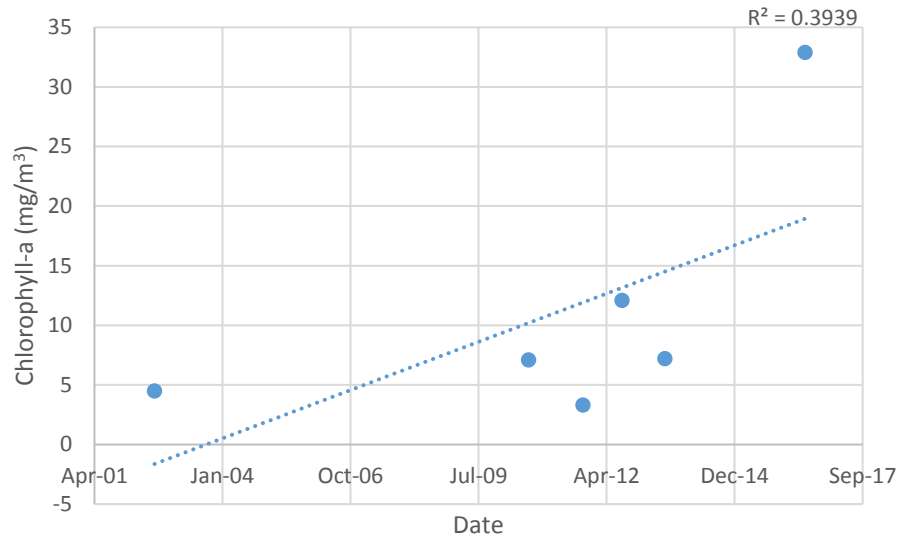


Figure 3-117: In-lake Chlorophyll-a Concentration Trend for Scaup Lake.

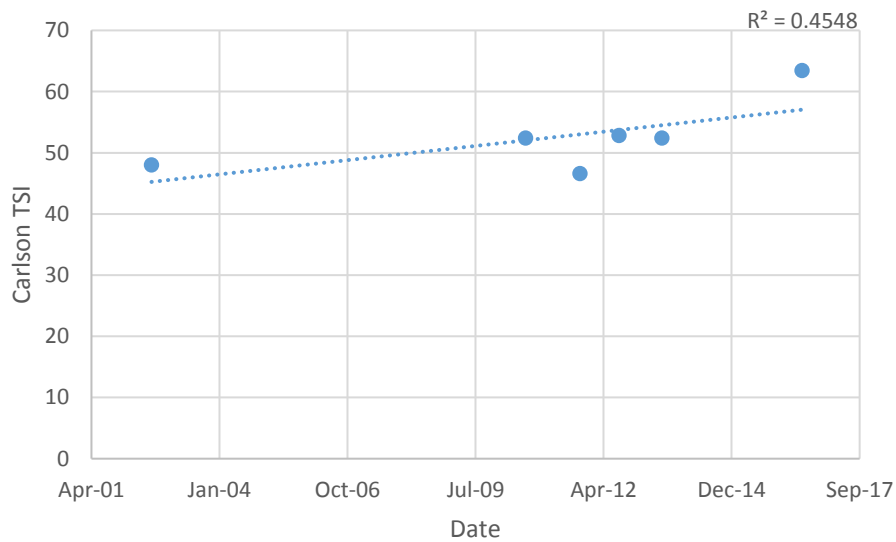


Figure 3-118: Carlson Trophic State Index Trend for Scaup Lake.

3.35 Shoshone Lake

Shoshone Lake has been sampled seven times since 1998. Its inlet has been sampled four times. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and

Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and inlet phosphorus concentration trends are presented in Figure 3-71, Figure 3-72, Figure 3-73, and Figure 3-74 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Shoshone Lake all decrease with time while the inlet phosphorus concentration is constant. They all have a low R^2 value suggesting there may be no correlation among the data points.

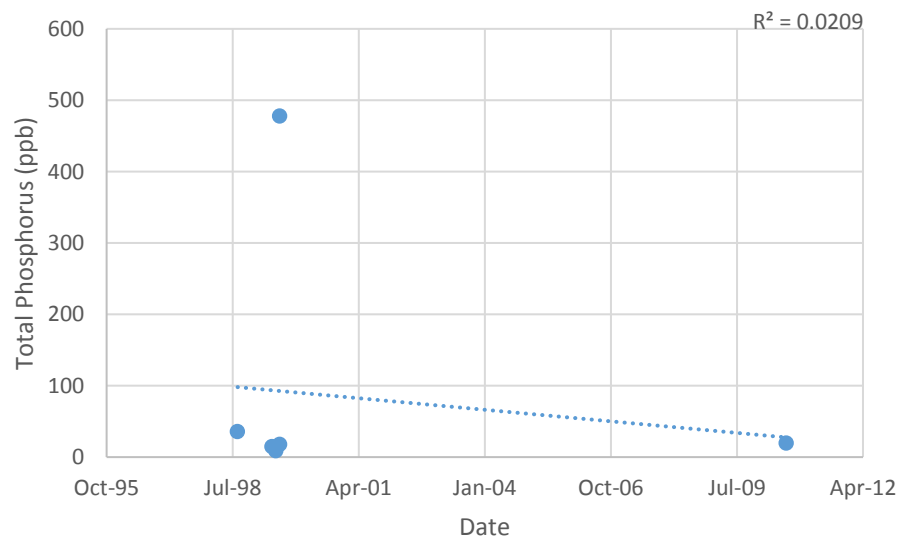


Figure 3-119: In-lake Phosphorus Concentration Trend for Shoshone Lake.

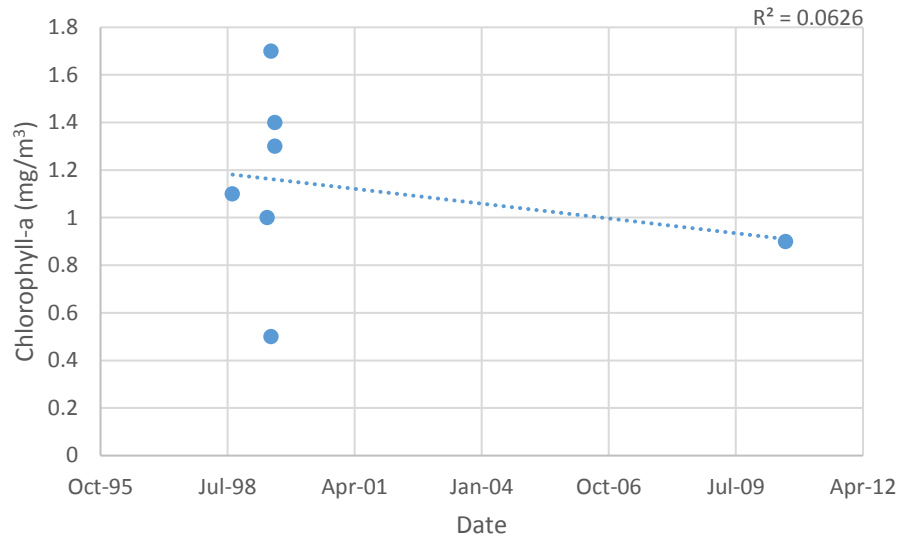


Figure 3-120: In-lake Chlorophyll-a Concentration Trend for Shoshone Lake.

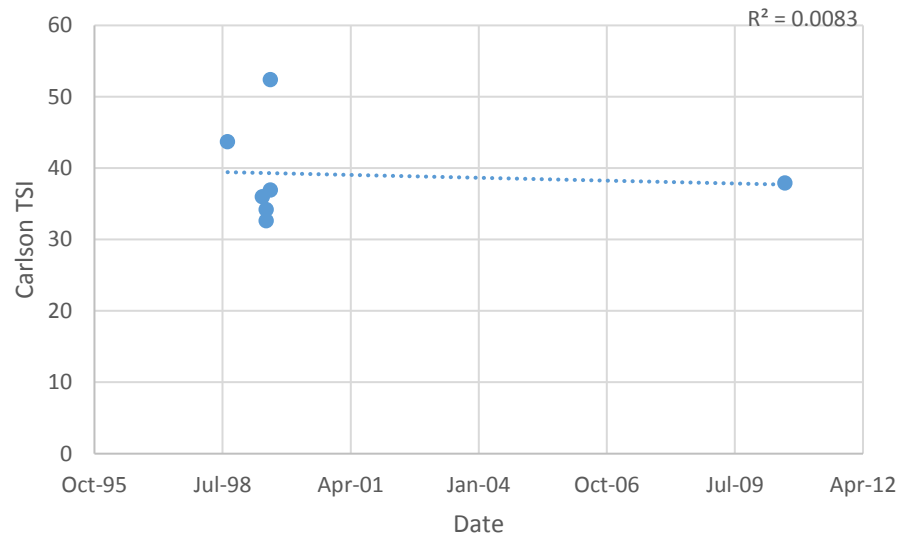


Figure 3-121: Carlson Trophic State Index Trend for Shoshone Lake.

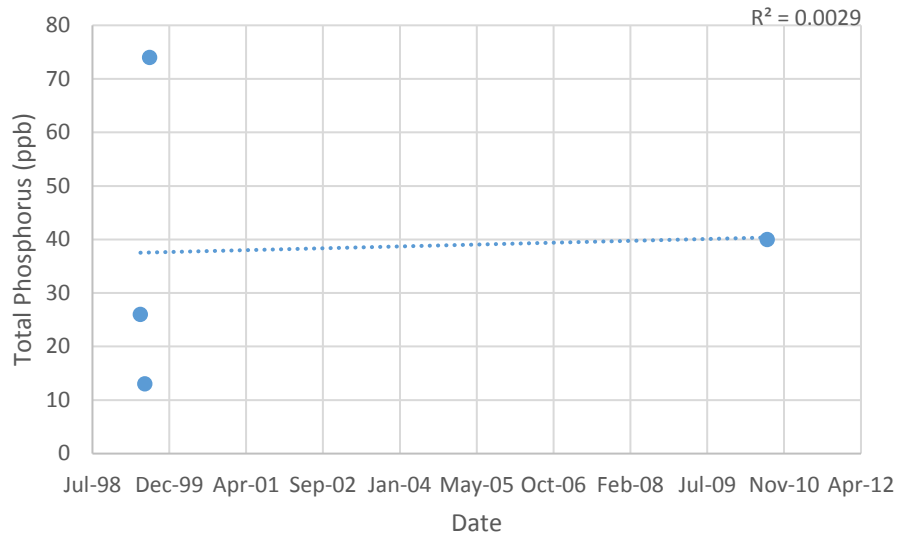


Figure 3-122: Phosphorus Concentration Trend for the Inlet of Shoshone Lake.

3.36 Shrimp Lake

Shrimp Lake has been sampled six times since 2004. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-123, Figure 3-124, and Figure 3-125 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Shrimp Lake decrease with time. While the total phosphorus and Carlson trophic state index have low R^2 values the chlorophyll-a concentration has an R^2 value of 0.9199. This shows that there is a near perfect correlation between the chlorophyll-a concentration and the change in time.

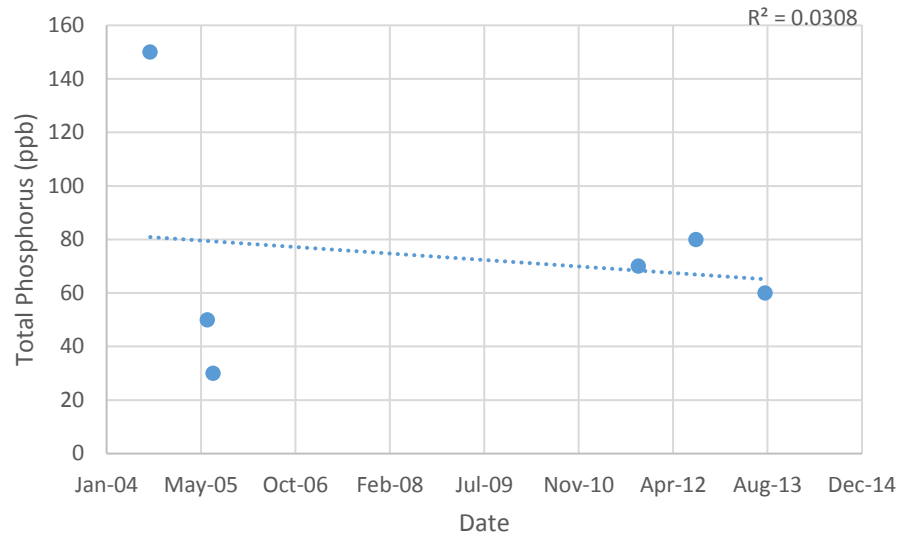


Figure 3-123: In-lake Phosphorus Concentration Trend for Shrimp Lake.

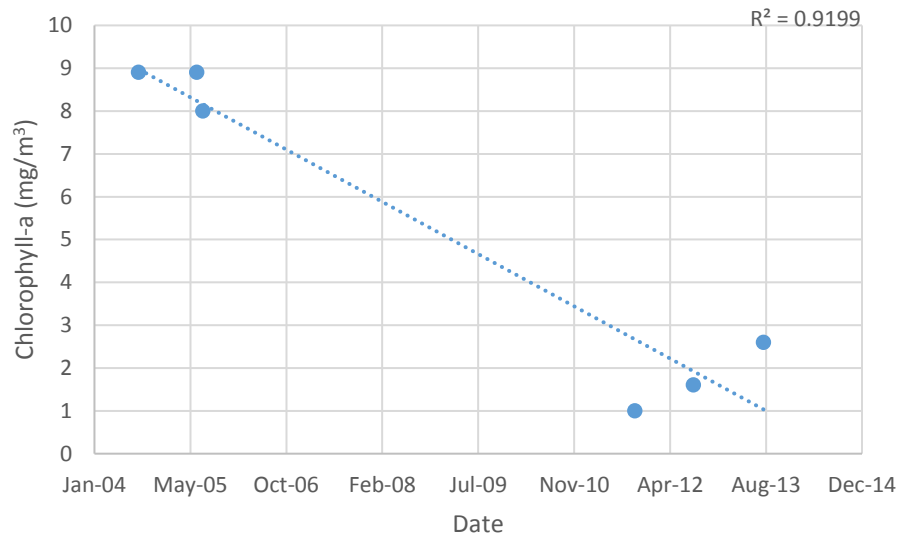


Figure 3-124: In-lake Chlorophyll-a Concentration Trend for Shrimp Lake.

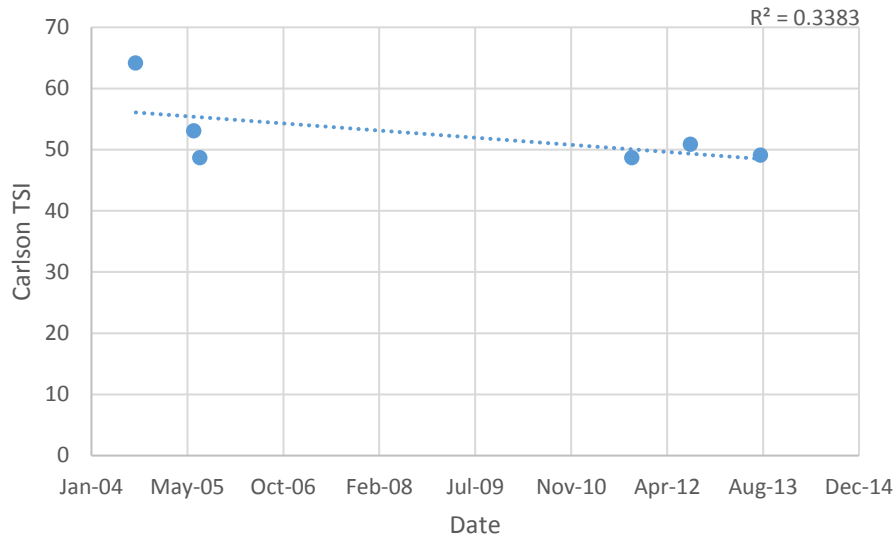


Figure 3-125: Carlson Trophic State Index Trend for Shrimp Lake.

3.37 South Twin Lake

South Twin Lake has been sampled twenty-three times since 1998. Its inlet has been sampled twenty-one times. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and inlet phosphorus concentration trends are presented in Figure 3-126, Figure 3-127, Figure 3-128, and Figure 3-129 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, Carlson trophic state index, and the inlet phosphorus concentration for South Twin Lake all increase with time. They all have a low R^2 value suggesting there may be no correlation between the data points. Some of the R^2 values could be affected by the presence of outliers.

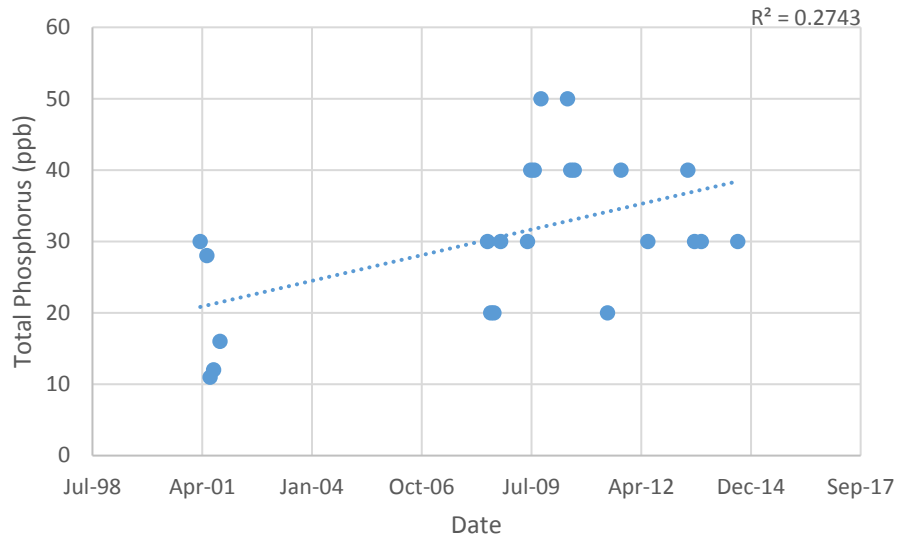


Figure 3-126: In-lake Phosphorus Concentration Trend for South Twin Lake.

