Water Quality Conditions

and

Long-Term Trends in Alberta Lakes

Government of Alberta

Water Quality Conditions and Long-Term Trends in Alberta Lakes

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Corrections

The following corrections were made to the report. They primarily concern the reporting of total phosphorus (TP) concentrations for Saskatoon Lake which were incorrectly summarised in the text. There are no changes to the TP data in the Tables and Figures.

Executive Summary (p. i) – replaced the sentence:

- *For lakes with trends, the overall change of TP was up to 10-fold greater than that of chlorophyll-a.* with
- *For lakes with trends, the overall change of TP was up to two orders of magnitude greater than that of chlorophyll-a.*

Results and Discussion (p. 15, final paragraph) – replaced the sentence:

- *Lakes with a significant increase of TP showed overall changes of less than about 30 ug/L (i.e., Baptiste, north basin; Crimson; Dillberry; Gregg; Gregoire; Jarvis; McLeod, east basin; Reesor; and Saskatoon) and up to about 60 ug/L (Steele and Thunder) (Table 13; Figures 51 to 93).* with
- *Lakes with a significant increase of TP showed overall changes of less than about 30 ug/L (Baptiste, north basin; Crimson; Dillberry; Gregg; Gregoire; Jarvis; McLeod, east basin; and Reesor) and from about 50 to 280 ug/L (Thunder, Steele and Saskatoon) (Table 13; Figures 51 to 93).*

Main Findings (p. 23) – replaced the sentence:

- *For lakes with trends, the overall change in TP was about ten-fold greater (up to 60 ug/L) than that for chlorophyll-a (<6 ug/L).* with
- *For lakes with trends, the overall change in TP was one to two orders of magnitude greater (up to about 280 ug/L) than that for chlorophyll-a (≤6 ug/L).*

Table 1 (p. 32) - The Table was re-formatted to show the complete information for Winagami Lake which was obscured in the original Table.

Figure 88 and 89 (p. 374 & 378) – Typos in the Figure headings were corrected.

Date: March 2013

The report including the revisions was re-posted to the Government of Alberta website: http://environment.gov.ab.ca/info/library/8544.pdf

EXECUTIVE SUMMARY

Alberta Environment and Water (AEW) monitors the surface water quality of provincial lakes to evaluate short- and long-term environmental conditions, and to inform lake management and policy. Monitoring of Alberta lakes reflects the ongoing demand for knowledge on current conditions, trends, ecology and impacts on lakes. Over time this demand has come from within AEW, partners and other users of lakes. Until now, there has been no statistical evaluation of long-term water quality trends for a comprehensive set of Alberta lakes.

Objectives of the study were to: (1) review the AEW provincial water quality database and select lakes with long-term data suitable for statistical trend analysis; (2) provide an overview of water quality conditions and long-term trends in the lakes; and (3) investigate the influences of water management and lake level on water quality.

Study Lakes: In total, there were 39 lakes (43 lake basins) with long-term water quality data (10 to 30 years). The dataset of 4,128 composite (or 'whole lake') samples made up 56% of the provincial AEW lake dataset. The study lakes, including six reservoirs, were mostly in settled areas. Over half were in the boreal natural region (59%) with fewer lakes in the mountains (10%), foothills (10%), parkland (13%) and grasslands (8%).

Water Quality Conditions: The lakes were predominately alkaline and freshwater (total dissolved solids, TDS <500 mg/L). Trophic condition of the lakes, based on algal biomass (chlorophyll-*a*), was mostly in the mesotrophic to hyper-eutrophic categories. Only three lakes were in the lowest oligotrophic category. As expected, there was a strong relationship between total phosphorus (TP) and chlorophyll-*a* levels in the lakes.

Seasonality: Most lakes did not show seasonality in total alkalinity and TDS. Change in pH levels was more common, due to algal growth in the summer months. In contrast, measures of trophic condition (TP and chlorophyll-*a* and transparency) exhibited seasonality in most lakes, except for those with lowest algal biomass. Seasonal changes of algal biomass generally followed those of TP with peaks in summer and early fall; in some lakes, peaks also occurred in the spring.

Long-term Trends: Total alkalinity and TDS showed two main patterns: close to half the lakes showed increasing trends or no trends. Few lakes declined in TDS and alkalinity. Lakes with increasing trends of TDS showed overall increases of <160 mg/L with few exceptions. Only nine lakes showed a trend in pH over the sample record.

Most lakes showed no trend for TP, chlorophyll-*a* and transparency. However, TP increased in 11 (26%) of the lakes while chlorophyll-*a* increased in only three lakes. In contrast, three and seven lakes declined in TP and chlorophyll-*a*, respectively. For lakes with trends, the overall change of TP was up to two orders of magnitude greater than that of chlorophyll-*a*.

The lack of an increase of chlorophyll-*a* in the eight lakes where TP increased was unexpected given the generally close relationship between these variables in the study. However, this illustrates the complexity of nutrient cycling and algal dynamics, and the need to further investigate causes in each lake.

The cause of the eutrophication (mostly TP increases) found in one-quarter of the study lakes is not clear at this time. But in general, these lakes were small, shallow and likely well mixed with high internal loading of phosphorus. Such polymictic lakes are common in Alberta. While this does not explain the cause of the trends, it indicates that polymictic lakes might be more susceptible to eutrophication over the 30-year study. Investigation of long-term temperature trends and potential influences on internal loading and productivity in the lakes would be helpful. Further context on the magnitude and rate of change of eutrophication in this study requires comparisons to longer-term influences of human settlement and climate change.

Almost all lakes exhibiting change in algal biomass were oligotrophic or mesotrophic. This suggests that lakes in lower trophic categories are more sensitive, or likely to show change due to phosphorus enrichment. Oligotrophic lakes are less common in Alberta.

Trends for other water variables (e.g., nitrogen, dissolved organic carbon and silica) were also examined in a subset of the study lakes. For most of the five lakes examined, no trends were commonly found for these variables. However, this is a small sample size of the study lakes.

Influence of Water Management: Diversions of river water to enhance lake level affected the water quality of three study lakes. The main effect of a diversion from the Red Deer River was the dilution of overall water quality in Alix Lake (a small lake) and a portion of Buffalo Lake, closest to the inflow.

In Wabamun Lake, effects of the treated water pumped to the lake were still evident (e.g., reduced phosphorus levels), but overall there was no long-term change in trophic condition of the lake. Effects of the large oil spill in 2005 were not evident in the water quality variables analysed in this study.

In Pine Lake, the start up of the hypolimnetic withdrawal system (to reduce the influence of internal phosphorus load) corresponded with step declines of phosphorus in 1999, but no long-term change (trend) was yet apparent. A more recent evaluation of the influence of the hypolimnetic system on trophic condition of the lake would be helpful.

There was consistency in the trend results for the reservoirs where no long-term change in water quality was usually found. This may be related to more frequent flushing compared to many natural lakes.

Lake Level Trends and Relationship to Water Quality: Lake level reflects the net change (inputs and outputs) in a lake water balance, thereby potentially influencing lake water quality. Lake level showed no trend in about half of the 37 lakes examined. The levels declined in 13 lakes and for six of these there was an overall decline of 1 to 2 m over the record.

Based on statistical correlations, lake level influenced TDS levels in 10 lakes. Over time, reduced inflows and ongoing evaporative concentration likely led to enhanced TDS in the lakes. Lake level increased in only five lakes. In contrast to TDS, lake level change had minimal relationship to TP and chlorophyll-*a* in the study lakes.

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- In particular I would like to thank Mary Raven for her technical support, attention to detail and good humour when preparing the provincial AEW lake dataset, lake data files, tables and formatting of the report. Lisa Brodziak also supported preparation of the lake dataset.
- Chris Rickard and Doreen LeClair were essential to data management and compilation of the original lake dataset.
- Credit is also well deserved to the numerous AEW field monitoring staff who collected the samples over the 30-year study, and to David Trew and Pat Mitchell who designed and implemented the original lake monitoring program that is ongoing. All AEW staff were involved in quality assurance steps. Field collections were also supported by partners including Alberta Lake Management Society and Alberta Tourism, Parks and Recreation.
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1.0 INTRODUCTION

Alberta Environment and Water (AEW) monitors surface water quality of provincial lakes to evaluate short- and longer-term environmental conditions, and to inform lake management and policy. The data are also important to improve scientific knowledge on ecological processes in the lakes, especially as it relates to nutrients and productivity (trophic state). There is a wide range of lake types in Alberta, including shallow, nutrient-rich (eutrophic) lakes in the boreal and parkland natural regions, some deep or large lakes across the province, saline lakes concentrated in the grasslands, and nutrient-poor (oligotrophic) lakes mostly found at higher elevations. The *Atlas of Alberta Lakes* includes detailed information on 100 lakes throughout the province (Mitchell and Prepas 1990). Many Alberta lakes are eutrophic due to the geology and extensive glacial till in their watersheds. However, settlement, land clearing and other human activities can enhance nutrient inputs to Alberta lakes (e.g., Blais *et al.* 2000; Lorenz *et al*. 2008; Schindler *et al.* 2008). Climate change is another broad-based factor that can influence the water balance, water quality and resident biota of Alberta lakes (e.g., Evans and Prepas 1996; Gartner Lee 2007).

Monitoring of water quality in lakes by AEW began in the1970s when the Department was established. The initial sampling by AEW and others typically relied on discrete (or 'grab') samples taken near the shore or at select sites, usually at the deepest area of a lake basin. Discrete samples provide valuable information on local conditions, but they are not directly comparable to more recent 'whole-lake' (composite) sampling developed by AEW. The latter began in the late 1970s and is now established as a standard procedure. Composite samples are composed of multiple sub-samples of the upper water column taken throughout a lake (Alberta Environment 2006). The upper water column is defined as the epilimnion or euphotic zone where plant growth (photosynthesis) is predominant. Standardisation of sampling methods is important to provide comparability of samples thereby supporting the evaluation of long-term trends.

Monitoring of Alberta lakes reflects the ongoing demand for knowledge on current conditions, trends, ecology and impacts on lakes. The demand comes from within AEW, partners and other users of lakes. Important partnerships in the collection of lake water data have included University of Alberta, Alberta Tourism, Parks and Recreation, Alberta Health and Wellness, Alberta Lake Management Society (ALMS) and watershed stewardship groups. Despite this demand, there has been no statistical evaluation of long-term trends in water quality for a comprehensive set of Alberta lakes.

The main objectives of this study were to:

- Review the AEW provincial water quality database and select lakes with long-term data suitable for statistical trend analysis;
- Provide an overview of the conditions and long-term trends of water quality in the selected lakes; and
- Investigate the influences or relationships of water management and lake level on lake water quality.

Due to the large quantity of results and summary materials, the tables and figures are organized together after the text of the report.

2.0 METHODS

2.1 Selection of Study Lakes

All lakes with composite ('whole-lake') samples in the AEW Water Data System (WDS) were reviewed to select ones with sufficient long-term data for the statistical evaluation of trends. This dataset, beginning in late 1970s, included over 520 lakes or reservoirs across the province (Figure 1). The key criteria for selecting lakes were those having at least 10 years of samples taken during the open-water months. The final determination of lakes used in the study was primarily based on the sampling frequency for key nutrient and trophic condition variables (i.e., total phosphorus and chlorophyll-*a*). This resulted in the selection of lakes with three to eight composite samples per year. In total 39 lakes (including six reservoirs), or 43 individual lake basins, were found with ≥10 years of monthly samples (Figure 2). These lakes were predominately within the settled areas of the province. A second group of about 40 lakes, with ≤9 years of composite samples and a monitoring span of one to three decades, was also identified for potential assessment at a later date.

2.2 Field Collection and Laboratory Analysis

The water quality data analysed were from composite samples of the euphotic zone or epilimnion of each lake. An epilimnion sample is vertically integrated from the lake surface to the thermocline. The euphotic sample is also a vertically integrated sample of the upper water column, but the lower limit is defined as having 1% of the light at the surface. The maximum depth for both of these sample types is to about 0.5 m above the lake bottom (i.e., when there is no thermocline or light at the lower limit is >1% of that at the surface). In practice, the epilimnion sample is more challenging to define because determination of the thermocline can be relatively subjective compared to the measurement of light. Epilimnetic composites were taken in 1979 and early 1980s, and there was some overlap with euphotic composite sampling during this period. However, the euphotic composite procedures were formally established as the main method to take lake composites from 1982 to the present. For the purposes of this study it was assumed that there was no major or discernible difference in the water quality of samples taken using either method. Composite samples were typically made up of 10 or more separate sub-samples taken throughout a lake (or lake basin). Further details of composite sampling and sample handling procedures are outlined in *Aquatic Ecosystems Field Sampling Protocols* (Alberta Environment 2006).

The composite samples were analysed for physical, chemical and biological characteristics. This usually included alkalinity, pH, conductivity, total dissolved solids, major ions, nutrients, chlorophyll-*a* and other variables. The samples were analysed at government and commercial laboratories. These included: AEW Monitoring Branch Water Laboratory, Edmonton (most recently the McIntyre Centre) and University of Alberta Water Laboratory (for phosphorus and chlorophyll-*a*)**;** Alberta Innovates Analytical Water Laboratory, Vegreville (formerly Alberta Research Council); Maxxam Analytics (formerly Chemex); and ALS Environmental (formerly EnviroTest).

Quality assurance (QA) data were collected as part of the lake monitoring programs. These data have included splits of the same sample, replicate samples and field blanks which contain clean water (Alberta Environment 2006). Over time, the QA results were routinely reviewed by the program scientist to identify any concerns, such as related to field collection methods or laboratory analysis. When issues were identified, the scientist worked with field and laboratory staff to resolve concerns and assure the quality of the water quality results stored in WDS.

2.3 Data Evaluation

Water Quality Variables Analysed

The lake dataset was reviewed to identify water quality variables with sufficient (open-water) composite samples for statistical analysis. For each variable, this included the evaluation of the total number of samples, number of years of data, number of samples per year and percentage of censored data (i.e., data less than the analytical method detection limit, MDL). Details for these criteria are presented in Appendix A.

Six commonly measured water quality variables were evaluated for all lakes. Alkalinity, pH and TDS provided measures of overall water quality, while TP and chlorophyll-*a* were used to define key nutrient and trophic conditions in the lakes, respectively. Chlorophyll-*a* is often used as a surrogate measure of algal biomass in the water column. Transparency, often measured as depth of Secchi disc visibility, was used to provide an estimate of suspended material (including phytoplankton) in the water column. An additional set of nine water quality variables were evaluated in five lakes (six lake basins) with the most frequent sampling record. These were: Baptiste Lake, north and south basins; Ethel Lake; Nakamun Lake; Pine Lake; and Wabamun Lake. The extra variables analysed were: dissolved phosphorus (DP); ammonia-N (NH_3-N); nitrate+nitrite-N (NO_3+NO_2-N); total Kjeldahl nitrogen (TKN); non-filterable residue (NFR); dissolved organic carbon (DOC); and silica. Total nitrogen (TN) and the ratio TP:TN were analysed to further evaluate nutrients and nitrogen limitation. Total nitrogen was based on the sum of TKN (i.e., organic nitrogen and NH_3-N) and nitrate+nitrite-N; half the MDL was used when NO_3+NO_2-N values were <MDL.

Preparation of Data

In the case of two study lakes, the number of individual composite samples varied for select sample dates from one to three over the sampling record. This was usually done to obtain information on spatial variability of water quality in each lake. In select years, composite samples were taken in the east and west basins of Wabamun Lake, and in the north, south and east portions of Pine Lake (Appendix A). In order that these samples could be compared to dates when whole lake composites were taken, the mean of any multiple composites on the same date was calculated and used in the trend analysis for each lake. In general, small differences in the water quality of separate composites taken on the same date were found.

Samples of the six water quality variables analysed in all lakes had almost no censored data (Appendix A). However, some of the additional variables analysed in the selected lakes had many censored values (e.g., NO_3+NO_2-N, NFR and silica; Appendix A). In order to reduce the potential influence of censored data on the trend analysis, variables with >25% censored data were not analysed. This only occurred in two cases, for NO_3+NO_2-N in Ethel and Wabamun lakes. In some cases, there were changes in the MDL value over the sample record, due to improvement of analytical methods or a change in the analytical laboratory. This occurred primarily for NO_3+NO_2-N, NH_3-N and silica. When this occurred, all censored values were converted to the highest MDL for that variable. This relatively simple method was used to reduce the effect of changes in MDL on the trend analysis, although there may be some loss of statistical power to detect a trend (Hirsch *et al*. 1982; Helsel and Hirsch 1991). During the preparation and analysis of individual lake datasets, various outliers were identified and checked (e.g., with the original field sheets and analytical laboratory reports) to ensure the electronic data were correct. No outliers were found to be errors and therefore, no data were removed from the lake data files.

Statistical Analysis

Nonparametric statistical tests were used for all analyses. In comparison to parametric methods, the nonparametric methods do not require normally distributed data although there may be some loss of statistical power (Zar 1996). Nonparametric methods that rely on ranked data are also helpful in dealing with data characteristics of some of the lakes analysed including gaps in the sample record (years and months), limited sample size and the presence of outliers (e.g., Gilbert 1987; Helsel and Hirsch 1991). Also, nonparametric methods to determine trends in water quality data are better developed in the scientific literature (see below) and statistical software is readily available.

All statistical tests were conducted using the WQHydro statistical software package (Aroner 2010). Statistical significance was determined for all tests at probability (p) values $\leq$0.05 and $\leq$0.01. Probability values close to statistical significance were also identified in the trend results (i.e., p>0.05 and $\leq$0.15) to show lakes which could be exhibiting change. This will provide more useful information to users of the results.

Seasonality and Correlation Tests

The Kruskal-Wallis test was used to determine seasonality, or differences among open-water months, for individual water quality variables. The Spearman rank correlation test was used to examine relationships between annual medians of pairs of water quality variables or between lake level and specific water quality variables. This test is based on using ranked data in the common Pearson product-moment correlation test (Zar 1996). The Spearman test provides a correlation coefficient (r_s) that shows the strength of the relationship (0 to 1) and whether it is positive or negative. The Z statistic is used to test whether the relationship is statistically different from zero.

Trend Tests

The Mann-Kendall or seasonal Kendall test was used to analyse for trends in the lake data. Both tests determine the presence of a monotonic trend (i.e., overall change in one direction) over time. The Mann-Kendall test (statistic and variance) is used to determine if the Y variable (water quality) increases or decreases with X (time). It is often used with small datasets which do not exhibit seasonality and there is no autocorrelation. Autocorrelation occurs when consecutive values are not independent and the previous value has a consistent influence on the next value. This is not unusual in water quality time series datasets. The seasonal Kendall test is a modification of the Mann-Kendall test where Mann-Kendall statistics are estimated for individual seasons (months in this study) over the sampling record, and these are summed to give statistics for the overall trend. The seasonal Kendall test and a modification to correct for autocorrelation were specifically developed to determine trends in surface water quality data especially in rivers (Hirsch *et al.* 1982; Hirsch and Slack 1984; Loftis *et al.* 1989; Helsel and Hirsch 1991). It has also been used to evaluate trends in lakes (Reckhow *et al.* 1993).

In this study, the seasonal Kendall test was used when there were >40 individual monthly data values over the sample record for a specific water quality variable. For water quality variables with more than one sample in the same month, which occurred intermittently in the lake dataset, the value closest to the mid-date of the month was used in the analysis. This is preferred over other statistics, such as the mean or median, when there are unequal samples among months (Helsel and Hirsch 1991; Reckhow *et al.* 1993; Aroner 2010). The Mann-Kendall test was used when there were ≤40 monthly data values (Gilbert 1987; Reckhow *et al.*1993). Annual medians were used in the Mann-Kendall test which eliminated the need to test for autocorrelation. In the majority of the trend tests (excluding a few Mann-Kendall tests), there were ≥10 years of samples.

Trends in lake level were analysed using the Mann-Kendall test. Trends were determined for the same period which coincided with the water quality sampling record. Lake level data were available for 37 lakes. There were no data for Tucker Lake and insufficient data for Spruce Coulee reservoir (five years). The sampling frequency for lake level was usually different from the water quality data. The records varied from very frequent measurements (e.g., daily or weekly) to very infrequent data (e.g., few or no records in some years). Annual medians were used in these Mann-Kendall tests.

Interpretation of Trend Results

Output form the Mann-Kendall and seasonal Kendall tests include common and separate statistics for the trend relationship. The Sen slope reflects the magnitude of a trend and it is based on the median of all slopes for pairs of data in the dataset (Helsel and Hirsch 1991). The Kendall's correlation coefficient (Tau) is a measure of the strength of the monotonic relationship between the water quality variable and time (0 to 1) and whether it is positive or negative. Correction for autocorrelation can be important when using the seasonal Kendall test, but should not be an issue for the Mann-Kendall test applied to annual data. WQHydro provides statistical probabilities for the seasonal Kendall statistic (SK) and a second seasonal Kendall statistic that is corrected for autocorrelation (SKC). Based on Aroner (2010), a test for autocorrelation was only done if the probabilities of these statistics were very different. In this study, this was determined based on three categories of statistical probability (i.e., $p \leq 0.01$; >0.01 and ≤ 0.05; and >0.05 and ≤ 0.15). If the paired SK and SKC probability results for a water quality variable were in different categories, the dataset was tested for the presence of autocorrelation. This was done following procedures in WQHydro by de-seasonalising and de-trending the dataset and testing for significant correlation between these data types (Aroner 2010). If the Spearman correlation coefficient was statistically significant, indicating the presence of autocorrelation, the SKC test statistic and associated probability value were calculated.

When interpreting statistical trend results, it is also important that the underlying data (or time series graph) is examined. This evaluation step, to understand the timing and frequency of sampling, and variability in the data, will provide confidence in the statistical results. For example, the occurrence and magnitude of a trend can be falsely reported (e.g., over- or under-estimated) when in some cases, the sampling frequency is limited, there is high temporal variability in the data, or the data do not follow a monotonic trend (e.g., see discussion of the trend for TDS in Miquelon Lake, Section 3.3.3). In comparison to the Mann-Kendall test, the seasonal Kendall test may be better suited to examine non-monotonic trends. This is because the seasonal Kendall test is based on changes within multiple individual and similar seasons (months in this study) rather than relying on less frequent annual data. However, in some situations, seasonal trends can also cancel each other out in the calculation of the test statistic, resulting in no overall trend. In this case, there may be value to focus the trend analysis on more specific questions or seasons, such as months when peak algal blooms occur.

3.0 RESULTS & DISCUSSION

In total there were 39 lakes (43 lake basins) with long-term data (Section 2.1). These lakes included six reservoirs and four lakes with two basins sampled separately. For consistency in the text, the 43 lake basins are referred to as the study lakes, unless there is a need to highlight a specific basin. The reservoirs are usually discussed together to identify any differences in water quality compared to natural lakes.

The following sections include: an overview of the provincial lake dataset; a summary of key features of the study lakes, their watersheds and relevant water management activities; detailed results on the current conditions, seasonality and long-term trends of water quality in each lake; and discussion of the potential influences of water management and lake level on water quality.

3.1 Provincial Lake Dataset

The dataset of all lakes sampled in AEW programs, a total of 7,364 composite samples, depicts a range of sampling intensity over three decades (Figure 3). For example, peak sampling in 1984 was associated with intensive collaborative sampling with the University of Alberta for lakes which were included in the *Atlas of Alberta Lakes* (Mitchell and Prepas (1990). Long-term sampling of lakes in provincial parks was established, in partnership with Alberta Tourism, Parks and Recreation, in the mid-1980s. Additional monitoring of recreational lakes, in partnership with the Alberta Lake Management Society (ALMS) and precursor volunteer groups, also began in the 1980s.

The same dataset organised by month shows that open-water sampling was typically done from May to October with a small number of samples after ice-breakup, in late April (Figure 4). Collectively, there were more samples during the summer months, when algal growth would be greatest. These data are important to understand the dynamics of water quality throughout the open-water period, especially nutrients and their relationship to algal production. Note that although winter samples are available for some lakes, these are not composite samples, are not necessarily good indicators of overall water quality condition, and are not included in this evaluation.

3.2 Characteristics of Study Lakes and Watersheds

The main geographic and physical features of the study lakes and watersheds, and information on water management are summarised in Tables 1a and 1b. More comprehensive background on most lakes is in the *Atlas of Alberta Lakes* (Mitchell and Prepas 1990). Only six lakes are not included in the atlas (i.e., Alix, Gregg, Hilda, Jarvis, Pine Coulee and Spruce Coulee).

The majority of lakes are in the boreal natural region (59%) with fewer numbers in the mountains (10%), foothills (10%), parkland (13%) and grasslands (8%) (Table 1a). Based on major river basins, most lakes are in the Peace-Athabasca (33%) and Beaver River basins (23%). A further 13% are in the North Saskatchewan River and Sounding Creek basins, and 31% are in the rest of the province (Table 1a and Figure 2).

Overall the lakes and their respective watersheds include a wide range of physical characteristics (Table 1a) which can influence lake water quality. For example, the ratio of lake drainage area (watershed): lake surface area and water residence time can be important factors potentially leading to elevated inflows, dilution and flushing of lake water (Table 1a). Water residence time is the average time required to replace the lake volume with inflow less loss by evaporation (Mitchell and Prepas 1990).

Lake Type and Relationship to Internal Loading of Phosphorus

Depth and overall morphology of a lake basin are important factors affecting lake condition. Deep lakes are usually dimictic with two main seasons when it is thermally stratified (open-water and ice-covered), and complete mixing of the lake primarily occurs in the spring (after ice breakup) and fall. In contrast, shallow lakes are well-mixed or mix frequently during the open-water period. These polymictic lakes (with no stable thermal stratification) are common in the boreal, parkland and grasslands regions of Alberta. Some lakes experience a combination of dimictic and polymictic conditions due to the strong influence of prevailing weather conditions (air temperature and wind).

In deep lakes, strong thermal stratification occurs when the water column is separated into warm (lighter) epilimnion and cooler (denser) hypolimnion. The metalimnion is the intermediate phase between these layers. Release of phosphorus from bottom sediments (internal loading) occurs in the hypolimnion, often due to low dissolved oxygen or reducing conditions above the sediments. Subsequent mixing of the hypolimnion and epilimnion can lead to increased nutrients and plant biomass (including blooms of algae and cyanobacteria or ‘blue green algae’) in the summer. Internal loading over the winter may also be important when spring mixing (or overturn) of the lake can enhance phosphorus levels in the water column, before onset of plant growth.

In comparison to dimictic lakes, internal loading can be more prevalent in shallow, polymictic lakes. In addition to frequent mixing, these lakes have relatively large surface areas and potentially greater contact and interaction between the water column and bottom sediments. Processes which can enhance the release of phosphorus from sediments in shallow lakes are many such as: increased microbial decomposition and physical-chemical processes in the warm sediments; more frequent even daily fluctuations of dissolved oxygen near the sediment-water interface; scouring and entrainment of sediments into the water column due to wind and convective currents; bioturbation and release of gas bubbles in the sediment; and macrophyte senescence and decomposition (Cooke *et al.* 2005). Internal loading can be a substantial component of nutrient budgets in Alberta lakes, where the phosphorus sediment load often exceeds all external sources (Mitchell and Prepas 1990). Lake sediments may be further enriched by human activities and land use (e.g., as indicated by various paleolimnological studies; Gartner Lee 2007).

Water Management Activities

Water management activities can influence the water quality of lakes. The study lakes include six reservoirs which are characterised as having major dams at the outlet, i.e., Moonshine, Newell, Pine Coulee, Reesor, Spruce Coulee and Travers (Table 1a). The dams were constructed before the start of water quality sampling in the lakes with one exception. Pine Coulee reservoir was filling in the early portion of the record (Section 3.4). Water use and management is specific to individual reservoirs, but they typically have short residence times compared to natural lakes (Tables 1a and 1b). In several reservoirs, there is substantial annual inflow and outflow (reflected as changes in the lake level) that can flush and alter water quality in the reservoir (Section 3.5).

Almost half of the remaining lakes have a weir at the outlet (Table 1a). These were typically constructed to stabilise or raise lake levels (Table 1b). Most weirs were either constructed before the start of the long-term water quality dataset, or older weirs were replaced in the 1980s (Table 1b). For some lakes, the lake level was altered during the water quality record (e.g., Beauvais and Ethel lakes) (Table 1b). However, these changes were relatively small and the influence on lake water quality was likely to be minor (and see Sections 3.4 and 3.5).

A smaller number of lakes with more active water management are those with a diversion of river water to maintain or enhance lake levels (i.e., Alix, Buffalo, Gull, Wabamun and Winagami) (Table 1b). However, the influence of some diversions on lake water quality cannot be evaluated because the start of the diversion does not coincide with the water quality record (i.e., Gull and Winagami lakes). Lastly, the installation of a hypolimnetic withdrawal system in Pine Lake was a more direct management action. This was intended to reduce the influence of internal phosphorus loading in the lake by pumping hypolimnetic water, richer in phosphorus, to the outlet stream (Table 1b) (Sosiak 2002a). Discussion of the influence of river diversions and the hypolimnetic withdrawal system is included in Section 3.3.3.

3.3 Findings for Water Quality

The 39 lakes (43 lake basins) with long-term data comprised 4,128 composite samples or about 56% of the composite samples in the provincial lake dataset (Section 3.1).

3.3.1 Lake Conditions

Summary statistics for all water quality variables in the lakes over the sampling record are in Tables 2a and 2b.

Overall Water Quality

The study lakes were predominately alkaline and had relatively high median pH values (Table 2a). Lowest alkalinity concentrations (median <100 mg/L) and pH values (median pH <8.0) were found in two boreal lakes, Gregoire and Sturgeon (Table 2a). Most of the lakes were freshwater with low TDS concentrations, while only two lakes had moderate to high salinity (Buffalo and Miquelon, respectively) (Figure 5). Overall the dominant cation and anion was usually calcium and bicarbonate, respectively, in study lakes. There was a transition from calcium to sodium as the dominant cation when TDS concentrations ranged from about 200 to 300 mg/L in the lakes; and sulphate replaced bicarbonate as the dominant anion in Moonshine and Miquelon lakes.

Trophic Condition

Phosphorus showed a wide range of concentrations which generally corresponded to similar relative changes of chlorophyll-*a* concentrations and trophic condition from oligotrophic to hyper-eutrophic lakes (Figures 6 and 7a). As expected, transparency was greatest in oligotrophic lakes (e.g., median Secchi depth = 3.8 to 6.2 m in Travers, Gregg and Jarvis) and lowest in hyper-eutrophic lakes (e.g., lowest median Secchi = 0.7 m in Saskatoon Lake) (Table 2a).

Algal biomass, measured as chlorophyll-*a*, is a key measure of trophic condition in lakes because it directly relates to primary productivity. Trophic categories, developed by the Organisation of Economic Cooperation and Development (OECD), have been commonly used in Alberta and elsewhere to classify the trophic condition of lakes (OECD 1982). Based on four main categories, the study lakes are spread fairly evenly among three categories, from mesotrophic to the highest category, hyper-eutrophic (Figure 6). Only three lakes are in the lowest trophic (oligotrophic) category which is characteristic of low nutrient environments. Oligotrophic lakes in Alberta are usually found at higher elevations, mostly in the mountains and upper foothills, and on the Canadian Shield in north-east Alberta.

Influence of Phosphorus and Salinity

Previous studies on Alberta lakes have identified phosphorus as the key limiting nutrient and have shown strong relationships between phosphorus and algal biomass (e.g., Dillon and Rigler 1974; Prepas and Trew 1983). Strong correlations between TP and chlorophyll-*a* have also been found in stratified and mixed Alberta lakes (Riley and Prepas 1984). Nitrogen and the N:P ratio are also known to influence algal biomass and composition in Alberta lakes, but it is not usually a limiting nutrient although studies are not conclusive on these relationships (e.g., Trimbee and Prepas 1987; Downing and McCauley 1992). In this study, nitrogen was only examined for select lakes. Another pattern found in Alberta lakes is reduced algal biomass associated with higher salinity in some lakes (TDS >500 mg/L); this occurred even when TP concentrations were at very high levels (Prepas and Trew 1983; Bierhuizen and Prepas 1985; Campbell and Prepas 1986).

As expected, a relatively strong relationship was found between TP and chlorophyll-*a* concentrations in the study lakes (r_s = 0.82, p <0.01, n = 43) (Figure 7a). The main outliers to this relationship were Miquelon and Saskatoon lakes with very high TP (i.e., 170 and 841 ug/L, respectively) (Figure 7a). Miquelon Lake was mesotrophic and the only truly saline lake (TDS >5,000 mg/L), while Saskatoon Lake was hyper-eutrophic and slightly saline (Figure 5). However, salinity alone was not the main factor controlling algal biomass in the study lakes. For example, TDS and chlorophyll-*a* concentrations were not correlated (r_s = -0.03, p = 0.85, n = 43) (Figure 7b). In addition, TDS and TP concentrations were only weakly correlated (r_s = 0.27, p = 0.08, n = 43) (Figure 7c). But the lack of clear relationships between TDS and chlorophyll-*a* or TP may be due to the study lakes being almost entirely freshwater. A larger sample size of saline lakes is needed to better determine these relationships. In addition, the composition and levels of major ions (components of TDS) and micronutrients can influence the composition and biomass phytoplankton in Alberta saline lakes (Campbell and Prepas 1986; Marino *et al.* 1990).

3.3.2 Seasonality

Seasonality or differences in the levels of overall water quality and trophic condition among the open-water months are presented in Tables 3, 4 and 5 and Figures 8 to 50.

Sample Record and Number of Years

Samples were taken in the majority of lakes over two or three decades, starting from 1979-85 to the late-2000s (Tables 2 and 3). The main exceptions to this general pattern were for Alix and Miquelon lakes where sample collection began in 1991-92 and continued for two decades. Pine Coulee, a relatively new reservoir, had the shortest sample record of 10 years, beginning in 1999, and it was filling during the early years. Other minor exceptions were for the secondary basins of McLeod and Sturgeon lakes which had sample spans just over one decade, and sampling was discontinued after mid-1990s (Tables 2 and 3).

There were minor differences in the entire sampling span and number of years for the water quality variables analysed in this study (Tables 3, 4 and 5). The main exception to this was for TDS which was not measured as frequently as the other variables.

Alkalinity, pH and Total Dissolved Solids

As noted above, most lakes were alkaline with relatively high pH and low TDS. For most lakes (60 to 79%), total alkalinity, pH and TDS concentrations were relatively stable from month to month (Table 3). Only four lakes (or five lake basins) exhibited seasonality for all three of these inter-related water quality variables (Table 3).

Annual medians of total alkalinity and pH or with TDS were strongly correlated (r_s = 0.87, p <0.1, n = 43 and r_s = 0.91, p <0.01, n = 43, respectively). Also, seasonality of alkalinity and TDS usually occurred concurrently in the same lake (Table 3). Seasonality for these seven lakes was probably related to lake residence time where shorter periods suggest relatively frequent flushing of the lake content. Baptiste (north and south basins), Beauvais, Ethel, and Steele lakes and three reservoirs (Newell, Spruce Coulee and Travers) all had residence times of $\leq$6 years (Table 1a). Overall, there were declining TDS and alkalinity concentrations from spring (after ice breakup) into early summer for all of these lakes and reservoirs (Figures 8 to 50).

In comparison to alkalinity and TDS, pH generally showed seasonality in more lakes (40%) (Table 3 and Figures 8 to 50). This was probably related to the influence of primary productivity (specifically photosynthesis) causing higher pH in lakes. For these lakes, highest pH typically occurred in the summer months when photosynthetic rates are greatest (Figures 8 to 50). Many of the lakes exhibiting seasonality in pH were also in the highest trophic categories (eutrophic and hyper-eutrophic) (Table 3 and Figure 6),

Total Phosphorus, Chlorophyll-a and Transparency

In contrast to pH, alkalinity, and TDS, most lakes (74 to 86%) showed seasonality in the three variables related to trophic condition (total phosphorus, chlorophyll-*a* and transparency) (Table 4). This is to be expected, as phytoplankton grow and accumulate during the open-water period of the year. Lakes with this pattern were primarily in the mesotrophic to hyper-eutrophic categories (Figure 6). Similar to the results for alkalinity, pH and TDS, the occurrence of seasonality for each trophic condition variable was usually the same in separate basins of the same lake (Table 4).

Only Alix, Jarvis and Miquelon lakes did not show seasonality for all three measurements of trophic condition (Table 4). An additional two lakes, Gregg and Travers, did not show seasonality in TP and chlorophyll-*a,* two important measures of trophic condition (Table 4). This general finding of no seasonality in trophic condition of these lakes may not be surprising because four of the lakes had the lowest algal biomass of the study lakes (Figure 6). Low nutrient lakes, such as these, would be expected to have lower variability in trophic condition compared to other nutrient enriched lakes (e.g., see variability in monthly box plots, Figures 8 to 50). The exception to this pattern was Alix Lake, at the low end of the eutrophic category (Figure 6), but its water quality was likely to be strongly influenced by the diversion Red Deer water (discussed in Section 3.3.3).

Total Phosphorus and chlorophyll-*a* concentrations generally followed similar monthly changes in the same lake (Figures 8 to 50). Two main patterns were evident in the lakes. In most lakes, the highest TP concentrations usually occurred later in the summer months, but in some lakes, TP concentrations were also elevated in the spring, at levels similar to those in the fall. This may be related to turnover of the lake in spring and fall. For example, this was found in the deeper south basin of Baptiste Lake compared to the north basin (Figures 9a and 10a). Elevated TP early and later in the open-water period could be due to internal loading of phosphorus from lake sediments and subsequent mixing of the water column (Section 3.2). Review of additional water quality data from the depth profile sites in each study lake (e.g., to determine the dynamics of thermal stratification and mixing) would help to better understand this.

Other Water Quality Variables

Dissolved phosphorus (DP) concentrations only showed seasonality in Baptiste (both basins) and Pine lakes, but not in Ethel, Nakamun and Wabamun lakes (Table 5). In contrast, TP concentrations showed seasonality in all of these lakes (Table 4). Dissolved phosphorus (DP) made up about 30% to 60% of TP in the lakes.

In most lakes there was strong seasonality in total nitrogen (TN), its components (NH_3-N, NO_3+NO_2-N, TKN) and the ratio of TN:TP (Table 5 and Figures 9b, 10b, 17b, 33b, 38b and 49b). Overall the median TN concentrations ranged from about 0.9 to 1.8 mg/L, and median TN:TP ratios varied from about 18 to 32 (Table 2b). The TN:TP ratios were well above the Redfield ratio (mass N:P = 7.2) below which nitrogen may be limiting for plant growth. In rare instances, the TN:TP approached the N:P ratio of 7.2 in these lakes (Figures 9b, 10b, 17b, 33b, 38b and 49b).

Non-filterable residue (NFR), a measure of suspended material) and silica showed seasonality in most lakes (Table 5). Overall the variation in NFR and silica was relatively small, although there was a tendency for higher concentrations to occur in the summer months which may be related to the influences of uptake by diatoms and runoff or inflow to the lakes (Figures 9b, 10b, 17b, 33b, 38b and 49b). Dissolved organic carbon (DOC) concentrations did not show large change for the lakes, and only weak seasonality was found in three lakes (Table 5 and Figures 9b, 10b, 17b, 33b, 38b and 49b).

Water management activities may have influenced some of the seasonal patterns in Pine and Wabamun lakes, but this was difficult to investigate without more detailed information on management.

3.3.3 Long-Term Trends

Results of long-term trends in water quality are presented in Tables 6 to 15 and Figures 51 to 94. The sample record and number of years is the same as reported above (Section 3.3.2). In most cases, the frequency of sampling is adequate to provide reasonable determination of trends, but caution is still warranted when interpreting the trend results (Section 2.3).

There were three main types of long-term datasets for the study lakes with samples that usually began in the early 1980s (Figures 51 to 93).

These lakes had:

- frequent monthly samples for all or most years over three decades;
- frequent monthly samples for most years over the same period, but with relatively large gaps of several years (e.g., mid-1990s to mid-2000s); and
- a group of lakes with more limited data (closer to 10 years) over the 30 year span and with frequent gaps in monthly samples.

Analysis of trends for some lakes in the latter group was sometimes problematic, in particular if the data for a water quality variable did not follow an overall monotonic trend. Lakes in the latter group included Hilda; Lac La Biche (east basin); Marie; Miquelon; Moore (Crane); and Tucker. Also, as noted in Section 2.3, the time series data used to determine trends should always be examined to ensure the statistical results are reasonable.

Discussion of overall change in a water quality variable showing a trend is based on differences in values at the start and end points of the trend line. Lakes with the probability of the trend test close to statistical significance ($p>0.05$ and $p\leq 0.15$) are also presented in the tables to aid with identifying lakes in potential transition. However, these results are not discussed in detail.

Alkalinity, pH and Total Dissolved Solids

Long-term trends for total alkalinity showed two main patterns among the 43 lake basins. Almost half the lakes showed no change in alkalinity concentrations (49%) and most of the remaining lakes (42%) showed an increase of alkalinity (Table 12). Only four lakes (Alix, Ethel, Jarvis and Moonshine) showed a declining trend of alkalinity concentrations (Table 12). There was a sharp decline of alkalinity in Alix Lake, about 200 mg/L between 1992-93 and 1996 (following a gap in the sample record), after which concentrations remained relatively stable (Figure 51). The decline in Alix Lake, a small lake (Table 1a), was probably due to flushing of the lake by the diversion of Red Deer River water to Buffalo Lake, beginning in 1996 (Table 1b). There was a relatively consistent, but small decline of alkalinity in Ethel Lake (<10 mg/L) (Figure 60a). This may have been related to a corresponding overall increase of the lake level over the sample period (Section

3.4), and a negative correlation between lake level and TDS (Section 3.5). The overall decline of alkalinity in Moonshine Lake was larger (about 50 mg/L) (Figure 73), but this did not appear to be related to lake level since it did not change over the same time period (Section 3.4).

Most lakes (77%) showed no change in pH over the sample record while only nine lakes (10 lake basins) showed a statistically significant change (Table 12). There was a relatively consistent increase of pH over the 10-year record in Pine Coulee although the overall change was small (about 0.2 pH units) (Figures 81). In other lakes, similar small changes of pH occurred, but there was more fluctuation in pH over the sampling record (e.g., Baptiste, south basin; Beauvais; and Gull lakes) (Figures 53a, 54 and 64). In some cases, there were limited data to support the trend (i.e., Tucker Lake) (Figure 91).

As expected, total dissolved solids (TDS) and alkalinity often showed the same trend in any given lake (Table 12). Approximately half of the lake basins showed a trend of increasing TDS concentrations (56%), 40% exhibited no trend, and only two lakes (Ethel and Moonshine) showed a significant decline (Table 12). Most lakes with an increasing trend of TDS showed an overall change <100 mg/L. Eight lakes showed an overall change of TDS from about 100 to 160 mg/L (i.e., Buffalo; Garner; Gull; Hilda; Moonshine; Moore; Saskatoon; and Wabamun) (Figures 51 to 93). The largest overall changes in TDS were found in Moose Lake (about 250 mg/L) (Figure 75) and Miquelon Lake.

The change of TDS in Miquelon Lake was substantial, about 4,000 mg/L (based on the trend line) (Figure 72). However, the Mann-Kendall test on annual medians did not show a trend (Z statistic = 1.15, $p = 0.25$, $n = 9$). This was because there was a small number of annual values and they did not follow a monotonic trend (Section 2.3). These TDS values increased from 1991 to 1995, declined to 1999, and then only two years were sampled (i.e., in 2003 and 2008). A better representation of the trend for the available data was to use the Mann-Kendall test on the larger dataset of monthly data ($n = 17$). This resulted in a statistically significant increasing trend for TDS (Tables 8 and 12; Figure 72). The trend also appeared to be related to lake level in Miquelon Lake which showed an overall decline beginning in the late 1990s (Section 3.4).

In general, there were some similarities in the occurrence of trends for alkalinity, pH and TDS in most reservoirs. For five of the six reservoirs, there were no trends for two or three of these water quality variables (Table 12). This may be partly related to the faster flushing of the reservoirs compared to natural lakes (Table 1a). Moonshine reservoir was the main exception to this general finding, where alkalinity declined by about 50 mg/L and TDS declined by 120 mg/L (Figure 73).

Phosphorus, Chlorophyll-a and Transparency

Most lakes (67%) showed no trend in total phosphorus (TP) concentrations, but 11 (26%) showed increasing trends and only three declined in TP (Table 13; Figure 94a). Lakes with a significant increase of TP showed overall changes of less than about 30 ug/L (Baptiste, north basin; Crimson; Dillberry; Gregg; Gregoire; Jarvis; McLeod, east basin; and Reesor) and from about 50 to 280 ug/L (Thunder, Steele and Saskatoon) (Table 13; Figures 51 to 93). Most of these lakes (excluding Dillberry and Reesor) were in the boreal and foothills natural regions of central Alberta (Figure 2). Lakes with decreasing trends of TP showed much smaller overall change, from about 4 to 11 ug/L

(Beauvais, Newell and Wabamun) (Table 13 and Figures 54, 77 and 92a). The reduction of TP in Newell and Wabamun lakes was likely due to water management activities (discussed below).Overall, the 14 lakes with trends in TP (increasing or decreasing) were found across all trophic categories, from oligotrophic to hyper-eutrophic (Figure 94a).

In contrast to the TP results, a greater number of lakes showed no statistical trend in chlorophyll-*a* concentrations (77%), only three lakes showed an increase and seven lakes declined in chlorophyll-*a* (Tables 13). Also, the lakes with increasing or decreasing trends showed small overall changes in chlorophyll-*a* concentrations, less than about 6 mg/m^3 (or ug/L) (Figures 51 to 93). The 10 lakes with increasing trends (Dillberry, Gregoire and Jarvis) or decreasing trends (Beauvais, Ethel, Hilda, Marie, Moore, Newell and North Buck) were in the lowest trophic categories, oligotrophic and mesotrophic (Figure 94b). Gregoire Lake was a minor exception to this finding, at the lower end of the eutrophic category (Figure 94b). Five of the lakes with trends for chlorophyll-*a* also showed the same corresponding change (increase or decrease) of TP (Beauvais, Dillberry, Gregoire, Jarvis and Newell) (Figures 94a and 94b). This may add more validity to the occurrence of the trends in those lakes (Table 13). However, the general occurrence of chlorophyll-*a* trends in lakes with lower trophic state (algal biomass) suggests that they are potentially more sensitive to phosphorus enrichment. Thus caution is warranted when considering the management and potential impacts in these lakes. Oligotrophic lakes are not as common in Alberta compared to other lake types.

Further comparisons of the chlorophyll-*a* and TP statistical results showed that chlorophyll-*a* concentrations did not always follow trends for TP in the same lake (Table 13). This was unexpected given that there was a close relationship between overall concentrations of TP and chlorophyll-*a* in the study lakes (Section 3.3.1; Figure 7a). For example, eight lakes showed a significant increase of TP, but they did not show a corresponding (statistically significant) trend for chlorophyll-*a* over the same period (Baptiste, north basin; Crimson; Gregg; McLeod, east basin; Reesor; Saskatoon; Steele; and Thunder) (Table 13). For three of these lakes (Crimson, Gregg and Thunder), there was some evidence of a corresponding trend for chlorophyll-*a* (i.e., when $p > 0.05$ and < 0.15) (Table 13). But overall, the general finding of no direct response of chlorophyll-*a* to TP concentrations appears to be real and not necessarily limited by infrequent sampling or small sample sizes for most of these lakes (Figures 51 to 93). Also, the reductions of chlorophyll-*a* do not appear to be related to elevated salinity, because the lakes were predominately freshwater and they showed no trend or relatively small changes of TDS (<160 mg/L) over the sample record.

These findings highlight the complexity of cause and effect relationships between phosphorus and algal biomass in the study lakes. A more detailed examination of available data for each lake is needed to better understand the trend results. As noted already (Section 3.2), various limnological processes may be involved (separately or together) in causing elevated phosphorus in individual lakes. Additional factors include the influences of other nutrients (e.g., nitrogen), temperature and solar radiation on the algal community and the role of macrophytes and other components of the lake food web. The trends may also have been influenced by change in human and climate factors. For example, determination of the nutrient balance of each lake relative to changes in land use in the watershed and recent climate would aid in determining causes of the trends. Also, see *Eutrophication in Study Lakes,* below, for more discussion.

Most lakes showed no trend in transparency (67%) and 14 lakes showed increasing or decreasing trends (Table 13). Correspondence between chlorophyll-*a* and transparency readings was not as strong as might be expected. Transparency readings, based on Secchi disc visibility, are sometimes used as a surrogate measure of algal biomass. Secchi disc readings are expected to decrease as algal biomass increases. However, in this study, more significant trends were found for transparency compared to chlorophyll-*a,* and there were several instances of trends for chlorophyll-*a* and no corresponding trend for transparency in the same lake (Table 13). This may simply be because Secchi measurements were usually taken at one site in a lake basin, whereas composite samples comprised multiple samples across the basin. However, other factors which could also have influenced these results were variability in Secchi measurements (e.g., due to ambient light conditions and visual perception by the technician) and differential influence of turbidity or transparency by different phytoplankton species. Measurement of trophic condition using chlorophyll-*a* concentrations would be expected to be more consistent and accurate over time, compared to Secchi disc readings.

The three variables related to trophic condition generally showed no major change in four of the six reservoirs (Table 13). As noted above, faster flushing of the reservoirs, compared to natural lakes, may have influenced these results. Exceptions to this were Reesor Lake that had the longest residence time of the reservoirs (Table 1a) and Newell Lake, an off-stream reservoir on the Bow River. Declining trends of TP and chlorophyll-*a* and an increasing trend of transparency in Newell Lake corresponded with reductions of nutrient loads from Calgary municipal wastewater treatment plants to the Bow River over the same period (Sosiak 2002b).

Eutrophication in Study Lakes

Evidence of eutrophication, mostly reflected by increases of TP, was found in about one-quarter of the study lakes. As noted above, the cause(s) of the trends is not clear without more detailed analysis of data for each lake and watershed. However, it is noteworthy that the lakes with increasing phosphorus (or chlorophyll-*a*) were usually shallow compared to the other study lakes. (e.g., see mean depths in Table 14). The lakes also tended to be smaller (area and volume) compared to lakes with decreasing trends of phosphorus or chlorophyll-*a* (Table 14). Shallow lakes were likely to be polymictic, i.e., well mixed and more prone to elevated internal loading of phosphorus in the water column (Section 3.2). While this does not explain the consistent change or trend of TP in the lakes, it indicates that these shallow lakes might be more susceptible to eutrophication over the 30-year period of this study. Investigation of long-term temperature trends in the study lakes and potential influences on internal loading and lake productivity is warranted.

Further context on the significance of the eutrophication trends of this study is how they compare to longer-term changes, prior to European settlement. This would need to be done for individual lakes, but it would give perspective on the magnitude and rate of change found in this study ($\leq$30 years). For example, ‘cultural’ eutrophication (due to human influences) from extensive land use change, poor land management, or excessive nutrient loading can occur over relatively short time periods. A recent compilation of available paleolimnological studies for Alberta lakes illustrates examples of studies where inferred phosphorus levels or associated change in aquatic communities (e.g., phytoplankton and chironomids) have occurred over different time frames, including after human settlement (Gartner Lee 2007). The paleolimnological studies also illustrate the importance of long-term climate change on salinity and trophic condition of Alberta lakes (Gartner Lee 2007).

Other Water Quality Variables

Trend results for dissolved phosphorus (DP) concentrations in the 5 lakes (6 basins) examined were similar to trends for TP in the same lake, with a minor exception of Baptiste Lake, south basin that showed a small change in DP but not for TP (Tables 13 and 15; Figure 53b). The general correspondence between these variables in each lake was not unexpected given that DP is a component of TP. In Wabamun Lake, there was an overall decline of DP ($p = 0.02$; Table 15), but also, a step decline of concentrations in 2005 (Figure 92b). A step decline of DP was also evident in Pine Lake in 1999 (Figure 80b). These changes and others in Wabamun and Pine lakes were likely related to water management activities (see next sub-section).

For components of nitrogen (i.e., NH_3-N, NO_3+NO_2-N and TKN), there was no consistent pattern in the occurrence and direction of trends among the lakes (Table 15). Overall, the ammonia-N concentrations showed seasonality in most lakes, a small increasing trend in Baptiste Lake (north basin), and a pattern of increasing concentrations in Wabamun Lake after about 2004-05 (Table 15; Figures 52b, 53b, 60b, 76b, 80b and 92b). Nitrate-nitrite-N (NO_3+NO_2-N) data were insufficient for trend analysis in Ethel and Wabamun lakes (for both lakes, 46% of the data were <MDL)**.** Of the four remaining lake basins (with 18 to 25% of the samples <MDL), only Pine Lake showed an increasing NO_3+NO_2-N trend (Table 15), although this result may have been influenced by censored data which were more prevalent in recent years (Figure 80b).

Total Kjeldahl nitrogen (TKN) showed increasing trends for both basins of Baptiste Lake and Nakamun Lake (Table 15; Figures 52b, 53b and 76b) and a declining trend in Ethel Lake (Table 15; Figure 60b). The trend results for total nitrogen (TN) were almost identical to TKN which was the main component of TN (Table 15; Figures 52b, 53b, 60b, 76b, 80b and 92b). The TN:TP ratio generally showed no trends in the lakes over three decades, although there was a step change in Wabamun Lake in mid-2000s, due to the change of TP (Figures 52b, 53b, 60b, 76b, 80b and 92b).

In most cases, there were no trends or major change in non-filterable residue (NFR), dissolved organic carbon (DOC) and silica concentrations (Table 15; Figures 52b, 53b, 60b, 76b, 80b and 92b). Exceptions included a clear trend for DOC in Nakamun Lake with an overall increase of about 5 mg/L (Figure 76b) and Wabamun Lake, where there was a decrease of DOC and silica concentrations beginning in mid-2000 (Figure 92b). The trends observed for several off these variables in the lakes may have been influenced by natural inflows and flushing (indirectly related to lake level) (Section 3.4), but water management was also likely to have been important in Wabamun Lake.

Influence of Water Management

River water is diverted into a number of the study lakes (Table 1b) usually for the purpose of maintaining or restoring lake levels. Based on the water quality time series graphs for the select lakes and the year when the diversion began, it is evident that diversions had an effect on the water quality of Alix, Buffalo and Wabamun lakes. In the case of Alix Lake, it is a very small lake and Red Deer River water is diverted through it to Buffalo Lake (Table 1b) (McDonald 2004). Only five of six variables analysed had data before and after the start of the diversion in 1996. These variables generally showed a step decrease (alkalinity, pH, TP and chlorophyll-*a*), or increase (transparency) in 1996 (Figure 51). Change in Buffalo Lake was not as clear, and was primarily evident in Secondary Bay which receives the diversion inflow. Alkalinity, pH and TDS values showed a step decrease in Secondary Bay from 1995 to 1996 (Figures 55 and 56). Only pH showed a step decline in 1996 in the main basin of Buffalo Lake (Figure 55). Higher concentrations of several water quality variables, especially for TDS and alkalinity, were also found in Buffalo Lake, main basin, compared to Secondary Bay (Figures 55 and 56)

Wabamun Lake receives treated North Saskatchewan River water in order to replenish lake inflow lost due to mining activity in the lake drainage. Previous analysis documented trends in lake water quality up to 2001, and changes associated with the inflow of treated water pumped to the lake, beginning in 1999 (Casey 2003). Changes included step increases of TDS and some major ions, and step decreases or declining concentrations of calcium carbonate, phosphorus (total and dissolved) and chlorophyll-*a* in the lake. Casey (2003) suggested that the step declines of TP and DP in 1999 were due to co-precipitation of phosphorus with enhanced calcium carbonate load in the treated water. Additional and increasing volumes of treated water were pumped to the lake from 2002 to early 2007, after which overall volume was reduced by about one-half (Figure 92c).

Since the previous evaluation, some patterns in water quality and trophic condition were evident in Wabamun Lake. These included: ongoing increases of TDS; stable and decreasing levels of alkalinity; stable levels of pH and transparency; maintenance of lower TP concentrations (similar to or lower than the step decline in 1999); and a tendency for slightly higher chlorophyll-*a* concentrations in recent years (Figure 92a and 92b). However, the overall trophic condition, based on algal biomass, did not change in the lake (Table 13). The remaining water quality variables also showed some gradual or step changes in concentrations specifically around 2005 and 2006 (e.g., DP, NH_3-N, TN:TP, DOC and silica) while others remained relatively stable since 2001 (e.g., NO_3+NO_2-N, NFR, TKN and TN) (Figure 92b).

Although these changes in Wabamun Lake were likely influenced by the treated water diversion, it is difficult to clearly attribute causes. For example, the timing of the most recent changes in lake water quality (2005-06) did not correspond well with the main change (substantial reduction) in the treated water volume that occurred in early 2007. It is possible that the water quality of the two treatment plants was different, but the relative proportion of water volumes from the plants was similar from about 2003 to early 2007 (Figure 92c). Another potential influence on lake water quality was a large spill of bunker oil (due to a train derailment) in 2005 and subsequent clean-up activities. Mitigation was largely physical including the use of containment booms and the removal of heavy oil, contaminated sediment, or vegetation over a three-year period. Lighter oil volatilised off the lake surface. Examination of the water quality data before and after the spill (on 5 August) showed no major change to any of the variables analysed in this study (with a minor exception of two relatively low DP concentrations in August and September 2005) (Figure 92b). This may not be surprising because the water quality variables analysed here do not include measures specific to oil (e.g., hydrocarbons, trace organic compounds and select metals). The commercial fishery for whitefish in Wabamun Lake was also closed after winter 2003 and has remained closed. Major change to the trophic levels of a lake food web can influence its components (e.g., composition and biomass of phytoplankton communities), but algal biomass remained relatively stable over the sample record.

A hypolimnetic withdrawal system in Pine Lake was initiated in 1999, in order to discharge phosphorus-rich water and thereby reduce the influence of internal phosphorus recycling in the lake. Prior to 1999, various projects were also completed to reduce nutrient loads to the lake (Sosiak 2002a). The long-term data for Pine Lake does not show a trend for TP, DP or chlorophyll-*a* concentrations from 1983 to 2009 (Table 13). However, it was evident that the start up of the withdrawal system corresponded with step declines of phosphorus, especially for DP (Figures 80a and 80b) (Sosiak 2002a). More recently, TP and DP concentrations showed a tendency for higher concentrations after about 2004-05, and then more stabilised levels in 2008-09 (Figure 80a and 80b). Chlorophyll-*a* showed a general pattern of higher concentrations in 2008-09 (Figure 80a). Although changes in phosphorus were evident in Pine Lake that corresponded to the start-up of the hypolimnetic withdrawal system, additional data are needed to fully understand whether longer term change will occur with ongoing use of the hypolimnetic withdrawal system. Another more recent evaluation of the operation of hypolimnetic system relative to trophic condition of the lake would also be helpful.

3.4 Trends in Lake Level

Results of trend analysis for lakes with lake level data that coincided with the water quality sampling record are in Table 16 and Figure 95. In most cases, there was reasonable overlap in the span of these records with some exceptions (Spruce Coulee and Tucker) (Table 16). There may also be some inaccuracies in the estimates of annual (median) lake levels due to infrequent data for some lakes (e.g., Beauvais, Long, Newell and Travers).

About half of the lakes showed no statistical trend in lake level (51%), 13 lakes showed a decreasing trend (35%) and only five had an increasing trend (14%) (Table 16). Six lakes (Dillberry; Garner; Miquelon; Nakamun; North Buck; and Saskatoon) showed an overall reduction of lake level by about 1 to 2 m (based on the trend line) (Figure 95). Some of these lakes, notably Dillberry, Garner and Miquelon are often considered as closed basins (with no permanent inflow and outflow) (Mitchell and Prepas 1990). The large increase of annual lake level in Pine Coulee (7 m based on the trend line) was due to the reservoir filling during the early portion of the monitoring record (Figure 95). The drawdown of the water level in Reesor Lake in 2008 was to facilitate rehabilitation of the outlet (Figure 95).

Excluding Pine Coulee and Spruce Coulee, the other reservoirs showed no overall change in annual water level over the water quality sampling record (Table 16). Of course some reservoirs, notably Newell and Travers, showed regular and relatively large annual fluctuation in lake level (Figures 95). This was due to annual storage and use of water in associated irrigation systems.

3.5 Relationship Between Lake Level and Water Quality

Results of correlation tests between lake level and total dissolved solids (TDS), total phosphorus (TP) and chlorophyll-*a* in the lakes are in Table 17. It was assumed that a change in lake level would reflect the net change (inputs and outputs) in a lake water balance, thereby potentially influencing lake water quality. Change in lake level was likely influenced by the prevailing climate, but measures of climate change (e.g., regional variation in precipitation and temperature) were not investigated in the study.

Most lakes showed no relationship between lake level and TDS (63%), but 13 of the remaining lakes showed negative correlations (Table 17). The only exception to this was Moore Lake with a positive correlation (Table 17). In most cases (10 lakes), the negative correlations occurred when there was declining trend for lake level (Table 17). Thus, TDS increased with declining lake level. This pattern was not unexpected, given that many of these lakes also had very long water residence times (>100 years; Table 1a). Over time reduced inflows and ongoing evaporative loss likely led to increased TDS concentrations in these waterbodies. However, more comprehensive evaluation of the lake water balance, TDS fluxes (if available) and climate measures would better explain these patterns and influences on the water quality of individual lakes.

In contrast to TDS, there were few correlations between lake level and the key measures of nutrient and trophic condition. Lake level was correlated with TP in seven lakes and with chlorophyll-*a* in six lakes (Table 17). The significant correlations were predominately negative (Table 17). This pattern is similar to that found for TDS. However, given the importance of the phosphorus sources and cycling in the study lakes, interpretation of the findings as being mostly due to reduced dilution or flushing of TP and chlorophyll-*a* levels is not appropriate. Also, of the five lakes with increasing lake level, only one (Ethel) showed a decreasing trend for TP or chlorophyll-*a* (Tables 13 and 17). This suggests that inflows or flushing was not the main controlling factor in these cases.

4.0 MAIN FINDINGS

Many Alberta lakes are nutrient rich due to geology and extensive coverage by glacial till. However, post-European settlement, associated land clearing and other human activities can enhance nutrient inputs to lake water and bottom sediments. Water management and lake level can also influence lake water quality.

Study Lakes

- In total, there were 39 lakes (43 lake basins) with long-term water quality data (10 to 30 years). The dataset of 4,128 composite (or ‘whole lake’) samples made up 56% of the provincial AEW lake dataset. The study lakes include six reservoirs.

- The lakes were mostly in settled areas of the province. Over half were in the boreal natural region (59%) including the Peace-Athabasca and Beaver rivers. Fewer lakes were in the mountains (10%), foothills (10%), parkland (13%) and grasslands (8%).

Water Quality Conditions

- The lakes were predominately alkaline and freshwater (with low total dissolved solids; <500 mg/L). Dominant ions were calcium or sodium and bicarbonate. Only two lakes had moderate or high salinity (i.e., Buffalo and Miquelon, respectively).

- Trophic condition of the lakes (based on chlorophyll-*a*) were predominately in the mesotrophic to hyper-eutrophic categories. Only three lakes were oligotrophic.

- As expected there was a strong relationship between total phosphorus (TP) and algal biomass (chlorophyll-*a*) levels in the lakes. Lower algal biomass was found in some lakes with higher TDS, but there were too few saline lakes to properly evaluate the relationship with salinity or components of TDS.

Seasonality

- Most lakes did not show seasonality (differences among months) in total alkalinity and TDS concentrations. Greater seasonality of pH in the lakes was likely caused by more algal growth (photosynthesis) in the summer months.

- In contrast to overall water quality, measures of trophic condition (TP, chlorophyll-*a* and transparency) exhibited seasonality in most lakes, except for those with lowest algal biomass.

- Seasonal changes of algal biomass generally followed those of TP with peaks in the summer and early fall. However, some lakes also showed high TP concentrations in the spring following lake overturn.

- Seasonality was also determined for other water quality variables (e.g., nitrogen and its components, non-filterable residue and silica) in a subset of the study lakes with the most frequent sampling record. Seasonality was found for most of these variables in the five lakes (six lake basins) examined.

Long-term Trends

- Total alkalinity and TDS showed two main patterns. For either variable, close to half the lakes showed increasing trends while most of the remaining lakes had no trend. Few lakes declined in TDS and alkalinity. Lakes with increasing trends of TDS showed overall increases of <160 mg/L with only two exceptions (Moose and Miquelon lakes). Only nine lakes showed a trend in pH over the sample record.

- Most lakes showed no trend in TP, chlorophyll-*a* and transparency ($\geq$67%) for up to 30 years. However, TP increased in 11 (26%) of the lakes while chlorophyll-*a* increased in only three lakes. In contrast, three and seven lakes declined in TP and chlorophyll-*a,* respectively. For lakes with trends, the overall change in TP was one to two orders of magnitude greater (up to about 280 ug/L) than that for chlorophyll-*a* ($\leq$6 ug/L).

- The lack of an increase of chlorophyll-*a* in the eight lakes where TP increased was unexpected given the generally close relationship between these variables in the lakes. However, this illustrates the complexity of nutrient cycling and algal dynamics, and the need to further investigate causes of this in each lake.

- The cause of the eutrophication (mostly TP increases) found in one-quarter of the study lakes is not apparent at this time. But in general, these lakes were small, shallow and likely well mixed with high internal loading of phosphorus. Such polymictic lakes are common in Alberta. While this does not explain the cause of the trends, it indicates that polymictic lakes might be more susceptible to eutrophication over the 30-year study. Investigation of long-term temperature trends and potential influences on internal loading and productivity of the lakes would be helpful. Also, further context on the magnitude and rate of change of eutrophication in this study requires comparisons to longer-term influences of human settlement and climate change including paleolimnological evidence.

- Nine of the 10 lakes with chlorophyll-*a* trends were oligotrophic or mesotrophic. This suggests that lakes in lower trophic categories are more sensitive, or likely to show change due to phosphorus enrichment. Oligotrophic lakes are less common in Alberta (mostly in Rocky Mountains, foothills and north-east Alberta).

- In the subset of five study lakes, there were few trends for other water quality variables (noted above) in the lakes. However, this is a relatively small sample size of the study lakes.

Influence of Water Management

- Diversions of river water to enhance lake level affected the water quality of three study lakes. The main effect of a diversion from the Red Deer River was the dilution of overall water quality in Alix Lake (a small lake) and a portion of Buffalo Lake, closest to the inflow.

- In Wabamun Lake, effects of the treated water pumped to the lake were still evident, comparable to a previous evaluation (e.g., reduced phosphorus concentrations). But overall there was no long-term change in trophic condition of the lake. Effects of the large hydrocarbon spill (due to a train derailment) in 2005 were not evident in the water quality variables analysed in this study.

- In Pine Lake, the start up of the hypolimnetic withdrawal system (to reduce the influence of internal phosphorus load) corresponded with step declines of TP and DP concentrations in 1999, but no long-term change (trend) was yet apparent. A more recent evaluation of the influence of the hypolimnetic system on trophic condition of the lake would be helpful.

- There was consistency in the trend results for the reservoirs where no long-term change in water quality was more commonly found. This may be related to more frequent flushing compared to many natural lakes.

Lake Level Trends and Relationship to Water Quality

- Lake level showed no trend in about half of the 37 lakes with coinciding water quality data. Lake level declined in 13 lakes and for six of these, there was an overall decline of 1 to 2 m (based on the trend line) over the record. Lake level increased in only five of the study lakes.

- Most lakes (63%) showed no correlation between lake level and TDS. However, 10 of the remaining lakes showed increased TDS with declining lake level. Many of these lakes also had very long water residence times (>100 years). Therefore, over time, reduced inflow and ongoing evaporative concentration likely led to enhanced TDS in these waterbodies. More comprehensive evaluation of this relationship could include the lake water balance, TDS flux and influences of climate.

- In contrast to TDS, there were few correlations between lake level and TP or chlorophyll-*a*. Of the five lakes with increasing lake levels, only one showed a decreasing trend for TP or chlorophyll-*a.* This suggests that inflows or flushing was not the main controlling factor in these cases.

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TABLES

A. LAKE/WATERSHED FEATURES AND WATER MANAGEMENT

Table 1a Main geographic and physical characteristics of the 39 lakes (43 lake basins) and their watersheds

Lake or Basin [A]	Outlet Structure	Natural Region [B]	Sub-Region [B]	Major River Basin	Drainage Area (km^2)	Surface Area (km^2)	Watershed: Lake Surface Area ratio	Volume (million m^3)	Maximum Depth (m)	Mean Depth (m)	Mean Annual Inflow (million m^3)	Water Residence Time (yrs)
Alix	Weir	Parkland	Central Parkland	Red Deer	59	1	91	1	3	2	---	---
Baptiste, North Basin	None	Boreal	Central Mixedwood	Athabasca	109	5	22	28	16	6	16	6
Baptiste, South Basin	---	Boreal	Central Mixedwood	Athabasca	179	5	38	57	28	12	16	6
Beauvais	Weir	Rocky Mountain	Montane	Oldman	7	1	8	4	11	7	1	4
Buffalo, Main Basin	---	Parkland	Central Parkland	Red Deer	1,440	94	15	248	7	3	24	>100
Buffalo, Secondary Bay	None	Parkland	Central Parkland	Red Deer	---	---	---	---	3	---	---	---
Crimson	None	Foothills	Lower Foothills	N. Saskatchewan	2	2	1	5	9	2	0.2	>100
Dillberry	None	Parkland	Central Parkland	Sounding Creek	12	1	15	2	11	3	0.2	>100
Elkwater	Weir	Rocky Mountain	Montane	S. Saskatchewan	26	2	11	8	8	4	2	6
Ethel (near Cold Lake)	Weir	Boreal	Central Mixedwood	Beaver	542	5	111	32	30	7	13	3
Garner	None	Boreal	Central Mixedwood	Beaver	26	6	4	50	15	8	1	>100
Gregg	None	Foothills	Lower Foothills	Athabasca	163	1	122	5	18	---	---	<1
Gregoire	Weir	Boreal	Central Mixedwood	Athabasca	232	26	9	100	7	4	27	4
Gull	None	Parkland	Central Parkland	Red Deer	206	81	3	437	8	5	14	>100
Hilda	None	Boreal	Central Mixedwood	Beaver	87	4	24	23	12	6	---	6
Jarvis	None	Foothills	Lower Foothills	Athabasca	70	1	48	12	25	---	---	2
Lac La Biche, E. Basin	None	Boreal	Dry Mixedwood	Athabasca	4,040	234	17	1,960	12	8	316	7
Long (near Boyle)	None	Boreal	Central Mixedwood	Beaver	82	6	14	29	9	4	5	8
Marie	None	Boreal	Central Mixedwood	Beaver	386	35	11	484	26	14	17	48
McLeod, East Basin	---	Foothills	Lower Foothills	Athabasca	46	4	12	19	11	5	4	6
McLeod, West Basin	Weir	Foothills	Lower Foothills	Athabasca	---	---	---	---	6	---	---	---
Miquelon	None	Boreal	Dry Mixedwood	Battle	35	9	4	24	6	3	2	>100
Moonshine	Dam	Boreal	Dry Mixedwood	Peace	7	0.3	24	0.4	4	1	0.4	---
Moore (Crane)	Weir	Boreal	Central Mixedwood	Beaver	37	9	4	77	26	8	2	>100
Moose	Weir	Boreal	Dry Mixedwood	Beaver	755	41	19	230	20	6	38	8
Nakamun	None	Boreal	Dry Mixedwood	Athabasca	45	4	13	16	8	5	1	21
Newell	Dam	Grassland	Dry Mixedgrass	Bow	85	66	1	321	20	5	295	2
North Buck	None	Boreal	Central Mixedwood	Beaver	100	19	5	47	6	2	3	41
Pigeon	Weir	Boreal	Dry Mixedwood	Battle	187	97	2	603	9	6	17	>100
Pine	None	Parkland	Central Parkland	Red Deer	150	4	39	21	12	5	3	9
Pine Coulee, South	Dam	Grassland	Foothills Fescue	Oldman	80	6	14	51	19	---	---	---
Reesor	Dam	Rocky Mountain	Montane	Milk	6	1	11	2	6	4	0.4	6
Saskatoon	None	Boreal	Central Mixedwood	Smoky	32	7	4	19	4	3	1	>100
Spruce Coulee	Dam	Rocky Mountain	Montane	Milk	4	0.2	19	0.7	6	3	---	3
Steele (Cross)	Weir	Boreal	Central Mixedwood	Athabasca	255	7	39	21	6	3	12	2
Sturgeon, Main Basin	Weir	Boreal	Dry Mixedwood	Smoky	571	49	12	266	10	5	47	7
Sturgeon, West Basin	---	Boreal	Dry Mixedwood	Smoky	---	---	---	---	3	---	---	---
Sylvan	None	Boreal	Dry Mixedwood	Red Deer	102	43	2	412	18	10	7	>100
Thunder	Weir	Boreal	Central Mixedwood	Athabasca	21	7	3	21	6	3	1	>100
Travers	Dam	Grassland	Mixed Grass	Oldman	4,230	23	188	413	40	18	404	1
Tucker	Weir	Boreal	Central Mixedwood	Beaver	312	7	47	19	8	3	15	2
Wabamun	Weir	Boreal	Dry Mixedwood	N. Saskatchewan	259	82	3	513	11	6	13	>100
Winagami	Weir	Boreal	Dry Mixedwood	Athabasca	221	47	5	81	5	2	13	2

Footnotes:
Pairs of lake basins shaded in grey are in the same lake
Lake names in bold font are reservoirs
[A] Source of lake and watershed information: Mitchell and Prepas (1990) and AEW
[B] Source: Natural Regions Committee (2006)

Table 1b Presence of outlet structures and water management activities in the lakes

Lake	Major River Basin	Outlet Structure [A]	Major Water Management or Related Activity [A]
Alix	Red Deer	Weir	Diversion of Red Deer River water to Buffalo Lake, via Alix Lake, began in 1996 (McDonald 2004); ongoing, operates in open-water months
Baptiste	Athabasca	None	
Beauvais	Oldman	Weir	Lake level was dropped in 1981 (for control of suckers) and again in 1985/86 to re-bulid the outlet weir, but there was no change to full suply level (Mitchell & Prepas 1990)
Buffalo	Red Deer	None	Diversion of Red Deer River water to Buffalo Lake, via Alix Lake, began in 1996 (McDonald 2004); ongoing, operates in open-water months
Crimson	N. Saskatchewan	None	
Dillberry	Sounding Creek	None	No permanent inlet or outlet (Mitchell & Prepas 1990)
Elkwater	S. Saskatchewan	Weir	Latest outlet structure was installed in 1978 (Mitchell & Prepas 1990)
Ethel (near Cold Lake)	Beaver	Weir	Weir installed in outlet stream in 1980 to raise lake level; new structure with higher sill level installed in 1986 (Mitchell & Prepas 1990)
Garner	Beaver	None	No permanent inlet or outlet (Mitchell & Prepas 1990)
Gregg	Athabasca	None	
Gregoire	Athabasca	Weir	Weir built at lake outlet in 1973 (Mitchell & Prepas 1990)
Gull	Red Deer	None	Diversion of Blindman River water to Gull Lake began 1977; pumping occurs when the lake level is below 898.89 m (Mitchell & LeClair 2003); ongoing pumping occurs in spring
Hilda	Beaver	None	
Jarvis	Athabasca	None	
Lac La Biche	Athabasca	None	
Long (near Boyle)	Beaver	None	
Marie	Beaver	None	
McLeod	Athabasca	Weir	Weir built in 1971 and a new one was installed as a fish barrier in 1987 (Mictchell & Prepas 1990)
Miquelon	Battle	None	No permanent inlet or outlet (Mitchell & Prepas 1990)
Moonshine	Peace	Dam	Dam constructed in 1959; main use is for recreation (Mitchell & Prepas 1990)
Moore (Crane)	Beaver	Weir	Earthen dyke replaced old structure in 1982 (Mitchell & Prepas 1990)
Moose	Beaver	Weir	Weir replaced old structure in 1986; source water for the town of Bonneyville (Mitchell & Prepas 1990)
Nakamun	Athabasca	None	
Newell	Bow	Dam	Reservoir level controlled by 18 structures (Mitchell & Prepas 1990); uses include irrigation, recreation and water supply for the City of Brooks
North Buck	Beaver	None	
Pigeon	Battle	Weir	Replaced weir with new structure and fish ladder in 1986 (Mitchell & Prepas 1990)
Pine	Red Deer	None	Hypolimnetic withdrawal system installed and began operation in 1999 (Sosiak 2002a); ongoing, operates in open-water period
Pine Coulee	Oldman	Dam	Reservoir uses include irrigation, recreation and water supply for the towns of Claresholm and Granum
Reesor	Milk	Dam	Original dam built in 1958; reservoir uses include recreation, some stock watering (Mitchell & Prepas 1990) and it is part of Inter-provincial Watering Program
Saskatoon	Smoky	None	
Spruce Coulee	Milk	Dam	Reservoir uses include recreation and some local stock watering
Steele (Cross)	Athabasca	Weir	Weir built in 1974 (Mitchell & Prepas 1990)
Sturgeon	Smoky	Weir	Weir replaced an older structure in 1969 (Mitchell & Prepas 1990)
Sylvan	Red Deer	None	
Thunder	Athabasca	Weir	Weir constructed in 1963 (Mitchell & Prepas 1990)
Travers	Oldman	Dam	Dam built in 1951-53 (Mitchell & Prepas 1990); reservoir uses include irrigation, recreation and water supply for the village of Champion, Little Bow Provincial Park and Little Bow Resort
Tucker	Beaver	Weir	Original weir in disrepair by 1982 (Mitchell & Prepas 1990)
Wabamun	N. Saskatchewan	Weir	Diversion of treated water from North Saskatchewan River began in 1997-98; two treatment plants with different volumes and periods of operation (see Figure 92c)
Winagami	Athabasca	Weir	Diversion from South Heart River after dam built in 1950 to impound water; canal from outlet back to S. Heart R. forms local water supplies (Mitchell & Prepas 1990)

Footnotes:
Lake names in bold font are reservoirs
[A] Source: AEW and others cited

B. WATER QUALITY CONDITIONS

This section includes summary statistics for water quality variables in the 43 lake basins over the sampling record. The six general and trophic variables are presented first (Table 2a) followed by the other variables analysed in the six selected lake basins (Table 2b). Lakes are listed alphabetically in each Table.

Table 2a Summary statistics for the six main water quality variables in the lakes

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-*a* (mg/m^3)	Transparency (Secchi depth, m)
Alix						
Mean	213.5	8.3	207.5	0.035	8.8	2.2
Standard Error	19.176	0.043	6.705	0.003	1.118	0.111
Median	152	8.31	193.5	0.0298	6.4	2.5
Mode	141	8.23	185	0.054	22.2	2.5
Standard Deviation	131.462	0.296	41.332	0.019	7.666	0.755
Sample Variance	17282.212	0.087	1708.332	0.000	58.766	0.570
Kurtosis	0.843	0.319	0.399	4.754	4.832	-0.571
Skewness	1.535	0.427	1.150	1.795	2.058	-0.417
Range	483	1.4	161	0.0997	38	3.2
Minimum	100	7.79	150	0.0103	0.7	0.7
Maximum	583	9.19	311	0.11	38.7	3.9
Count	47	47	38	47	47	46
Baptiste, North Basin						
Mean	171.8	8.5	191.7	0.070	34.2	1.9
Standard Error	0.797	0.029	1.100	0.003	2.392	0.087
Median	172	8.4	191.03	0.0631	28.6	1.725
Mode	172	8.2	196	0.038	27.3	1
Standard Deviation	8.204	0.295	11.218	0.033	25.429	0.922
Sample Variance	67.306	0.087	125.850	0.001	646.631	0.851
Kurtosis	-0.178	0.127	0.288	2.822	2.128	1.222
Skewness	-0.030	0.764	0.252	1.403	1.327	1.081
Range	41	1.32	55.86	0.1813	128.8	4.85
Minimum	150	7.9	165.14	0.029	2.7	0.55
Maximum	191	9.22	221	0.2103	131.5	5.4
Count	106	106	104	111	113	112
Baptiste, South Basin						
Mean	169.2	8.5	189.6	0.064	32.4	1.8
Standard Error	1.038	0.030	1.204	0.003	2.233	0.081
Median	169	8.5	189.5	0.055	27.6	1.7
Mode	166	8.4	190	0.055	24.7	1.4
Standard Deviation	10.590	0.304	12.159	0.027	23.732	0.861
Sample Variance	112.156	0.092	147.834	0.001	563.201	0.741
Kurtosis	15.716	2.335	1.881	6.144	6.449	4.775
Skewness	-2.507	-0.491	0.921	1.938	1.977	1.632
Range	89	2	74.81	0.1624	151	5.62
Minimum	101	7.2	164.19	0.0306	3	0.48
Maximum	190	9.2	239	0.193	154	6.1
Count	104	104	102	111	113	113
Beauvais						
Mean	154.6	8.3	158.4	0.026	8.0	2.8
Standard Error	1.723	0.026	1.767	0.001	0.668	0.101
Median	153	8.31	156.79	0.025	6	2.575
Mode	145	8.4	168	0.032	4.9	2.5
Standard Deviation	11.813	0.177	11.719	0.006	6.231	0.959
Sample Variance	139.557	0.031	137.340	0.000	38.825	0.920
Kurtosis	-0.685	-0.281	-0.933	0.194	9.669	0.010
Skewness	0.488	-0.018	0.114	0.759	2.738	0.660
Range	47	0.75	43.93	0.0288	38.8	4.4
Minimum	135	7.95	139.07	0.016	1.3	1
Maximum	182	8.7	183	0.0448	40.1	5.4
Count	47	47	44	88	87	90

Table 2a Summary statistics for the six main water quality variables in the lakes (continued)

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (mg/m^3)	Transparency (Secchi depth, m)
Buffalo, Main Basin						
Mean	1132.3	9.2	1836.6	0.066	10.7	2.1
Standard Error	8.594	0.014	15.630	0.002	0.957	0.106
Median	1143.5	9.2	1860	0.0659	8.675	1.8
Mode	1170	9.2	1820	0.055	4.6	1.5
Standard Deviation	72.926	0.121	132.627	0.017	8.775	0.969
Sample Variance	5318.153	0.015	17589.830	0.000	77.008	0.939
Kurtosis	3.354	0.216	1.848	-0.029	2.755	1.701
Skewness	-1.309	-0.437	-1.046	-0.187	1.576	1.458
Range	406	0.63	734	0.0772	43.2	4.1
Minimum	829	8.85	1326	0.028	1	0.9
Maximum	1235	9.48	2060	0.1052	44.2	5
Count	72	72	72	81	84	84
Buffalo, Secondary Bay						
Mean	886.0	9.1	1425.3	0.080	12.4	1.2
Standard Error	12.070	0.022	22.327	0.003	1.151	0.093
Median	884	9.08	1420	0.0793	9.8	1.1
Mode	843	9	1200	0.066	9.4	0.4
Standard Deviation	97.313	0.177	177.218	0.027	9.494	0.708
Sample Variance	9469.875	0.031	31406.249	0.001	90.140	0.501
Kurtosis	-0.498	2.833	-0.788	0.005	0.151	-0.173
Skewness	0.184	1.115	0.155	0.473	0.894	0.679
Range	434	1.02	705.6	0.1238	37	3
Minimum	678	8.78	1090	0.027	1.1	0.25
Maximum	1112	9.8	1795.6	0.1508	38.1	3.25
Count	65	65	63	68	68	58
Crimson						
Mean	142.3	8.5	138.9	0.021	6.7	2.5
Standard Error	2.188	0.032	2.469	0.001	0.692	0.125
Median	139	8.51	138	0.019	5	2.3
Mode	137	8.4	134	0.022	4.2	1.5
Standard Deviation	14.350	0.210	14.184	0.012	5.873	1.064
Sample Variance	205.919	0.044	201.173	0.000	34.498	1.132
Kurtosis	-0.717	0.976	-0.441	32.341	6.160	0.952
Skewness	0.170	0.812	0.019	4.907	2.389	0.862
Range	58	0.95	56	0.0986	30.4	5.25
Minimum	114	8.15	112	0.006	1.6	1
Maximum	172	9.1	168	0.1046	32	6.25
Count	43	43	33	73	72	73
Dillberry						
Mean	207.9	8.6	208.1	0.022	5.1	3.1
Standard Error	3.270	0.041	5.875	0.001	0.374	0.139
Median	203	8.6	197	0.0206	4.5	3
Mode	203	8.6	193	0.01	3.5	2
Standard Deviation	20.937	0.263	32.710	0.010	3.104	1.169
Sample Variance	438.350	0.069	1069.944	0.000	9.637	1.366
Kurtosis	-0.757	14.990	0.061	7.067	12.951	-0.005
Skewness	0.490	-3.065	1.174	1.843	2.796	0.578
Range	73	1.74	105.31	0.063	20.8	5.5
Minimum	178	7.3	171.69	0.006	1.4	1
Maximum	251	9.04	277	0.069	22.2	6.5
Count	41	41	31	69	69	71

Table 2a Summary statistics for the six main water quality variables in the lakes (continued)

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (mg/m^3)	Transparency (Secchi depth, m)
Elkwater						
Mean	215.9	8.5	259.9	0.039	6.5	2.5
Standard Error	1.229	0.021	2.117	0.002	0.496	0.132
Median	215	8.53	259	0.0368	5.2	2
Mode	210	8.6	265	0.025	1.9	1.5
Standard Deviation	9.908	0.170	15.555	0.017	5.363	1.457
Sample Variance	98.162	0.029	241.965	0.000	28.758	2.123
Kurtosis	-0.341	2.370	1.293	4.185	2.408	0.552
Skewness	0.304	-1.233	0.712	1.471	1.566	1.146
Range	46	0.94	79.51	0.1007	25.7	6.25
Minimum	194	7.9	230.49	0.013	0.6	0.75
Maximum	240	8.84	310	0.1137	26.3	7
Count	65	65	54	119	117	121
Ethel (near Cold Lake)						
Mean	155.8	8.3	156.4	0.023	7.7	3.5
Standard Error	0.459	0.020	0.651	0.000	0.269	0.075
Median	155	8.4	155.37	0.0214	6.85	3.3
Mode	155	8.4	153	0.019	5.6	3
Standard Deviation	5.338	0.229	7.565	0.005	3.335	0.902
Sample Variance	28.490	0.053	57.228	0.000	11.123	0.814
Kurtosis	1.993	2.915	-0.033	1.750	0.990	0.352
Skewness	-0.171	-1.676	0.368	0.974	1.127	0.774
Range	37	1.27	38.4	0.0338	14.73	4.45
Minimum	135	7.45	137	0.01	2.93	1.75
Maximum	172	8.72	175.4	0.0438	17.66	6.2
Count	135	135	135	139	154	144
Garner						
Mean	494.3	9.0	608.2	0.036	7.8	4.3
Standard Error	4.856	0.019	6.674	0.001	0.866	0.231
Median	503.5	9.035	615	0.0346	5	4
Mode	530	9.1	592	0.032	4.2	5
Standard Deviation	26.599	0.102	36.552	0.010	6.711	1.806
Sample Variance	707.527	0.010	1336.069	0.000	45.043	3.263
Kurtosis	-0.096	0.700	0.013	0.190	2.543	0.524
Skewness	-0.758	-0.268	-0.585	-0.044	1.705	0.596
Range	93.5	0.45	145.99	0.0492	30.7	9.6
Minimum	436.5	8.8	528.01	0.006	1.1	0.4
Maximum	530	9.25	674	0.0552	31.8	10
Count	30	30	30	61	60	61
Gregg						
Mean	182.8	8.3	186.4	0.010	1.6	5.7
Standard Error	1.423	0.028	1.290	0.001	0.075	0.146
Median	184	8.3	185.5	0.0092	1.5	5.5
Mode	181	8.4	185	0.009	1	5.5
Standard Deviation	9.112	0.180	7.065	0.005	0.585	1.159
Sample Variance	83.020	0.032	49.917	0.000	0.342	1.344
Kurtosis	4.502	0.666	0.767	9.005	0.928	0.813
Skewness	-1.777	-0.692	-0.444	2.598	1.060	-0.296
Range	46	0.89	33	0.0267	2.6	6.5
Minimum	151	7.72	167	0.0053	0.7	2
Maximum	197	8.61	200	0.032	3.3	8.5
Count	41	41	30	58	61	63

Table 2a Summary statistics for the six main water quality variables in the lakes (continued)

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (mg/m^3)	Transparency (Secchi depth, m)
Gregoire						
Mean	56.8	7.6	69.5	0.033	10.3	2.2
Standard Error	0.756	0.064	1.253	0.001	0.817	0.097
Median	56	7.76	68.95	0.031	8.3	2
Mode	56	7.9	65	0.0241	5.1	1.75
Standard Deviation	5.234	0.441	7.516	0.011	7.620	0.921
Sample Variance	27.398	0.195	56.486	0.000	58.071	0.849
Kurtosis	-0.621	0.322	6.903	0.360	9.430	2.768
Skewness	0.287	-0.857	1.952	0.920	2.506	1.431
Range	21.7	2.03	42.81	0.0506	50.1	4.95
Minimum	46.3	6.33	57.4	0.0161	0.9	0.8
Maximum	68	8.36	100.21	0.0667	51	5.75
Count	48	48	36	88	87	91
Gull						
Mean	653.5	9.1	769.1	0.044	8.4	2.4
Standard Error	3.967	0.012	5.838	0.001	0.506	0.107
Median	653	9.1	770	0.044	7.94	2.25
Mode	646	9.1	785	0.044	4.3	2
Standard Deviation	28.050	0.087	41.278	0.010	4.172	0.873
Sample Variance	786.815	0.008	1703.874	0.000	17.405	0.763
Kurtosis	2.220	0.399	0.849	0.444	0.856	4.964
Skewness	0.981	-0.544	0.504	0.270	0.758	2.061
Range	152	0.39	205	0.0528	20.8	4.7
Minimum	599	8.82	688	0.022	1	1.3
Maximum	751	9.21	893	0.0748	21.8	6
Count	50	50	50	67	68	67
Hilda						
Mean	364.8	8.6	426.6	0.024	6.9	2.7
Standard Error	7.742	0.122	10.968	0.002	0.880	0.091
Median	331	8.8	388.2	0.021	5	2.5
Mode	327	8.9	NA	0.016	5.51	2.5
Standard Deviation	48.350	0.764	68.493	0.010	6.287	0.602
Sample Variance	2337.746	0.583	4691.332	0.000	39.530	0.362
Kurtosis	-1.448	26.162	-1.455	16.391	12.401	-0.315
Skewness	0.642	-4.749	0.603	3.542	3.172	0.347
Range	128	4.71	183	0.063	35.78	2.5
Minimum	316	4.33	359	0.013	2.6	1.5
Maximum	444	9.04	542	0.076	38.38	4
Count	39	39	39	39	51	44
Jarvis						
Mean	152.9	8.2	157.3	0.013	1.6	6.2
Standard Error	1.413	0.030	0.863	0.003	0.220	0.130
Median	151	8.255	158	0.0092	1.395	6.2
Mode	152	8.27	153	0.012	1.2	5.5
Standard Deviation	9.155	0.191	4.805	0.020	1.760	1.033
Sample Variance	83.813	0.037	23.092	0.000	3.098	1.066
Kurtosis	11.236	0.292	-1.024	55.319	51.431	-0.396
Skewness	3.066	-0.692	-0.147	7.314	6.873	0.427
Range	50	0.84	16	0.1564	14.1	4.3
Minimum	142	7.68	149	0.006	0.7	4.5
Maximum	192	8.52	165	0.1624	14.8	8.8
Count	42	42	31	60	64	63

Table 2a Summary statistics for the six main water quality variables in the lakes (continued)

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (mg/m^3)	Transparency (Secchi depth, m)
Lac La Biche, E. Basin						
Mean	141.6	8.3	154.6	0.118	37.2	2.3
Standard Error	1.382	0.066	1.893	0.013	10.614	0.150
Median	142.5	8.295	154.5	0.0984	17.2	2.25
Mode	142	8.6	152	0.091	8.6	2.5
Standard Deviation	7.311	0.350	10.019	0.081	64.560	0.935
Sample Variance	53.454	0.123	100.389	0.007	4168.026	0.874
Kurtosis	0.396	-0.848	0.424	10.573	26.980	1.811
Skewness	-0.615	0.058	-0.741	2.686	4.893	0.676
Range	31.5	1.2	38.98	0.454	390.08	5
Minimum	123.5	7.7	130.02	0.031	2.72	0.25
Maximum	155	8.9	169	0.485	392.8	5.25
Count	28	28	28	38	37	39
Long (near Boyle)						
Mean	199.8	8.4	218.4	0.053	21.0	2.5
Standard Error	1.728	0.038	2.303	0.003	1.571	0.112
Median	198.5	8.405	215.60	0.0425	15.05	2.2
Mode	205	8.4	221	0.022	12.6	2
Standard Deviation	14.666	0.325	17.838	0.030	17.773	1.269
Sample Variance	215.092	0.105	318.189	0.001	315.871	1.610
Kurtosis	-0.045	7.062	-0.080	2.930	1.687	0.721
Skewness	0.007	-0.323	0.442	1.629	1.381	0.935
Range	77	2.71	85	0.156	89.4	6.5
Minimum	157	6.99	183	0.014	1.8	0.5
Maximum	234	9.7	268	0.17	91.2	7
Count	72	72	60	124	128	128
Marie						
Mean	140.1	8.2	139.4	0.016	4.6	3.6
Standard Error	1.220	0.056	1.290	0.001	0.369	0.187
Median	139	8.39	139.29	0.0144	4.105	3.5
Mode	134	8.4	140	0.013	NA	3.75
Standard Deviation	7.811	0.360	8.257	0.005	2.558	1.268
Sample Variance	61.020	0.130	68.179	0.000	6.546	1.608
Kurtosis	-1.337	-0.867	1.575	2.516	7.358	2.367
Skewness	0.022	-0.646	0.830	1.263	2.145	1.157
Range	26	1.22	40.88	0.026	14.46	6.5
Minimum	126	7.54	126.12	0.006	1.6	1.5
Maximum	152	8.76	167	0.032	16.06	8
Count	41	41	41	40	48	46
McLeod, East Basin						
Mean	146.0	8.2	158.7	0.026	9.2	3.3
Standard Error	0.597	0.029	0.941	0.001	0.662	0.099
Median	146	8.25	158.49	0.0247	6.99	3
Mode	148	8.3	156	0.021	4.4	2.5
Standard Deviation	4.425	0.211	6.521	0.007	6.850	1.022
Sample Variance	19.578	0.045	42.523	0.000	46.918	1.044
Kurtosis	-0.120	0.203	2.978	0.591	1.279	0.077
Skewness	-0.412	-0.375	-0.162	0.610	1.318	0.700
Range	20	1.07	39.61	0.0374	29.1	4.5
Minimum	134	7.63	136.13	0.0118	1.5	1.5
Maximum	154	8.7	175.74	0.0492	30.6	6
Count	55	55	48	102	107	107

Table 2a Summary statistics for the six main water quality variables in the lakes (continued)

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (mg/m^3)	Transparency (Secchi depth, m)
McLeod, West Basin						
Mean	146.1	8.3	159.0	0.022	7.2	3.4
Standard Error	0.803	0.033	1.426	0.001	0.943	0.139
Median	146	8.26	156.84	0.0218	4.85	3.45
Mode	146	8.2	155	0.022	5.3	4
Standard Deviation	4.248	0.176	7.545	0.006	6.667	1.003
Sample Variance	18.049	0.031	56.927	0.000	44.446	1.005
Kurtosis	-1.037	0.971	-0.164	0.408	4.724	0.632
Skewness	0.056	0.184	0.766	0.754	2.152	-0.177
Range	14	0.85	27.9	0.029	29.9	5.5
Minimum	139	7.86	149	0.01	1.5	0.5
Maximum	153	8.71	176.9	0.039	31.4	6
Count	28	28	28	48	50	52
Miquelon						
Mean	1730.5	9.4	6722.1	0.175	3.7	2.2
Standard Error	139.293	0.018	470.571	0.014	0.494	0.123
Median	1640	9.38	6091.69	0.143	2.7	2.25
Mode	2320	9.35	NA	NA	2	2.5
Standard Deviation	750.114	0.098	1940.213	0.093	3.314	0.853
Sample Variance	562671.044	0.010	3764426.158	0.009	10.980	0.728
Kurtosis	-0.684	-0.154	1.739	2.017	20.782	-0.906
Skewness	-0.473	-0.057	1.661	1.368	4.025	0.143
Range	2345	0.42	6450	0.4452	21.5	3.25
Minimum	405	9.18	4950	0.0318	0.4	0.75
Maximum	2750	9.6	11400	0.477	21.9	4
Count	29	29	17	45	45	48
Moonshine						
Mean	152.9	8.2	454.7	0.160	28.3	2.0
Standard Error	3.748	0.049	8.631	0.013	3.798	0.091
Median	159	8.18	457	0.1098	16.37	1.825
Mode	197	8.2	425	0.06	3.8	1.25
Standard Deviation	26.235	0.342	53.898	0.130	37.021	0.892
Sample Variance	688.274	0.117	2904.970	0.017	1370.540	0.795
Kurtosis	-0.838	0.019	-0.499	1.825	12.094	-0.522
Skewness	-0.187	0.445	-0.143	1.555	3.064	0.505
Range	96	1.45	219	0.5885	233.98	3.6
Minimum	102	7.6	347	0.0245	1.02	0.4
Maximum	198	9.05	566	0.613	235	4
Count	49	49	39	94	95	96
Moore (Crane)						
Mean	391.9	8.8	451.5	0.024	6.3	3.1
Standard Error	7.461	0.037	9.165	0.001	0.544	0.127
Median	363	8.875	417.1	0.023	5.255	3.1
Mode	354	8.9	398	0.023	NA	2.5
Standard Deviation	47.184	0.231	57.963	0.005	3.924	0.909
Sample Variance	2226.369	0.053	3359.654	0.000	15.397	0.826
Kurtosis	-1.576	1.655	-1.684	1.817	3.247	-0.749
Skewness	0.233	-1.456	0.353	0.563	1.570	0.368
Range	151	0.9	161.5	0.0259	19.41	3.4
Minimum	310	8.09	384.5	0.011	1.19	1.6
Maximum	461	8.99	546	0.0369	20.6	5
Count	40	40	40	41	52	51

Table 2a Summary statistics for the six main water quality variables in the lakes (continued)

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (mg/m^3)	Transparency (Secchi depth, m)
Moose						
Mean	286.9	8.8	472.0	0.044	20.5	2.5
Standard Error	4.313	0.029	10.353	0.001	1.643	0.129
Median	288	8.8	471	0.0435	15.4	2.25
Mode	333	8.4	436	0.043	12.3	3
Standard Deviation	31.399	0.215	75.368	0.013	15.413	1.234
Sample Variance	985.887	0.046	5680.293	0.000	237.569	1.523
Kurtosis	-1.185	-0.258	-1.005	0.123	1.455	6.651
Skewness	0.418	-0.148	0.471	0.390	1.165	2.066
Range	96	0.97	241.05	0.063	78.9	7.75
Minimum	243	8.35	365.95	0.014	0.4	0.75
Maximum	339	9.32	607	0.077	79.3	8.5
Count	53	53	53	89	88	91
Nakamun						
Mean	153.6	8.7	170.4	0.082	41.4	1.6
Standard Error	1.118	0.040	1.499	0.003	3.458	0.103
Median	152.5	8.61	168.15	0.075	30	1.3
Mode	153	8.1	188	0.134	31.4	0.75
Standard Deviation	11.933	0.426	16.001	0.036	37.880	1.129
Sample Variance	142.392	0.181	256.025	0.001	1434.910	1.275
Kurtosis	-0.075	-0.161	0.930	2.132	1.395	1.500
Skewness	0.297	0.399	0.731	1.062	1.456	1.383
Range	60	2.03	83	0.2048	155.6	4.95
Minimum	129	7.87	142	0.022	3.1	0.3
Maximum	189	9.9	225	0.2268	158.7	5.25
Count	114	114	114	119	120	120
Newell						
Mean	124.9	8.2	193.1	0.020	5.6	3.6
Standard Error	0.794	0.038	1.298	0.001	0.571	0.124
Median	125	8.21	193.97	0.0167	4	3.5
Mode	125	8.4	201	0.016	2.1	3
Standard Deviation	6.202	0.299	9.538	0.008	5.324	1.178
Sample Variance	38.463	0.089	90.964	0.000	28.347	1.388
Kurtosis	-0.201	3.748	0.777	0.919	6.766	1.463
Skewness	-0.625	-1.597	-0.455	1.263	2.498	0.977
Range	27	1.56	48.31	0.0351	27.01	6.3
Minimum	108	6.97	168.69	0.0099	1.2	1.2
Maximum	135	8.53	217	0.045	28.21	7.5
Count	61	61	54	91	87	91
North Buck						
Mean	183.1	8.5	196.3	0.031	8.7	2.3
Standard Error	2.107	0.030	2.476	0.001	0.912	0.124
Median	185	8.53	198	0.0311	7	2
Mode	179	8.6	200	0.033	7.8	2
Standard Deviation	13.159	0.188	15.461	0.006	6.943	0.906
Sample Variance	173.167	0.035	239.038	0.000	48.208	0.821
Kurtosis	-0.488	0.110	-0.701	-0.779	9.821	0.017
Skewness	-0.383	-0.046	-0.254	0.365	2.728	0.917
Range	47	0.89	58.38	0.0224	40.6	3.4
Minimum	158	8.12	165.62	0.0215	1.1	1.1
Maximum	205	9.01	224	0.0439	41.7	4.5
Count	39	39	39	59	58	53

Table 2a Summary statistics for the six main water quality variables in the lakes (continued)

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (mg/m^3)	Transparency (Secchi depth, m)
Pigeon						
Mean	150.8	8.4	157.7	0.035	17.2	2.2
Standard Error	0.889	0.024	1.200	0.001	1.287	0.105
Median	151	8.44	156	0.0327	14.4	1.9
Mode	144	8.4	157	0.02	8.3	1.5
Standard Deviation	6.884	0.183	9.220	0.012	11.650	0.960
Sample Variance	47.393	0.033	85.012	0.000	135.720	0.922
Kurtosis	1.427	-0.131	0.768	0.004	-0.729	1.436
Skewness	0.249	-0.510	0.983	0.719	0.626	1.286
Range	42	0.75	43.3	0.056	42.3	4.5
Minimum	131	7.95	140.7	0.014	1.8	0.9
Maximum	173	8.7	184	0.07	44.1	5.4
Count	60	60	59	82	82	84
Pine						
Mean	316.8	8.6	434.3	0.078	24.1	2.5
Standard Error	1.158	0.018	2.294	0.002	1.662	0.103
Median	315	8.65	430.17	0.075	18.15	2.317
Mode	320.333	8.49	448	0.083	7.8	1.25
Standard Deviation	11.636	0.182	22.706	0.024	20.221	1.240
Sample Variance	135.388	0.033	515.571	0.001	408.877	1.537
Kurtosis	0.759	-0.398	0.292	1.554	3.444	0.272
Skewness	0.868	0.387	0.858	0.958	1.593	0.958
Range	59	0.773	98.333	0.140	115.233	5.4
Minimum	296	8.31	395.667	0.038	2.033	0.733
Maximum	355	9.083	494	0.178	117.267	6.133
Count	101	101	98	147	148	144
Pine Coulee, South						
Mean	238.9	8.4	295.8	0.057	13.6	2.5
Standard Error	3.669	0.018	5.729	0.005	2.078	0.229
Median	241	8.37	297	0.0535	9	2.3
Mode	250	8.4	320	0.067	NA	2.1
Standard Deviation	26.204	0.130	37.565	0.032	13.626	1.550
Sample Variance	686.674	0.017	1411.140	0.001	185.669	2.403
Kurtosis	-0.188	0.263	-0.331	1.983	3.585	0.041
Skewness	-0.441	-0.232	0.066	1.192	1.787	0.704
Range	115	0.66	170	0.163	62.36	5.95
Minimum	168	8	216	0.003	1.14	0.15
Maximum	283	8.66	386	0.166	63.5	6.1
Count	51	51	43	50	43	46
Reesor						
Mean	127.5	8.3	120.7	0.038	12.6	2.8
Standard Error	2.372	0.037	2.234	0.002	1.309	0.133
Median	127	8.32	120.5	0.031	7.4	2.6
Mode	102	8.3	110	0.026	2.9	3
Standard Deviation	19.704	0.308	16.715	0.019	13.608	1.389
Sample Variance	388.230	0.095	279.382	0.000	185.188	1.930
Kurtosis	-0.795	2.689	0.717	4.319	4.416	-0.587
Skewness	0.343	-0.751	0.510	1.817	2.031	0.393
Range	72	1.89	83.3	0.1064	65.8	5.7
Minimum	94	7.16	90.7	0.0136	1.2	0.5
Maximum	166	9.05	174	0.12	67	6.2
Count	69	69	56	110	108	109

Table 2a Summary statistics for the six main water quality variables in the lakes (continued)

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (mg/m^3)	Transparency (Secchi depth, m)
Saskatoon						
Mean	595.0	9.0	669.0	0.850	42.0	0.9
Standard Error	8.974	0.030	13.245	0.020	5.763	0.074
Median	619	9.04	682.08	0.8580	21.1	0.725
Mode	582	9.1	565	1.09	13.1	0.5
Standard Deviation	62.819	0.208	83.768	0.185	52.507	0.690
Sample Variance	3946.187	0.043	7017.022	0.034	2757.020	0.476
Kurtosis	-0.479	-0.102	-0.019	2.270	7.810	14.778
Skewness	-0.733	-0.525	0.015	-0.901	2.641	3.261
Range	244	0.9	407	1.0777	292	4.8
Minimum	439	8.46	480	0.1223	1	0.2
Maximum	683	9.36	887	1.2	293	5
Count	49	49	40	84	83	86
Spruce Coulee						
Mean	122.8	8.2	121.0	0.022	5.2	4.4
Standard Error	2.136	0.036	2.647	0.001	0.368	0.140
Median	121	8.2	116.5	0.0205	4.25	4
Mode	114	8.1	133	0.019	4	4
Standard Deviation	17.482	0.298	19.448	0.007	3.828	1.465
Sample Variance	305.629	0.089	378.227	0.000	14.655	2.147
Kurtosis	-0.843	3.270	-0.685	0.572	9.177	-0.267
Skewness	0.237	0.709	0.378	0.903	2.400	0.548
Range	67	1.95	76	0.0321	25.8	7
Minimum	90	7.4	86	0.01	1	1.5
Maximum	157	9.35	162	0.0421	26.8	8.5
Count	67	67	54	111	108	109
Steele (Cross)						
Mean	144.5	8.3	146.4	0.121	45.6	2.1
Standard Error	2.134	0.042	1.468	0.007	4.799	0.129
Median	145.5	8.27	148	0.0961	22.37	1.7
Mode	138	8.4	148	0.1143	3.35	1
Standard Deviation	16.804	0.333	10.481	0.079	50.788	1.385
Sample Variance	282.362	0.111	109.861	0.006	2579.396	1.917
Kurtosis	23.254	0.868	0.160	0.362	1.362	0.265
Skewness	-3.848	0.782	-0.294	1.003	1.491	0.980
Range	127	1.63	50	0.3661	220.5	6
Minimum	41	7.66	120	0.02	1.6	0.25
Maximum	168	9.29	170	0.3861	222.1	6.25
Count	62	62	51	113	112	115
Sturgeon, Main Basin						
Mean	76.0	7.9	93.0	0.117	44.8	2.3
Standard Error	1.303	0.060	1.757	0.012	7.396	0.124
Median	74	7.81	88.69	0.0868	20.2	2.075
Mode	65	7.8	88	0.0546	12.7	2
Standard Deviation	9.836	0.455	12.422	0.110	71.326	1.202
Sample Variance	96.745	0.207	154.307	0.012	5087.438	1.444
Kurtosis	-1.118	1.392	-0.791	13.626	37.271	0.359
Skewness	0.354	0.813	0.505	3.167	5.396	0.778
Range	34.5	2.3	45.364	0.7315	583.1	5.93
Minimum	61.3	7	74.636	0.0265	2.5	0.07
Maximum	95.8	9.3	120	0.758	585.6	6
Count	57	57	50	91	93	94

Table 2a Summary statistics for the six main water quality variables in the lakes (continued)

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (mg/m^3)	Transparency (Secchi depth, m)
Sturgeon, West Basin						
Mean	64.2	7.9	84.2	0.104	39.9	1.3
Standard Error	1.392	0.115	1.607	0.008	5.553	0.126
Median	63.6	7.67	83.75	0.0939	31.085	1
Mode	52	7.5	87	0.19	67.7	0.4
Standard Deviation	8.116	0.669	9.368	0.056	39.267	0.881
Sample Variance	65.872	0.447	87.760	0.003	1541.860	0.776
Kurtosis	1.092	0.234	-0.560	4.438	12.909	4.371
Skewness	0.727	1.117	0.517	1.853	2.977	1.983
Range	35	2.4	33.956	0.2781	234.5	4.1
Minimum	51	6.9	70.044	0.043	4.3	0.4
Maximum	86	9.3	104	0.3211	238.8	4.5
Count	34	34	34	49	50	49
Sylvan						
Mean	325.9	8.8	338.2	0.021	4.5	4.7
Standard Error	4.009	0.020	3.008	0.001	0.361	0.148
Median	329.5	8.805	340	0.0199	3.3	4.5
Mode	326	8.8	337	0.016	1.4	4
Standard Deviation	29.460	0.149	21.694	0.008	3.366	1.390
Sample Variance	867.879	0.022	470.644	0.000	11.328	1.932
Kurtosis	48.233	14.485	32.164	21.970	2.420	0.247
Skewness	-6.765	-2.999	-5.089	3.519	1.550	0.565
Range	223	1	157	0.0667	16.5	6.9
Minimum	119	8	201	0.005	0.4	2.1
Maximum	342	9	358	0.0717	16.9	9
Count	54	54	52	87	87	88
Thunder						
Mean	241.2	8.7	253.9	0.078	34.9	1.5
Standard Error	2.155	0.029	2.522	0.006	2.963	0.090
Median	239	8.66	251.17	0.0611	24.8	1.225
Mode	244	8.6	245	0.033	12.3	2
Standard Deviation	17.900	0.239	20.947	0.059	29.775	0.909
Sample Variance	320.403	0.057	438.775	0.003	886.543	0.827
Kurtosis	2.109	-0.496	4.984	24.070	0.080	1.309
Skewness	1.211	0.297	1.823	3.847	0.984	1.361
Range	86	1	118.78	0.469	116.2	3.6
Minimum	215	8.27	225.22	0.022	2.3	0.5
Maximum	301	9.27	344	0.491	118.5	4.1
Count	69	69	69	100	101	102
Travers						
Mean	136.0	8.2	211.2	0.016	2.5	3.9
Standard Error	1.179	0.043	2.316	0.001	0.196	0.125
Median	135	8.3	207.7	0.0134	2.05	3.8
Mode	140	8.4	197	0.014	1.5	4
Standard Deviation	8.580	0.314	16.701	0.008	1.777	1.121
Sample Variance	73.615	0.099	278.940	0.000	3.157	1.256
Kurtosis	0.770	2.542	1.484	17.262	14.311	-0.363
Skewness	0.761	-1.561	1.203	3.592	3.253	0.332
Range	39.4	1.42	72.97	0.06	12	4.85
Minimum	122.6	7.19	187.03	0.006	0.7	1.75
Maximum	162	8.61	260	0.066	12.7	6.6
Count	53	53	52	81	82	81

Table 2a Summary statistics for the six main water quality variables in the lakes (concluded)

Lake or Basin	Total Alkalinity (mg/L)	pH	Total Dissolved Solids (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (mg/m^3)	Transparency (Secchi depth, m)
Tucker						
Mean	206.4	8.3	209.1	0.071	27.0	1.7
Standard Error	2.495	0.078	2.366	0.005	3.155	0.270
Median	204.5	8.3	207.25	0.0727	19.06	1.15
Mode	203	8.3	201	0.0892	27.2	0.7
Standard Deviation	14.969	0.470	14.194	0.031	22.970	1.664
Sample Variance	224.083	0.221	201.473	0.001	527.600	2.769
Kurtosis	1.030	0.166	0.374	-0.946	1.260	3.347
Skewness	0.779	-0.379	0.673	0.184	1.186	2.034
Range	69	2.2	65	0.1194	96.76	6.2
Minimum	183	7.08	182	0.024	1.54	0.3
Maximum	252	9.28	247	0.1434	98.3	6.5
Count	36	36	36	42	53	38
Wabamun						
Mean	202.4	8.5	266.9	0.032	11.4	2.3
Standard Error	0.849	0.017	2.539	0.001	0.373	0.046
Median	205	8.535	257	0.0312	10.475	2.2
Mode	212	8.5	251	0.031	8.3	2
Standard Deviation	11.885	0.239	35.455	0.007	5.332	0.646
Sample Variance	141.250	0.057	1257.077	0.000	28.435	0.418
Kurtosis	-0.510	3.349	-0.543	0.735	0.452	0.051
Skewness	-0.350	-1.459	0.717	0.267	0.807	0.611
Range	63	1.44	148	0.0455	26.17	3.1
Minimum	170	7.46	217	0.011	1.63	1
Maximum	233	8.9	365	0.0565	27.8	4.1
Count	196	196	195	187	204	199
Winagami						
Mean	178.3	8.4	278.7	0.125	42.9	1.9
Standard Error	1.999	0.035	3.991	0.010	5.068	0.109
Median	176	8.395	273	0.0799	22.7	1.725
Mode	169	8.3	283	0.087	12.8	2
Standard Deviation	16.721	0.293	31.429	0.101	49.660	1.081
Sample Variance	279.584	0.086	987.764	0.010	2466.118	1.170
Kurtosis	0.677	-0.243	5.348	1.769	3.908	0.109
Skewness	0.709	-0.038	1.897	1.567	1.879	0.893
Range	78	1.48	172.85	0.4395	261.6	4.55
Minimum	144	7.62	226.15	0.032	1	0.45
Maximum	222	9.1	399	0.4715	262.6	5
Count	70	70	62	98	96	98

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

Lake names in bold font are reservoirs

NA = not applicable

Table 2b Summary statistics for the additional water quality variables in selected lakes

Lake or Basin	Dissolved Phosphorus (mg/L)	Ammonia (NH_3-N) (mg/L)	Nitrate+Nitrite (NO_3+NO_2-N) (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Nitrogen: Total Phosphorus	Non-Filterable Residue (mg/L)	Dissolved Organic Carbon (mg/L)	Silica (mg/L)
Baptiste, North Basin									
Mean	0.027	0.048	0.018	1.2	1.2	19.5	4.9	17.6	1.6
Standard Error	0.002	0.013	0.003	0.029	0.029	0.583	0.401	0.397	0.138
Median	0.0179	0.019	0.005	1.17	1.2	18.2	4	17.45	1
Mode	0.0194	0.017	0.005	0.88	1.281	13	2	17.5	0.5
Standard Deviation	0.024	0.134	0.031	0.299	0.299	5.979	3.953	4.048	1.391
Sample Variance	0.001	0.018	0.001	0.089	0.090	35.747	15.626	16.388	1.934
Kurtosis	11.232	86.150	8.272	0.876	0.740	-0.408	5.544	71.703	1.627
Skewness	3.026	8.954	2.876	0.867	0.807	0.406	2.201	7.749	1.423
Range	0.1519	1.337	0.157	1.56	1.56	27.138	19.6	42.7	6.1
Minimum	0.007	0.003	0.001	0.7	0.7	7	1	12.3	0.1
Maximum	0.1589	1.34	0.158	2.26	2.26	34.138	20.6	55	6.2
Count	106	103	107	108	107	105	97	104	102
Baptiste, South Basin									
Mean	0.027	0.045	0.037	1.2	1.2	21.6	4.7	17.4	1.0
Standard Error	0.002	0.006	0.015	0.028	0.031	0.831	0.330	0.276	0.072
Median	0.0172	0.019	0.014	1.145	1.2	21.3	4	17	0.875
Mode	0.0143	0.01	0.02	1.1	1.14	30	2	17.4	0.5
Standard Deviation	0.024	0.062	0.159	0.287	0.313	8.431	3.212	2.786	0.719
Sample Variance	0.001	0.004	0.025	0.082	0.098	71.084	10.320	7.763	0.517
Kurtosis	11.968	6.631	98.091	4.678	5.473	13.993	4.839	42.376	1.637
Skewness	2.936	2.573	9.757	1.713	1.935	2.425	1.836	5.338	1.334
Range	0.1591	0.315	1.619	1.86	1.88	67.845	18.2	27.6	3.4
Minimum	0.008	0.005	0.001	0.68	0.69	6.647	0.8	12.4	0.1
Maximum	0.1671	0.32	1.62	2.54	2.57	74.493	19	40	3.5
Count	105	101	105	106	105	103	95	102	100
Ethel (near Cold Lake)									
Mean	0.009	0.024	0.004	0.7	0.7	32.7	2.5	10.8	1.7
Standard Error	0.000	0.004	0.001	0.010	0.011	0.739	0.157	0.091	0.084
Median	0.0078	0.013	0.002	0.7	0.7	31.9	2	10.8	1.7
Mode	0.0078	0.01	0.0005	0.7	0.7	27	2	11	1.5
Standard Deviation	0.003	0.047	0.009	0.129	0.142	8.528	1.702	1.098	0.972
Sample Variance	0.000	0.002	0.000	0.017	0.020	72.724	2.898	1.205	0.945
Kurtosis	8.692	99.169	87.570	6.655	8.305	3.885	12.683	41.107	2.090
Skewness	2.508	9.185	8.770	2.114	0.756	0.742	2.841	4.621	1.096
Range	0.023	0.539	0.1015	0.88	1.323	65.111	12.6	12.3	5.1
Minimum	0.004	0.001	0.0005	0.44	0.002	0.089	0.4	8.2	0.1
Maximum	0.027	0.54	0.102	1.32	1.325	65.2	13	20.5	5.2
Count	141	152	153	152	153	133	118	146	135

Table 2b Summary statistics for the additional water quality variables in selected lakes (concluded)

Lake or Basin	Dissolved Phosphorus (mg/L)	Ammonia (NH_3-N) (mg/L)	Nitrate+Nitrite (NO_3+NO_2-N) (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)	Total Nitrogen: Total Phosphorus	Non-Filterable Residue (mg/L)	Dissolved Organic Carbon (mg/L)	Silica (mg/L)
Nakamun									
Mean	0.025	0.070	0.014	1.9	1.9	25.6	7.1	17.8	6.8
Standard Error	0.001	0.011	0.003	0.059	0.059	0.890	0.535	0.210	0.369
Median	0.02145	0.027	0.006	1.72	1.8	23.4	5	17.3	6.85
Mode	0.02	0.018	0.006	1.6	1.602	22	2	17	6.6
Standard Deviation	0.014	0.117	0.030	0.636	0.636	9.465	5.538	2.244	3.936
Sample Variance	0.000	0.014	0.001	0.404	0.405	89.577	30.668	5.037	15.495
Kurtosis	12.333	18.695	45.721	11.013	10.824	13.359	1.868	-0.041	-0.970
Skewness	3.109	3.857	5.993	2.272	2.235	2.710	1.288	0.834	-0.046
Range	0.0961	0.834	0.265	4.95	4.952	75.455	28	9.5	14.2
Minimum	0.008	0.006	0.001	0.8	0.8	9.363	1	14	0.1
Maximum	0.1041	0.84	0.266	5.75	5.752	84.818	29	23.5	14.3
Count	118	115	115	115	115	113	107	114	114
Pine									
Mean	0.039	0.125	0.027	1.7	1.7	23.5	3.6	17.6	3.6
Standard Error	0.001	0.009	0.003	0.026	0.027	0.475	0.231	0.124	0.201
Median	0.035	0.096	0.014	1.673	1.7	23	3	17.7	3.2
Mode	0.026	0.02	0.05	1.38	1.83	24	2	17.7	2.867
Standard Deviation	0.014	0.102	0.030	0.303	0.308	5.436	2.152	1.137	2.075
Sample Variance	0.000	0.010	0.001	0.092	0.095	29.554	4.633	1.292	4.306
Kurtosis	1.279	1.360	6.120	-0.218	-0.177	0.310	0.142	-0.514	0.520
Skewness	1.343	1.290	2.092	0.394	0.392	0.379	0.910	0.169	0.857
Range	0.064	0.473	0.185	1.64	1.635	29.690	9	5.167	9.333
Minimum	0.019	0.01	0.001	0.92	0.926	9.526	1	15.433	0.133
Maximum	0.083	0.483	0.186	2.56	2.562	39.217	10	20.6	9.467
Count	142	131	134	131	131	131	87	84	107
Wabamun									
Mean	0.010	0.025	0.004	0.9	0.9	30.1	4.7	12.0	1.9
Standard Error	0.000	0.002	0.000	0.014	0.015	0.763	0.200	0.143	0.095
Median	0.0104	0.016	0.002	0.9	0.9	28.3	4	11.8	1.75
Mode	0.01	0.005	0.0015	0.8	0.95	30.5	2	12.4	0.5
Standard Deviation	0.003	0.027	0.006	0.203	0.204	10.146	2.756	1.956	1.313
Sample Variance	0.000	0.001	0.000	0.041	0.041	102.935	7.594	3.825	1.724
Kurtosis	6.858	27.417	12.976	41.838	41.591	36.964	4.249	44.169	0.054
Skewness	1.212	4.182	3.440	4.575	4.562	4.533	1.677	5.646	0.748
Range	0.0238	0.249	0.0385	2.42	2.4175	107.318	17.5	19.6	5.82
Minimum	0.0035	0.001	0.0005	0.44	0.445	14.182	1	8.6	0.08
Maximum	0.0273	0.25	0.039	2.86	2.8625	121.5	18.5	28.2	5.9
Count	184	199	198	197	196	177	189	187	193

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

C. SEASONALITY IN WATER QUALITY

This section includes (Kruskal-Wallis test) results for seasonality (differences among months) for the water quality variables in the 43 lake basins. The six general and trophic variables are presented first (Tables 3 and 4) followed by the other variables analysed in the six select lake basins (Table 5). Lakes are listed alphabetically in each Table. See Section 2.3 for more detail.

Table 3 Seasonality for total alkalinity, pH and total dissolved solids in the lakes

Kruskal-Wallis Test Statistic (KW) and Statistical Significance (Sig.) Based on Probability (p)

Lake or Basin	Total Alkalinity: Available Data Span	Total Alkalinity: No. Yr	Total Alkalinity: KW	Total Alkalinity: p [A]	Total Alkalinity: Sig. [A]	pH: Available Data Span	pH: No. Yr	pH: KW	pH: p [A]	pH: Sig. [A]	Total Dissolved Solids: Available Data Span	Total Dissolved Solids: No. Yr	Total Dissolved Solids: KW	Total Dissolved Solids: p [A]	Total Dissolved Solids: Sig. [A]
Alix	1992-07	10	2.35	0.80	ns	1992-07	10	3.74	0.59	ns	1996-07	8	3.65	0.60	ns
Baptiste, North Basin	1983-07	18	17.65	<0.01	**	1983-07	18	32.48	<0.01	**	1983-07	18	14.21	0.01	**
Baptiste, South Basin	1983-07	18	22.51	<0.01	**	1983-07	18	43.63	<0.01	**	1983-07	18	13.48	0.02	*
Beauvais	1984-08	18	14.11	0.02	*	1984-08	18	8.97	0.11	ns	1984-08	17	12.46	0.03	*
Buffalo, Main Basin	1984-07	16	4.52	0.48	ns	1984-07	16	5.46	0.36	ns	1984-07	16	3.52	0.62	ns
Buffalo, Secondary Bay	1985-07	15	7.10	0.21	ns	1985-07	15	10.08	0.07	ns	1985-07	15	7.02	0.22	ns
Crimson	1984-07	20	6.15	0.29	ns	1984-07	20	7.15	0.21	ns	1984-03	18	10.38	0.07	ns
Dillberry	1984-08	17	5.16	0.40	ns	1984-08	17	9.40	0.09	ns	1984-08	15	1.41	0.92	ns
Elkwater	1983-07	24	5.74	0.33	ns	1983-07	24	6.16	0.29	ns	1983-03	21	1.73	0.89	ns
Ethel (near Cold Lake)	1979-08	22	36.80	<0.01	**	1979-08	22	29.83	<0.01	**	1979-08	22	17.92	<0.01	**
Garner	1984-00	14	3.44	0.63	ns	1984-00	14	14.45	0.01	**	1984-00	14	1.31	0.93	ns
Gregg	1988-08	18	3.88	0.57	ns	1988-08	18	3.74	0.59	ns	1988-08	16	7.46	0.19	ns
Gregoire	1989-08	18	14.53	0.01	**	1989-08	18	12.51	0.03	*	1989-08	16	8.17	0.15	ns
Gull	1983-08	18	11.61	0.04	*	1983-08	18	16.44	0.01	**	1983-08	18	10.50	0.06	ns
Hilda	1979-07	11	4.17	0.53	ns	1979-07	11	9.59	0.09	ns	1979-07	11	7.16	0.21	ns
Jarvis	1988-08	18	7.50	0.19	ns	1988-08	18	4.08	0.54	ns	1988-08	16	3.48	0.63	ns
Lac La Biche, E. Basin	1983-04	10	5.05	0.41	ns	1983-04	10	6.44	0.27	ns	1983-04	10	4.29	0.51	ns
Long (near Boyle)	1983-08	25	3.73	0.59	ns	1983-08	25	17.16	<0.01	**	1983-08	23	8.90	0.11	ns
Marie	1979-09	11	3.99	0.55	ns	1979-09	11	11.74	0.04	*	1979-09	11	4.08	0.54	ns
McLeod, East Basin	1984-07	21	5.74	0.33	ns	1984-07	21	9.88	0.08	ns	1984-03	19	10.34	0.07	ns
McLeod, West Basin	1985-95	11	5.86	0.32	ns	1985-95	11	9.69	0.09	ns	1985-95	11	7.33	0.19	ns
Miquelon	1991-08	11	3.15	0.53	ns	1991-08	11	6.01	0.20	ns	1991-08	9	4.48	0.35	ns
Moonshine	1983-07	20	8.96	0.11	ns	1983-07	20	4.97	0.42	ns	1983-02	18	6.25	0.28	ns
Moore (Crane)	1979-09	12	4.25	0.51	ns	1979-09	12	7.29	0.20	ns	1979-09	12	6.59	0.25	ns
Moose	1983-09	20	6.91	0.23	ns	1983-09	20	11.00	0.05	*	1983-09	20	6.68	0.25	ns
Nakamun	1983-08	18	9.28	0.16	ns	1983-08	18	24.77	<0.01	**	1983-08	18	7.57	0.27	ns
Newell	1983-07	19	34.65	<0.01	**	1983-07	19	12.52	0.03	*	1983-03	17	23.95	<0.01	**
North Buck	1983-03	15	5.14	0.40	ns	1983-03	15	9.32	0.10	ns	1983-03	15	4.04	0.54	ns
Pigeon	1983-08	19	9.14	0.10	ns	1983-08	19	16.05	0.01	**	1983-08	19	6.01	0.31	ns
Pine	1983-09	20	2.87	0.83	ns	1983-09	20	42.52	<0.01	**	1983-09	20	1.44	0.96	ns
Pine Coulee, South	1999-08	10	4.20	0.65	ns	1999-08	10	6.23	0.40	ns	1999-08	10	0.89	0.97	ns
Reesor	1983-07	24	10.48	0.06	ns	1983-07	24	8.23	0.14	ns	1983-03	21	24.65	<0.01	**
Saskatoon	1983-07	21	10.71	0.06	ns	1983-07	21	11.56	0.04	*	1983-03	19	9.03	0.11	ns
Spruce Coulee	1983-07	24	33.24	<0.01	**	1983-07	24	4.10	0.53	ns	1983-03	21	31.73	<0.01	**
Steele (Cross)	1983-08	23	20.90	<0.01	**	1983-08	23	25.28	<0.01	**	1983-08	21	20.09	<0.01	**
Sturgeon, Main Basin	1983-07	22	2.50	0.78	ns	1983-07	22	4.28	0.51	ns	1983-03	20	3.48	0.63	ns
Sturgeon, West Basin	1983-94	12	5.07	0.41	ns	1983-94	12	5.56	0.35	ns	1983-94	12	3.01	0.70	ns
Sylvan	1983-09	19	5.07	0.41	ns	1983-09	19	7.95	0.16	ns	1983-09	19	7.62	0.18	ns
Thunder	1983-09	21	3.17	0.79	ns	1983-09	21	11.33	0.08	ns	1983-09	21	2.05	0.92	ns
Travers	1983-00	16	19.70	<0.01	**	1983-00	16	2.19	0.82	ns	1983-00	16	15.36	0.01	**
Tucker	1979-07	10	8.57	0.13	ns	1979-07	10	8.04	0.15	ns	1979-07	10	5.65	0.34	ns
Wabamun	1980-08	29	4.46	0.62	ns	1980-08	29	43.63	<0.01	**	1980-08	29	3.54	0.74	ns
Winagami	1983-07	21	7.78	0.17	ns	1983-07	21	14.98	0.01	**	1983-03	19	7.61	0.18	ns

Summary of Seasonality (n=43)

Seasonality	Total Alkalinity No.	Total Alkalinity %	pH No.	pH %	Total Dissolved Solids No.	Total Dissolved Solids %
Not Significant (p>0.05)	**33**	77	**26**	60	**34**	79
Statistically Significant (p≤0.05)	**10**	23	**17**	40	**9**	21

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded (p >0.05)

Table 4 Seasonality for total phosphorus, chlorophyll-*a* and transparency in the lakes

Lake or Basin	Total Phosphorus					Chlorophyll-*a*					Transparency				
	Kruskal-Wallis Test Statistic (KW) and Statistical Significance (Sig.) Based on Probability (p)														
	Available Data					Available Data					Available Data				
	Span	No. Yr	KW	p [A]	Sig. [A]	Span	No. Yr	KW	p [A]	Sig. [A]	Span	No. Yr	KW	p [A]	Sig. [A]
Alix	1992-07	10	4.36	0.50	ns	1992-07	10	7.27	0.20	ns	1992-07	10	7.55	0.18	ns
Baptiste, North Basin	1983-07	18	58.25	<0.01	**	1983-07	18	64.35	<0.01	**	1983-07	18	48.57	<0.01	**
Baptiste, South Basin	1983-07	18	60.94	<0.01	**	1983-07	18	49.91	<0.01	**	1983-07	18	49.67	<0.01	**
Beauvais	1984-08	21	16.87	0.01	**	1984-08	21	19.86	<0.01	**	1984-08	21	10.30	0.07	ns
Buffalo, Main Basin	1984-07	16	10.79	0.06	*	1984-07	17	48.88	<0.01	**	1984-07	17	18.19	<0.01	**
Buffalo, Secondary Bay	1985-07	15	19.08	<0.01	**	1985-07	15	32.76	<0.01	**	1986-07	14	21.36	<0.01	**
Crimson	1984-08	23	19.79	<0.01	**	1984-08	23	24.46	<0.01	**	1984-08	23	19.81	<0.01	**
Dillberry	1984-08	19	13.74	0.02	*	1984-08	19	19.87	<0.01	**	1984-08	19	25.72	<0.01	**
Elkwater	1982-08	27	54.66	<0.01	**	1982-08	27	80.32	<0.01	**	1982-08	27	68.09	<0.01	**
Ethel (near Cold Lake)	1979-08	21	39.86	<0.01	**	1979-08	22	68.40	<0.01	**	1980-08	22	50.15	<0.01	**
Garner	1984-00	14	6.76	0.24	ns	1984-00	14	26.16	<0.01	**	1984-00	14	21.48	<0.01	**
Gregg	1988-08	20	3.59	0.46	ns	1988-08	20	7.40	0.19	ns	1988-08	20	11.35	0.05	*
Gregoire	1989-08	20	30.68	<0.01	**	1989-08	20	41.67	<0.01	**	1989-08	20	20.57	<0.01	**
Gull	1983-08	18	11.91	0.04	*	1983-08	18	23.68	<0.01	**	1983-08	18	13.69	0.02	*
Hilda	1979-07	11	11.54	0.04	*	1979-07	11	25.63	<0.01	**	1979-07	12	10.83	0.06	ns
Jarvis	1988-08	20	1.81	0.77	ns	1988-08	20	3.20	0.67	ns	1988-08	20	2.65	0.75	ns
Lac La Biche, E. Basin	1983-04	10	14.99	0.01	**	1983-04	10	20.44	<0.01	**	1983-04	10	14.47	0.01	**
Long (near Boyle)	1983-08	26	62.50	<0.01	**	1983-08	26	78.15	<0.01	**	1983-08	26	57.17	<0.01	**
Marie	1979-09	10	11.01	0.05	*	1980-09	9	4.33	0.50	ns	1980-09	11	7.09	0.21	ns
McLeod, East Basin	1984-08	24	25.01	<0.01	**	1984-08	24	51.87	<0.01	**	1984-08	24	22.56	<0.01	**
McLeod, West Basin	1985-95	11	8.09	0.15	ns	1985-95	11	24.77	<0.01	**	1985-99	12	8.16	0.15	ns
Miquelon	1991-08	13	3.88	0.42	ns	1991-08	13	5.62	0.23	ns	1991-08	15	5.43	0.25	ns
Moonshine	1983-08	24	33.23	<0.01	**	1983-08	24	17.82	<0.01	**	1983-08	24	8.28	0.14	ns
Moore (Crane)	1979-09	11	11.72	0.04	*	1979-09	11	22.56	<0.01	**	1980-09	10	26.34	<0.01	**
Moose	1983-09	20	34.43	<0.01	**	1983-09	20	54.98	<0.01	**	1983-09	20	43.17	<0.01	**
Nakamun	1983-08	18	40.88	<0.01	**	1983-08	18	50.04	<0.01	**	1983-08	18	38.47	<0.01	**
Newell	1983-08	22	5.13	0.40	ns	1983-08	22	12.99	0.02	*	1983-08	22	6.76	0.24	ns
North Buck	1983-03	15	11.07	0.05	*	1986-03	14	28.60	<0.01	**	1991-03	13	22.49	<0.01	**
Pigeon	1983-08	19	21.05	<0.01	**	1983-08	19	38.41	<0.01	**	1983-08	20	19.68	<0.01	**
Pine	1983-09	21	18.57	0.01	**	1983-09	21	66.82	<0.01	**	1983-09	21	47.20	<0.01	**
Pine Coulee, South	1999-08	10	19.48	<0.01	**	1999-08	10	22.22	<0.01	**	1999-08	10	12.23	0.06	ns
Reesor	1982-08	25	17.28	<0.01	**	1982-08	25	39.46	<0.01	**	1982-08	25	21.83	<0.01	**
Saskatoon	1983-08	24	17.25	<0.01	**	1986-08	23	12.75	0.03	*	1986-08	23	9.71	0.08	ns
Spruce Coulee	1982-08	25	9.03	0.11	ns	1982-08	25	36.99	<0.01	**	1982-08	25	17.59	<0.01	**
Steele (Cross)	1983-08	26	64.95	<0.01	**	1983-08	26	50.46	<0.01	**	1983-08	26	51.48	<0.01	**
Sturgeon, Main Basin	1983-08	25	46.81	<0.01	**	1983-08	25	41.82	<0.01	**	1983-08	25	19.79	<0.01	**
Sturgeon, West Basin	1983-94	12	25.94	<0.01	**	1983-94	12	23.76	<0.01	**	1983-94	12	14.15	0.02	*
Sylvan	1983-09	19	14.74	0.01	**	1983-09	19	40.06	<0.01	**	1983-09	20	15.62	0.01	**
Thunder	1983-09	21	15.26	0.02	*	1983-09	21	26.79	<0.01	**	1983-09	21	18.38	0.01	**
Travers	1983-00	16	7.30	0.20	ns	1983-00	16	10.30	0.07	ns	1983-00	16	24.82	<0.01	**
Tucker	1979-07	9	25.10	<0.01	**	1979-07	10	28.12	<0.01	**	1980-07	8	23.28	<0.01	**
Wabamun	1981-08	28	25.32	<0.01	**	1980-08	29	102.95	<0.01	**	1980-08	28	100.81	<0.01	**
Winagami	1983-08	24	19.04	<0.01	**	1983-08	24	49.80	<0.01	**	1983-08	24	33.57	<0.01	**

Summary of Seasonality (n=43)

Seasonality	Total Phosphorus No.	Total Phosphorus %	Chlorophyll-*a* No.	Chlorophyll-*a* %	Transparency No.	Transparency %
Not Significant (p>0.05)	**9**	21	**6**	14	**11**	26
Statistically Significant (p≤0.05)	**34**	79	**37**	86	**32**	74

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded (p >0.05)

Table 5 Seasonality for the additional water quality variables in selected lakes

Kruskal-Wallis Test Statistic (KW) and Statistical Significance (Sig.) Based on Probability (p)

Lake or Basin	Dissolved Phosphorus					Ammonia-N					Nitrate-Nitrite-N				
	Available Data					Available Data					Available Data				
	Span	No. Yr	KW	p [A]	Sig. [A]	Span	No. Yr	KW	p [A]	Sig. [A]	Span	No. Yr	KW	p [A]	Sig. [A]
Baptiste, North Basin	1983-07	17	28.48	<0.01	**	1983-07	17	41.27	<0.01	**	1983-07	18	46.12	<0.01	**
Baptiste, South Basin	1983-07	17	62.79	<0.01	**	1983-07	17	38.92	<0.01	**	1983-07	18	29.71	<0.01	**
Ethel (near Cold Lake)	1979-08	21	7.83	0.17	ns	1979-08	22	23.84	<0.01	**	1979-08	22	16.64	<0.01	** [B]
Nakamun	1983-08	18	5.61	0.47	ns	1983-08	18	25.04	<0.01	**	1983-08	18	27.50	<0.01	**
Pine	1983-09	20	35.61	<0.01	**	1983-09	20	30.13	<0.01	**	1983-09	21	36.71	<0.01	**
Wabamun	1981-08	28	2.16	0.90	ns	1980-08	29	5.42	0.49	ns	1980-08	29	25.57	<0.01	** [B]

Kruskal-Wallis Test Statistic (KW) and Statistical Significance (Sig.) Based on Probability (p)

Lake or Basin	Total Kjeldahl Nitrogen					Total Nitrogen					Total Nitrogen: Total Phosphorus				
	Available Data					Available Data					Available Data				
	Span	No. Yr	KW	p [A]	Sig. [A]	Span	No. Yr	KW	p [A]	Sig. [A]	Span	No. Yr	KW	p [A]	Sig. [A]
Baptiste, North Basin	1983-07	18	59.14	<0.01	**	1983-07	18	58.73	<0.01	**	1983-07	18	34.47	<0.01	**
Baptiste, South Basin	1983-07	18	33.72	<0.01	**	1983-07	18	30.70	<0.01	**	1983-07	18	62.07	<0.01	**
Ethel (near Cold Lake)	1979-08	22	10.97	0.05	*	1979-08	22	11.67	0.04	*	1979-08	21	25.37	<0.01	**
Nakamun	1983-08	18	43.83	<0.01	**	1983-08	18	43.50	<0.01	**	1983-08	18	15.70	0.02	*
Pine	1983-09	20	26.67	<0.01	**	1983-09	20	28.57	<0.01	**	1983-09	20	14.35	0.03	*
Wabamun	1980-08	29	22.28	<0.01	**	1980-08	29	22.00	<0.01	**	1981-08	28	7.53	0.28	ns

Kruskal-Wallis Test Statistic (KW) and Statistical Significance (Sig.) Based on Probability (p)

Lake or Basin	Non-Filterable Residue					Dissolved Organic Carbon					Silica				
	Available Data					Available Data					Available Data				
	Span	No. Yr	KW	p [A]	Sig. [A]	Span	No. Yr	KW	p [A]	Sig. [A]	Span	No. Yr	KW	p [A]	Sig. [A]
Baptiste, North Basin	1984-07	16	29.30	<0.01	**	1983-07	18	12.07	0.03	*	1983-07	17	27.63	<0.01	**
Baptiste, South Basin	1984-07	16	27.17	<0.01	**	1983-07	18	8.78	0.12	ns	1983-07	17	36.51	<0.01	**
Ethel (near Cold Lake)	1979-08	21	4.39	0.49	ns	1980-08	21	12.04	0.03	*	1979-08	22	54.34	<0.01	**
Nakamun	1984-08	17	33.75	<0.01	**	1983-08	18	15.63	0.02	*	1983-08	18	10.80	0.10	ns
Pine	1989-07	14	31.59	<0.01	**	1989-09	15	7.33	0.29	ns	1983-07	17	17.15	0.01	**
Wabamun	1980-08	28	35.81	<0.01	**	1980-08	28	8.34	0.21	ns	1980-08	29	16.72	0.01	**

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded (p >0.05)

[B] Individual MDL concentrations were used for these tests (instead of the highest MDL) due to excessive censored data (ie, 46% of the samples were <MDL) (Section 2.3)

D. LONG TERM TRENDS IN WATER QUALITY

This section includes detailed statistical results for trends (seasonal Kendall or Mann-Kendall tests) for water quality variables in the 43 lake basins. Results for the six general and trophic variables are presented by variable (Tables 6, 7, 8, 9, 10 and 11) and the main findings of these tests (statistical significance of each trend and direction of change) are summarised in separate tables (Tables 12 and 13). Trends in total phosphorus and chlorophyll-*a* relative to general features of lakes and watersheds are summarised separately (Table 14). Results for the remaining water quality variables analysed in the six select lake basins are also included (Table 15). Lakes are listed alphabetically in each Table. See Section 2.3 for more detail.

Table 6 Trends for total alkalinity in the lakes

Total Alkalinity			Seasonal Kendall or Mann-Kendall Test, Common Statistics			Seasonal Kendall Test Corrected for Autocorrelation (SKC) or Unadjusted (SK)					Test for Autocorrelation			Mann-Kendall Test (≤ 40 months)		
Lake or Basin	Available Data		Slope, Change in Median per Year and Correlation Coefficient			Test Statistic (Z), Total No. Samples and Statistical Probability (p) for SKC and SK					Spearman Correlation (r_s), Z Statistic and Probability (p)			Z Statistic, Total No. Years and Statistical Probability (p)		
	Span	No. Yr	Sen Slope	% / Yr	Tau	SKC Z	SK Z	No. Month	SKC p [A, B, C]	SK p [A, B, C]	r_s	Z	p [A]	Z	No. Yr	p [A, B]
Alix	1992-07	10	-11.3536	7.42	-0.46	-2.04		46	**0.04**	<0.01	0.82	4.54	<0.01			
Baptiste, North Basin	1983-07	18	0.7478	0.43	0.51	3.12		90	<0.01	<0.01						
Baptiste, South Basin	1983-07	18	0.7624	0.45	0.55	3.39		89	<0.01	<0.01						
Beauvais	1984-08	18	-0.3540	0.23	-0.16	-0.78		45	0.44	0.27						
Buffalo, Main Basin	1984-07	16	-3.2100	0.28	-0.12	-0.96		64	**0.34**	0.07	0.87	5.41	<0.01			
Buffalo, Secondary Bay	1985-07	15	-4.5900	0.52	-0.13	-0.82		62	**0.41**	0.12	0.84	5.29	<0.01			
Crimson	1984-07	20	-0.1000	0.07	-0.06									-0.33	20	0.75
Dillberry	1984-08	17	2.0205	1.01	0.81									4.49	17	<0.01
Elkwater	1983-07	24	-0.1760	0.08	0.15	-0.52		63	0.61	0.45						
Ethel (near Cold Lake)	1979-08	22	-0.2530	0.16	-0.37	-2.67		111	0.01	<0.01						
Garner	1984-00	14	6.0243	1.21	0.80									3.94	14	<0.01
Gregg	1988-08	18	-0.0838	0.05	-0.07									-0.34	18	0.73
Gregoire	1989-08	18	0.3418	0.61	0.09	1.48	1.92	44	0.14	**0.05**	0.30	1.07	0.28			
Gull	1983-08	18	2.2085	0.34	0.25	2.74		48	0.01	<0.01						
Hilda	1979-07	11	3.8472	0.98	0.75									3.11	11	<0.01
Jarvis	1988-08	18	-0.3350	0.22	-0.38									-2.13	18	0.03
Lac La Biche, E. Basin	1983-04	10	0.6853	0.48	0.33									1.25	10	0.21
Long (near Boyle)	1983-08	25	1.6324	0.83	0.53	3.98		68	<0.01	<0.01						
Marie	1979-09	11	0.3802	0.26	0.33									1.33	11	0.18
McLeod, East Basin	1984-07	21	0.0000	0.00	0.01	0.37		54	0.71	0.61						
McLeod, West Basin	1985-95	11	0.0000	0.00	0.00									0.00	11	>.99
Miquelon	1991-08	11	36.8337	2.30	0.24									0.93	11	0.35
Moonshine	1983-07	20	-2.1400	1.35	-0.45	-2.36		46	0.02	<0.01						
Moore (Crane)	1979-09	12	3.4406	0.83	0.85									3.77	12	<0.01
Moose	1983-09	20	3.8950	1.38	0.87	4.83		50	<0.01	<0.01						
Nakamun	1983-08	18	1.0050	0.66	0.56	3.07		97	<0.01	<0.01						
Newell	1983-07	19	-0.0249	0.02	-0.01	-0.32		47	0.75	0.66						
North Buck	1983-03	15	2.0244	1.09	0.75									3.82	15	<0.01
Pigeon	1983-08	19	0.3361	0.22	0.15	1.40		50	**0.16**	0.04	0.60	2.34	0.02			
Pine	1983-09	20	0.9822	0.31	0.34	2.53		86	**0.01**	<0.01	0.84	6.39	<0.01			
Pine Coulee, South	1999-08	10	-0.7470	0.30	-0.26	-0.12		49	0.90	0.81						
Reesor	1983-07	24	1.2024	0.95	0.39	1.66		67	**0.10**	0.01	0.68	2.90	<0.01			
Saskatoon	1983-07	21	2.4092	0.39	0.17	1.01		46	0.31	0.16						
Spruce Coulee	1983-07	24	0.5589	0.47	0.31	1.39		65	**0.17**	0.04	0.48	2.00	0.05			
Steele (Cross)	1983-08	23	0.4007	0.28	0.33	1.53	1.81	**59**	0.13	**0.07**	0.14	0.52	0.61			
Sturgeon, Main Basin	1983-07	22	1.0524	1.41	0.60	3.54		55	<0.01	<0.01						
Sturgeon, West Basin	1983-94	12	1.4607	2.26	0.47									2.06	12	0.04
Sylvan	1983-09	19	0.4506	0.14	0.24	2.11		48	0.03	0.02						
Thunder	1983-09	21	2.2844	0.96	0.45	2.95		59	<0.01	<0.01						
Travers	1983-00	16	0.9559	0.71	0.33									1.71	16	0.09
Tucker	1979-07	10	0.9603	0.47	0.47									1.79	10	0.07
Wabamun	1980-08	29	1.1800	0.58	0.72	5.47		163	<0.01	<0.01						
Winagami	1983-07	21	0.2495	0.14	0.23	0.65		66	0.52	0.39						

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded (p >0.05)

[B] For the trend tests, probability values close to statistical significance (~ns) are shaded in blue (p >0.05 & ≤0.15)

[C] For the SK and SKC tests, probablity values in bold font were selected based on results of the autocorrelation test (Section 2.3)

Table 7 Trends for pH in the lakes

pH			Seasonal Kendall or Mann-Kendall Test, Common Statistics			Seasonal Kendall Test Corrected for Autocorrelation (SKC) or Unadjusted (SK)					Test for Autocorrelation			Mann-Kendall Test ($\leq$ 40 months)		
Lake or Basin	Available Data		Slope, Change in Median per Year and Correlation Coefficient			Test Statistic (Z), Total No. Samples and Statistical Probability (p) for SKC and SK					Spearman Correlation (r_s), Z Statistic and Probability (p)			Z Statistic, Total No. Years and Statistical Probability (p)		
	Span	No. Yr	Sen Slope	% / Yr	Tau	SKC Z	SK Z	No. Month	SKC p [A, B, C]	SK p [A, B, C]	r_s	Z	p [A]	Z	No. Yr	p [A, B]
Alix	1992-07	10	-0.0283	0.34	-0.42	-1.55		46	**0.12**	0.02	0.50	2.78	0.01			
Baptiste, North Basin	1983-07	18	0.0083	0.10	0.20	1.66		90	**0.10**	0.02	0.28	2.34	0.02			
Baptiste, South Basin	1983-07	18	0.0074	0.09	0.17	1.64	1.97	89	0.10	**0.05**	0.11	0.91	0.36			
Beauvais	1984-08	18	-0.0124	0.15	-0.15	-1.86	-2.30	45	0.06	**0.02**	0.45	1.10	0.27			
Buffalo, Main Basin	1984-07	16	-0.0098	0.11	-0.41	-2.09		64	**0.04**	<0.01	0.77	4.79	<0.01			
Buffalo, Secondary Bay	1985-07	15	-0.0147	0.16	-0.35	-1.96		62	**0.05**	<0.01	0.81	5.11	<0.01			
Crimson	1984-07	20	-0.0056	0.07	-0.11									-0.62	20	0.54
Dillberry	1984-08	17	-0.0018	0.02	-0.05									-0.25	17	0.80
Elkwater	1983-07	24	0.0009	0.01	0.21	0.37		63	0.71	0.62						
Ethel (near Cold Lake)	1979-08	22	0.0030	0.04	0.15	1.40		111	**0.16**	0.04	0.30	2.67	0.01			
Garner	1984-00	14	0.0027	0.03	0.07									0.28	14	0.78
Gregg	1988-08	18	-0.0079	0.10	-0.24									-1.33	18	0.18
Gregoire	1989-08	18	-0.0072	0.09	-0.18	-0.19		44	0.85	0.82						
Gull	1983-08	18	-0.0025	0.03	-0.42	-2.14		48	**0.03**	0.01	0.56	2.46	0.01			
Hilda	1979-07	11	0.0104	0.12	0.56									2.34	11	0.02
Jarvis	1988-08	18	-0.0076	0.09	-0.19									-1.06	18	0.29
Lac La Biche, E. Basin	1983-04	10	0.0109	0.13	0.02									0.00	10	>.99
Long (near Boyle)	1983-08	25	0.0033	0.04	0.04	0.95		68	0.34	0.23						
Marie	1979-09	11	0.0034	0.04	0.15									0.55	11	0.58
McLeod, East Basin	1984-07	21	-0.0035	0.04	-0.24	-0.98		54	0.33	0.26						
McLeod, West Basin	1985-95	11	0.0167	0.20	0.18									0.70	11	0.48
Miquelon	1991-08	11	-0.0084	0.09	-0.44									-1.80	11	0.07
Moonshine	1983-07	20	-0.0113	0.14	-0.34	-1.31		46	0.19	0.20						
Moore (Crane)	1979-09	12	0.0043	0.05	0.56									2.40	12	0.02
Moose	1983-09	20	0.0115	0.13	0.14	2.11	2.55	50	0.03	**0.01**	0.04	0.13	0.90			
Nakamun	1983-08	18	0.0090	0.10	0.06	1.00		97	**0.32**	0.10	0.36	3.09	<0.01			
Newell	1983-07	19	0.0014	0.02	-0.05	0.33		47	0.74	0.66						
North Buck	1983-03	15	-0.0050	0.06	-0.15									-0.71	15	0.48
Pigeon	1983-08	19	0.0000	0.00	-0.01	-0.37		50	0.71	0.71						
Pine	1983-09	20	-0.0056	0.07	-0.15	-1.62	-2.01	86	0.11	**0.04**	0.05	0.40	0.69			
Pine Coulee, South	1999-08	10	0.0301	0.36	0.59	2.69		49	0.01	<0.01						
Reesor	1983-07	24	-0.0009	0.01	0.13	-0.10		67	0.92	0.90						
Saskatoon	1983-07	21	0.0000	0.00	-0.04	-0.03		46	0.97	0.97						
Spruce Coulee	1983-07	24	0.0018	0.02	0.22	0.49		65	0.63	0.53						
Steele (Cross)	1983-08	23	0.0061	0.07	0.01	0.67		59	0.50	0.46						
Sturgeon, Main Basin	1983-07	22	0.0026	0.03	0.15	0.52		55	0.61	0.61						
Sturgeon, West Basin	1983-94	12	0.0848	1.10	0.41									1.79	12	0.07
Sylvan	1983-09	19	-0.0020	0.02	-0.15	-1.15		48	0.25	0.22						
Thunder	1983-09	21	0.0075	0.09	0.06	1.40	1.71	59	0.16	**0.09**	0.29	1.28	0.20			
Travers	1983-00	16	0.0033	0.04	0.13									0.63	16	0.53
Tucker	1979-07	10	0.0299	0.35	0.42									1.61	10	0.11
Wabamun	1980-08	29	0.0000	0.00	0.04	-0.28		163	0.78	0.65						
Winagami	1983-07	21	-0.0069	0.08	-0.02	-0.70		66	0.48	0.41						

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink ($p \leq 0.01$ = **) or yellow ($p > 0.01$ & ≤ 0.05 = *); results of no statistcal (ns) difference are not shaded ($p > 0.05$)

[B] For the trend tests, probability values close to statistical significance (~ns) are shaded in blue ($p > 0.05$ & ≤ 0.15)

[C] For the SK and SKC tests, probablity values in bold font were selected based on results of the autocorrelation test (Section 2.3)

Table 8 Trends for total dissolved solids in the lakes

Total Dissolved Solids			Seasonal Kendall or Mann-Kendall Test, Common Statistics			Seasonal Kendall Test Corrected for Autocorrelation (SKC) or Unadjusted (SK)					Test for Autocorrelation			Mann-Kendall Test (≤ 40 months)		
Lake or Basin	Available Data		Slope, Change in Median per Year and Correlation Coefficient			Test Statistic (Z), Total No. Samples and Statistical Probability (p) for SKC and SK					Spearman Correlation (r_s), Z Statistic and Probability (p)			Z Statistic, Total No. Years and Statistical Probability (p)		
	Span	No. Yr	Sen Slope	% / Yr	Tau	SKC Z	SK Z	No. Month	SKC p [A, B, C]	SK p [A, B, C]	r_s	Z	p [A]	Z	No. Yr	p [A, B]
Alix	1996-07	8	-2.5500	1.33	0.14									-0.37	8	0.71
Baptiste, North Basin	1983-07	18	1.1351	0.59	0.58	3.58		89	<0.01	<0.01						
Baptiste, South Basin	1983-07	18	1.1815	0.62	0.58	3.74		88	<0.01	<0.01						
Beauvais	1984-08	17	-0.1253	0.08	0.03	-0.12		43	0.90	0.88						
Buffalo, Main Basin	1984-07	16	-5.3400	0.29	-0.10	-0.69		64	0.49	0.20						
Buffalo, Secondary Bay	1985-07	15	-5.9600	0.42	-0.08	-0.48		60	0.63	0.37						
Crimson	1984-03	18	0.0303	0.02	0.02									0.08	18	0.94
Dillberry	1984-08	15	3.8795	1.96	0.92									4.75	15	<0.01
Elkwater	1983-03	21	1.7828	0.69	0.63	3.07		54	<0.01	<0.01						
Ethel (near Cold Lake)	1979-08	22	-0.5970	0.38	-0.54	-3.88		111	<0.01	<0.01						
Garner	1984-00	14	7.4700	1.23	0.89									4.38	14	<0.01
Gregg	1988-08	16	0.4144	0.22	0.42									2.22	16	0.03
Gregoire	1989-08	16	0.4995	0.72	0.30									1.58	16	0.12
Gull	1983-08	18	4.2844	0.56	0.38	3.44		48	<0.01	<0.01						
Hilda	1979-07	11	5.5755	1.20	0.75									3.11	11	<0.01
Jarvis	1988-08	16	0.2258	0.14	0.15									0.77	16	0.44
Lac La Biche, E. Basin	1983-04	10	1.1364	0.73	0.47									1.79	10	0.07
Long (near Boyle)	1983-08	23	2.3017	1.07	0.71	4.48		59	<0.01	<0.01						
Marie	1979-09	11	0.3596	0.25	0.33									1.33	11	0.18
McLeod, East Basin	1984-03	19	0.0150	0.01	0.11	0.21		48	0.83	0.76						
McLeod, West Basin	1985-95	11	-0.5230	0.34	-0.27									-1.09	11	0.28
Miquelon [D]	1991-08	9	224.39	3.68	0.51									2.84	17 [D]	<0.01
Moonshine	1983-02	18	-6.7900	1.50	-0.46									-2.65	18	0.01
Moore (Crane)	1979-09	12	4.6272	0.97	0.91									4.05	12	<0.01
Moose	1983-09	20	9.5102	2.04	0.96	5.29		50	<0.01	<0.01						
Nakamun	1983-08	18	1.4797	0.88	0.46	3.51		97	<0.01	<0.01						
Newell	1983-03	17	0.3701	0.19	0.32	1.69	2.23	43	0.09	**0.03**	0.32	1.15	0.25			
North Buck	1983-03	15	2.5723	1.29	0.81									4.16	15	<0.01
Pigeon	1983-08	19	0.5809	0.37	0.42	1.92		49	**0.06**	0.01	0.65	2.43	0.02			
Pine	1983-09	20	1.8031	0.42	0.26	2.10		84	**0.04**	<0.01	0.83	6.09	<0.01			
Pine Coulee, South	1999-08	10	3.3394	1.12	0.06	0.13		41	0.90	0.82						
Reesor	1983-03	21	0.0000	0.00	-0.09	0.00	0.00	56	1.00	**0.99**	0.59	1.88	0.06			
Saskatoon	1983-03	19	7.9022	1.15	0.38									2.24	19	0.03
Spruce Coulee	1983-03	21	0.1670	0.14	-0.12	0.29		54	0.77	0.70						
Steele (Cross)	1983-08	21	0.1477	0.10	0.16	0.59		51	0.55	0.52						
Sturgeon, Main Basin	1983-03	20	1.9879	2.24	0.86	4.45		48	<0.01	<0.01						
Sturgeon, West Basin	1983-94	12	2.0390	2.33	0.76									3.36	12	<0.01
Sylvan	1983-09	19	0.5339	0.16	0.18	1.16		47	0.25	0.13						
Thunder	1983-09	21	2.5339	1.01	0.60	3.67		59	<0.01	<0.01						
Travers	1983-00	16	2.1196	1.02	0.38									1.98	16	0.05
Tucker	1979-07	10	0.4391	0.21	0.29									1.07	10	0.28
Wabamun	1980-08	29	4.0592	1.56	0.90	6.84		162	<0.01	<0.01						
Winagami	1983-03	19	2.5051	0.92	0.49	2.37		59	**0.02**	<0.01	0.53	2.47	0.01			

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded (p >0.05)

[B] For the trend tests, probability values close to statistical significance (~ns) are shaded in blue (p >0.05 & ≤0.15)

[C] For the SK and SKC tests, probablity values in bold font were selected based on results of the autocorrelation test (Section 2.3)

[D] Based on monthly values (Sections 2.3 and 3.3.3)

Table 9 Trends for total phosphorus in the lakes

Total Phosphorus: Lake or Basin	Available Data: Span	Available Data: No. Yr	Seasonal Kendall or Mann-Kendall Test, Common Statistics — Slope, Change in Median per Year and Correlation Coefficient: Sen Slope	% / Yr	Tau	Seasonal Kendall Test Corrected for Autocorrelation (SKC) or Unadjusted (SK) — Test Statistic (Z), Total No. Samples and Statistical Probability (p) for SKC and SK: SKC Z	SK Z	No. Month	SKC p [A, B, C]	SK p [A, B, C]	Test for Autocorrelation — Spearman Correlation (r_s), Z Statistic and Probability (p): r_s	Z	p [A]	Mann-Kendall Test (≤ 40 months) — Z Statistic, Total No. Years and Statistical Probability (p): Z	No. Yr	p [A, B]
Alix	1992-07	10	-0.0026	8.53	-0.47	-1.89		46	**0.06**	<0.01	0.48	2.69	0.01			
Baptiste, North Basin	1983-07	18	0.0008	1.25	0.22	2.08	2.91	94	0.04	**<0.01**	0.20	1.70	0.09			
Baptiste, South Basin	1983-07	18	0.0002	0.40	0.09	0.98		94	0.33	0.22						
Beauvais	1984-08	21	-0.0002	0.65	-0.35	-1.93	-2.23	75	0.05	**0.03**	0.13	0.91	0.36			
Buffalo, Main Basin	1984-07	16	-0.0004	0.57	-0.17	-0.68		67	0.49	0.32						
Buffalo, Secondary Bay	1985-07	15	-0.0006	0.76	-0.11	-0.66		64	0.51	0.37						
Crimson	1984-08	23	0.0002	1.10	0.23	2.07		65	**0.04**	0.01	0.57	3.31	<0.01			
Dillberry	1984-08	19	0.0005	2.74	0.53	3.43		65	<0.01	<0.01						
Elkwater	1982-08	27	-0.0003	0.68	-0.09	-1.06		112	**0.29**	0.11	0.57	5.07	<0.01			
Ethel (near Cold Lake)	1979-08	21	0.0001	0.23	0.08	0.87		112	0.38	0.22						
Garner	1984-00	14	0.0003	1.00	0.26	0.81		59	0.42	0.24						
Gregg	1988-08	20	0.0002	1.84	0.27	1.87	2.08	51	0.06	**0.04**	0.36	1.90	0.06			
Gregoire	1989-08	20	0.0006	1.81	0.28	2.15		72	**0.03**	<0.01	0.49	3.36	<0.01			
Gull	1983-08	18	-0.0020	0.38	0.12	-0.60		56	0.55	0.49						
Hilda	1979-07	11	-0.0004	1.68	-0.35									-1.40	11	0.16
Jarvis	1988-08	20	0.0002	2.00	0.20	2.20		53	**0.03**	<0.01	0.54	2.97	<0.01			
Lac La Biche, E. Basin	1983-04	10	0.0022	2.34	0.24									0.89	10	0.37
Long (near Boyle)	1983-08	26	0.0003	0.70	0.07	0.99		103	**0.32**	0.13	0.48	3.90	<0.01			
Marie	1979-09	10	-0.0001	0.76	-0.25									-0.90	10	0.37
McLeod, East Basin	1984-08	24	0.0004	1.51	0.32	2.63		91	0.01	<0.01						
McLeod, West Basin	1985-95	11	0.0003	1.19	0.11	0.79		45	0.43	0.34						
Miquelon	1991-08	13	-0.0005	0.40	-0.10									-0.43	13	0.67
Moonshine	1983-08	24	0.0027	2.49	0.08	1.78		82	**0.07**	0.01	0.71	4.83	<0.01			
Moore (Crane)	1979-09	11	-0.0001	0.29	-0.17									-0.63	11	0.53
Moose	1983-09	20	0.0002	0.37	0.18	0.89		81	0.37	0.18						
Nakamun	1983-08	18	0.0003	0.42	0.03	0.68		102	0.49	0.25						
Newell	1983-08	22	-0.0004	2.62	-0.40	-2.69		74	0.01	<0.01						
North Buck	1983-03	15	-0.0002	0.69	-0.11	-0.75		55	0.46	0.37						
Pigeon	1983-08	19	0.0003	0.94	0.09	0.92		68	0.36	0.19						
Pine	1983-09	21	-0.0001	0.17	-0.01	-0.14		102	0.89	0.82						
Pine Coulee, South	1999-08	10	-0.0039	7.23	-0.01	-1.33		48	**0.18**	0.05	0.39	2.26	0.02			
Reesor	1982-08	25	0.0006	1.95	0.10	2.10		105	**0.04**	<0.01	0.64	5.66	<0.01			
Saskatoon	1983-08	24	0.0110	1.29	0.27	2.01		76	**0.04**	<0.01	0.75	4.91	<0.01			
Spruce Coulee	1982-08	25	-0.0001	0.41	-0.08	-0.73		105	0.47	0.29						
Steele (Cross)	1983-08	26	0.0025	2.68	0.31	2.93		104	0.00	<0.01						
Sturgeon, Main Basin	1983-08	25	0.0013	1.47	0.13	1.78		86	0.07	0.03	0.34	2.45	0.01			
Sturgeon, West Basin	1983-94	12	0.0001	0.14	-0.13	0.03		47	0.98	0.96						
Sylvan	1983-09	19	0.0001	0.35	0.10	0.54		72	0.59	0.45						
Thunder	1983-09	21	0.0019	3.58	0.38	2.41		85	0.02	<0.01	0.55	4.35	<0.01			
Travers	1983-00	16	0.0003	2.12	0.00	1.09		59	0.28	0.13						
Tucker	1979-07	9	0.0008	0.99	0.22									0.73	9	0.47
Wabamun	1981-08	28	-0.0002	0.76	-0.03	-1.97		162	**0.05**	<0.01	0.39	4.44	<0.01			
Winagami	1983-08	24	-0.0022	2.77	0.21	1.59		91	**0.11**	0.01	0.79	6.02	<0.01			

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded (p >0.05)

[B] For the trend tests, probability values close to statistical significance (~ns) are shaded in blue (p >0.05 & ≤0.15)

[C] For the SK and SKC tests, probablity values in bold font were selected based on results of the autocorrelation test (Section 2.3)

Table 10 Trends for chlorophyll-*a* in the lakes

Chlorophyll-*a*			Seasonal Kendall or Mann-Kendall Test, Common Statistics			Seasonal Kendall Test Corrected for Autocorrelation (SKC) or Unadjusted (SK)					Test for Autocorrelation			Mann-Kendall Test (≤ 40 months)		
Lake or Basin	Available Data		Slope, Change in Median per Year and Correlation Coefficient			Test Statistic (Z), Total No. Samples and Statistical Probability (p) for SKC and SK					Spearman Correlation (r_s), Z Statistic and Probability (p)			Z Statistic, Total No. Years and Statistical Probability (p)		
	Span	No. Yr	Sen Slope	% / Yr	Tau	SKC Z	SK Z	No. Month	SKC p [A, B, C]	SK p [A, B, C]	r_s	Z	p [A]	Z	No. Yr	p [A, B]
Alix	1992-07	10	-0.6029	9.42	-0.28	-1.35	-1.64	46	0.18	**0.10**	0.33	1.85	0.06			
Baptiste, North Basin	1983-07	18	-0.0707	0.26	-0.03	-0.32		96	0.75	0.74						
Baptiste, South Basin	1983-07	18	-0.0260	0.09	-0.01	-0.11		96	0.91	0.91						
Beauvais	1984-08	21	-0.1503	2.48	-0.37	-2.10		74	0.04	0.02						
Buffalo, Main Basin	1984-07	17	-0.0127	0.17	0.01	-0.11		69	0.91	0.91						
Buffalo, Secondary Bay	1985-07	15	-0.1247	1.27	-0.18	-0.82		64	0.41	0.24						
Crimson	1984-08	23	0.0800	1.65	0.10	1.47		64	**0.14**	0.05	0.54	3.16	<0.01			
Dillberry	1984-08	19	0.1216	2.76	0.29	3.07		65	<0.01	<0.01						
Elkwater	1982-08	27	-0.0374	0.78	0.02	-0.87		110	0.38	0.19						
Ethel (near Cold Lake)	1979-08	22	-0.0909	1.34	-0.23	-2.54		119	0.01	<0.01						
Garner	1984-00	14	-0.0504	1.04	0.12	-0.40		58	0.69	0.70						
Gregg	1988-08	20	0.0200	1.39	0.13	1.64		54	0.10	0.08						
Gregoire	1989-08	20	0.2314	2.79	0.15	2.06		71	**0.04**	<0.01	0.30	2.07	0.04			
Gull	1983-08	18	-0.0168	0.21	0.20	-0.10		57	0.92	0.92						
Hilda	1979-07	11	-0.1350	3.29	-0.71									-2.96	11	<0.01
Jarvis	1988-08	20	0.0287	2.06	0.21	2.31		57	**0.02**	<0.01	0.34	2.00	0.05			
Lac La Biche, E. Basin	1983-04	10	0.4723	2.68	0.20									0.72	10	0.47
Long (near Boyle)	1983-08	26	-0.0303	0.23	-0.04	-0.47		108	0.64	0.62						
Marie	1980-09	9	-0.1080	2.74	-0.78									-2.81	9	<0.01
McLeod, East Basin	1984-08	24	-0.0276	0.41	-0.03	-0.37		95	0.71	0.63						
McLeod, West Basin	1985-95	11	-0.1990	3.98	-0.08	-1.03		45	0.30	0.24						
Miquelon	1991-08	13	0.0856	3.18	0.26									1.16	13	0.25
Moonshine	1983-08	24	0.2924	1.60	0.04	1.26		83	**0.21**	0.07	0.42	2.93	<0.01			
Moore (Crane)	1979-09	11	-0.1840	3.07	-0.60									-2.49	11	0.01
Moose	1983-09	20	0.1275	0.85	0.11	0.85		81	0.39	0.34						
Nakamun	1983-08	18	0.4517	1.47	0.08	1.27		103	**0.20**	0.08	0.39	3.60	<0.01			
Newell	1983-08	22	-0.2102	6.57	-0.57	-3.65		71	<0.01	<0.01						
North Buck	1986-03	14	-0.2984	4.36	-0.33	-2.55		54	0.01	<0.01						
Pigeon	1983-08	19	-0.1996	1.53	-0.23	-0.86		68	0.39	0.32						
Pine	1983-09	21	0.1275	0.70	-0.02	0.58		102	0.56	0.43						
Pine Coulee, South	1999-08	10	-0.0830	0.92	-0.07	-0.34		43	0.74	0.58						
Reesor	1982-08	25	0.1140	1.63	0.14	1.28		102	**0.20**	0.06	0.58	4.86	<0.01			
Saskatoon	1986-08	23	-0.4113	1.83	-0.24	-1.01		75	0.31	0.29						
Spruce Coulee	1982-08	25	-0.0077	0.19	0.06	-0.07		103	0.95	0.94						
Steele (Cross)	1983-08	26	0.0664	0.28	-0.01	0.28		103	0.78	0.78						
Sturgeon, Main Basin	1983-08	25	-0.1250	0.63	0.02	-0.26		88	0.80	0.79						
Sturgeon, West Basin	1983-94	12	-0.2768	0.89	0.00	-0.16		48	0.88	0.83						
Sylvan	1983-09	19	-0.0091	0.28	0.02	-0.13		72	0.90	0.89						
Thunder	1983-09	21	1.1150	6.18	0.15	1.87		86	**0.06**	<0.01	0.60	4.73	<0.01			
Travers	1983-00	16	0.0000	0.00	-0.18	-0.02		59	0.98	0.98						
Tucker	1979-07	10	1.1559	3.33	0.33									1.25	10	0.21
Wabamun	1980-08	29	-0.0428	0.40	0.02	-1.02		169	0.31	0.20						
Winagami	1983-08	24	-0.4405	2.12	-0.19	-1.59		89	**0.11**	0.06	0.38	2.85	<0.01			

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded (p >0.05)

[B] For the trend tests, probability values close to statistical significance (~ns) are shaded in blue (p >0.05 & ≤0.15)

[C] For the SK and SKC tests, probablity values in bold font were selected based on results of the autocorrelation test (Section 2.3)

Table 11 Trends for transparency in the lakes

Transparency			Seasonal Kendall or Mann-Kendall Test, Common Statistics			Seasonal Kendall Test Corrected for Autocorrelation (SKC) or Unadjusted (SK)					Test for Autocorrelation			Mann-Kendall Test (≤ 40 months)		
Lake or Basin	Available Data		Slope, Change in Median per Year and Correlation Coefficient			Test Statistic (Z), Total No. Samples and Statistical Probability (p) for SKC and SK					Spearman Correlation (r_s), Z Statistic and Probability (p)			Z Statistic, Total No. Years and Statistical Probability (p)		
						SKC	SK		SKC	SK						
	Span	No. Yr	Sen Slope	% / Yr	Tau	Z	Z	No. Month	p [A, B, C]	p [A, B, C]	r_s	Z	p [A]	Z	No. Yr	p [A, B]
Alix	1992-07	10	0.0661	2.64	0.51	2.12		45	**0.03**	<0.01	0.36	2.00	0.05			
Baptiste, North Basin	1983-07	18	0.0050	0.29	0.05	0.58		95	0.56	0.44						
Baptiste, South Basin	1983-07	18	-0.0010	0.06	-0.07	-0.72		96	0.47	0.40						
Beauvais	1984-08	21	0.0430	1.69	0.44	2.09		77	**0.04**	<0.01	0.35	2.45	0.01			
Buffalo, Main Basin	1984-07	17	-0.0232	1.22	-0.07	-1.12	-1.53	69	0.26	**0.13**	0.24	1.63	0.10			
Buffalo, Secondary Bay	1986-07	14	-0.0341	3.10	-0.02	-1.22		54	**0.22**	0.12	0.34	2.00	0.05			
Crimson	1984-08	23	-0.0647	2.59	-0.36	-3.13		64	<0.01	<0.01						
Dillberry	1984-08	19	-0.0733	2.44	-0.59	-3.65		67	<0.01	<0.01						
Elkwater	1982-08	27	0.0048	0.26	0.01	0.80		112	0.42	0.42						
Ethel (near Cold Lake)	1980-08	22	0.0033	0.10	-0.01	-0.05		118	0.96	0.95						
Garner	1984-00	14	-0.0625	1.56	-0.23	-0.81		59	0.42	0.29						
Gregg	1988-08	20	-0.0250	0.46	-0.15	-1.22	-1.48	54	0.22	**0.14**	0.31	1.73	0.08			
Gregoire	1989-08	20	-0.0292	1.46	-0.16	-1.46		73	**0.14**	0.03	0.62	4.41	<0.01			
Gull	1983-08	18	-0.0386	1.68	-0.47	-3.25		55	<0.01	<0.01						
Hilda	1979-07	12	0.0141	0.52	0.18									0.76	12	0.45
Jarvis	1988-08	20	-0.0707	1.14	-0.27	-1.98		55	0.05	0.03						
Lac La Biche, E. Basin	1983-04	10	-0.0748	3.15	-0.51									-1.97	10	0.05
Long (near Boyle)	1983-08	26	0.0033	0.15	0.09	0.64		107	0.52	0.48						
Marie	1980-09	11	0.0195	0.52	0.05									0.16	11	0.88
McLeod, East Basin	1984-08	24	-0.0417	1.32	-0.26	-2.14		94	**0.03**	<0.01	0.43	3.28	<0.01			
McLeod, West Basin	1985-99	12	-0.0913	2.61	-0.18	-1.43		47	0.15	0.09						
Miquelon	1991-08	15	-0.0782	3.13	-0.26									-1.29	15	0.20
Moonshine	1983-08	24	-0.0200	1.11	0.00	-1.49		84	**0.14**	0.03	0.52	3.69	<0.01			
Moore (Crane)	1980-09	10	0.0449	1.41	0.51									1.97	10	0.05
Moose	1983-09	20	0.0002	0.01	-0.09	-0.03		83	0.98	0.97						
Nakamun	1983-08	18	-0.0013	0.10	0.00	-0.37		103	0.71	0.57						
Newell	1983-08	22	0.0500	1.43	0.27	2.12	2.61	74	0.03	**0.01**	0.23	1.62	0.11			
North Buck	1991-03	13	0.0701	3.50	0.28	1.79		48	**0.07**	0.03	0.47	2.21	0.03			
Pigeon	1983-08	20	0.0167	0.83	0.11	1.14		69	0.25	0.19						
Pine	1983-09	21	-0.0201	0.85	-0.03	-0.98		100	**0.33**	0.15	0.45	3.94	<0.01			
Pine Coulee, South	1999-08	10	0.1249	5.43	0.04	0.75		43	0.45	0.34						
Reesor	1982-08	25	-0.0817	3.14	-0.30	-3.55		104	<0.01	<0.01						
Saskatoon	1986-08	23	0.0002	0.03	0.08	-0.03		76	0.98	0.97						
Spruce Coulee	1982-08	25	-0.0198	0.49	-0.22	-0.91		105	0.37	0.17						
Steele (Cross)	1983-08	26	0.0238	1.38	0.18	1.61		104	**0.11**	0.04	0.31	2.69	0.01			
Sturgeon, Main Basin	1983-08	25	-0.0111	0.51	-0.02	-0.78		88	0.43	0.39						
Sturgeon, West Basin	1983-94	12	0.0492	4.92	0.35	1.75	2.23	47	0.08	**0.03**	0.13	0.69	0.49			
Sylvan	1983-09	20	0.0100	0.22	0.02	0.36		73	0.72	0.64						
Thunder	1983-09	21	-0.0346	2.60	-0.23	-2.20		86	**0.03**	<0.01	0.52	4.12	<0.01			
Travers	1983-00	16	0.0000	0.00	0.17	-0.32		58	0.75	0.67						
Tucker	1980-07	8	-0.0126	1.14	-0.30									-0.88	8	0.38
Wabamun	1980-08	28	0.0055	0.25	0.15	0.99		165	**0.32**	0.12	0.33	3.87	<0.01			
Winagami	1983-08	24	0.0167	0.95	0.31	2.08		91	0.04	0.02						