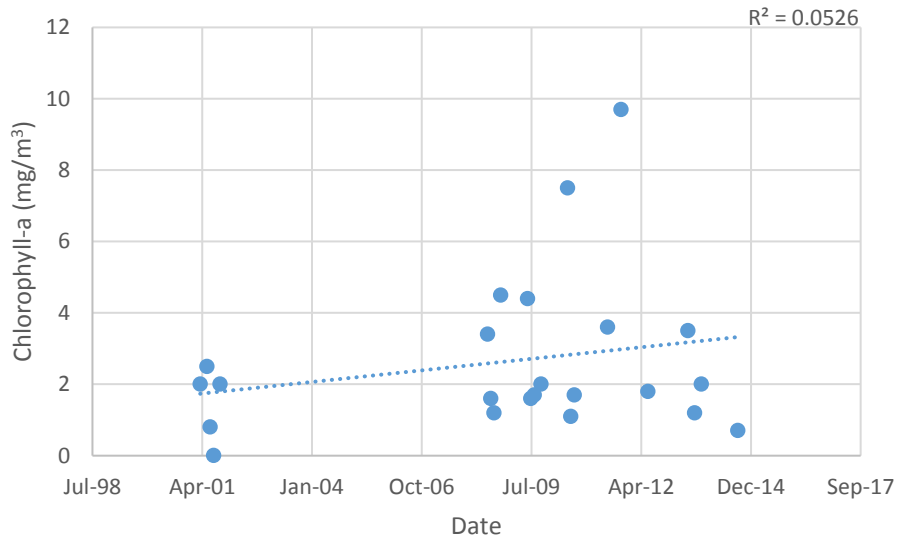
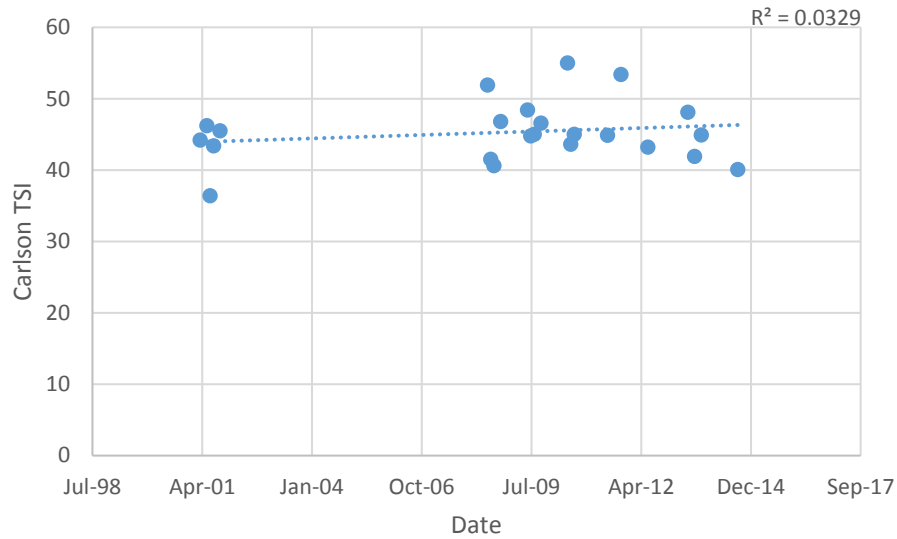


Figure 3-127: In-lake Chlorophyll-a Concentration Trend for South Twin Lake.



The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Swan Lake increase with time. They all have a low R^2 value suggesting there may be no correlation among the data points.





Sylvan Lake has been sampled twenty-four times since 2004. Its inlet has been sampled twenty-one times. The data for in-lake and inlet phosphorus concentration, chlorophyll-a

concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and inlet phosphorus concentration index trends are presented in Figure 3-133, Figure 3-134, Figure 3-135, and Figure 3-136 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Sylvan Lake all decrease with time while the inlet phosphorus concentration slightly increases. They have low R^2 values suggesting there may be no correlation among the data points.

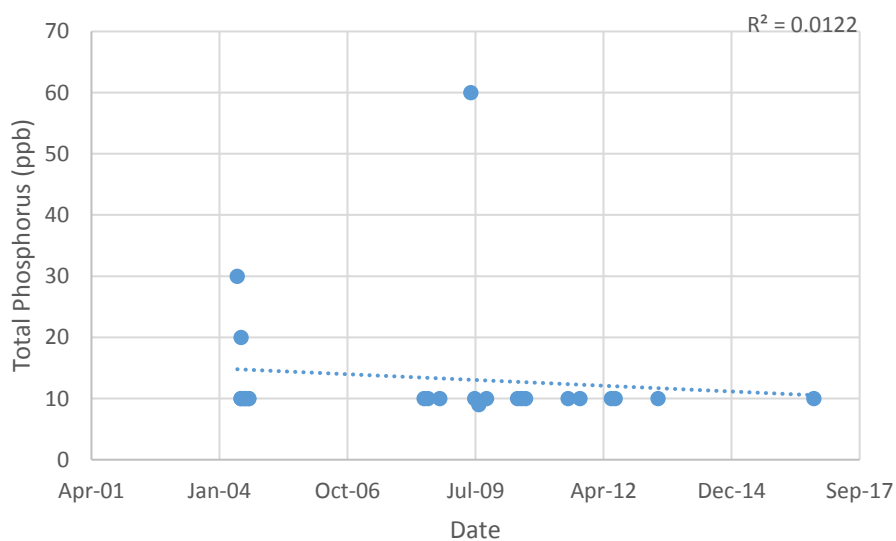


Figure 3-133: In-lake Phosphorus Concentration Trend for Sylvan Lake.

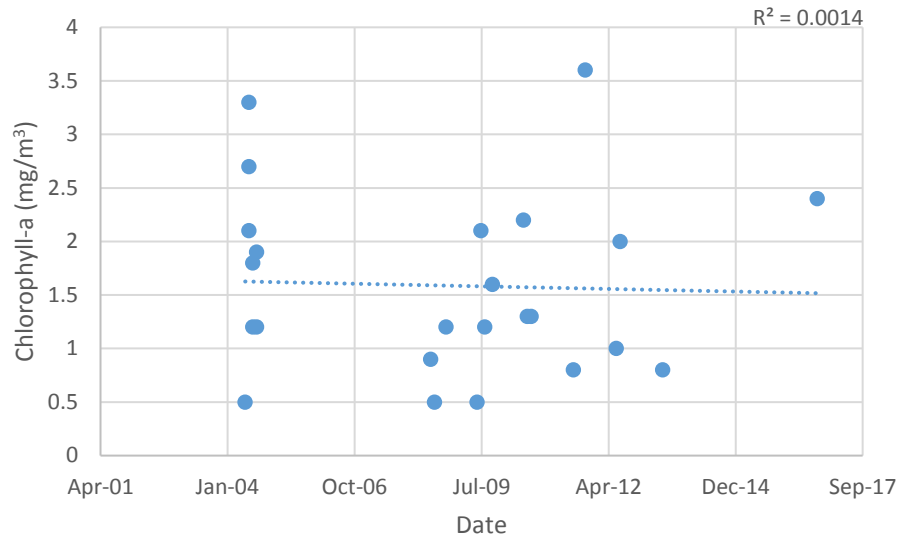


Figure 3-134: In-lake Chlorophyll-a Concentration Trend for Sylvan Lake.

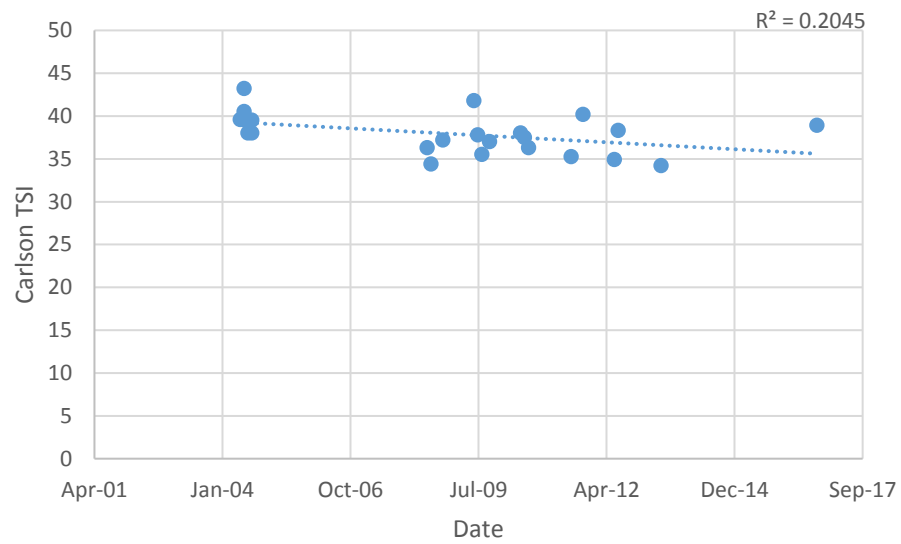
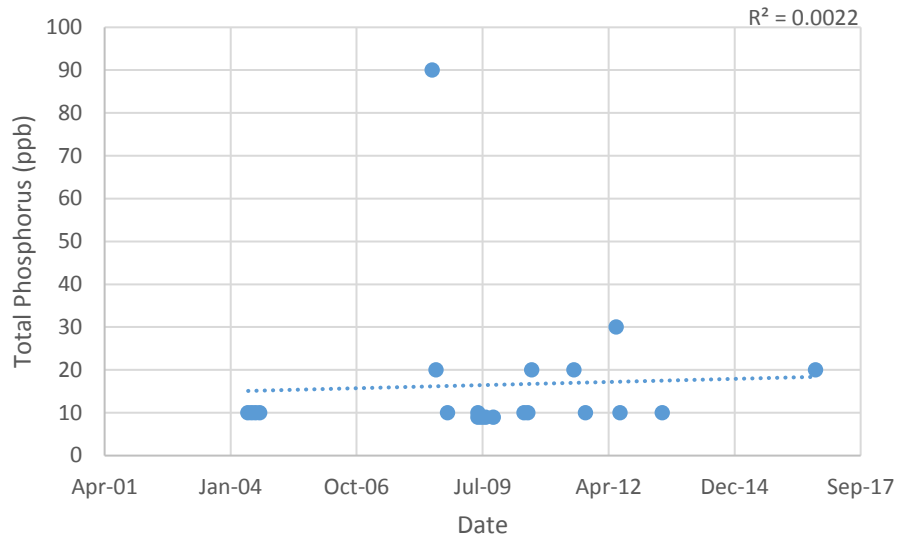


Figure 3-135: Carlson Trophic State Index Trend for Sylvan Lake.



3.40 Tanager Lake

Tanager Lake has been sampled nine times since 2001. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-137, Figure 3-138, and Figure 3-139 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Tanager Lake decrease with time. They all have a low R^2 value suggesting there may be no correlation among the data points.

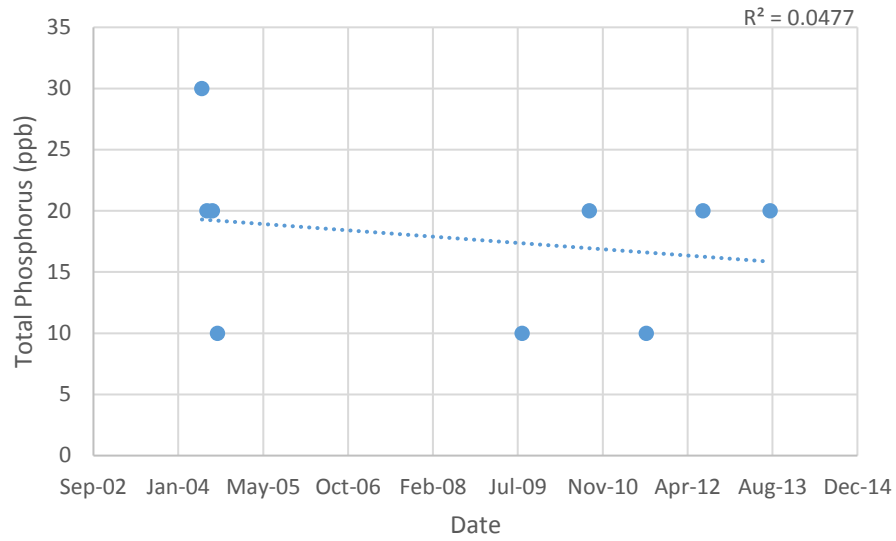


Figure 3-137: In-lake Phosphorus Concentration Trend for Tanager Lake.

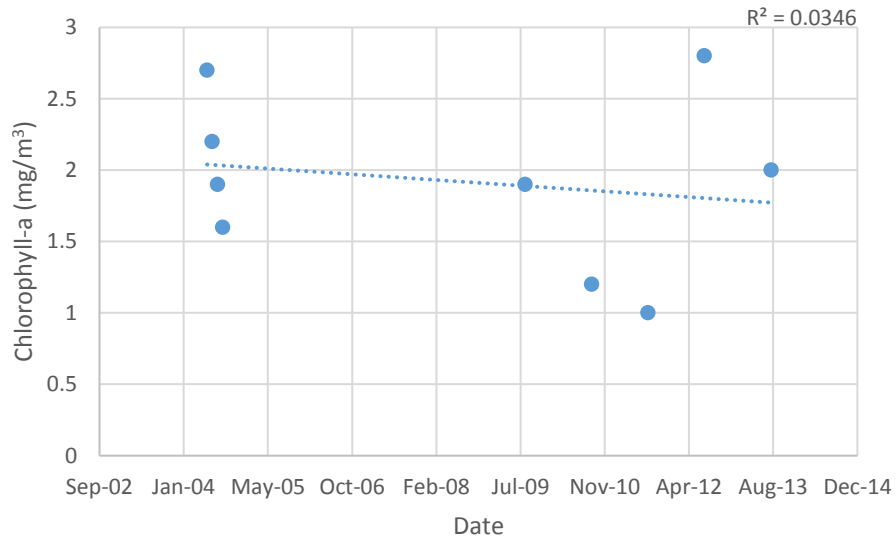


Figure 3-138: In-lake Chlorophyll-a Concentration Trend for Tanager Lake.

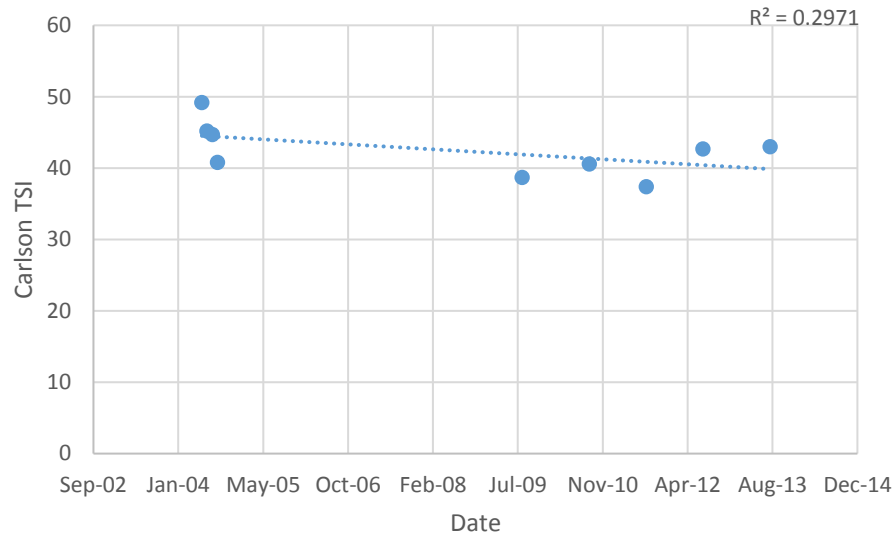


Figure 3-139: Carlson Trophic State Index Trend for Tanager Lake.

3.41 Terrace Springs

Terrace Springs has been sampled five times since 2007. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-140, Figure 3-141, and Figure 3-142 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index trend for Terrace Springs increase with time. They have high R^2 values suggesting correlation among the data points. This indicates that Terrace Springs could be advancing in the eutrophication process.

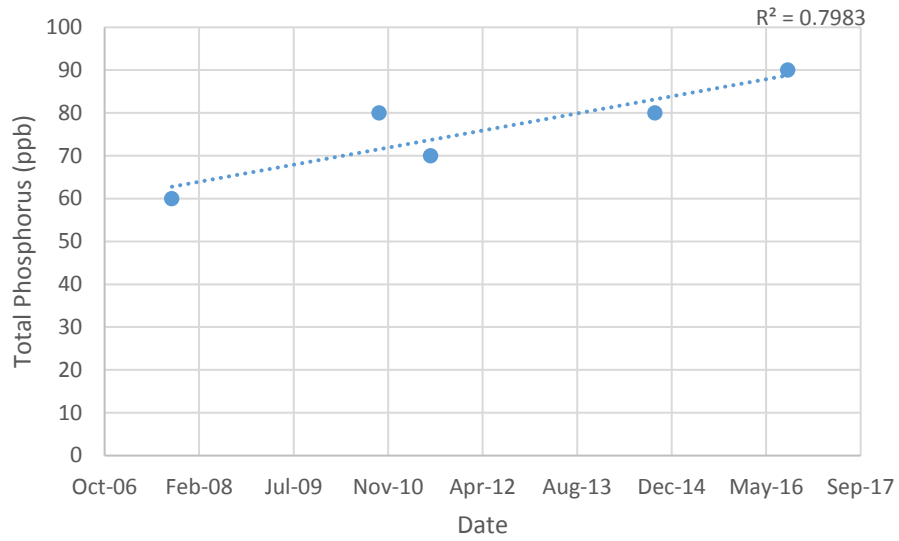


Figure 3-140: In-lake Phosphorus Concentration Trend for Terrace Springs.