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded (p >0.05)

[B] For the trend tests, probability values close to statistical significance (~ns) are shaded in blue (p >0.05 & ≤0.15)

[C] For the SK and SKC tests, probablity values in bold font were selected based on results of the autocorrelation test (Section 2.3)

Table 12 Summary of trends for total alkalinity, pH and total dissolved solids in the lakes

Lake or Basin	Total Alkalinity: Sig.	Total Alkalinity: >0.15	Total Alkalinity: >0.05 & ≤0.15	Total Alkalinity: ≤0.05	pH: Sig.	pH: >0.15	pH: >0.05 & ≤0.15	pH: ≤0.05	Total Dissolved Solids: Sig.	Total Dissolved Solids: >0.15	Total Dissolved Solids: >0.05 & ≤0.15	Total Dissolved Solids: ≤0.05
	Statistical Significance (Sig.) and Direction of Change [A]				Statistical Significance (Sig.) and Direction of Change [A]				Statistical Significance (Sig.) and Direction of Change [A]			
		Based on Probability (p)				Based on Probability (p)				Based on Probability (p)		
Alix	*			↓	~ns		↓		ns	↔		
Baptiste, North Basin	**			↑	~ns		↑		**			↑
Baptiste, South Basin	**			↑	*			↑	**			↑
Beauvais	ns	↔			*			↓	ns	↔		
Buffalo, Main Basin	ns	↔			*			↓	ns	↔		
Buffalo, Secondary Bay	ns	↔			*			↓	ns	↔		
Crimson	ns	↔			ns	↔			ns	↔		
Dillberry	**			↑	ns	↔			**			↑
Elkwater	ns	↔			ns	↔			**			↑
Ethel (near Cold Lake)	**			↓	ns	↔			**			↓
Garner	**			↑	ns	↔			**			↑
Gregg	ns	↔			ns	↔			*			↑
Gregoire	*			↑	ns	↔			~ns		↑	
Gull	**			↑	*			↓	**			↑
Hilda	**			↑	*			↑	**			↑
Jarvis	*			↓	ns	↔			ns	↔		
Lac La Biche, E. Basin	ns	↔			ns	↔			~ns		↑	
Long (near Boyle)	**			↑	ns	↔			**			↑
Marie	ns	↔			ns	↔			ns	↔		
McLeod, East Basin	ns	↔			ns	↔			ns	↔		
McLeod, West Basin	ns	↔			ns	↔			ns	↔		
Miquelon	ns	↔			~ns		↓		**			↑
Moonshine	**			↓	ns	↔			**			↓
Moore (Crane)	**			↑	*			↑	**			↑
Moose	**			↑	**			↑	**			↑
Nakamun	**			↑	ns	↔			**			↑
Newell	ns	↔			ns	↔			*			↑
North Buck	**			↑	ns	↔			**			↑
Pigeon	ns	↔			ns	↔			*			↑
Pine	**			↑	*			↓	*			↑
Pine Coulee, South	ns	↔			**			↑	ns	↔		
Reesor	~ns		↑		ns	↔			ns	↔		
Saskatoon	ns	↔			ns	↔			*			↑
Spruce Coulee	ns	↔			ns	↔			ns	↔		
Steele (Cross)	~ns		↑		ns	↔			ns	↔		
Sturgeon, Main Basin	**			↑	ns	↔			**			↑
Sturgeon, West Basin	*			↑	~ns		↑		**			↑
Sylvan	*			↑	ns	↔			~ns		↑	
Thunder	**			↑	~ns		↑		**			↑
Travers	~ns		↑		ns	↔			*			↑
Tucker	~ns		↑		~ns		↑		ns	↔		
Wabamun	**			↑	ns	↔			**			↑
Winagami	ns	↔			ns	↔			*			↑

Summary of Trends (n=43)

Trend	Total Alkalinity: No.	Total Alkalinity: %	pH: No.	pH: %	Total Dissolved Solids: No.	Total Dissolved Solids: %
Not Significant (p>0.05)	**21**	48.8	**33**	76.7	**17**	39.5
Increase (p ≤0.05)	**18**	41.9	**5**	11.6	**24**	55.8
Decrease (p ≤0.05)	**4**	9.3	**5**	11.6	**2**	4.7

Footnotes:

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[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded or are shaded in blue when the probability values are close to statistical significance (~ns, p >0.05 & ≤0.15)

Table 13 Summary of trends for total phosphorus, chlorophyll-*a* and transparency in the lakes

Lake or Basin	Total Phosphorus				Chlorophyll-*a*				Transparency			
	Statistical Significance (Sig.) and Direction of Change [A]				Statistical Significance (Sig.) and Direction of Change [A]				Statistical Significance (Sig.) and Direction of Change [A]			
		Based on Probability (p)				Based on Probability (p)				Based on Probability (p)		
	Sig.	>0.15	>0.05 & ≤0.15	≤0.05	Sig.	>0.15	>0.05 & ≤0.15	≤0.05	Sig.	>0.15	>0.05 & ≤0.15	≤0.05
Alix	~ns		↓		~ns		↓		*			↑
Baptiste, North Basin	**			↑	ns	↔			ns	↔		
Baptiste, South Basin	ns	↔			ns	↔			ns	↔		
Beauvais	*			↓	*			↓	*			↑
Buffalo, Main Basin	ns	↔			ns	↔			~ns		↓	
Buffalo, Secondary Bay	ns	↔			ns	↔			ns	↔		
Crimson	*			↑	~ns		↑		**			↓
Dillberry	**			↑	**			↑	**			↓
Elkwater	ns	↔			ns	↔			ns	↔		
Ethel (near Cold Lake)	ns	↔			**			↓	ns	↔		
Garner	ns	↔			ns	↔			ns	↔		
Gregg	*			↑	~ns		↑		~ns		↓	
Gregoire	*			↑	*			↑	~ns		↓	
Gull	ns	↔			ns	↔			**			↓
Hilda	ns	↔			**			↓	ns	↔		
Jarvis	*			↑	*			↑	*			↓
Lac La Biche, E. Basin	ns	↔			ns	↔			*			↓
Long (near Boyle)	ns	↔			ns	↔			ns	↔		
Marie	ns	↔			**			↓	ns	↔		
McLeod, East Basin	**			↑	ns	↔			*			↓
McLeod, West Basin	ns	↔			ns	↔			~ns		↓	
Miquelon	ns	↔			ns	↔			ns	↔		
Moonshine	~ns		↑		ns	↔			~ns		↓	
Moore (Crane)	ns	↔			**			↓	*			↑
Moose	ns	↔			ns	↔			ns	↔		
Nakamun	ns	↔			ns	↔			ns	↔		
Newell	**			↓	**			↓	**			↑
North Buck	ns	↔			**			↓	~ns		↑	
Pigeon	ns	↔			ns	↔			ns	↔		
Pine	ns	↔			ns	↔			ns	↔		
Pine Coulee, South	ns	↔			ns	↔			ns	↔		
Reesor	*			↑	ns	↔			**			↓
Saskatoon	*			↑	ns	↔			ns	↔		
Spruce Coulee	ns	↔			ns	↔			ns	↔		
Steele (Cross)	**			↑	ns	↔			~ns		↑	
Sturgeon, Main Basin	~ns		↑		ns	↔			ns	↔		
Sturgeon, West Basin	ns	↔			ns	↔			*			↑
Sylvan	ns	↔			ns	↔			ns	↔		
Thunder	*			↑	~ns		↑		*			↓
Travers	ns	↔			ns	↔			ns	↔		
Tucker	ns	↔			ns	↔			ns	↔		
Wabamun	*			↓	ns	↔			ns	↔		
Winagami	~ns		↓		~ns		↓		*			↑

Summary of Trends (n=43)

Trend	Total Phosphorus		Chlorophyll-*a*		Transparency	
	No.	%	No.	%	No.	%
Not Significant (p>0.05)	**29**	67.4	**33**	76.7	**29**	67.4
Increase (p ≤0.05)	**11**	25.6	**3**	7.0	**6**	14.0
Decrease (p ≤0.05)	**3**	7.0	**7**	16.3	**8**	18.6

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded or are shaded in blue when the probability values are close to statistical significance (~ns, p >0.05 & ≤0.15)

Table 14 Trends in total phosphorus and chlorophyll-*a* relative to general features of the lakes and watersheds

Lake or Basin [C]	Total Phosphorus		Chlorophyll-*a*		Drainage Area (km^2)	Surface Area (km^2)	Watershed: Lake Surface Area ratio	Volume (million m^3)	Maximum Depth (m)	Mean Depth (m)	Mean Annual Inflow (million m^3)	Water Residence Time (yrs) [D]
	Statistical Significance & Trend Direction [A]				Characteristics of Lakes and Watersheds [B]							
Increasing Trend of Total Phosphorus or Chlorophyll-*a*												
Baptiste, North Basin	**	↑	ns	↔	109	5	22	28	16	6	16	6
Crimson	*	↑	~ns	↑	2	2	1	5	9	2	0.2	100
Dillberry	**	↑	**	↑	12	1	15	2	11	3	0	100
Gregg	*	↑	~ns	↑	163	1	122	5	18	---	---	1
Gregoire	*	↑	*	↑	232	26	9	100	7	4	27	4
Jarvis	*	↑	*	↑	70	1	48	12	25	---	---	2
McLeod, East Basin	**	↑	ns	↔	46	4	12	19	11	5	4	6
Reesor	*	↑	ns	↔	6	1	11	2	6	4	0.4	6
Saskatoon	*	↑	ns	↔	32	7	4	19	4	3	1	100
Steele (Cross)	**	↑	ns	↔	255	7	39	21	6	3	12	2
Thunder	*	↑	~ns	↑	21	7	3	21	6	3	1	100
Mean (n = 11)					**86**	**6**	**26**	**21**	**11**	**4**	**7**	**39**
Decreasing Trend of Total Phosphorus or Chlorophyll-*a*												
Beauvais	*	↓	*	↓	7	1	8	4	11	7	1	4
Ethel (near Cold Lake)	ns	↔	**	↓	542	5	111	32	30	7	13	3
Hilda	ns	↔	**	↓	87	4	24	23	12	6	---	6
Marie	ns	↔	**	↓	386	35	11	484	26	14	17	48
Moore (Crane)	ns	↔	**	↓	37	9	4	77	26	8	2	100
Newell	**	↓	**	↓	85	66	1	321	20	5	295	2
North Buck	ns	↔	**	↓	100	19	5	47	6	2	3	41
Wabamun	*	↓	ns	↔	259	82	3	513	11	6	13	100
Mean (n = 6) [E]					**193**	**12**	**27**	**111**	**18**	**7**	**7**	**33**
No Statistical Trend ($p>0.05$) of Total Phosphorus or Chlorophyll-*a*												
Alix	~ns	↓	~ns	↓	59	1	91	1	3	2	---	---
Baptiste, South Basin	ns	↔	ns	↔	179	5	38	57	28	12	16	6
Buffalo, Main Basin	ns	↔	ns	↔	1,440	94	15	248	7	3	24	100
Elkwater	ns	↔	ns	↔	26	2	11	8	8	4	2	6
Garner	ns	↔	ns	↔	26	6	4	50	15	8	1	100
Gull	ns	↔	ns	↔	206	81	3	437	8	5	14	100
Lac La Biche, E. Basin	ns	↔	ns	↔	4,040	234	17	1,960	12	8	316	7
Long (near Boyle)	ns	↔	ns	↔	82	6	14	29	9	4	5	8
Miquelon	ns	↔	ns	↔	35	9	4	24	6	3	2	100
Moonshine	~ns	↑	ns	↔	7	0	24	0	4	1	0.4	---
Moose	ns	↔	ns	↔	755	41	19	230	20	6	38	8
Nakamun	ns	↔	ns	↔	45	4	13	16	8	5	1	21
Pigeon	ns	↔	ns	↔	187	97	2	603	9	6	17	100
Pine	ns	↔	ns	↔	150	4	39	21	12	5	3	9
Pine Coulee, South	ns	↔	ns	↔	80	6	14	51	19	---	---	---
Spruce Coulee	ns	↔	ns	↔	4	0	19	1	6	3	---	3
Sturgeon, Main Basin	~ns	↑	ns	↔	571	49	12	266	10	5	47	7
Sylvan	ns	↔	ns	↔	102	43	2	412	18	10	7	100
Travers	ns	↔	ns	↔	4,230	23	188	413	40	18	404	1
Tucker	ns	↔	ns	↔	312	7	47	19	8	3	15	2
Winagami	~ns	↓	~ns	↓	221	47	5	81	5	2	13	2
Mean (n = 21)					**607**	**36**	**28**	**235**	**12**	**6**	**51**	**38**

Footnotes:

Separate lake basins for lakes with two basins are shaded in grey

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink ($p < 0.01$ = **) or yellow ($p > 0.01$ & < 0.05 = *); results of no statistcal (ns) difference are shaded in blue ($p > 0.05$ & < 0.15) or have no shading ($p > 0.15$)

[B] Lake and watershed features are based on Table 1a

[C] Secondary lake basins for Buffalo, McLeod and Sturgeon lakes are excluded because of limited data (only maximum depths were available)

[D] Water residence times of >100 or <1 are converted to the corresponding units to allow calculation of the means for the three groups of lakes

[E] Calculation of the means excludes Newell and Wabamun lakes because of the influence of water management on lake water quality

Table 15 Trends for the additional water quality variables in selected lakes

Other Water Quality Variables			Seasonal Kendall or Mann-Kendall Test, Common Statistics			Seasonal Kendall Test Corrected for Autocorrelation (SKC) or Unadjusted (SK)					Test for Autocorrelation			Summary Trend Results			
Lake or Basin	Available Data		Slope, Change in Median per Year and Correlation Coefficient			Test Statistic (Z), Total No. Samples and Statistical Probability (p) for SKC and SK					Spearman Correlation (r_s), Z Statistic and Probability (p)			Statistical Significance (Sig.) and Direction of Change [A]	Based on Probability (p)		
	Span	No. Yr	Sen Slope	% / Yr	Tau	SKC Z	SK Z	No. Month	SKC p [A, B, C]	SK p [A, B, C]	r_s	Z	p [A]	Sig.	>0.15	>0.05 & ≤0.15	≤0.05
Dissolved Phosphorus																	
Baptisite, North Basin	1983-07	17	0.0003	1.89	0.25	2.14		90	**0.03**	<0.01	0.23	1.94	0.05	*			↑
Baptisite, South Basin	1983-07	17	0.0002	1.18	0.22	2.02	2.76	89	0.04	**0.01**	0.23	1.90	0.06	**			↑
Ethel (near Cold Lake)	1979-08	21	0.0000	0.39	0.11	1.12		111	**0.26**	0.11	0.38	3.52	<0.01	ns	↔		
Nakamun	1983-08	18	0.0002	0.95	0.10	1.40		102	**0.16**	0.03	0.52	4.68	<0.01	ns	↔		
Pine	1983-09	20	-0.0001	0.16	0.03	-0.25		98	0.80	0.71				ns	↔		
Wabamun	1981-08	28	-0.0001	1.17	-0.17	-2.34		160	**0.02**	<0.01	0.57	6.51	<0.01	*			↓
Ammonia																	
Baptisite, North Basin	1983-07	17	0.0007	3.55	0.2853	2.78		88	0.01	<0.01				**			↑
Baptisite, South Basin	1983-07	17	0.0002	1.11	0.1027	0.91		87	0.36	0.23				ns	↔		
Ethel (near Cold Lake)	1979-08	22	-0.0003	2.45	-0.2059	-1.91		115	**0.06**	0.00	0.30	2.84	<0.01	~ns		↓	
Nakamun	1983-08	18	0.0005	1.73	0.0829	1.48		98	0.14	0.06				~ns		↑	
Pine	1983-09	20	0.0008	0.78	0.1036	0.92		96	0.36	0.27				ns	↔		
Wabamun	1980-08	29	0.0009	3.42	0.1801	2.59		166	0.01	<0.01				**			↑
Nitrate+Nitrite																	
Baptisite, North Basin	1983-07	18	0.0001	1.87	0.1270	1.24		91	**0.22**	0.10	0.36	3.04	<0.01	ns	↔		
Baptisite, South Basin	1983-07	18	0.0000	0.00	0.0221	0.34		90	0.73	0.71				ns	↔		
Ethel (near Cold Lake)	1979-08	22	Insufficient Data											Insufficient Data [D]			
Nakamun	1983-08	18	0.0000	0.00	0.0351	1.03		98	0.30	0.22				ns	↔		
Pine	1983-09	21	0.0004	2.85	0.3009	2.74		99	0.01	<0.01				**			↑
Wabamun	1980-08	29	Insufficient Data											Insufficient Data [D]			
Total Kjeldahl Nitrogen																	
Baptisite, North Basin	1983-07	18	0.0086	0.75	0.26	2.10		92	**0.04**	<0.01	0.28	2.40	0.02	*			↑
Baptisite, South Basin	1983-07	18	0.0110	0.97	0.30	2.37		91	**0.02**	<0.01	0.44	3.68	<0.01	*			↑
Ethel (near Cold Lake)	1979-08	22	-0.0030	0.43	-0.22	-2.11		115	**0.03**	<0.01	0.38	3.61	<0.01	*			↓
Nakamun	1983-08	18	0.0214	1.20	0.39	1.98		98	**0.05**	<0.01	0.56	4.90	<0.01	*			↑
Pine	1983-09	20	0.0133	0.79	0.17	1.81		96	**0.07**	<0.01	0.70	5.97	<0.01	~ns		↑	
Wabamun	1980-08	29	0.0006	0.07	-0.04	0.33		166	0.74	0.62				ns	↔		
Total Nitrogen																	
Baptisite, North Basin	1983-07	18	0.0090	0.76	0.25	2.09		91	**0.04**	<0.01	0.28	2.33	0.02	*			↑
Baptisite, South Basin	1983-07	18	0.0112	0.96	0.31	2.32		90	**0.02**	<0.01	0.49	4.05	<0.01	*			↑
Ethel (near Cold Lake)	1979-08	22	-0.0033	0.47	-0.22	-2.16		115	**0.03**	<0.01	0.41	3.83	<0.01	*			↓
Nakamun	1983-08	18	0.0202	1.12	0.29	1.94		98	**0.05**	<0.01	0.57	4.93	<0.01	*			↑
Pine	1983-09	20	0.0139	0.82	0.17	1.88		96	**0.06**	<0.01	0.71	6.05	<0.01	~ns		↑	
Wabamun	1980-08	29	0.0017	0.19	0.00	0.85		166	0.40	0.19				ns	↔		
Total Nitrogen: Total Phosphorus																	
Baptisite, North Basin	1983-07	18	-0.1145	0.60	-0.12	-1.36	-1.61	89	0.17	**0.11**	0.22	1.83	0.07	~ns		↓	
Baptisite, South Basin	1983-07	18	0.0532	0.25	0.09	1.14		88	0.26	0.24				ns	↔		
Ethel (near Cold Lake)	1979-08	21	-0.2160	0.70	-0.19	-1.71		106	**0.09**	0.01	0.50	4.46	<0.01	~ns		↓	
Nakamun	1983-08	18	0.1428	0.62	0.23	1.06		97	**0.29**	0.09	0.42	3.67	<0.01	ns	↔		
Pine	1983-09	20	0.2147	0.93	0.14	1.46		96	**0.14**	0.03	0.36	3.08	<0.01	ns	↔		
Wabamun	1981-08	28	0.1997	0.69	0.10	1.83		157	**0.07**	<0.01	0.32	3.55	<0.01	~ns		↑	

Table 15 Trends for additional water quality variables in selected lakes (concluded)

Other Water Quality Variables			Seasonal Kendall or Mann-Kendall Test, Common Statistics			Seasonal Kendall Test Corrected for Autocorrelation (SKC) or Unadjusted (SK)					Test for Autocorrelation			Summary Trend Results			
Lake or Basin	Available Data		Slope, Change in Median per Year and Correlation Coefficient			Test Statistic (Z), Total No. Samples and Statistical Probability (p) for SKC and SK					Spearman Correlation (r_s), Z Statistic and Probability (p)			Statistical Significance (Sig.) and Direction of Change [A]			
						SKC	SK		SKC	SK					Based on Probability (p)		
	Span	No. Yr	Sen Slope	% / Yr	Tau	Z	Z	No. Month	p [A, B, C]	p [A, B, C]	r_s	Z	p [A]	Sig.	>0.15	>0.05 & ≤0.15	≤0.05
Non-Filterable Residue																	
Baptisite, North Basin	1984-07	16	-0.0769	1.92	-0.23	-1.96	-2.49	83	0.05	**0.01**	0.23	1.82	0.07	**			↓
Baptisite, South Basin	1984-07	16	-0.0612	1.53	-0.17	-1.65		82	**0.10**	0.05	0.39	3.13	<0.01	~ns		↓	
Ethel (near Cold Lake)	1979-08	21	-0.0237	1.19	-0.18	-1.45	-2.06	99	0.15	**0.04**	0.21	1.83	0.07	*			↓
Nakamun	1984-08	17	0.0000	0.00	-0.15	-0.08		92	0.94	0.90				ns	↔		
Pine	1989-07	14	-0.0260	0.87	-0.07	-0.59		73	0.56	0.39				ns	↔		
Wabamun	1980-08	28	-0.0342	0.85	-0.14	-1.62		158	**0.10**	0.02	0.18	2.04	0.04	~ns		↓	
Dissolved Organic Carbon																	
Baptisite, North Basin	1983-07	18	0.0844	0.49	0.25	1.80		89	**0.07**	<0.01	0.57	4.67	<0.01	~ns		↑	
Baptisite, South Basin	1983-07	18	0.1000	0.59	0.29	2.03		88	**0.04**	<0.01	0.58	4.72	<0.01	*			↑
Ethel (near Cold Lake)	1980-08	21	0.0000	0.00	0.02	0.27		113	0.78	0.73				ns	↔		
Nakamun	1983-08	18	0.2060	1.19	0.66	3.83		98	<0.01	<0.01				**			↑
Pine	1989-09	15	-0.0360	0.20	-0.13	-0.75		72	0.46	0.18				ns	↔		
Wabamun	1980-08	28	0.0349	0.29	0.18	1.69		158	**0.09**	0.01	0.38	4.26	<0.01	~ns		↑	
Silica																	
Baptisite, North Basin	1983-07	17	0.0208	2.08	0.18	2.08		87	0.04	0.02				*			↑
Baptisite, South Basin	1983-07	17	0.0098	1.22	0.16	1.54		86	0.12	0.06				~ns		↑	
Ethel (near Cold Lake)	1979-08	22	0.0091	0.53	0.10	0.84		111	0.40	0.21				ns	↔		
Nakamun	1983-08	18	-0.1310	1.84	-0.10	-1.08		97	**0.28**	0.04	0.77	6.70	<0.01	ns	↔		
Pine	1983-07	17	0.1171	3.58	0.26	1.79		79	**0.07**	<0.01	0.52	3.85	<0.01	~ns		↑	
Wabamun	1980-08	29	0.0000	0.00	-0.07	0.16		160	0.88	0.79				ns	↔		

Footnotes:

Pairs of lake basins shaded in grey are in the same lake

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded (p >0.05)

[B] For the trend tests, probability values close to statistical significance (~ns) are shaded in blue (p >0.05 & ≤0.15)

[C] For the SK and SKC tests, probablity values in bold font were selected based on results of the autocorrelation test (Section 2.3)

[D] See Section 3.3.3

E. TRENDS IN LAKE LEVEL AND RELATIONSHIP TO WATER QUALITY

This section includes detailed statistical results for trends (Mann-Kendall test) in lake level for the 37 lakes with data that coincided with the water quality sampling record (Table 16). Correlation results between lake level and key water variables in lake basins are also presented (Table 17). Lakes are listed alphabetically in each Table. See Section 2.3 for more detail.

Table 16 Trends for annual lake level in lakes with coinciding water quality data

Lake Level			Mann-Kendall Test (Annual Median)						Summary Trend Results			
	Data Coinciding with Water Quality Record		Slope, Change in Median per Year and Correlation Coefficient			Z Statistic, Total Number of Years and Statistical Probability (p) [A]			Statistical Significance (Sig.) and Direction of Change [A]			
										Based on Probability (p)		
Lake or Basin	**Span**	**No. Yr**	**Sen Slope**	**% / yr**	**Tau**	**Z**	**No. Yr**	**p**	**Sig.**	**>0.15**	**>0.05 & ≤0.15**	**≤0.05**
Alix	1996-07	8	-0.0046	0.00	-0.30	-1.30	12	0.19	ns	↔		
Baptisite	1983-07	18	-0.0048	0.00	-0.23	-1.56	24	0.12	~ns		↓	
Beauvais	1984-08	21	0.0151	0.00	0.20	1.40	25	0.16	ns	↔		
Buffalo	1984-07	17	0.0154	0.00	0.37	2.53	24	0.01	* *			↑
Crimson	1984-08	23	0.0088	0.00	0.43	2.97	25	<0.01	* *			↑
Dillberry	1984-08	19	-0.0510	0.01	-0.71	-4.93	25	<0.01	* *			↓
Elkwater	1982-08	27	0.0055	0.00	0.14	1.00	27	0.32	ns	↔		
Ethel (near Cold Lake)	1980-08	22	0.0168	0.00	0.28	2.08	29	0.04	*			↑
Garner	1984-00	14	-0.1290	0.02	-0.84	-4.65	17	<0.01	* *			↓
Gregg	1988-08	20	0.0090	0.00	0.21	1.30	21	0.19	ns	↔		
Gregoire	1989-08	20	0.0080	0.00	0.41	2.50	20	0.01	* *			↑
Gull	1983-08	18	-0.0206	0.00	-0.50	-3.53	26	<0.01	* *			↓
Hilda	1980-07	11	-0.0182	0.00	-0.30	-2.19	28	0.03	*			↓
Jarvis	1988-08	20	-0.0243	0.00	-0.47	-2.93	21	<0.01	* *			↓
Lac La Biche	1983-04	10	-0.0120	0.00	-0.17	-1.07	22	0.28	ns	↔		
Long (near Boyle)	1983-08	26	-0.0188	0.00	-0.43	-3.04	26	<0.01	* *			↓
Marie	1980-09	11	0.0046	0.00	0.21	1.61	30	0.11	~ns		↑	
McLeod	1984-08	24	0.0013	0.00	0.06	0.40	25	0.69	ns	↔		
Miquelon	1996-08	11	-0.1090	0.01	-0.74	-3.61	14	<0.01	* *			↓
Moonshine	1983-08	24	-0.0060	0.00	-0.18	-1.28	26	0.20	ns	↔		
Moore (Crane)	1980-08	11	0.0061	0.00	0.13	0.98	29	0.33	ns	↔		
Moose	1983-09	20	-0.0198	0.00	-0.40	-2.92	27	<0.01	* *			↓
Nakamun	1983-08	18	-0.0381	0.01	-0.56	-3.97	26	<0.01	* *			↓
Newell	1983-92	7	0.0304	0.00	0.33	1.25	10	0.21	ns	↔		
North Buck	1983-03	15	-0.0518	0.01	-0.53	-3.35	21	<0.01	* *			↓
Pigeon	1983-08	20	-0.0059	0.00	-0.21	-1.50	26	0.13	~ns		↓	
Pine	1983-09	21	0.0026	0.00	0.17	1.21	27	0.23	ns	↔		
Pine Coulee	2000-08	9	0.8528	0.08	0.67	2.40	9	0.02	*			↑
Reesor	1982-08	27	0.0042	0.00	0.12	0.83	27	0.40	ns	↔		
Saskatoon	1983-08	24	-0.0502	0.01	-0.59	-4.23	26	<0.01	* *			↓
Spruce Coulee	2004-08	5	Insufficient data									
Steele (Cross)	1996-08	13	-0.0049	0.00	-0.08	-0.33	14	0.74	ns	↔		
Sturgeon	1983-08	25	-0.0075	0.00	-0.19	-1.37	26	0.17	ns	↔		
Sylvan	1983-08	19	0.0046	0.00	0.11	0.75	26	0.45	ns	↔		
Thunder	1983-09	21	-0.0261	0.00	-0.54	-3.96	27	<0.01	* *			↓
Travers	1989-00	10	-0.0769	0.01	-0.36	-1.58	12	0.11	~ns		↓	
Tucker	No data											
Wabamun	1980-08	29	-0.0273	0.00	-0.46	-3.49	29	<0.01	* *			↓
Winagami	1983-08	24	0.0046	0.00	0.17	1.21	26	0.23	ns	↔		

Summary of Trends (n=37)

Trend	No.	%
Not Significant (p>0.05)	**19**	51.4
Increase (p ≤0.05)	**5**	13.5
Decrease (p ≤0.05)	**13**	35.1

Footnotes:

Lake names in bold font are reservoirs

[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded or are shaded in blue when the probability values are close to statistical significance (~ns, p >0.05 & ≤0.15)

Table 17 Trends in lake level and correlations between lake level and total dissolved solids, total phosphorus and chlorophyll-*a* in the lakes

Lake or Basin	Trend in Lake Level: Statistical Significance (Sig.) and Direction of Change [A, B]				Correlation Between Lake Level and Water Quality: Total Dissolved Solids [A]				Total Phosphorus [A]				Chlorophyll-*a* [A]			
		Based on Probability (p)			Spearman Correlation (r_s), Z Statistic, Probability (p) and Sample Number (n)											
	Sig.	>0.15	>0.05 & ≤0.15	≤0.05	r_s	Z	p	n	r_s	Z	p	n	r_s	Z	p	n
Alix	ns	↔			0.10	0.25	0.80	8	-0.75	-2.00	0.05	8	-0.48	-1.26	0.21	8
Baptiste, North Basin	~ns		↓		-0.19	-0.77	0.44	18	-0.04	-0.17	0.86	18	-0.09	-0.38	0.70	18
Baptiste, South Basin	~ns		↓		-0.17	-0.68	0.50	18	-0.08	-0.35	0.73	18	-0.02	-0.06	0.95	18
Beauvais	ns	↔			0.15	0.59	0.55	17	-0.28	-1.25	0.21	21	-0.39	-1.73	0.08	21
Buffalo, Main Basin	* *			↑	-0.54	-2.10	0.04	16	-0.41	-1.58	0.11	16	-0.24	-0.97	0.33	17
Crimson	* *			↑	-0.31	-1.30	0.19	18	0.17	0.79	0.43	23	-0.08	-0.38	0.70	23
Dillberry	* *			↓	-0.94	-3.53	<0.01	15	-0.92	-3.90	<0.01	19	-0.57	-2.40	0.02	19
Elkwater	ns	↔			-0.31	-1.39	0.17	21	-0.14	-0.71	0.47	27	-0.38	-1.93	0.05	27
Ethel (near Cold Lake)	*			↑	-0.44	-1.96	0.05	21	0.08	0.33	0.74	20	0.11	0.49	0.62	21
Garner	* *			↓	-0.94	-3.40	<0.01	14	-0.15	-0.55	0.58	14	0.09	0.31	0.76	14
Gregg	ns	↔			-0.18	-0.71	0.48	16	0.23	0.99	0.32	20	-0.05	-0.22	0.83	20
Gregoire	* *			↑	0.32	1.25	0.21	16	0.00	-0.01	0.99	20	0.21	0.92	0.36	20
Gull	* *			↓	-0.72	-2.98	<0.01	18	0.02	0.08	0.94	18	0.02	0.07	0.94	18
Hilda	*			↓	-0.55	-1.65	0.10	10	0.49	1.47	0.14	10	0.09	0.27	0.79	10
Jarvis	* *			↓	-0.24	-0.94	0.35	16	-0.44	-1.92	0.06	20	-0.57	-2.50	0.01	20
Lac La Biche, E. Basin	ns	↔			-0.13	-0.38	0.70	10	0.08	0.24	0.81	10	-0.20	-0.60	0.55	10
Long (near Boyle)	* *			↓	-0.68	-3.17	<0.01	23	0.23	1.15	0.25	26	0.08	0.42	0.68	26
Marie	~ns		↑		-0.07	-0.22	0.83	10	-0.06	-0.17	0.87	9	-0.40	-1.13	0.26	9
McLeod, East Basin	ns	↔			-0.27	-1.13	0.26	17	0.06	0.27	0.79	24	0.32	1.53	0.13	24
Miquelon	* *			↓	-1.00	-2.00	0.05	5	-0.87	-2.45	0.01	9	-0.72	-2.03	0.04	9
Moonshine	ns	↔			-0.40	-1.64	0.10	18	0.11	0.53	0.59	24	0.05	0.26	0.80	24
Moore (Crane)	ns	↔			0.82	2.45	0.01	10	-0.53	-1.49	0.14	9	-0.48	-1.37	0.17	9
Moose	* *			↓	-0.70	-3.03	<0.01	20	-0.01	-0.03	0.98	20	-0.47	-2.05	0.04	20
Nakamun	* *			↓	-0.66	-2.71	0.01	18	-0.24	-0.98	0.33	18	-0.37	-1.53	0.13	18
Newell	ns	↔			-0.37	-0.83	0.41	6	-0.39	-0.96	0.34	7	-0.43	-1.05	0.29	7
North Buck	* *			↓	-0.23	-0.84	0.40	15	-0.38	-1.43	0.15	15	0.04	0.13	0.90	14
Pigeon	~ns		↓		0.10	0.44	0.66	19	-0.47	-2.00	0.05	19	-0.67	-2.84	<0.01	19
Pine	ns	↔			-0.35	-1.55	0.12	20	0.57	2.54	0.01	21	0.31	1.38	0.17	21
Pine Coulee, South	*			↑	0.11	0.31	0.76	9	0.35	0.99	0.32	9	-0.28	-0.80	0.42	9
Reesor	ns	↔			-0.63	-2.81	<0.01	21	-0.40	-1.98	0.05	25	-0.30	-1.45	0.15	25
Saskatoon	* *			↓	-0.95	-4.04	<0.01	19	-0.64	-3.06	<0.01	24	0.11	0.51	0.61	23
Spruce Coulee	---	Insufficient data														
Steele (Cross)	ns	↔			-0.20	-0.57	0.57	9	-0.03	-0.11	0.91	13	-0.46	-1.60	0.11	13
Sturgeon, Main Basin	ns	↔			-0.34	-1.50	0.13	20	-0.27	-1.32	0.19	25	-0.22	-1.09	0.28	25
Sylvan	ns	↔			-0.23	-0.94	0.35	18	-0.23	-0.95	0.34	18	-0.11	-0.44	0.66	18
Thunder	* *			↓	-0.63	-2.81	<0.01	21	-0.29	-1.28	0.20	21	-0.07	-0.33	0.74	21
Travers	~ns		↓		0.02	0.07	0.94	10	0.04	0.13	0.90	10	-0.24	-0.71	0.48	10
Tucker	---	No Data														
Wabamun	* *			↓	-0.62	-3.29	<0.01	29	-0.07	-0.36	0.72	28	0.33	1.75	0.08	29
Winagami	ns	↔			-0.38	-1.63	0.10	19	-0.05	-0.25	0.80	24	0.04	0.20	0.84	24

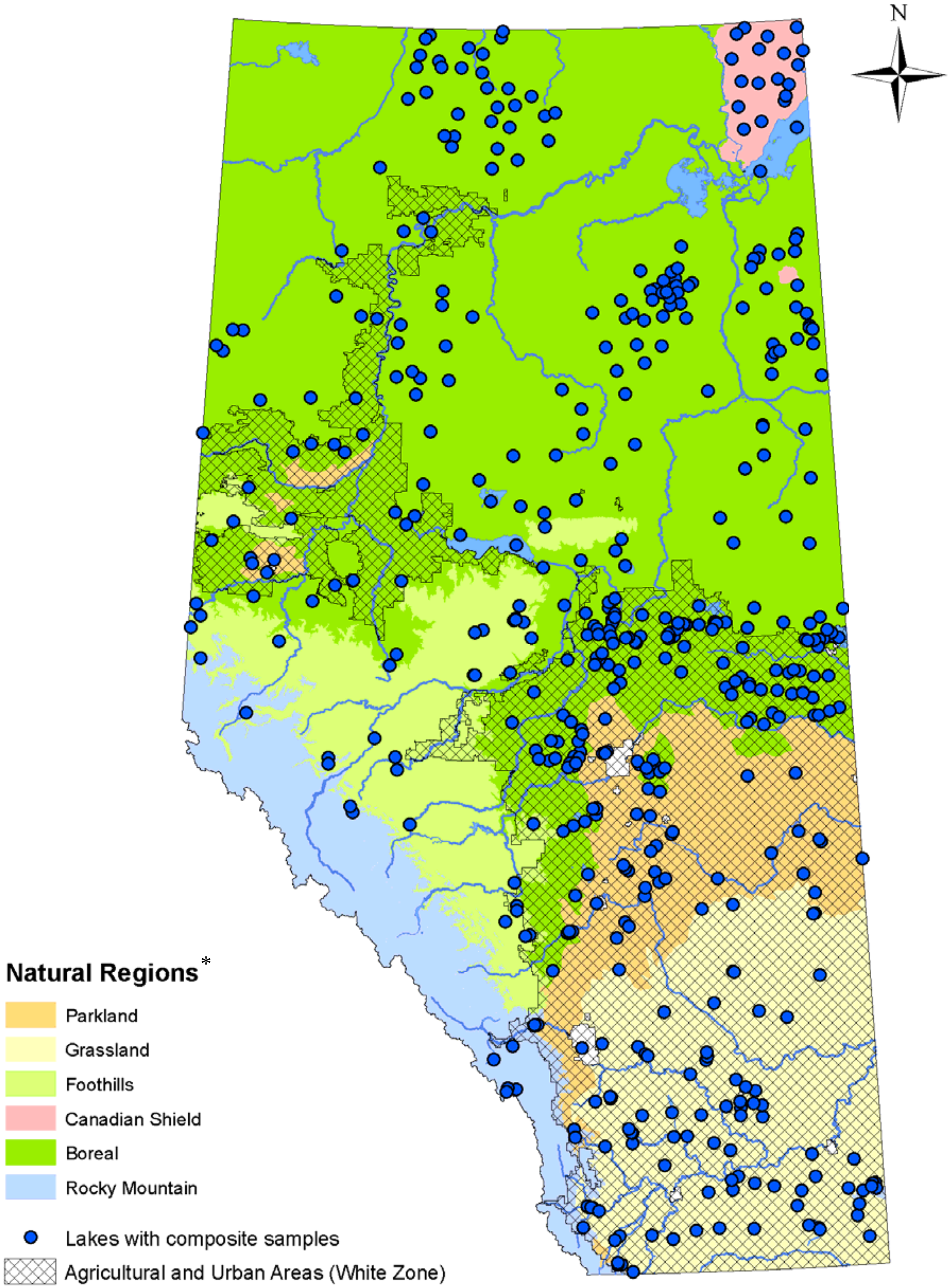
Summary of Correlation Results (n=38)

Lake Level x Water Quality Variable	Total Dissolved Solids No.	%	Total Phosphorus No.	%	Chlorophyll-*a* No.	%
Not Significant (p>0.05)	**24**	63	**31**	82	**32**	84
Statistically Significant (p≤0.05)	**14**	37	**7**	18	**6**	16

Footnotes:
Lake names in bold font are reservoirs
For lakes with two basins, shaded in gray, the basin(s) with the longest water quality sampling record was used
[A] Statistically significant results are shaded in pink (p ≤0.01 = **) or yellow (p >0.01 & ≤0.05 = *); results of no statistcal (ns) difference are not shaded (p >0.05)
[B] For the trend tests, probability values close to statistical significance (~ns) are shaded in blue (p >0.05 & ≤0.15)

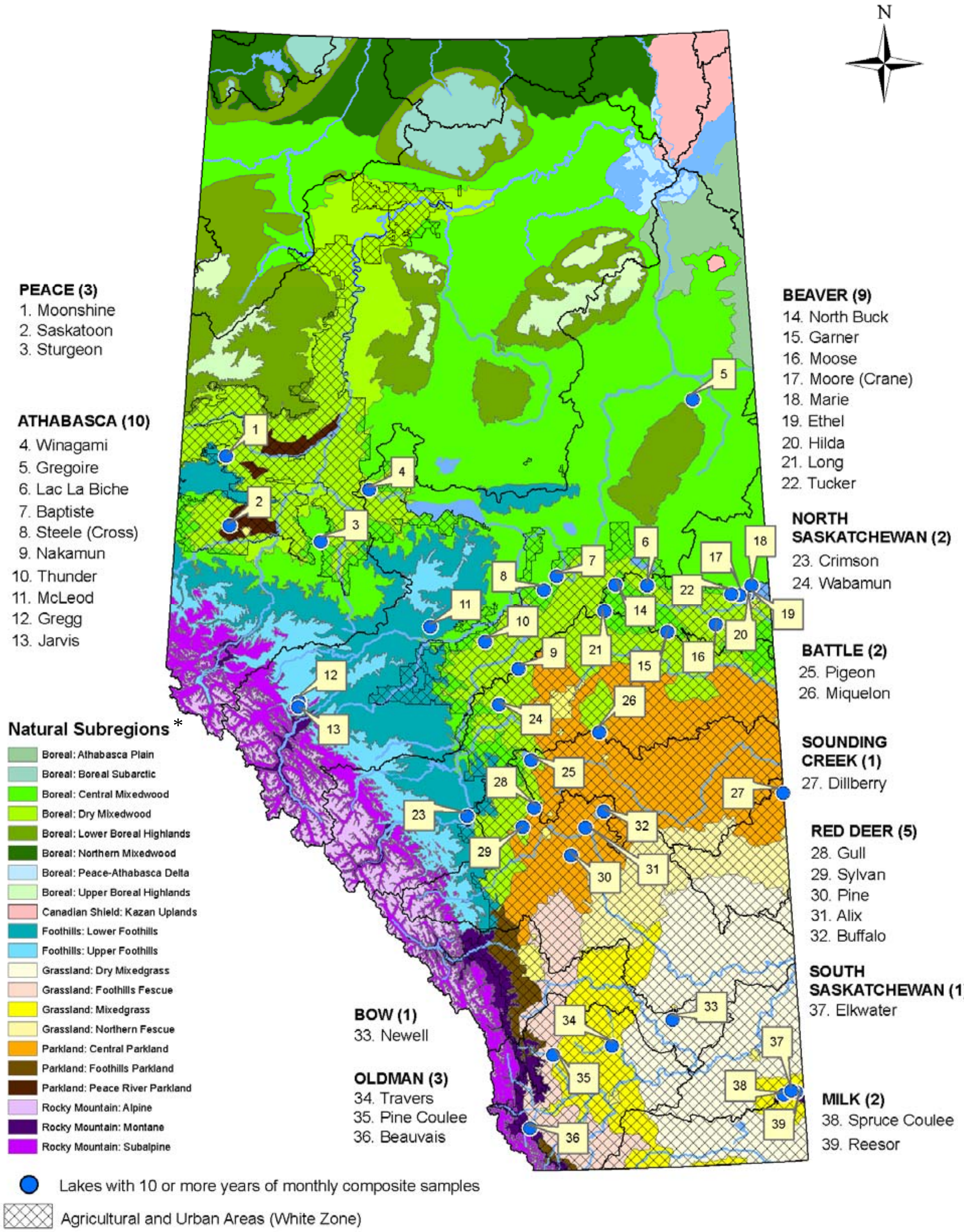
FIGURES

A. LAKES WITH COMPOSITE SAMPLES



* Source: Natural Regions Committee (2006)

Figure 1 Lakes with open-water composite samples taken in Alberta Environment monitoring programs, 1979 to 2009



* Source: Natural Regions Committee (2006)

Figure 2 Lakes with ≥10 years of open-water composite samples taken in Alberta Environment monitoring programs, 1979 to 2009

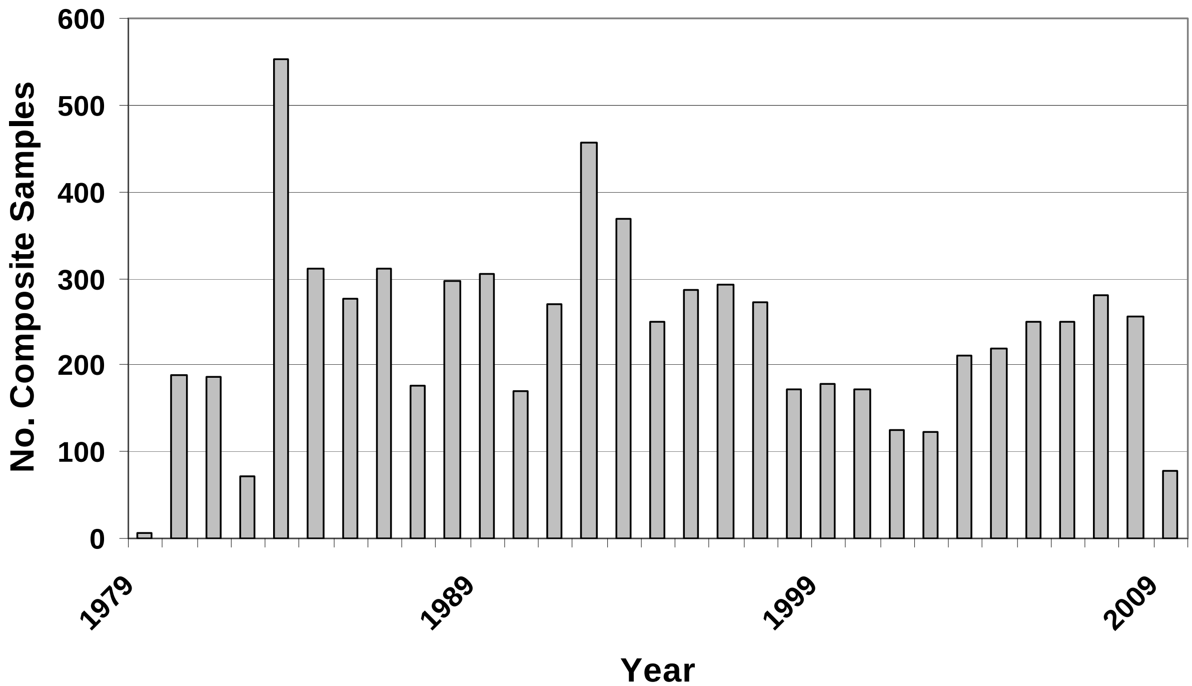


Figure 3 Number of composite samples taken annually in Alberta Environment monitoring programs, 1979 to 2009

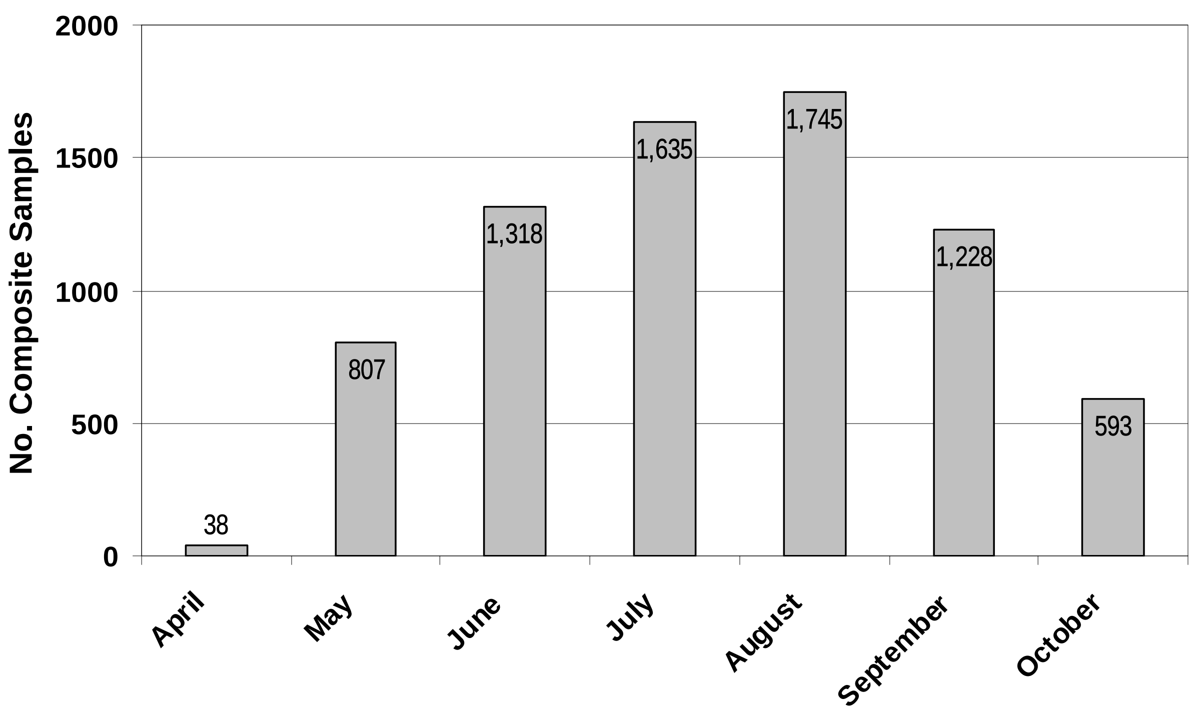


Figure 4 Number of composite samples taken monthly in Alberta Environment monitoring programs, 1979 to 2009. Sample number for each month is shown

B. WATER QUALITY CONDITIONS

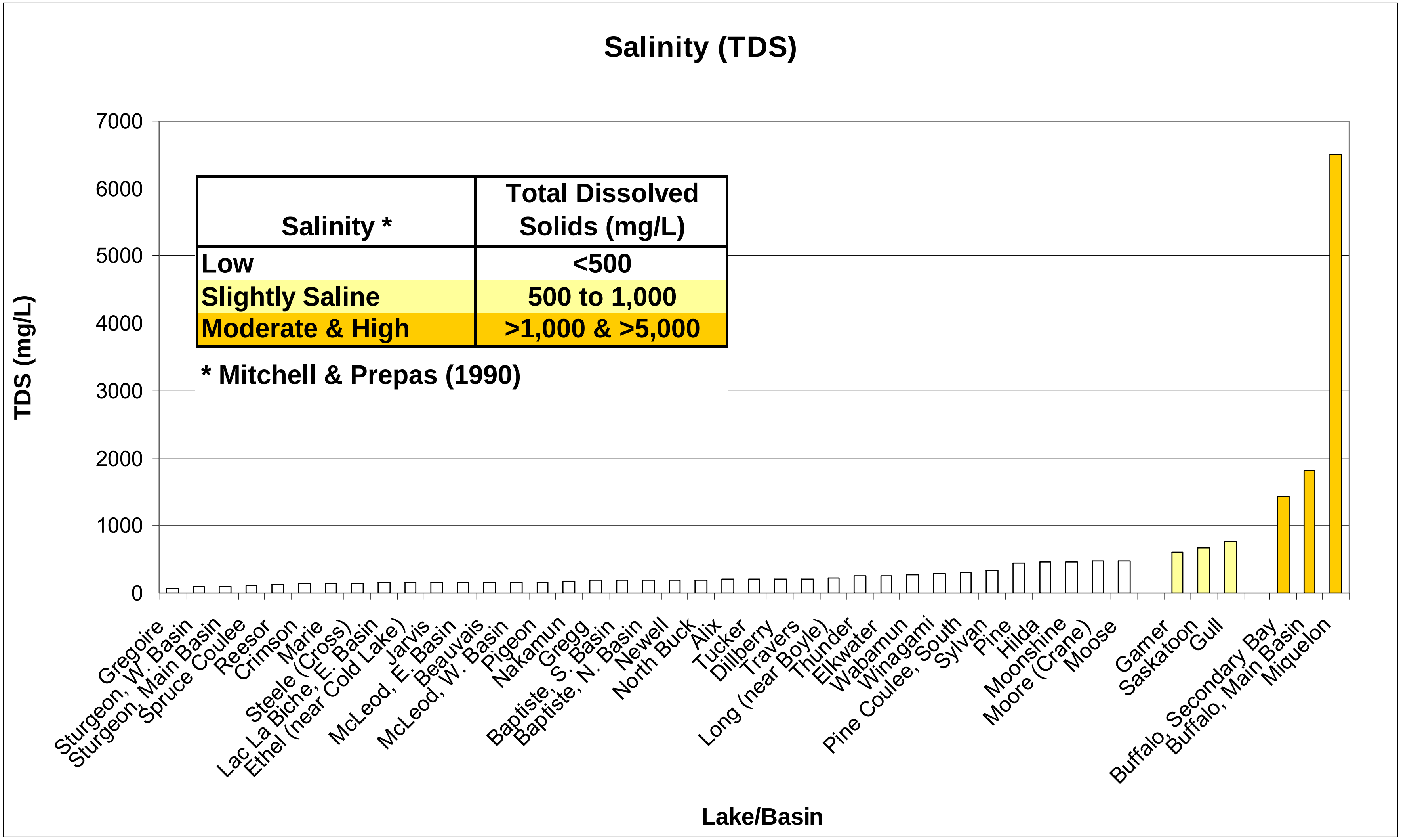


Figure 5 Salinity of the 43 lake basins with ≥10 years of composite samples. Values are based on the average of the annual median total dissolved solids (TDS) concentration in the composite samples, 1979 to 2009

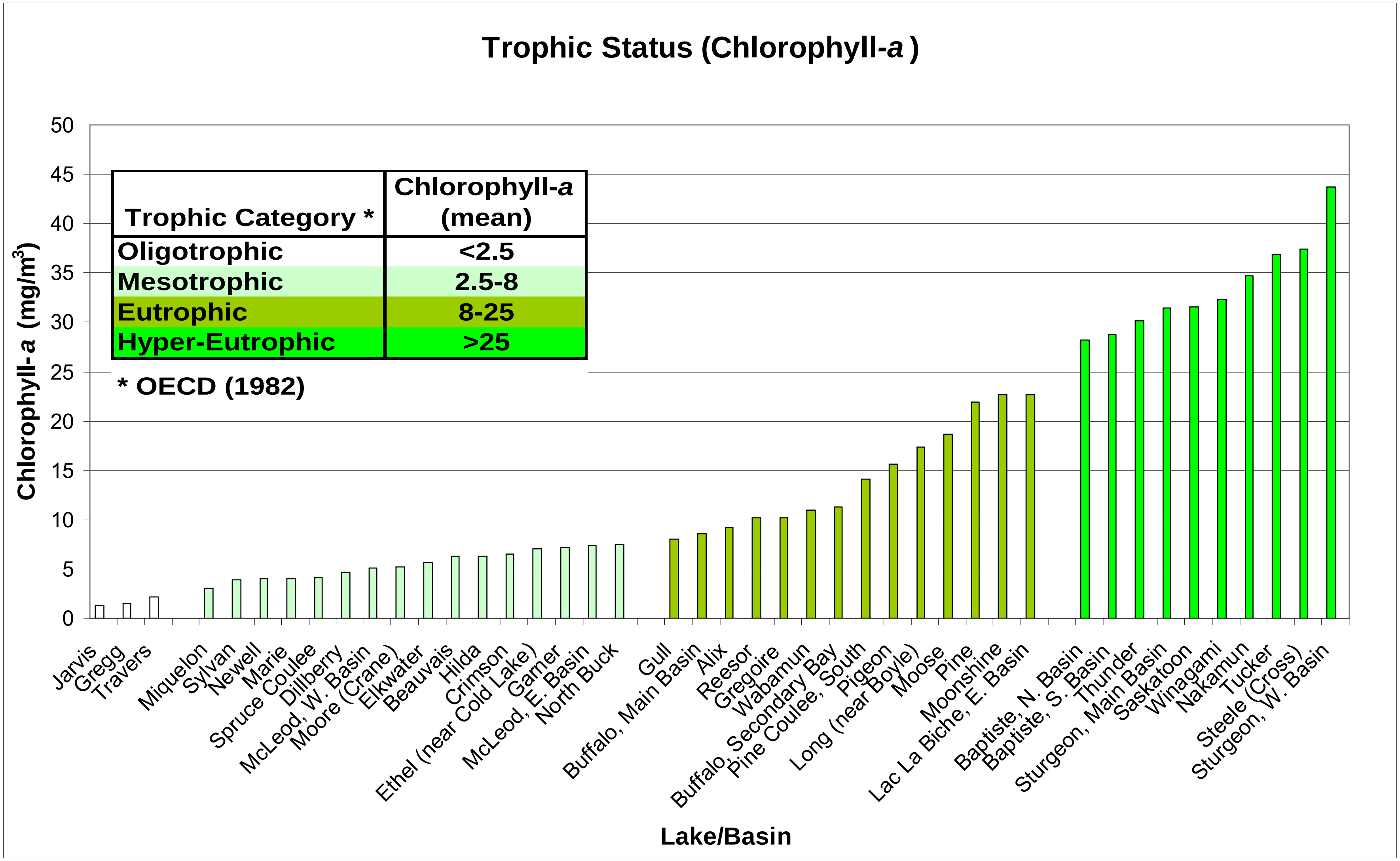


Figure 6 Trophic condition of the 43 lake basins with ≥10 years of composite samples. Values are based on the average of the annual median chlorophyll-*a* concentration in the composite samples, 1979 to 2009

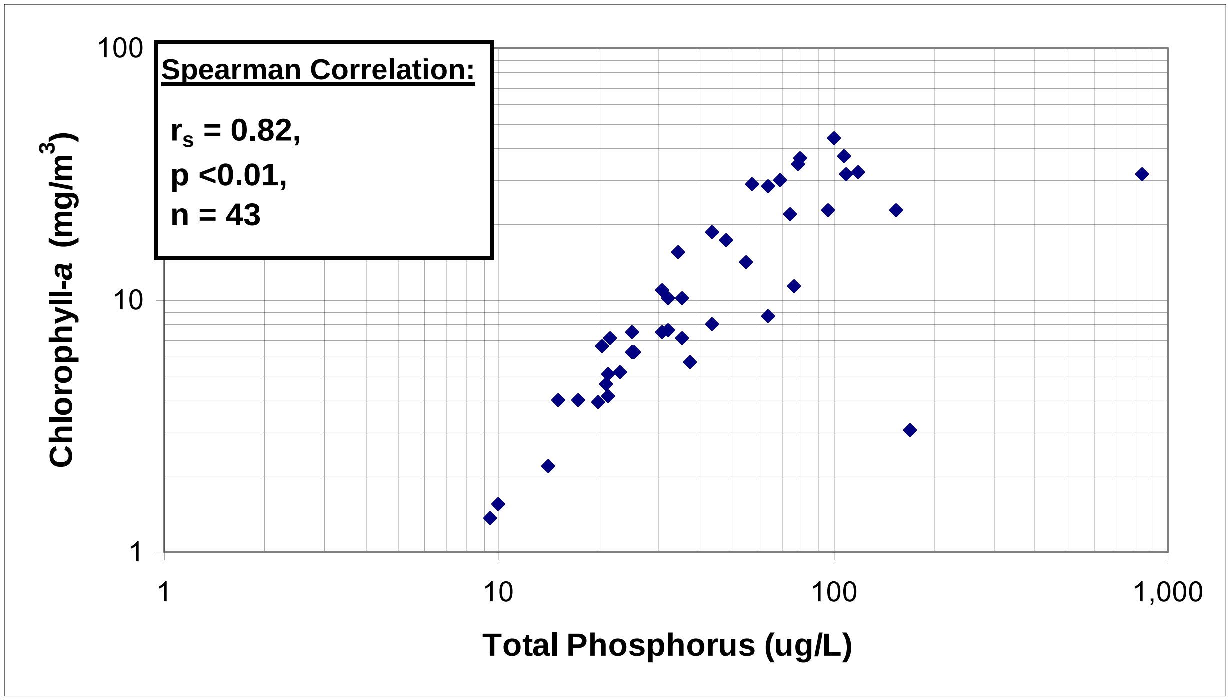


Figure 7a Correlation between total phosphorus and chlorophyll-*a* (log scale) in the lake basins. Each datum is based on the average of the annual median concentration in the samples, 1979 to 2009

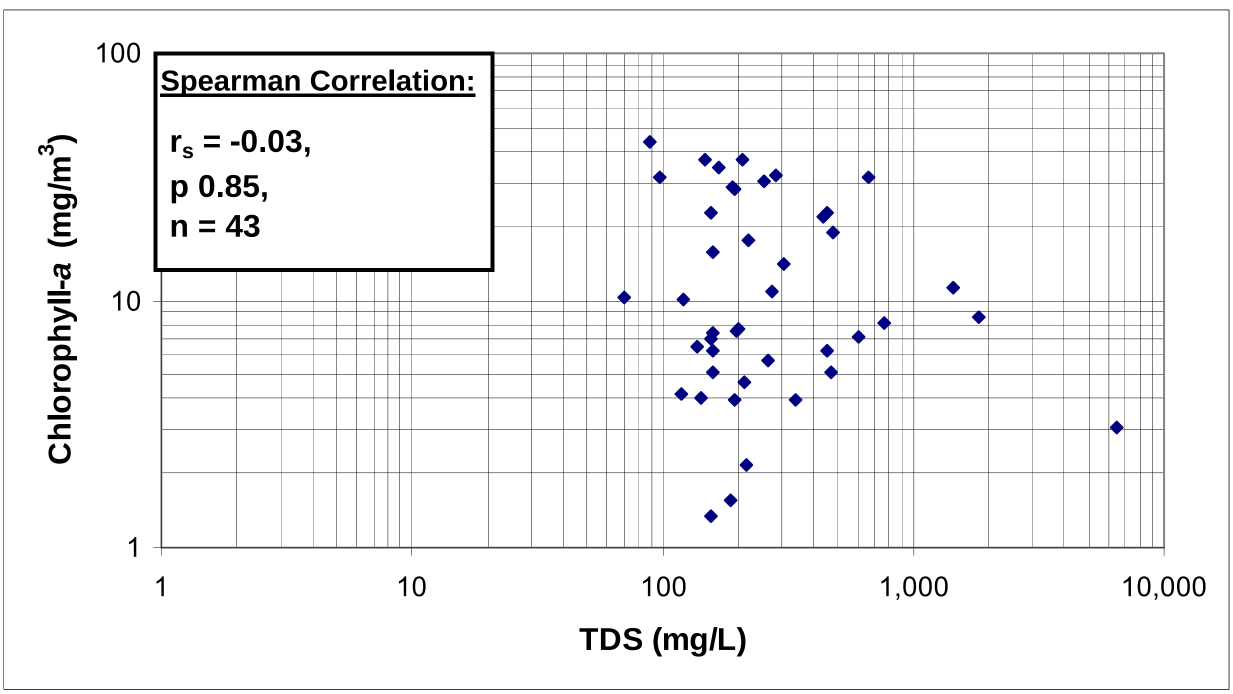


Figure 7b Correlation between chlorophyll-*a* and total dissolved solids (log scale) in the lake basins. Each datum is based on the average of the annual median concentration in the samples, 1979 to 2009

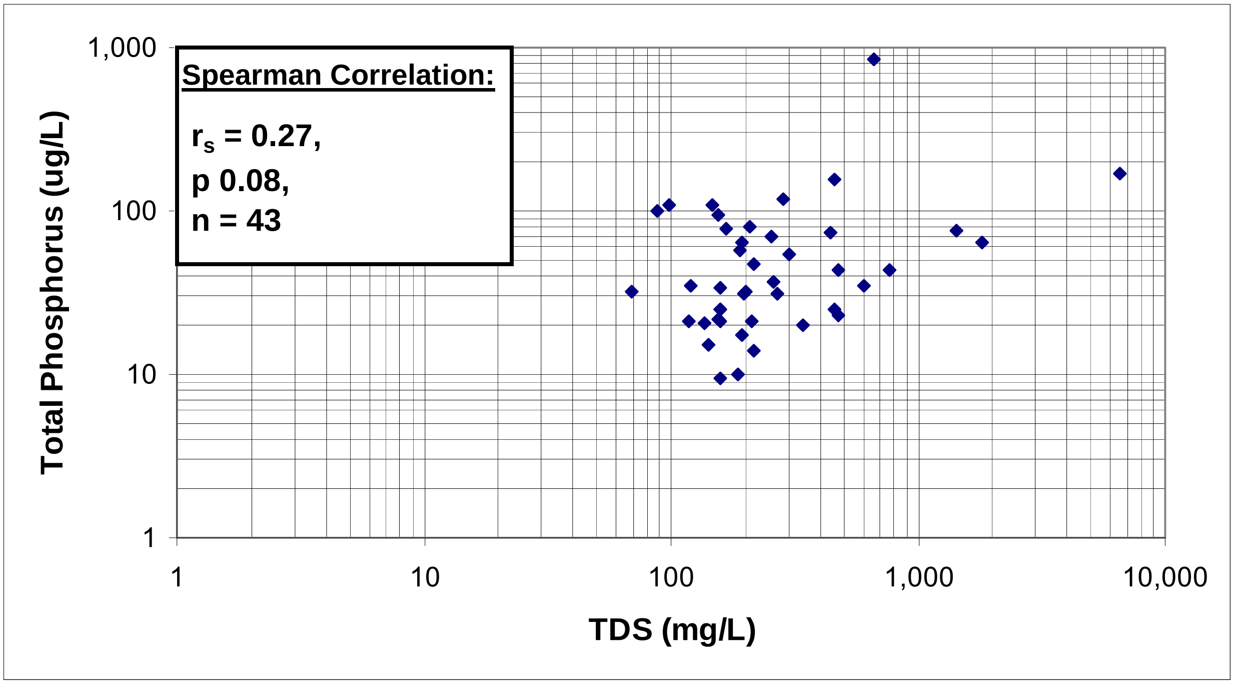
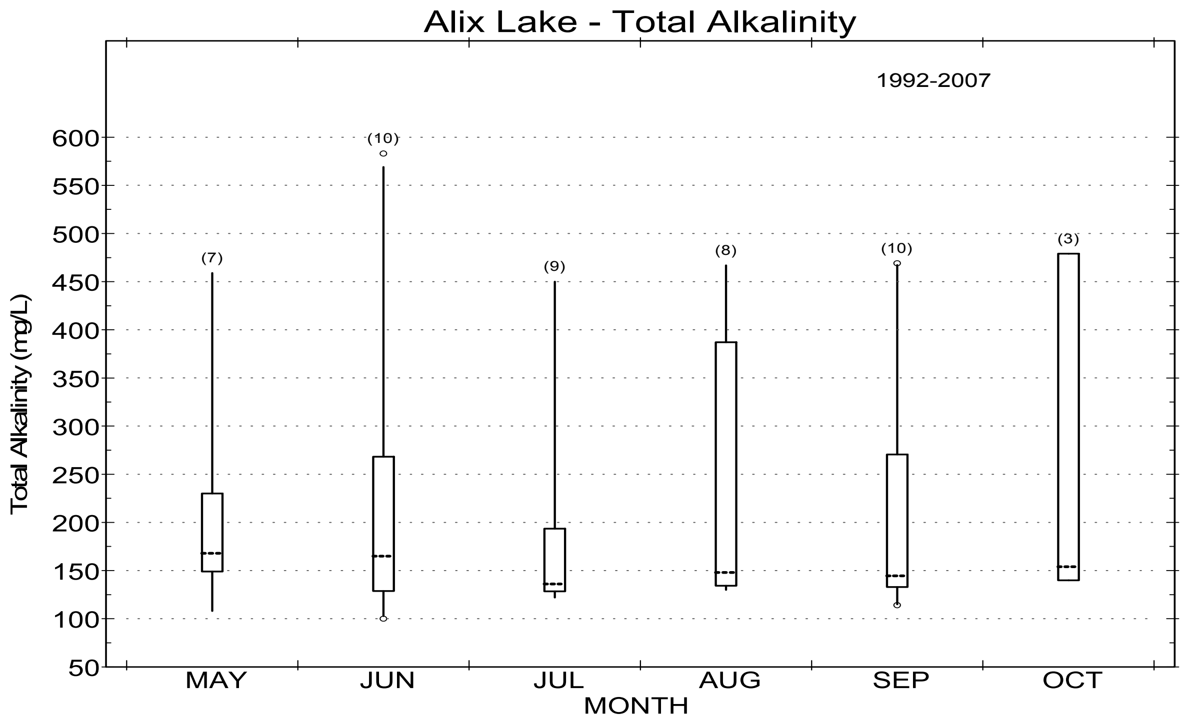


Figure 7c Correlation between total phosphorus and total dissolved solids (log scale) in the lake basins. Each datum is based on the average of the annual median concentration in the samples, 1979 to 2009

C. SEASONALITY IN WATER QUALITY

This section includes box and whisker plots of monthly samples for the water quality variables in the 43 lake basins. Lakes are listed in alphabetical order. Each box plot delineates the 75-th and 25-th percentiles around the median (horizontal line), vertical lines show the 90-th and 10-th percentiles, and open circles show the remaining data. Sample number is shown in brackets above each box plot. Each graph of the water quality variables shows the sample record span and select statistical probability results (p) of the Kruskal-Wallis test (K-W). Only some categories statistical probability (p) are shown (e.g., when p > 50, 75, 95 or 99%), but the actual p values are in Tables 3, 4 and 5. See Section 2.3 for more detail.



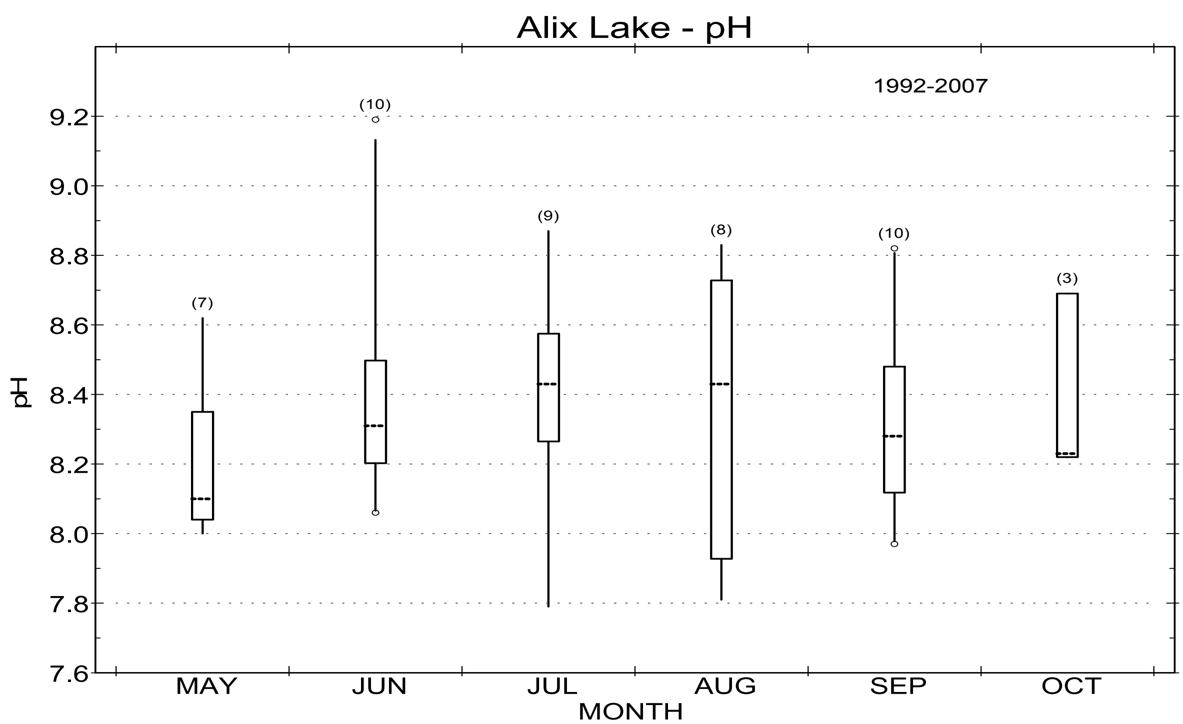
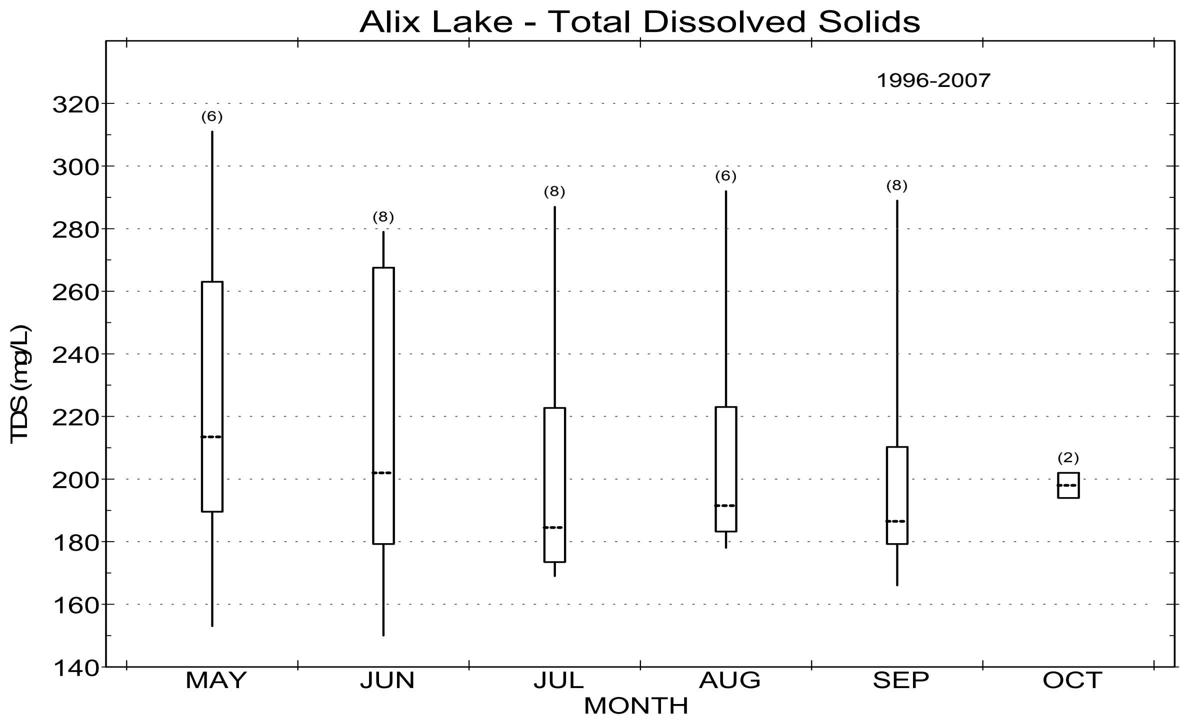


Figure 8 **Alix Lake –** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



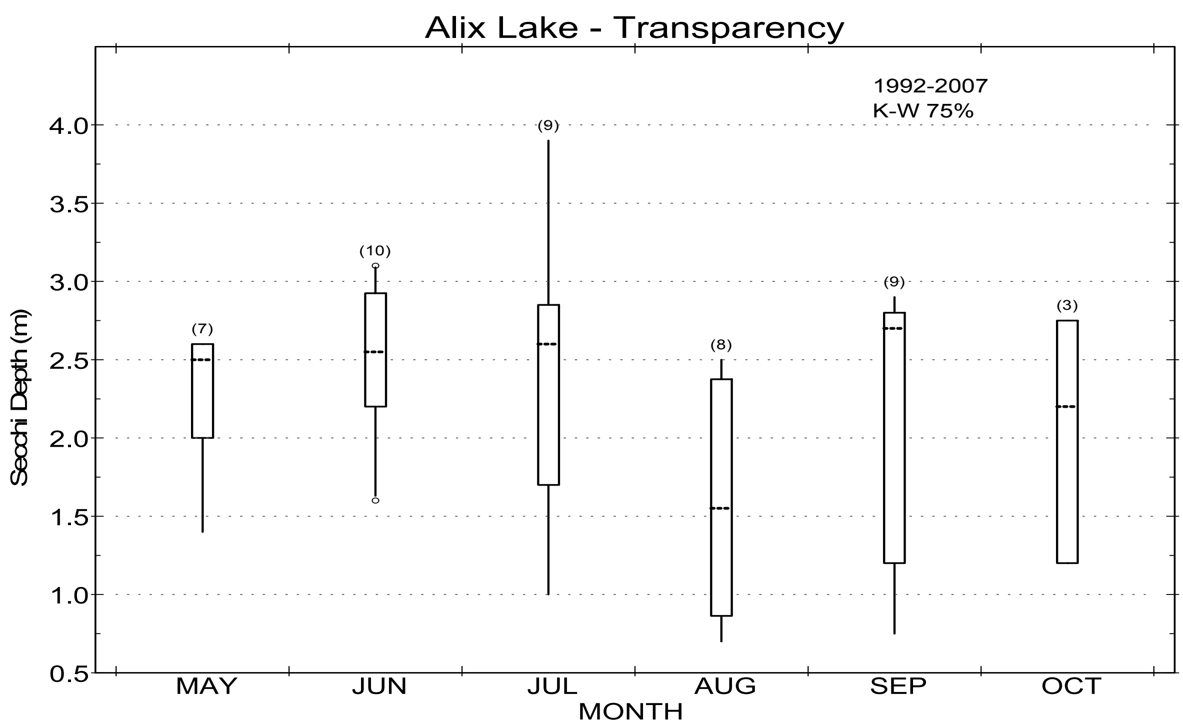
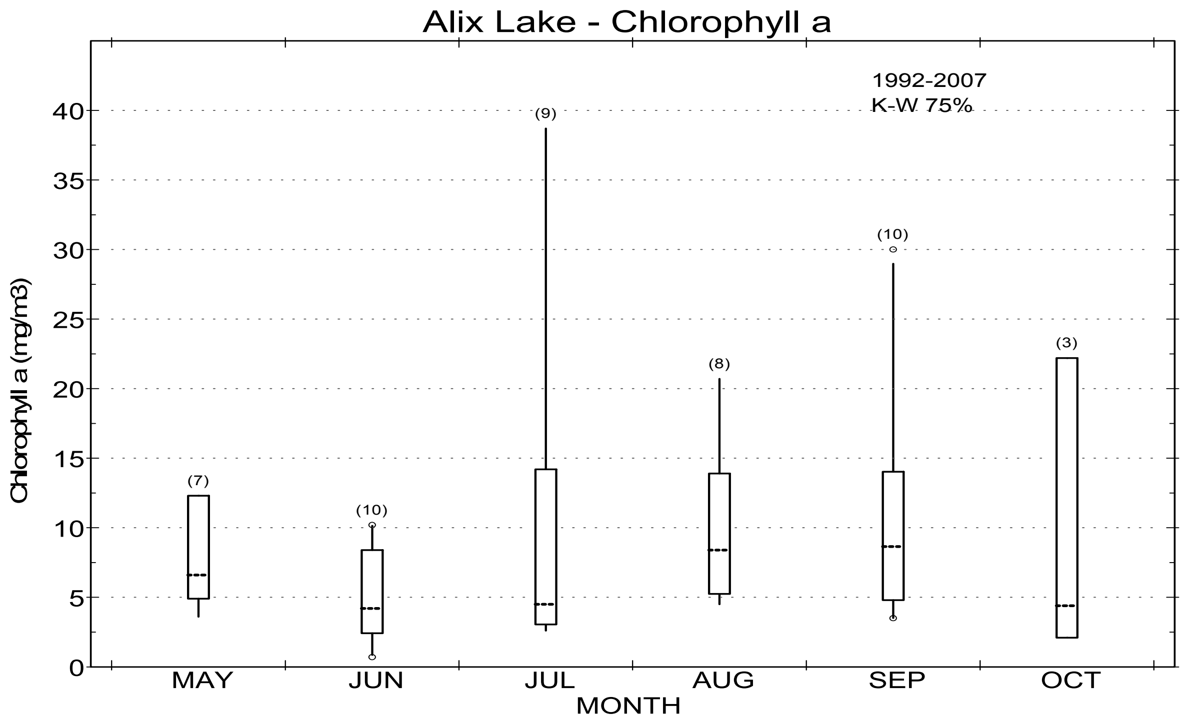


Figure 8 **Alix Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



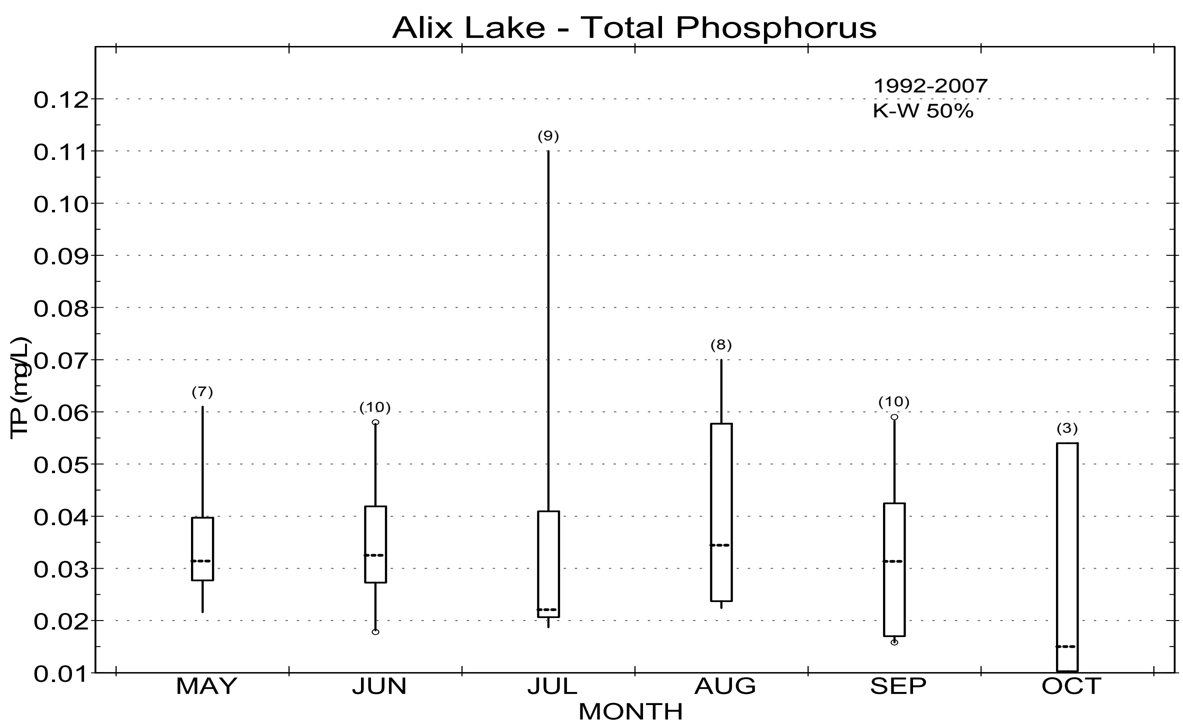
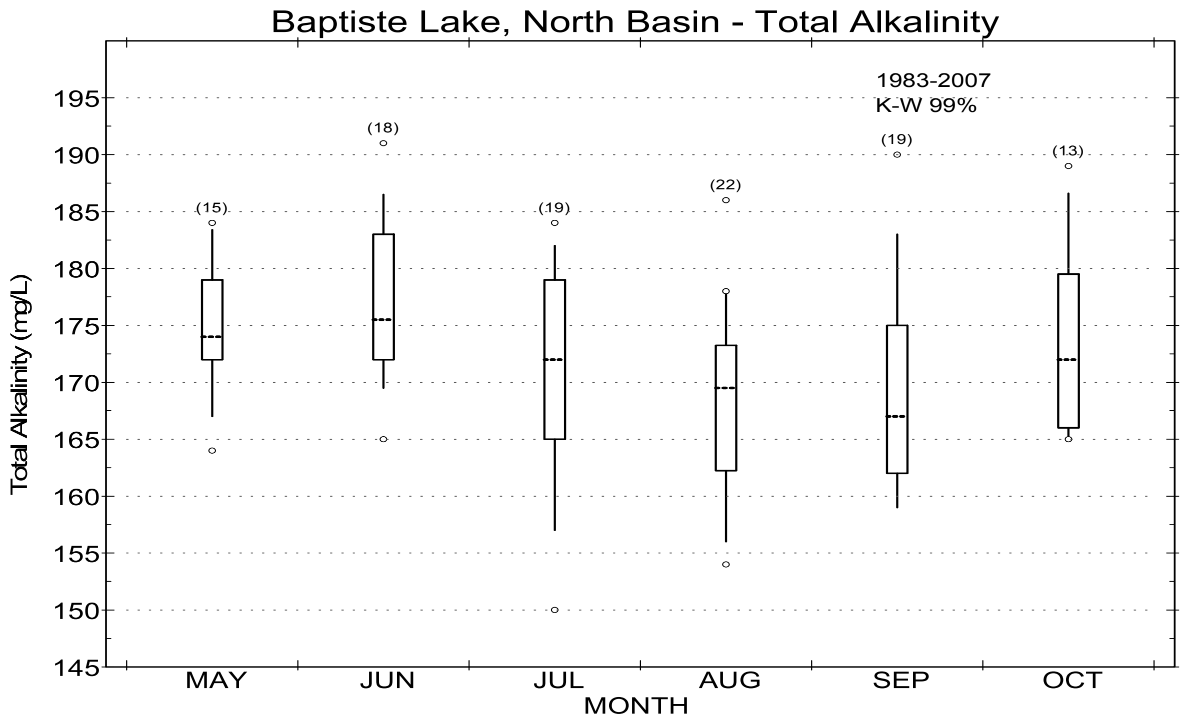