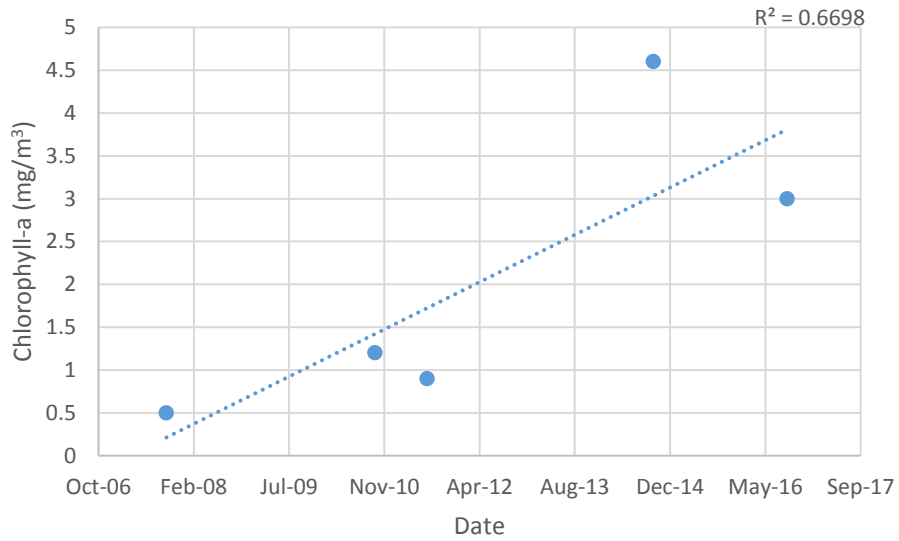


Figure 3-141: In-lake Chlorophyll-a Concentration Trend for Terrace Springs.

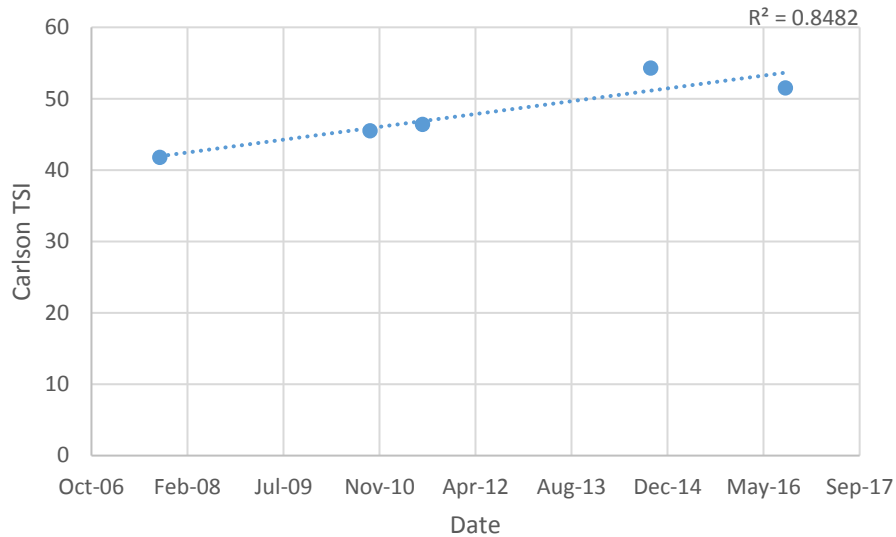


Figure 3-142: Carlson Trophic State Index Trend for Terrace Springs.

3.42 Trout Lake East

Trout Lake East and its inlet have been sampled thirty-three times since 2004. Its outlet has been sampled three times. The data for in-lake, inlet, and outlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, the inlet phosphorus trends, and outlet phosphorus trends are presented in Figure 3-143, Figure 3-144, Figure 3-145, Figure 3-146, and Figure 3-147 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Trout Lake East all trend upward. However, they all have a low R^2 value suggesting the data may not be correlated. The inlet and outlet phosphorus concentrations shows a decrease over time. They also have low R^2 values suggesting the data is not correlated.



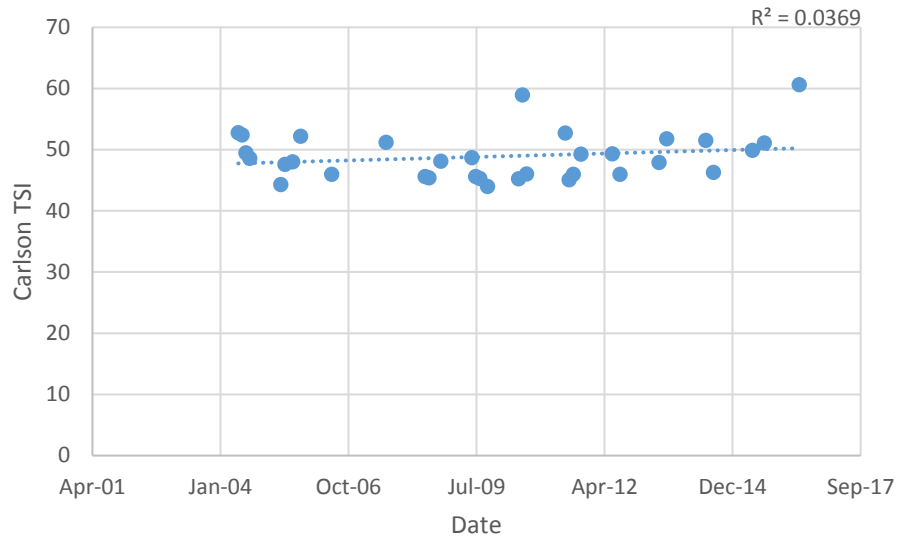


Figure 3-145: Carlson Trophic State Index Trend for Trout Lake East.

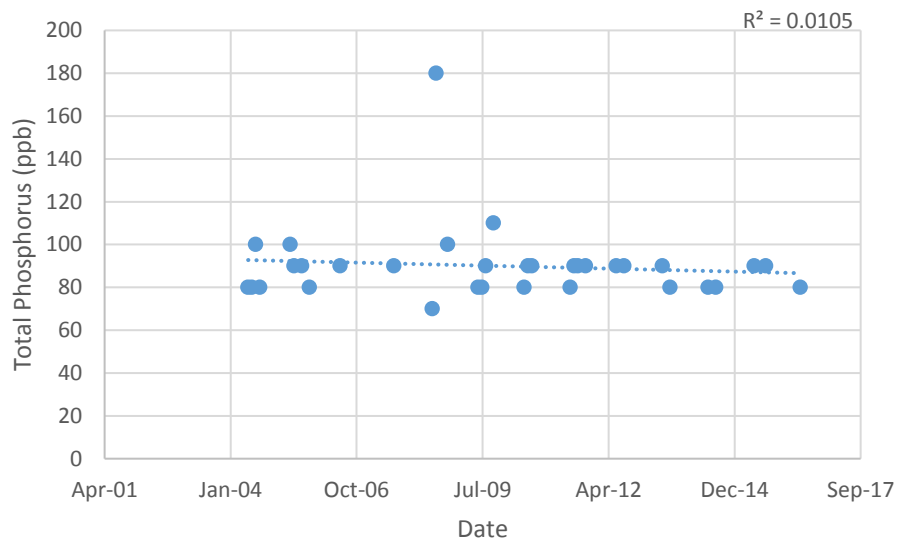


Figure 3-146: Phosphorus Concentration Trend for the Inlet of Trout Lake East.

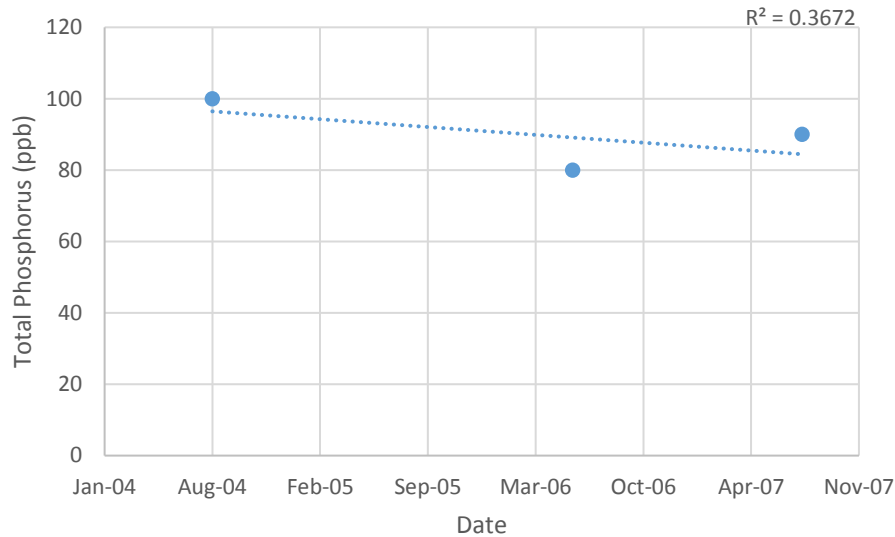


Figure 3-147: Phosphorus Concentration Trend for the Outlet of Trout Lake East.

3.43 Trout Lake West

Trout Lake West has been sampled five times since 2005. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-148, Figure 3-149, and Figure 3-150 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Trout Lake West all increase with time. The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index have R^2 values of 0.8842, 0.3152, and 0.5037 respectively. This suggests there is some correlation among the data points and the lake may be advancing in the eutrophication process.

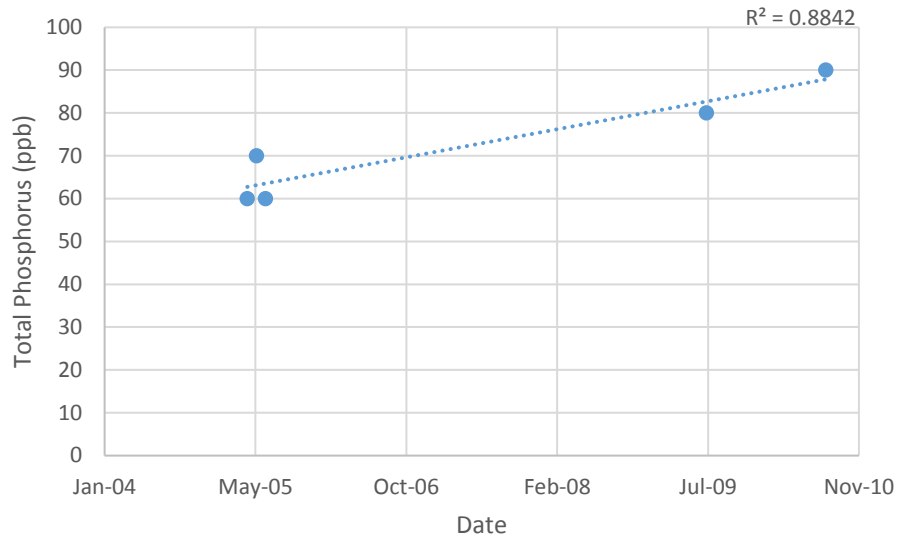


Figure 3-148: In-lake Phosphorus Concentration Trend for Trout Lake West.

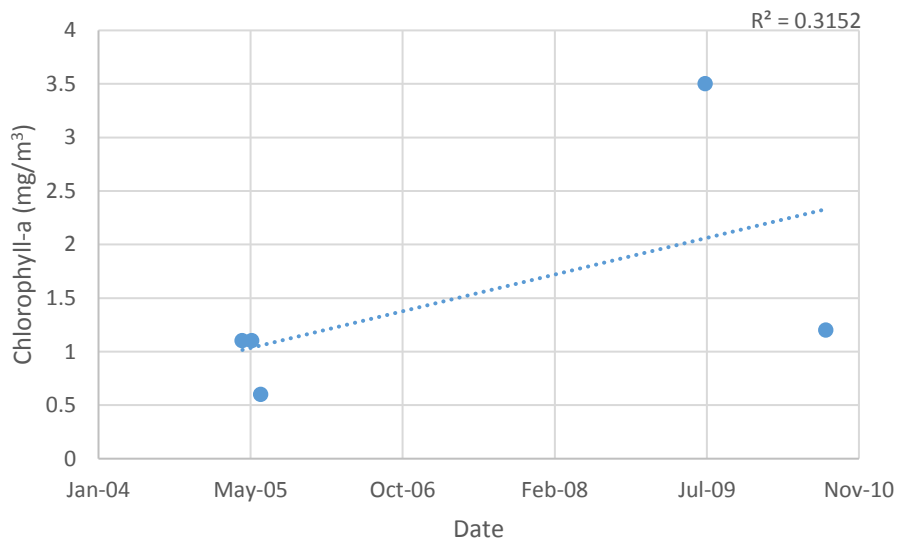


Figure 3-149: In-lake Chlorophyll-a Concentration Trend for Trout Lake West.

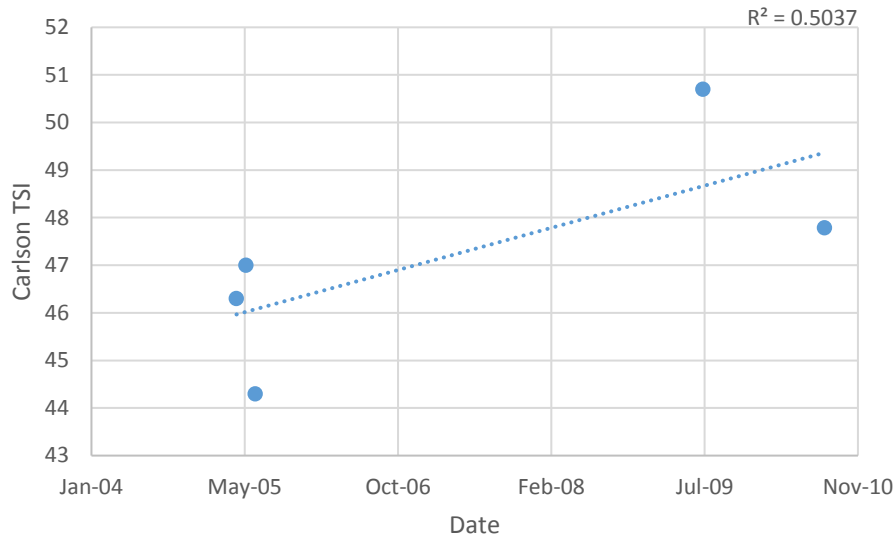


Figure 3-150: Carlson Trophic State Index Trend for Trout Lake West.

3.44 Trumpeter Pond

Trumpeter Pond has been sampled four times since 2004. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-151, Figure 3-152, and Figure 3-153 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Trumpeter Pond all increase with time. The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index have R^2 values of 0.2583, 0.3212, and 0.5819 respectively. This suggests there is a possible correlation among the data points.

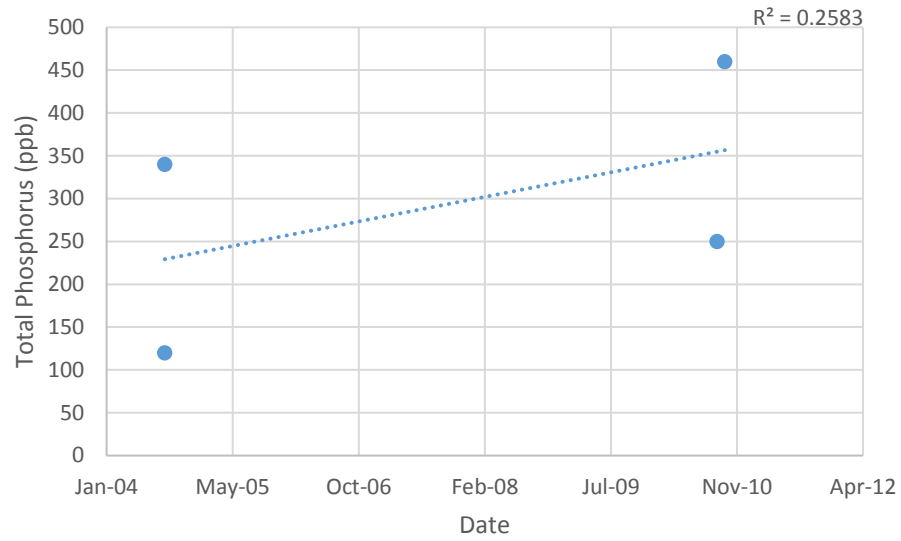


Figure 3-151: In-lake Phosphorus Concentration Trend for Trumpeter Pond.

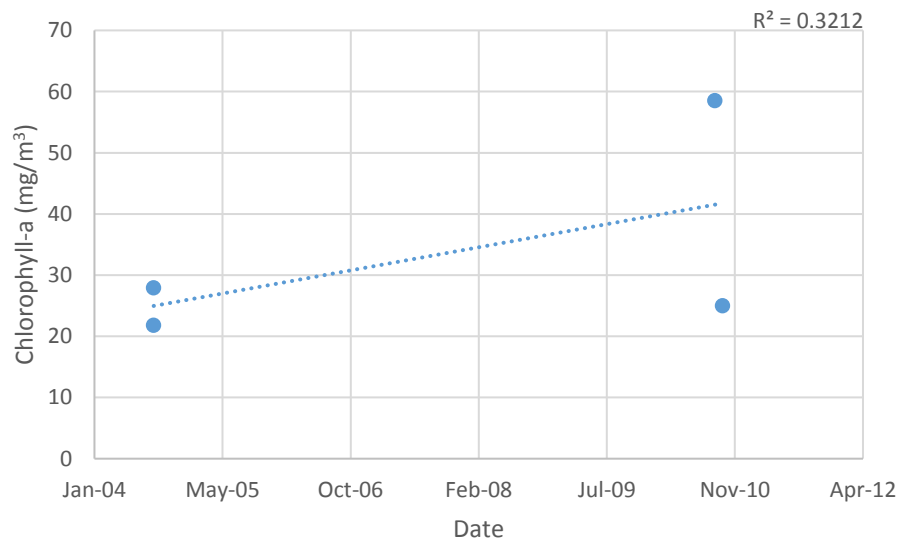


Figure 3-152: In-lake Chlorophyll-a Concentration Trend for Trumpeter Pond.