Figure 8 **Alix Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



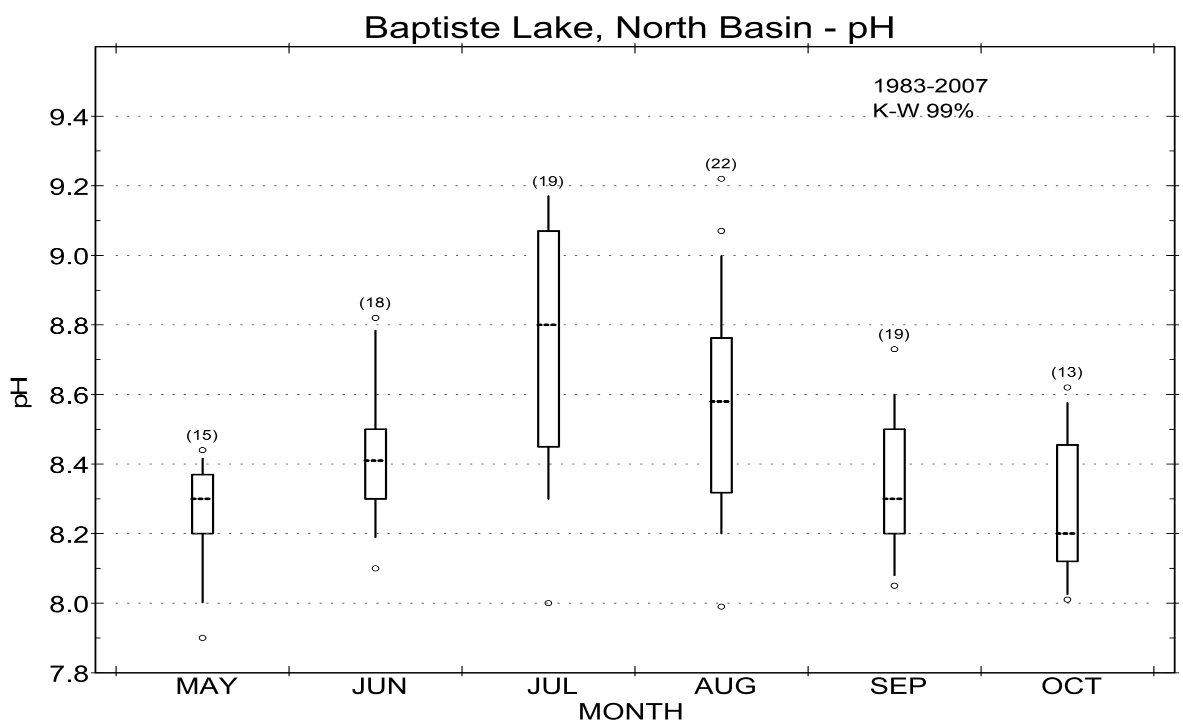
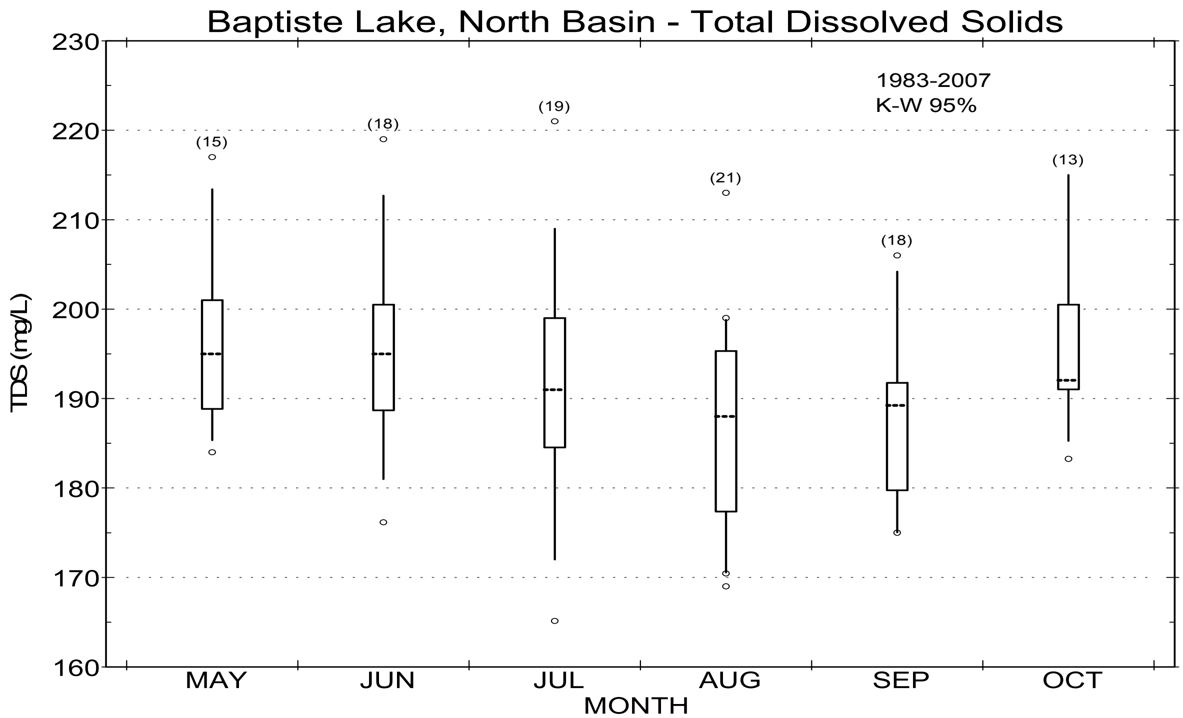


Figure 9a **Baptiste Lake, North Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



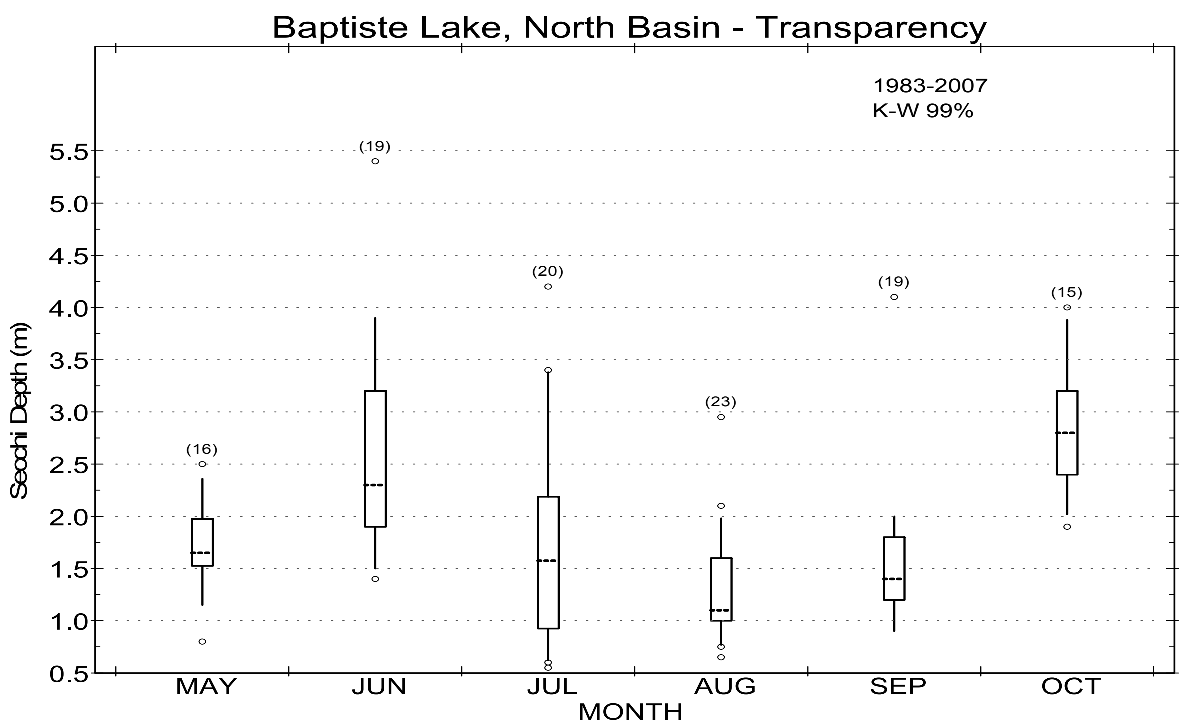
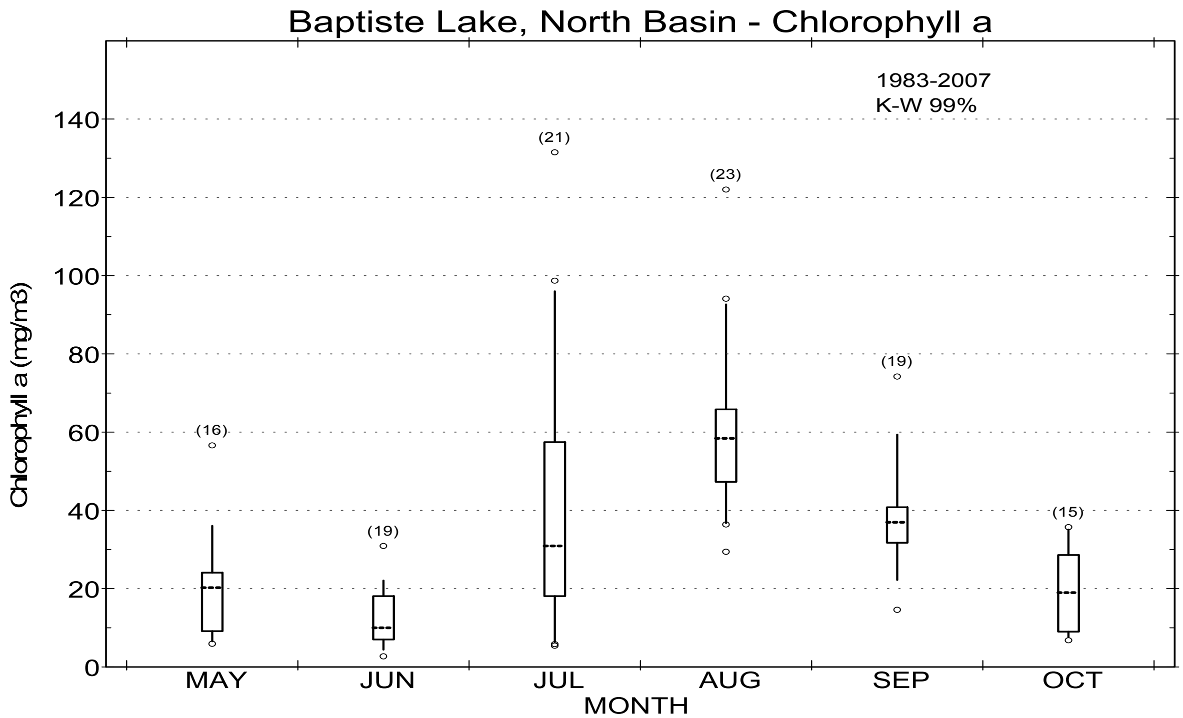


Figure 9a **Baptiste Lake, North Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



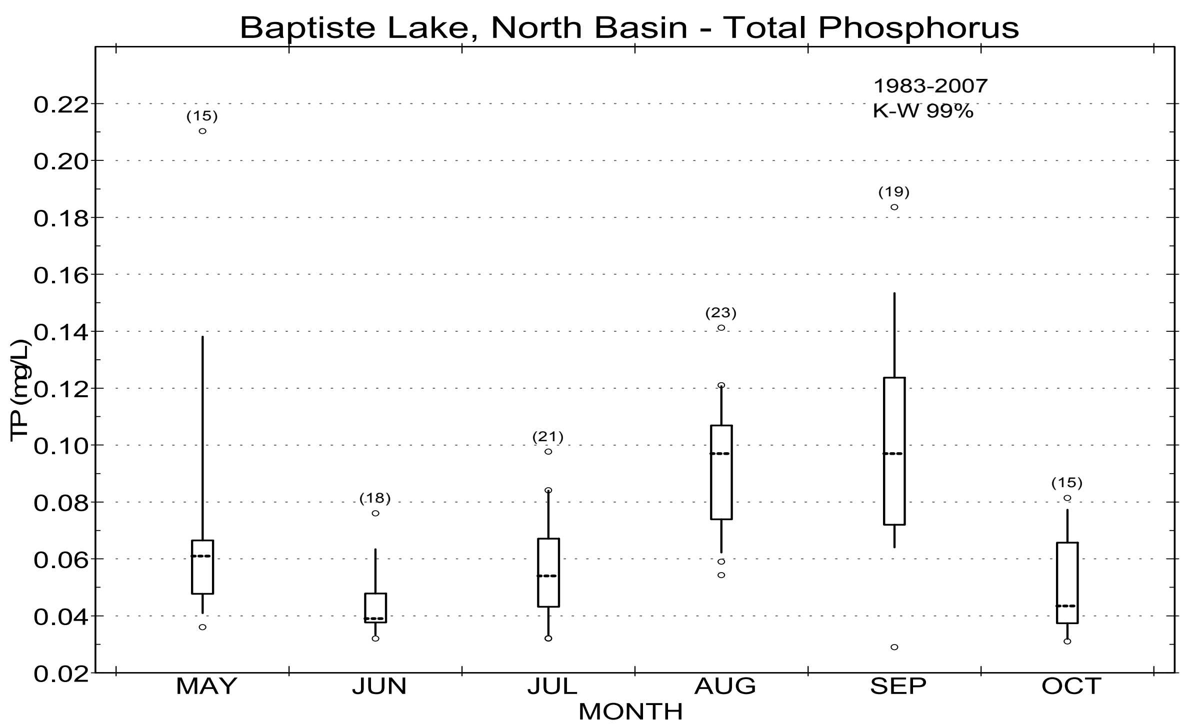
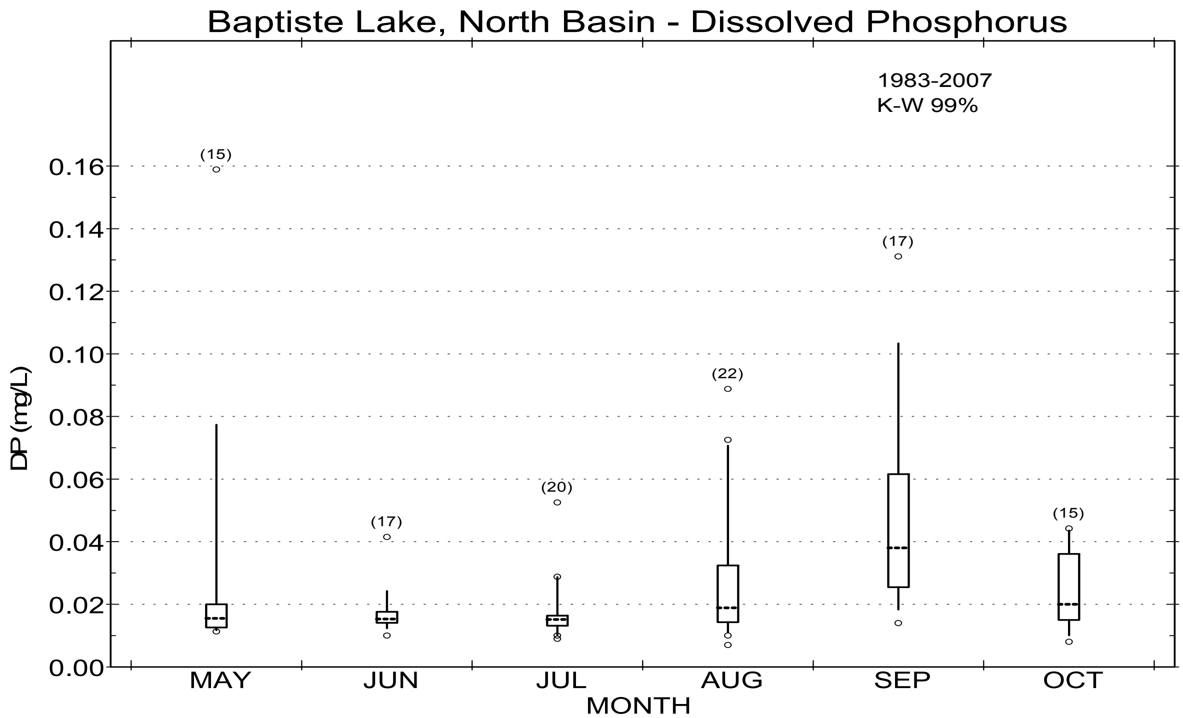


Figure 9a **Baptiste Lake, North Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



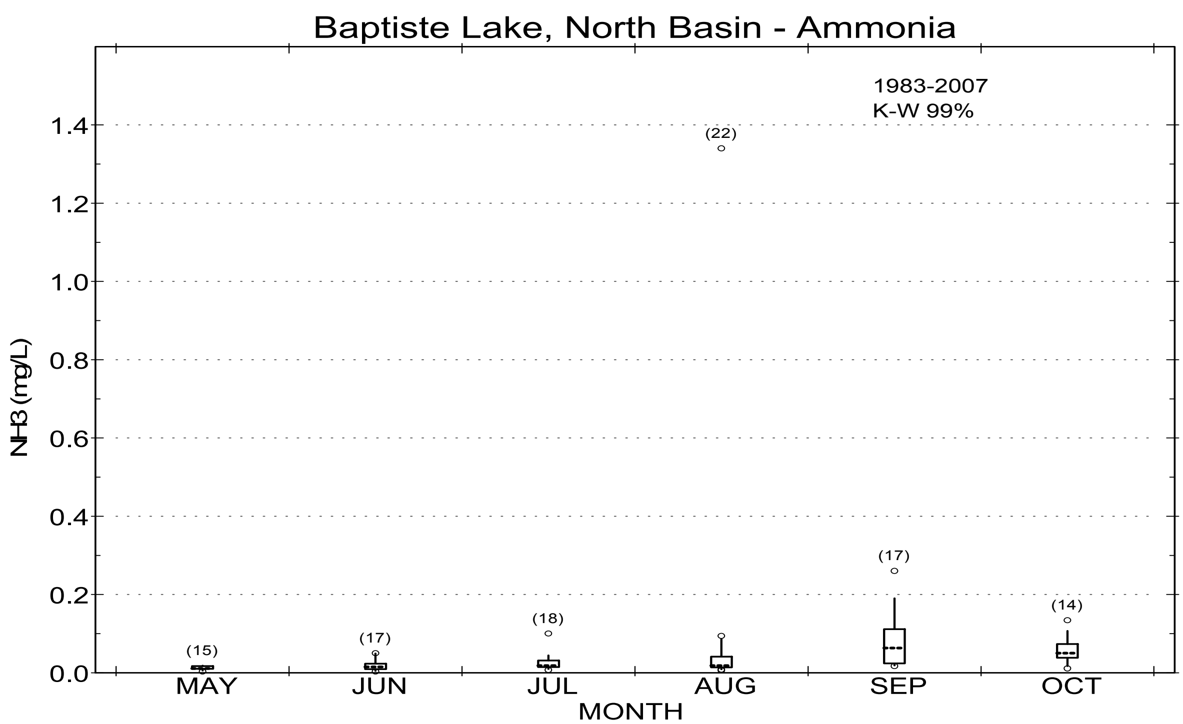
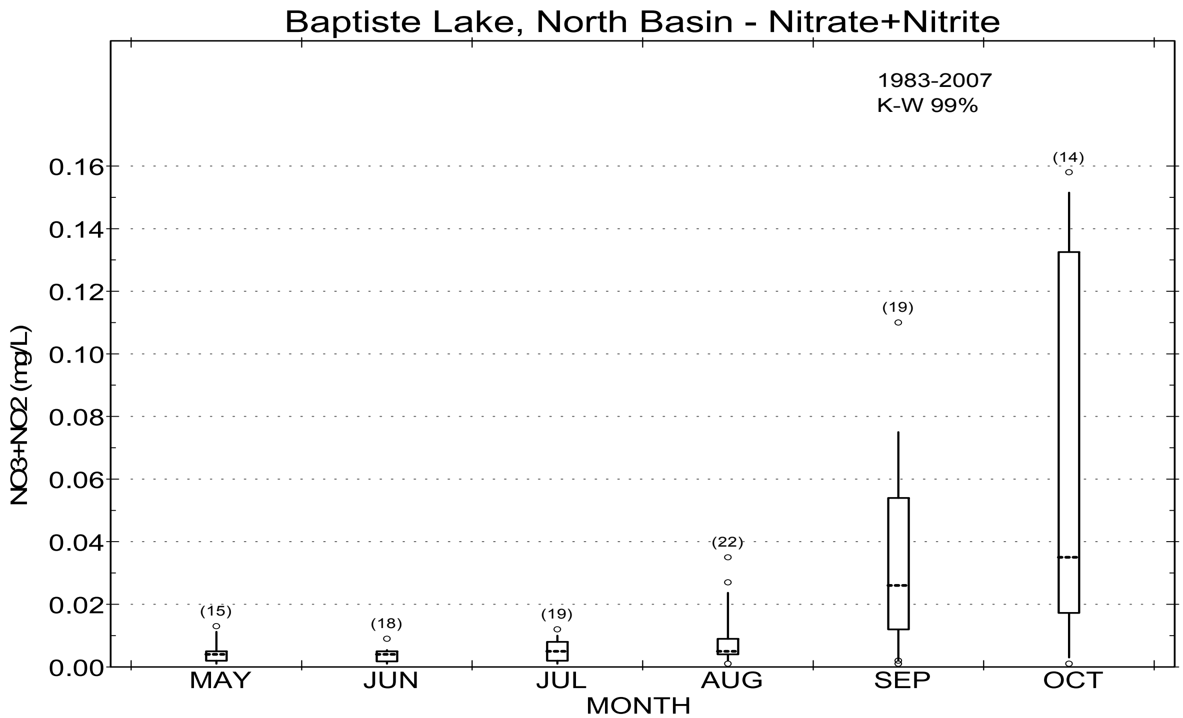


Figure 9b **Baptiste Lake, North Basin -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month



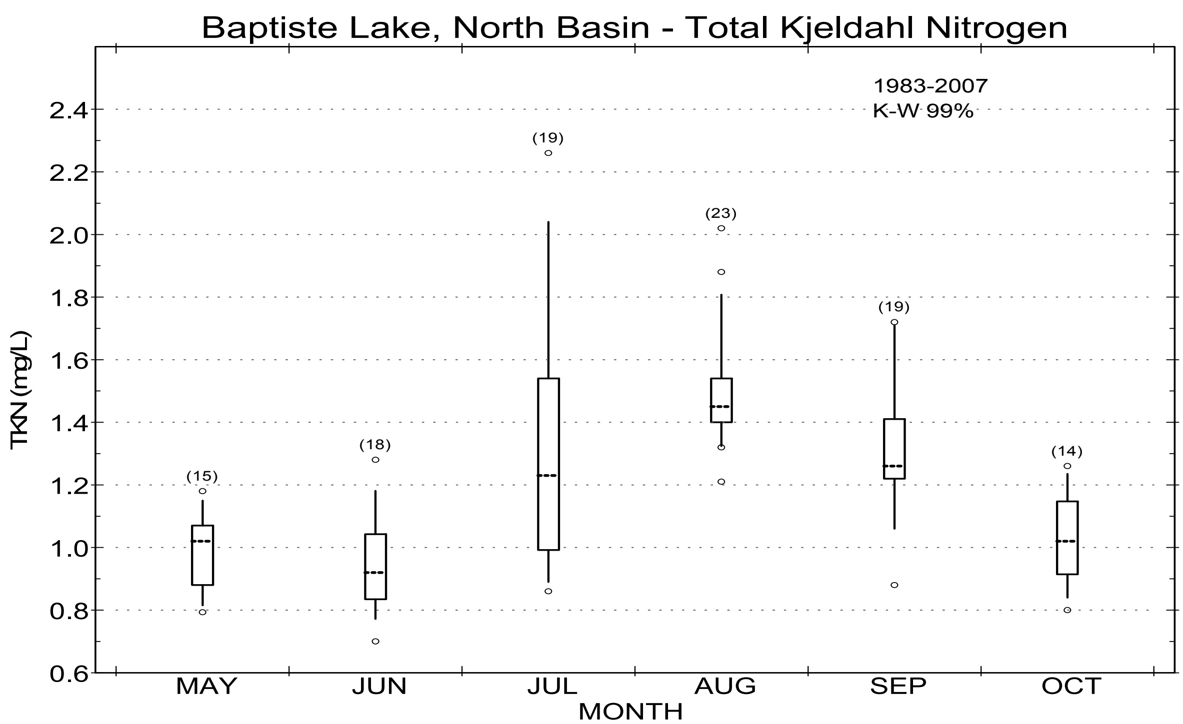
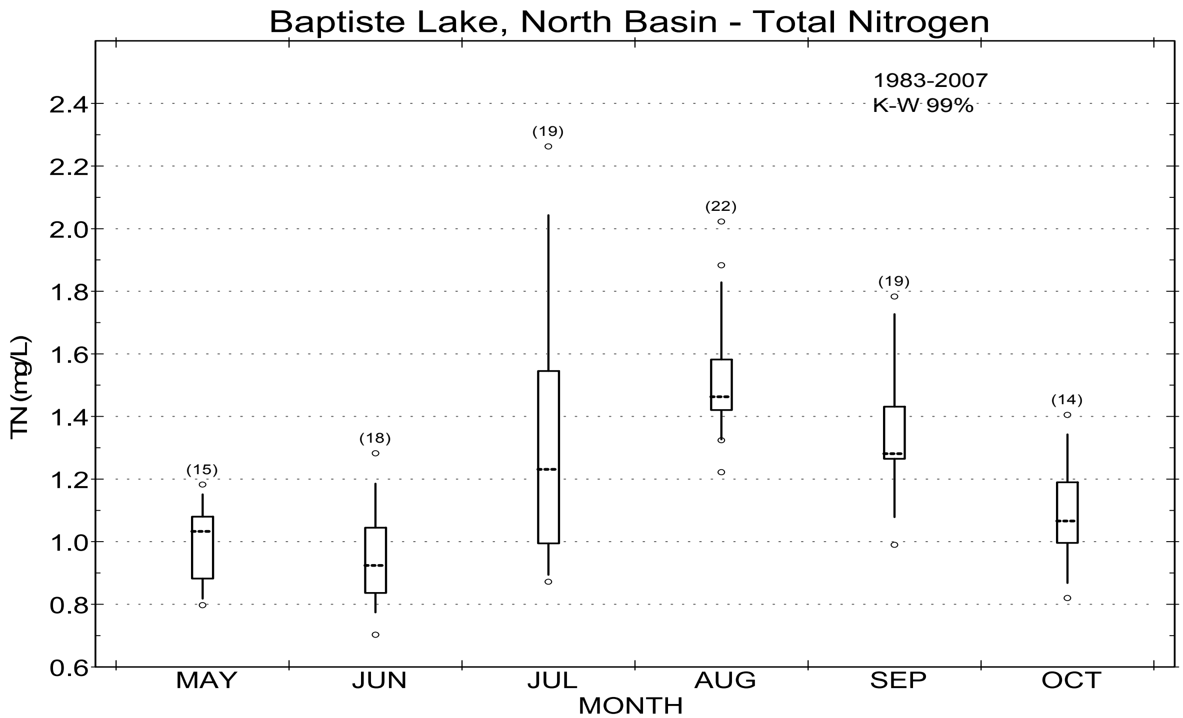


Figure 9b **Baptiste Lake, North Basin -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)



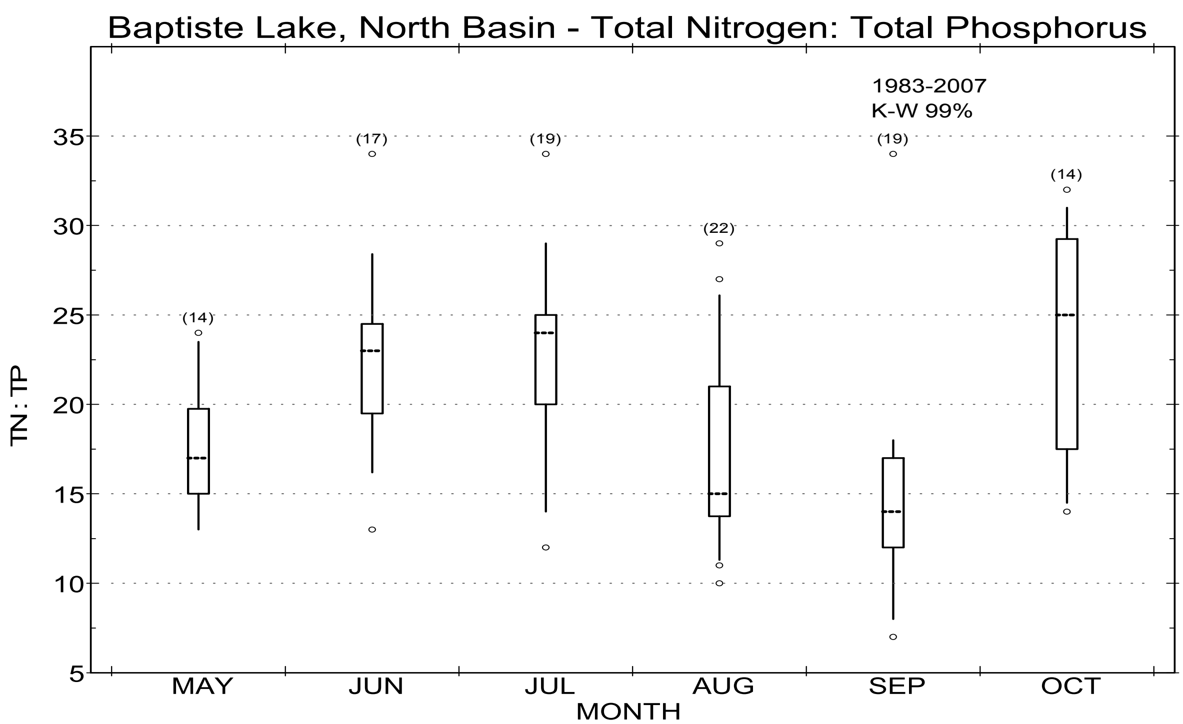
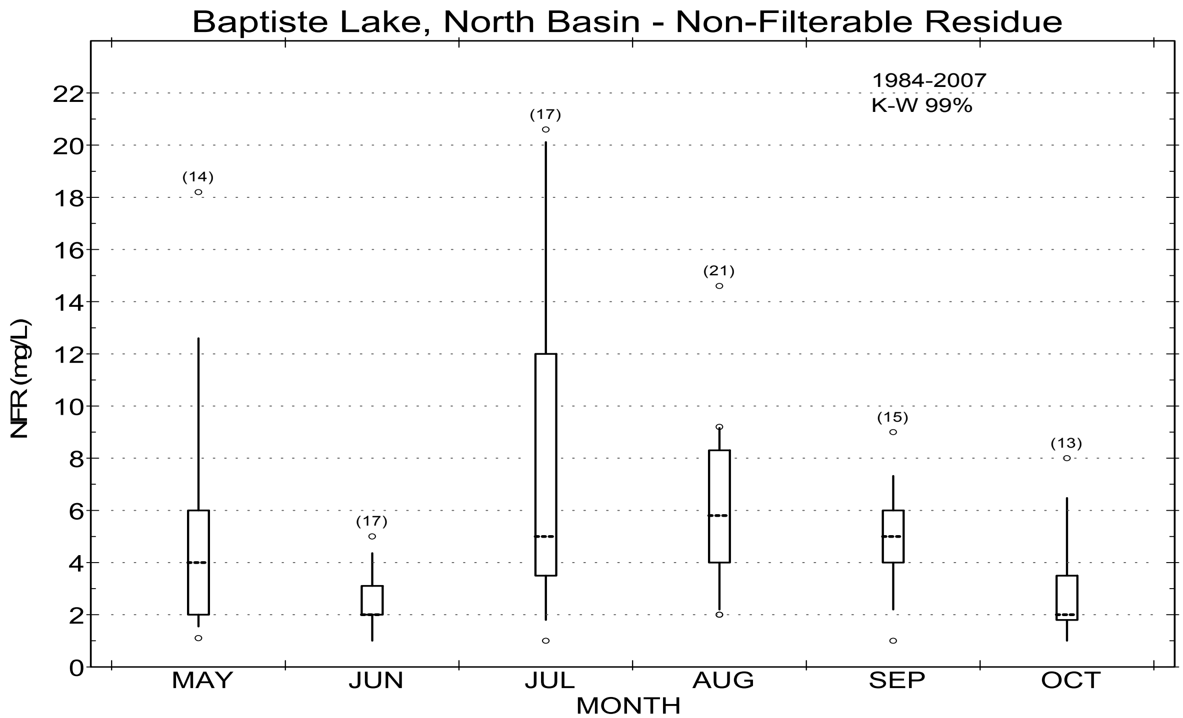


Figure 9b **Baptiste Lake, North Basin -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)



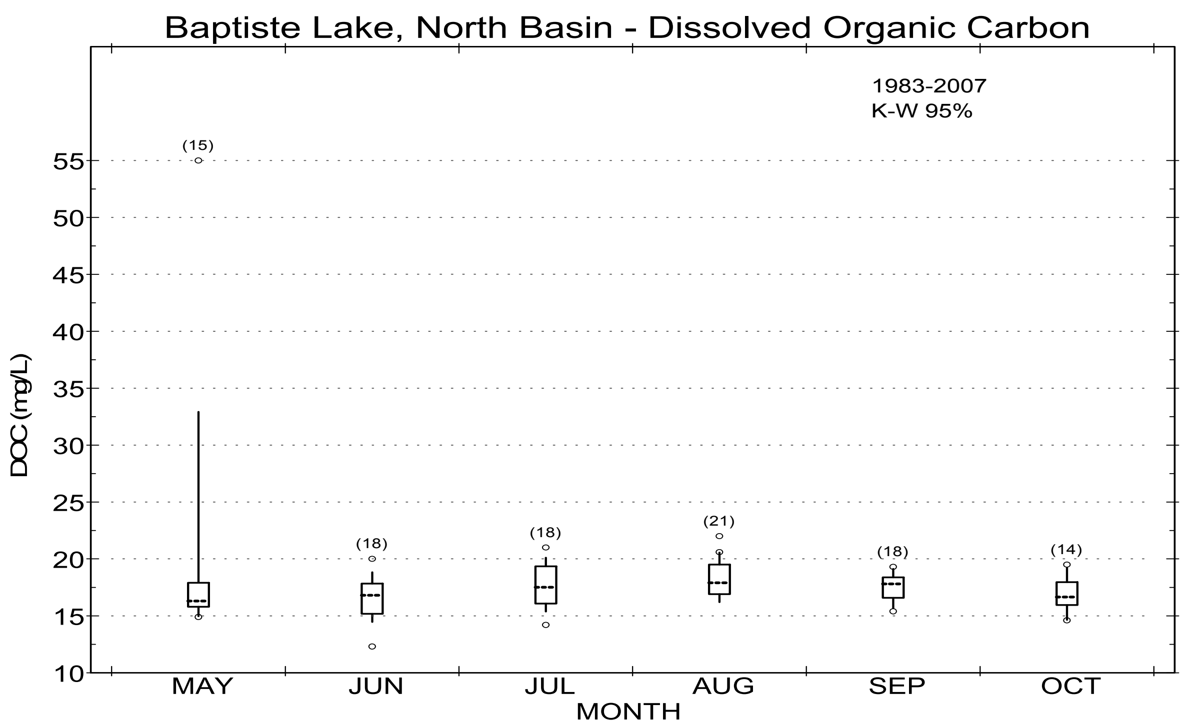


Figure 9b **Baptiste Lake, North Basin -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)

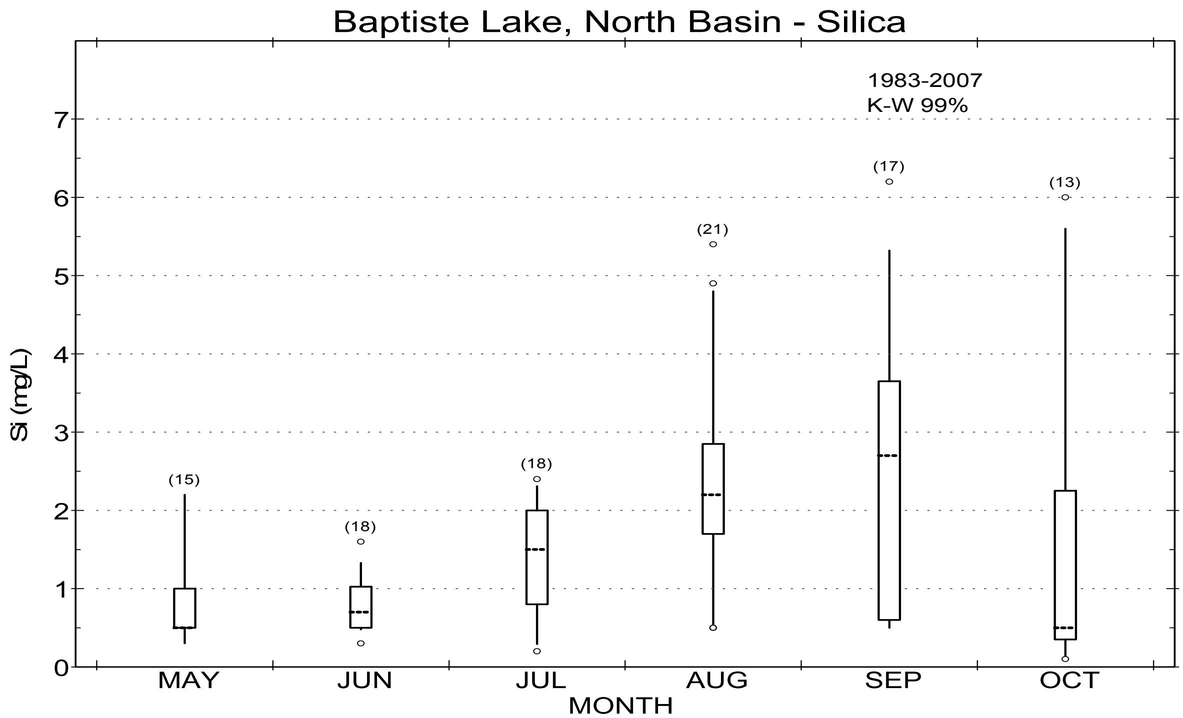
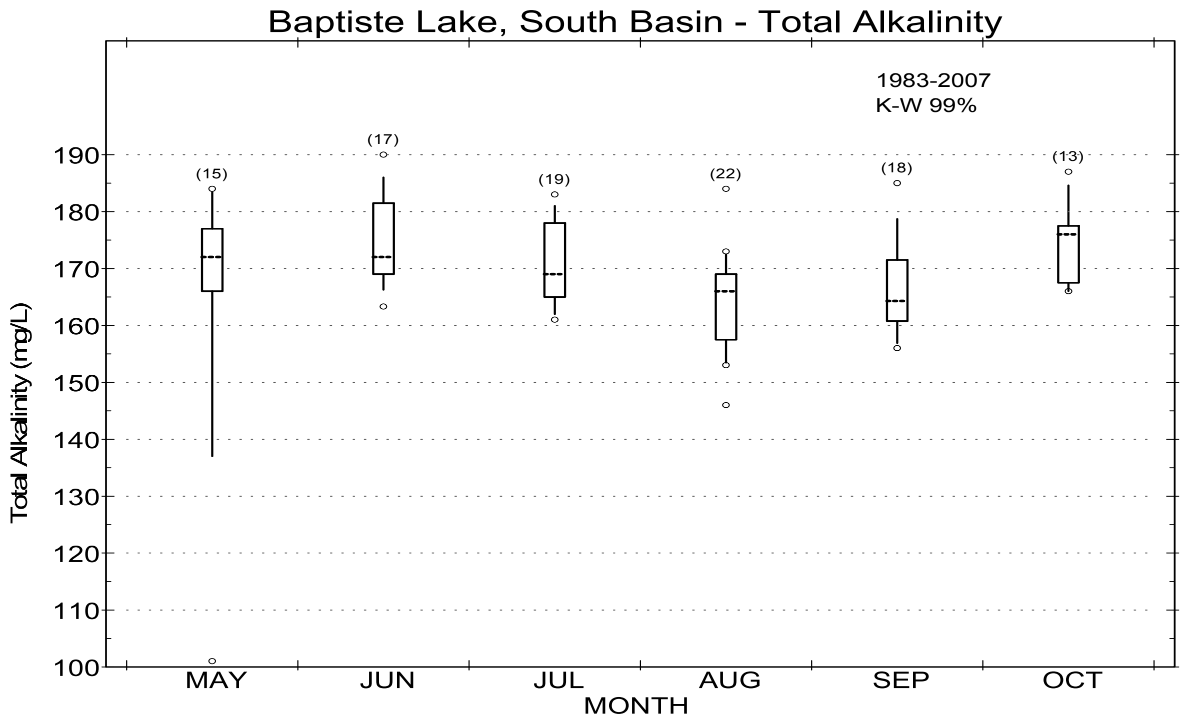


Figure 9b **Baptiste Lake, North Basin -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (concluded)



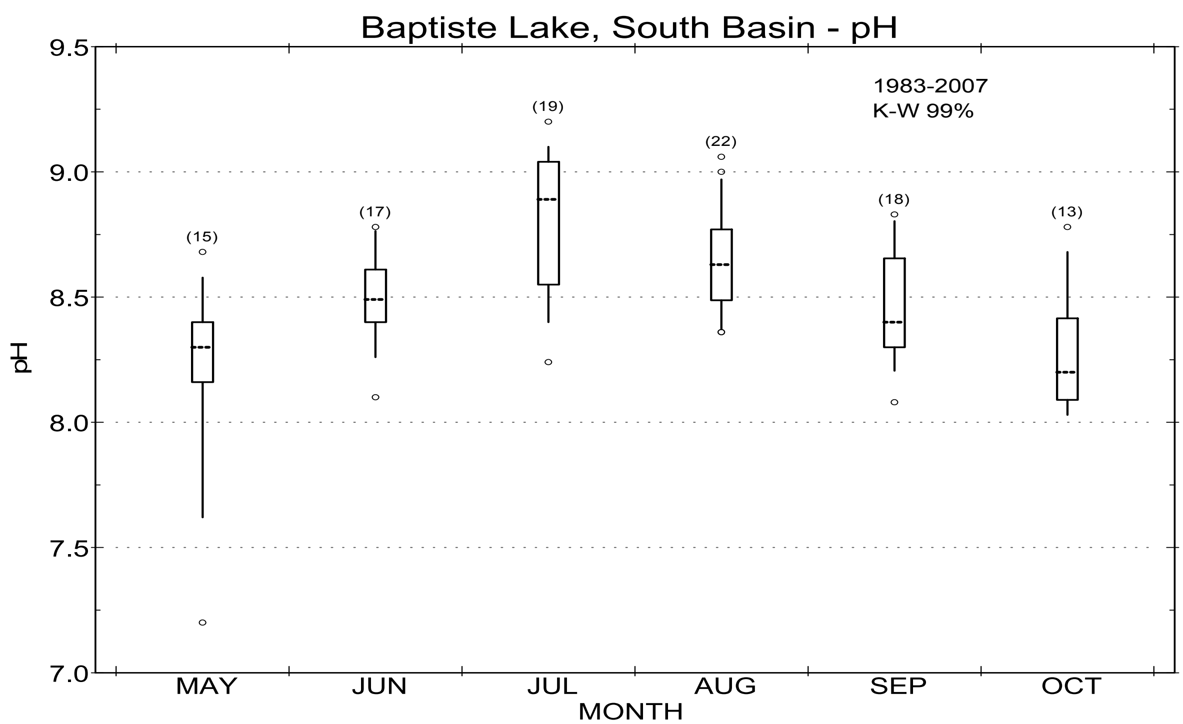
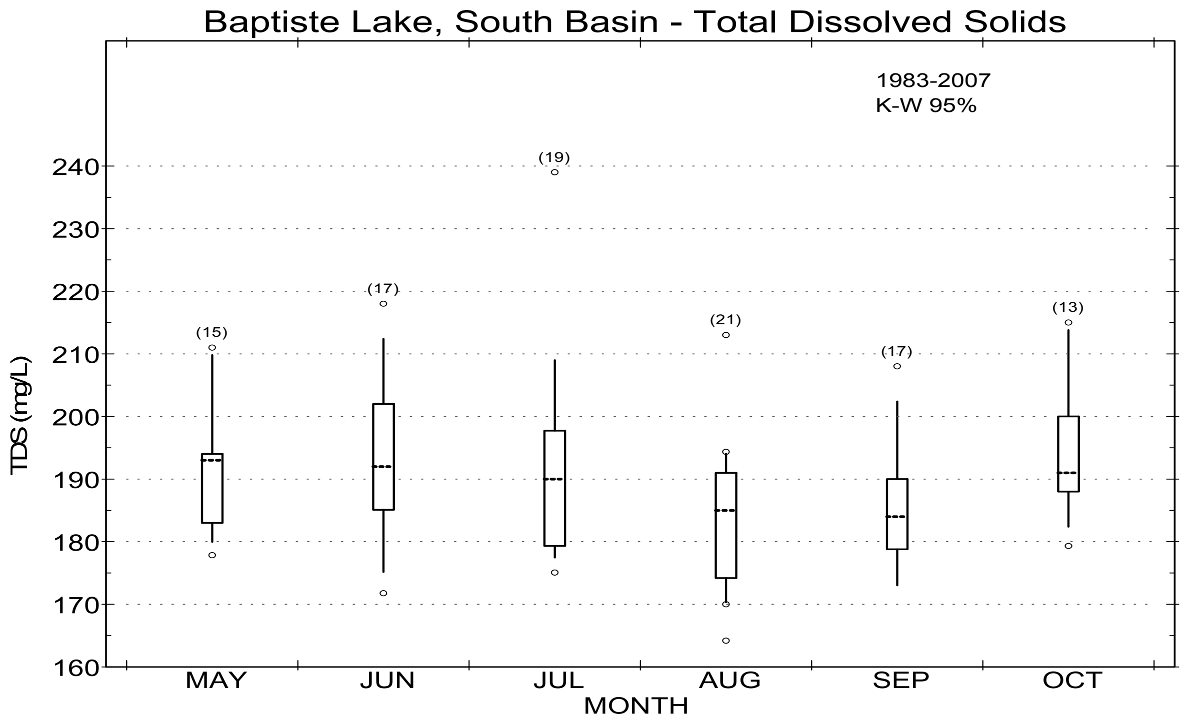


Figure 10a **Baptiste Lake, South Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



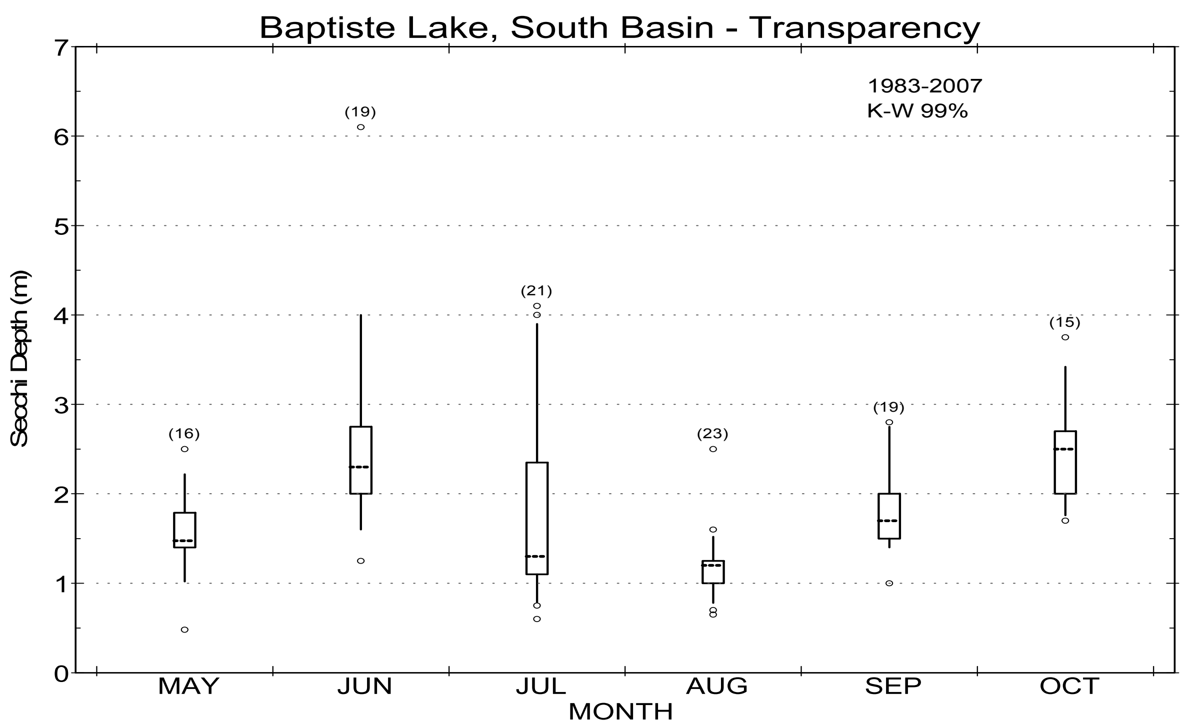
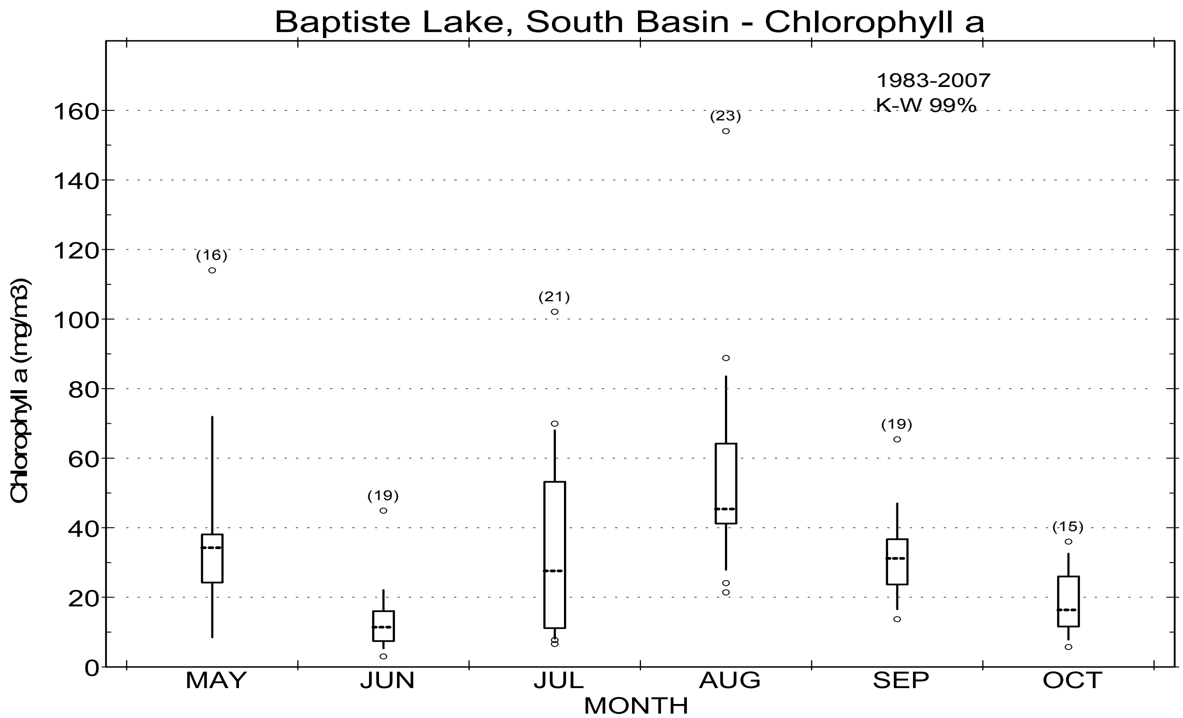


Figure 10a **Baptiste Lake, South Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



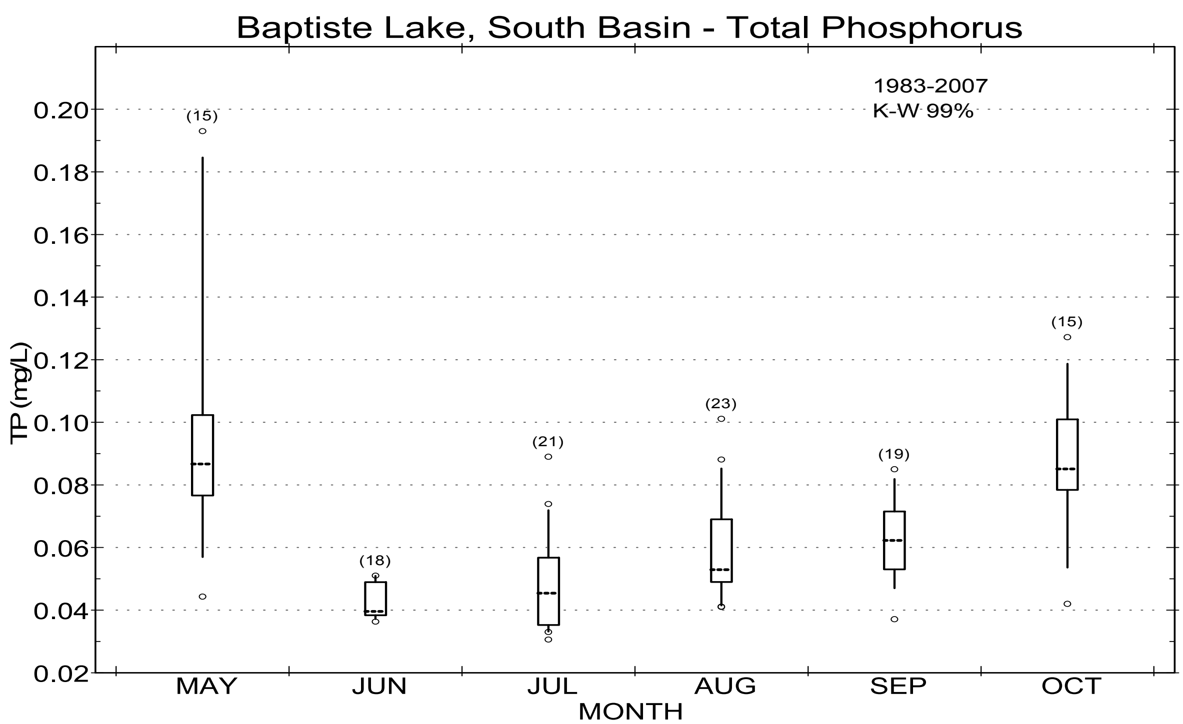
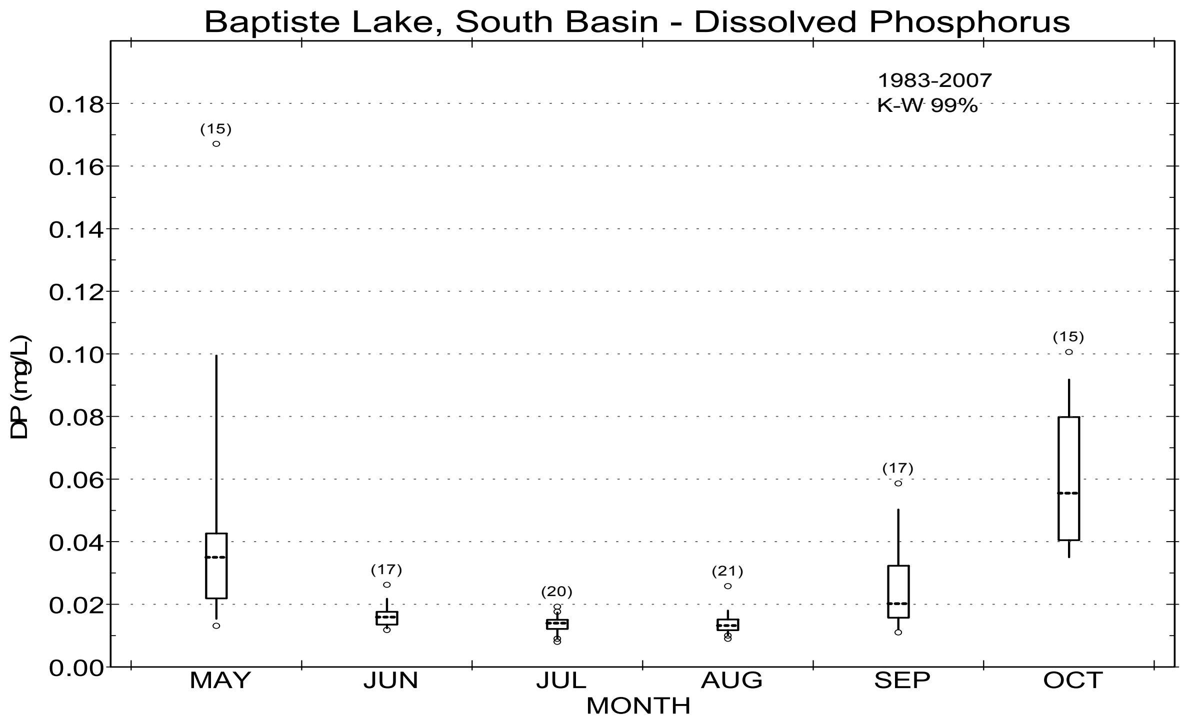


Figure 10a **Baptiste Lake, South Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



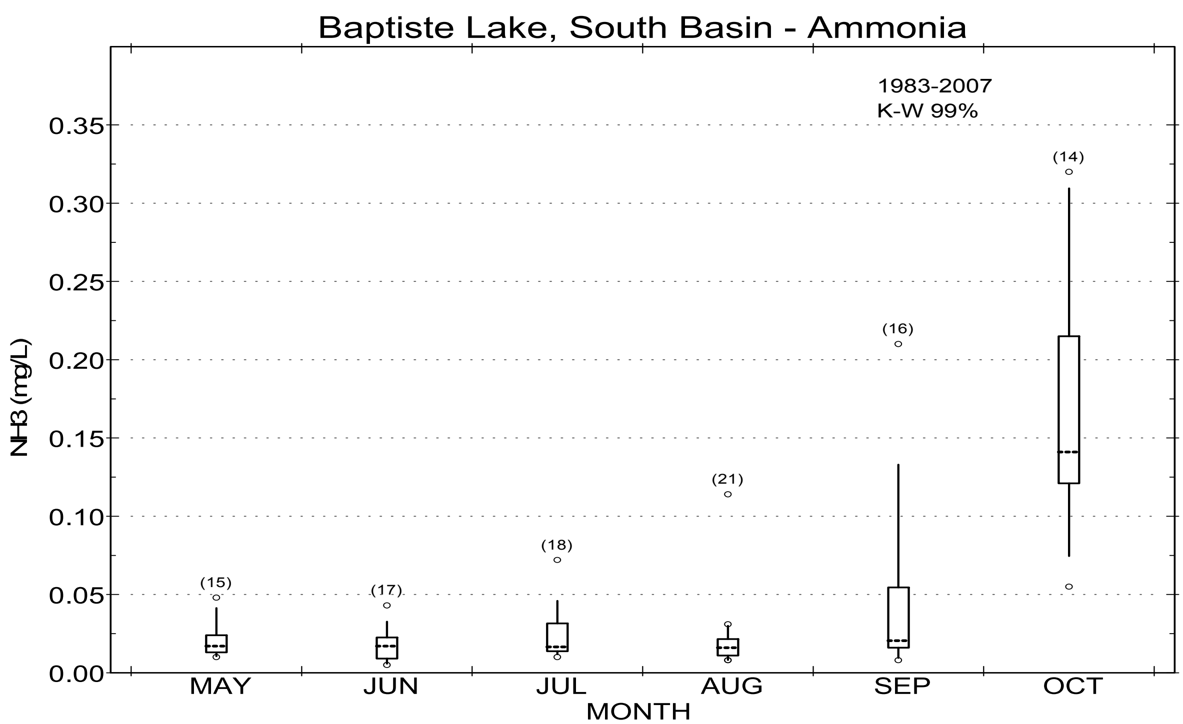
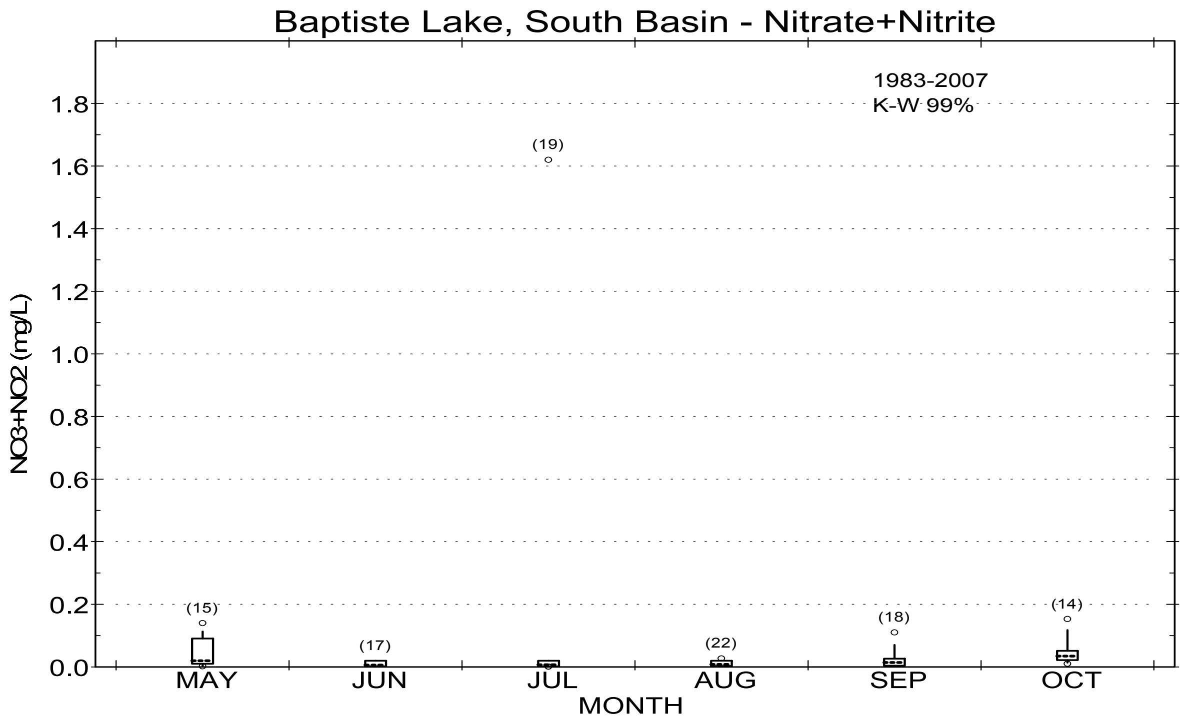


Figure 10b **Baptiste Lake, South Basin -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month



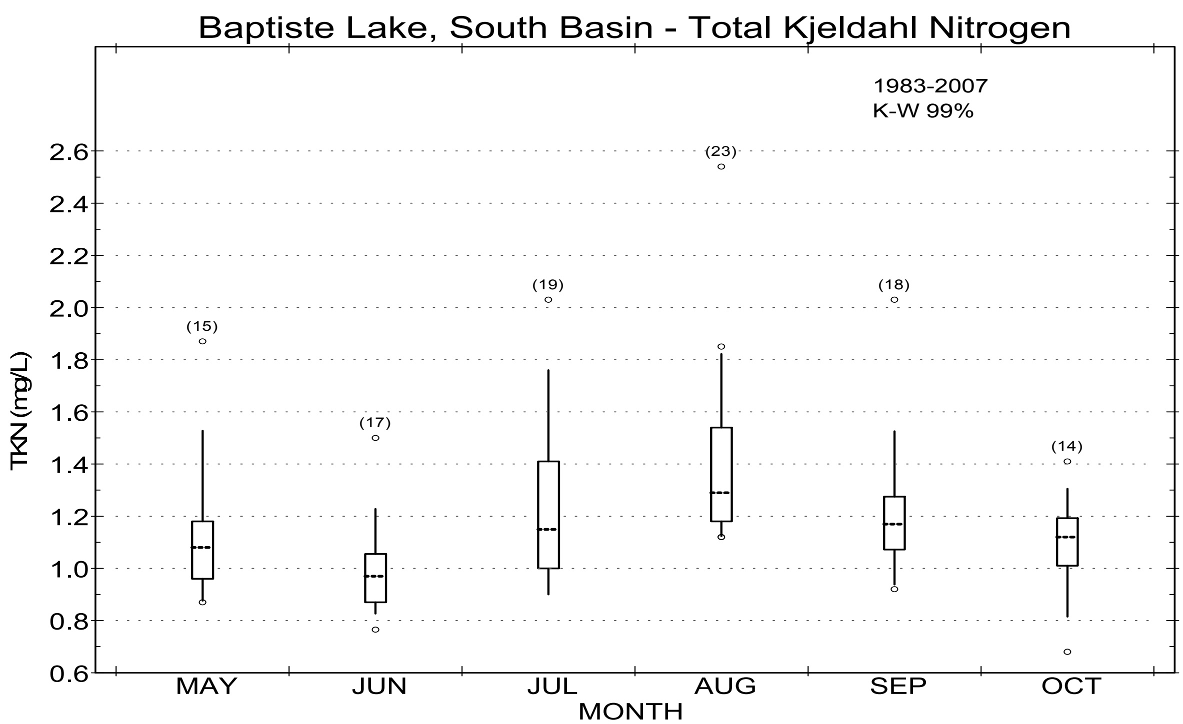
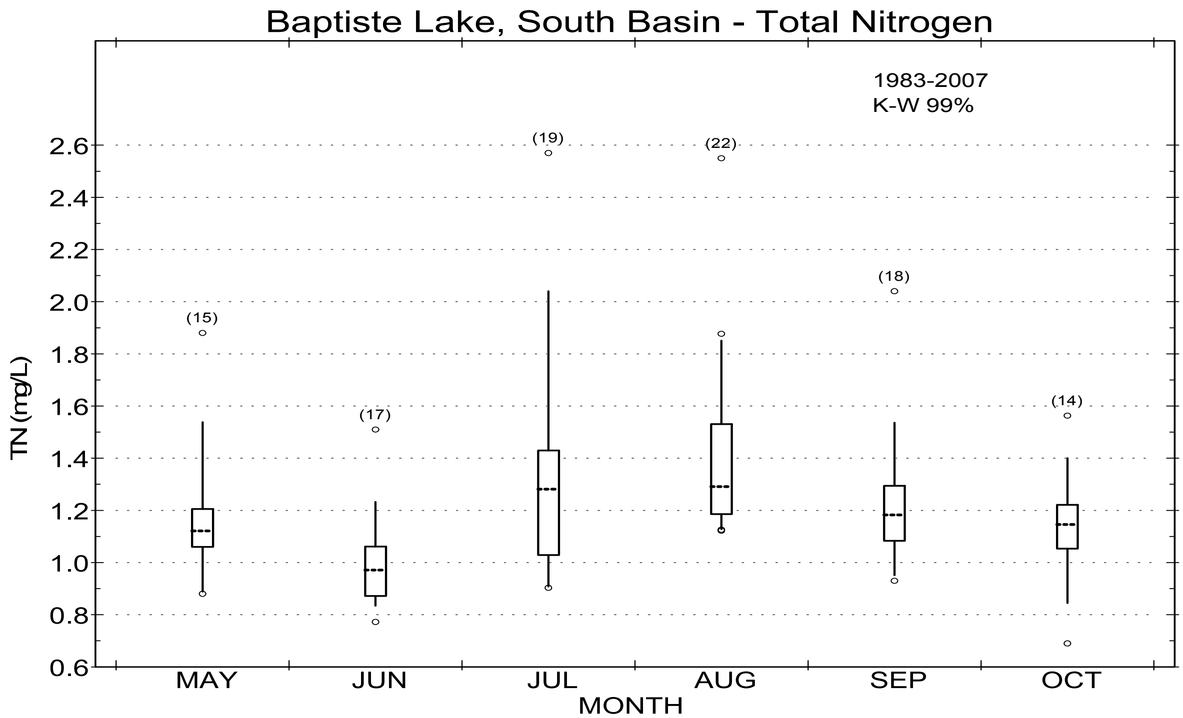


Figure 10b **Baptiste Lake, South Basin -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)



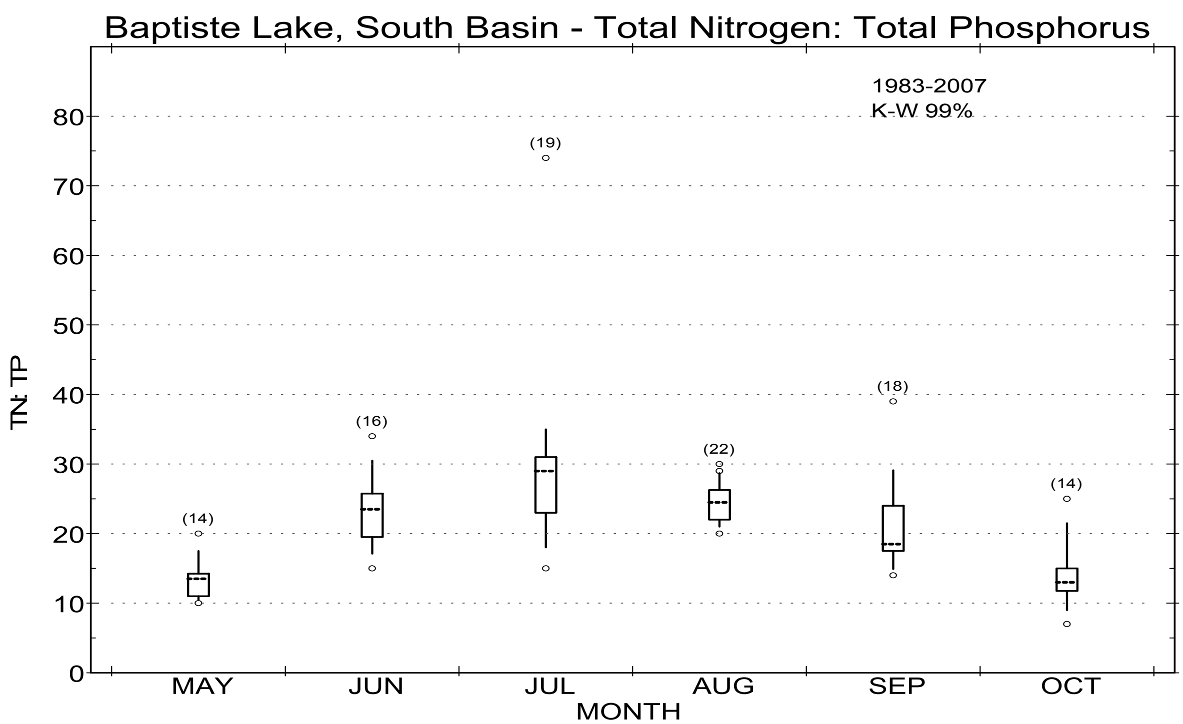
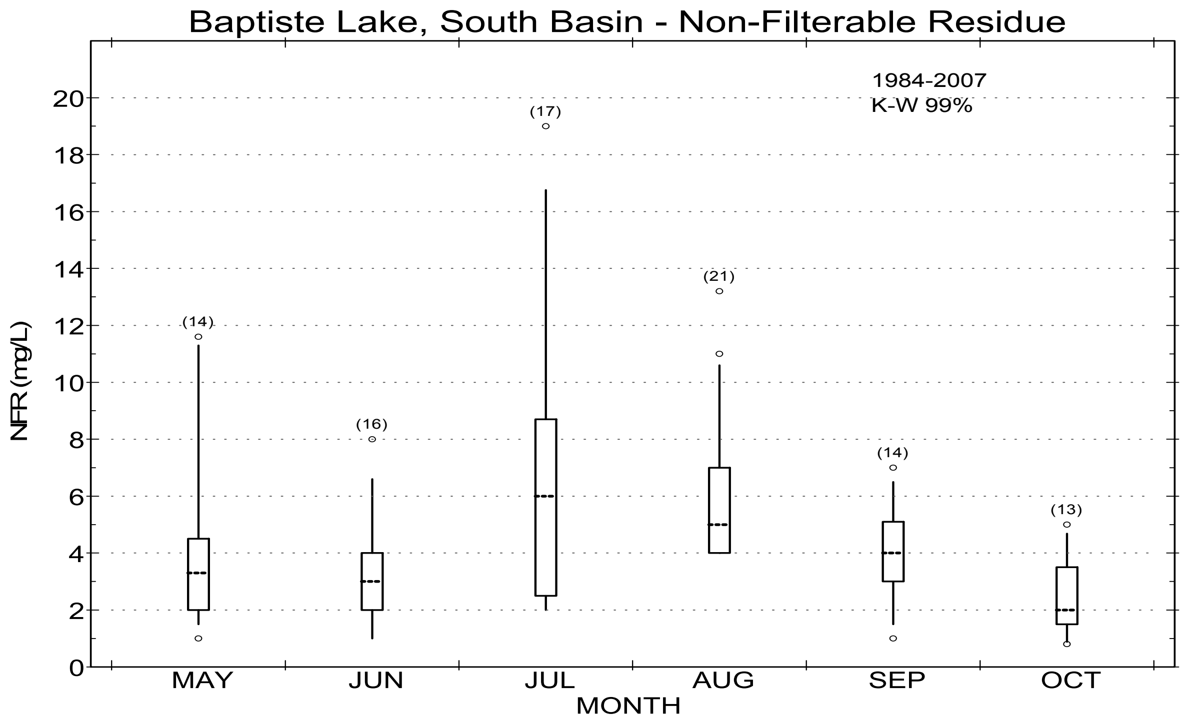


Figure 10b **Baptiste Lake, South Basin -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)



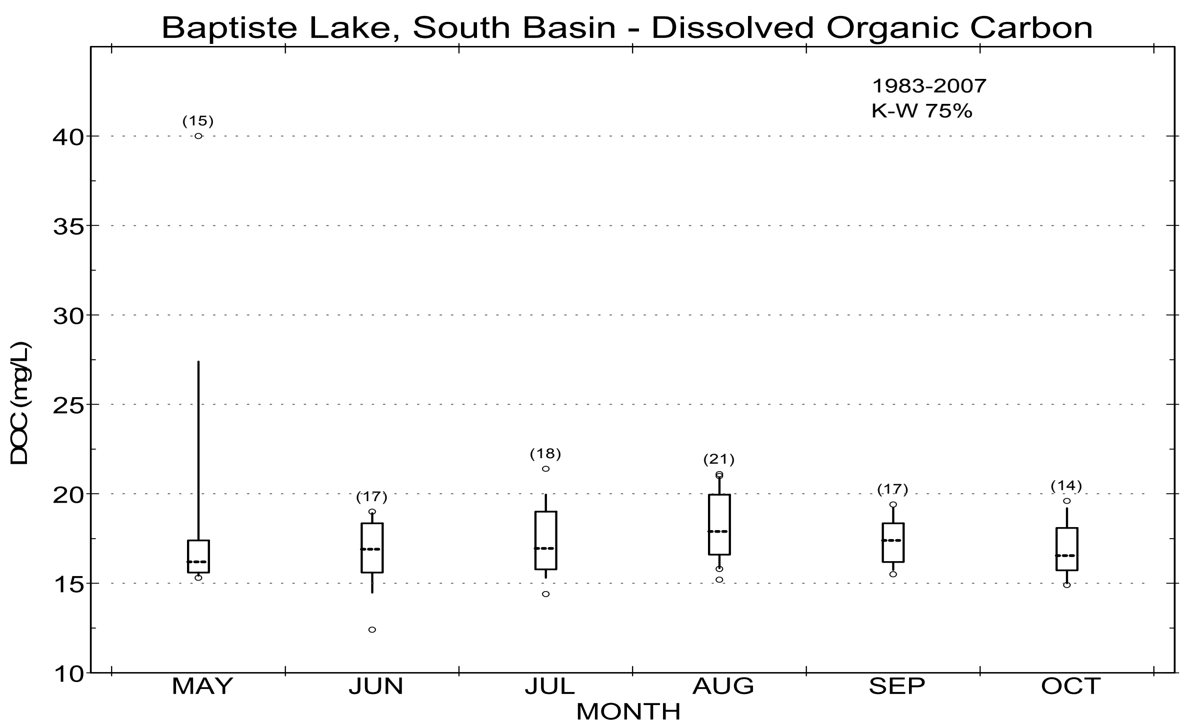


Figure 10b **Baptiste Lake, South Basin -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)

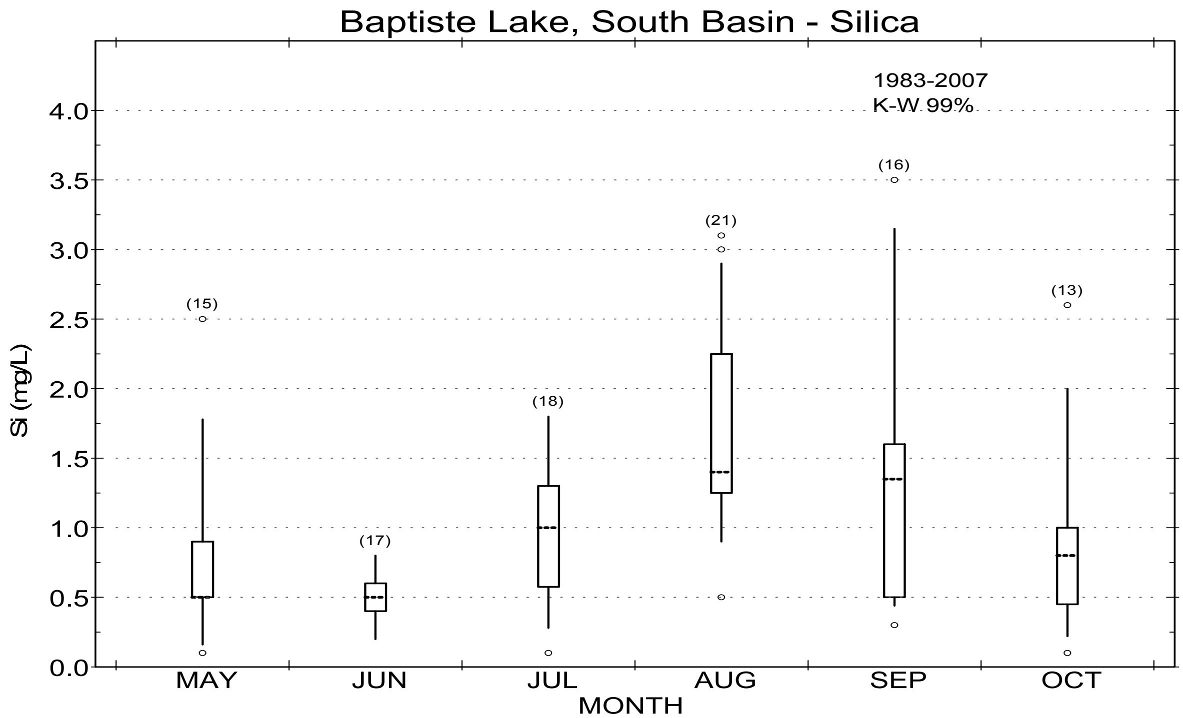
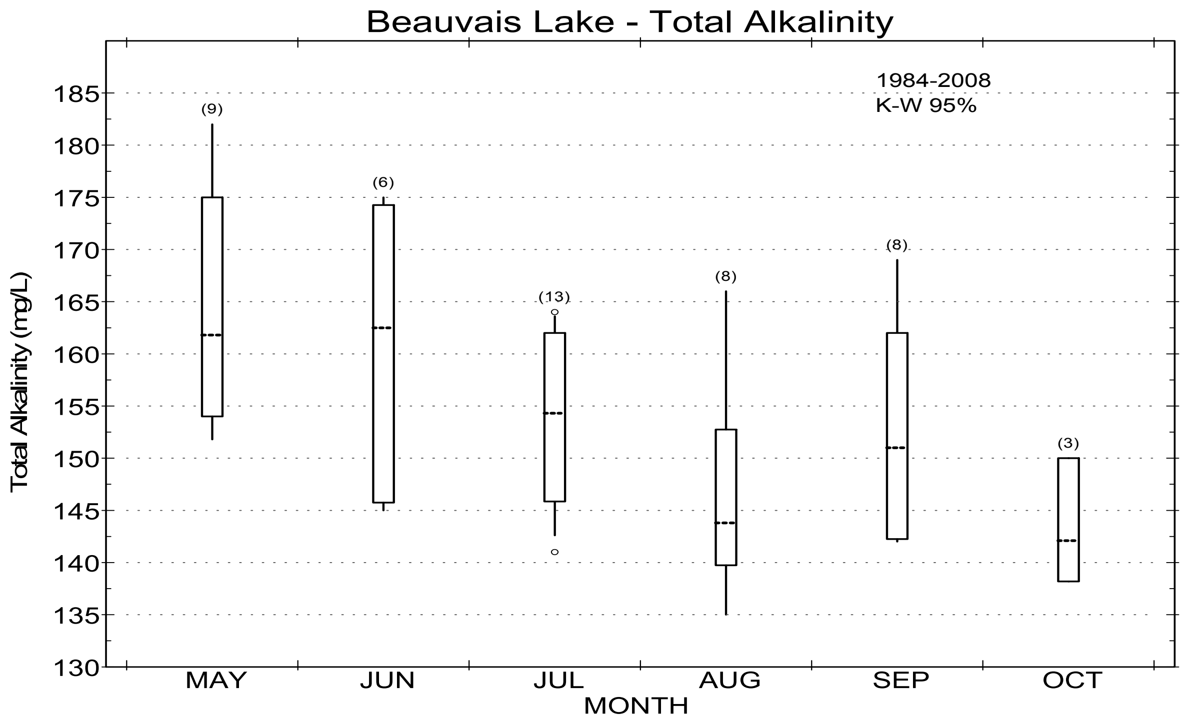


Figure 10b **Baptiste Lake, South Basin -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (concluded)



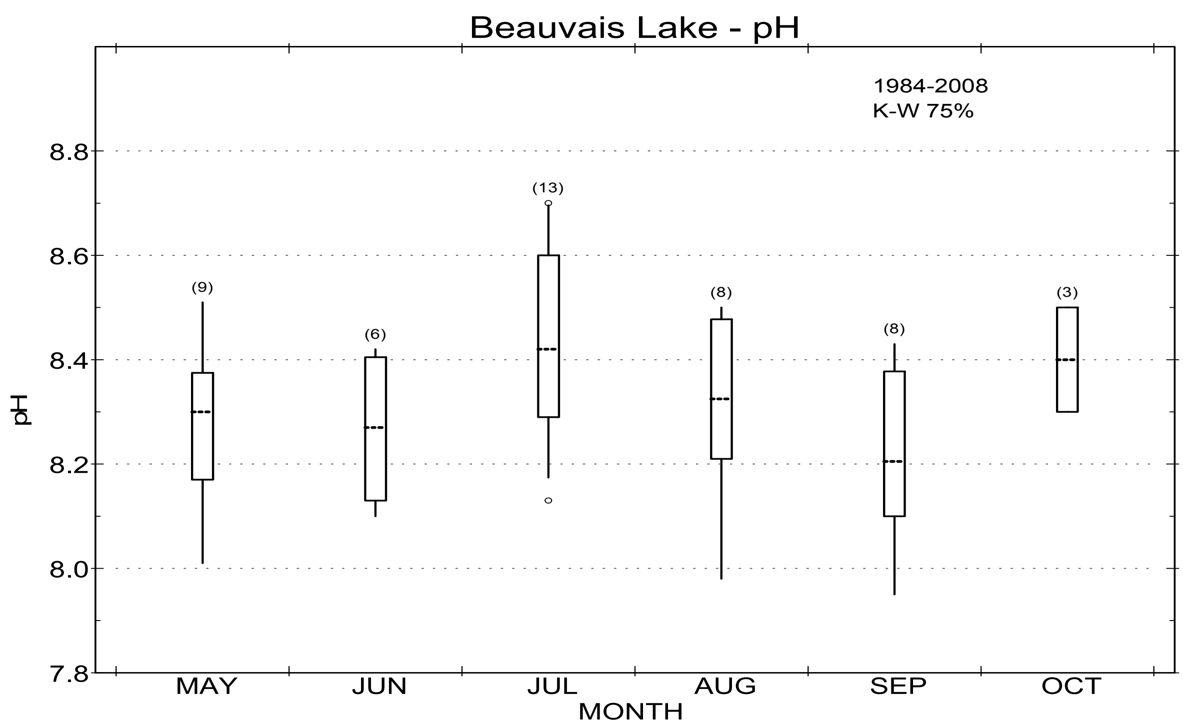
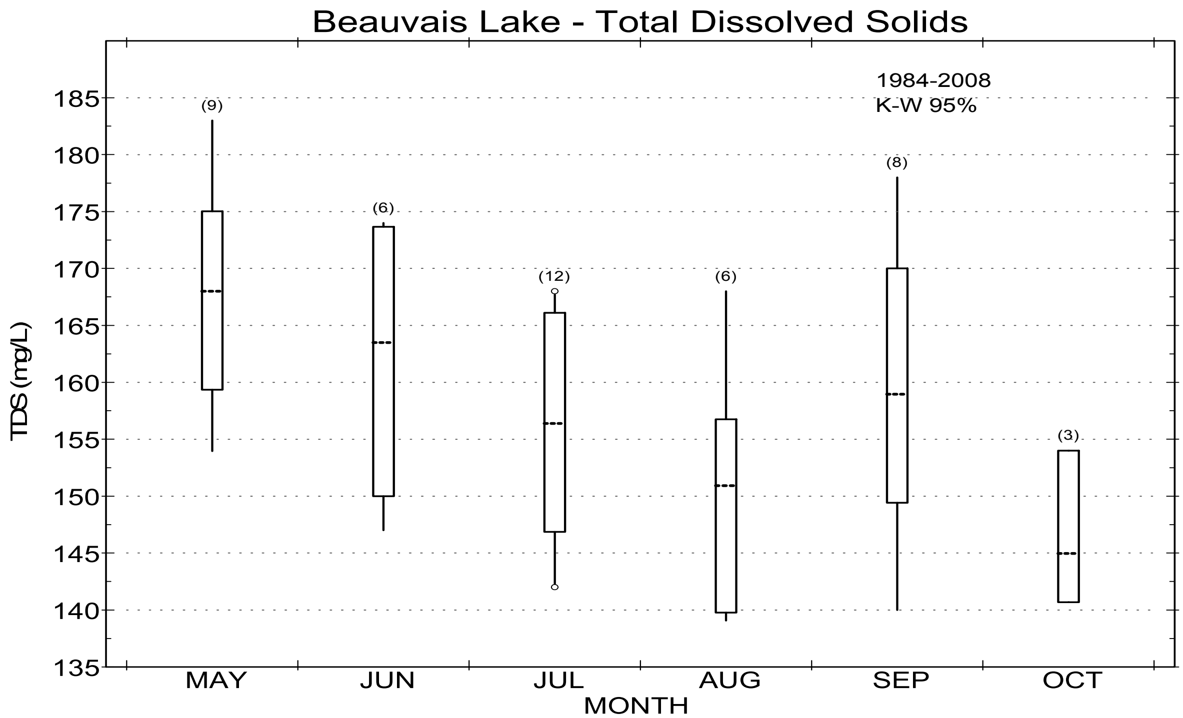