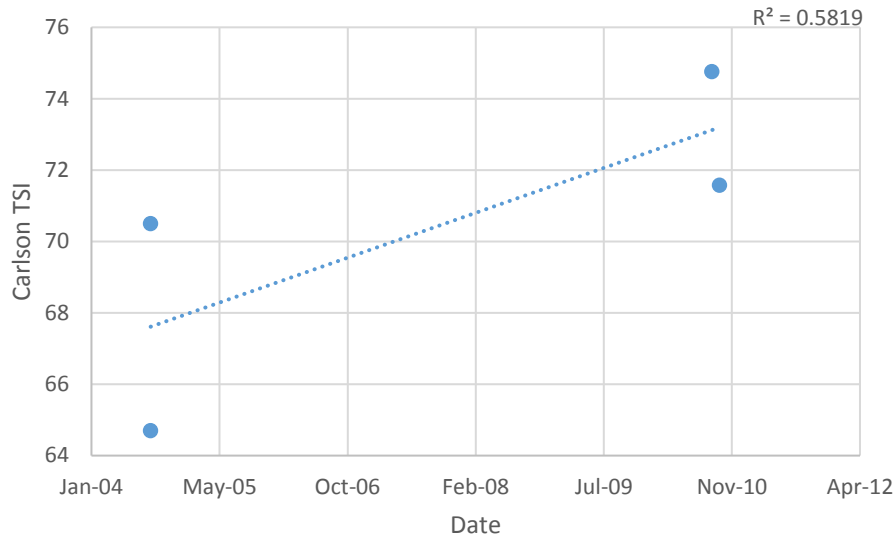


Figure 3-153: Carlson Trophic State Index Trend for Trumpeter Pond.

3.45 Turbid Lake

Turbid Lake has been sampled three times since 2004. Its inlet and outlet have been sampled twice. The data for in-lake, inlet, and outlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, the inlet phosphorus, and outlet phosphorus trends are presented in Figure 3-154, Figure 3-155, Figure 3-156, Figure 3-157, and Figure 3-158 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Turbid Lake all trend downward. However, they all have low R^2 values suggesting the data may not be correlated. The inlet phosphorus concentration remains constant and outlet phosphorus concentration shows an increase over time. The inlet and outlet phosphorus concentrations have only two data points available so no conclusions can be made regarding their trends significance.

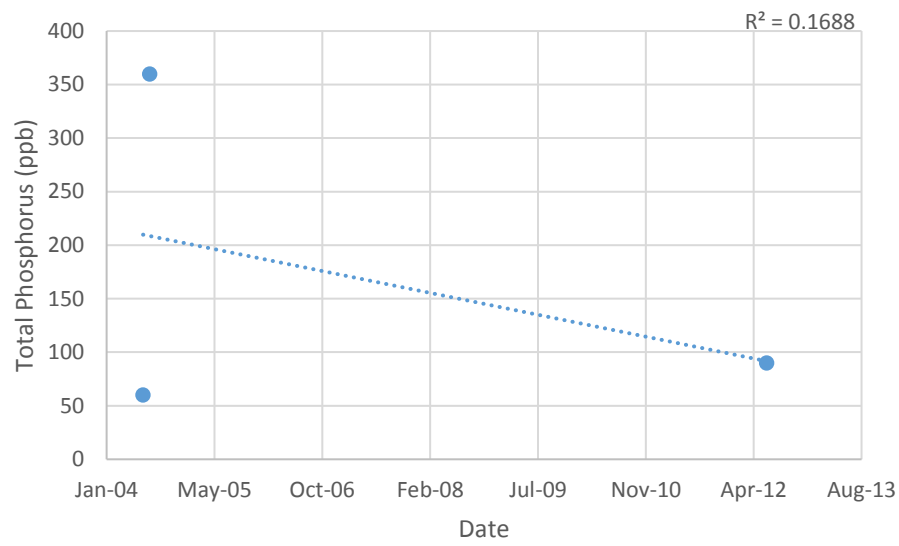


Figure 3-154: In-lake Phosphorus Concentration Trend for Turbid Lake.

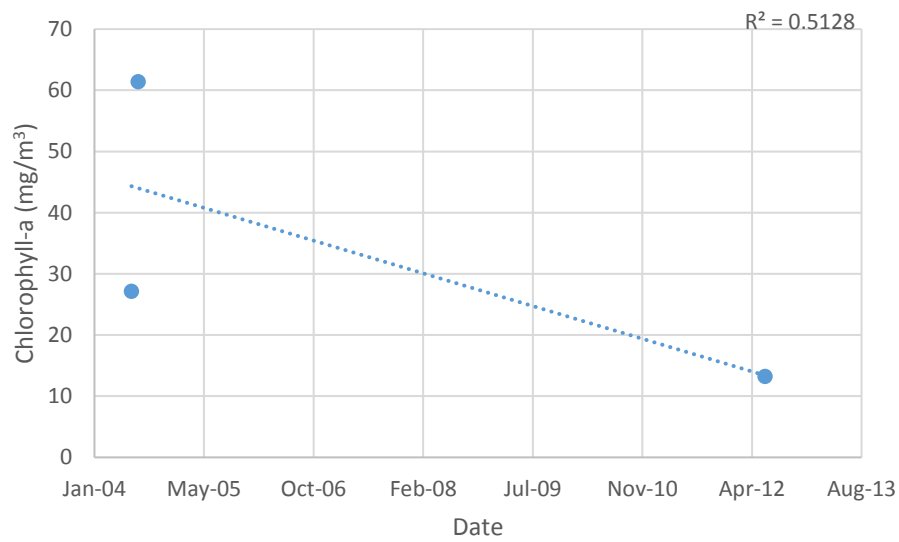


Figure 3-155: In-lake Chlorophyll-a Concentration Trend for Turbid Lake.

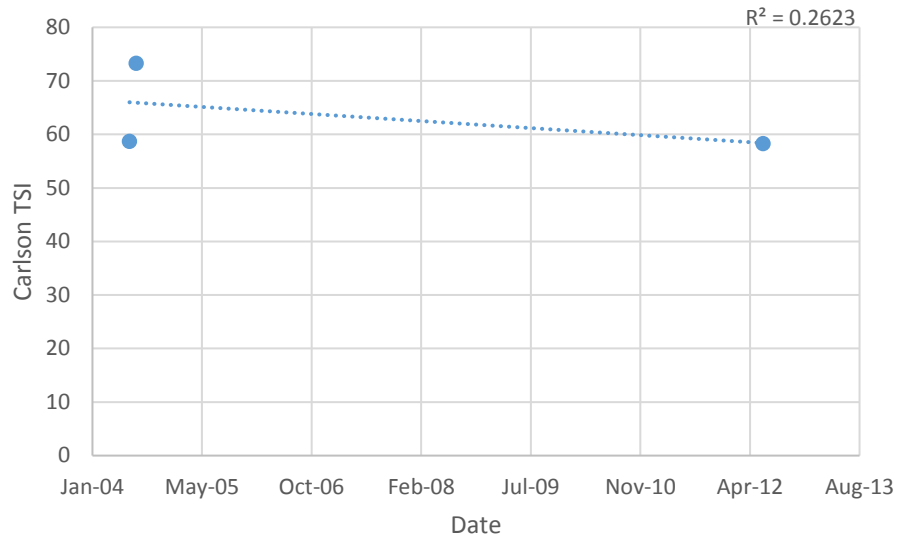


Figure 3-156: Carlson Trophic State Index Trend for Turbid Lake.

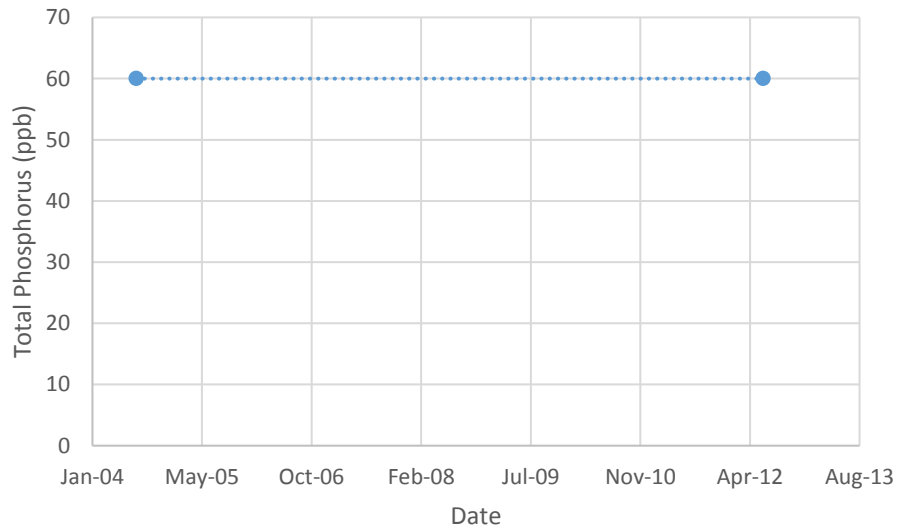


Figure 3-157: Phosphorus Concentration Trend for the Inlet of Turbid Lake.

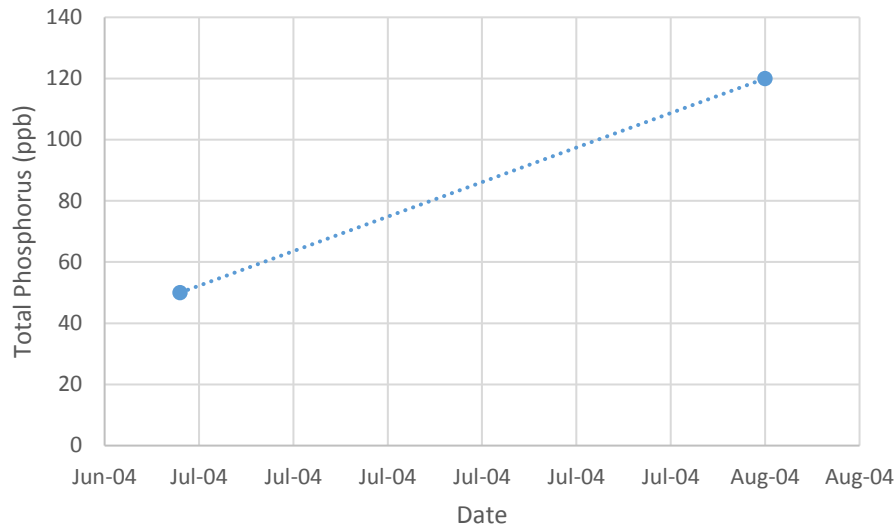


Figure 3-158: Phosphorus Concentration Trend for the Outlet of Turbid Lake.

3.46 Wolf Lake

Wolf Lake has been sampled five times since 2000. Its inlet has been sampled three times. The data for in-lake and inlet phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, Carlson trophic state index, and inlet phosphorus concentration trends are presented in Figure 3-159, Figure 3-160, Figure 3-161, and Figure 3-162 respectively.

The in-lake and inlet phosphorus concentration and chlorophyll-a concentration trends for Wolf Lake all decrease with time while the Carlson trophic state index trend is constant. They all have a low R^2 value suggesting there is no correlation among the data points.

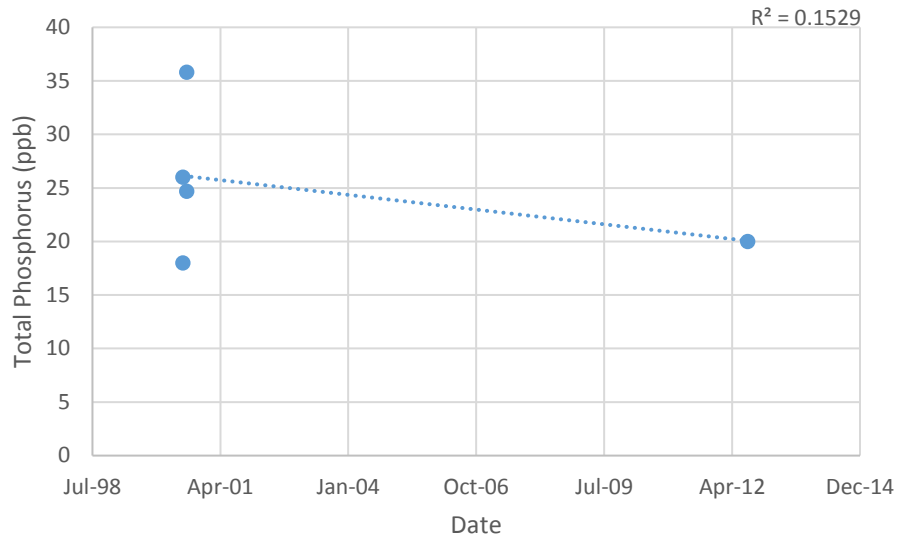


Figure 3-159: In-lake Phosphorus Concentration Trend for Wolf Lake.

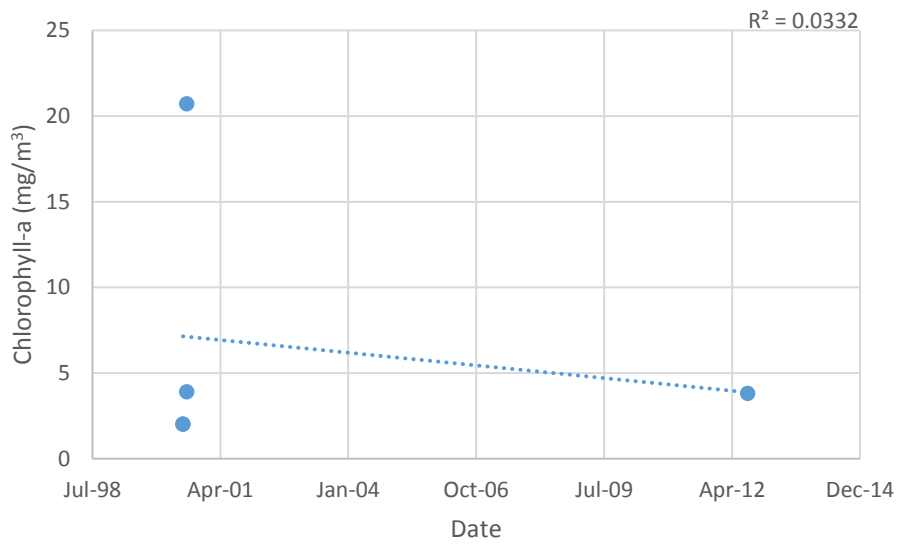


Figure 3-160: In-lake Chlorophyll-a Concentration Trend for Wolf Lake.

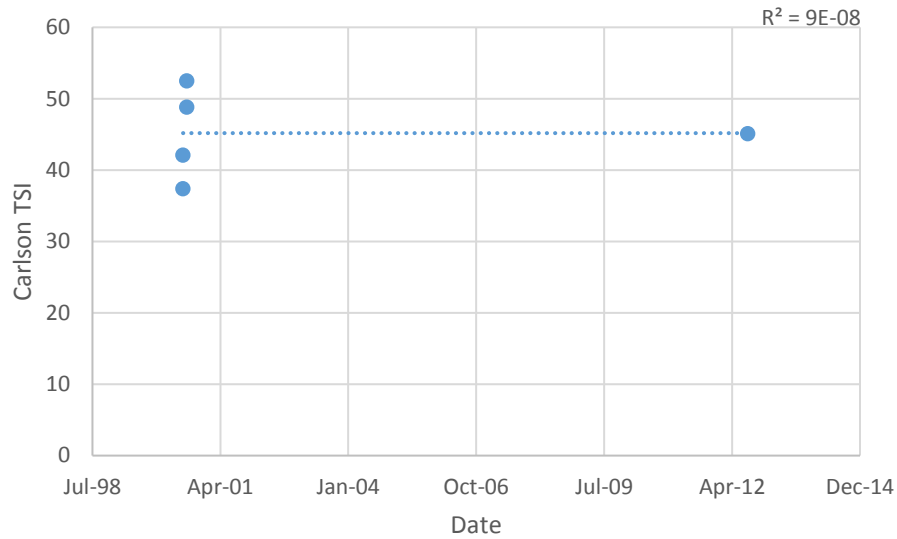


Figure 3-161: Carlson Trophic State Index Trend for Wolf Lake.

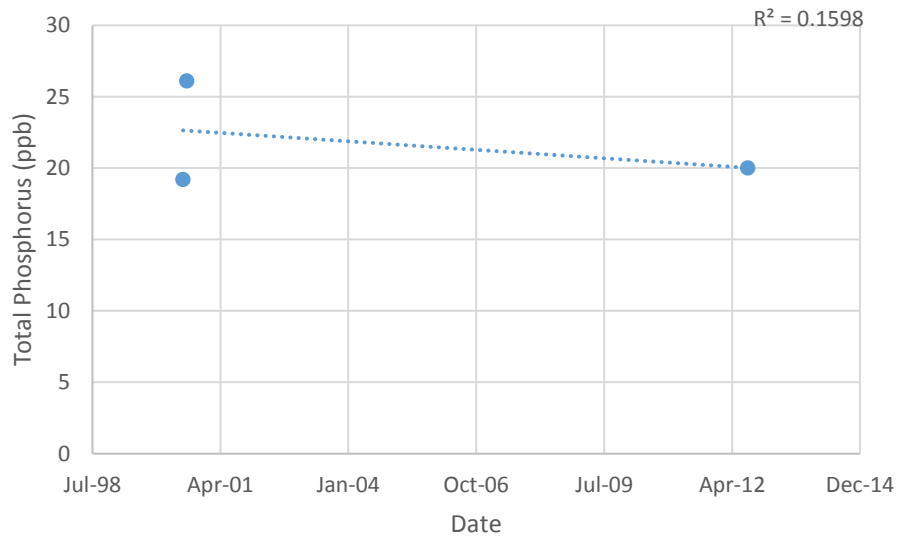


Figure 3-162: Phosphorus Concentration Trend for the Inlet of Wolf Lake.