Figure 11 **Beauvais Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



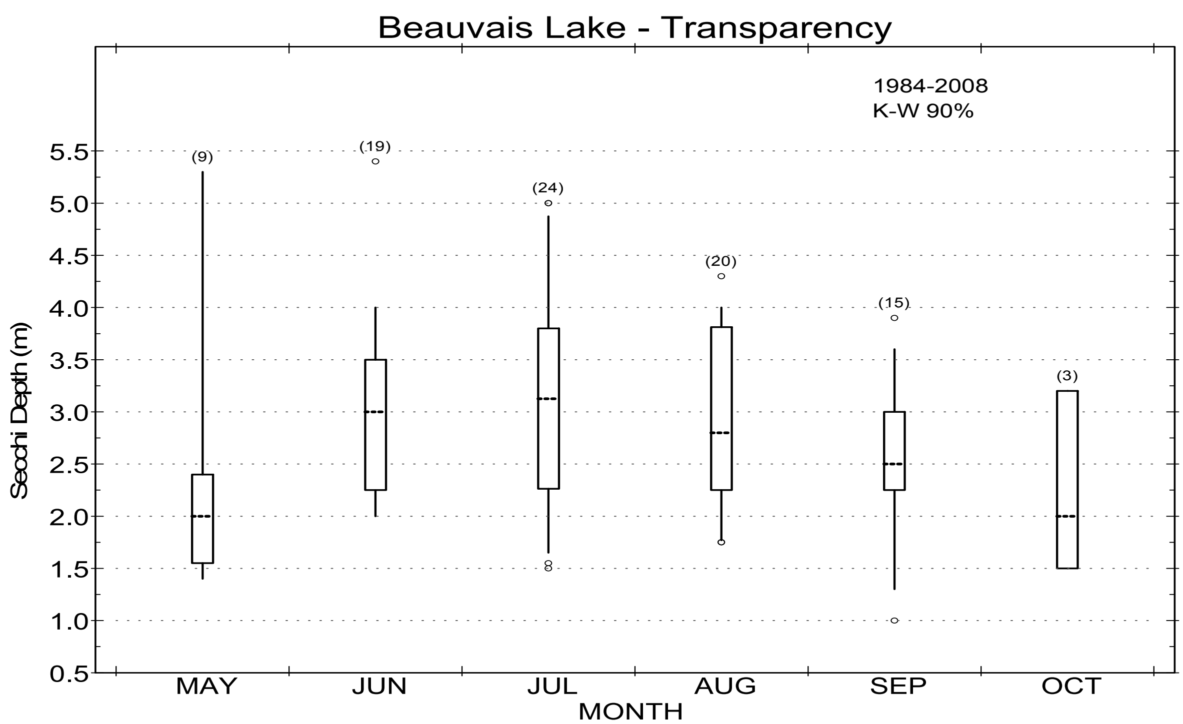
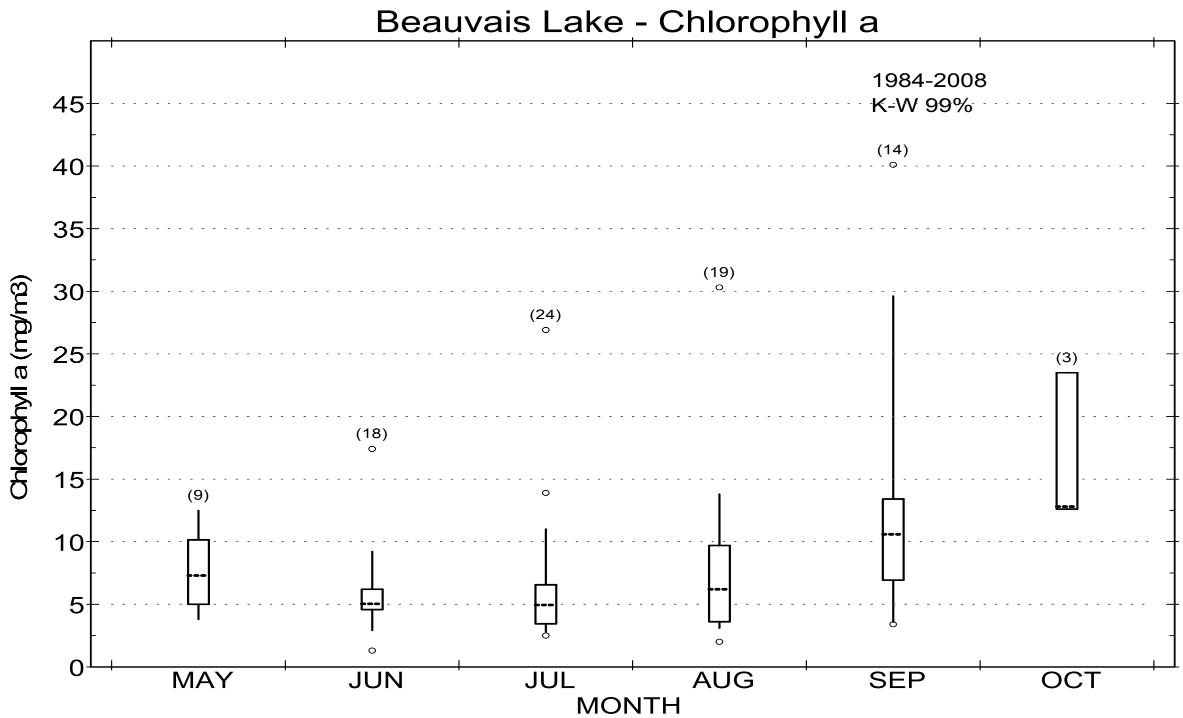


Figure 11 **Beauvais Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



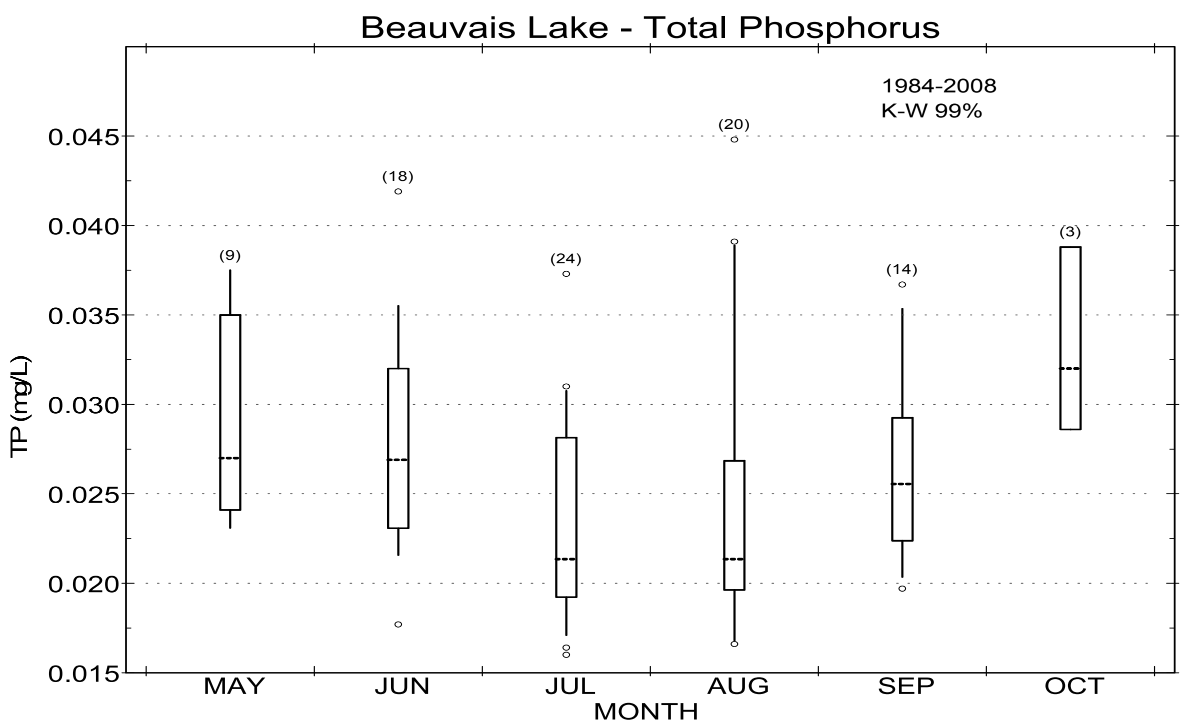
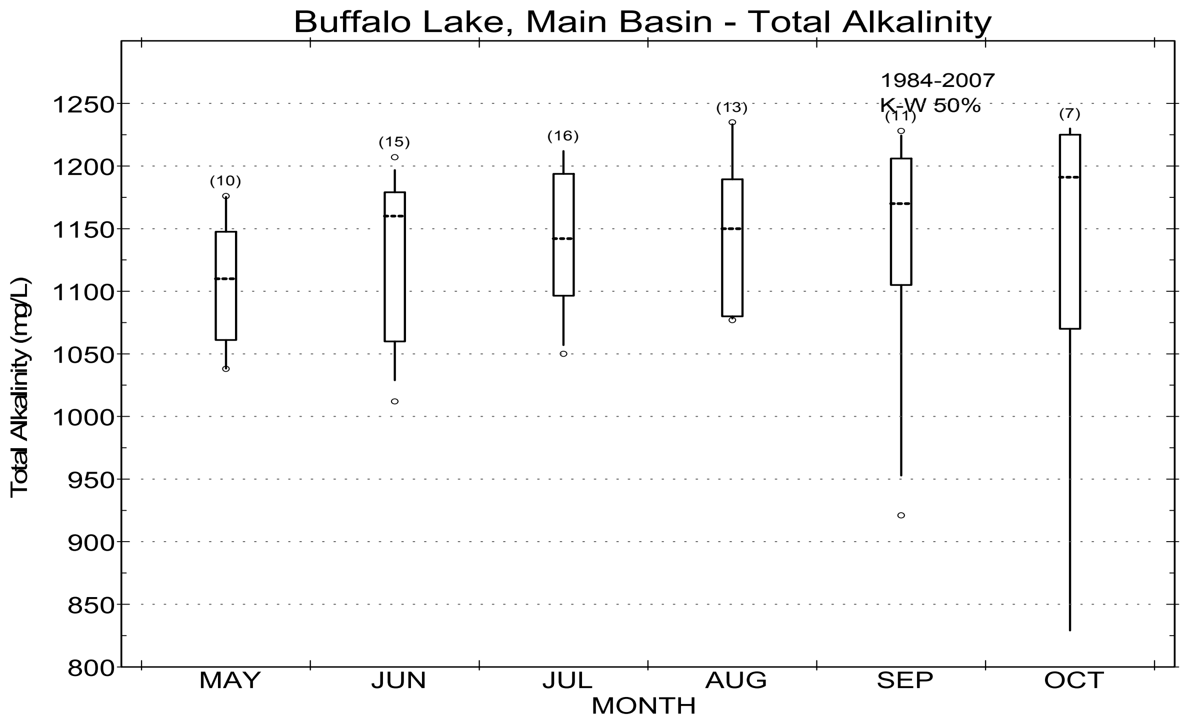


Figure 11 **Beauvais Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



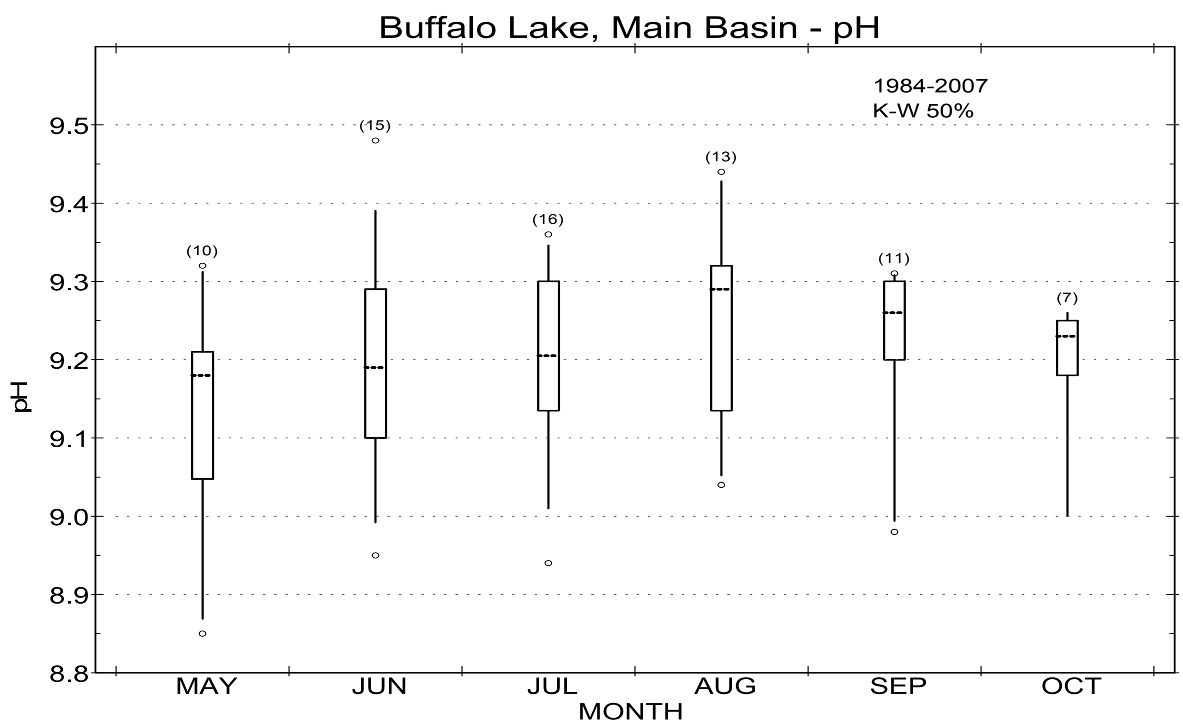
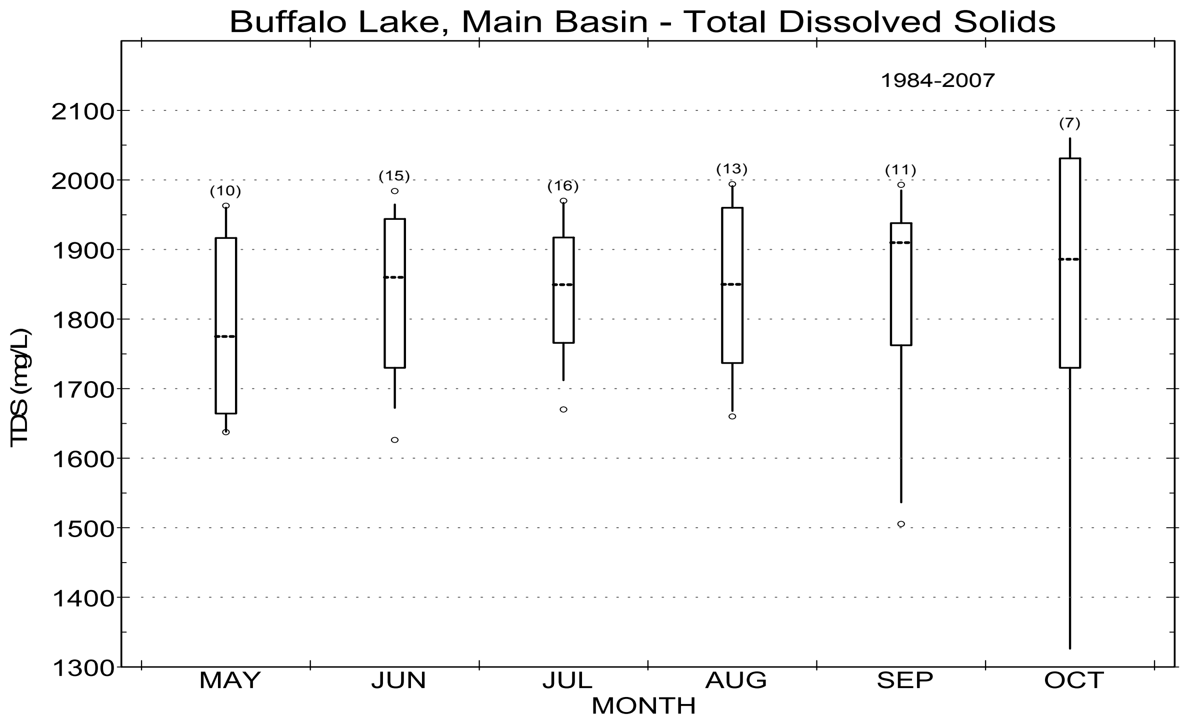


Figure 12 **Buffalo Lake, Main Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



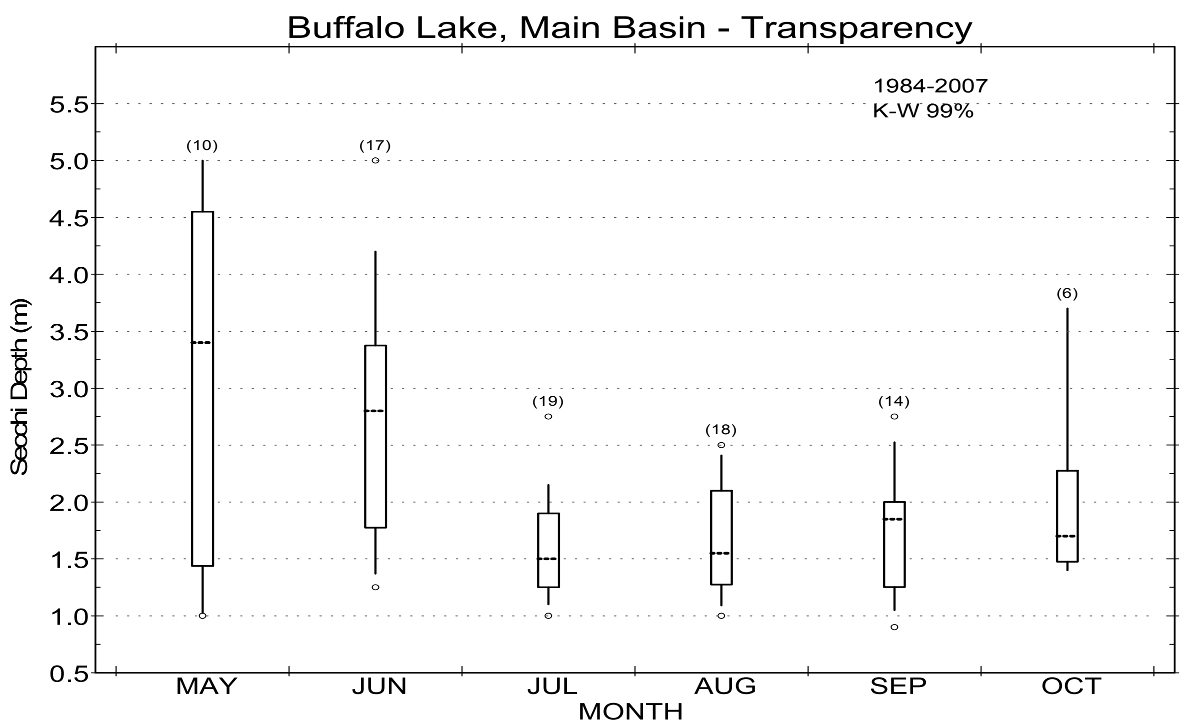
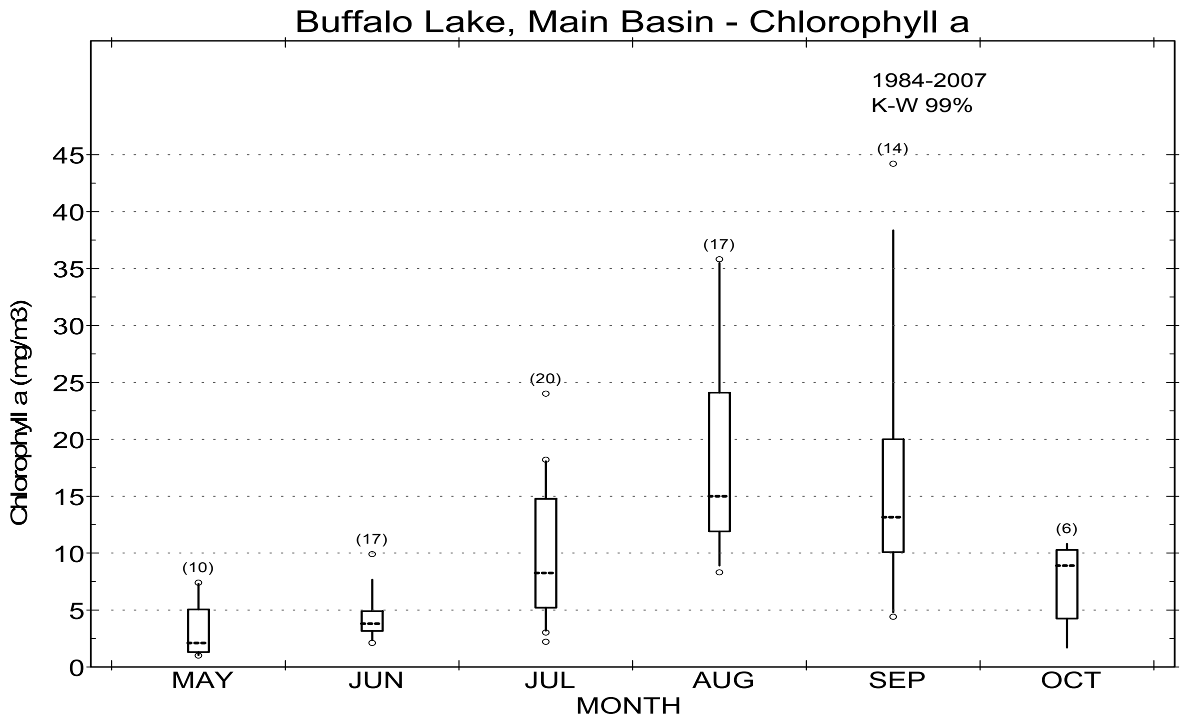


Figure 12 **Buffalo Lake, Main Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



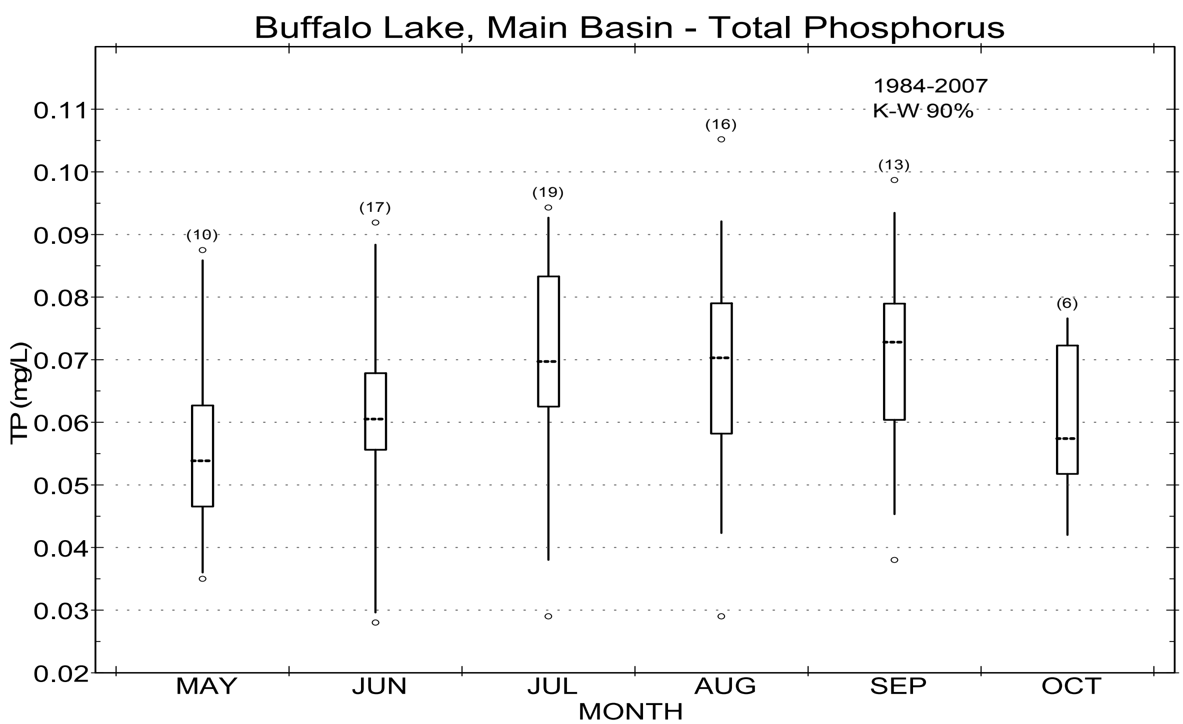
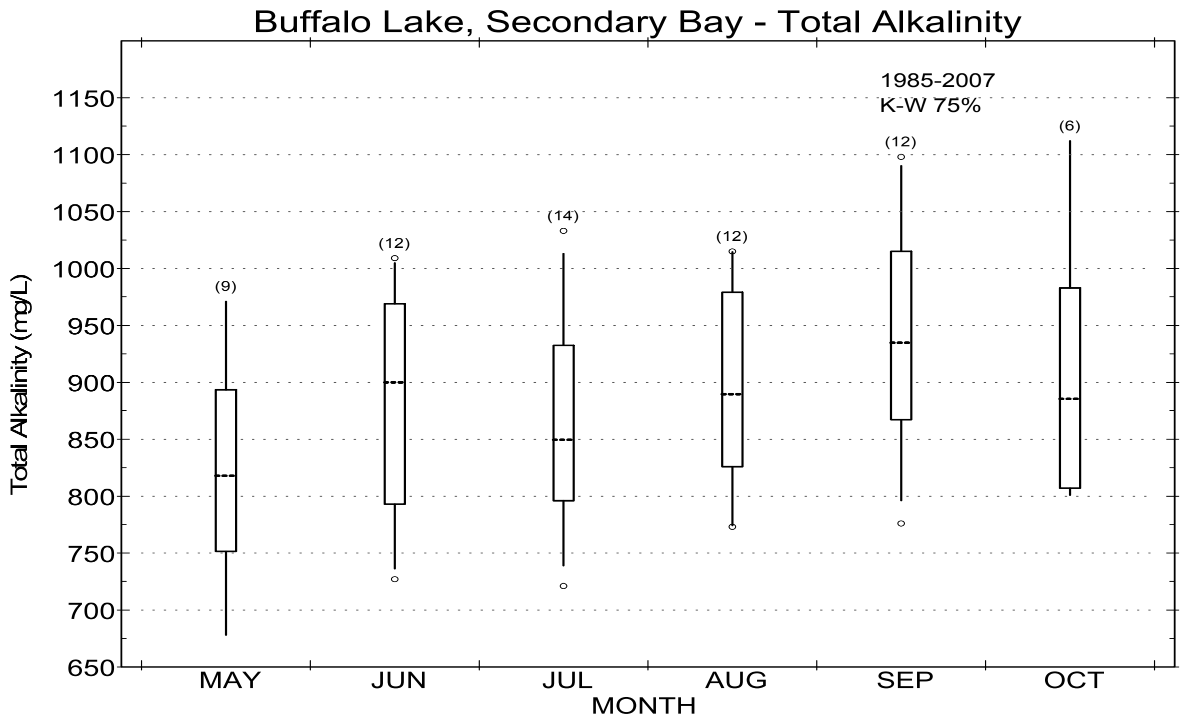


Figure 12 **Buffalo Lake, Main Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



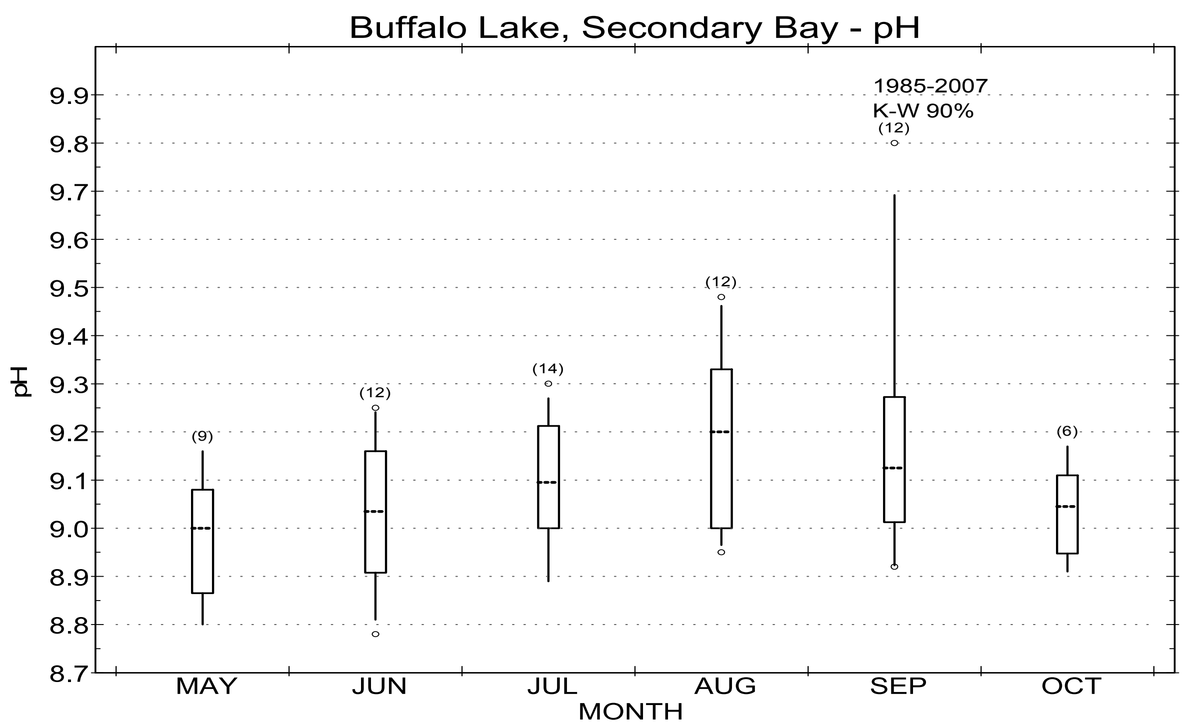
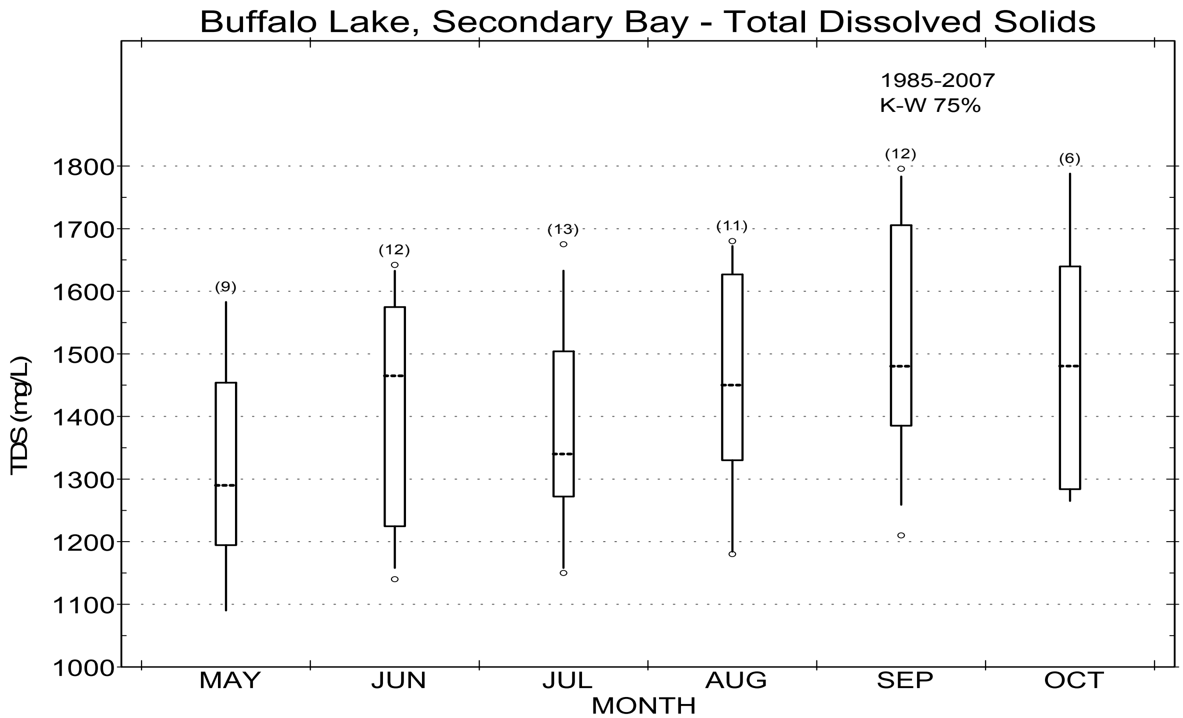


Figure 13 **Buffalo Lake, Secondary Bay** - Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



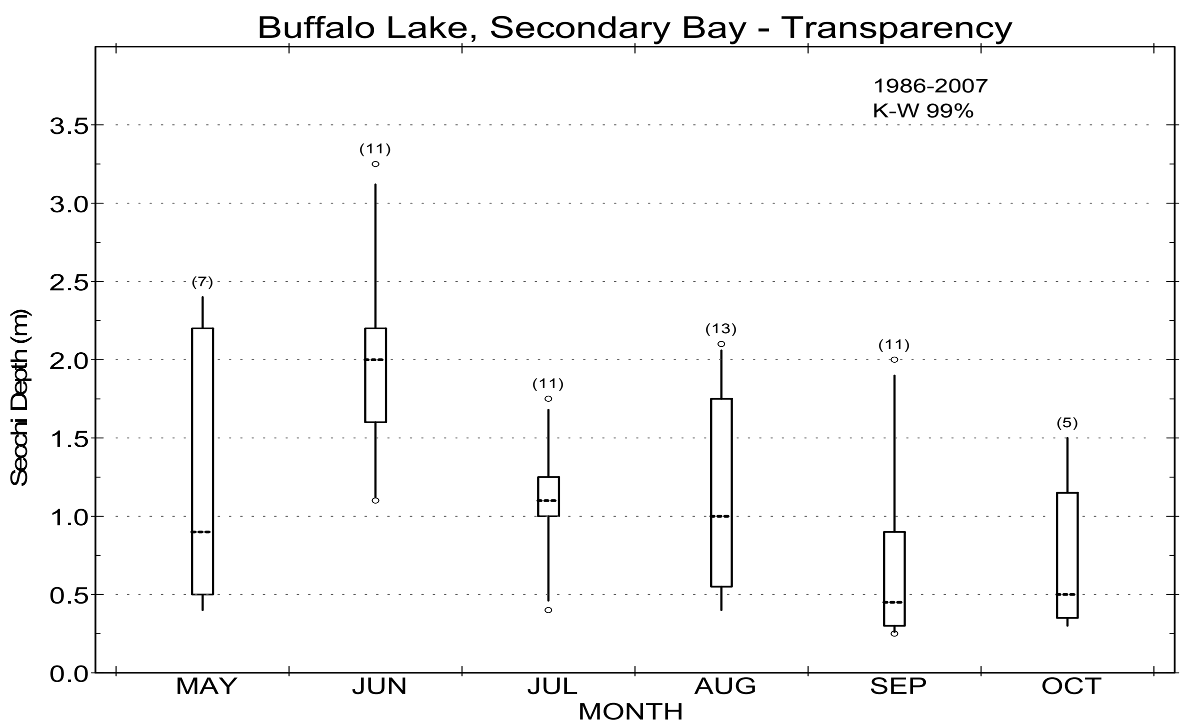
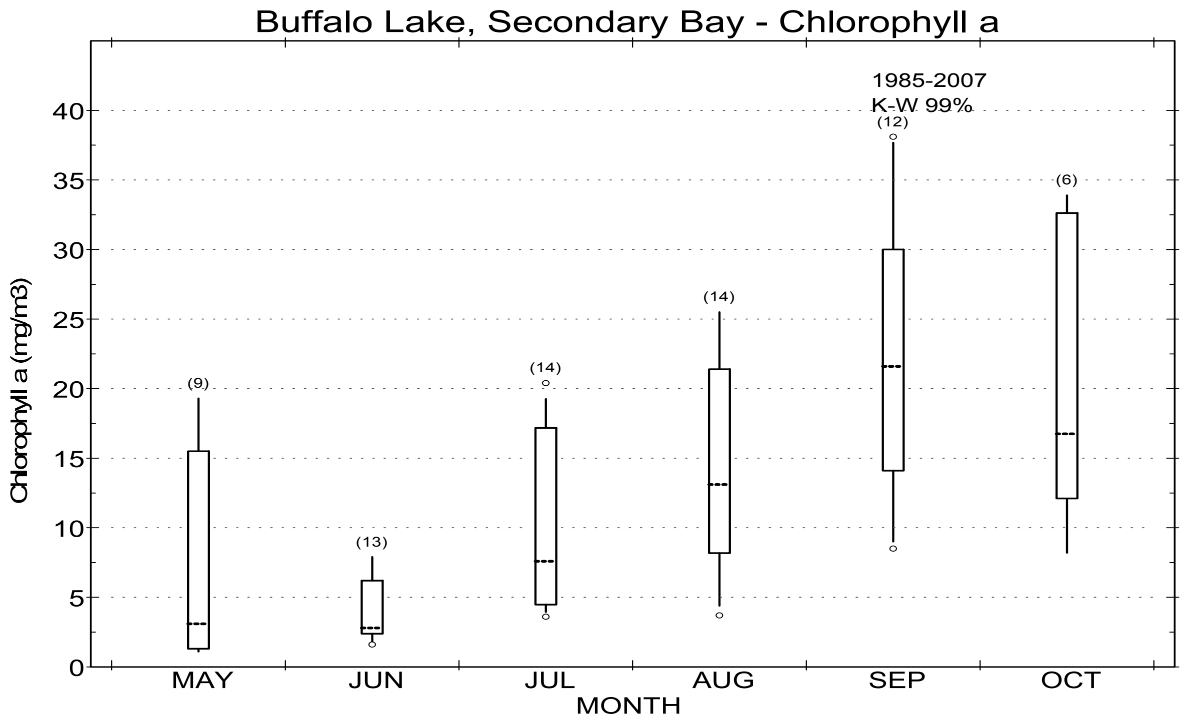


Figure 13 **Buffalo Lake, Secondary Bay** - Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



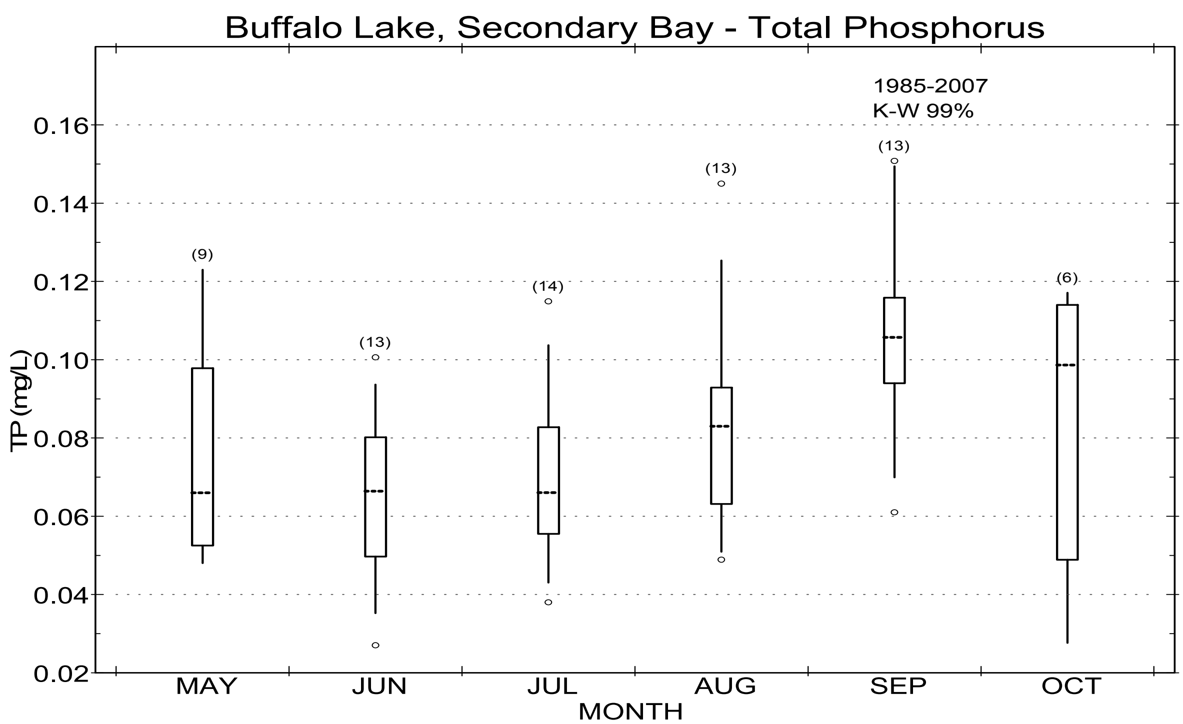
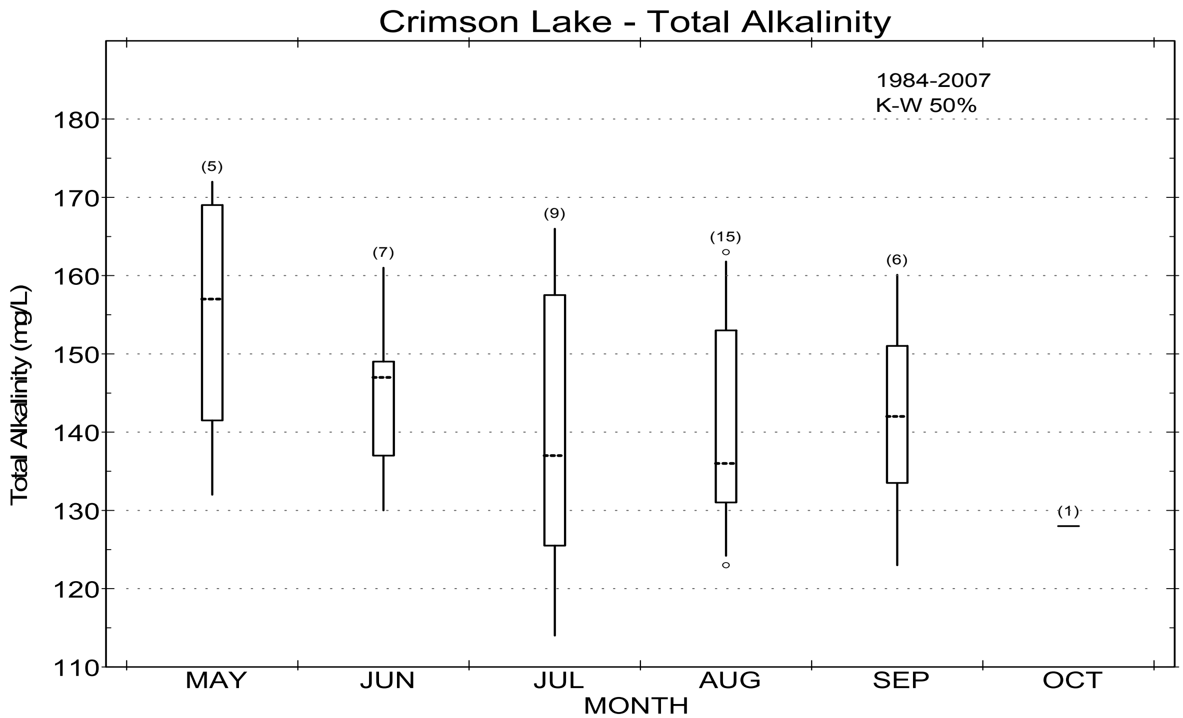


Figure 13 **Buffalo Lake, Secondary Bay** - Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



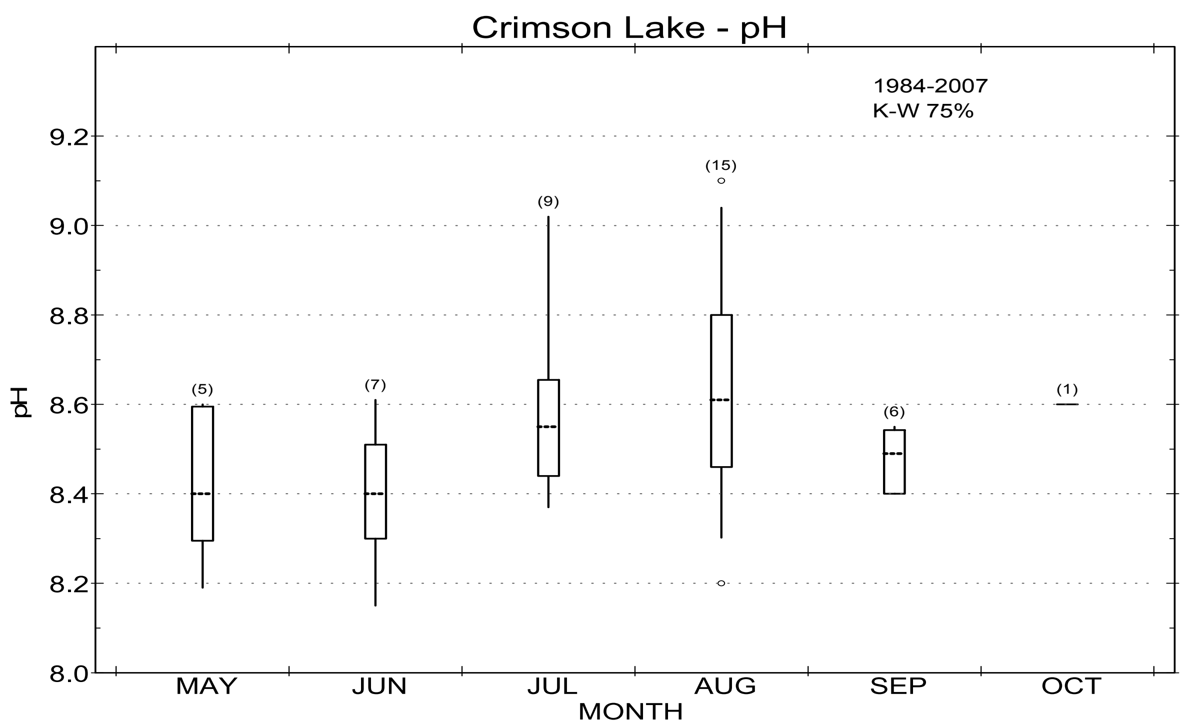
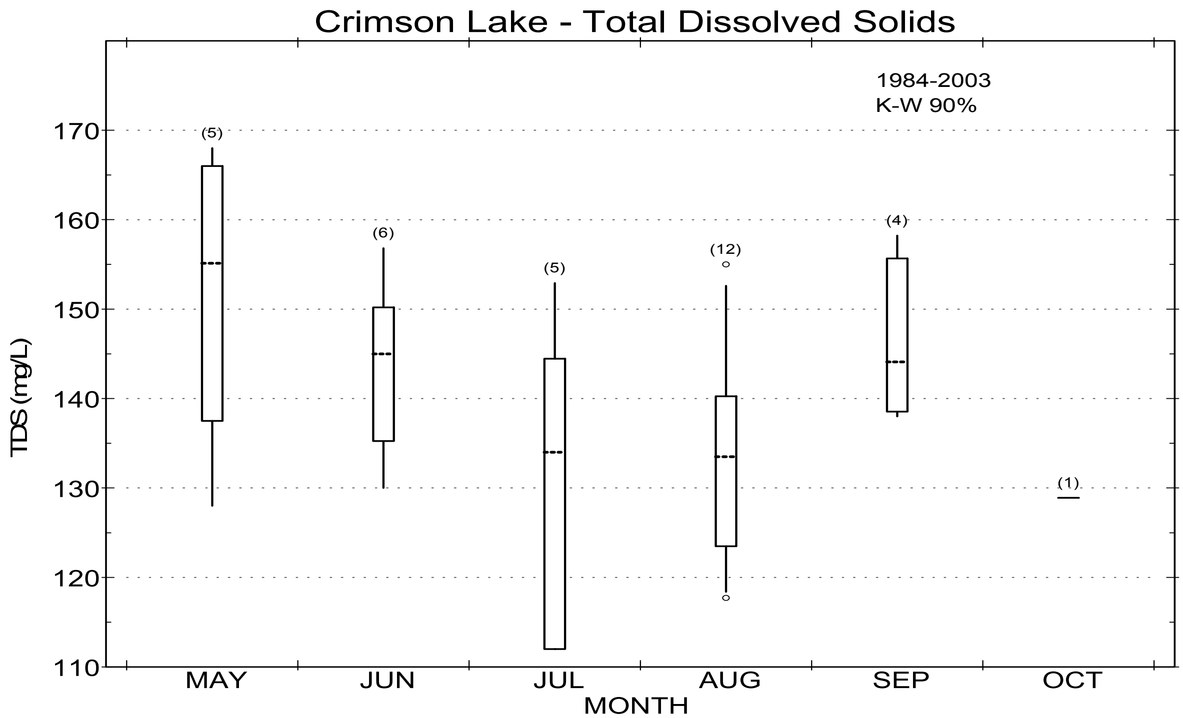


Figure 14 **Crimson Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



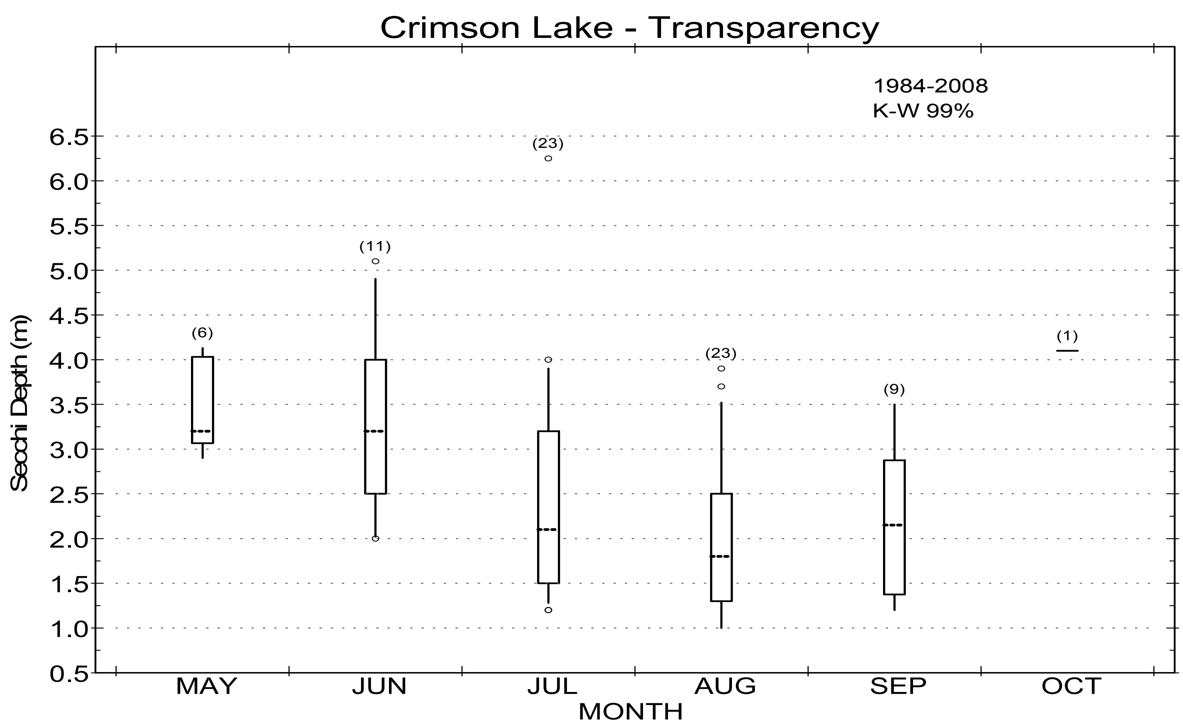
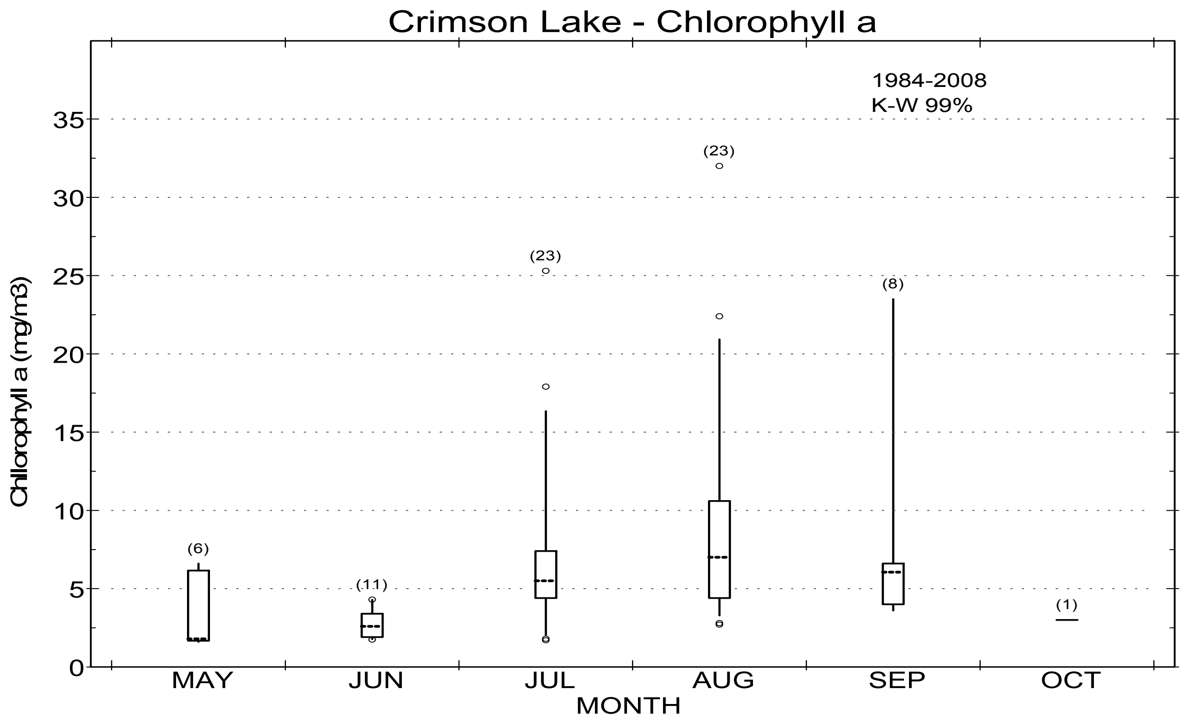


Figure 14 **Crimson Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



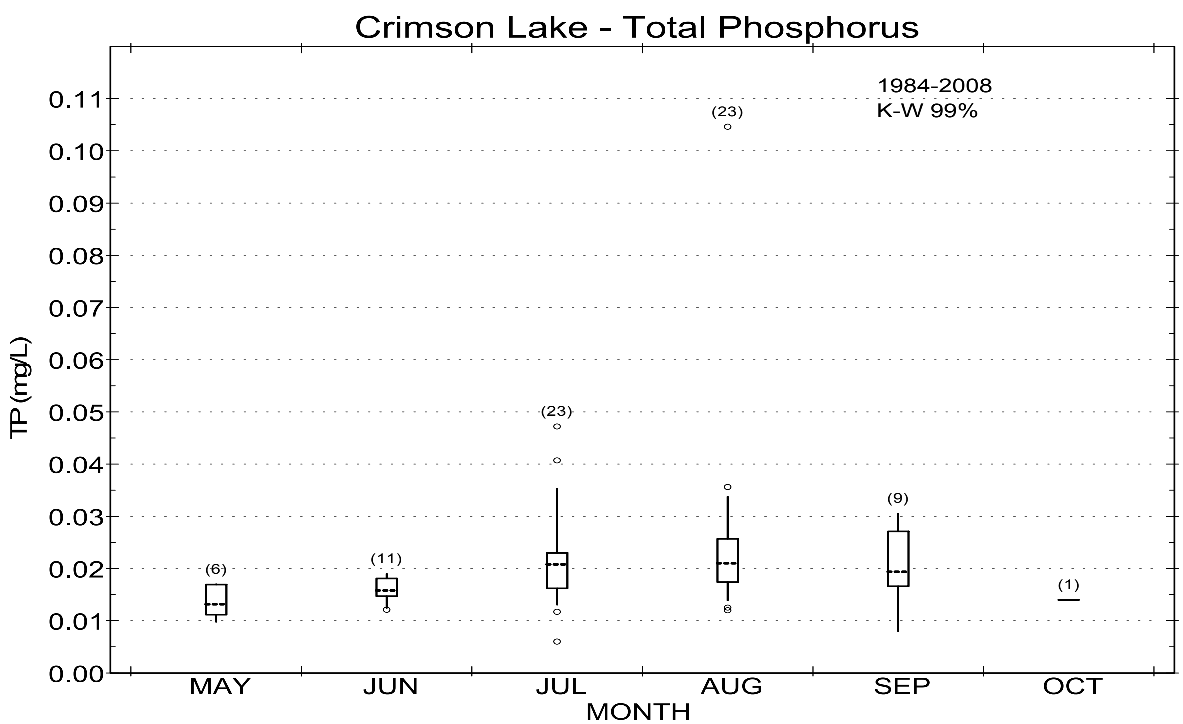
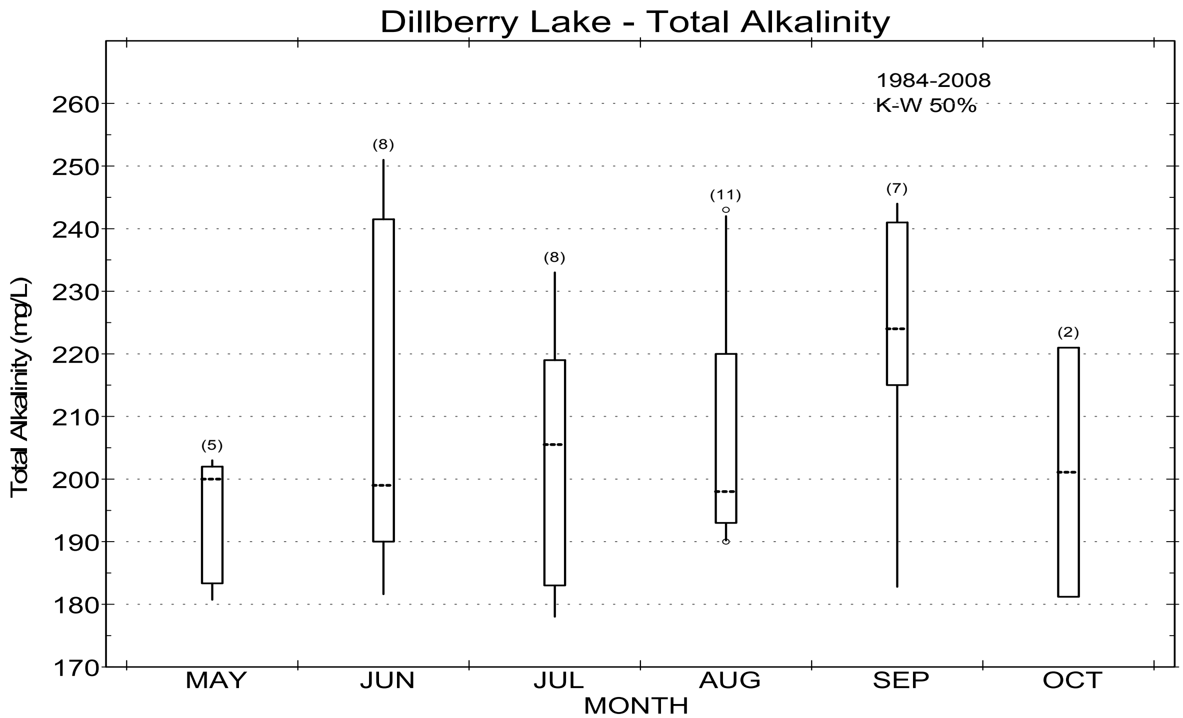


Figure 14 **Crimson Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



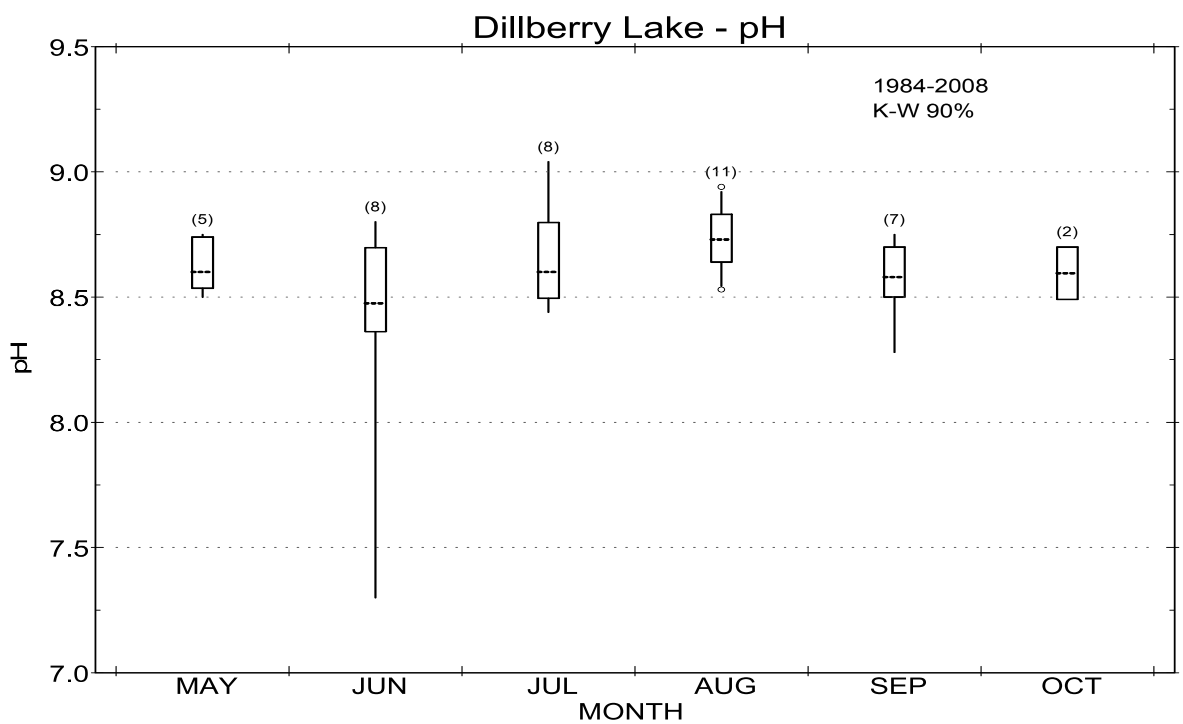
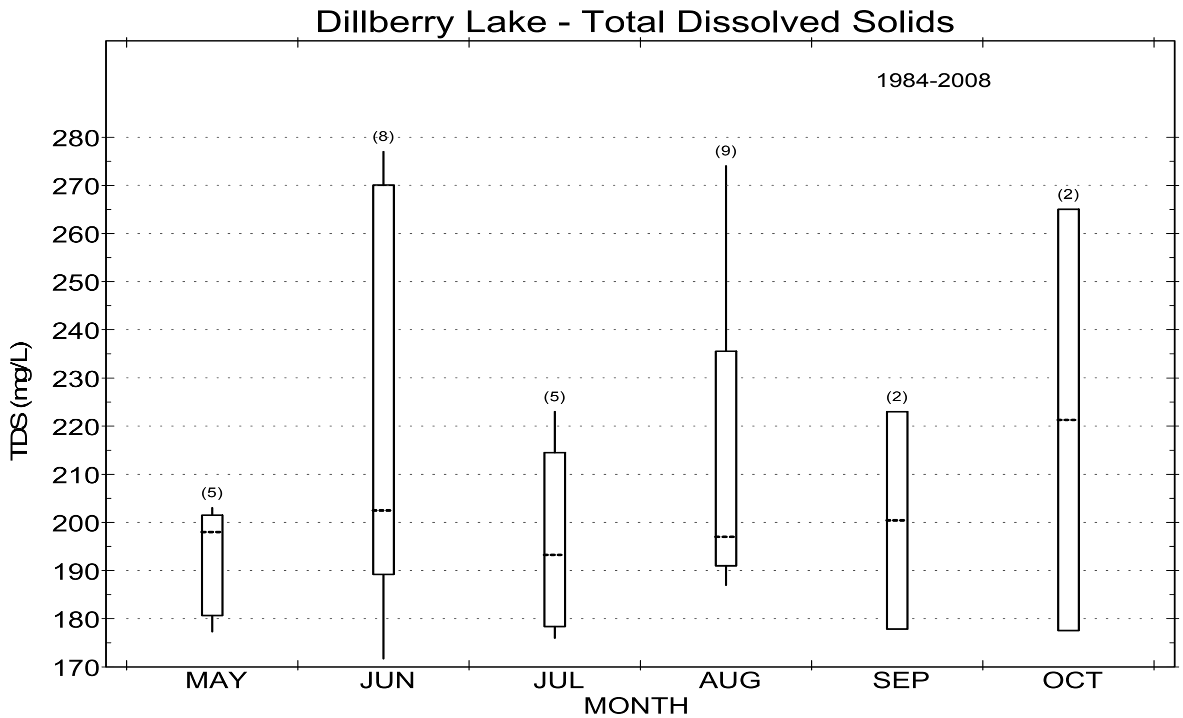


Figure 15 **Dillberry Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month.



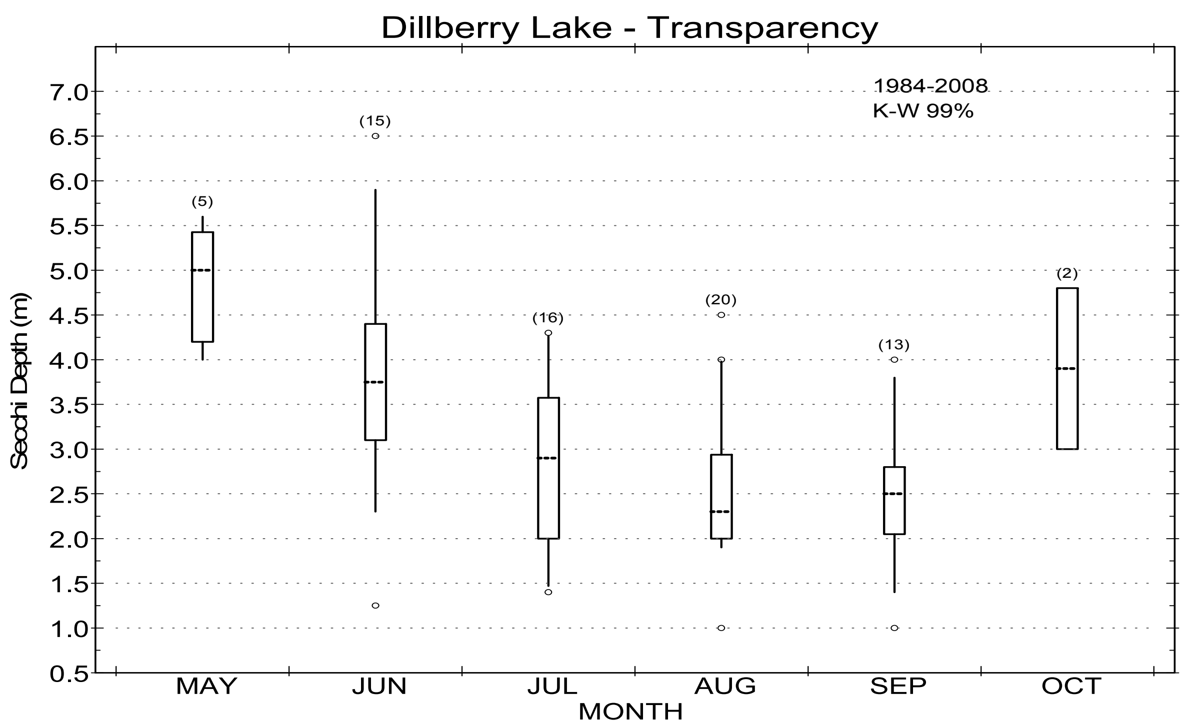
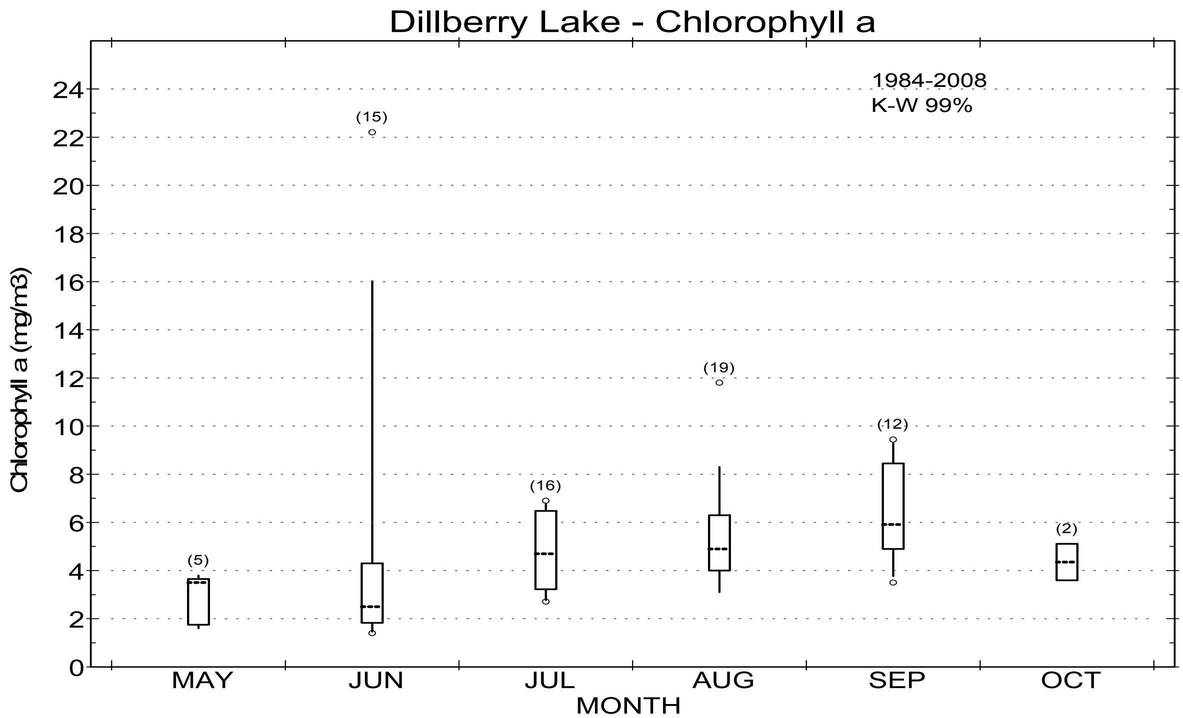


Figure 15 **Dillberry Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



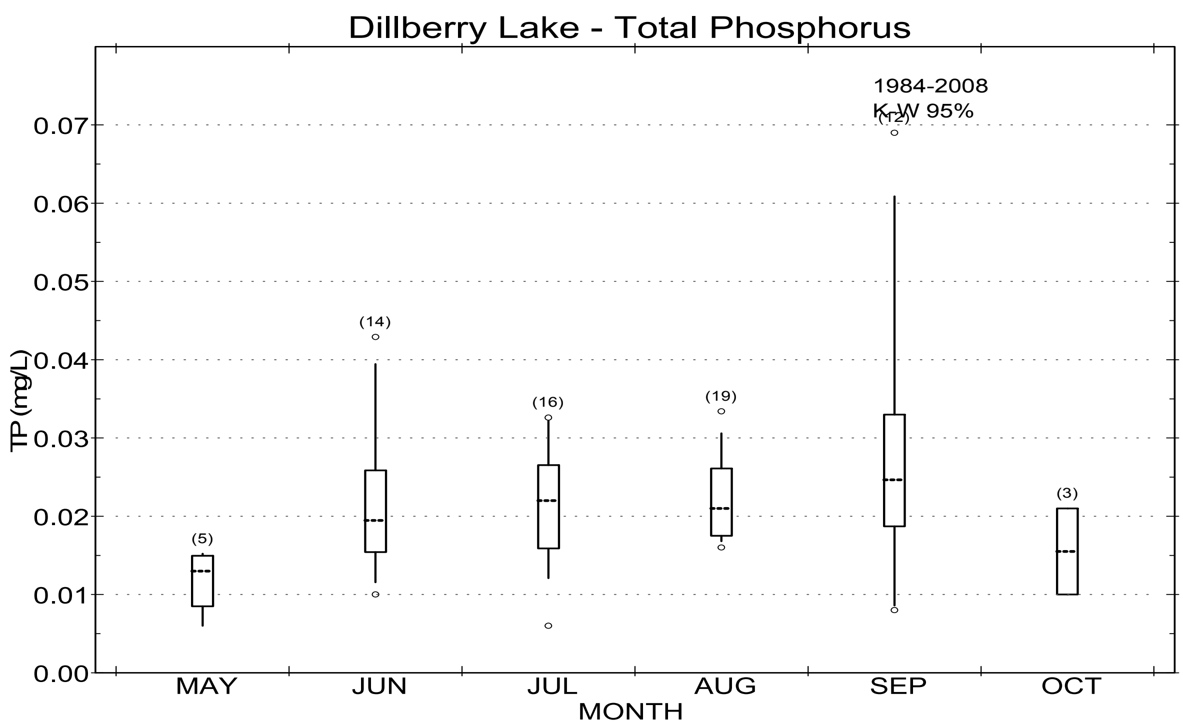
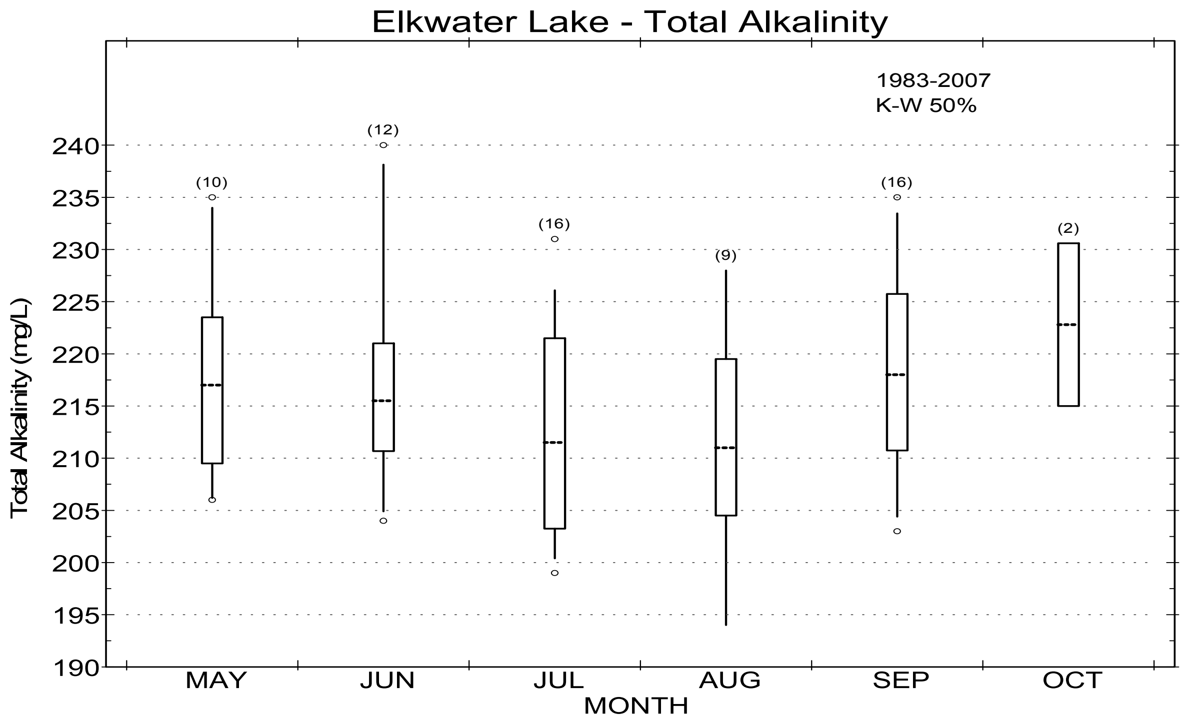


Figure 15 **Dillberry Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



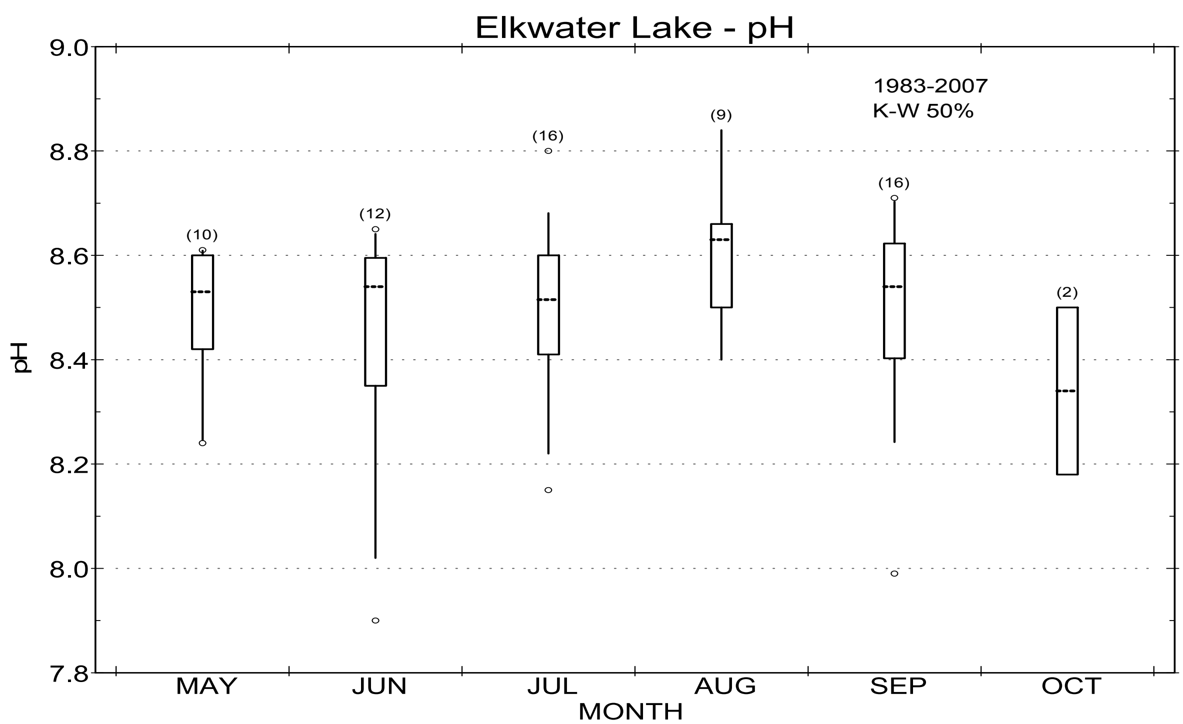
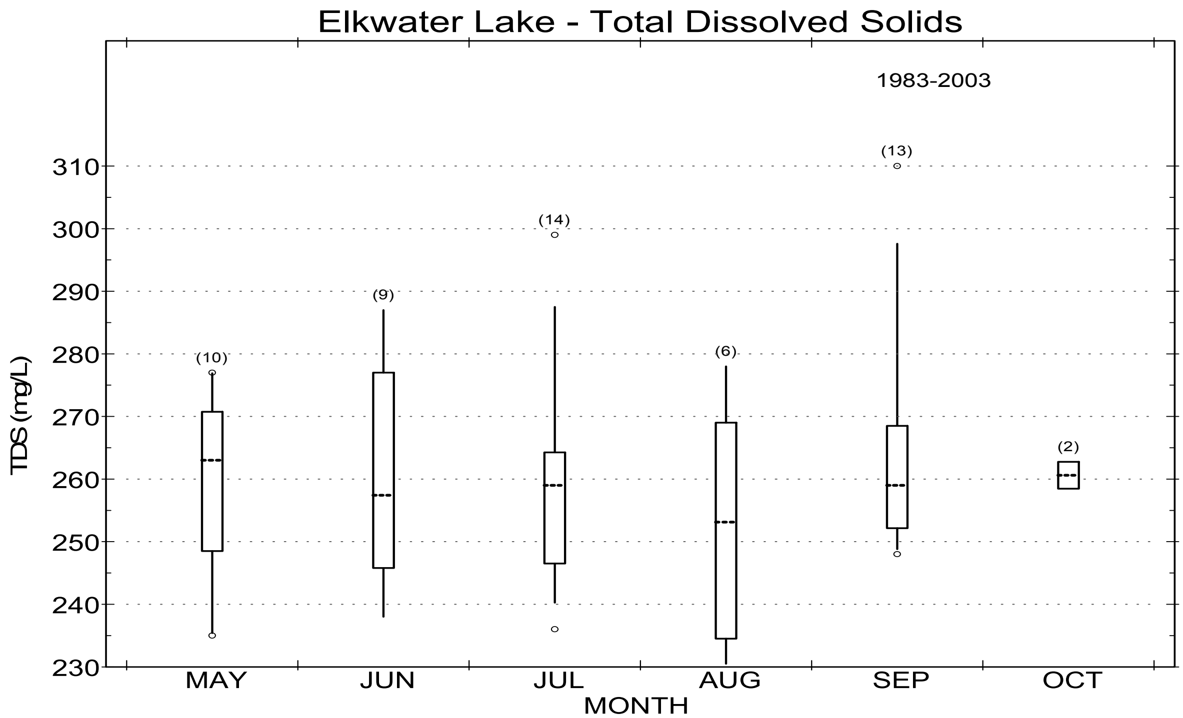


Figure 16 **Elkwater Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



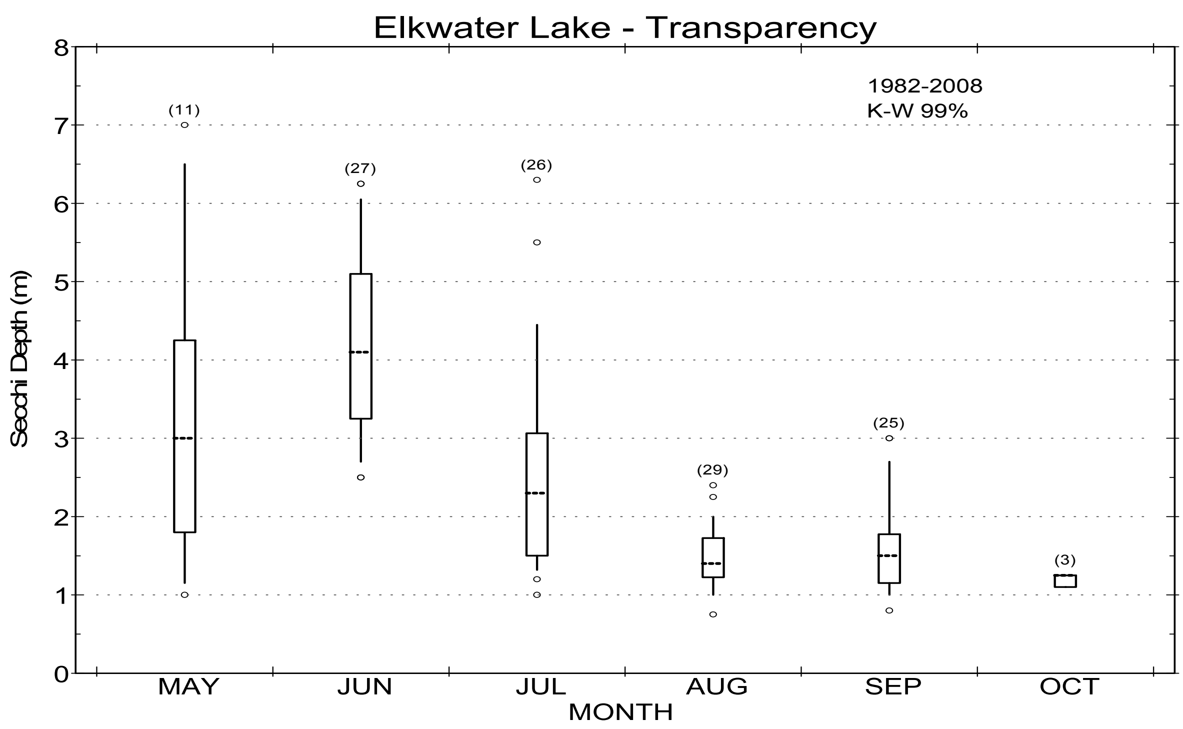
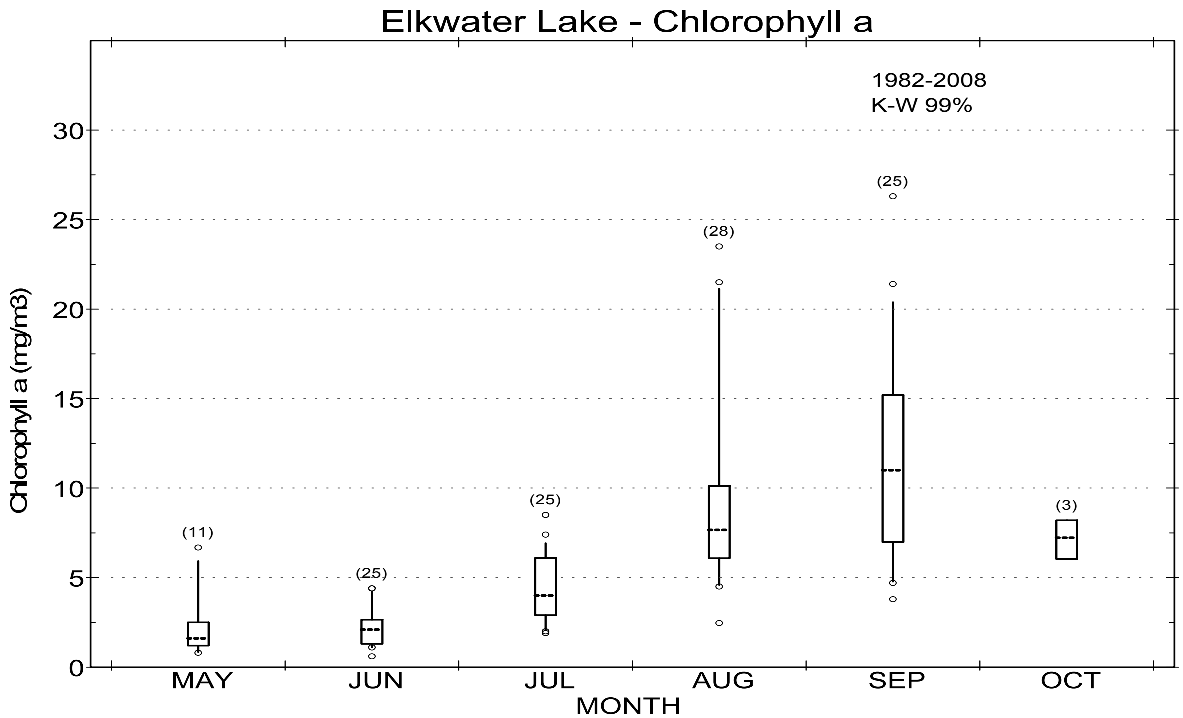