3.47 Yellowstone Lake at Bridge Bay

Yellowstone Lake at Bridge Bay has been sampled eight times since 2004. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index were

plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-163, Figure 3-164, and Figure 3-165 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index for Yellowstone Lake at Bridge Bay increase with time. The in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index have R^2 values of 0.2229, 0.6528, and 0.6145 respectively. This suggests there is a possible correlation among the data points and the lake may be advancing in the eutrophication process.

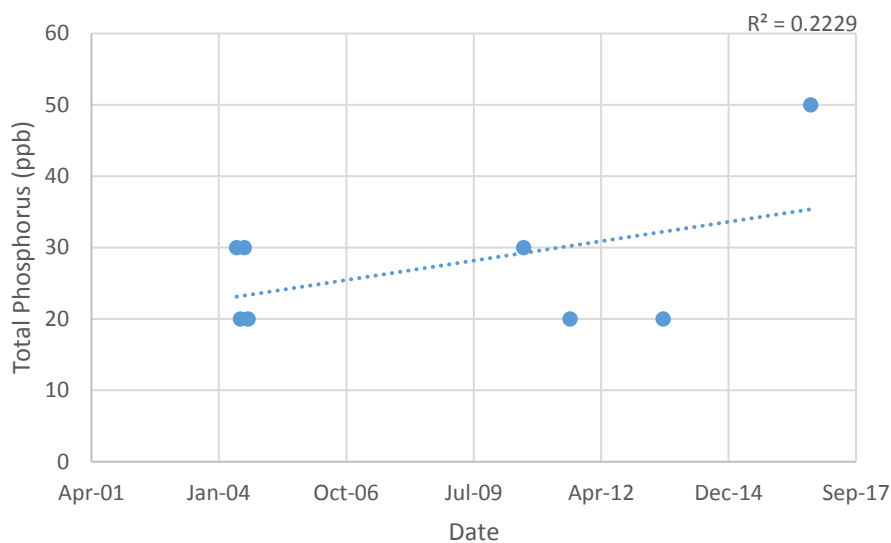


Figure 3-163: In-lake Phosphorus Concentration Trend for Yellowstone Lake at Bridge Bay.

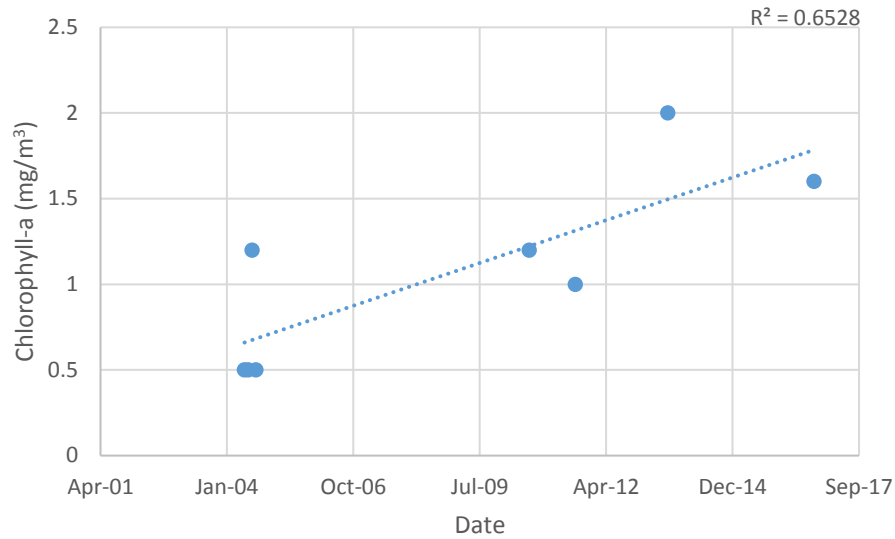


Figure 3-164: In-lake Chlorophyll-a Concentration Trend for Yellowstone Lake at Bridge Bay.

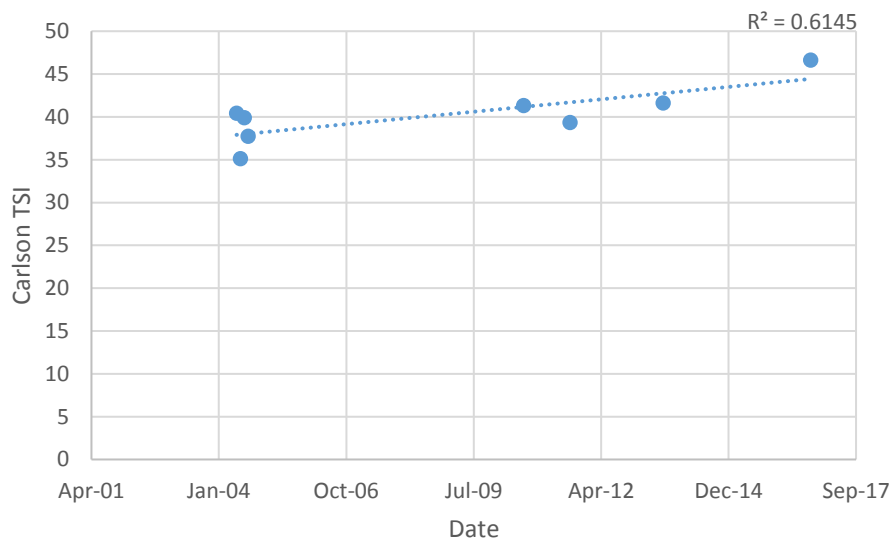


Figure 3-165: Carlson Trophic State Index Trend for Yellowstone Lake at Bridge Bay.

3.48 Yellowstone Lake at Grant Marina (West Thumb)

Yellowstone Lake at West Thumb has been sampled seven times since 2004. The data for in-lake phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index

were plotted in order to determine the trend. The in-lake phosphorus, chlorophyll-a, and Carlson trophic state index trends are presented in Figure 3-166, Figure 3-167, and Figure 3-168 respectively.

The in-lake phosphorus concentration, chlorophyll-a concentration, and the Carlson trophic state index trends for Yellowstone Lake at West Thumb decrease with time. They have low R^2 values suggesting there is no correlation among the data points.

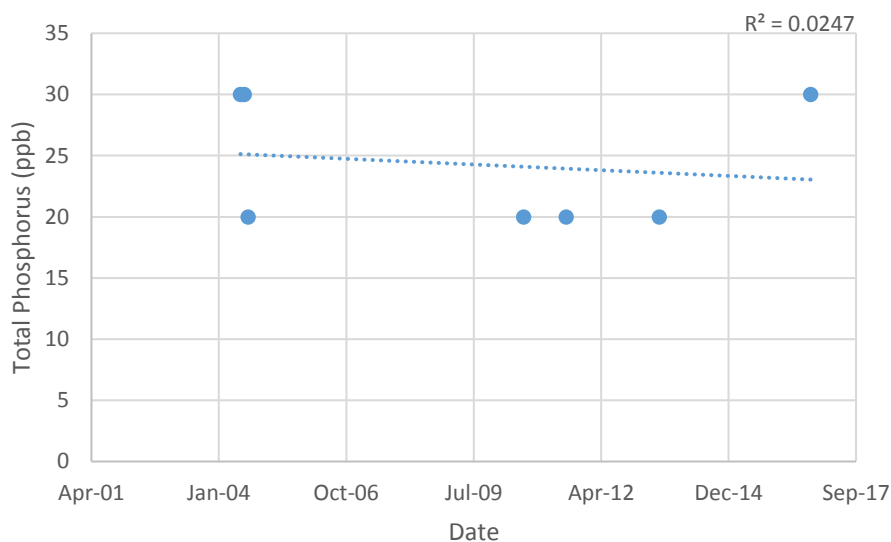


Figure 3-166: In-lake Phosphorus Concentration Trend for Yellowstone Lake at Grant Marina

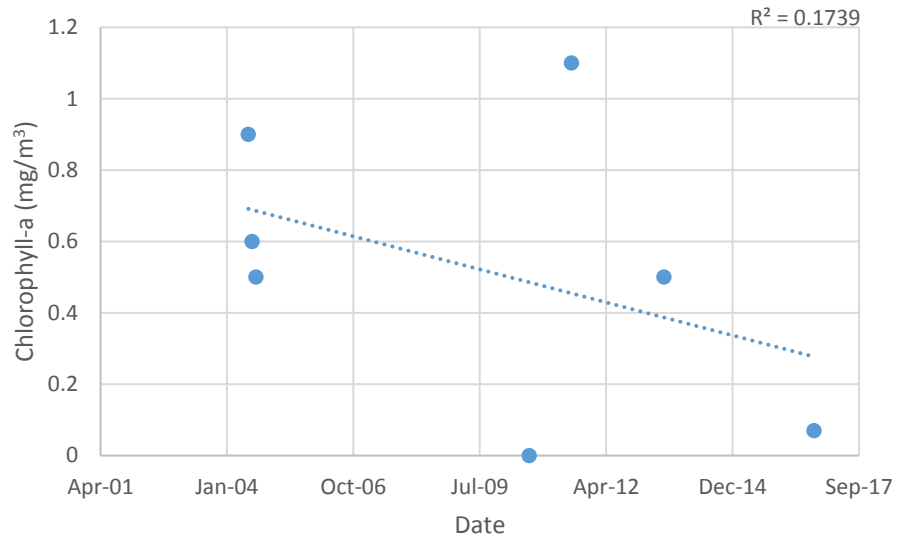


Figure 3-167: In-lake Chlorophyll-a Concentration Trend for Yellowstone Lake at Grant Marina.

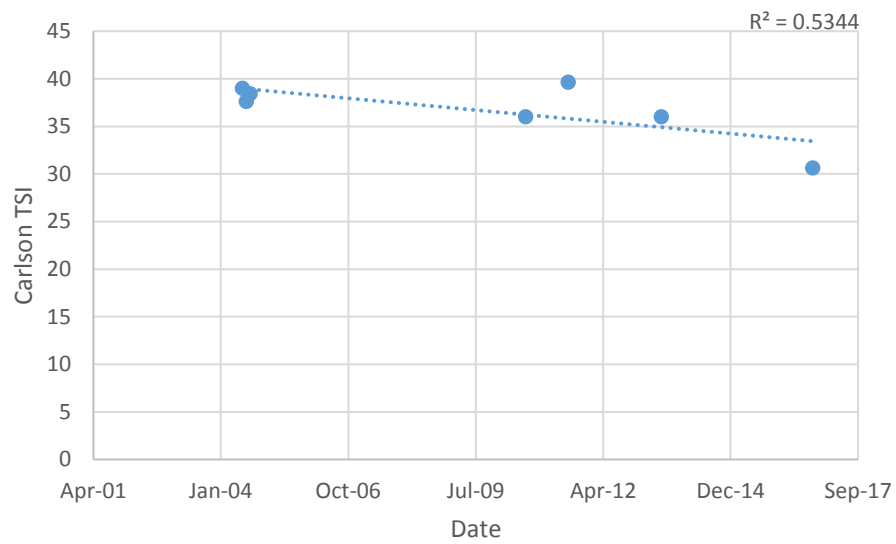


Figure 3-168: Carlson Trophic State Index Trend for Yellowstone Lake at Grant Marina.

4 CONCLUSION

A trophic state classification is an indicator of the health of a body of water. Dr. Miller has been sampling lakes and ponds in Yellowstone National Park since 1998 in order to monitor their trophic states. This report covers the samples taken in 2012 through 2016. The main constituents considered were phosphorus and chlorophyll-a concentrations. The Carlson trophic state was determined for every lake sampled. The Larsen-Mercier and Vollenweider Models were also used when inlet data were available. Table 4-1 shows the average trophic state classification for each lake during this time period.

Trends for the in-lake phosphorus concentration, chlorophyll-a concentration, the Carlson trophic state index, and the inlet and outlet phosphorus concentrations were developed. All of the data ever sampled were used to determine these trends. All of the raw data are located in the Appendix. Most of the plots show trends that are increasing or decreasing; however, most trends show little to no correlation so no firm conclusions can be made.

Feather Lake seemed to have a significant trend. The lake's phosphorus concentration, chlorophyll-a concentration, and Carlson trophic state index decrease over time. Each has an R^2 value of 0.7 or larger indicating a strong statistical correlation. From these plots, Feather Lake appears to be reversing the eutrophication process.

Table 4-1: Average Trophic State Classifications for 2012 through 2016

Lake	Average Trophic State Classification
Blacktail Pond	Mesotrophic
Buck Lake	Slightly Eutrophic
Cascade Lake	Strongly Mesotrophic
Clear Lake	Strongly Mesotrophic
Divide Lake	Slightly Oligotrophic
Druid Lake	Mesotrophic
Duck Lake	Slightly Oligotrophic
Feather Lake	Slightly Eutrophic
Floating Island Lake	Strongly Eutrophic
Goose Lake	Strongly Mesotrophic
Grebe Lake	Mesotrophic
Grizzly Lake	Slightly Oligotrophic
Harlequin Lake	Strongly Mesotrophic
Hazel Lake	Slightly Eutrophic
Hot Beach Pond	Strongly Eutrophic
Hot Lake	Mesotrophic
Ice Lake	Slightly Mesotrophic
Indian Pond	Strongly Eutrophic
Isa Lake	Mesotrophic
Joffee Lake	Slightly Oligotrophic
Joffee Lake II	Slightly Oligotrophic
Lewis Lake	Slightly Mesotrophic
Lily Pad Lake	Mesotrophic
Lost Lake	Mesotrophic
Lower Basin Lake	Eutrophic
North Twin Lake	Slightly Eutrophic
Nymph Lake	Strongly Eutrophic
Pool by Morning Glory Pool	Eutrophic
Ribbon Lake	Mesotrophic
Scaup Lake	Slightly Eutrophic
Shrimp Lake	Strongly Mesotrophic
South Twin Lake	Strongly Mesotrophic
Swan Lake	Strongly Mesotrophic
Sylvan Lake	Slightly Mesotrophic
Tanager Lake	Mesotrophic
Terrace Spring	Strongly Mesotrophic
Trout Lake East	Eutrophic
Trubid Lake	Eutrophic
Wolf Lake	Mesotrophic
Yellowstone Lake at Bridge Bay	Mesotrophic
Yellowstone Lake at West Thumb	Slightly Oligotrophic

Riddle Lake also seems to be experiencing a possible reversal of the eutrophication process. Most other lakes that show good correlation seem to be advancing in the eutrophication process. The lakes that show increasing trends are Hot Lake, Pool by Morning Glory Pool, Scaup Lake, Terrace Springs, Trout Lake West, and Yellowstone Lake at Bridge Bay

Continual monitoring of the lakes and ponds in Yellowstone National Park will lead to a better understanding of the trends and their significance.

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APPENDIX A. TABULATED DATA

Dr. Miller has been sampling lakes and ponds in Yellowstone National Park since 1998.

The following tables contain all of the data ever recorded for each lake.

Table A-1: Beaver Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2011	Aug	Inlake NE	2	2.7	30				48.85
2011	Aug	Inlet			20	0.2	0.06	0	
2010	Aug	Inlake NE	2.5	22	100				59.43
2010	Oct	Inlake NE	3.5	2.3	40				46.02
2009	Aug	Inlet			200	0.1	0.06	0.85	
2009	Aug	Inlake NE	2.5	3.4	30				47.5
2008	Jun	Inlet			40	2.0	0.06	0	
2008	Jun	Outlet			100	1.0			
2008	Jun	Inlake NE	3	5.8	10				43.1
2001	Apr	Inlet			50	3.0	0.04	0.4	
2001	Apr	Inlake E	2.5	3.4	30				47.5
2001	Jun	Inlet			43	0.3	0.04	0.09	
2001	Jun	Inlake E	1	0.5	39				46.9
2001	Jul	Inlet			75	0.3	0.04	0.63	
2001	Jul	Inlake NE	3.5	1.2	28				42.2
2001	Aug	Inlet			10	2.0	0.04	0	
2001	Aug	Inlake NE	2	0.2	29				39.2
2001	Oct	Inlet			12	1.0	0.04	0	
2001	Oct	Inlake NE	1	2	20				53.7

Table A-2: Blacktail Pond

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2013	Aug	Inlake	2	3.3	30				48.5
2012	Oct	Inlake	4	1	20				39.3
2011	Aug	Inlake SE	2	14.8	50				55.87
2010	Sep	Inlake SE	2.5	10.7	80				56
2009	Aug	Inlake SE	2.5	4.9	40				50.1
2008	Jun	Inlake SE	2	8.2	40				52.9
2008	Jul	Inlake SE	2.5	14.9	40				53.7
2008	Aug	Inlake SE	2.5	17.5	15				49.5
2008	Oct	Inlake SE	2.5	4	20				46.1
2001	Apr	Inlake SE	3.5	2.8	20				43.3
2001	Jul	Inlet			26	0.5	0.13	0.38	
2001	Jul	Inlake SE	3.5	0.7	16				37.7
2001	Aug	Inlake W	2	0	13				45.6
2001	Oct	Inlake W	2.5		14				44.5

Table A-3: Buck Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jun	Inlake	3	3.8	20				45.1
2016	Jun	Inlet			80	1.0	0.25	0.75	
2015	Jun	Inlake	3	24.4	20				51.2
2015	Jun	Inlet			90	0.5	0.25	0.78	
2015	Sep	Inlake	2	19.5	20				52.4
2015	Sep	Inlet			80	1.0	0.25	0.75	
2014	Jun	Inlake	4	1.8	20				41.2
2014	Jun	Inlet			60	1.0	0.25	0.67	
2014	Aug	Inlake	4	0.9	20				39.0
2014	Aug	Inlet			80	1.0	0.25	0.75	
2013	Jun	Inlake	4	1.4	20				40.4
2013	Jun	Inlet			70	1.0	0.25	0.71	
2013	Aug	Inlake	2	5.3	20				48.1
2013	Aug	Inlet			90	0.5	0.25	0.78	
2012	Jun	Inlake	3	2.7	30				45.9
2012	Jun	Inlet			150	0.5	0.25	0.8	
2012	Aug	Inlake	2	10.5	30				52.3
2012	Aug	Inlet			100	0.5	0.25	0.7	
2011	Jun	Inlake W	3	5	20				45.97
2011	Jun	Inlet			110	2.0	0.25	0.82	
2011	Jul	Inlake W	1	22.3	40				59.47
2011	Jul	Inlet			80	1.0	0.25	0.50	
2011	Aug	Inlake W	2	14.8	30				53.41
2011	Aug	Inlet			90	2.0	0.25	0.67	