Figure 16 **Elkwater Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



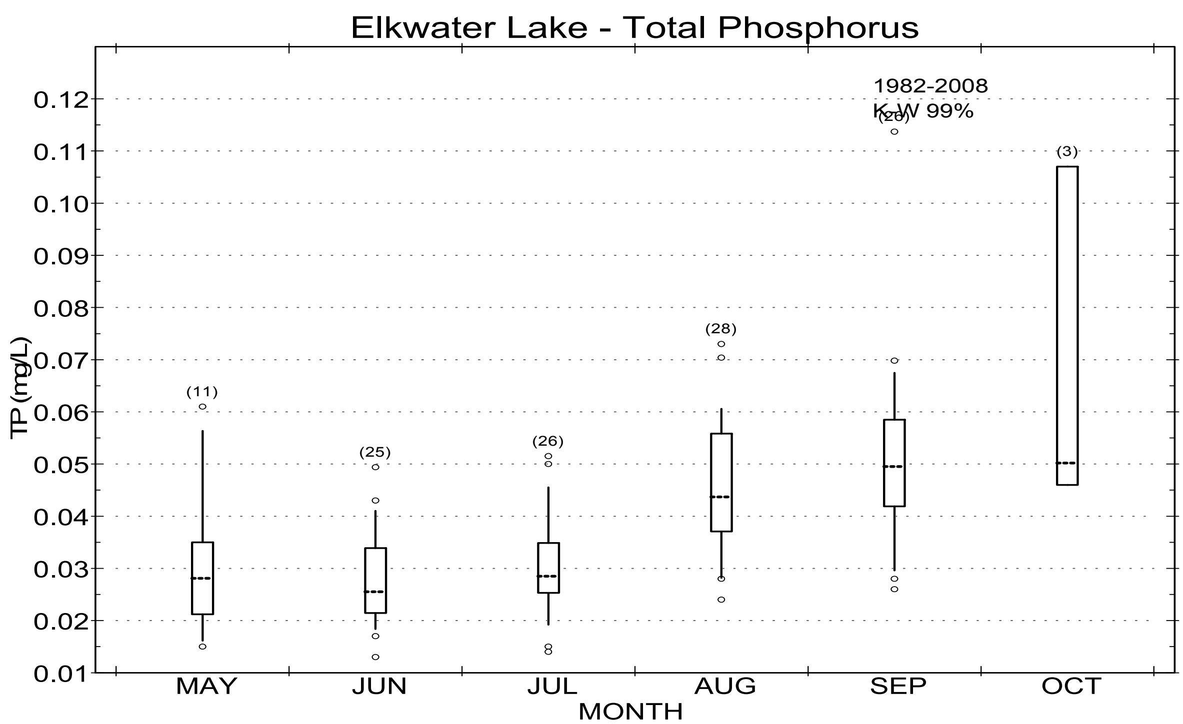
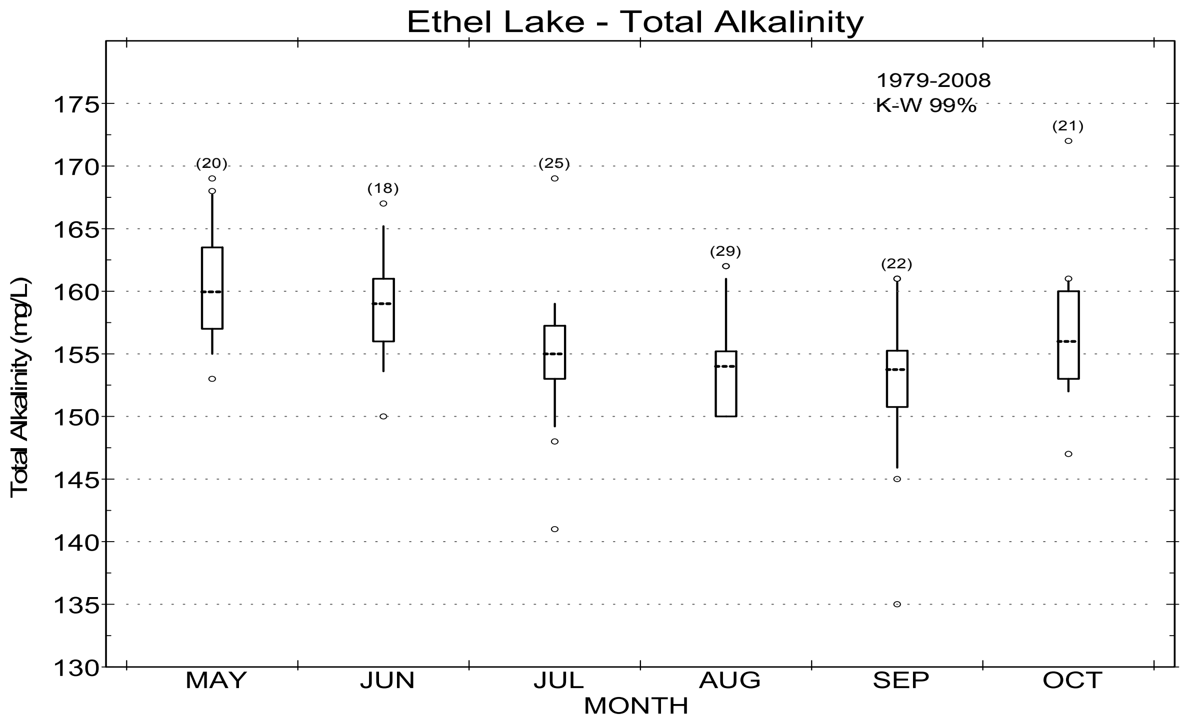


Figure 16 **Elkwater Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



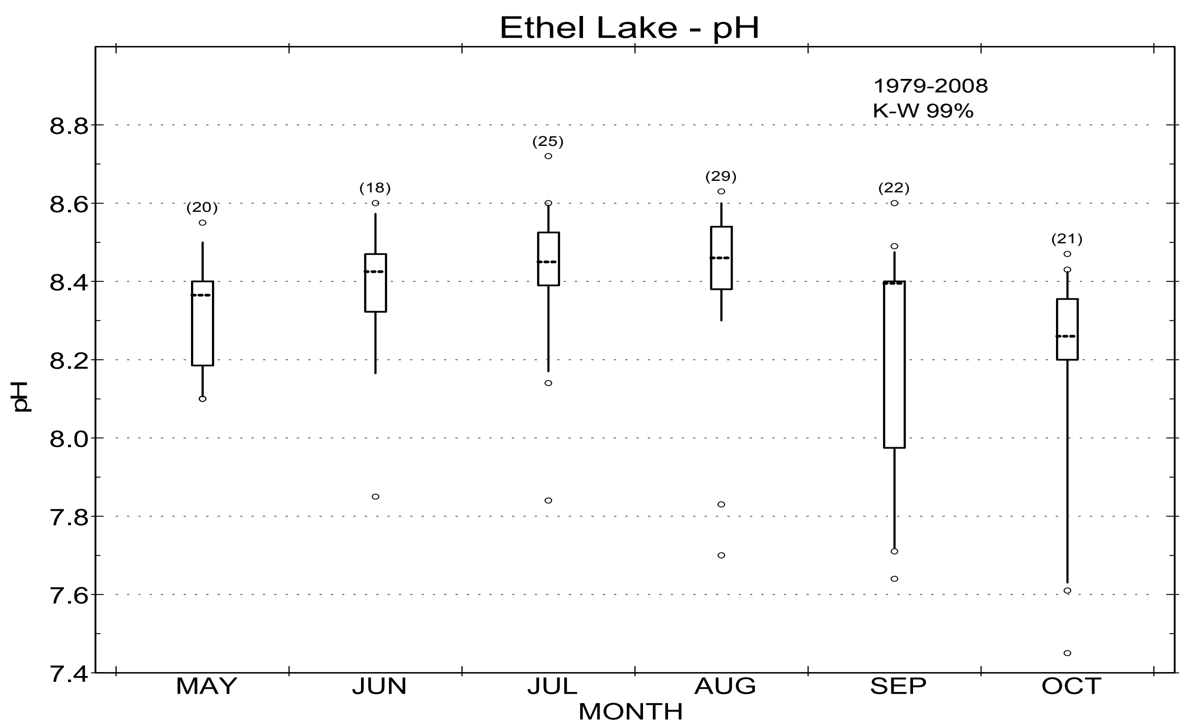
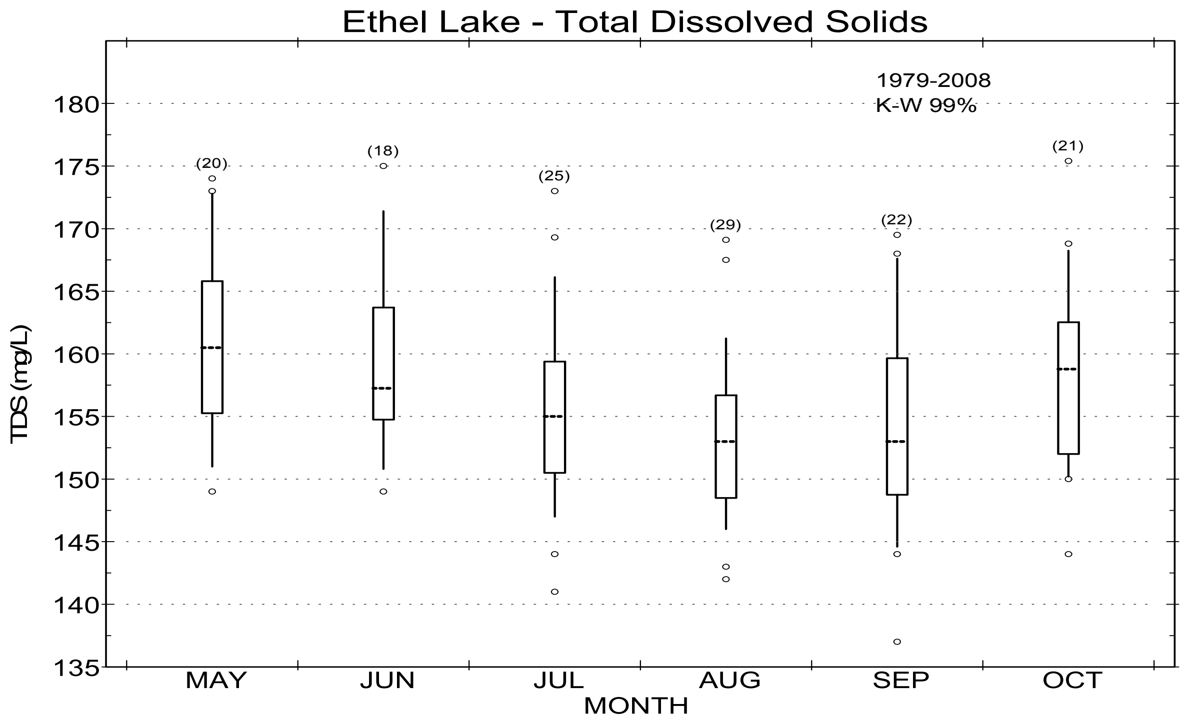


Figure 17a **Ethel Lake (near Cold Lake) -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



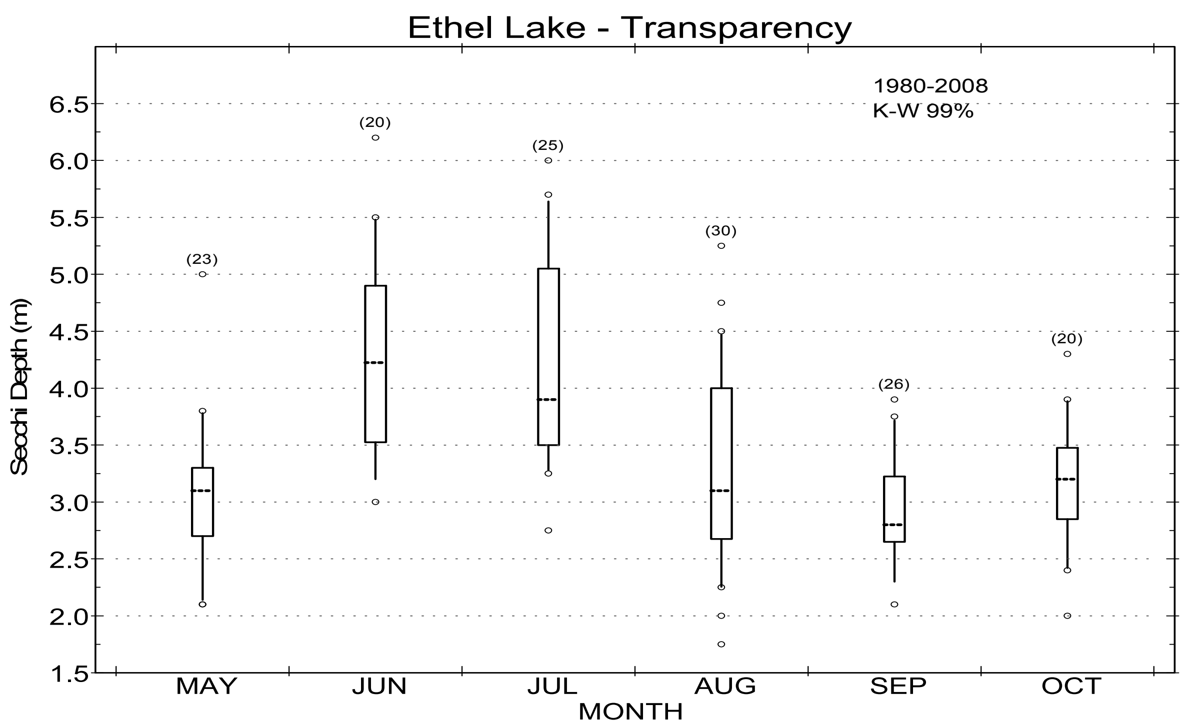
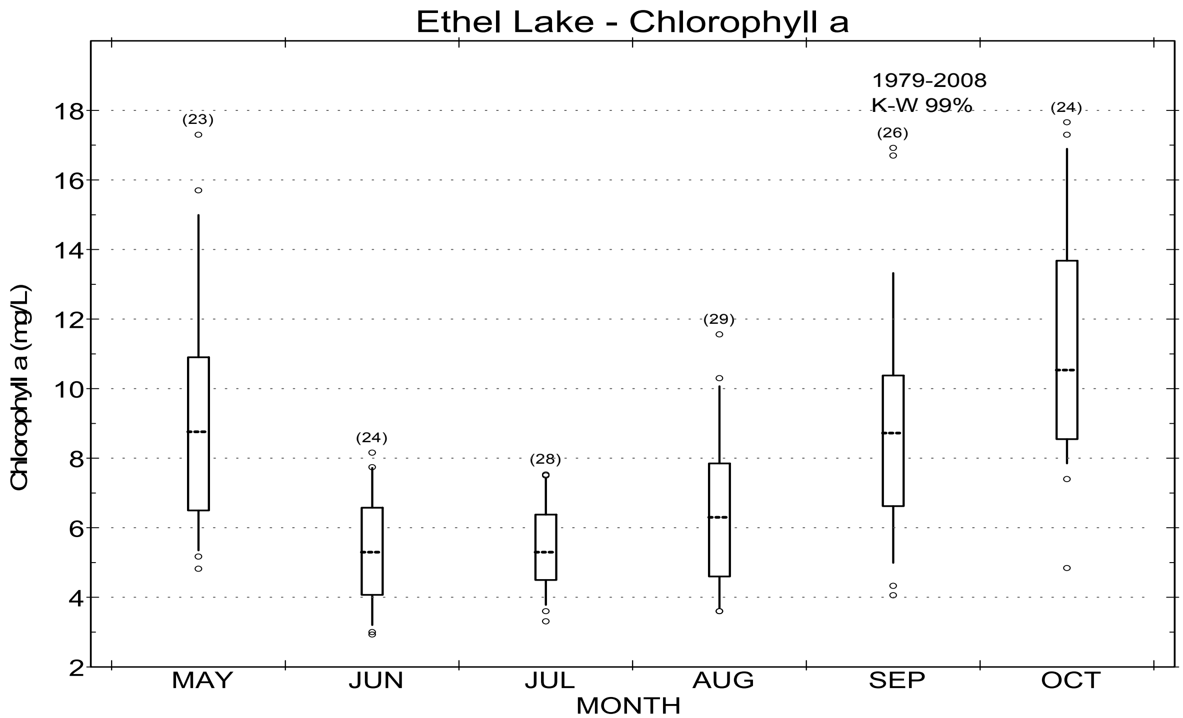


Figure 17a **Ethel Lake (near Cold Lake) -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



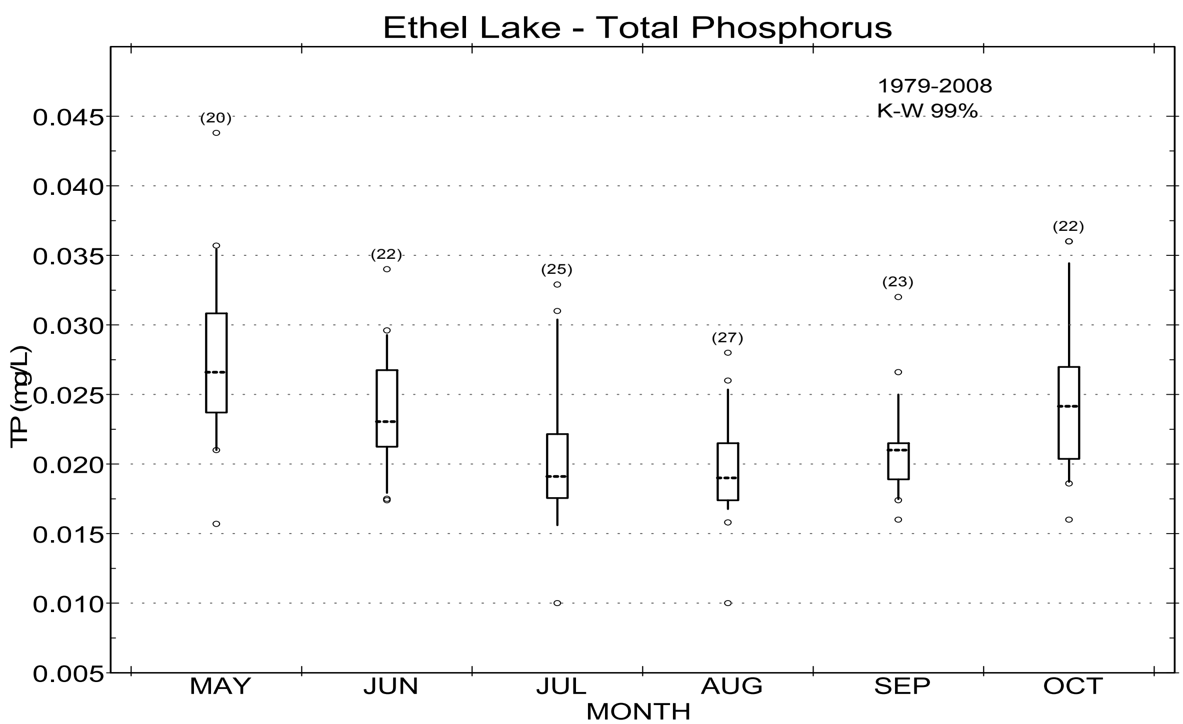
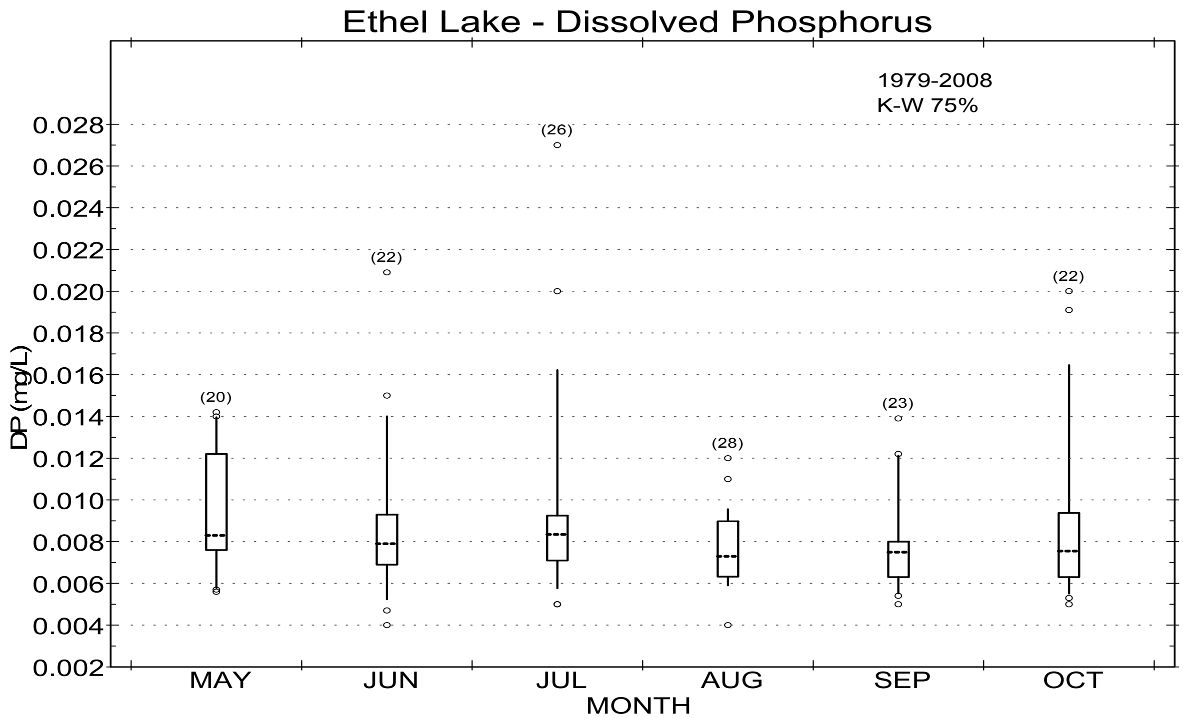


Figure 17a **Ethel Lake (near Cold Lake) -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



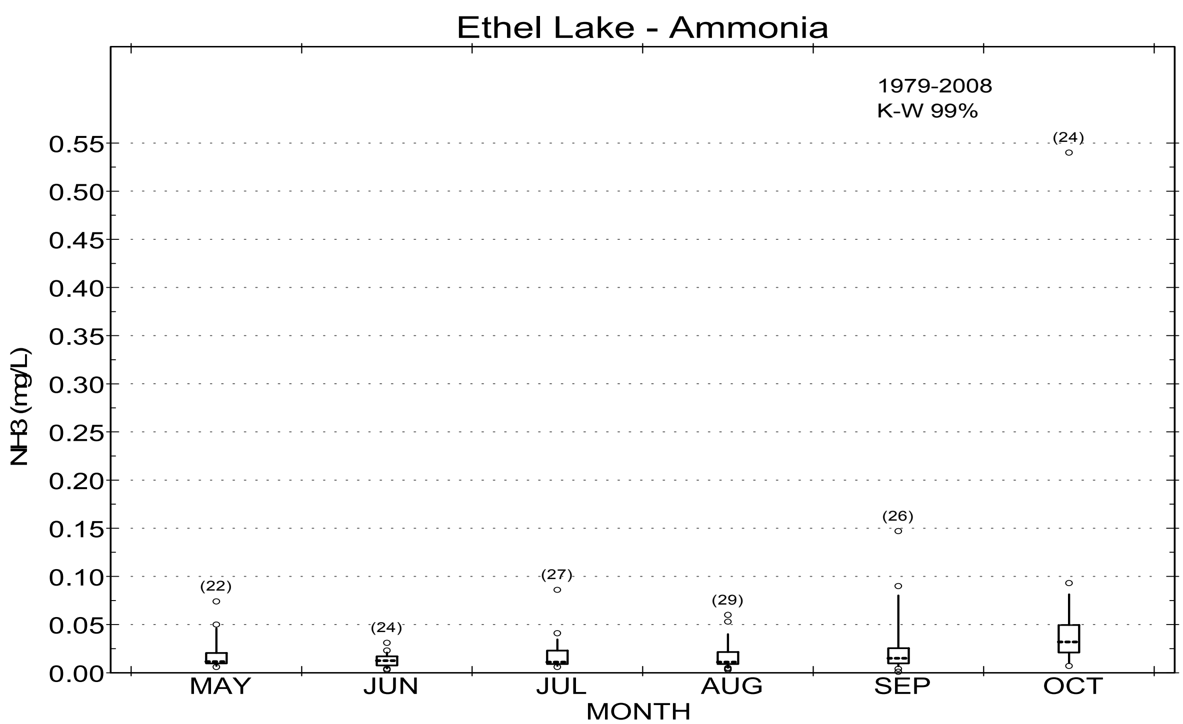
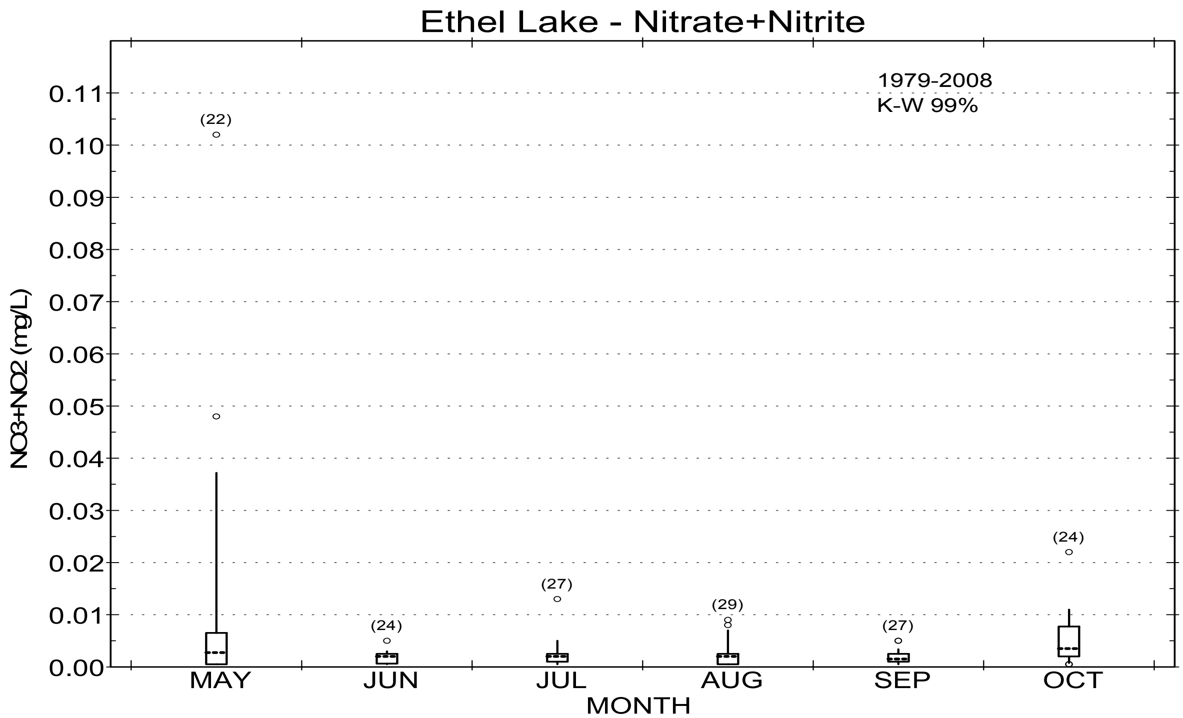


Figure 17b **Ethel Lake (near Cold Lake) -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month



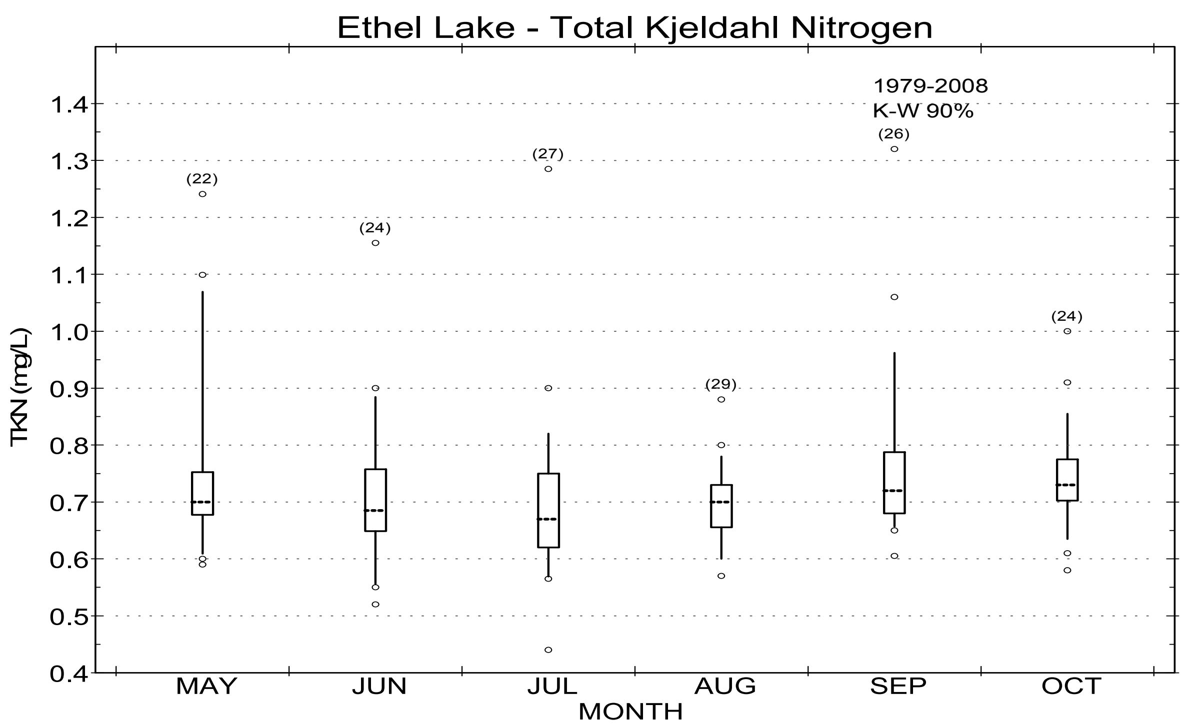
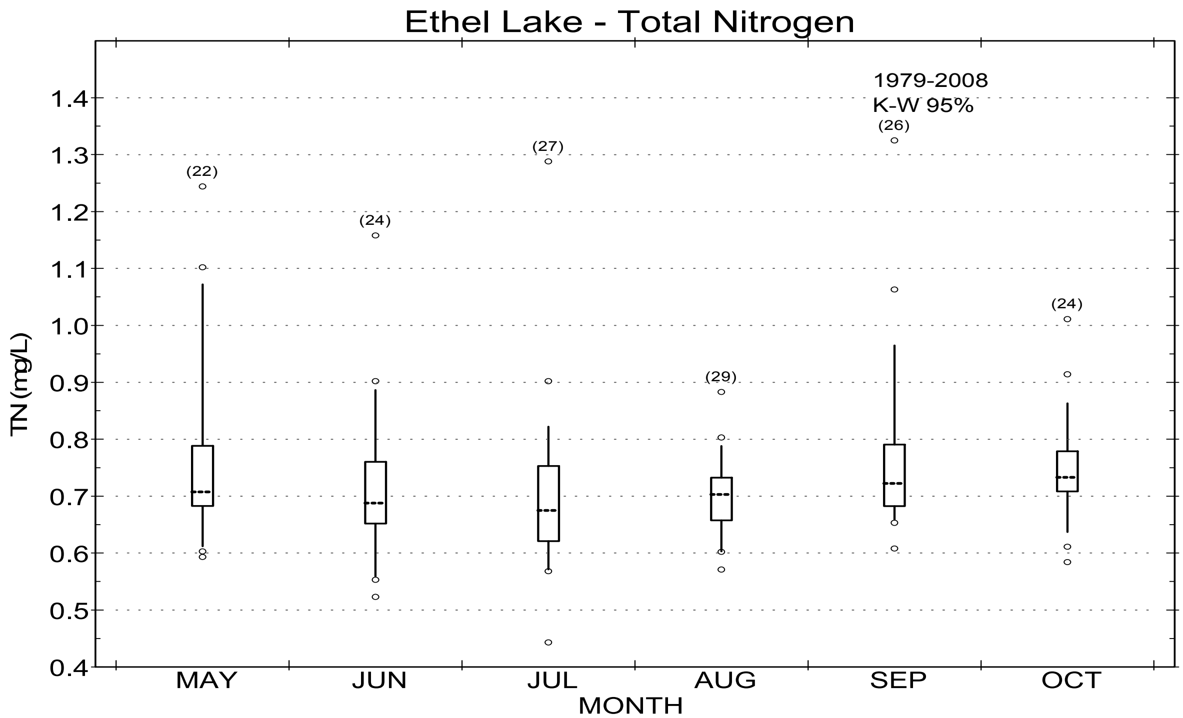


Figure 17b **Ethel Lake (near Cold Lake) -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month. Note that 46% of the nitrate+nitrite-N samples were <MDL and the MDL concentration was used for these data (continued)



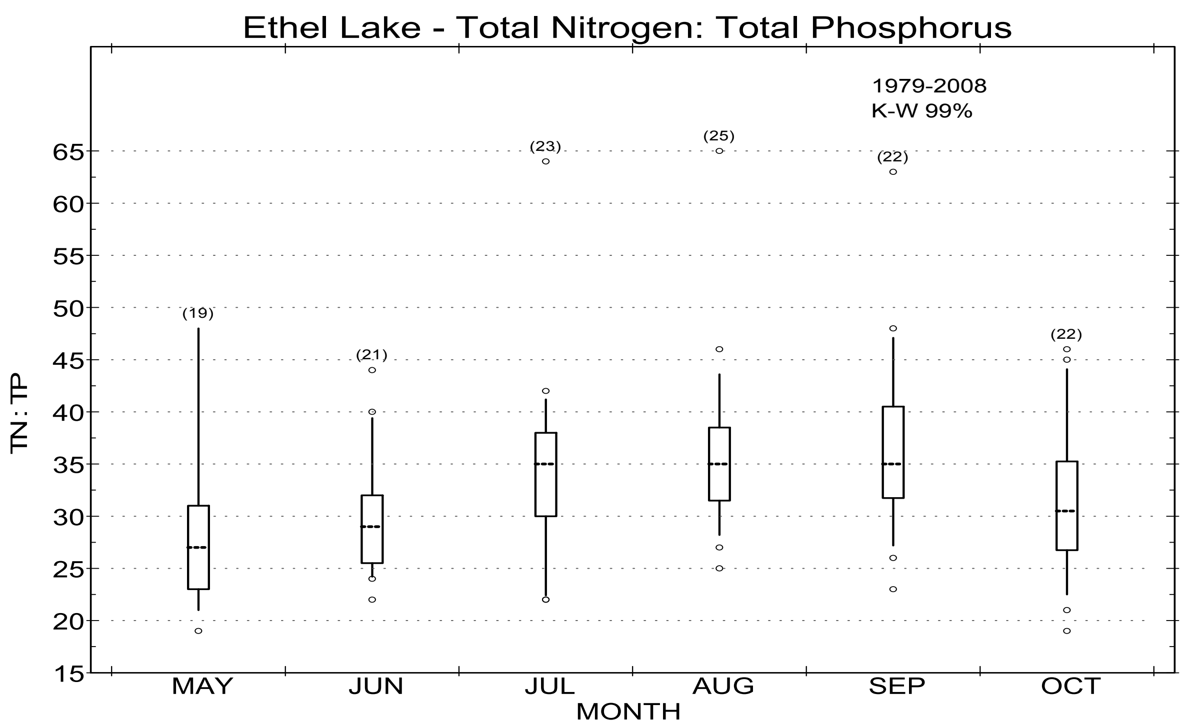
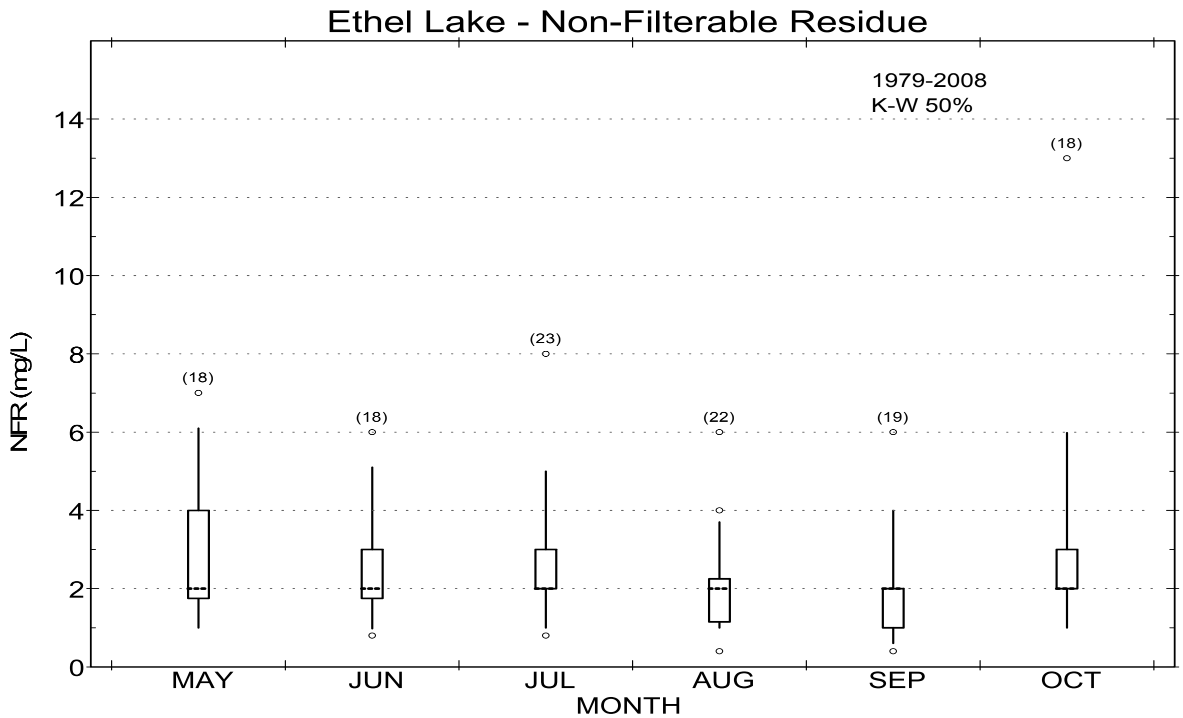


Figure 17b **Ethel Lake (near Cold Lake) -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)



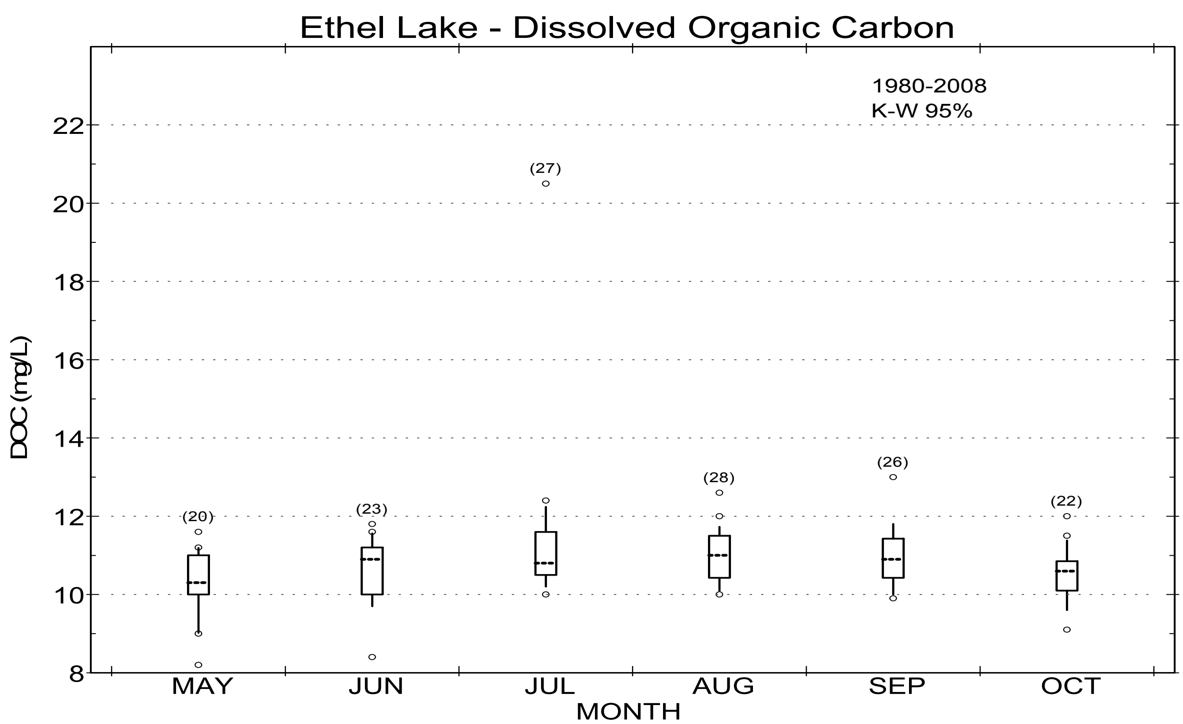


Figure 17b **Ethel Lake (near Cold Lake)** - Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)

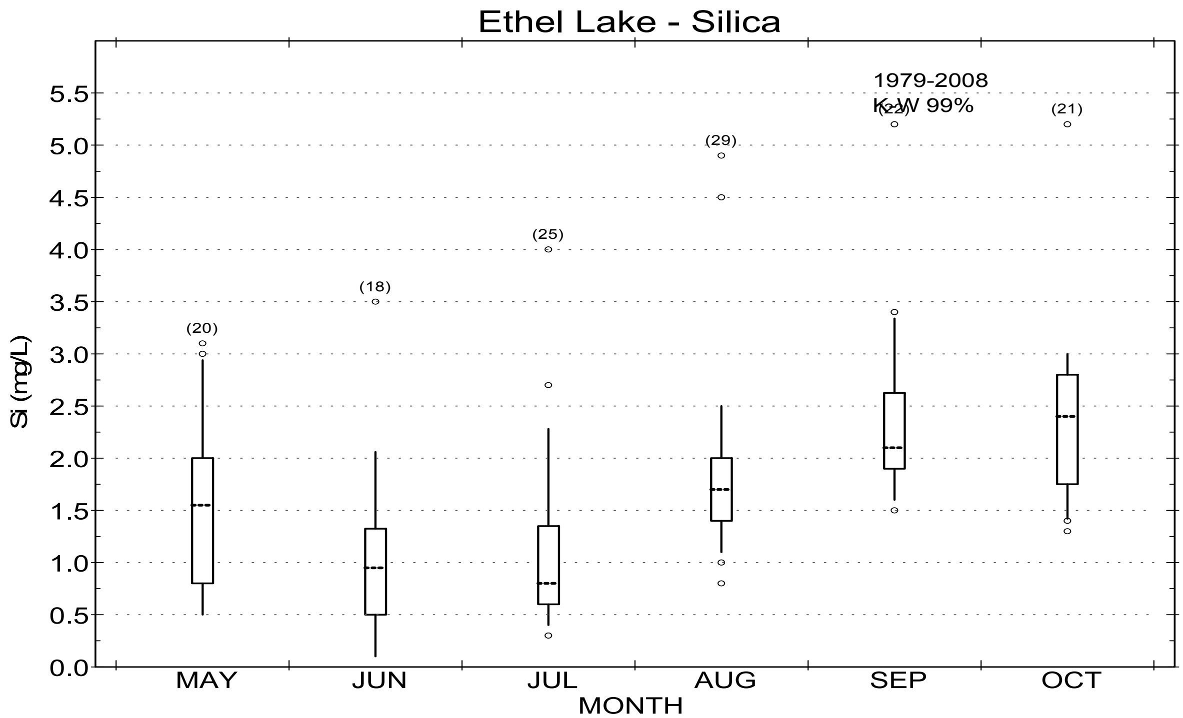
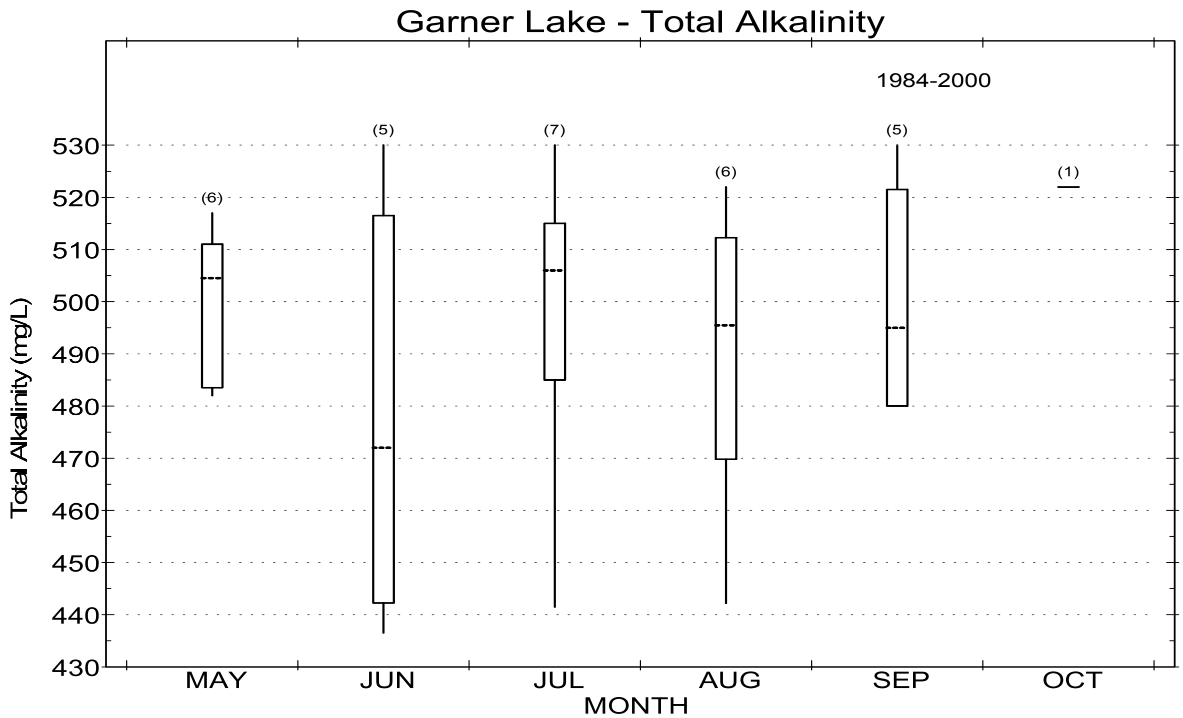


Figure 17b **Ethel Lake (near Cold Lake) -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (concluded)



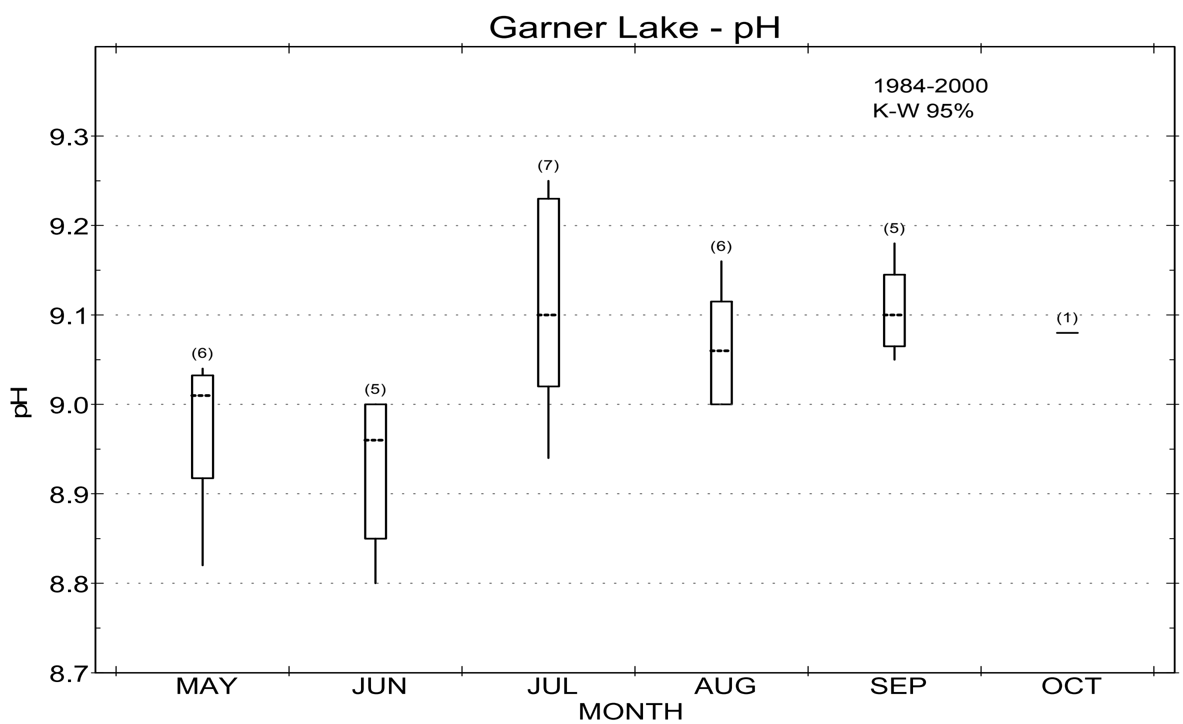
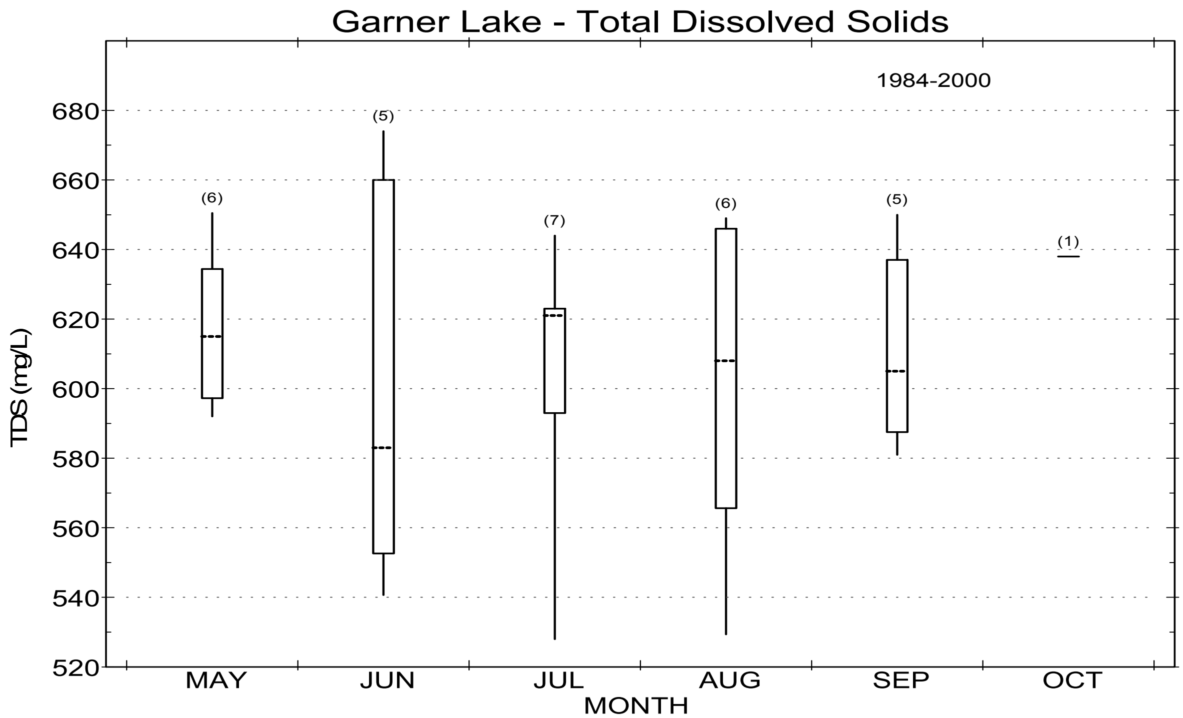


Figure 18 **Garner Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



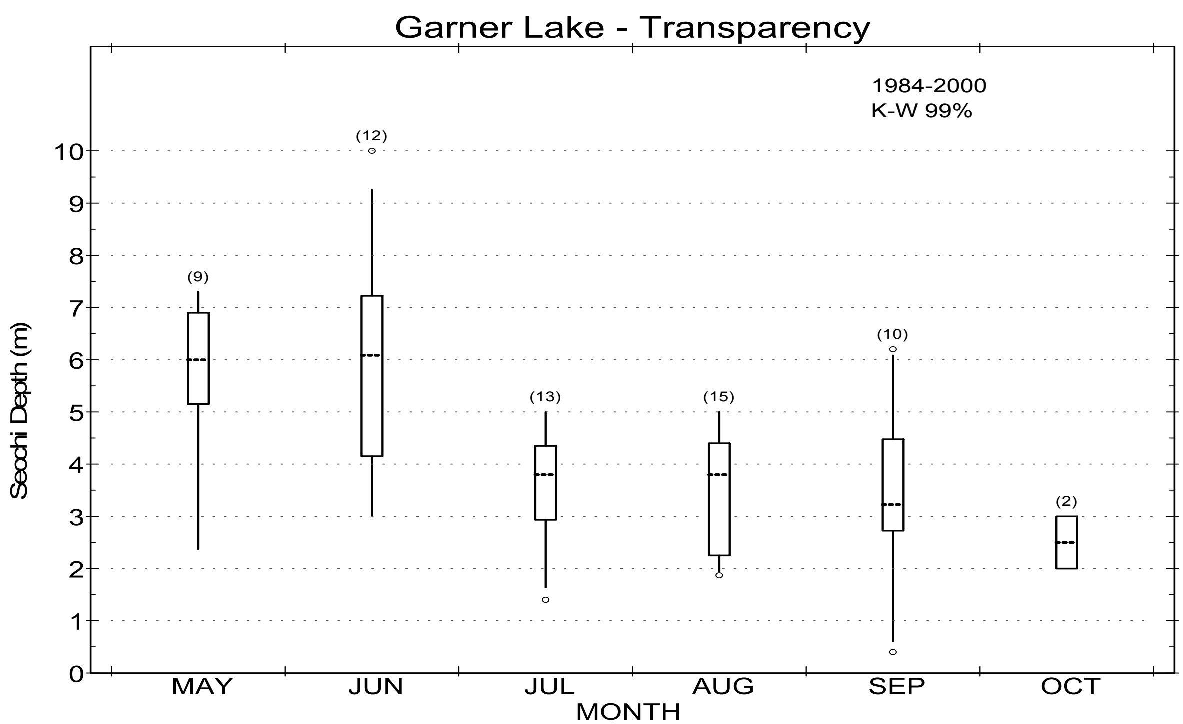
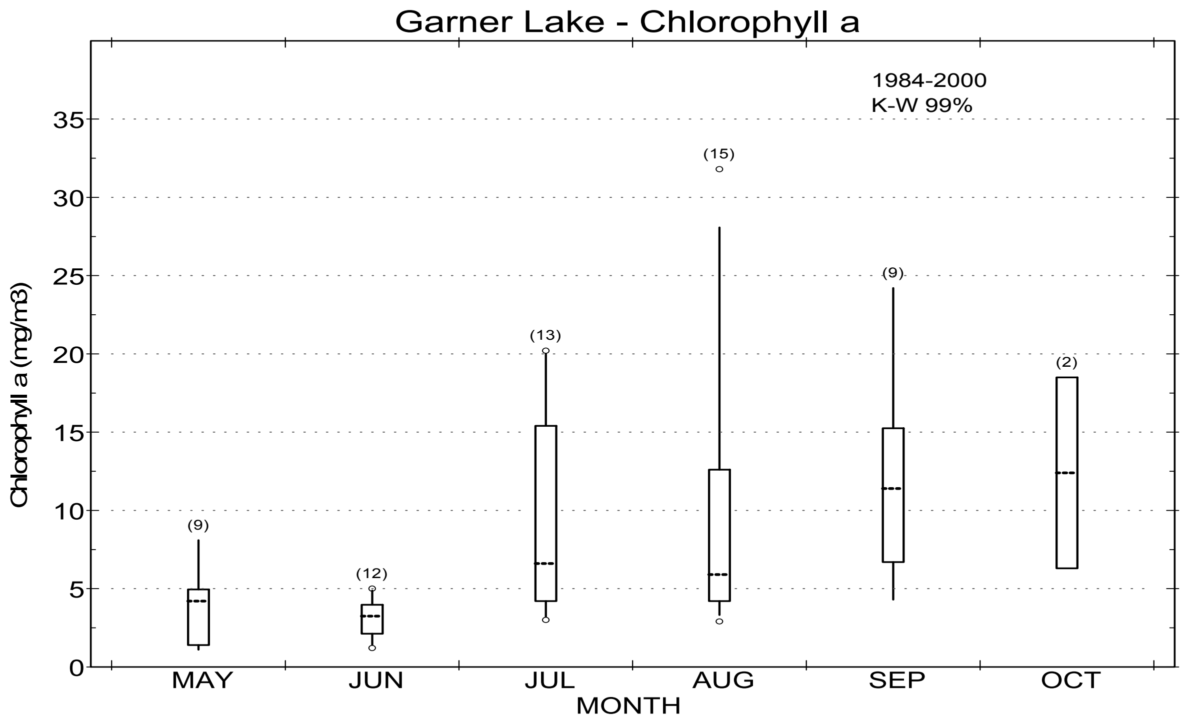


Figure 18 **Garner Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



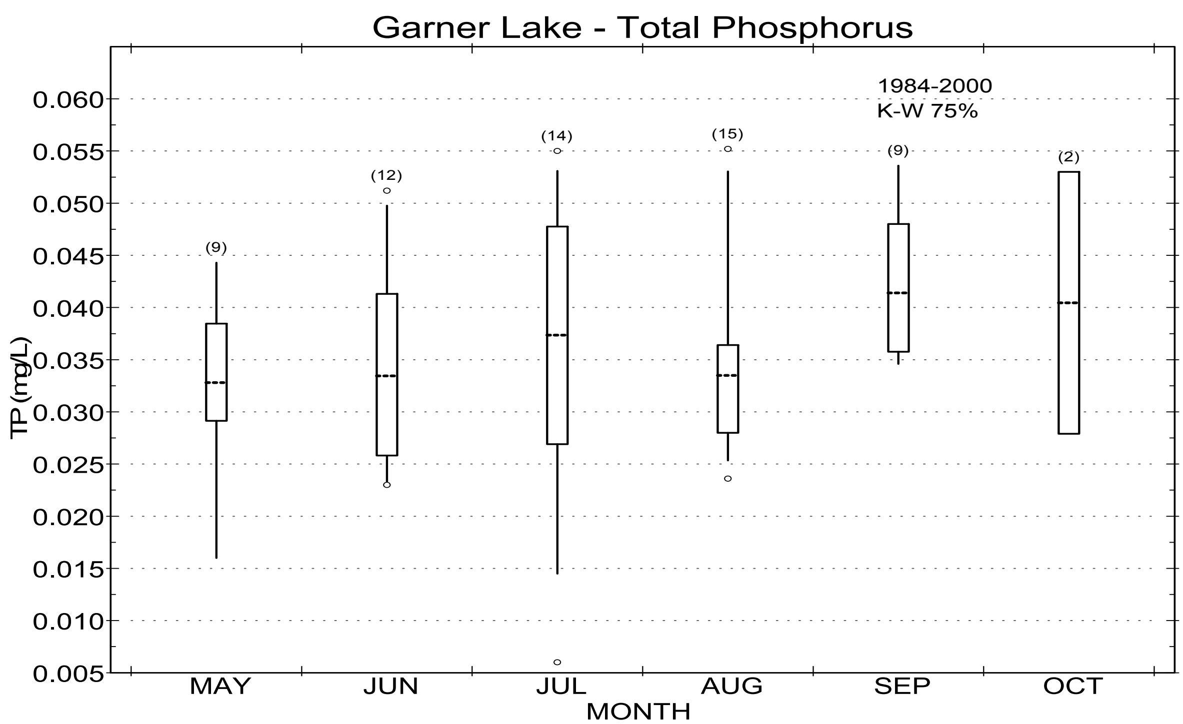
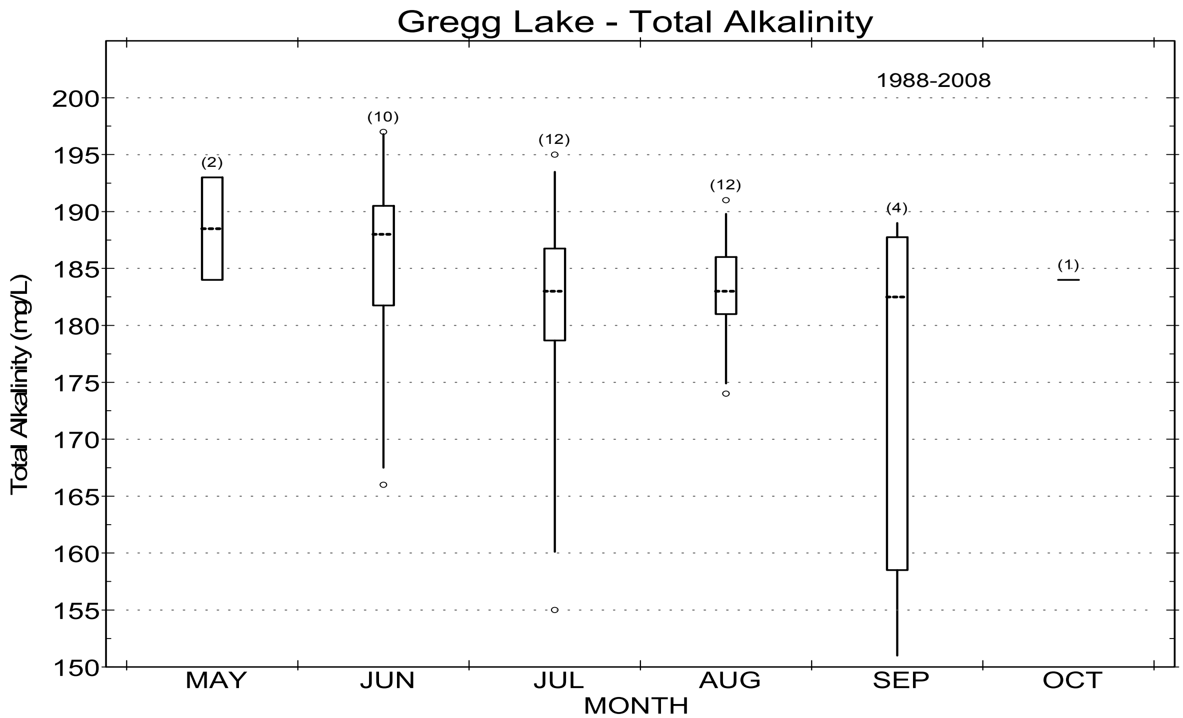


Figure 18 **Garner Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



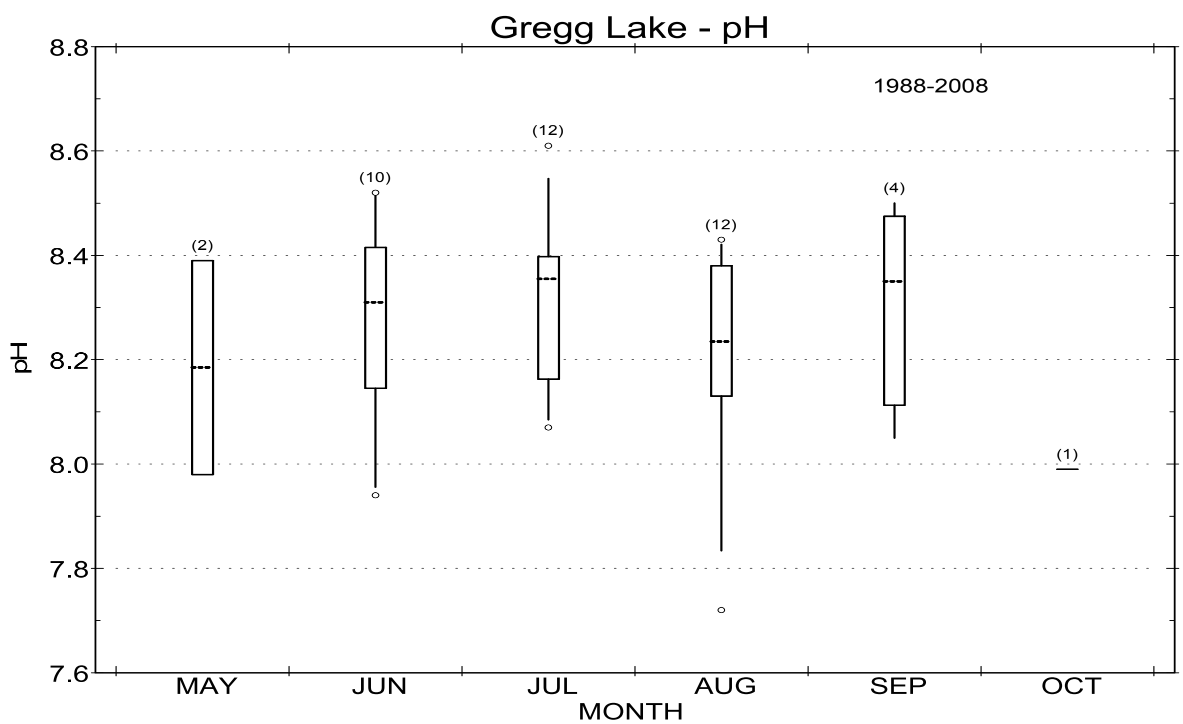
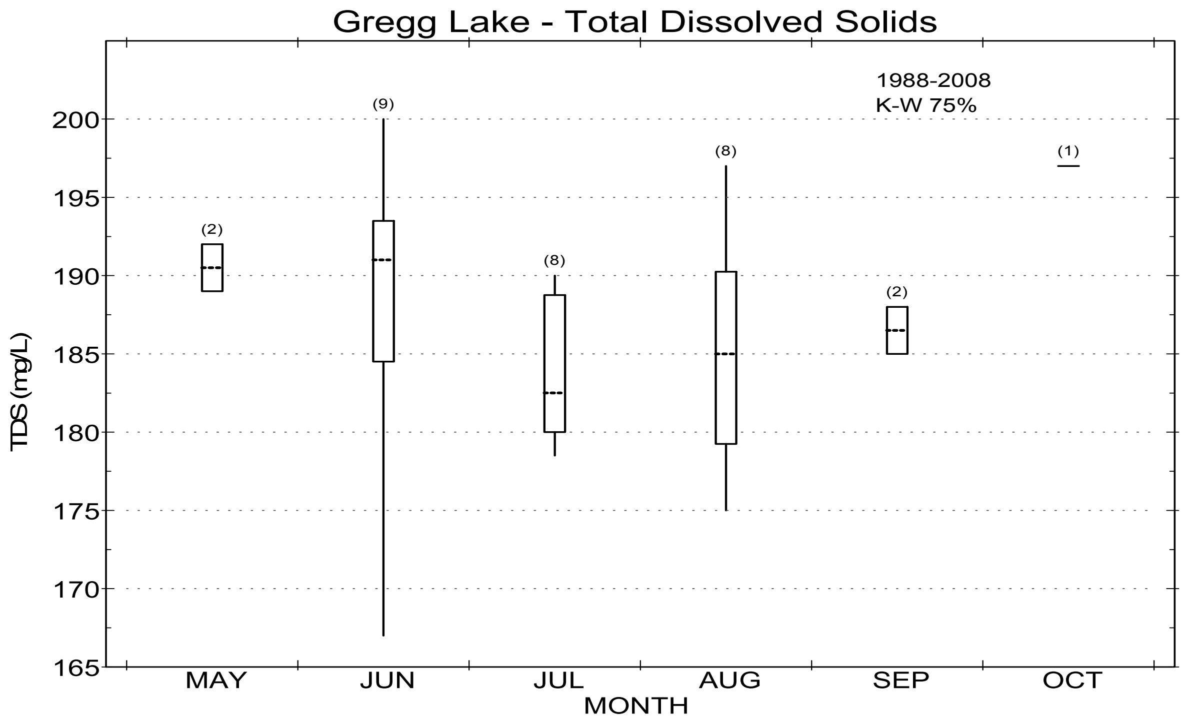


Figure 19 **Gregg Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



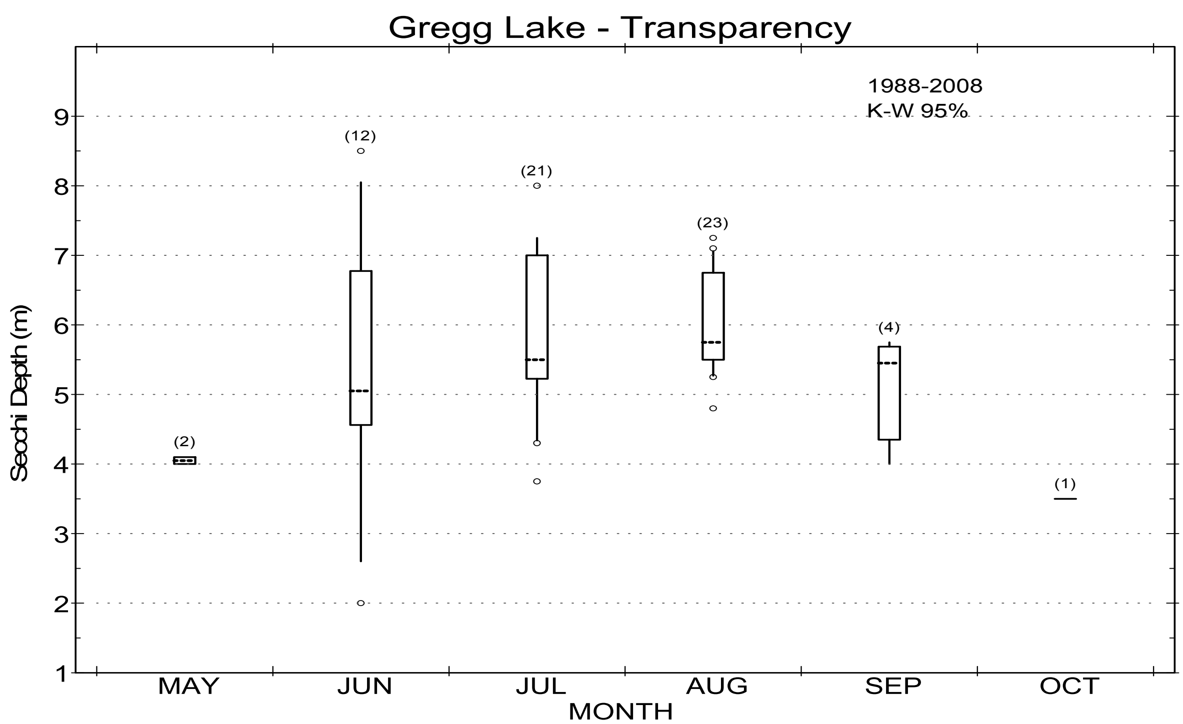
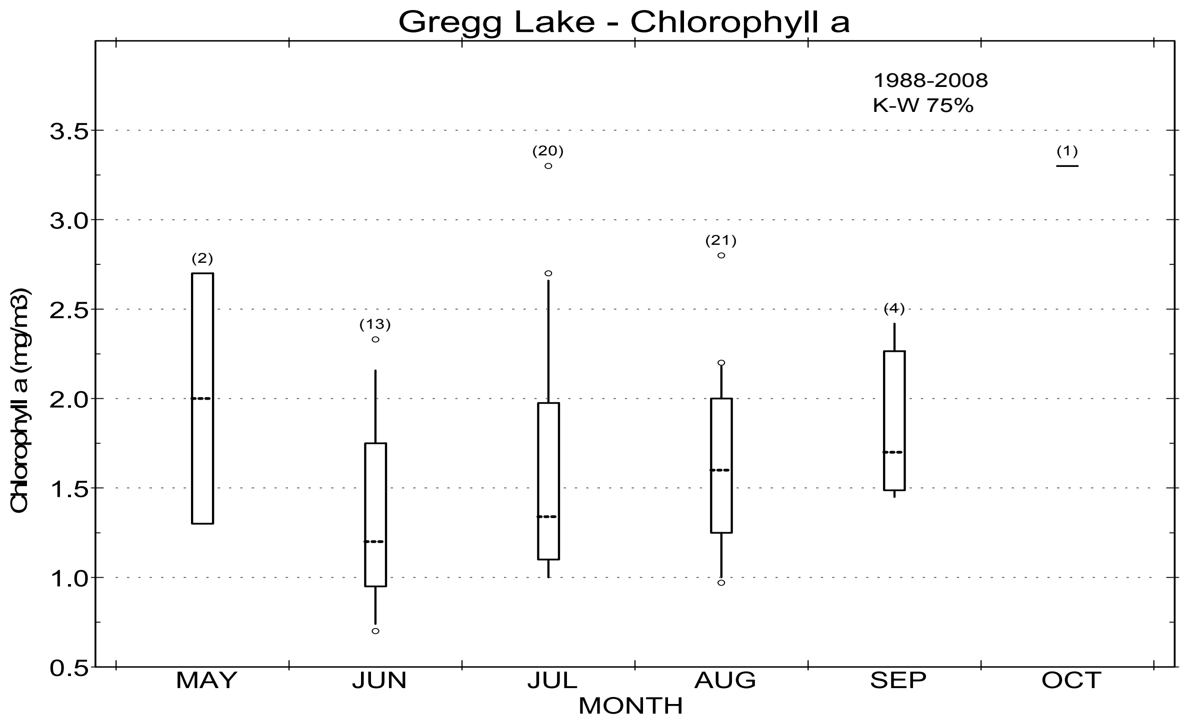


Figure 19 **Gregg Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



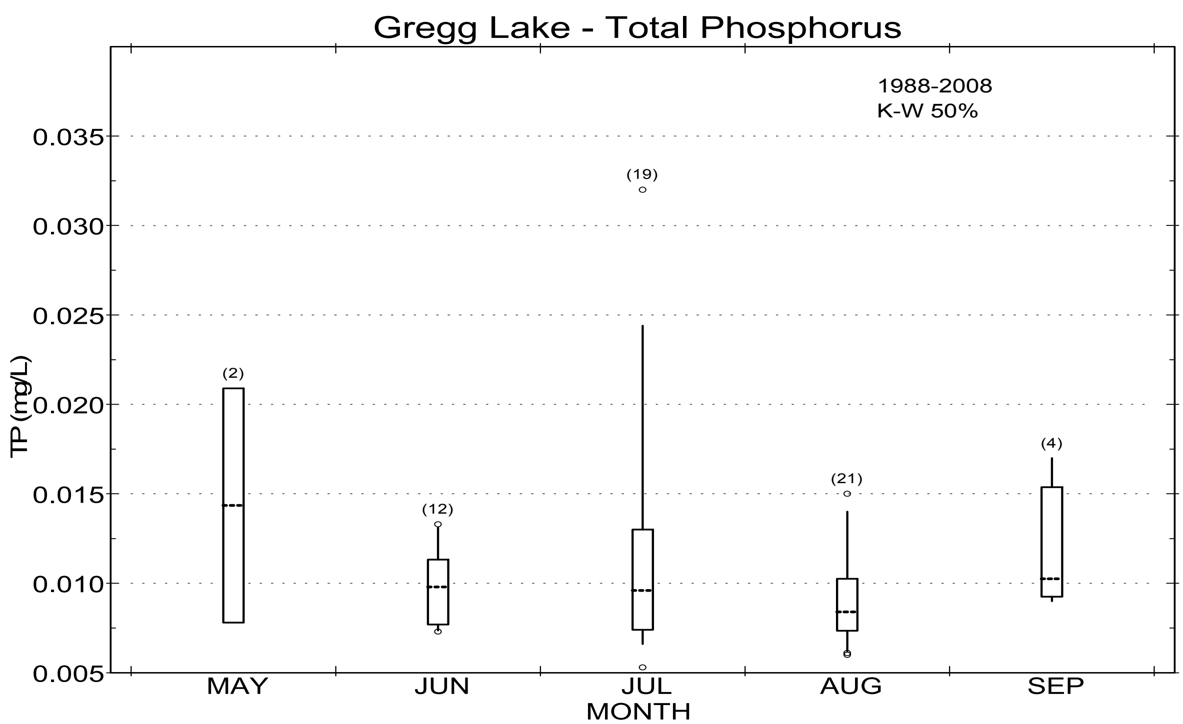
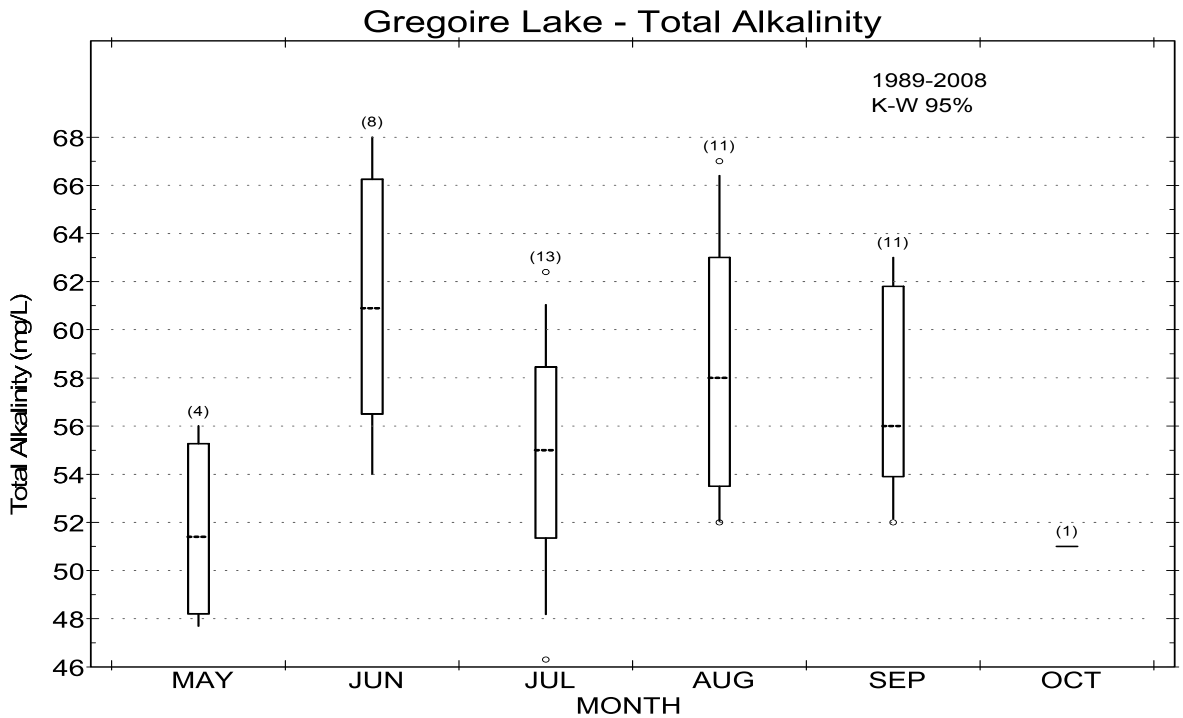


Figure 19 **Gregg Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



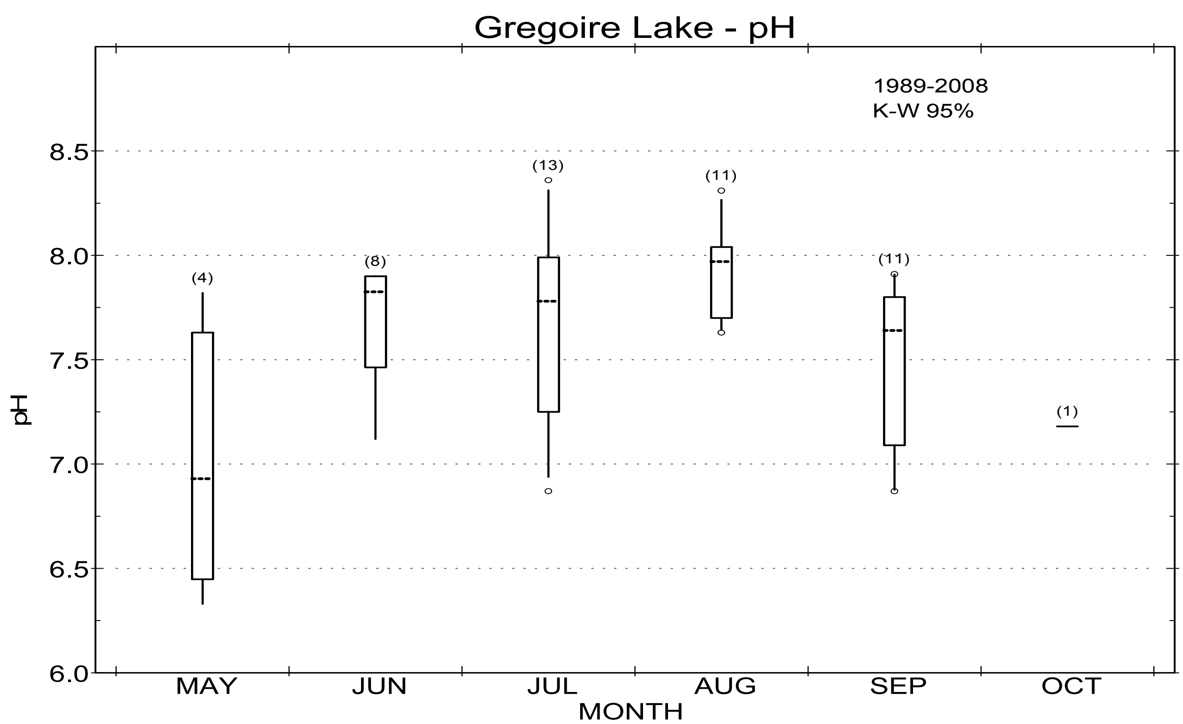
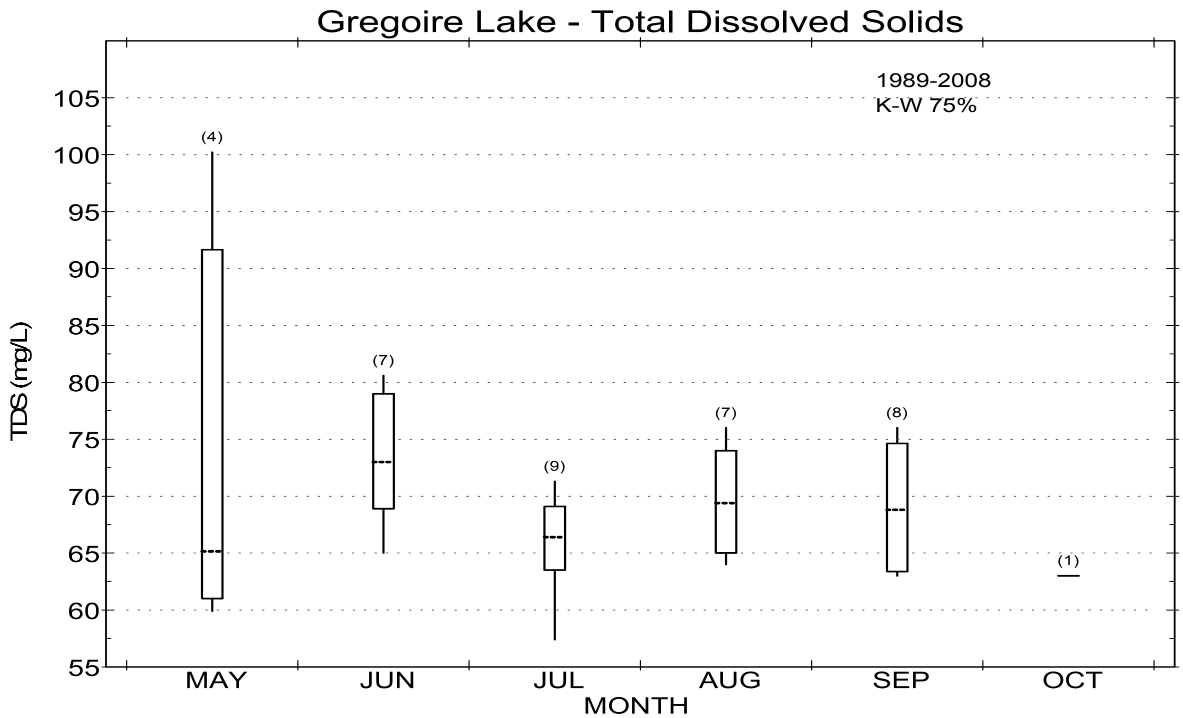