Table A-4: Buck Lake Continued

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2011	Oct	Inlake W	2	9.7	40				53.41
2011	Oct	Inlet			90	2.0	0.25	0.56	
2010	Jun	Inlake W	3.5	4.2	30				46.61
2010	Jun	Inlet			90	1.0	0.25	0.67	
2010	Jul	Inlake W	3.5	1.7	20				41.70
2010	Jul	Inlet			100	1.0	0.25	0.8	
2010	Aug	Inlake W	3.5	3.4	20				43.97
2010	Aug	Inlet			80	1.0	0.25	0.75	
2009	Jun	Inlet			80	1.0	0.25	0.75	
2009	Jun	Inlake W	3	3.5	20				44.80
2009	Jul	Inlet			80	1.0	0.25	0.63	
2009	Jul	Inlake W	3.5	8.2	30				48.80
2009	Aug	Inlet			70	1.0	0.25	0.86	
2009	Aug	Inlake W	2.5	3.4	10				42.20
2009	Oct	Inlet			60	2.5	0.25	0.17	
2009	Oct	Inlake W	2.5	10.4	50				53.60
2008	Jun	Inlet			70	0.5	0.25	0.57	
2008	Jun	Inlake W	2.5	2.4	30				46.40
2008	Jul	Inlet			100	0.5	0.25	0.7	
2008	Jul	Inlake W	2.5	19.8	30				53.30
2008	Oct	Inlet			100	2.0	0.25	0.8	
2008	Oct	Outlet			20	2.0			
2008	Oct	Inlake W	2	15.6	30				53.60
2007	Aug	Inlet			100	0.5	0.25	0.7	
2007	Aug	Inlake W	4.5	4.7	30				45.80
2006	Jun	Inlet			80	0.5	0.25	0.75	
2006	Jun	Inlake w	2.5	1.8	20				43.50
2005	May	Inlet			100	1.0	0.25	0.7	
2005	May	Inlake W	3	1.7	30				44.40
2005	Jun	Inlet			90	1.0	0.25	67	
2005	Jun	Inlake W	3	1.9	30				44.70
2005	Jul	Inlet			70	1.0	0.25	0.57	
2005	Jul	Inlake W	2.5	2.9	30				47.00
2005	Aug	Inlet			70	1.0	0.25	0.43	
2005	Aug	Inlake W	1	33.9	40				60.80
2005	Oct	Inlet			100	1.0	0.25	0.7	
2005	Oct	Inlake W	2.5	5.5	30				49.10
2004	Jun	Inlet			70	1.0	0.25	0.57	
2004	Jun	Inlake W	2	2.2	30				47.20
2004	Jul	Inlet			70	1.0	0.25	0.57	
2004	Jul	Inlake W	2	13.1	30				53.00
2004	Aug	Inlet			110	1.0	0.25	0.73	
2004	Aug	Inlake W	1	27.9	30				58.80
2004	Sep	Inlet			80	1.5	0.25	0.63	
2004	Sep	Inlake W	2	3	30				48.20

Table A-5: Cascade Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2015	Jun	Inlake	3	3	20				44.30
2015	Jun	Inlet			60	0.5	0.33	0.667	
2014	Jun	Inlake	2	5.4	30				50.10
2014	Jun	Inlet			30	2.0	0.33	0	
2014	Sep	Inlake	2	4.9	20				47.90
2014	Sep	Inlet			50	1.0	0.33	0.6	
2013	Aug	Inlake	2	5.7	20				48.30
2013	Aug	Inlet			40	0.5	0.33	0.5	
2012	Aug	Inlake	2	5.7	20				48.30
2012	Aug	Inlet			40	4.0	0.33	0.500	
2011	Aug	Inlake N	2	8.2	30				51.48
2011	Aug	Inlet			50	2.0	0.33	0.4	
2010	Aug	Inlake N	2.5	16.1	40				54.00
2010	Aug	Inlet			40	1.0	0.33	0	
2010	Sep	Inlake N	3.5	5.1	30				47.24
2010	Sep	Inlet			30	0.5	0.33	0	
2000	Jun	Inlet			22.6	2.0	0.33	0	
2000	Jun	Outlet NE			40	2.0			
2000	Jun	Inlake NE	1.5	7.2	28				52.1
2000	Aug	Inlet			30.1	1.0	0.33	0.48	
2000	Aug	Inlake NE	2.5	3.8	15.7				44.8
2000	Oct	Inlet			14.6	2.0	0.33	0	
2000	Oct	Outlet			29.1	2.0			
2000	Oct	Inlake NE	5	9.3	19.5				45.4
2000	Jun	Inlake NW	2.5	4.1	24.6				47.2
2000	Aug	Inlake NW	2.5	3.2	28.4				47.1
2000	Oct	Inlake NW	5	3.1	14.9				40.5

Table A-6: Clear Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jun	Inlake	3	1.8	20				42.6
2015	Jul	Inlake	2	11.1	50				54.9
2014	Jun	Inlake	2	0.5	40				43.7
2014	Aug	Inlake	3	1.7	40				45.8
2013	Jun	Inlake	1	19.1	110				63.8
2013	Aug	Inlake	1	10.1	40				56.9
2012	Jul	Inlake	3	0.8	40				43.3
2012	Oct	Inlake	2	18.2	80				58.8
2011	Jun	Inlake S	3	0.6	40				42.37
2011	Jun	Inlet			110	0.2	0.1	0.64	
2011	Oct	Inlake S	2	2.5	40				48.98
2010	Jun	Inlake S	3.5	2.9	60				48.73
2010	Jul	Inlake S	2.5	1.9	60				48.96
2010	Aug	Inlake S	2.5	3.9	50				50.44
2009	Jun	Inlake S	2.5	0.6	50				44.3
2009	Aug	Inlake S	2.5	5.3	20				47
2009	Oct	Inlake S	2.5	2.4	30				46.4
2008	Jul	Inlake S	3.5	0.9	30				41.6
2008	Aug	Inlake S	3	2.4	30				45.5
2008	Oct	Inlake S	2.5	6.5	40				51
2004	Jun	Inlet			80	0.2	0.1	0.13	
2004	Jun	Inlake S	2	5	70				53.9
2004	Jul	Inlake S	1.5	8.5	50				55.4
2004	Aug	Inlake S	1	9.8	90				60.7
2004	Sep	Inlake S	1	3.5	30				52

Table A-7: Crevice Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2005	Aug	Inlake	3	1.4	40				45.1

Table A-8: Divide Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2015	Sep	Inlake	5	1.2	10				35.5

Table A-9: Druid Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2014	Aug	Inlake	3	3.6	20				44.9
2013	Jun	Inlake	3	1.8	30				44.6
2013	Aug	Inlake	2	3.8	50				51.4
2012	Jun	Inlake	3	6.4	30				48.7
2012	Aug	Inlake	2	3.5	30				48.7
2012	Oct	Inlake	3	3.8	40				48.4
2011	Jun	Inlake SE	3	1.6	20				42.24
2011	Oct	Inlake SE	2	6.5	50				53.18
2010	Oct	Inlake SE	3.5	7.6	50				51

Table A-10: Duck Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jul	Inlake	2	3.3	50				51
2015	Sep	Inlake	4	0.7	10				34.8
2014	Sep	Inlake	3	0.5	10				35.1
2013	Jun	Inlake	4	0.7	10				34.8
2013	Jul	Inlake	3	0.9	10				37
2013	Aug	Inlake	4	1	10				36
2012	Jun	Inlake	5	0.7	10				33.8
2011	Jun	Inlake SW	4	3.5	20				43.42
2011	Aug	Inlake SW	4	0.5	10				33.73
2010	Jun	Inlake SW	5	1.1	10				35.23
2010	Jul	Inlake SW	4.5	0.8	20				38.03
2009	Aug	Inlake SW	3.5	0.7	9				34.9
2009	Oct	Inlake SW	4.5	2.1	10				37.8
2008	Jun	Inlake SW	2.5	1.9	10				40.3
2003	Aug	Inlake E	2.5	2.7	20				44.8
1999	Jun	Inlake E	5.5	0.5	15				34.1
1999	Aug	Inlake E	5	1.9	13				38.3

Table A-11: Eleanor Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2011	Jul	Inlake E	4	1.5	10				37.32
2010	Jun	Inlake E	4	0.5	10				33.73
2010	Jul	Inlake E	3.5	0.5	10				34.37
2010	Aug	Inlake E	3.5	0.7	10				35.47
2009	Jun	Inlake E	4.5	0.5	10				33.1
2009	Aug	Inlake E	3.5	0.7	9				34.9
2008	Jun	Inlet			30	1.0	0.02	0.33	
2008	Jun	Outlet			20	1.0			
2008	Jun	Inlake E	3.5	0.5	20				41.3
2008	Jul	Inlet			10	5.0	0.02	0	
2008	Jul	Inlake E	2.5	0.5	10				36
2008	Oct	Inlet			20	0.1	0.02	0	
2008	Oct	Inlake E	2.5	2.6	20				44.7
2004	Jun	Inlet			10	1.0	0.02	0	
2004	Jun	Inlake E	5	0.5	10				32.6
2004	Jul	Inlet			10	3.0	0.02	0	
2004	Jul	Inlake E	3.5	1.3	20				40.8
2004	Aug	Inlake E	3	1.2	20				41.3

Table A-12: Feather Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2015	Jul	Inlake	3	1.9	220				54.3
2014	Aug	Inlake	3	2.9	220				55.7
2014	Sep	Inlake	2	2.2	200				56.3
2013	Jun	Inlake	2	3.4	220				58.2
2013	Aug	Inlake	2	6.3	240				60.6
2012	Aug	Inlake	2	4.3	240				59.4
2011	Oct	Inlake S	2	14.5	260				63.73
2010	Oct	Inlake S	2.5	11.5	260				61.9

Table A-13: Floating Island Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2012	Oct	Inlake	1	10.2	190				64.4
2011	Jul	Inlake W	2	28.6	70				59.64
2010	Aug	Inlake W	1.5	24.5	80				61.16
2004	Jul	Inlake W	1	25	150				66.2

Table A-14: Goose Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2015	Jul	Inlake	4	1	20				39.3
2015	Jul	Inlet			30	1.0	0.21	0.333	
2014	Aug	Inlake	3	1.9	20				42.8
2014	Aug	Inlet			30	2.0	0.21	0.333	
2014	Sep	Inlake	4	1.1	10				36.3
2014	Sep	Inlet			20	2.0	0.21	0.5	
2013	Jun	Inlake	3	0.6	20				39
2013	Jun	Inlet			30	2.0	0.21	0.333	
2013	Aug	Inlake	2	2.2	30				47.2
2013	Aug	Inlet			20	1.0	0.21	0	
2012	Aug	Inlake	2	2	30				46.9
2012	Aug	Inlet			30	2.0	0.21	0	
2011	Jun	Inlake W	3	0.9	20				40.36
2011	Jun	Inlet			20	2.5	0.21	0	
2011	Oct	Inlake W	3	3	20				44.3
2011	Oct	Inlet			10	1.0	0.21	0	
2010	Oct	Inlake W	4.5	21.7	20				48.82
2010	Oct	Inlet			20	1.0	0.21	0	
2009	Jun	Inlet			10	3.0	0.21	0	
2009	Jun	Inlake W	4.5	1.2	10				36
2009	Jul	Inlet			50	1.5	0.21	0.6	
2009	Jul	Inlake W	4	1.9	20				41.4
2009	Aug	Inlet			20	2.0	0.21	0.5	
2009	Aug	Inlake W	3.5	1.2	10				37.2
2001	Jul	Inlet			24	2.0	0.21	0.38	
2001	Jul	Inlake W	3.5	0	15				42.6

Table A-15: Grebe Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2012	Aug	Inlake	3	4.5	20				45.6
2012	Aug	Inlet			20	4.0	1.7	0	
2000	Jul	Inlet			15.6	5.0	1.7	0	
2000	Jul	Outlet			19.2	6.0			
2000	Jul	Inlake E	3	3.6	18				43.1
2000	Aug	Inlet			42.2	4.0	1.7	0.38	
2000	Aug	Outlet			26.1	5.0			
2000	Aug	Inlake E	2.5	4.7	22.8				47.3
2000	Jul	Inlake W	3	1.9	25				36.9
2000	Aug	Inlake W	2.5	6.7	32.8				50.2

Table A-16: Grizzly Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2012	Aug	Inlake	6	0.7	10				32.9
2010	Aug	North	4.5	1.5	10				36.75

Table A-17: Harlequin Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2015	Jun	Inlake	2	4.7	30				49.7
2012	Jul	Inlake	2	3	30				48.2
2012	Oct	Inlake	2	19.4	80				59
2011	Jul	Inlake S	2	4.3	30				49.37
2010	Jun	Inlake S	2.5	5.3	30				48.98
2009	Jul	Inlake S	2.5	2.2	20				44.2
2009	Oct	Inlake S	2.5	7.6	40				51.5
2008	Jun	Inlake S	1.5	3.6	20				48.2
2008	Jul	Inlake S	1.5	4.6	30				51
2008	Oct	Inlake S	2	11.7	40				56
2007	Oct	Inlake S	1.5	12.1	150				61.9
2003	Jun	Inlake S	3.5	2	20				42.2
2003	Aug	Inlake S	2.5	2.5	20				44.6
2002	Jul	Inlake S	4	8.8	19				46.2
2001	Jun	Inlake S	2.5	7.3	19				47.8
2001	Jul	Inlake S	2.5	1.4	15				41.3
2001	Aug	Inlake S	2	0.4	15				38.3

Table A-18: Hazel Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jun	Inlake	4	1.1	30				41.6
2016	Jun	Inlet E			100	0.1	0.019	0.7	
2013	Jun	Inlake	3	1.1	30				43
2013	Jun	Inlet			80	1.0	0.019	0.625	
2012	Jun	Inlake	2	2.1	40				48.4
2012	Jun	Inlet E			40	1.0	0.019	1	
2012	Aug	Inlake	2	7	30				51
2012	Aug	Inlet E			90	0.1	0.019	0.667	
2011	Jun	Inlake E	2	1	20				42.65
2011	Jun	Inlet			30	5.0	0.019	0.33	
2011	Jul	Inlake E	2	22.4	20				52.82
2011	Jul	Inlet			40	1.0	0.019	0.5	
2010	Aug	Inlake E	2	97.6	230				69.37
2010	Oct	Inlake E	3.5	1.7	30				43.65
2010	Oct	Inlet			140	5.0	0.019	0.79	
2001	Apr	Inlet			26	5.0	0.019	0	
2001	Apr	Inlake E	2.5	2	26				49
2001	Jun	Inlet			28	1.0	0.019	0.14	
2001	Jun	Inlake E	2.5	1.8	24				44.4
2001	Jul	Inlet			42	1.0	0.019	0.71	
2001	Jul	Inlake E	2.5	0.2	15				33.9
2001	Aug	Inlet			17	0.5	0.019	0.12	
2001	Aug	Inlake E	2	1.9	15				43.4
2001	Oct	Inlet			22	0.3	0.019	0.27	
2001	Oct	Inlake E	1.5	2	16				49.2

Table A-19: Heart Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
1999	Jul	Inlet			13	40.0	2		
1999	Jul	Inlake NW	7.5	0.5	11			0.15	31.1
1999	Jul	Inlake SW	7.5	1.5	15			0	36.2
1999	Aug	Inlet			24	25.0	2		
1999	Aug	Inlake NW	7.5	1.5	13			0.46	35.5
1999	Aug	Inlake SW	7.5	4.4	14			0.42	39.4

Table A-20: Hot Beach Pond

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Oct	Inlake	2	29.9	150				63.4
2013	Aug	Inlake	2	1.1	70				49
2012	Aug	Inlake	1	33.6	590				73.7
2011	Oct	Inlake S	1	10.9	180				64.36
2010	Sep	Inlake S	1.5	372	1300				83.45
2010	Oct	Inlake S	1	88.9	600				77.01
2004	Jun	Inlake S	1	30	200				68.2
2004	Jul	Inlake S	1	13.2	90				61.7
2004	Aug	Inlake S	1	39	480				73.2
2004	Sep	Inlake S	2	3.1	30				48.3

Table A-21: Hot Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jul	Inlake	3	2	30				44.9
2010	Oct	Inlake NW	5	0	30				37.93
2001	Jun	Inlet			10		0.003	0.2	
2001	Jun	Inlake NW	3.5	0	8				38

Table A-22: Ice Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Oct	Inlake	3	3.4	20				44.7
2013	Jun	Inlake	5	1.1	10				35.2
2013	Jul	Inlake	5	1.7	10				36.7
2012	Jul	Inlake	5	0.8	20				37.5
2012	Oct	Inlake	4	2.5	10				39
2011	Aug	Inlake SW	4	2	20				41.59
2010	Sep	Inlake SW	4.5	2.9	20				42.24
2009	Jul	inlet			60	0.1	2.28	0.83	
2009	Jul	Inlake NW	4.5	0.8	10				34.7
2009	Aug	Inlake SW	3.5	1.3	9				37
2009	Oct	Inlake SW	4.5	3.4	10				39.4
2000	Jun	Inlet			25	0.1	2.28	0.16	
2000	Jun	Outlet			21	0.1			
2000	Jun	Inlake NW	2.5	1.7	35				46
2000	Aug	Inlet			34.8	0.1	2.28	0.09	
2000	Aug	Inlake NW	5	2.4	31.8				43.3
2000	Oct	Inlet			22.6	0.1	2.28	0.28	
2000	Oct	Outlet			16.2	0.1			
2000	Oct	Inlake NW	5	2.4	12.5				38.8
2000	Jun	Inlake SW	2.5	1.2	21				42.4
2000	Aug	Inlake SW	5	1.8	18.8				39.9
2000	Oct	Inlake SW	5	2.2	16.2				39.8