Figure 20 **Gregoire Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



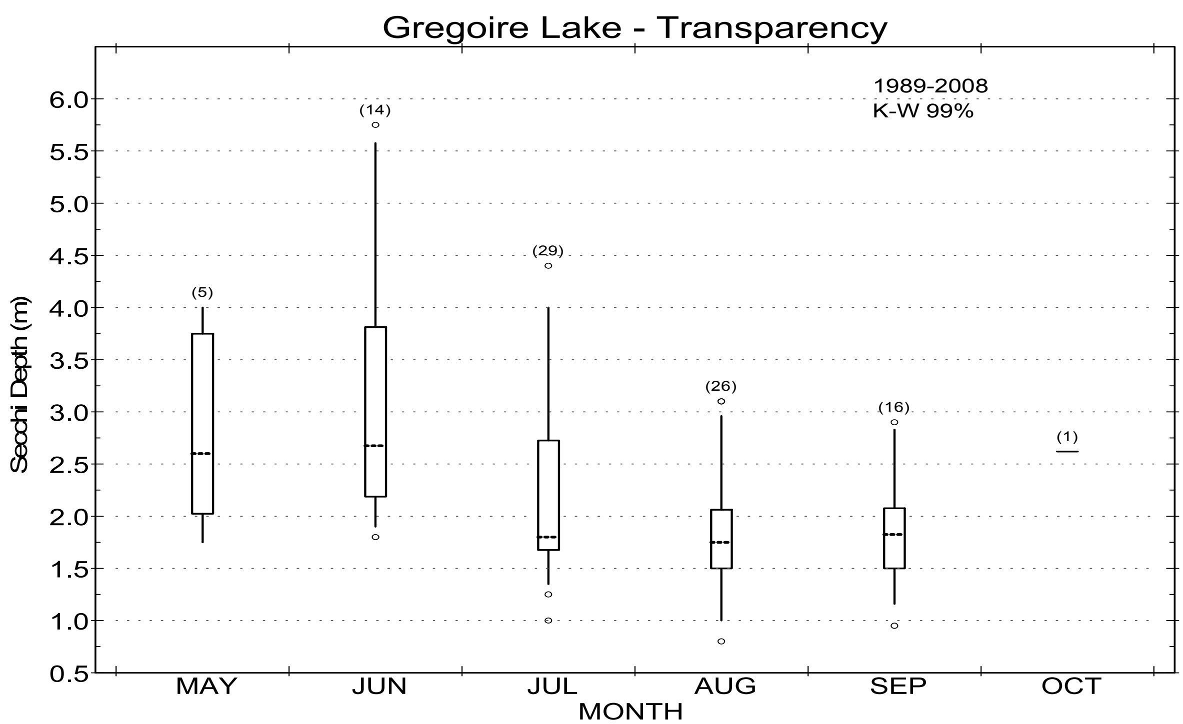
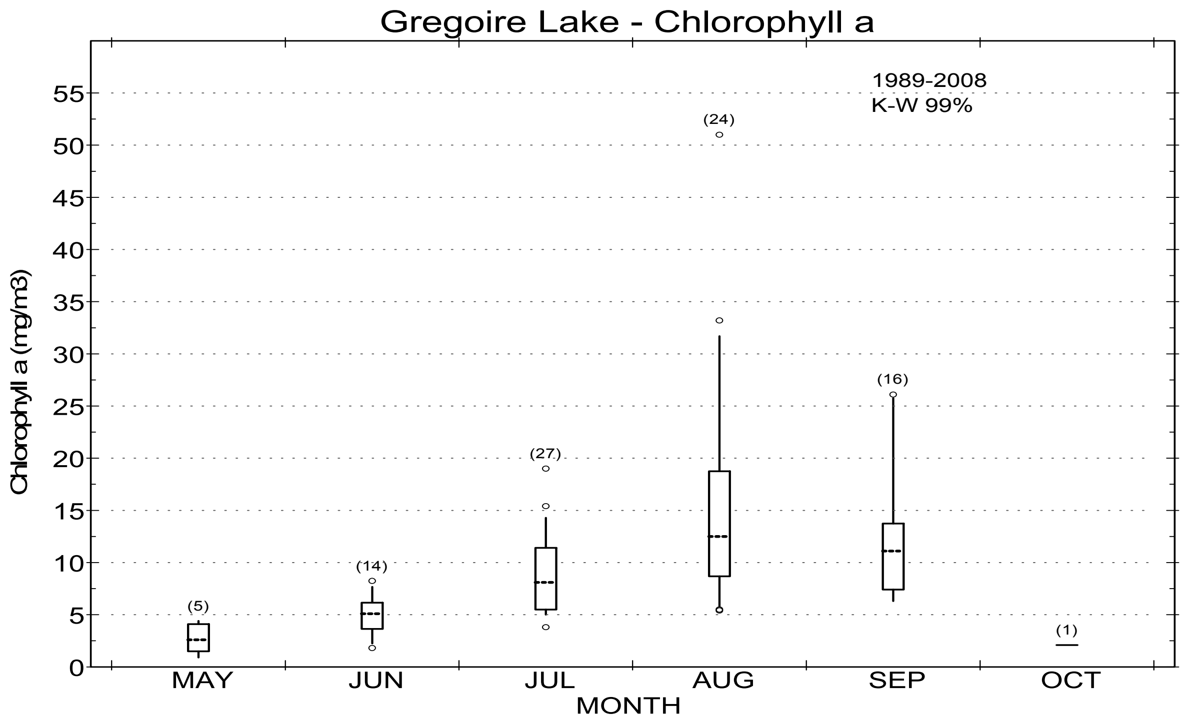


Figure 20 **Gregoire Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



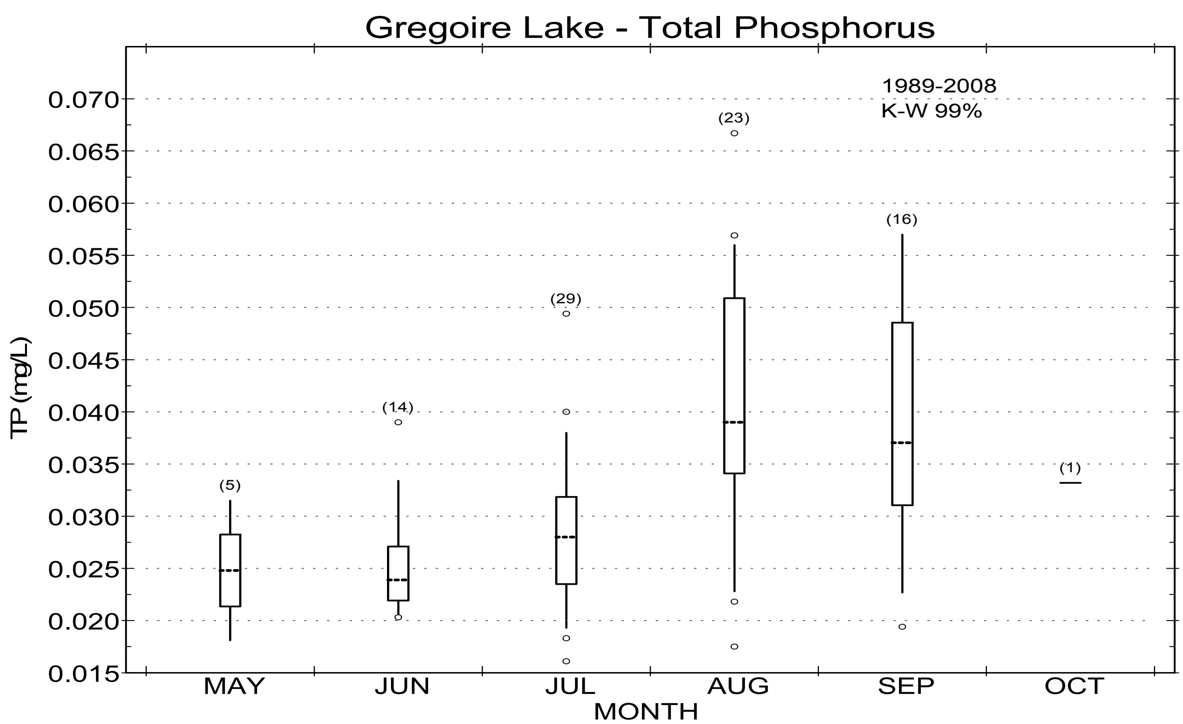
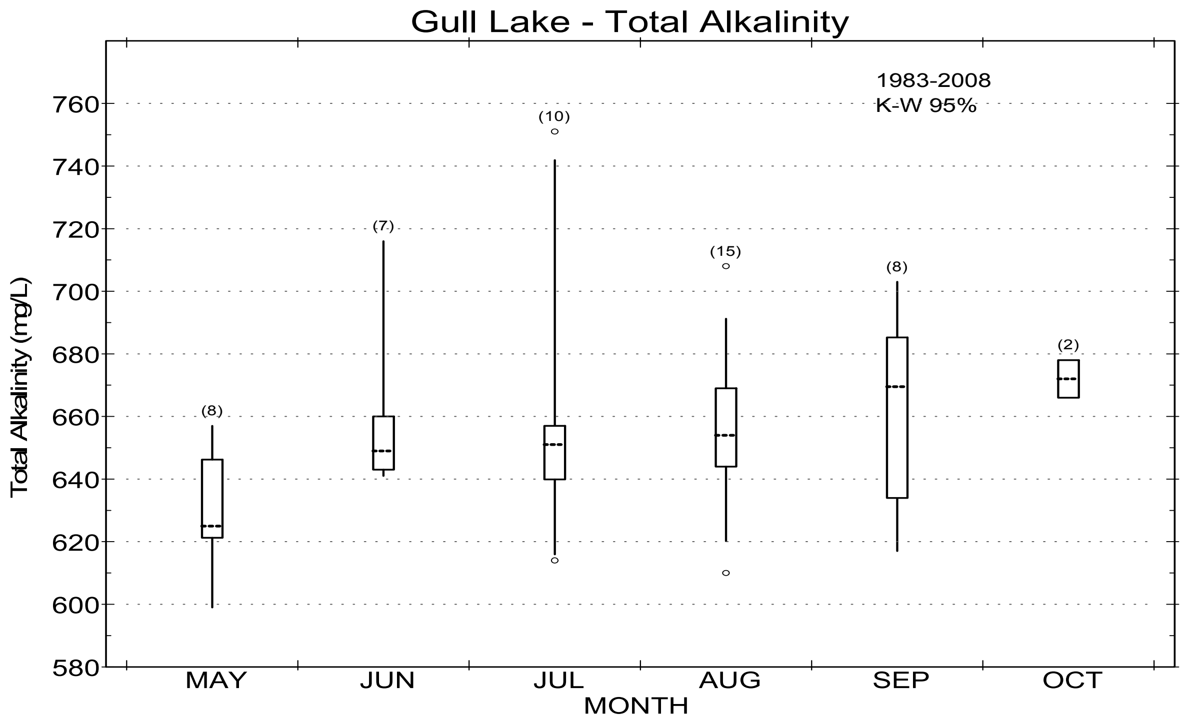


Figure 20 **Gregoire Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



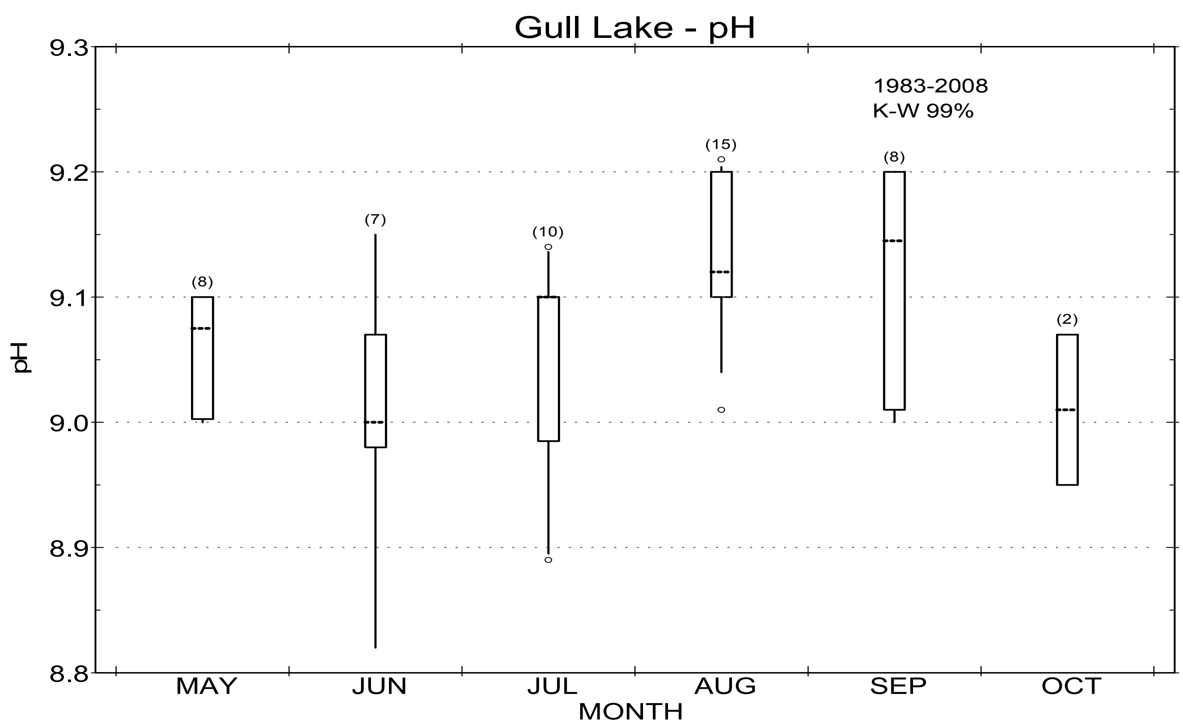
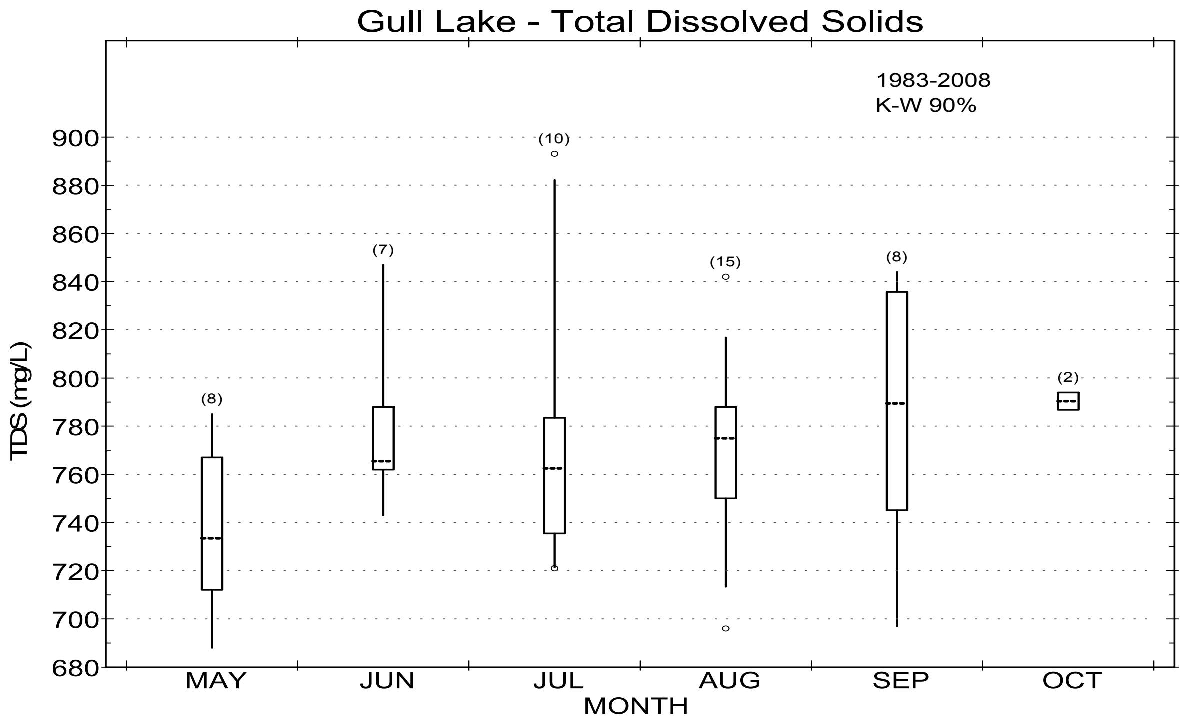


Figure 21 **Gull Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



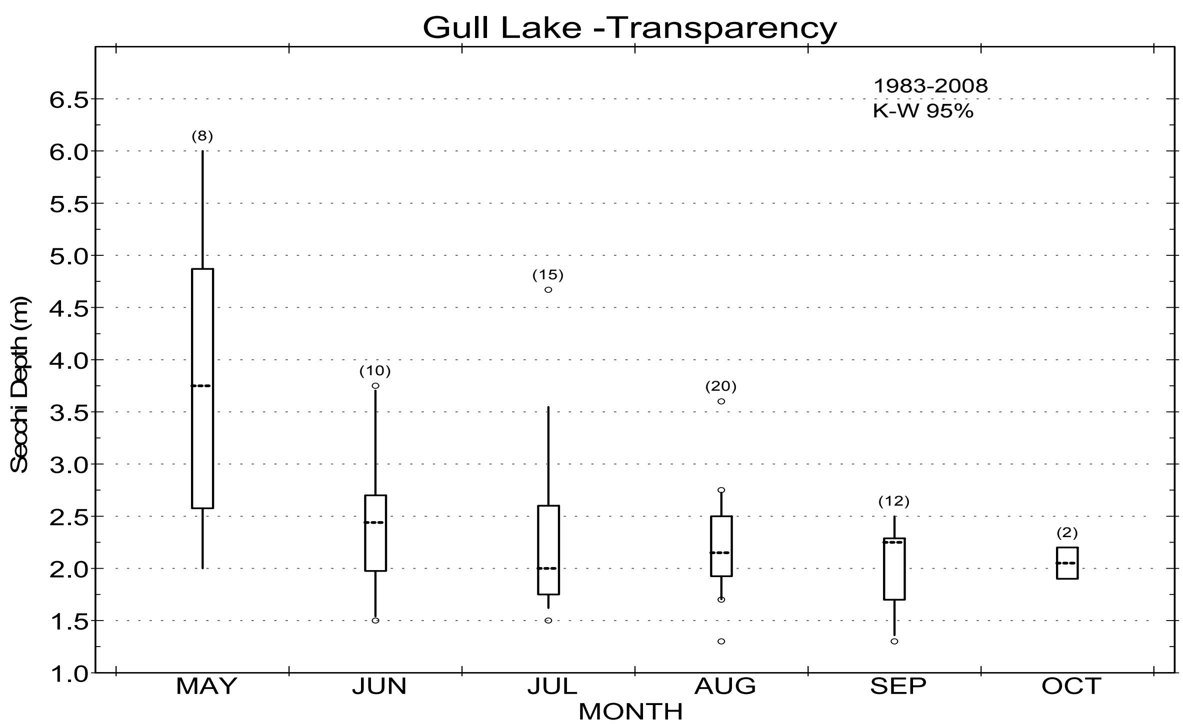
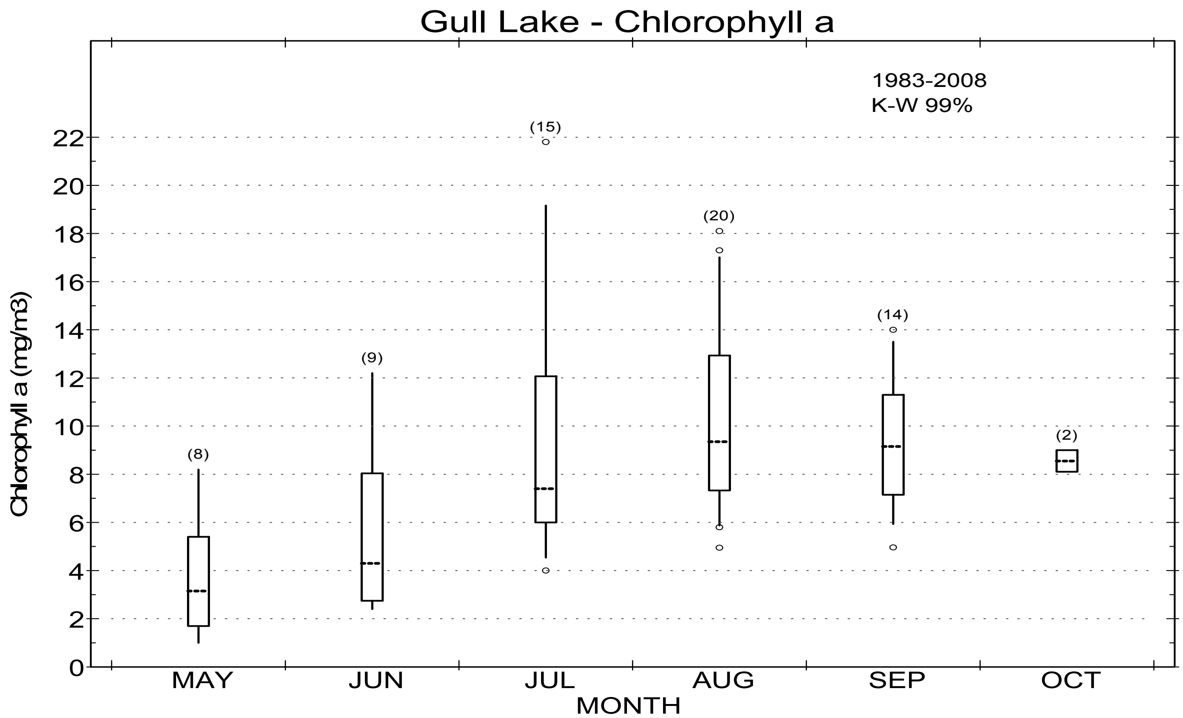


Figure 21 **Gull Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



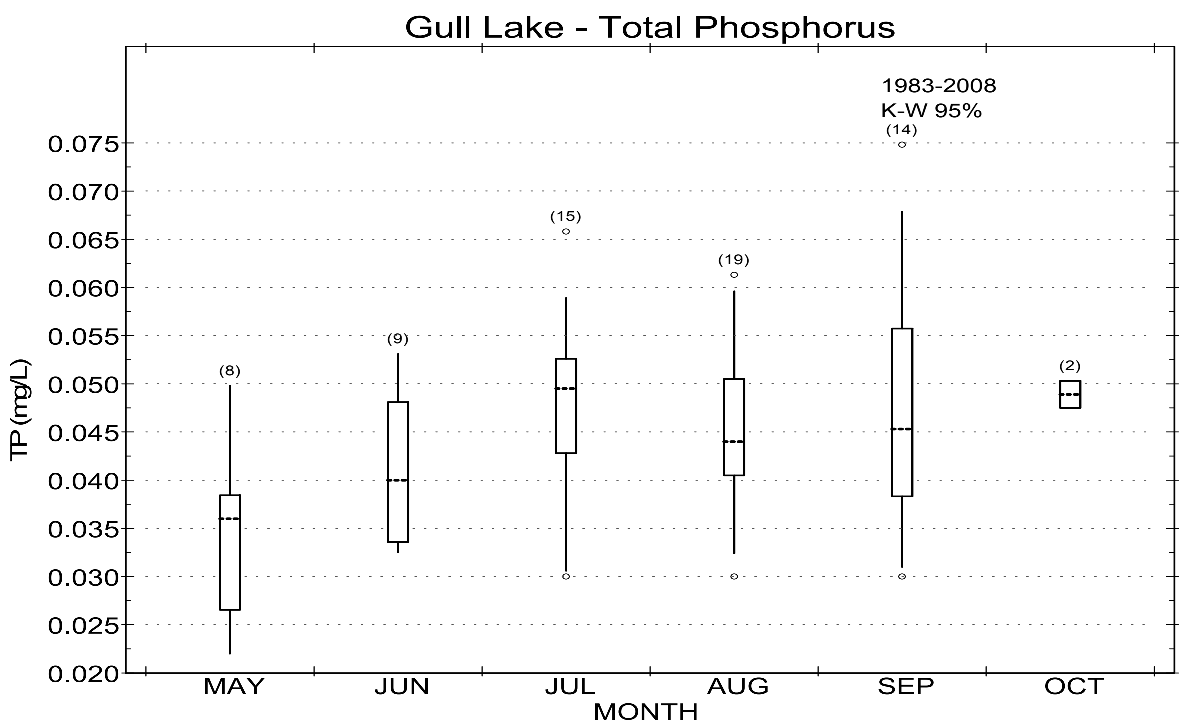
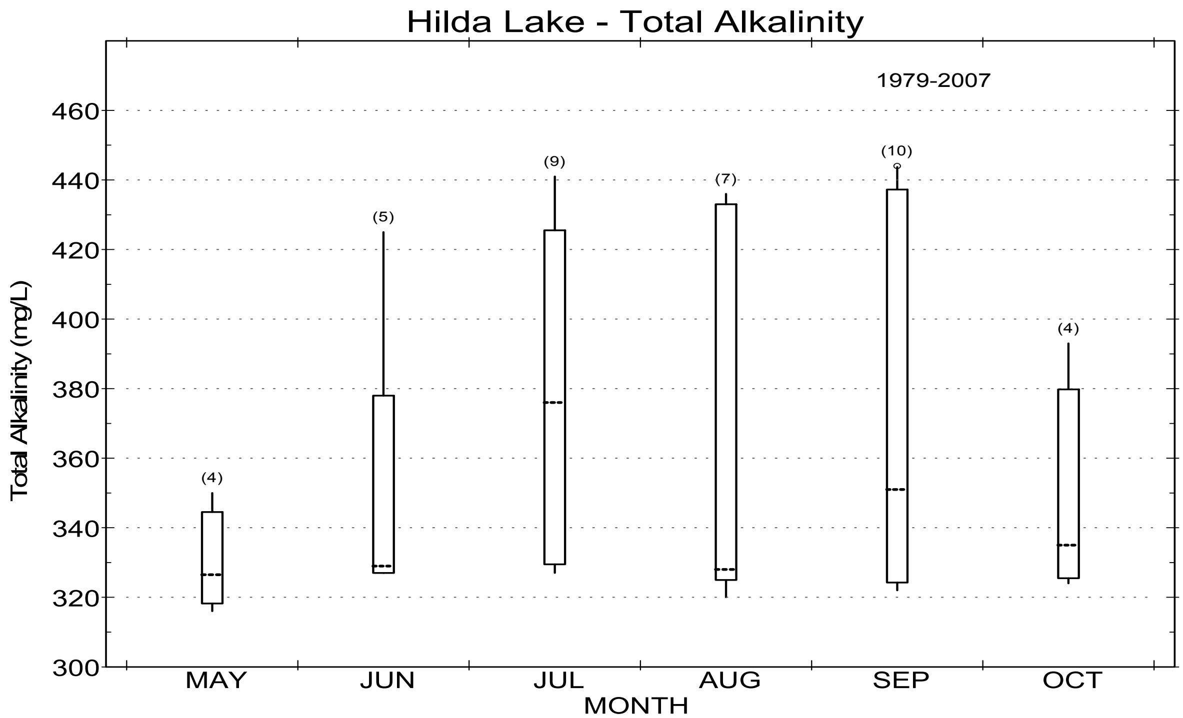


Figure 21 **Gull Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



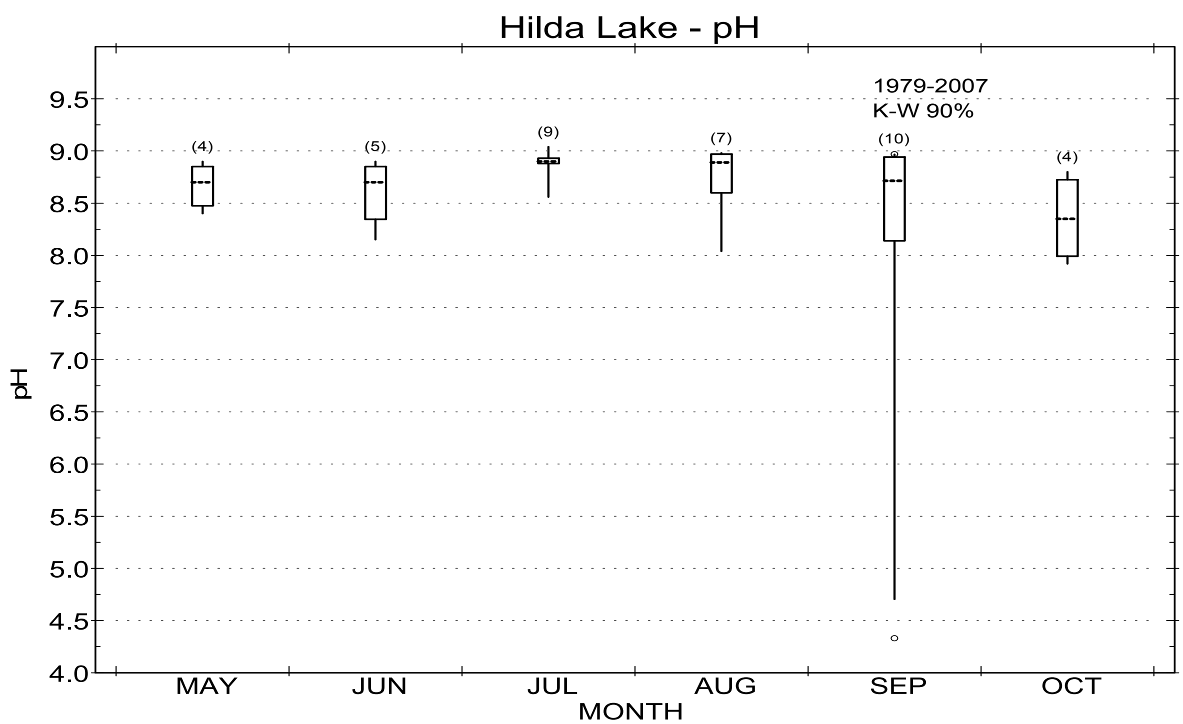
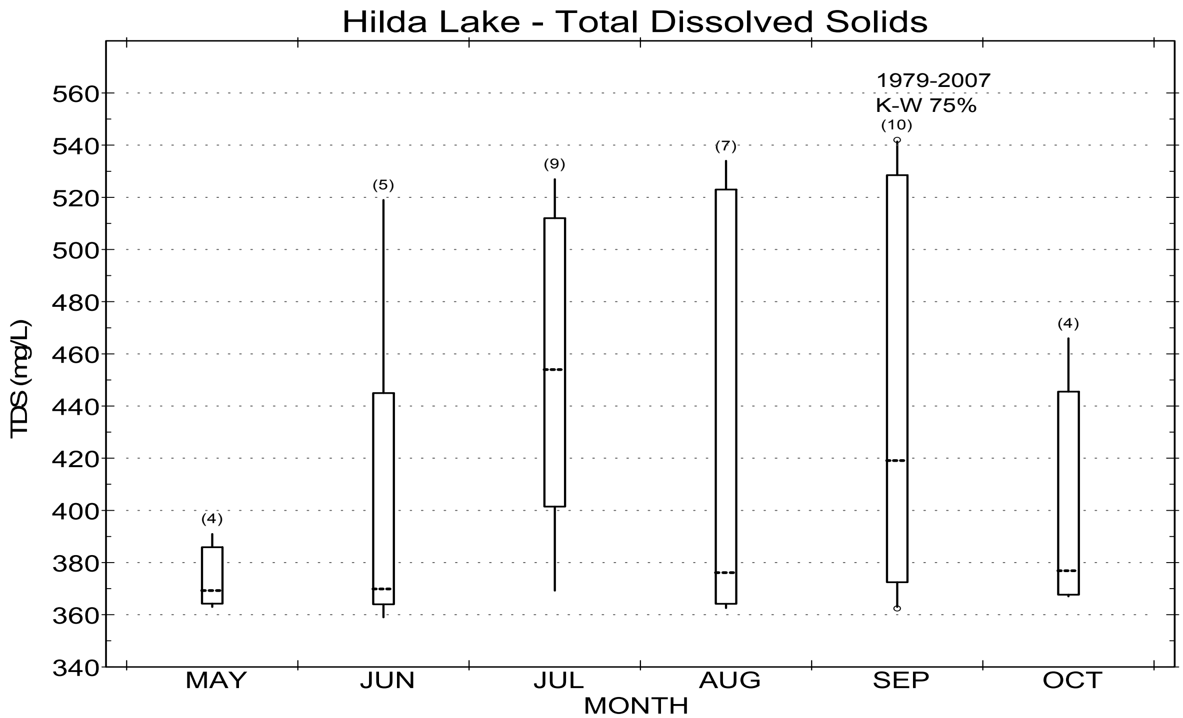


Figure 22 **Hilda Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



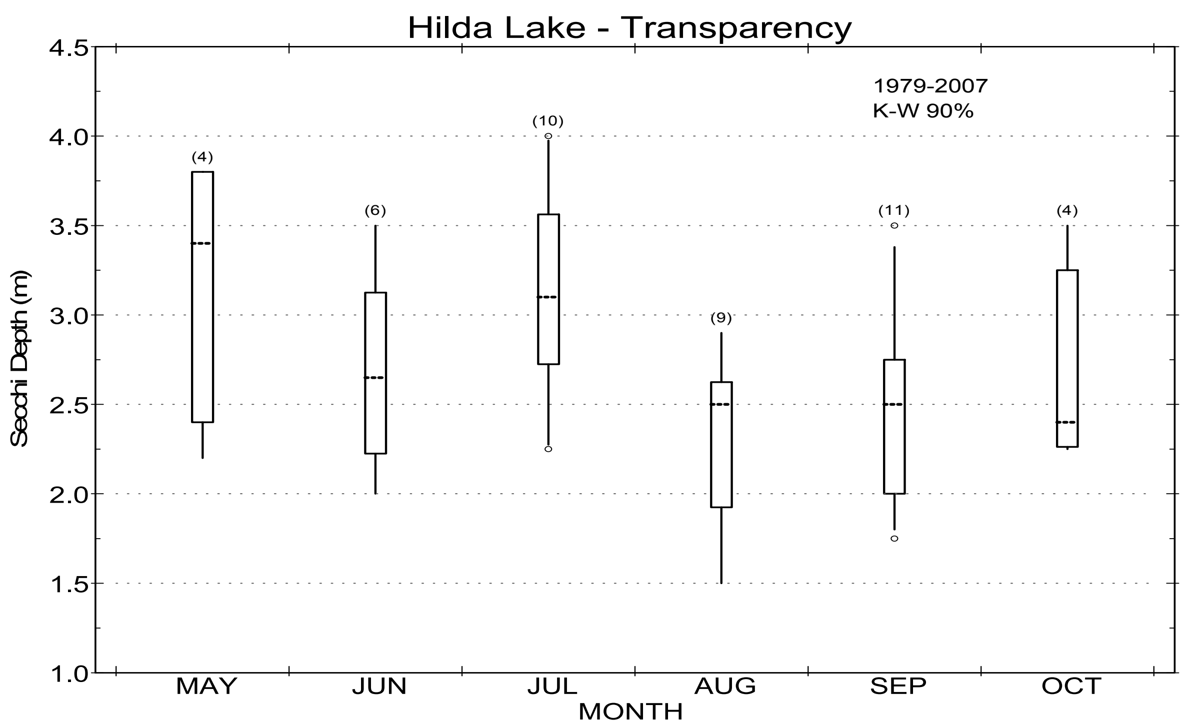
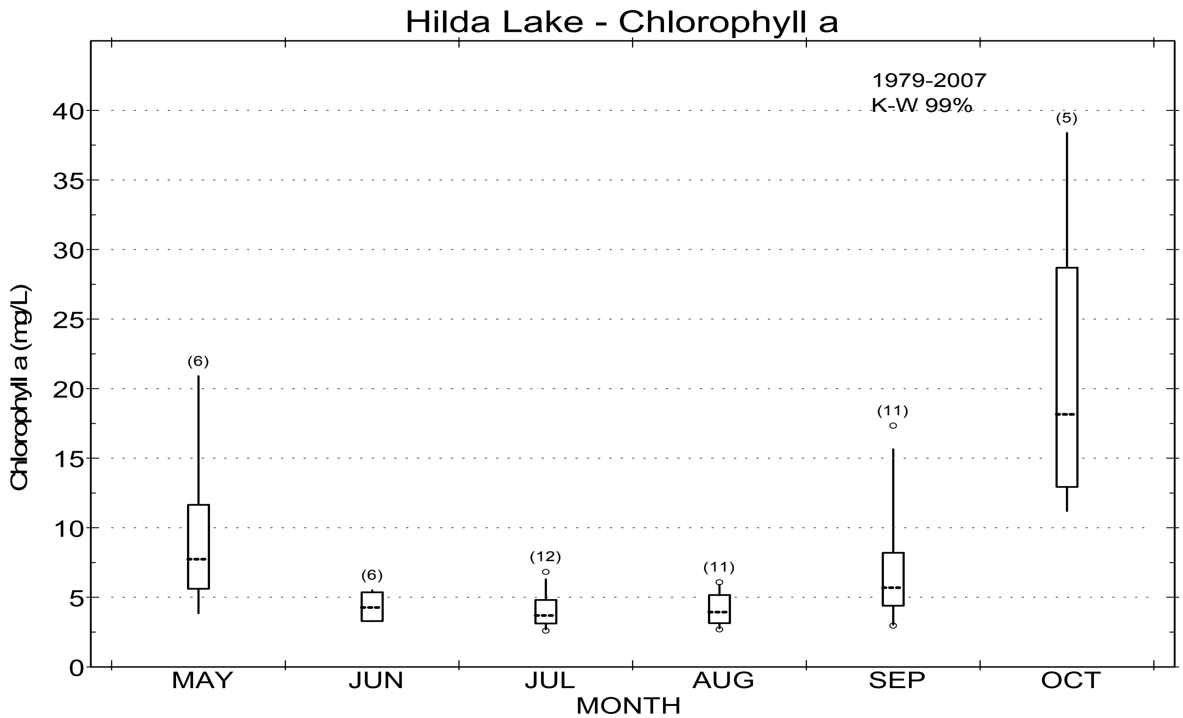


Figure 22 **Hilda Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



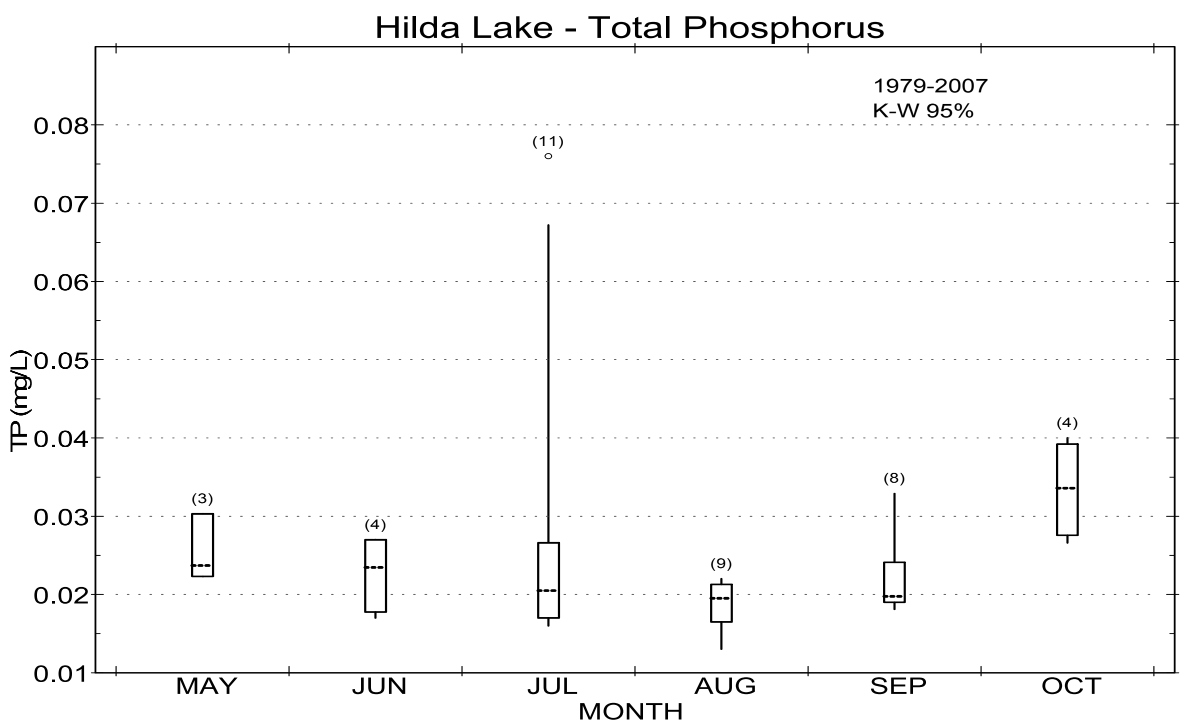


Figure 22 **Hilda Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)

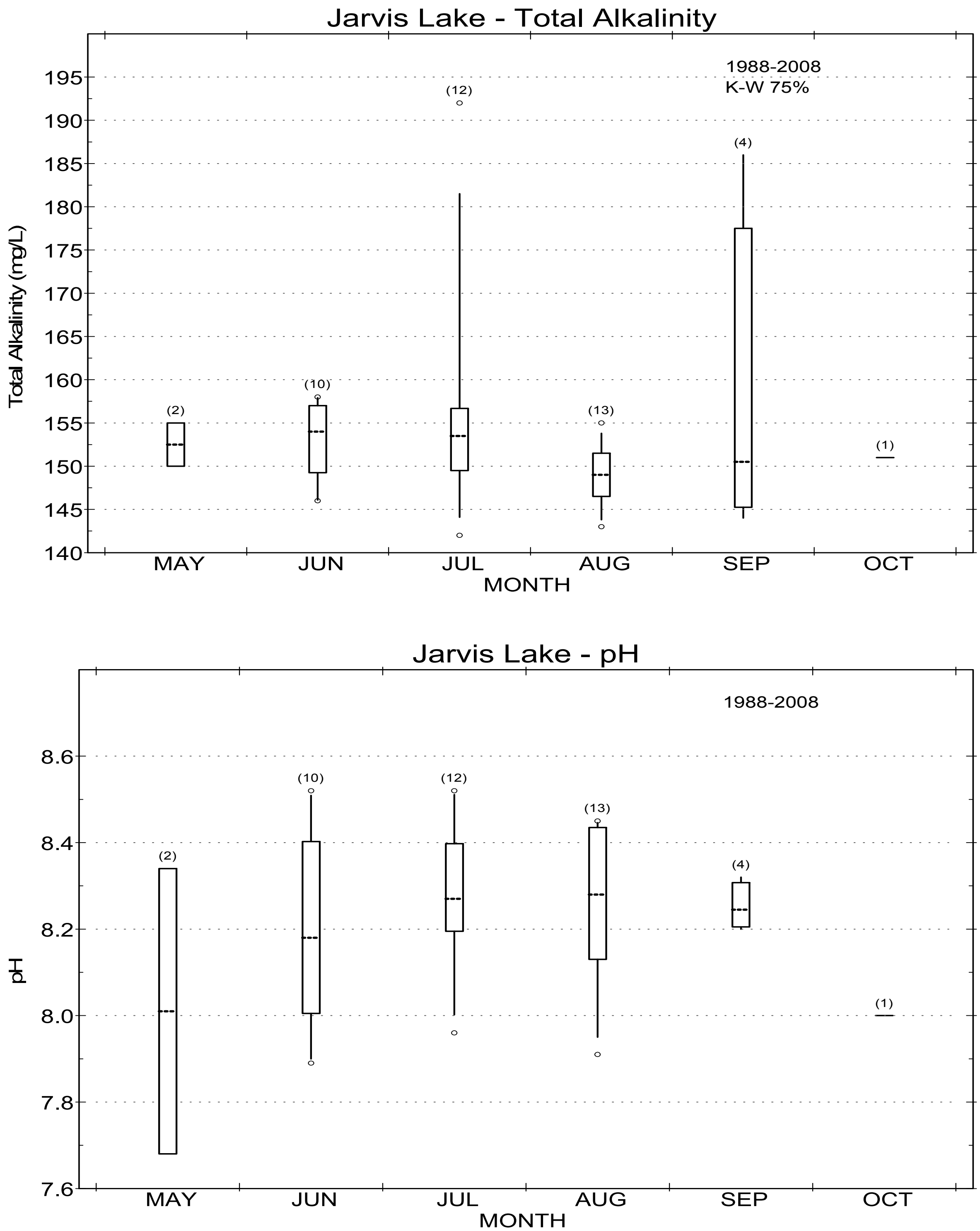
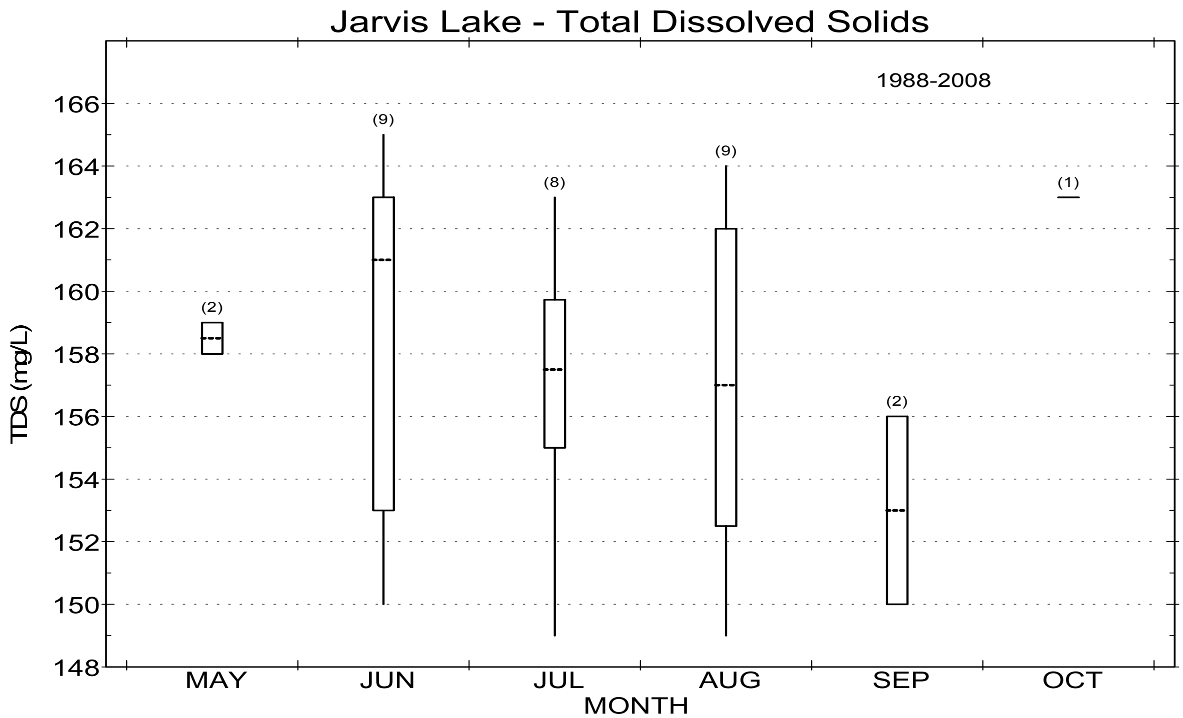


Figure 23 **Jarvis Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



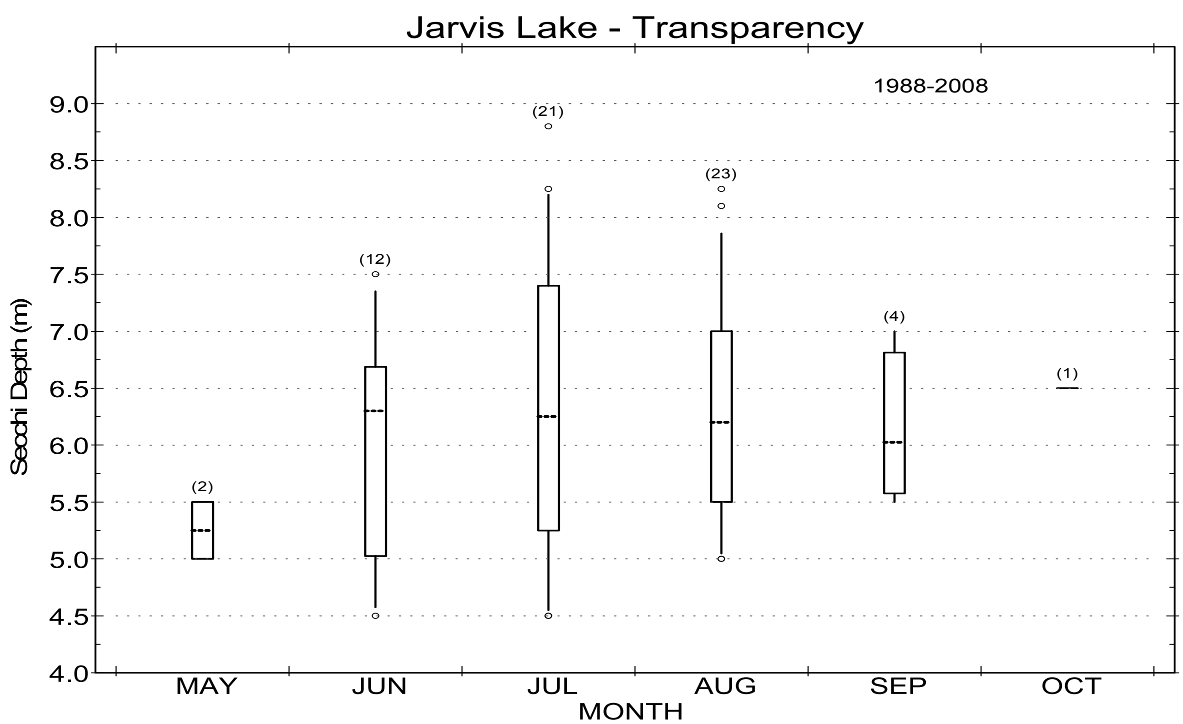
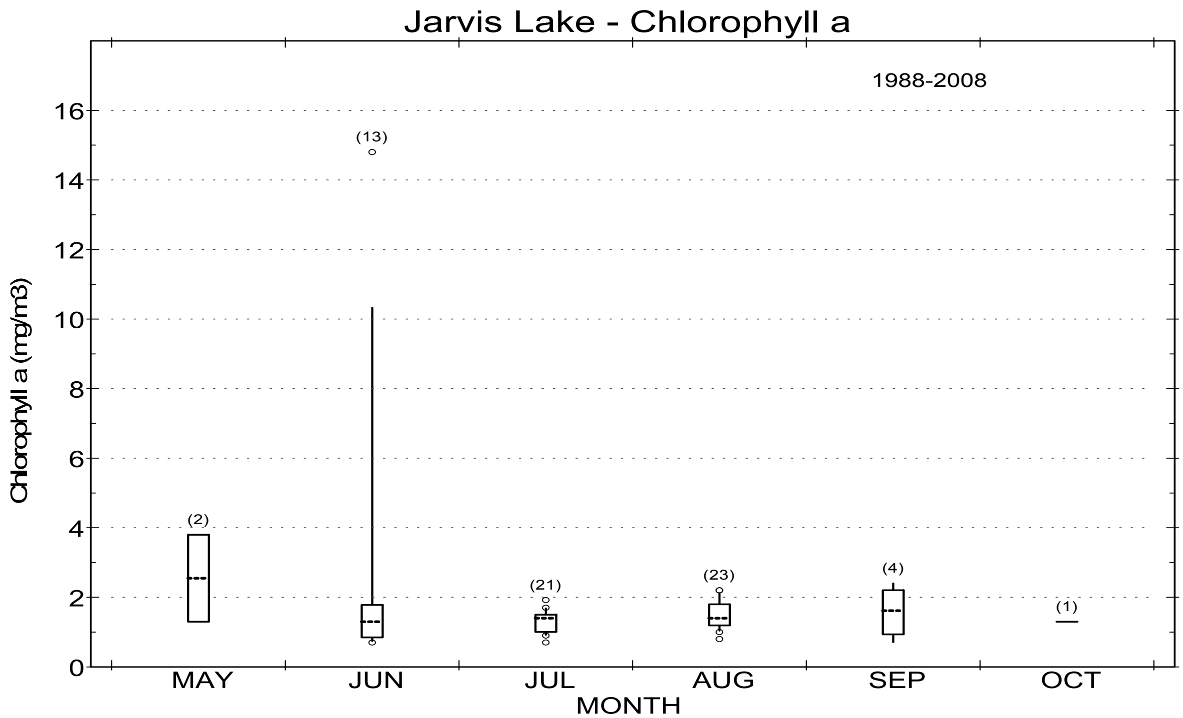


Figure 23 **Jarvis Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



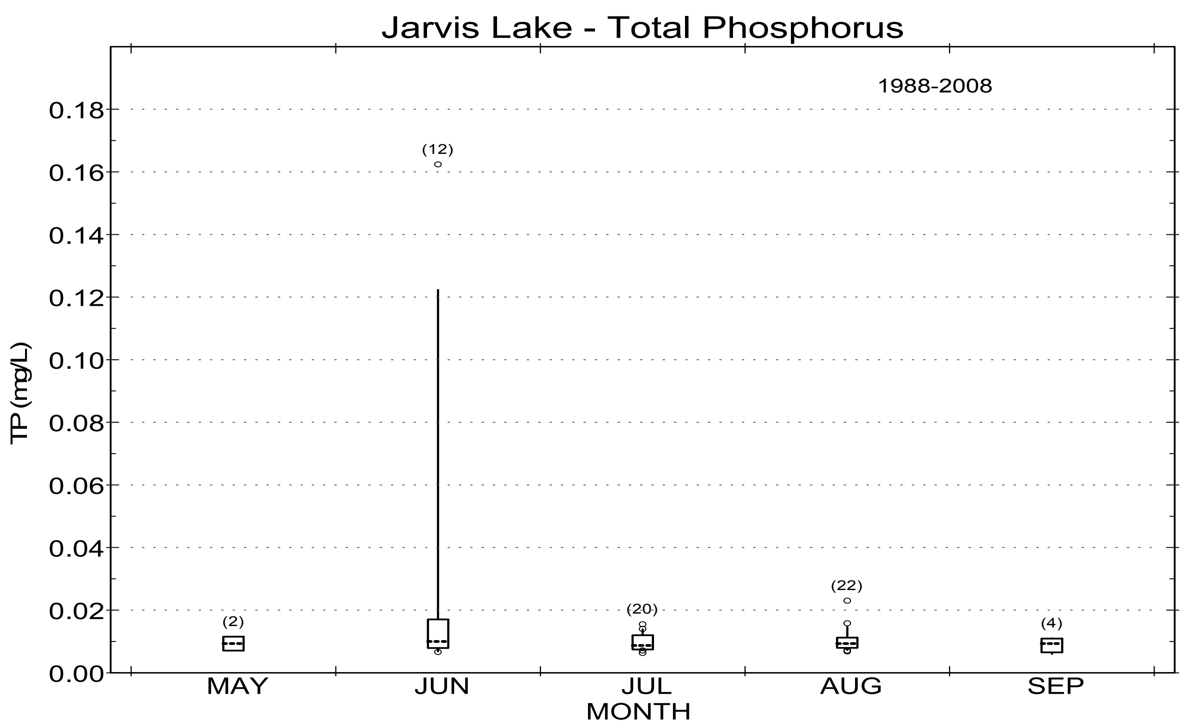
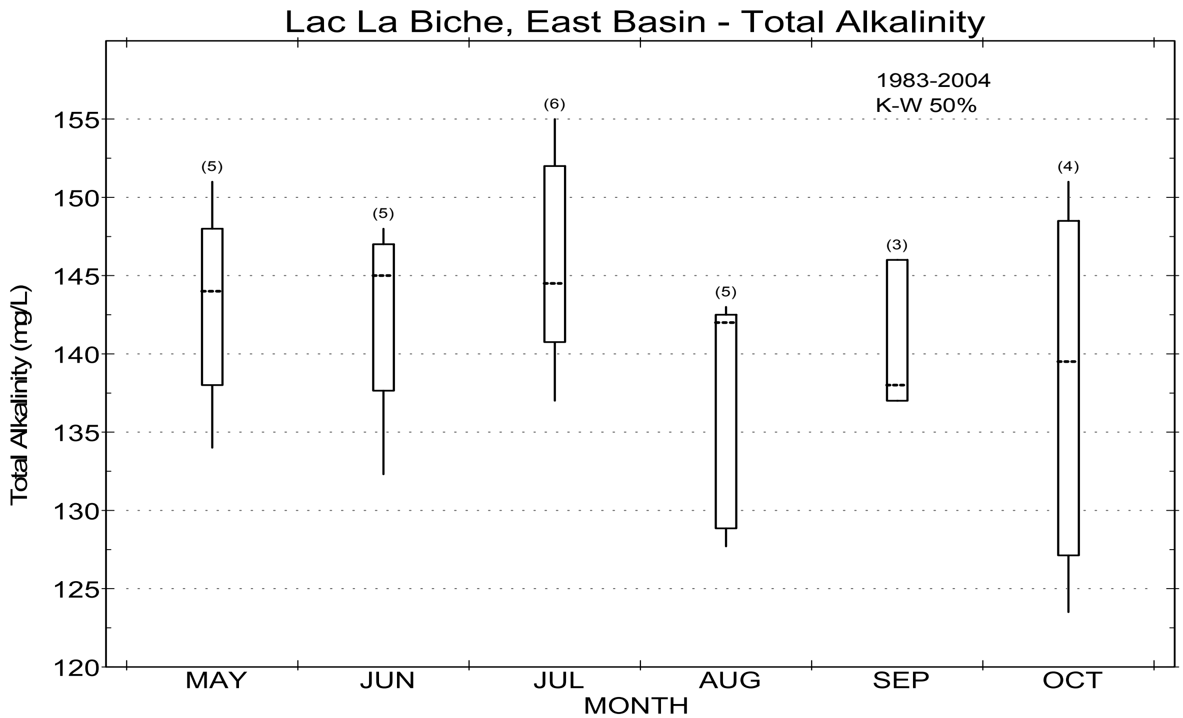


Figure 23 **Jarvis Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



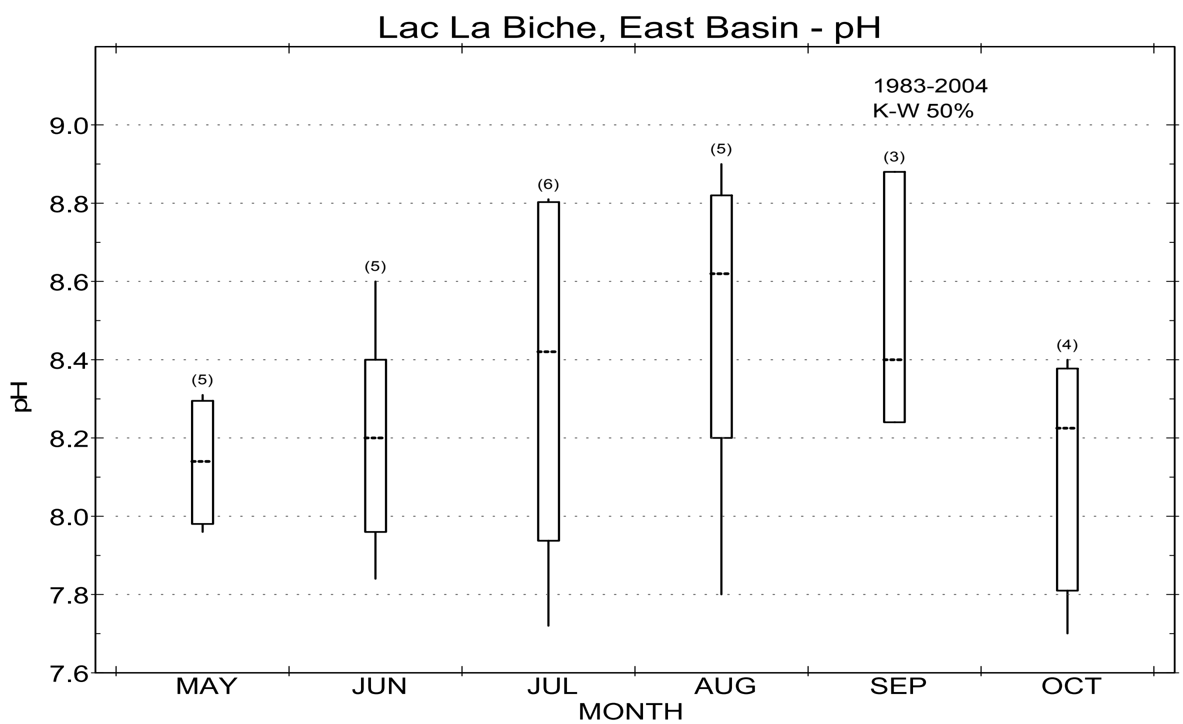
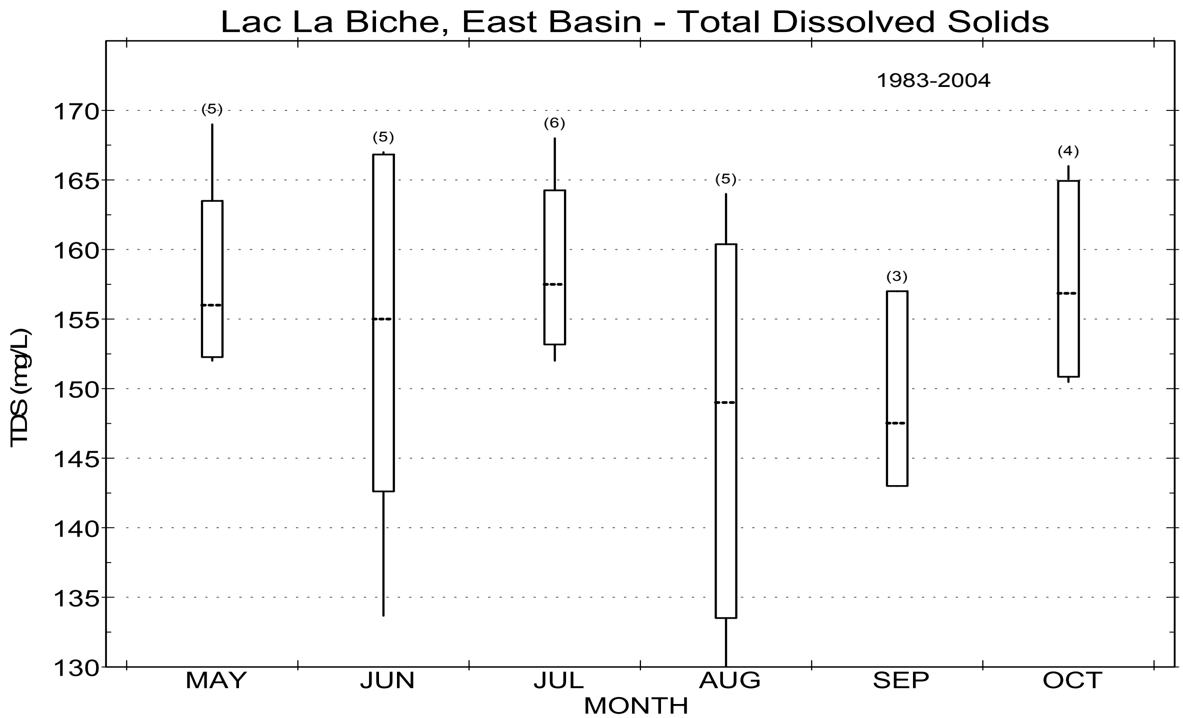


Figure 24 **Lac La Biche, East Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



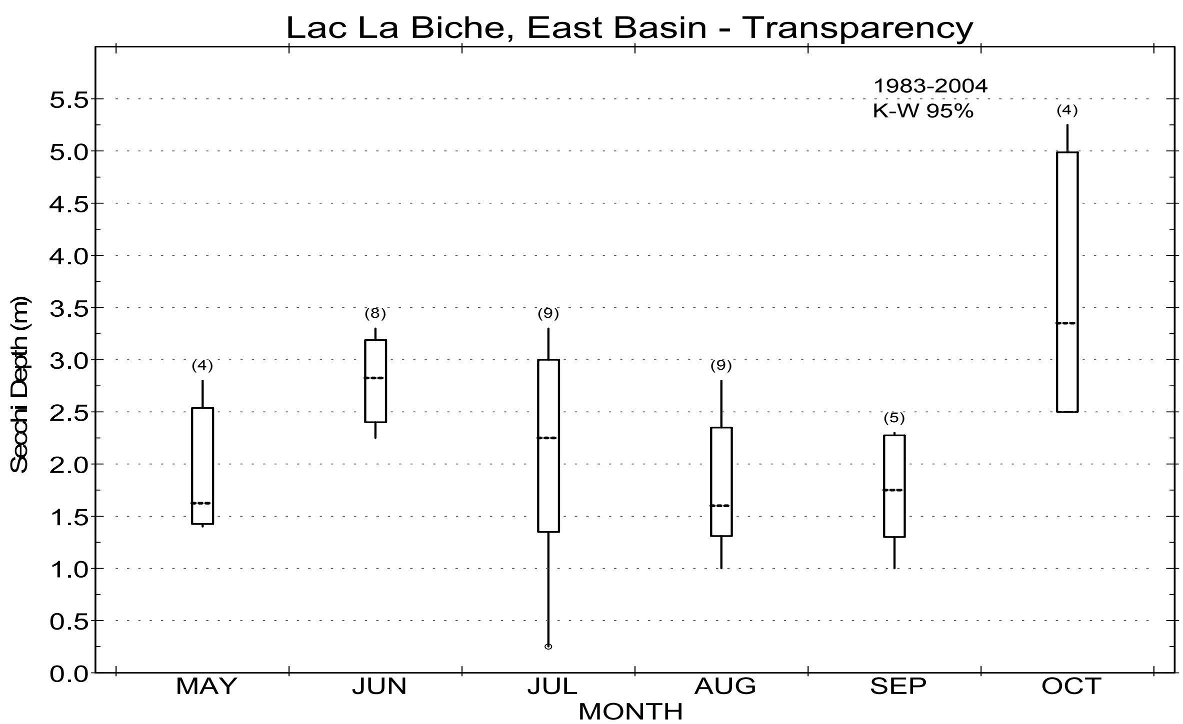
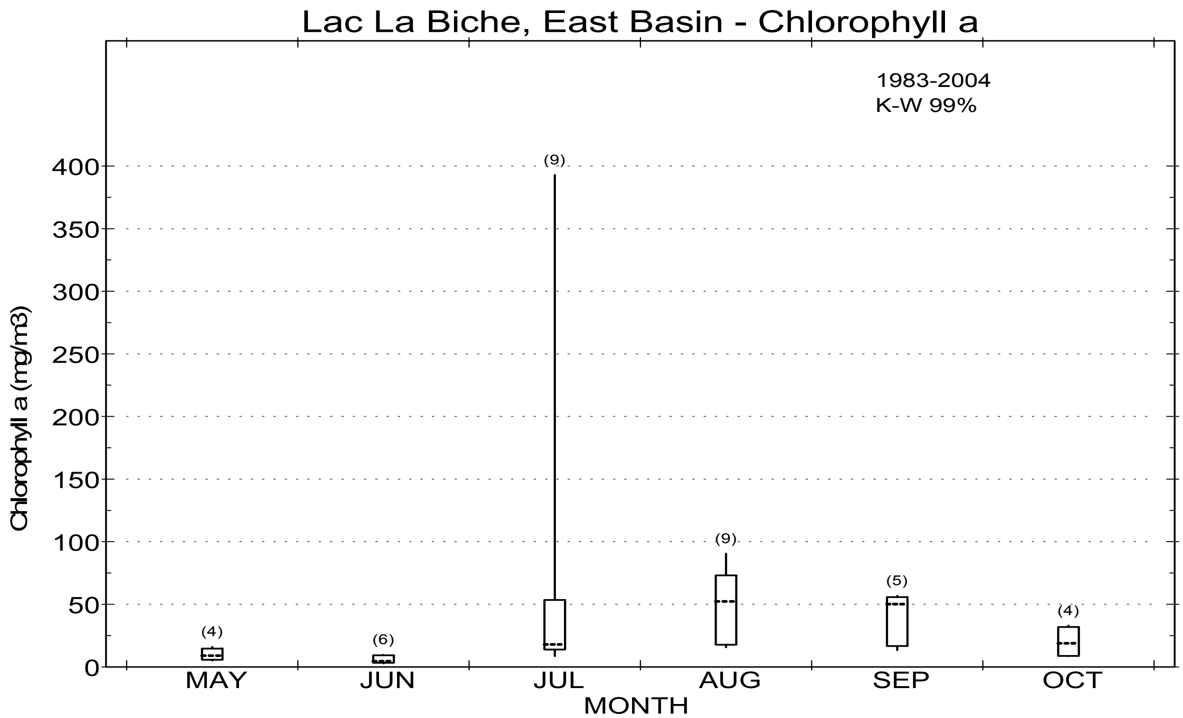


Figure 24 **Lac La Biche, East Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



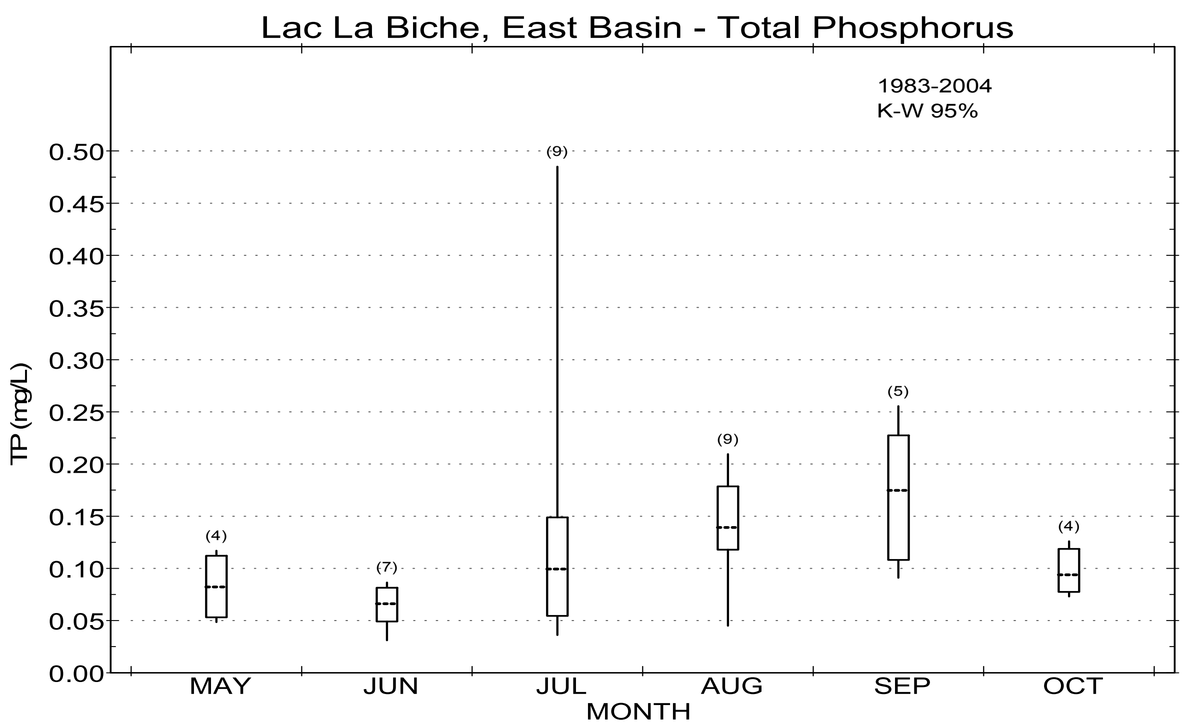
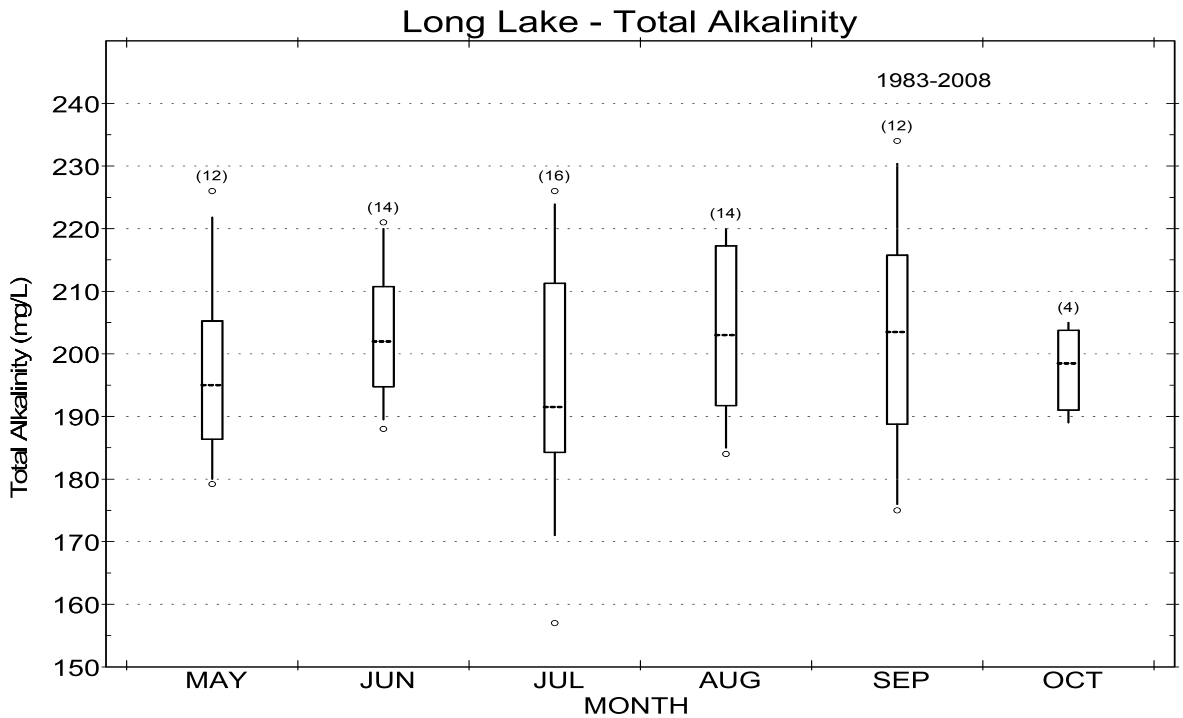


Figure 24 **Lac La Biche, East Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



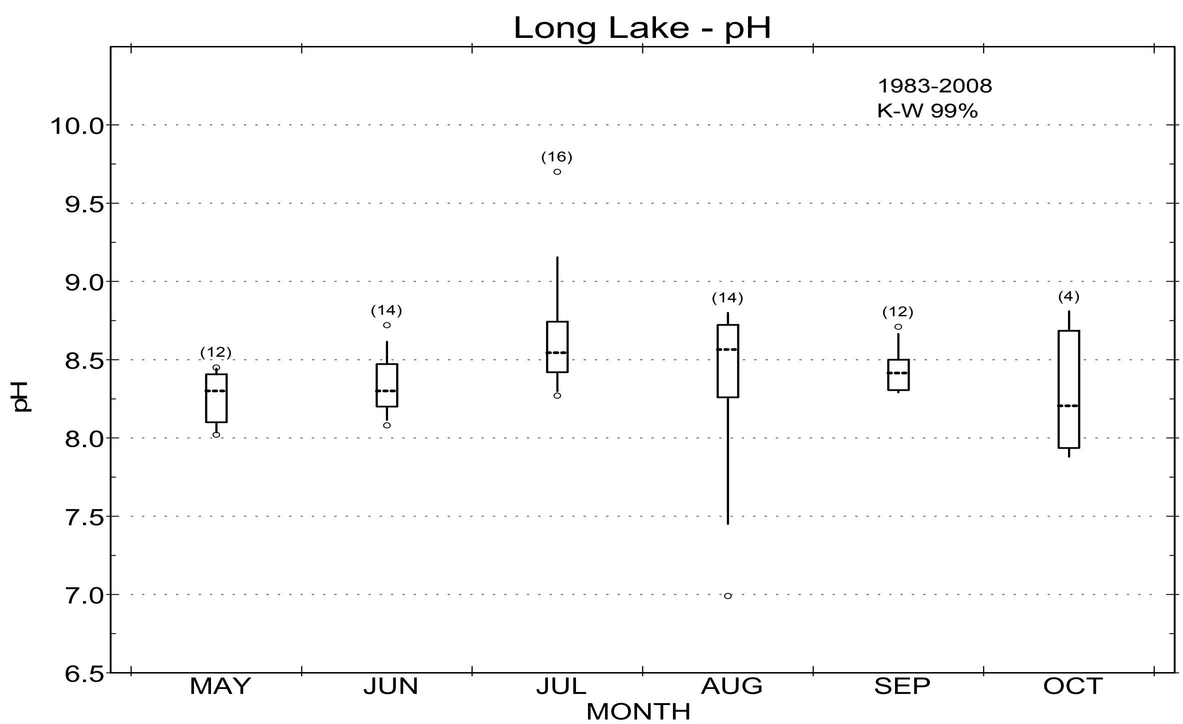
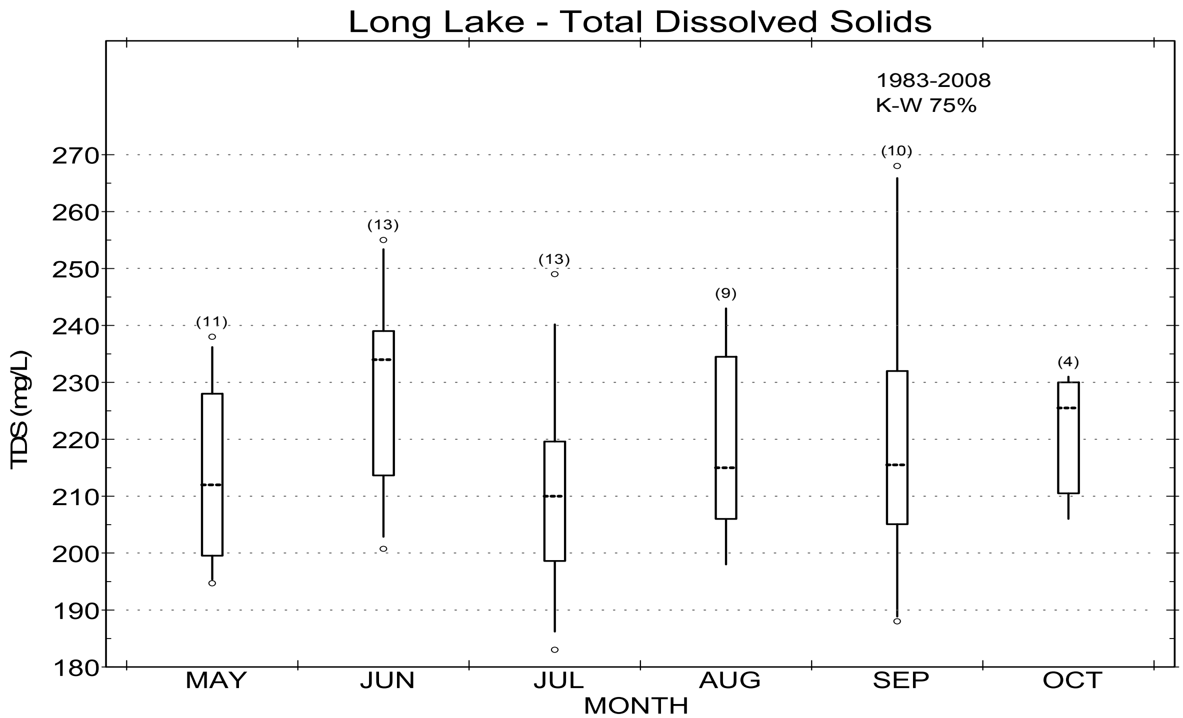


Figure 25 **Long Lake (near Boyle)** - Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



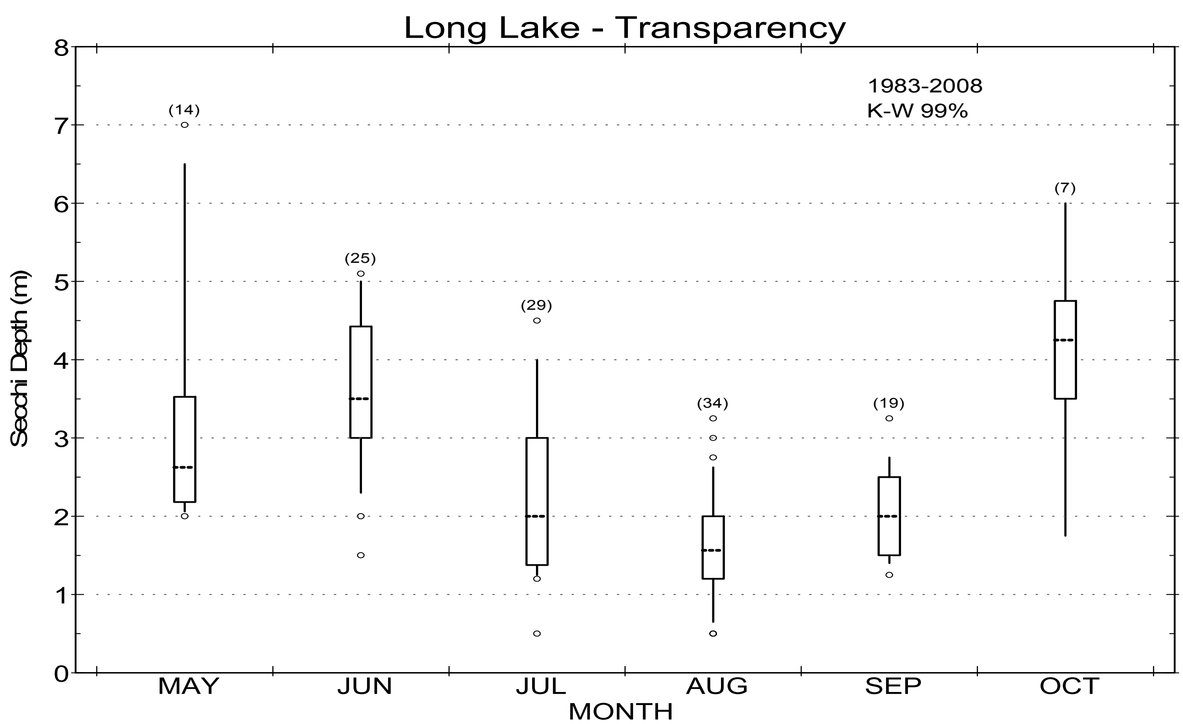
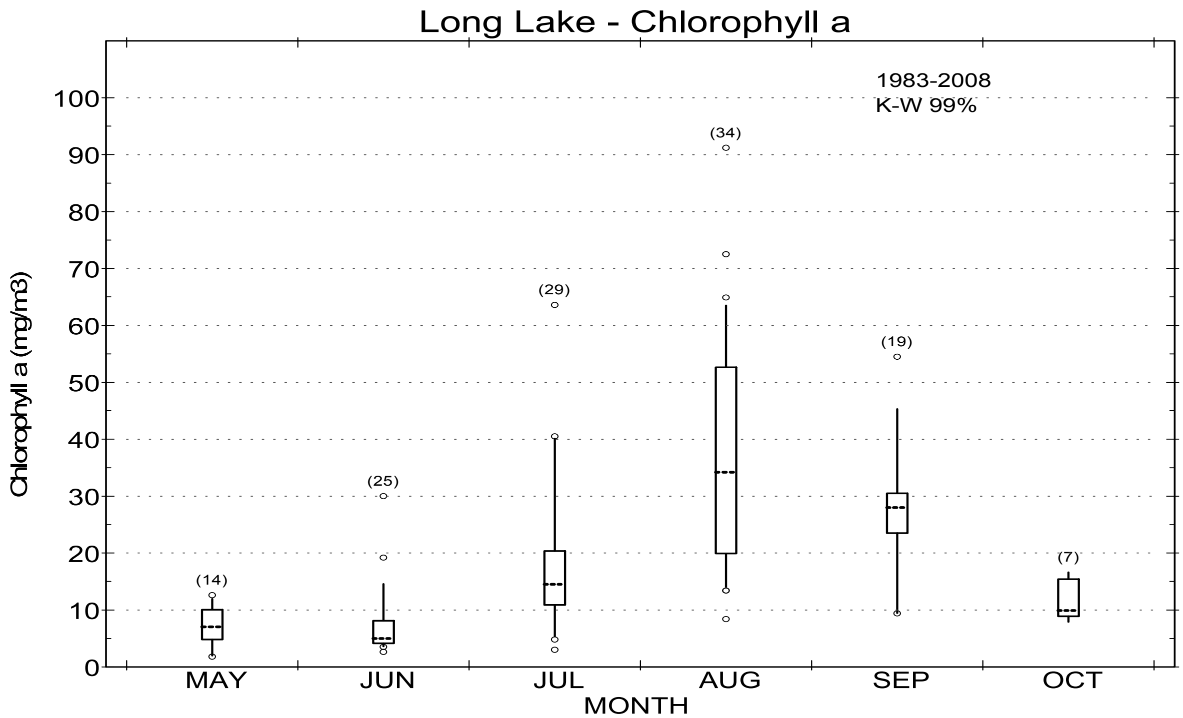


Figure 25 **Long Lake (near Boyle)** - Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



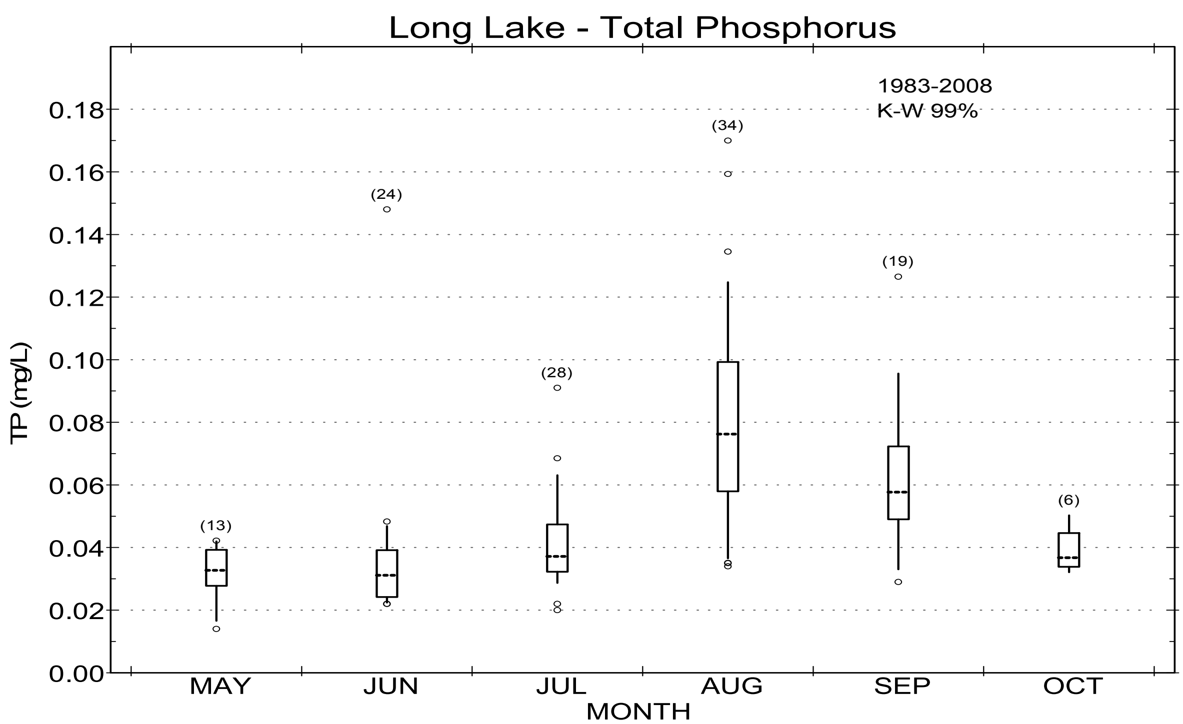
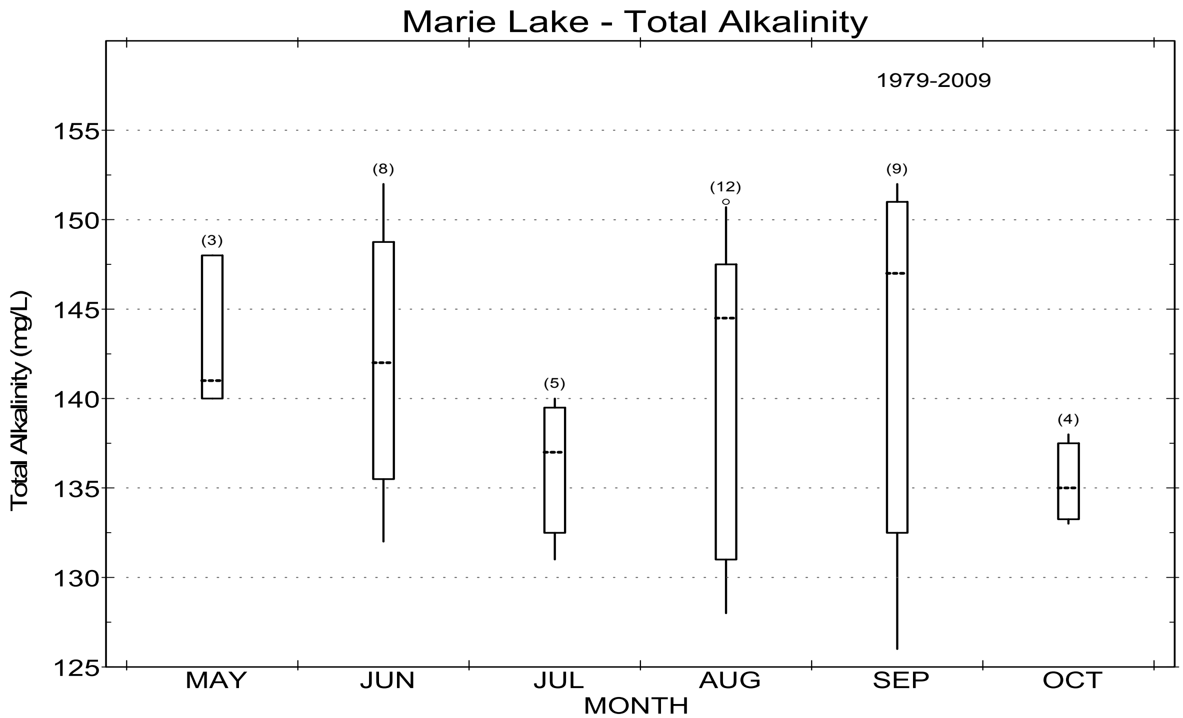