Table A-23: Indian Pond

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jun	Inlake	1	1.2	520				62.2
2016	Jun	Inlet			100	0.1	0.2	0	
2016	Oct	Inlake	2	20.7	570				68.7
2015	Jun	Inlake	2	1.6	520				59.9
2015	Jun	Inlet			200	0.1	0.2	0	
2015	Sep	Inlake	2	10.6	520				66
2015	Sep	Inlet			230	0.1	0.2	0	
2014	Jun	Inlake	1	3.3	570				66
2014	Aug	Inlake	2	4.2	530				63.1
2014	Oct	Inlake	2	4.6	530				63.4
2013	Jun	Inlake	2	1.1	540				58.8
2013	Jun	Inlet			160	0.0	0.2	0	
2013	Jul	Inlake	1	2.7	550				65.2
2013	Aug	Inlake	2	7.6	570				65.4
2013	Aug	Inlet			1000	0.1	0.2	0.45	

Table A-24: Indian Pond Continued

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2012	Jun	Inlake	2	1.2	550				59.2
2012	Jun	Inlet			110	0.3	0.2	0	
2012	Jul	Inlake	2	1.8	560				60.6
2012	Jul	Inlet			150	0.1	0.2	0	
2012	Aug	Inlake	2	79.9	680				73.9
2012	Aug	Inlet			160	0.1	0.2	0	
2011	Jul	Inlake W	3	2.5	300				56.72
2011	Aug	Inlake W	3	4.6	550				61.63
2011	Aug	Inlet			110	0.2	0.2	0	
2011	Oct	Inlake W	2	4.2	530				63.1
2010	Jun	Inlake W	4.5	2.7	500				57.48
2010	Jun	Inlet			200	0.2	0.2	0	
2010	Jul	Inlake W	2.5	1.2	490				62.93
2010	Jul	Inlet			220	0.1	0.2	0	
2010	Aug	Inlake W	1.5	2.5	580				63.22
2010	Sep	Inlake W	2.5	6.6	640				64.41
2010	Oct	Inlake W	3.5	6.6	550				62.07
2010	Oct	Inlet			130	0.1	0.2	0	
2009	Jun	Inlet			500	0.2	0.2	0.88	
2009	Jun	Inlake W	4.5	2.5	60				47
2009	Jul	Inlet			50	0.5	0.2	0	
2009	Jul	Inlake W	3.5	8.9	510				62.7
2009	Aug	Inlet			100	0.1	0.2	0	
2009	Aug	Inlake W	2.5	10.7	500				64.8
2009	Oct	Inlet			190	0.1	0.2	0	
2009	Oct	Inlake W	3.5	11.9	530				63.8
2008	Jun	Inlet			140	0.5	0.2	0	
2008	Jun	Inlake W	3.5	1.5	500				56.8
2008	Jul	Inlet			60	0.2	0.2	0	
2008	Jul	Inlake W	3.5	2.8	480				58.6
2008	Aug	Inlet			100	0.2	0.2	0	
2008	Aug	Inlake W	2.5	9.7	530				64.8
2008	Oct	Inlet			90	0.5	0.2	0	
2008	Oct	Inlake W	2.5	12.8	530				65.7
2006	Jun	Inlet			110	0.5	0.2	0	
2006	Jun	Outlet			550	0.5	0.2		
2006	Jun	Inlake S	2	0.9	520				58
2005	Jun	Inlet			60	0.4	0.2	0	
2005	Jun	Inlake W	2	0.7	510				57.1
2005	Jul	Inlet			140	0.4	0.2	0	
2005	Jul	Inlake W	2.5	0.9	500				56.7
2005	Aug	Inlake W	2	9.5	550				65.9
2005	Oct	Inlake W	3	55.3	610				70.3
2004	Jun	Inlake W	2	3.9	510				62.7
2004	Jul	Inlake W	1.5	0.9	530				59.4
2004	Aug	Inlake W	1.5	8.1	610				67.3
2004	Sep	Inlake W	1	4.2	530				66.4

Table A-25: Isa Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jul	Inlake	3	3.6	20				44.9
2012	Aug	Inlake	2	2.7	30				47.9
2011	Oct	Inlake	1	2.5	40				52.31
2010	Jul	Inlake	2.5	2.3	40				47.64
2010	Oct	Inlake	2.5	5.3	30				48.98
1999	Aug	Inlake	2.5	4.2	30				44.6

Table A-26: Joffee Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2012	Aug	Inlake	4	0.5	10				33.7
2012	Oct	Inlake	4	0.5	10				33.7

Table A-27: Joffee Lake II

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2013	Aug	Inlake	4	0.5	10				33.7

Table A-28: Lake of the Woods

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2010	Sep	Inlake S	2.5	87.1	260				68.52
2010	Sep	Inlet			60	1.0	1	0	
2001	Jun	Inlake S	3.5	5.2	27				46.8

Table A-29: Lewis Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2013	Jul	Inlake	8	0.5	10				30.4
2012	Jul	Inlake	6	0.6	20				35.7
2012	Jul	Inlet NE			20	0.0	0.8	0	
2011	Jun	Inlake SE	5	1.2	10				35.52
2011	Aug	Inlake SE	5	0.7	20				37.09
2010	Jun	Inlake SE	6	1.7	10				35.78
2010	Aug	Inlake SE	5.5	0.7	20				36.63
2009	Aug	Inlake NE	5	1.3	20				39.1
2009	Jun	Inlake SE	4	1.5	20				40.6
2009	Oct	Inlake SE	5	0.9	10				34.6
1999	Jun	Inlet N			16	5.0	0.8	0.73	
1999	Jun	Inlake N	6	0.7	16				35.1
1999	Jun	Inlake SE	6	1.9	14				37.7
1999	Jul	Inlet NW			10	250.0	0.8	0	
1999	Jul	Inlake N	7.5	0.9	36				38.8
1999	Aug	Inlet N			41	1.0	0.8	0.13	
1999	Aug	Inlet NW			16.7	200.0	0.8	0.93	
1999	Aug	Inlake N	7.5	2.9	12				37.3
1999	Aug	Inlake N	7.5	1.7	12				35.6
1999	Aug	Inlake SE	7	1.1	11				35.1
1998	Sep	Inlake SE	7	1.3	20				40.3

Table A-30: Lily Pad Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jun	Inlake	1	13.4	40				57.8
2015	Jul	Inlake	2	3.1	20				46.4
2014	Jun	Inlake	3	0.6	20				39
2014	Aug	Inlake	3	0.5	10				35.1
2013	Jun	Inlake	3	1.2	30				43.3
2013	Aug	Inlake	2	2	20				44.9
2012	Jul	Inlake	3	2.2	30				45.2
2012	Oct	Inlake	2	10.1	60				55.5
2011	Jun	Inlake S	2	1.7	20				44.39
2011	Oct	Inlake S	1	116	230				73.27
2010	Jun	Inlake S	2.5	1.5	10				39.58
2010	Jul	Inlake S	2.5	4.1	20				46.2
2010	Aug	Inlake S	2.5	2.4	20				44.44
2010	Sep	Inlake S	2.5	49.1	190				65.14
2009	Jun	Inlake S	1.5	0.9	20				43.7
2009	Aug	Inlake S	3.5	1.1	10				36.9
2009	Oct	Inlake S	2.5	8.3	40				51.8
2008	Jul	Inlake S	3.5	0.9	10				36.3
2008	Aug	Inlake S	2.5	14.2	20				50.2
2008	Oct	Inlake S	2.5	29.5	70				58.7
2006	Jun	Inlake S	4	0.5	50				31.9
2004	Jun	Inlake S	2	0.5	10				37
2004	Jul	Inlake S	2	2.4	10				42.2
2004	Aug	Inlake S	1.5	1.4	10				41.8
2004	Oct	Inlake S	2	1.2	10				39.9

Table A-31: Lost Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jun	Inlake	4	3.5	10				40.1
2015	Jul	Inlake	2	3.5	20				46.7
2015	Sep	Inlake	2	4.4	20				47.5
2014	Jun	Inlake	2	2.6	30				47.7
2014	Aug	Inlake	2	5.2	20				48
2014	Sep	Inlake	3	4	20				45.2
2013	Jun	Inlake	3	3.9	20				45.2
2013	Aug	Inlake	2	5.2	20				48
2012	Jun	Inlake	3	0.7	50				43.9
2012	Aug	Inlake	2	4.5	30				49.5
2012	Oct	Inlake	2	23.4	60				58.2

Table A-32: Lost Lake Continued

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2011	Jun	Inlake N	2	8.7	40				53.06
2011	Jul	Inlake N	3	3.1	30				46.35
2011	Aug	Inlake N	3	4	10				41.91
2011	Aug	inlet			30	0.0	0.51	0.67	
2010	Jun	Inlake N	2.5	1.5	10				47
2010	Jul	Inlake N	2.5	4.1	20				48.9
2010	Aug	Inlake N	2.5	2.4	20				49.8
2010	Sep	Inlake NE	2.5	49.1	190				49.6
2009	Jun	Inlake N	2.5	4.2	20				46.3
2009	Jul	Inlet			90	0.0	0.51	0.667	
2009	Jul	Inlake N	2.5	5.9	30				49.3
2009	Aug	Inlet			30	0.5	0.51	0.333	
2009	Aug	Inlake NW	2.5	8.9	20				48.7
2009	Oct	Inlake NW	2.5	13.7	40				53.5
2008	Jun	Inlet			50	1.0	0.51	0.4	
2008	Jun	Inlake N	2.5	4.8	30				48.7
2008	Aug	Inlet			60	0.0	0.51	0.67	
2008	Aug	Inlake N	1.5	5.4	20				49.5
2008	Oct	Inlet			60	0.0	0.51	0.67	
2008	Oct	Inlake N	2	7.9	20				49.4
2007	Aug	Inlet			50	0.1	0.51	0.2	
2007	Aug	Inlake N	2.5	4.9	40				50.1
2006	Jun	Inlet			60	0.5	0.51	0.33	
2006	Jun	Inlake N	2.5	3.1	40				48.6
2005	May	Inlet			50	0.5	0.51	0.4	
2005	May	Inlake N	2.5	2.7	30				46.8
2005	Jun	Inlet			60	0.5	0.51	0.5	
2005	Jun	Inlake N	3	1.6	30				44.2
2005	Jul	Inlet			60	0.5	0.51	0.5	
2005	Jul	Inlake N	1	18.5	30				57.5
2005	Aug	Inlet			70	0.5	0.51	0.71	
2005	Aug	Inlake N	2.75	3.3	20				45
2005	Oct	Inlake N	2	15.3	40				54.9
2004	Jun	Inlet			100	0.5	0.55	0.7	
2004	Jun	Inlake N	1.75	7.6	30				51.9
2004	Jul	Inlet			30	0.5	0.55	0.33	
2004	Jul	Outlet			20	0.5			
2004	Jul	Inlake N	1.5	15.8	30				55
2004	Aug	Inlet			90	0.5	0.55	0.67	
2004	Aug	Inlake N	3	4.4	30				47.5
2004	Sep	Inlet			50	0.5	0.55	0.4	
2004	Sep	Inlake N	2	0.9	30				44.3

Table A-33: Lower Basin Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jul	Inlake	3	2.6	310				57
2015	Jul	Inlake	2	8.7	280				62.4
2014	Jun	Inlake	2	2.5	290				58.5
2014	Aug	Inlake	2	2.3	280				58.1
2014	Oct	Inlake	2	8.5	280				62.3
2013	Jun	Inlake	2	8.2	310				62.7
2013	Jul	Inlake	2	1.8	300				57.6
2013	Aug	Inlake	2	2	290				57.8
2012	Aug	Inlake	2	3.1	310				59.5
2012	Oct	Inlake	3	5.3	320				59.5

Table A-34: Mallard Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2010	Aug	Inlake SE	4.5	1.2	20				39.35
2010	Aug	Inlet			30	1.0	1	0.33	

Table A-35: North Twin Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2014	Sep	Inlake	4	0.5	30				39
2014	Sep	Inlet			120	1.0	0.49	0.75	
2013	Jun	Inlake	2	3.1	40				49.7
2013	Jun	Inlet			260	0.5	0.49	0.84615385	
2013	Aug	Inlake	2	2.6	50				50.2
2013	Aug	Inlet			140	0.0	0.49	0.64285714	
2012	Jul	Inlake	2	2.1	30				47
2012	Jul	Inlet			170	1.0	0.49	0.82352941	
2012	Oct	Inlake	3	1	50				45.1
2012	Oct	Inlet			170	0.1	0.49	0.70588235	
2011	Jun	Inlake E	3	0.5	30				40.39
2011	Jun	Inlet			60	2.0	0.49	0.5	
2011	Oct	Inlake E	3	1.4	30				43.76
2011	Oct	Inlet			130	0.3	0.49	0.77	
2010	Jun	Inlake E	2.5	2.9	30				47.01
2010	Jun	inlet			100	2.0	0.49	0.7	
2010	Jul	Inlake E	3.5	0.7	40				42.13
2010	Jul	inlet			170	0.5	0.49	0.76	
2010	Aug	Inlake E	2.5	1.2	50				46.58
2010	Aug	inlet			190	0.5	0.49	0.74	
2009	Jun	inlet			200	2.0	0.49	0.8	
2009	Jun	Inlake E	3.5	6.8	40				49.6
2009	Jul	inlet			40	0.5	0.49	0	
2009	Jul	Inlake E	3.5	1.4	190				51.9
2009	Aug	inlet			200	0.1	0.49	0.85	
2009	Aug	Inlake E	3.5	0.8	30				41.25
2009	Oct	inlet			150	0.1	0.49	0.6	
2009	Oct	Inlake E	3.5	2	60				47.5
2008	Jun	inlet			140	2.0	0.49	0.86	
2008	Jun	Inlake E	2.5	3.8	20				45.9
2008	Jul	inlet			200	0.5	0.49	0.85	
2008	Jul	Inlake E	3.5	4.1	30				46.5
2008	Aug	inlet			170	0.3	0.49	0.35	
2008	Aug	Inlake E	2.5	17.1	110				59.1
2008	Oct	inlet			160	0.3	0.49	0.88	
2008	Oct	Inlake E	3	1.3	20				41.6
2001	Apr	inlet			71	2.0	0.49	0.77	
2001	Apr	Inlake E	3.5	3.1	16				42.6
2001	Jun	inlet			113	0.5	0.49	0.76	
2001	Jun	Inlake E	2.5	1.1	27				43.3
2001	Jul	inlet			103	0.5	0.49	0.88	
2001	Jul	Inlake E	3	0	12				42.1
2001	Aug	inlet			70	0.5	0.49	0.86	
2001	Aug	Inlake E	2.5	0	10				42.1
2001	Oct	inlet			70	0.3	0.49	0.77	
2001	Oct	Inlake E	2.5		16				45.5

Table A-36: Nymph Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2014	Aug	Inlake	1	148	150				72
2014	Aug	Inlet N			1000	2.0	0.055	0.84	
2013	Jun	Inlake	1	3.9	100				58.2
2013	Aug	Inlake	1	6.1	160				61.9
2013	Aug	Inlet N			210	0.5	0.055	0.52380952	
2012	Jun	Inlake	1	2.5	100				56.7
2012	Jun	Inlet N			80	3.0	0.055	0	
2012	Aug	Inlake	2	6.8	110				57.1
2012	Aug	Inlet N			140	1.0	0.055	0.21428571	
2011	Jul	Inlake E	1	9.3	100				61.011
2011	Aug	Inlet N			130	4.0	0.055	0.44	
2011	Aug	Inlet E			50	1.0	0.055	0.44	
2010	Jun	Inlake E	2.5	2.5	70				50.6
2010	Jun	inlet N			50	6.0	0.055	0	
2010	Jul	Inlake E	2.5	14.4	130				59.3
2010	Jul	Inlet N			120	3.0	0.055	0	
2010	Aug	Inlake E	2	9.5	150				59.7
2010	Aug	Inlet N			120	3.0	0.055	0	
2009	Jul	Inlet			110	2.0	0.055	0	
2009	Jul	Inlake E	2	10.1	180				60.8
2009	Aug	Inlet			100	1.5	0.055	0	
2009	Aug	Inlake E	2.5	6.3	100				55.3
2009	Oct	Inlet			110	2.0	0.055	0	
2009	Oct	Inlake E	2.5	1.6	120				51.7
2008	Jun	Inlet			30	1.0	0.055	0	
2008	Jun	Inlake E	1.5	16.7	120				61.9
2008	Oct	Inlet			90	0.5	0.055	0	
2008	Oct	Inlake E	1.5	4.7	110				57.3
2001	Apr	Inlet			20	5.0	0.055	0	
2001	Apr	Inlake E	3	1.2	62				46.7
2001	Jun	Inlet			16	3.0	0.055	0	
2001	Jun	Inlake E	2.5	0.9	65				46.9
2001	Jul	Inlet			22	2.0	0.055	0	
2001	Jul	Inlake E	0.5	2.4	38				55.3
2001	Aug	Inlet			10	1.5	0.055	0	
2001	Aug	Inlake E	0.15	4.7	203				71.3
2001	Oct	Inlet			16	1.0	0.055	0	
2001	Oct	Inlake E	0.1	0	130				83.8

Table A-37: Petrified Tree Stream

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jun	Inlet to Lost Lake			10	0.3		0	
2014	Jun	Inlet to Lost Lake			30	2.0		0	
2012	Jun	Inlet to Lost Lake			20	2.0		0	

Table A-38: Pool by Morning Glory Pool

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2012	Aug	Inlake	5	3.1	560				58
2010	Oct	Inlake	5	3.9	520				58.36
2001	Aug	Inlake	5	4	12				38.4

Table A-39: Ribbon Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2013	Aug	Inlake	3	8.6	10				44.4
2010	Sep	Inlake N	2	26.8	40				56.74
2006	Jun	Outlet			50	2.0	0.01	0	
2006	Jun	Inlake NE	0.7	2.3	40				53.8
2006	Jun	Inlake NW	0.7	1.7	50				53.8

Table A-40: Riddle Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2010	Oct	Inlake NW	2.5	14.4	80				56.97
2008	Jul	Inlet			134	1.0	2	0.85	
2008	Jul	Inlake NW	4	6.9	20				45.6
1999	Aug	Inlake NW	7.5	4.1	14				39.2

Table A-41: Scaup Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jul	Inlake	1	32.9	70				63.4
2013	Jul	Inlake	2	7.2	40				52.4
2012	Aug	Inlake	2	12.1	30				52.8
2011	Oct	Inlake S	2	3.3	20				46.56
2010	Aug	Inlake S	2.5	7.1	50				52.4
2002	Aug	Inlake S	2	4.5	22				48

Table A-42: Shoshone Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2010	Aug	Inlake NE	5	0.9	20				37.91
2010	Aug	Inlet			40	3.0	3.6	0.5	
1999	Jun	Inlet			26	200.0	3.6	0.61	
1999	Jun	Inlake NE	6	1	15				36
1999	Jul	Inlet			13	65.0	3.6	0.42	
1999	Jul	Inlake W	7.5	0.5	15				32.6
1999	Jul	Outlet			11	200.0	3.6	0	
1999	Jul	Inlake NW	7.5	1.7	9				34.2
1999	Aug	Inlet			74	8.0	3.6	0	
1999	Aug	Inlake SW	7.5	1.3	478				52.4
1999	Aug	Inlake SE	7.5	1.4	18				36.9
1998	Sep	Inlake NE	7.5	1.1	36				43.7

Table A-43: Shrimp Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2013	Aug	Inlake	3	2.6	60				49.1
2012	Aug	Inlake	2	1.6	80				50.9
2011	Oct	Inlake SW	2	1	70				48.68
2005	Jul	Inlake SW	2.5	8.9	50				53.1
2005	Aug	Inlake SW	3	8	30				48.7
2004	Sep	Inlake SW	2.5	8.9	150				64.2

Table A-44: South Twin Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2014	Sep	Inlake	4	0.7	30				40.1
2014	Sep	Inlet			30	1.0	0.8	0	
2013	Jun	Inlake	3	3.5	40				48.1
2013	Aug	Inlake	4	1.2	30				41.9
2013	Aug	Inlet			30	0.0	0.8	0	
2012	Jun	Inlake	4	1.8	30				43.2
2012	Jun	Inlet			30	1.0	0.8	0	
2012	Oct	Inlake	3	2	30				44.9
2011	Jun	Inlake E	3	3.6	20				44.89
2011	Jun	Inlet**			30	1.0	0.8	0	
2011	Oct	Inlake E	2	9.7	40				53.41
2011	Oct	Inlet**			30	1.0	0.8	0	
2010	Jun	Inlake E	1.5	7.5	50				55.03
2010	Jun	Inlet**			30	1.0	0.8	0	
2010	Jul	Inlake E	3.5	1.1	40				43.61
2010	Jul	Inlet**			40	1.0	0.8	0	
2010	Aug	Inlake E	3.5	1.7	40				45.03
2010	Aug	Inlet**			50	1.0	0.8	0	
2009	Jun	Inlake E	2.5	4.4	30				48.4
2009	Jun	Inlet**			40	1.0	0.8	0	
2009	Jul	Inlet**			190	1.0	0.8	0	51.9
2009	Jul	Inlake E	3.5	1.6	40				44.8
2009	Aug	Inlet**			30	1.0	0.8	0	41.2
2009	Aug	Inlake E	3.5	1.7	40				45
2009	Oct	Inlet**			60	1.0	0.8	0	
2009	Oct	Inlake E	3.5	2	50				46.6
2008	Jun	Inlake E	1	3.4	30				51.9
2008	Jun	Inlet**			20	1.0	0.8	0	
2008	Jul	Inlake E	3.5	1.6	20				41.5
2008	Jul	Inlet**			30	1.0	0.8	0	
2008	Aug	Inlet**			110	1.0	0.8	0	
2008	Aug	Inlake E	3.5	1.2	20				40.6
2008	Oct	Inlet**			20	1.0	0.8	0	
2008	Oct	Inlake E	3.5	4.5	30				46.8
2001	Apr	Inlet**			16	1.0	0.8	0	
2001	Apr	Inlake E	3	2	30				44.2
2001	Jun	Inlet**			27	1.0	0.8	0	
2001	Jun	Inlake E	2.5	2.5	28				46.2
2001	Jul	Inlet**			12	1.0	0.8	0	
2001	Jul	Inlake E	3.5	0.8	11				36.4
2001	Aug	Inlet**			10	1.0	0.8	0	
2001	Aug	Inlake E	2.5	0	12				43.4
2001	Oct	Inlet**			16	1.0	0.8	0	
2001	Oct	Inlake E	2.5	2	16				45.5

Table A-45: Swan Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2015	Jun	Inlake	2	2.1	30				47
2014	Jun	Inlake	2	3.8	30				49
2014	Aug	Inlake	2	3.8	30				49
2014	Sep	Inlake	2	6.7	40				52.2
2013	Jun	Inlake	2	7.1	40				52.4
2013	Aug	Inlake	1	7.6	60				57.9
2012	Jun	Inlake	4	1.8	20				41.2
2012	Oct	Inlake	1	21.3	210				67.3
2011	Jun	Inlake S	3	0.9	20				40.36
2011	Oct	Inlake S	2	6.4	70				54.75
2010	Jun	Inlake S	3.5	1.6	20				41.5
2010	Jul	Inlake S	2.5	4.7	40				49.97
2010	Aug	Inlake S	1.5	14.4	100				60.49
2009	Jun	Inlake S	3.5	1.8	20				41.9
2009	Jul	Inlake S	2.5	18.7	140				60.5
2009	Aug	Inlake S	2.5	1.7	20				43.3
2009	Oct	Inlake S	1.5	4.9	50				53.6
2008	Jun	Inlake S	2.5	2.3	40				47.6
2008	Jul	Inlake S	2.5	1.4	30				44.6
2008	Aug	Inlake S	2.5	7.6	40				51.5
2008	Oct	Inlake S	2.5	3.3	30				47.4
2001	Apr	Inlake S	2	4.3	54				52.2
2001	Jun	Inlake S	2.5	2.4	49				48.7
2001	Jul	Inlake S	3.5	0.5	24				38.6
2001	Aug	Inlake S	2	0.3	24				43.5

Table A-46: Sylvan Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Oct	Inlake	4	2.4	10				38.9
2016	Oct	Inlet N			20	0.1	0.2	0.5	
2013	Jun	Inlake	5	0.8	10				34.2
2013	Jun	Inlet E			10	10.0	0.2	0	
2012	Jun	Inlake	5	1	10				34.9
2012	Jun	Inlet E			30	25.0	0.2	0.67	
2012	Jul	Inlake	4	2	10				38.3
2012	Jul	Inlet NW			10	2.0	0.2	0	
2011	Jul	Inlake N	4	0.8	10				35.26
2011	Jul	Inlet N			20	2.0	0.2	0.5	
2011	Oct	Inlake N	4	3.6	10				40.18
2011	Oct	Inlet N			10	1.0	0.2	0.5	
2010	Jun	Inlake N	4.5	2.2	10				38
2010	Jun	Inlet N			10	3.0	0.2	0	
2010	Jul	Inlake N	3.5	1.3	10				37.49
2010	Jul	Inlet N			10	2.0	0.2	0	
2010	Aug	Inlake N	4.5	1.3	10				36.28
2010	Aug	Inlet N			20	1.0	0.2	0.5	
2009	Jun	Inlet N			9	3.0	0.2	0	
2009	Jun	Inlet E			10	20.0	0.2		
2009	Jun	Inlake N	4.5	0.5	60				41.8
2009	Jul	Inlet N			9	1.0	0.2	0	
2009	Jul	Inlake N	4.5	2.1	10				37.8
2009	Aug	Inlet E			9	5.0	0.2	0	
2009	Aug	Inlake N	4.5	1.2	9				35.5
2009	Oct	Inlet N			9	0.5	0.2	0	
2009	Oct	Inlake N	4.5	1.6	10				37
2008	Jun	Inlet E			90	20.0	0.2	0.89	
2008	Jun	Inlake N	3.5	0.9	10				36.3
2008	Jul	Inlet N			20	1.0	0.2	0.5	
2008	Jul	Inlake N	3.5	0.5	10				34.4
2008	Oct	Inlet N			10	0.5	0.2	0	
2008	Oct	Inlake N	3.5	1.2	10				37.2
2004	Jun	Inlet N			10	1.0	0.2	0	
2004	Jun	Inlake NE	3.5	2.7	20				43.2
2004	Jul	Inlet N			10	1.0	0.2	0	
2004	Jul	Inlake NE	3.5	3.3	10				40.5
2004	Aug	Inlet N			10	5.0	0.2	0	
2004	Aug	Inlake NE	3	1.8	10				39.3
2004	Sep	Inlet N			10	5.0	0.2	0	
2004	Sep	Inlake NE	3	1.9	10				39.5
2004	Jun	Inlake N	3.5	0.5	30			0	39.6
2004	Jul	Inlake N	3	2.1	10			0	39.8
2004	Aug	Inlake NW	3	1.2	10			0	38
2004	Sep	Inlake N	3	1.2	10			0	38

Table A-47: Tanager Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2013	Aug	Inlake	3	2	20				43
2012	Jul	Inlake	4	2.8	20				42.7
2011	Aug	Inlake SE	3	1	10				37.37
2010	Sep	Inlake SE	3.5	1.2	20				40.56
2009	Aug	Inlake SE	3.5	1.9	10				38.7
2004	Jun	Outlet			20	1.0			
2004	Jun	Inlake SE	1.5	2.7	30				49.2
2004	Jul	Inlake SE	2	2.2	20				45.2
2004	Aug	Inlake SE	2	1.9	20				44.7
2004	Sep	Inlake SE	2	1.6	10				40.8

Table A-48: Terrace Springs

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Sep	Inlake	3	3	90				51.5
2014	Oct	Inlake	2	4.6	80				54.3
2011	Jul	Inlake S	3	0.9	70				46.38
2010	Oct	Inlake S	5	1.2	80				45.51
2007	Oct	Inlake S	4.5	0.5	60				41.8

Table A-49: Trout Lake East

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Jun	Inlake	2	8.3	200				60.6
2016	Jun	Inlet			80	4.0	0.3	0	
2015	Jun	Inlake	3	3.3	60				49.9
2015	Jun	Inlet			90	5.0	0.3	0.33	
2015	Sep	Inlake	3	3.1	80				51.1
2015	Sep	Inlet			90	4.0	0.3	0.11	
2014	Jun	Inlake	2	2.4	70				51.5
2014	Jun	Inlet			80	5.0	0.3	0.125	
2014	Aug	Inlake	3	1.1	60				46.3
2014	Aug	Inlet			80	5.0	0.3	0.25	
2013	Jun	Inlake	4	1.5	90				47.9
2013	Jun	Inlet			90	5.0	0.3	0	
2013	Aug	Inlake	3	2.8	100				51.8
2013	Aug	Inlet			80	4.0	0.3	0	
2012	Jun	Inlake	2	1	80				49.3
2012	Jun	Inlet			90	10.0	0.3	0.11	
2012	Aug	Inlake	3	0.8	70				46
2012	Aug	Inlet			90	5.0	0.3	0.22	
2011	Jun	Inlake E	3	4.3	90				52.71

Table A-50: Trout Lake East Continued

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2011	Jun	Inlet			80	10.0	0.3	0	
2011	Jul	Inlake E	3	0.5	80				45.1
2011	Jul	Inlet			90	15.0	0.3	0.11	
2011	Aug	Inlake E	3	0.8	70				46
2011	Aug	Inlet			90	10.0	0.3	0.22	
2011	Oct	Inlake E	3	1.8	80				49.29
2011	Oct	Inlet			90	6.0	0.3	0.11	
2010	Jun	Inlake E	5	1.1	80				45.23
2010	Jun	Inlet			80	10.0	0.3	0	
2010	Jul	Inlake E	3.5	9.2	230				58.96
2010	Jul	Inlet			90	4.0	0.3	0	
2010	Aug	Inlake E	3.5	0.7	90				46.03
2010	Aug	Inlet			90	6.0	0.3	0	
2009	Jun	Inlet			80	10.0	0.3	0.25	
2009	Jun	Inlake E	3.5	2.9	60				48.7
2009	Jul	Inlet			80	5.0	0.3	0.13	
2009	Jul	Inlake E	3.5	0.9	70				45.6
2009	Aug	Inlet			90	5.0	0.3	0.22	
2009	Aug	Inlake E	2.5	0.5	70				45.3
2009	Oct	Inlet			110	4.5	0.3	0.36	
2009	Oct	Inlake E	4.5	0.8	70				44
2008	Jun	Inlet			70	5.0	0.3	0	
2008	Jun	Inlake E	3.5	0.9	70				45.6
2008	Jul	Inlet			180	6.0	0.3	0.61	
2008	Jul	Inlake E	4.5	1.2	70				45.4
2008	Oct	Inlet			100	5.0	0.3	0.3	
2008	Oct	Inlake E	4	2.3	70				48.1
2007	Aug	Inlet			90	3.5	0.3	0	
2007	Aug	Outlet			90	4.5			
2007	Aug	Inlake E	3.5	4	80				51.2
2006	Jun	Inlet			90	5.0	0.3	0.11	
2006	Jun	Outlet			80	6.0			
2006	Jun	Inlake E	2.8	0.5	90				46
2005	May	Inlet			100	7.0	0.3	0.4	
2005	May	Inlake E	3	0.6	60				44.3
2005	Jun	Inlet			90	6.0	0.3	0.22	
2005	Jun	Inlake E	3	1.3	70				47.6
2005	Aug	Inlet			90	4.0	0.3	0.33	
2005	Aug	Inlake E	2.5	1.4	60				48
2005	Oct	Inlet			80	4.0	0.3	0.13	

Table A-51: Trout Lake East Continued

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2005	Oct	Inlake E	3	5.3	70				52.2
2004	Jun	Inlet			80	6.0	0.3	0	
2004	Jun	Inlake E	1.5	1.2	110				52.8
2004	Jul	Inlet			80	5.0	0.3	0	
2004	Jul	Inlake E	2.5	3	90				52.4
2004	Aug	Inlet			100	4.0	0.3	0	
2004	Aug	Outlet			100	5.0			
2004	Aug	Inlake E	3.5	2.4	80				49.5
2004	Sep	Inlet			80	4.0	0.3	0	
2004	Sep	Inlake E	2.5	1.1	80				48.6

Table A-52: Trout Lake West

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2010	Aug	Inlake W	3.5	1.2	90				47.79
2009	Jul	Inlake W	3.5	3.5	80				50.7
2005	May	Inlake W	3	1.1	60				46.3
2005	Jun	Inlake W	3	1.1	70				47
2005	Jul	Inlet			80	5.0	0.3	0.25	
2005	Jul	Inlake W	3	0.6	60				44.3

Table A-53: Trumpeter Pond

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2010	Sep	Inlake W	0.5	58.5	250				74.76
2010	Oct	Inlake W	1	25	460				71.58
2004	Sep	Inlake W	1	27.9	340				70.5
2004	Sep	Inlake E	1	21.8	120				64.7

Table A-54: Turbid Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2012	Jun	Inlake	2	13.2	90				58.3
2012	Jun	Inlet			60	3.0	0.82	0	
2004	Jul	Outlet			50	8.0			
2004	Jul	Inlake NW	2	27.1	60				58.7
2004	Aug	Inlet			60	4.0	0.82	0	
2004	Aug	Outlet			120	6.0			
2004	Aug	Inlake SW	1	61.4	360				73.3

Table A-55: Wolf Lake

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2012	Aug	Inlake	3	3.8	20				45.1
2012	Aug	Inlet			20	5.0	0.47	0	
2000	Jul	Inlet			19.2	10.0	0.47	0	
2000	Jul	Outlet			24.7	10.0			
2000	Jul	Inlake N	2.5	2	18				42.1
2000	Aug	Inlet			26.1	3.0	0.47	0.05	
2000	Aug	Inlake N	2.5	20.7	24.7				52.5
2000	Jul	Inlake S		2	26				37.4
2000	Aug	Inlake S	2.5	3.9	35.8				48.8

Table A-56: Yellowstone Lake at Bridge Bay

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Oct	Inlake	3	1.6	50				46.6
2013	Aug	Inlake	4	2	20				41.6
2011	Aug	Inlake***	4	1	20				39.32
2010	Aug	Inlake	4.5	1.2	30				41.3
2004	Jun	Inlake	3	0.5	30				40.4
2004	Jul	Inlake	6	0.5	20				35.1
2004	Aug	Inlake	6	1.2	30				39.9
2004	Sep	Inlake	3.5	0.5	20				37.7

Table A-57: Yellowstone Lake at Grant Marina

Year	Month	Location	Secchi Depth (meters)	Chlorophyll-a (ppb)	Phosphorus (ppb)	Flow (cfs)	Hydraulic Residence Time (years)	Phosphorus Retention Coefficient	Carlson TSI
2016	Oct	Inlake	6	0.07	30				30.6
2013	Jul	Inlake	5	0.5	20				36
2011	Jul	Inlake	4	1.1	20				39.64
2010	Aug	Inlake	5	0	20				35.99
2004	Jul	Inlake	6	0.9	30				39
2004	Aug	Inlake	6	0.6	30				37.6