Figure 25 **Long Lake (near Boyle) -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



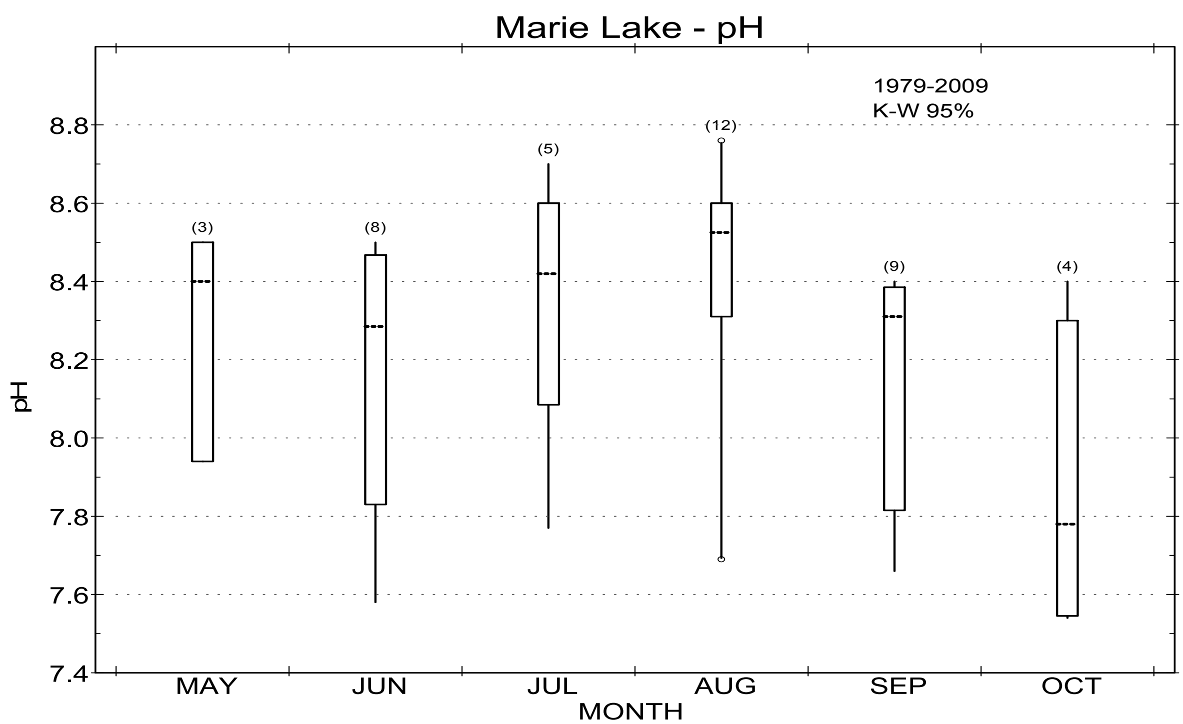
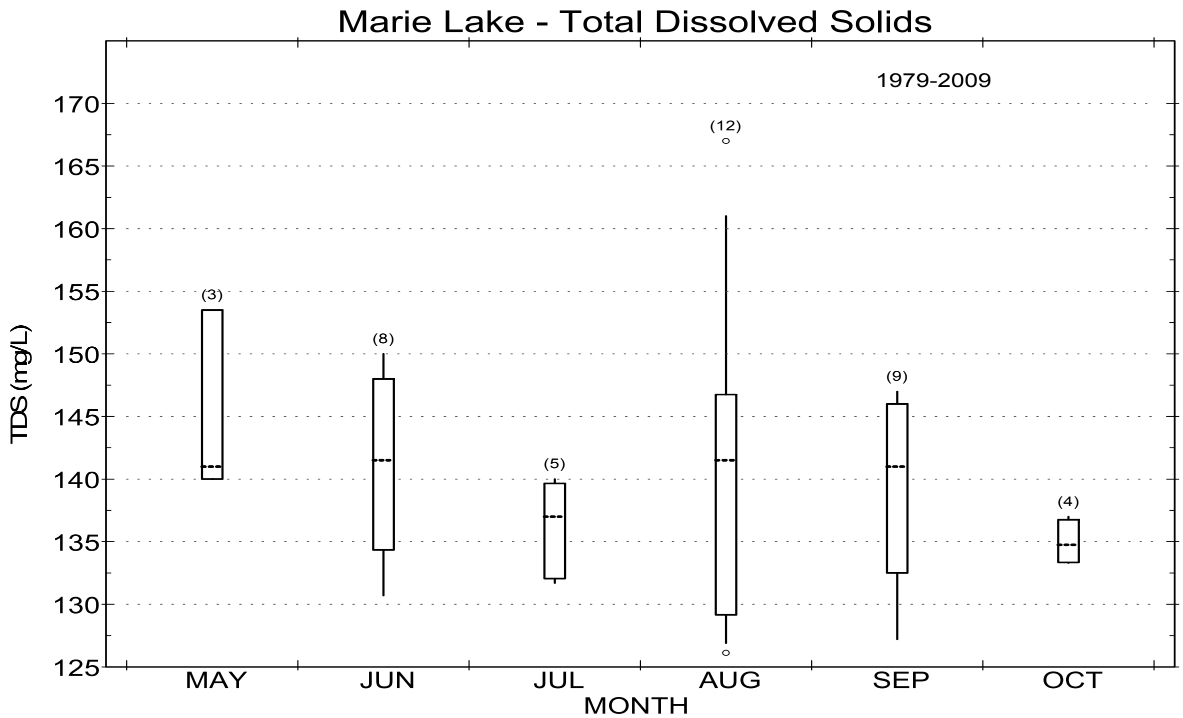


Figure 26 **Marie Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



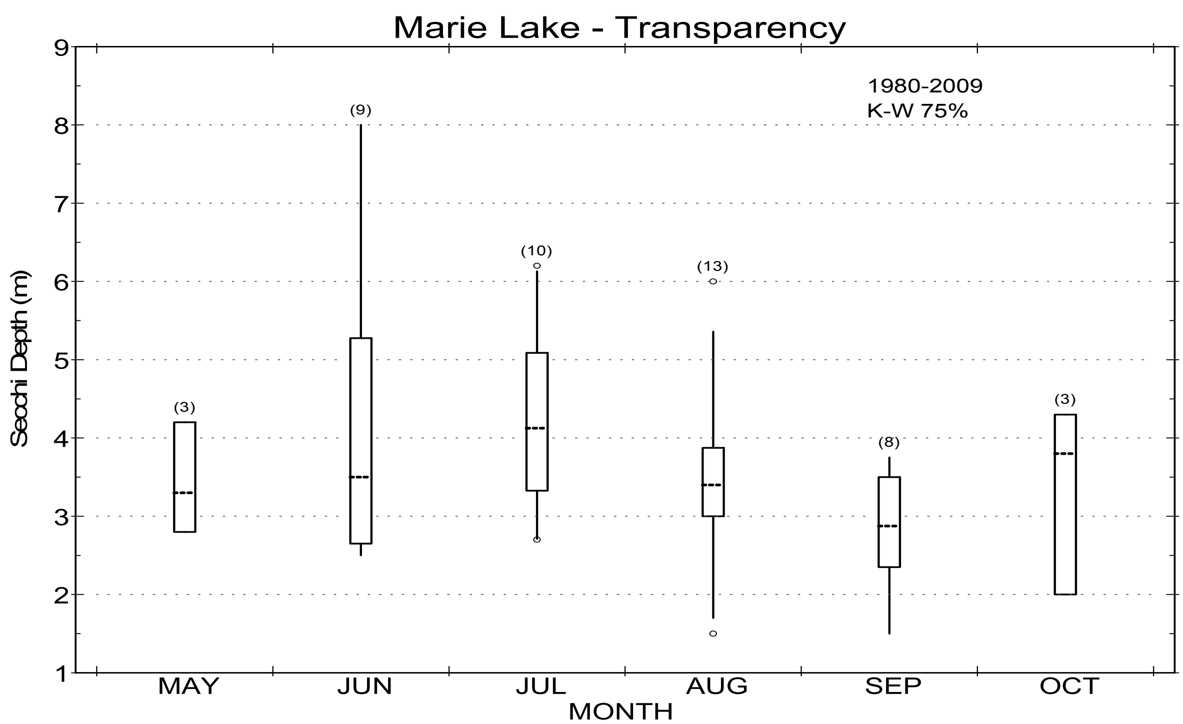
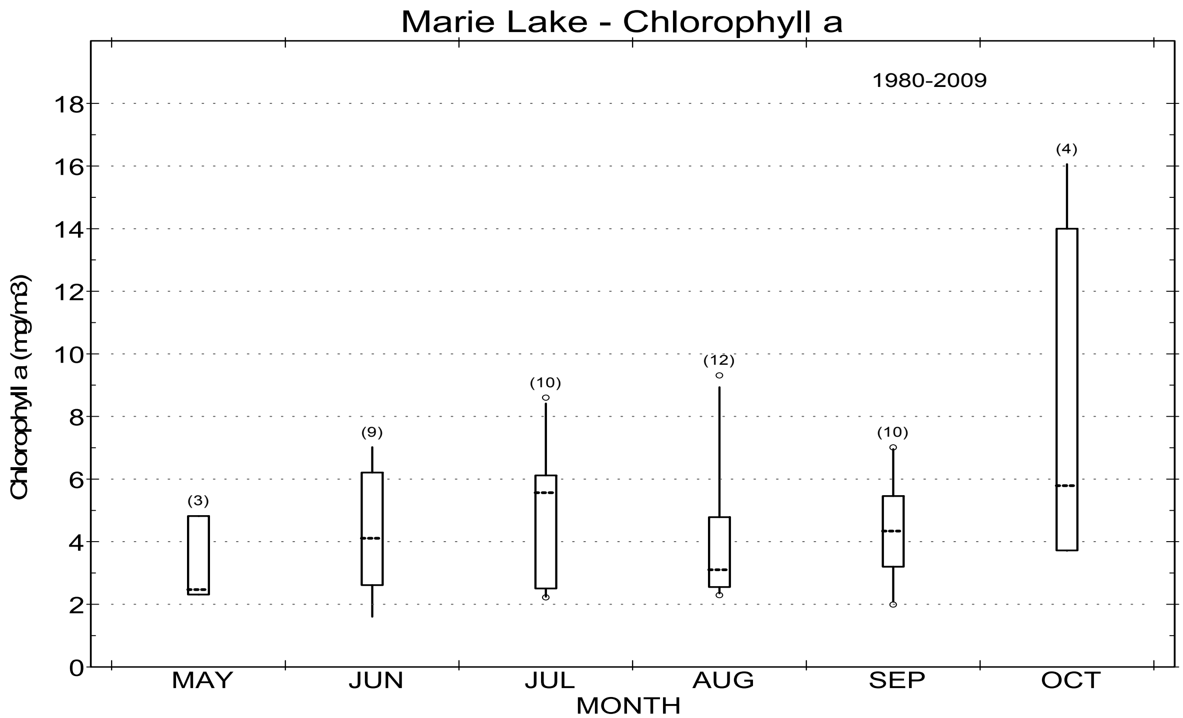


Figure 26 **Marie Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



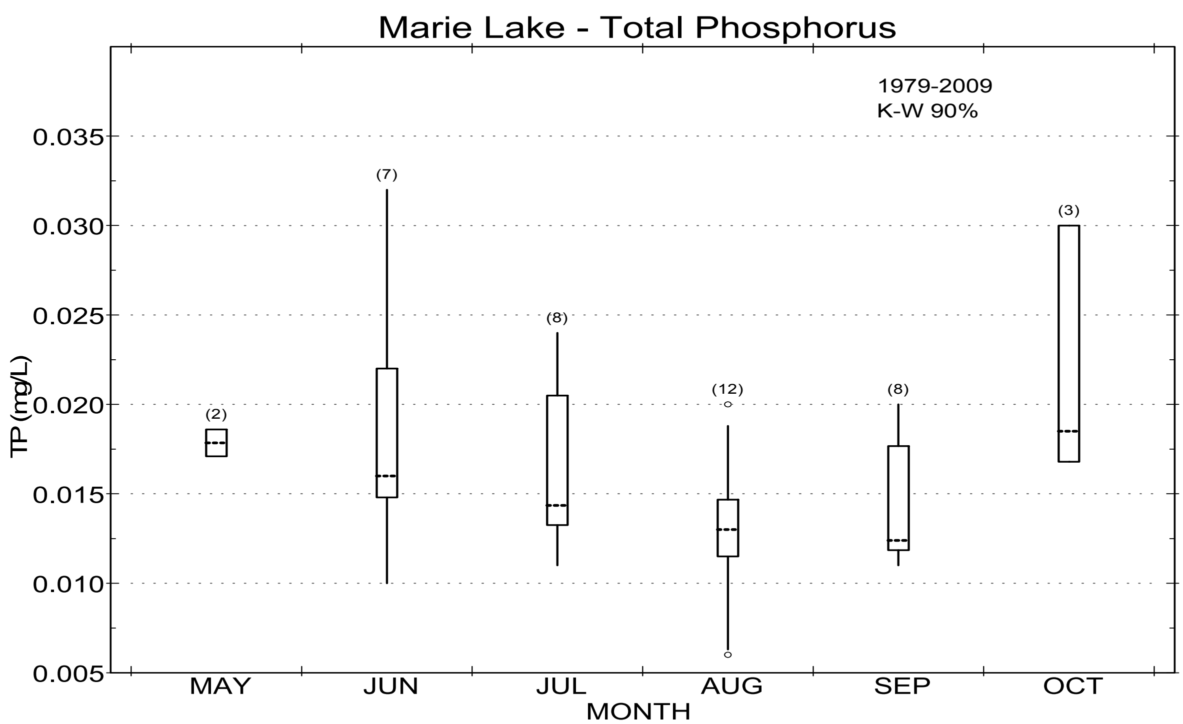
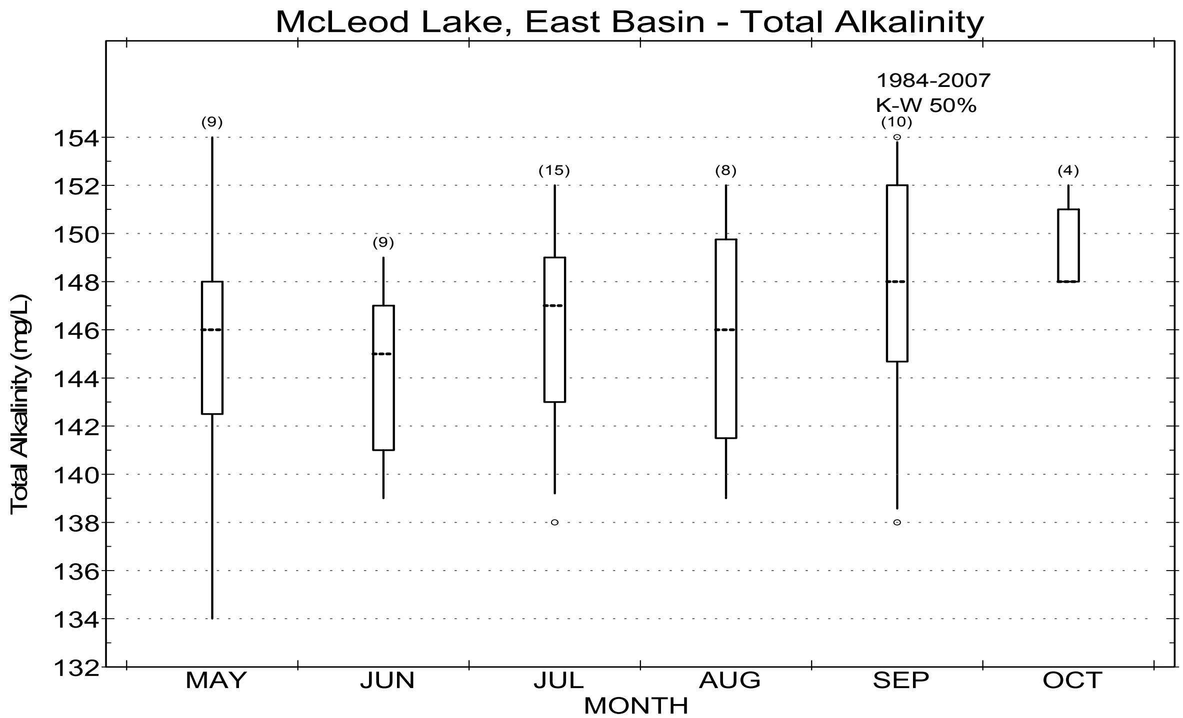


Figure 26 **Marie Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



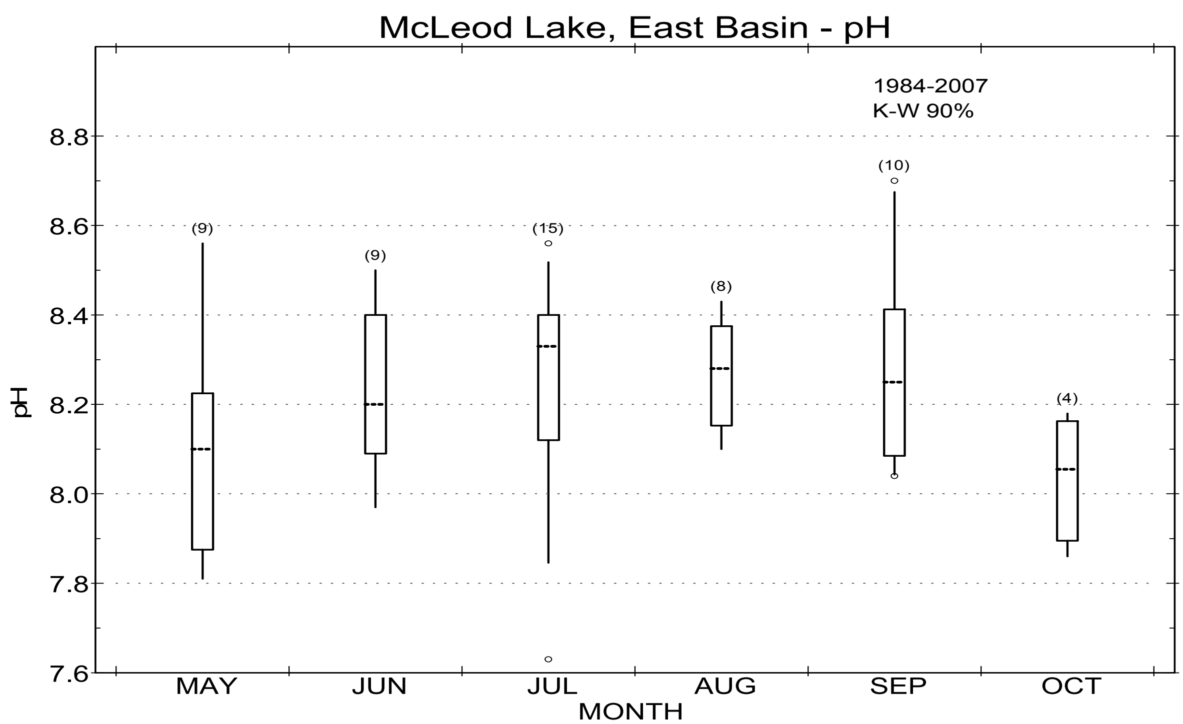
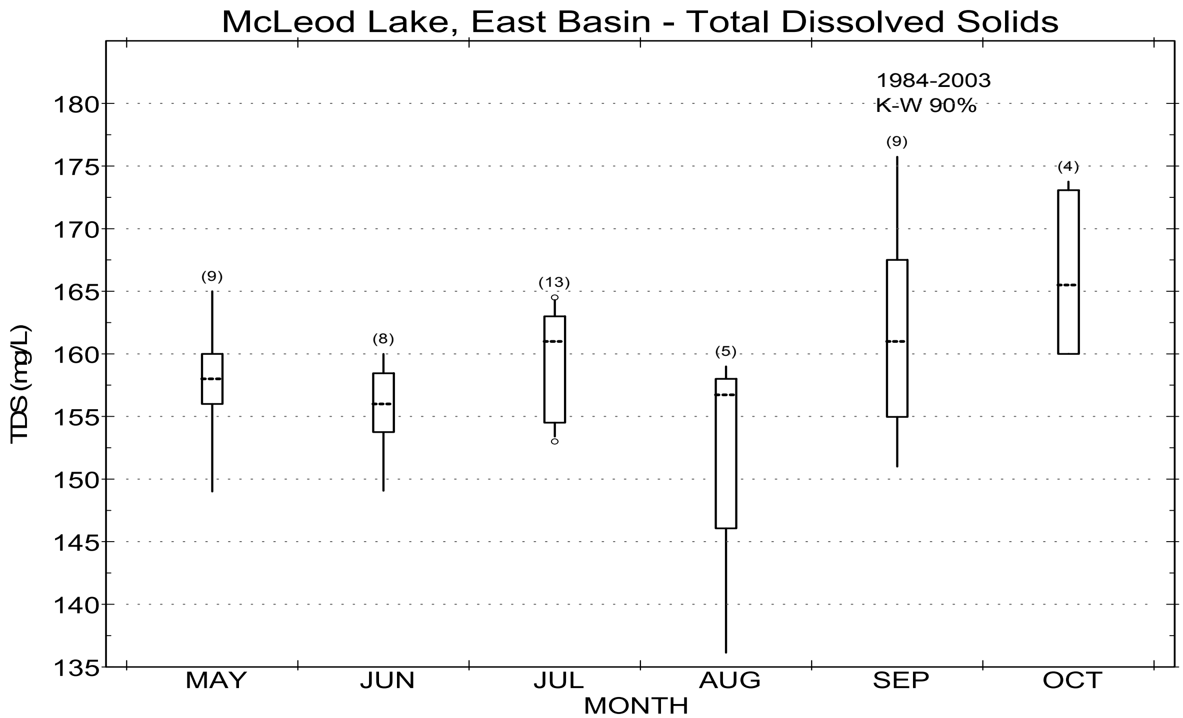


Figure 27 **McLeod Lake, East Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



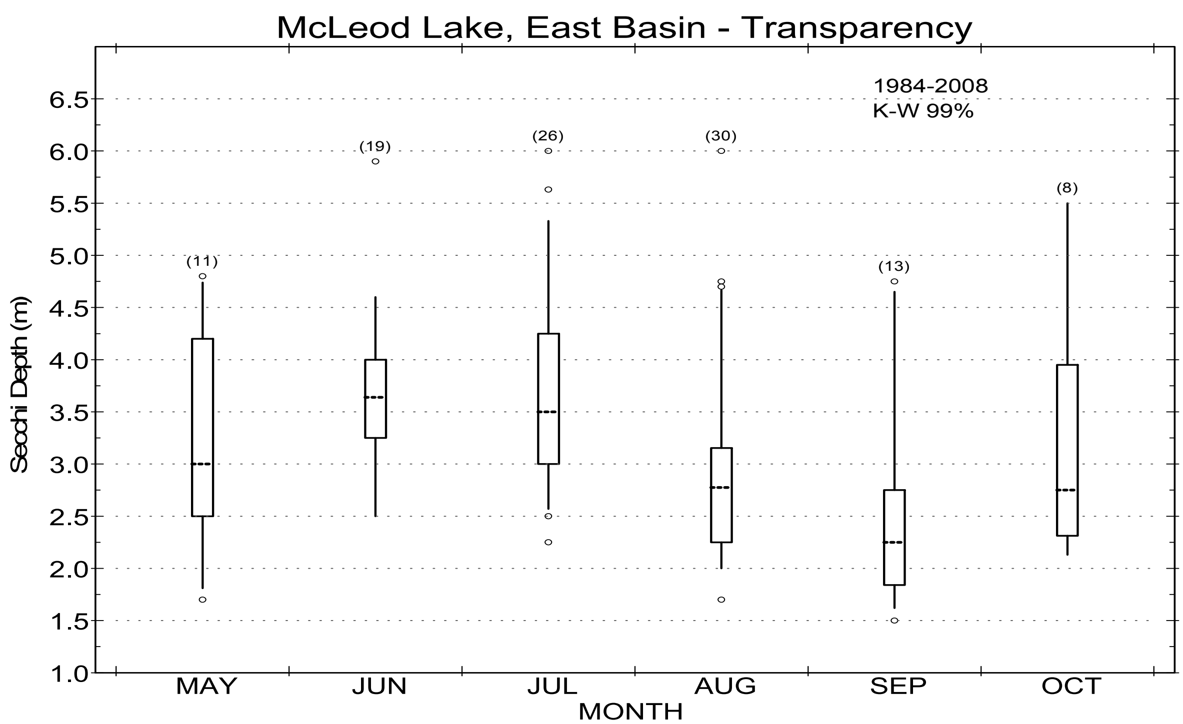
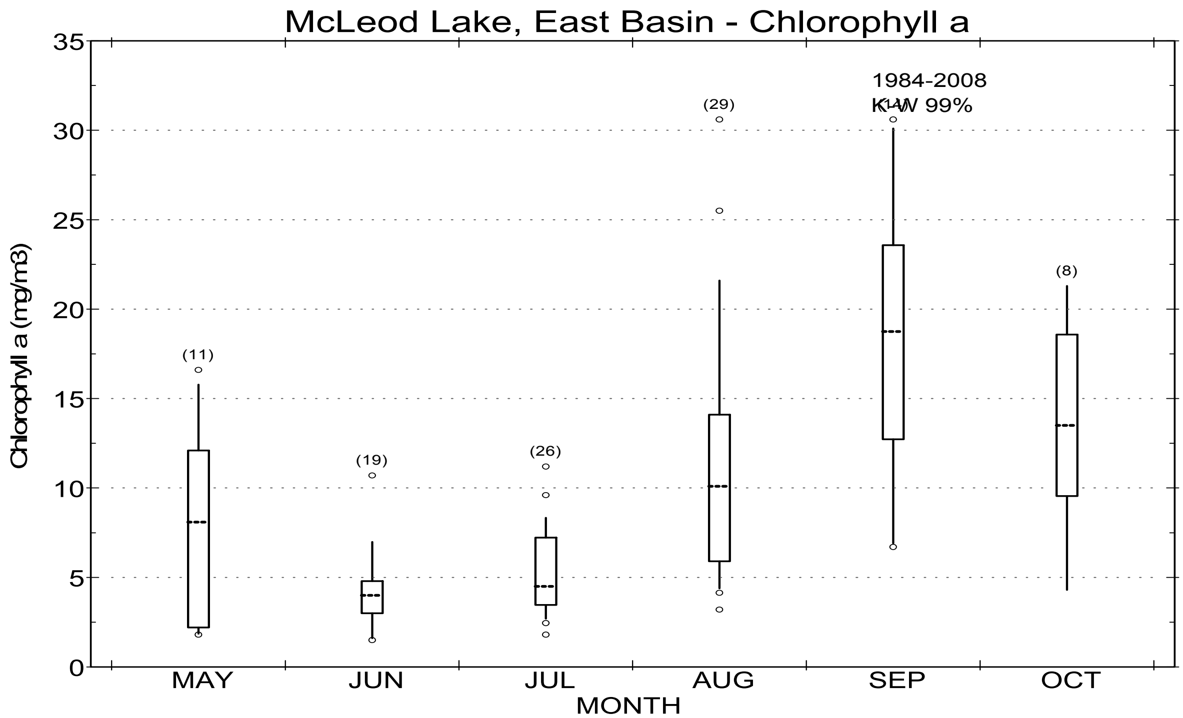


Figure 27 **McLeod Lake, East Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



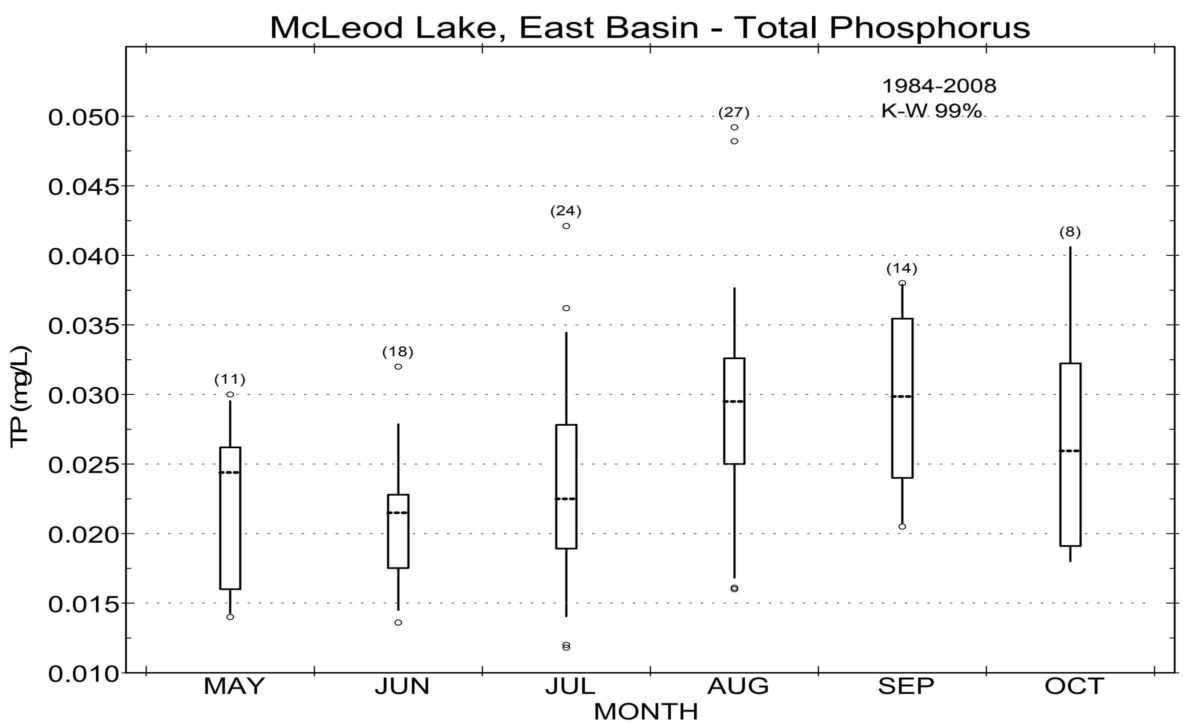


Figure 27 **McLeod Lake, East Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)

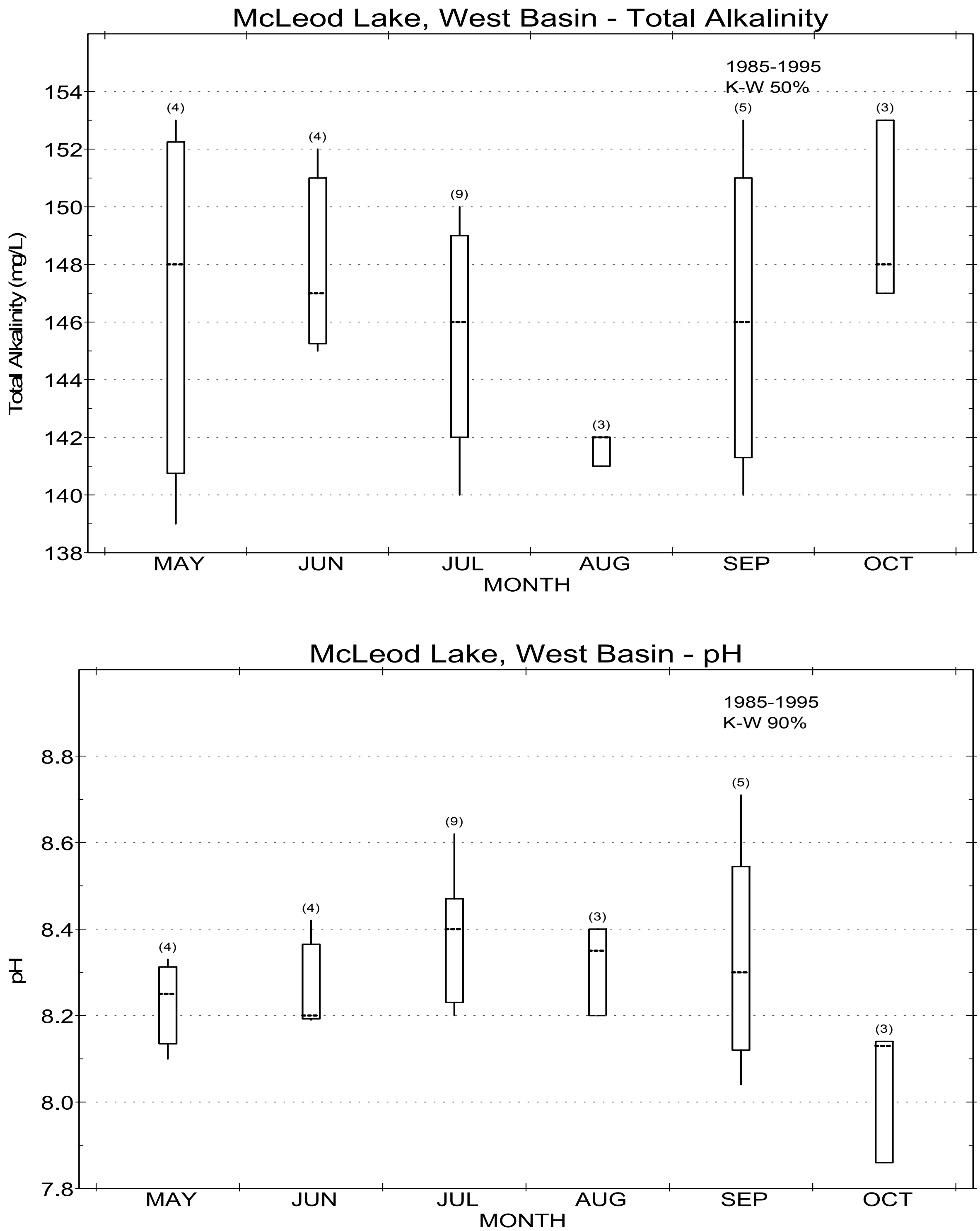
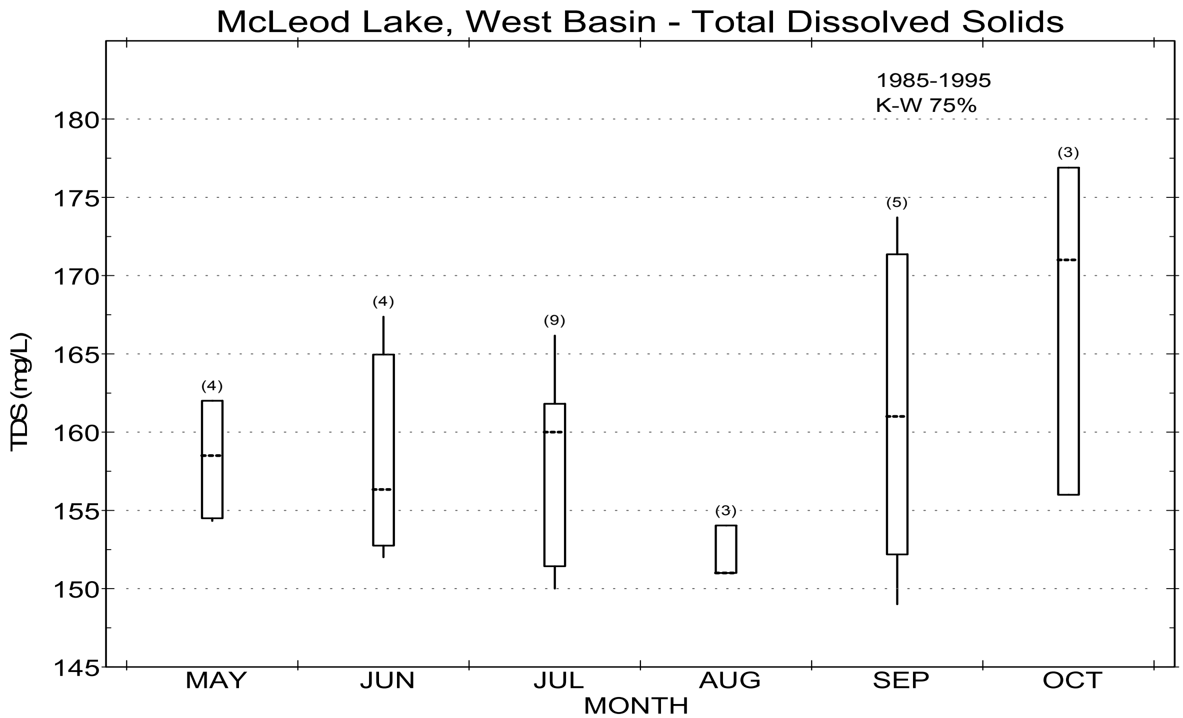


Figure 28 **McLeod Lake, West Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



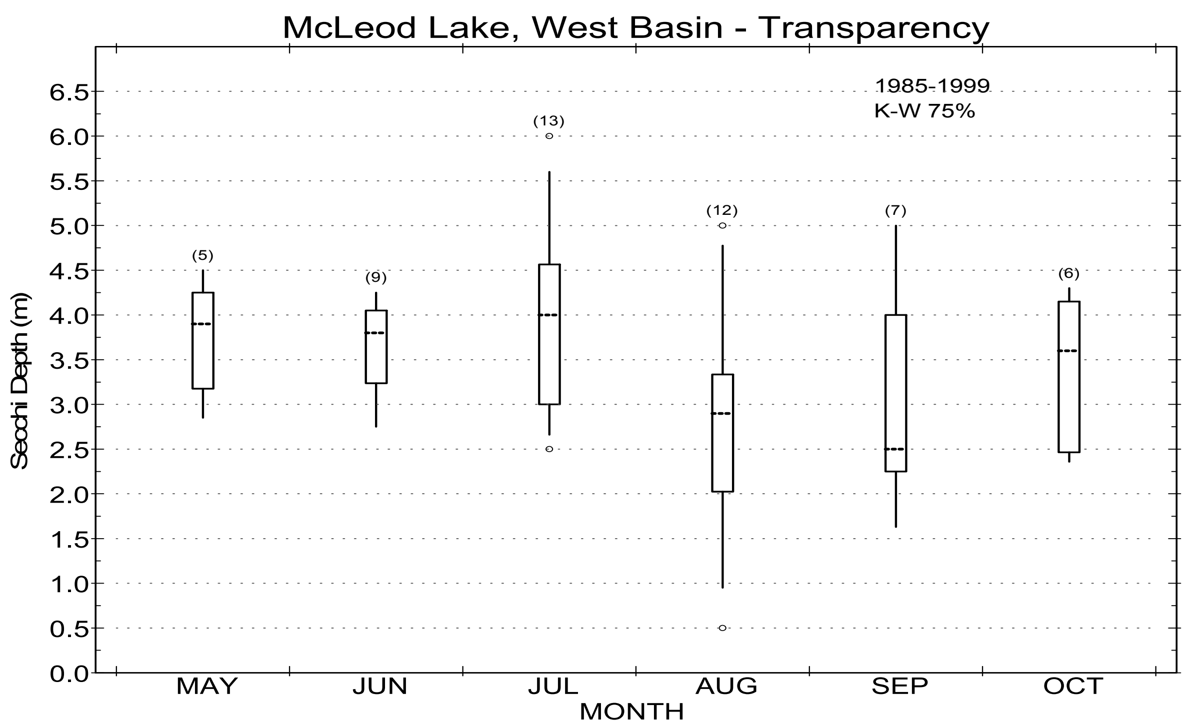
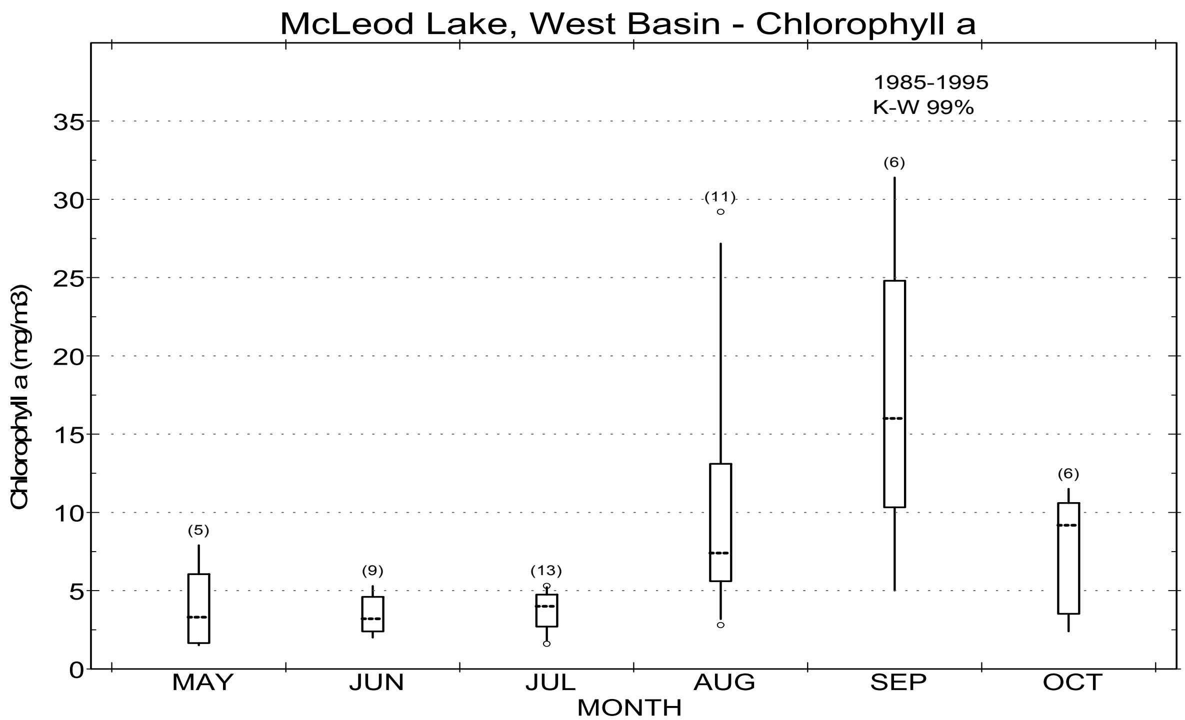


Figure 28 **McLeod Lake, West Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



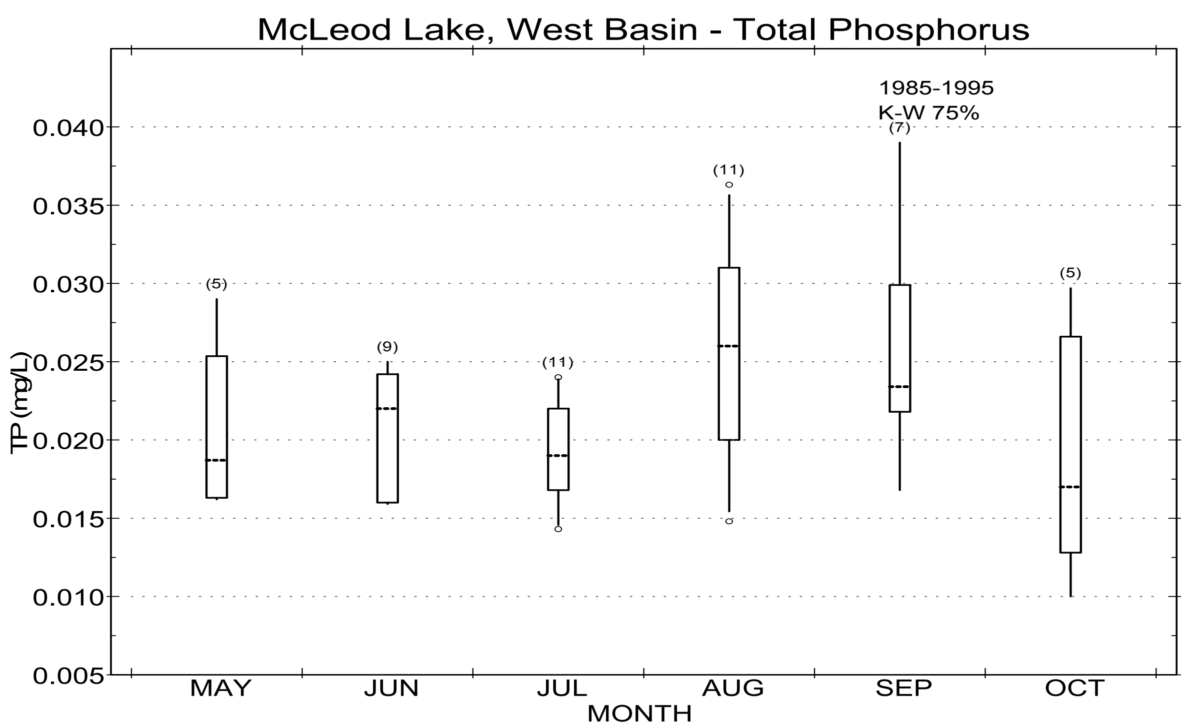
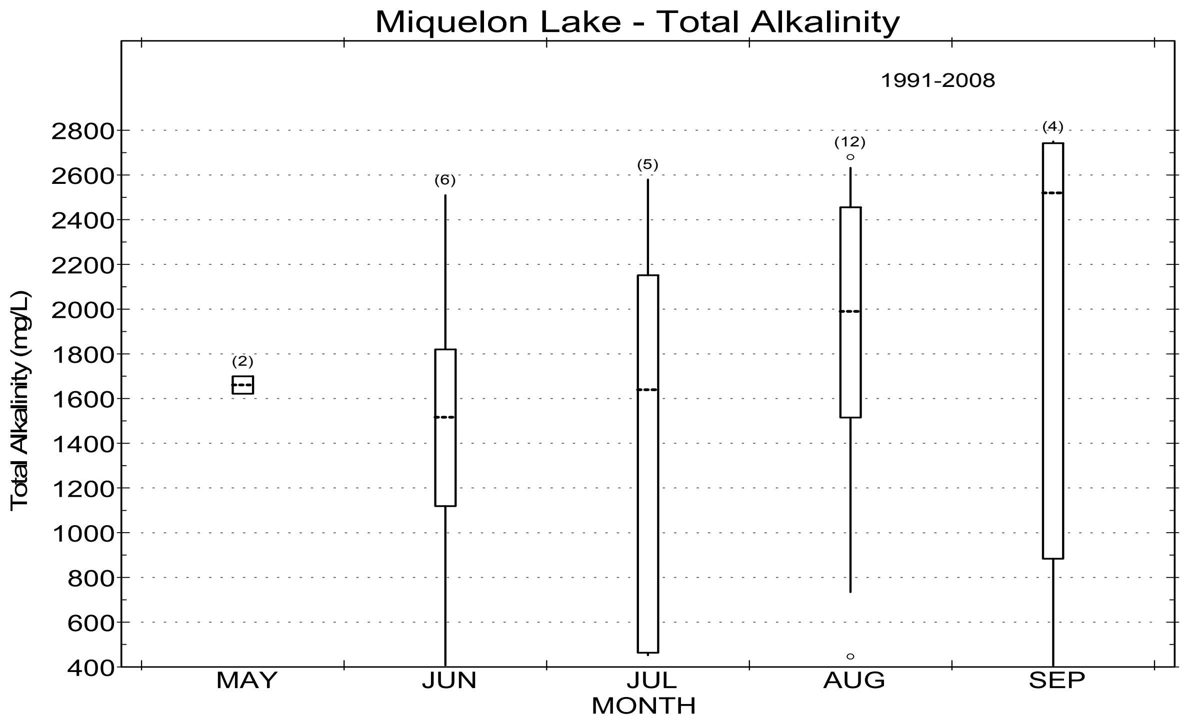


Figure 28 **McLeod Lake, West Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



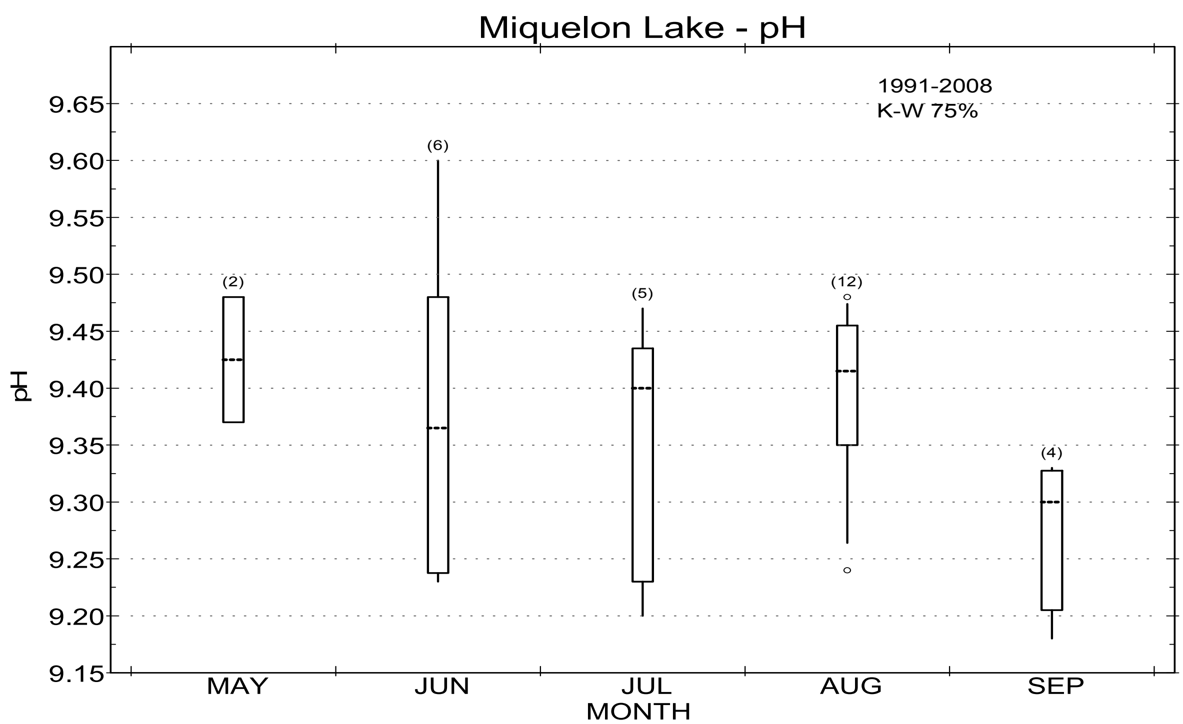
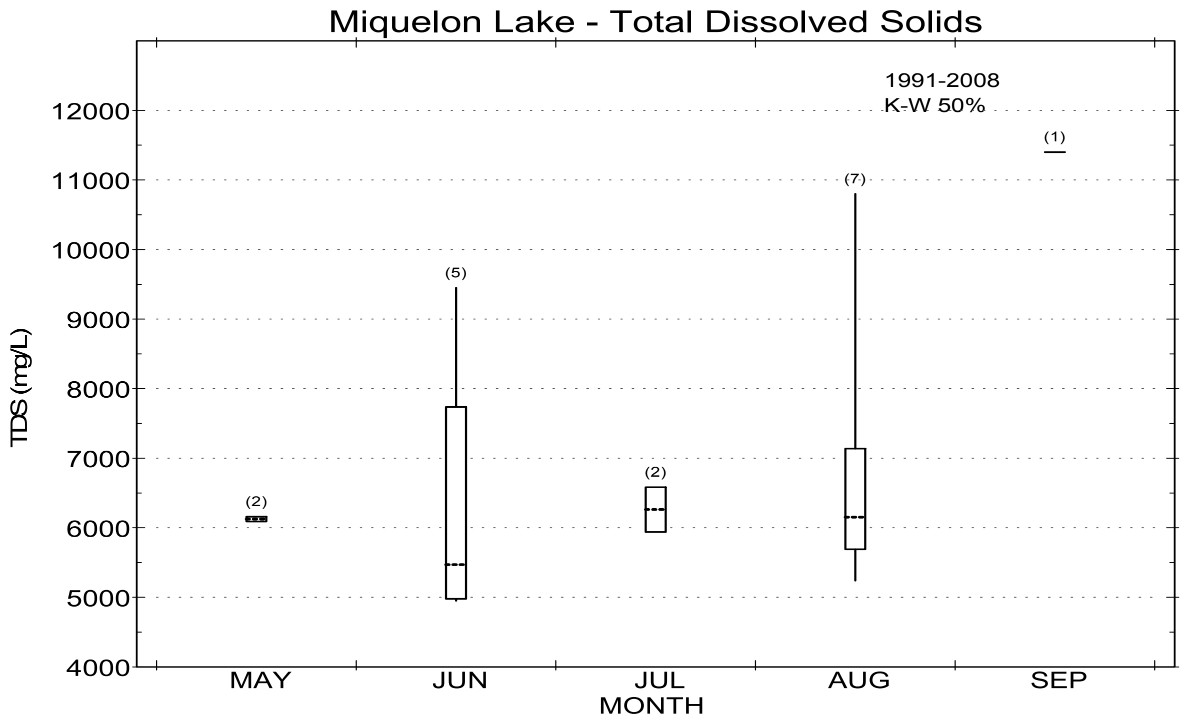


Figure 29 **Miquelon Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



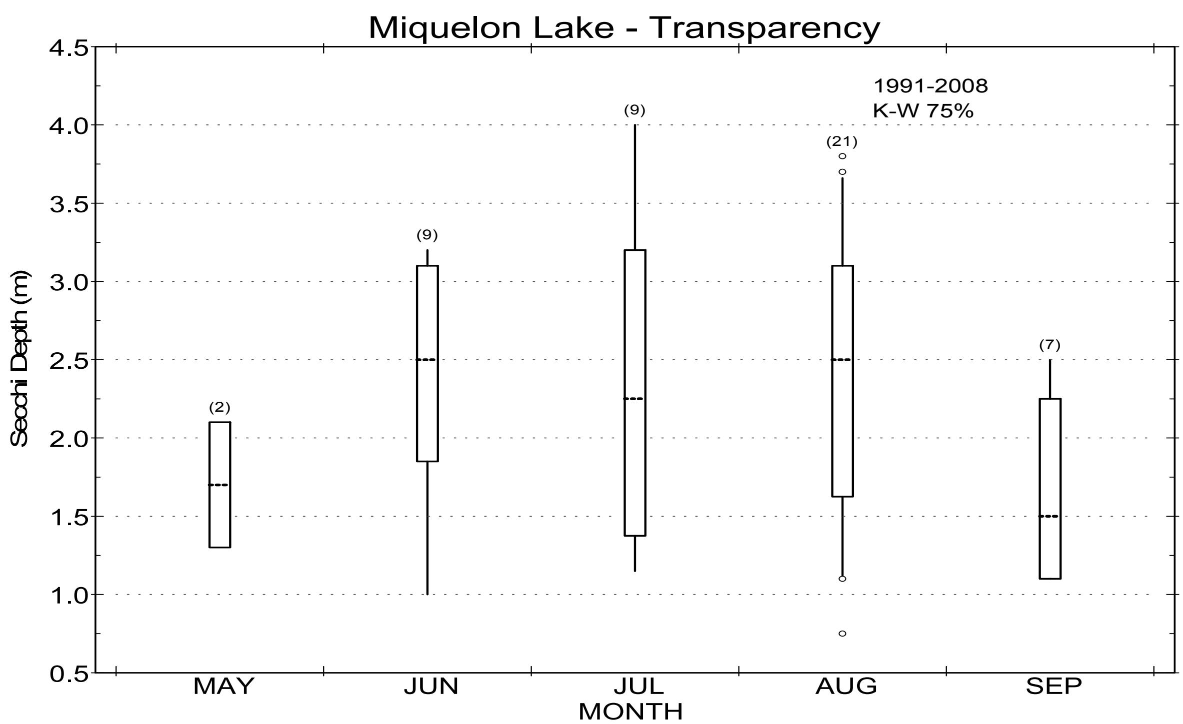
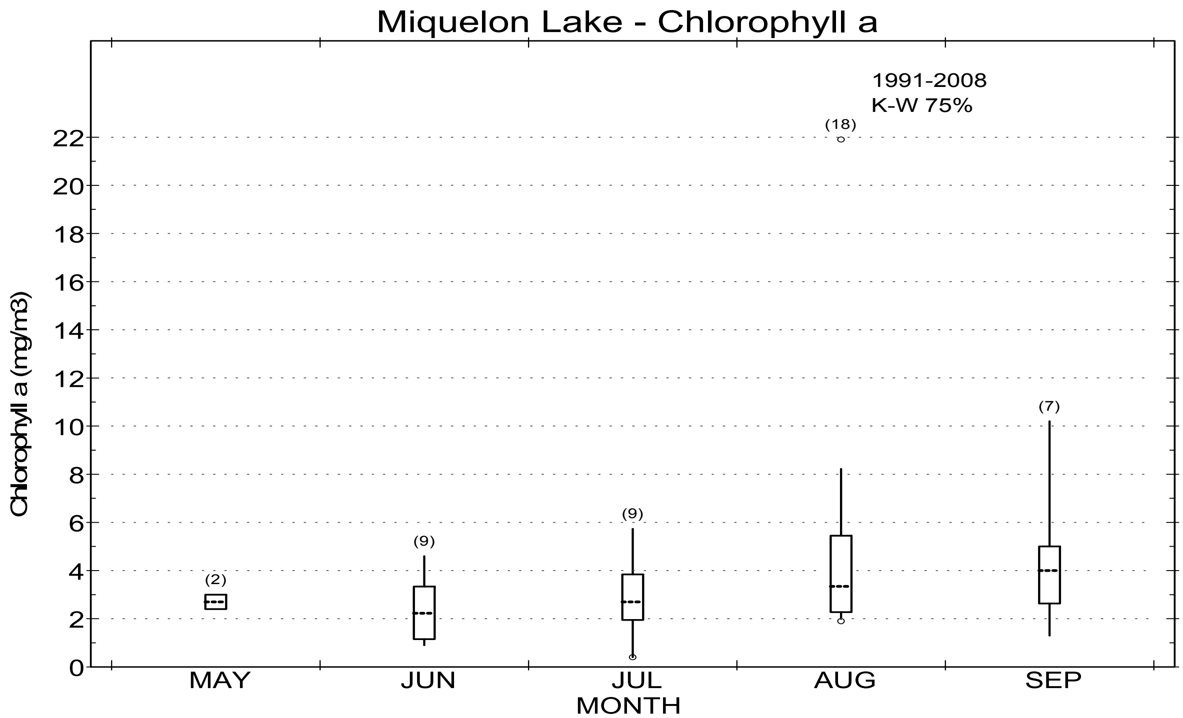


Figure 29 **Miquelon Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



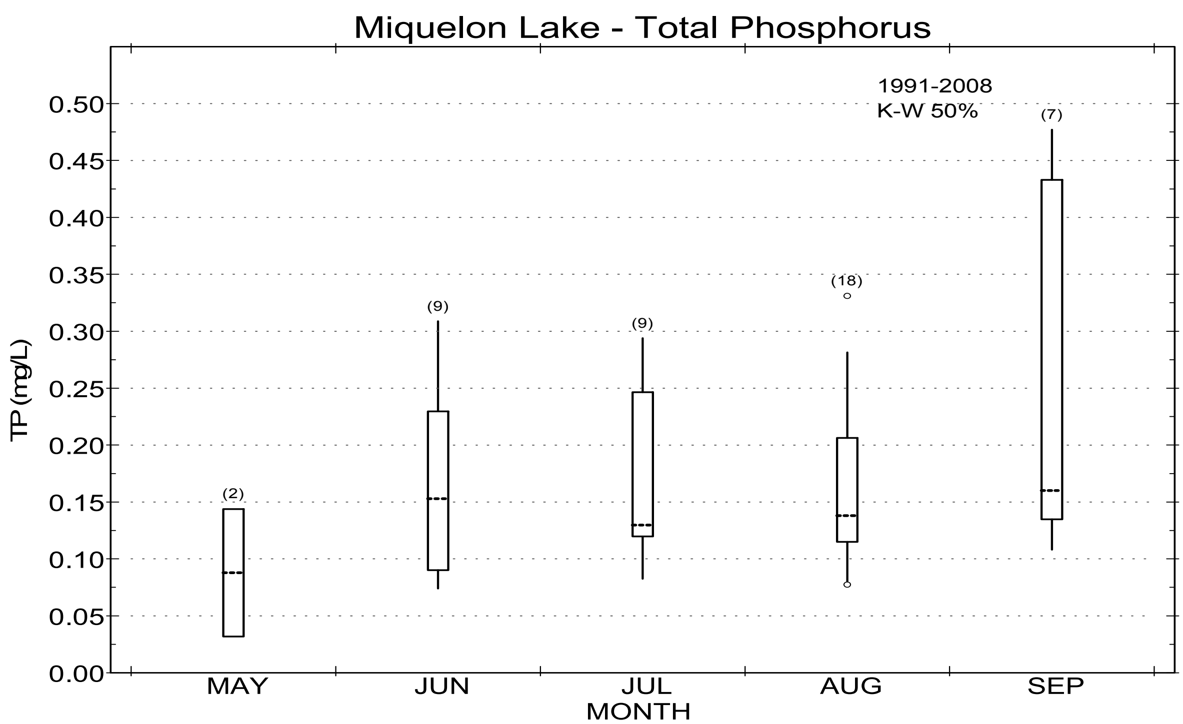


Figure 29 **Miquelon Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)

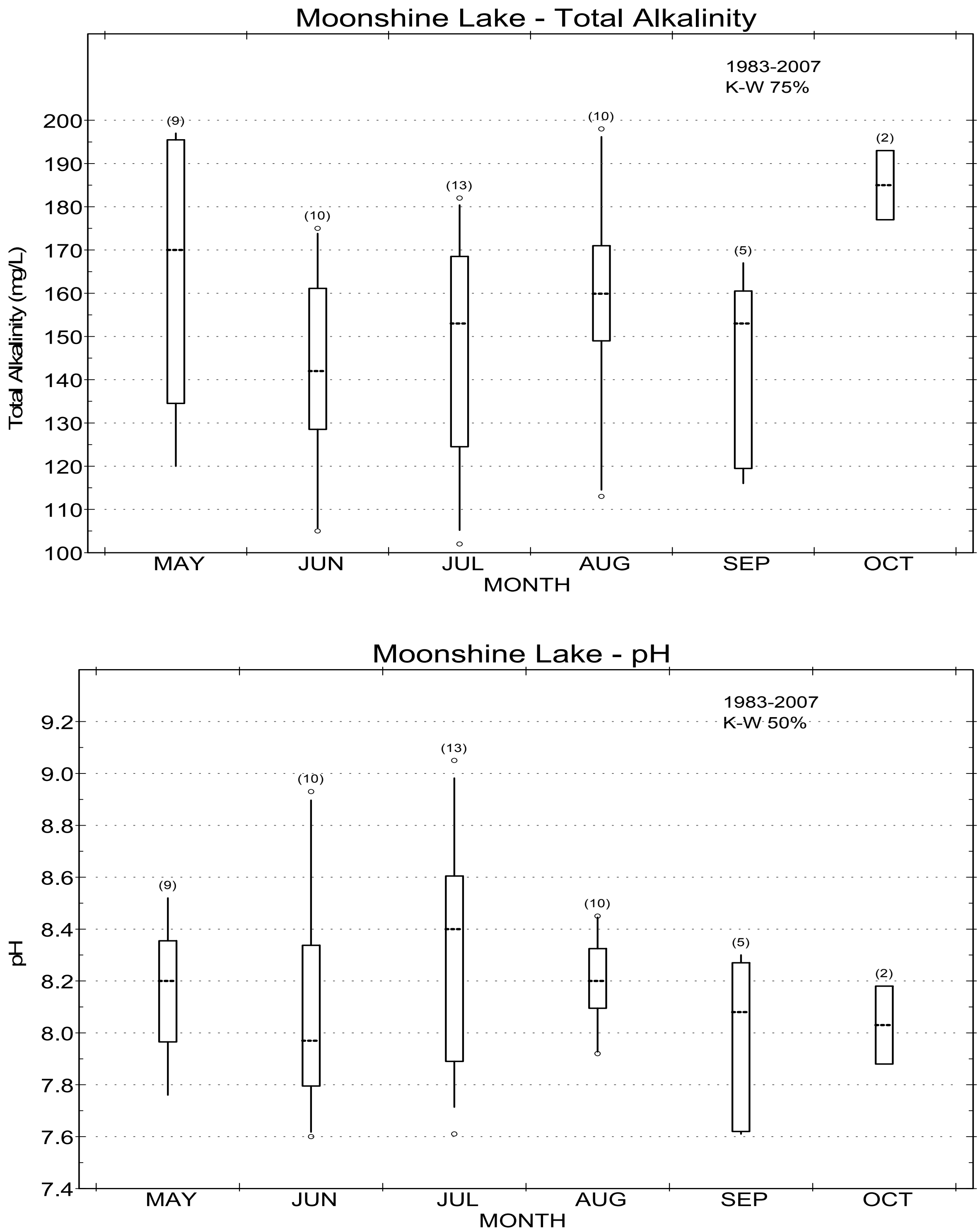
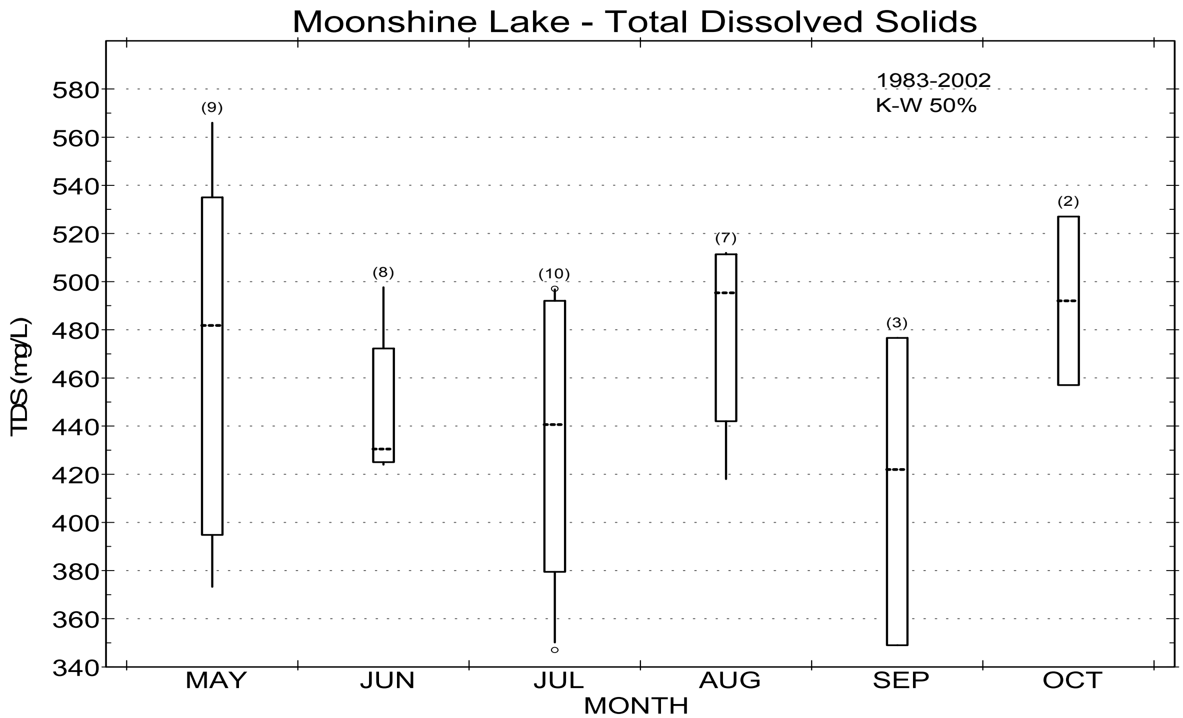


Figure 30 **Moonshine Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



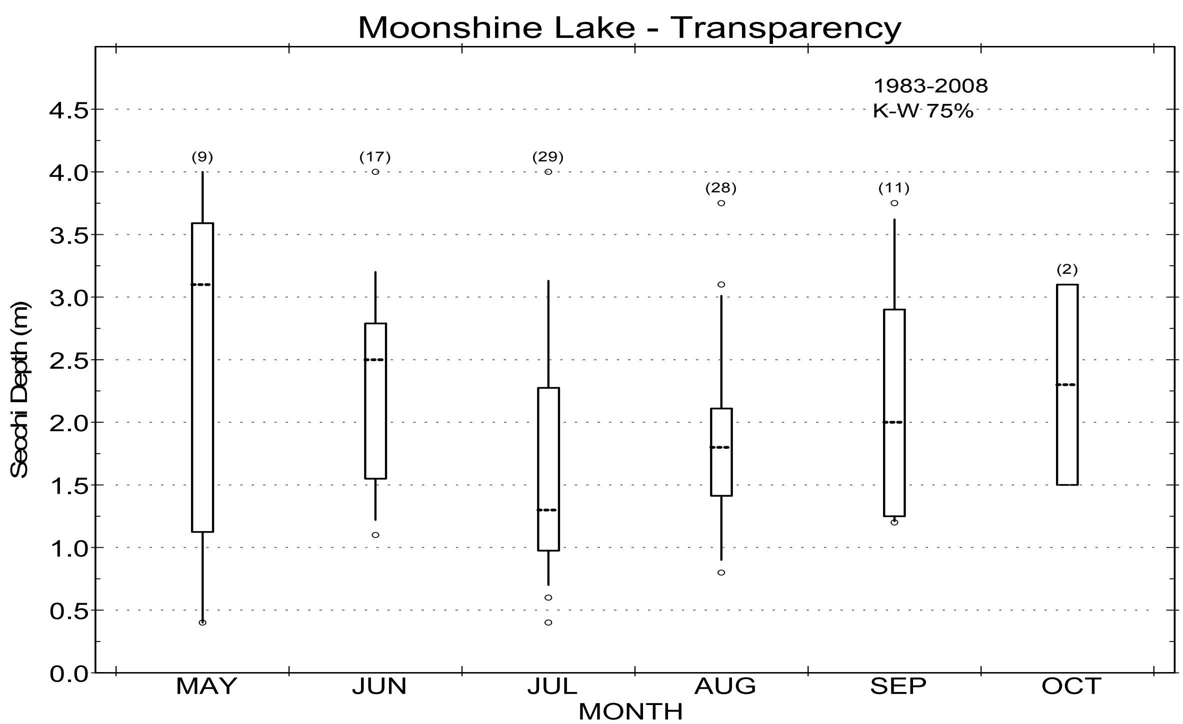
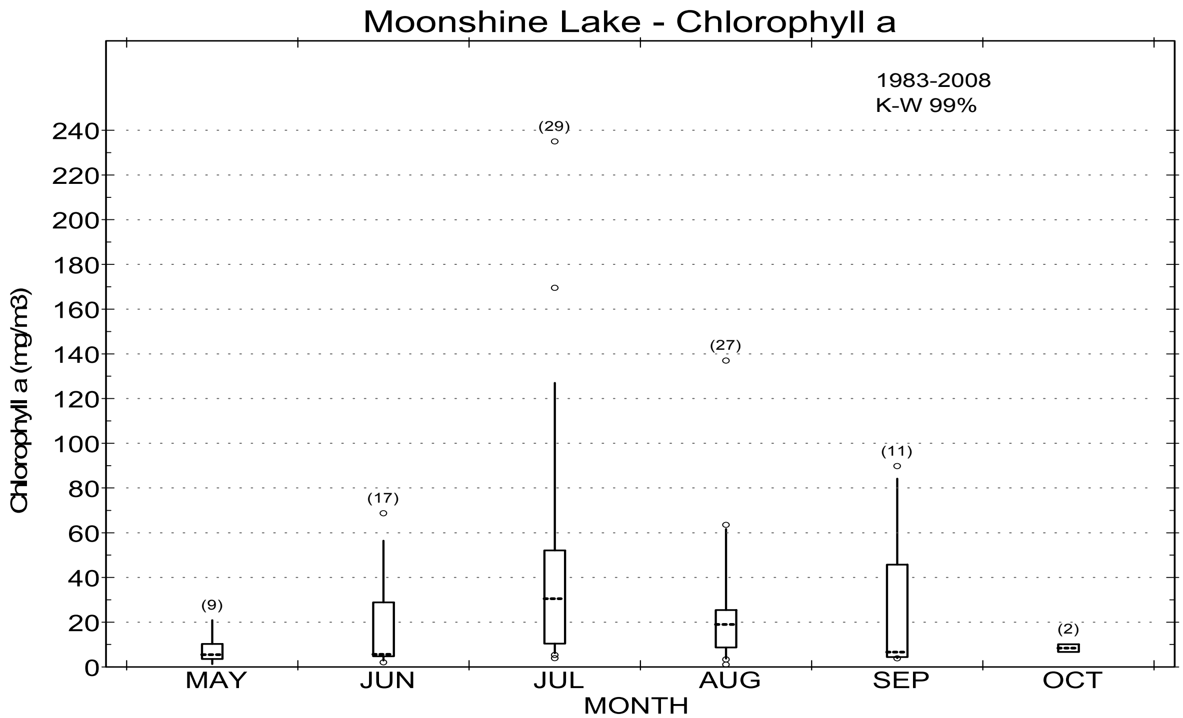


Figure 30 **Moonshine Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



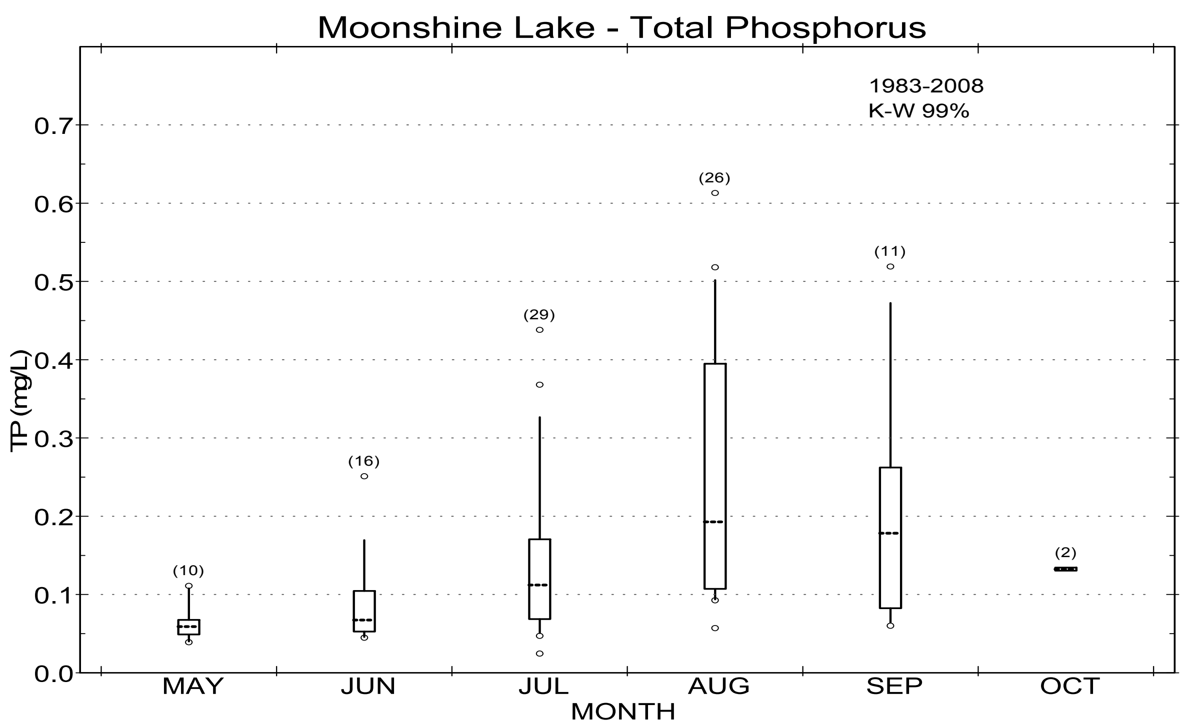
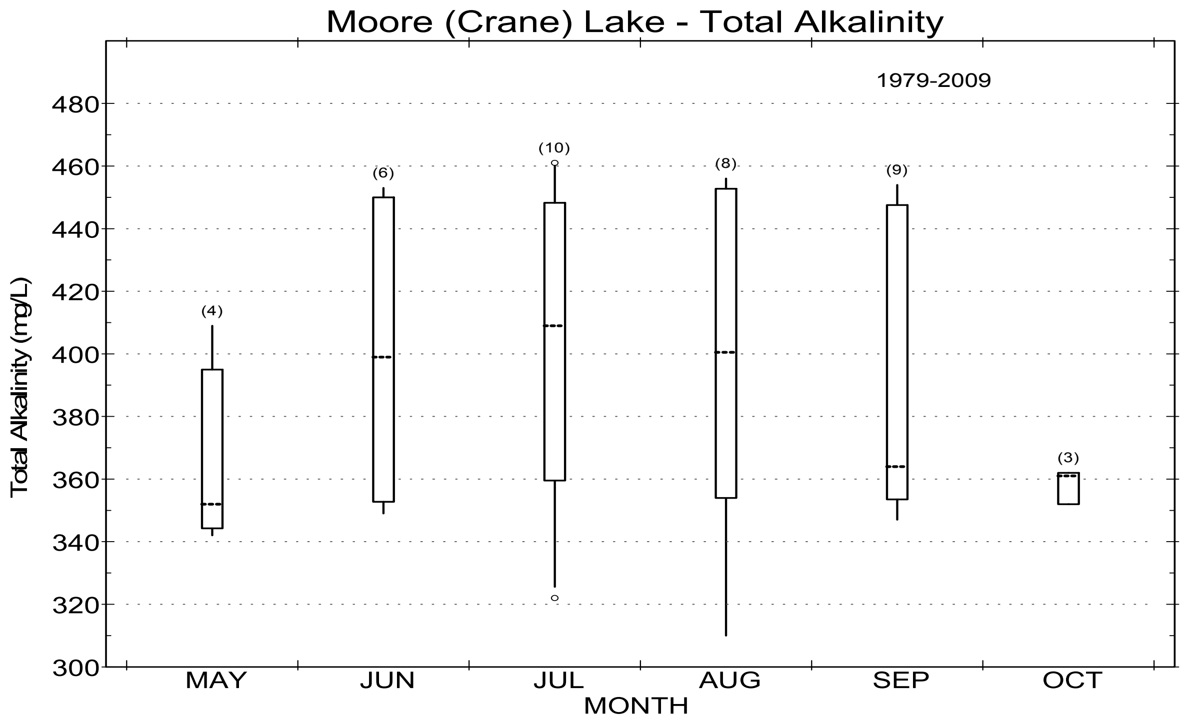


Figure 30 **Moonshine Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



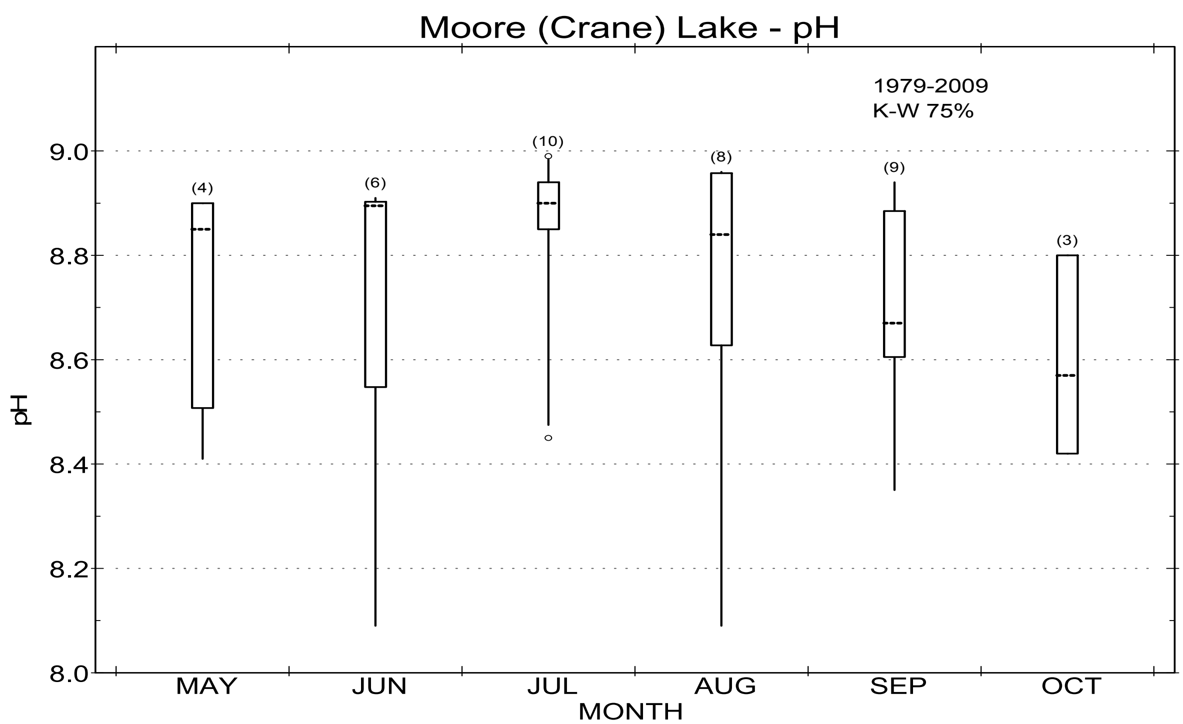
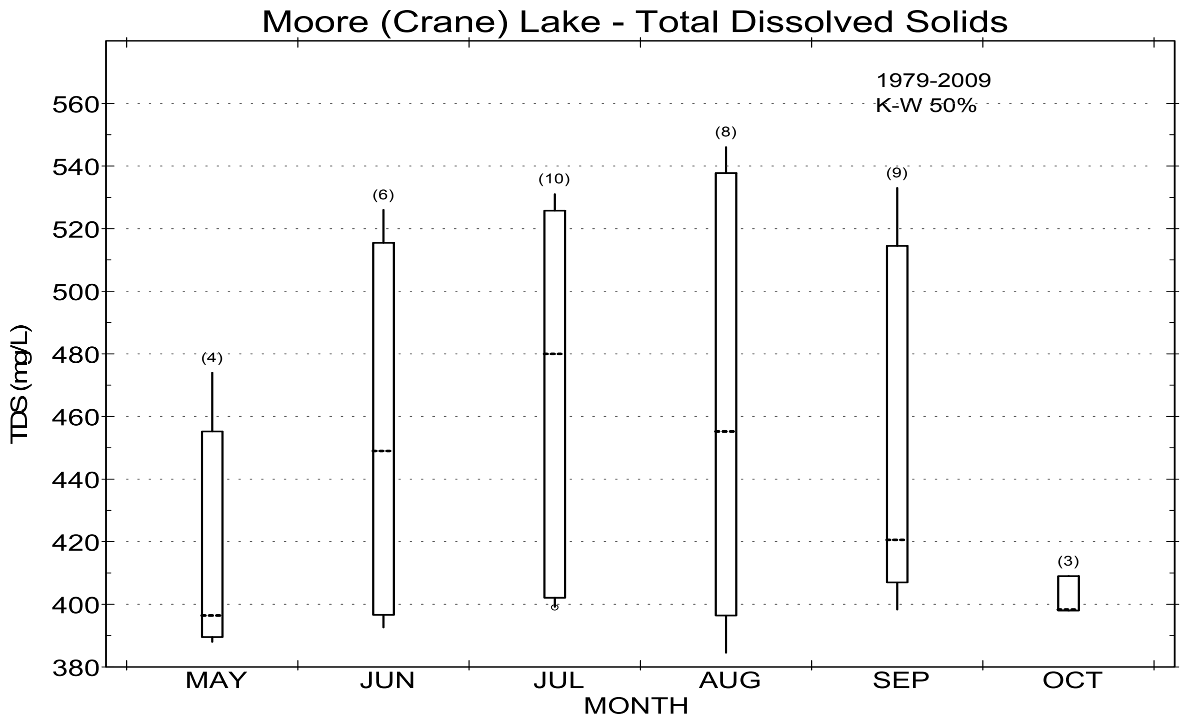


Figure 31 **Moore (Crane) Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month.



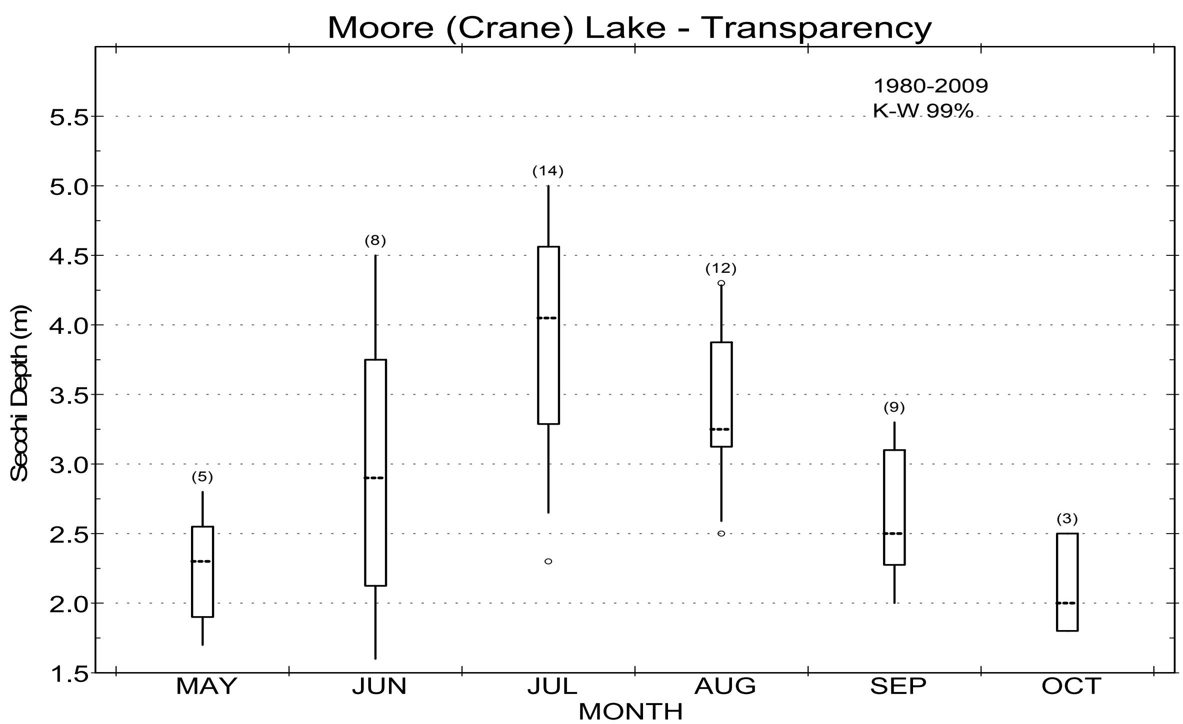
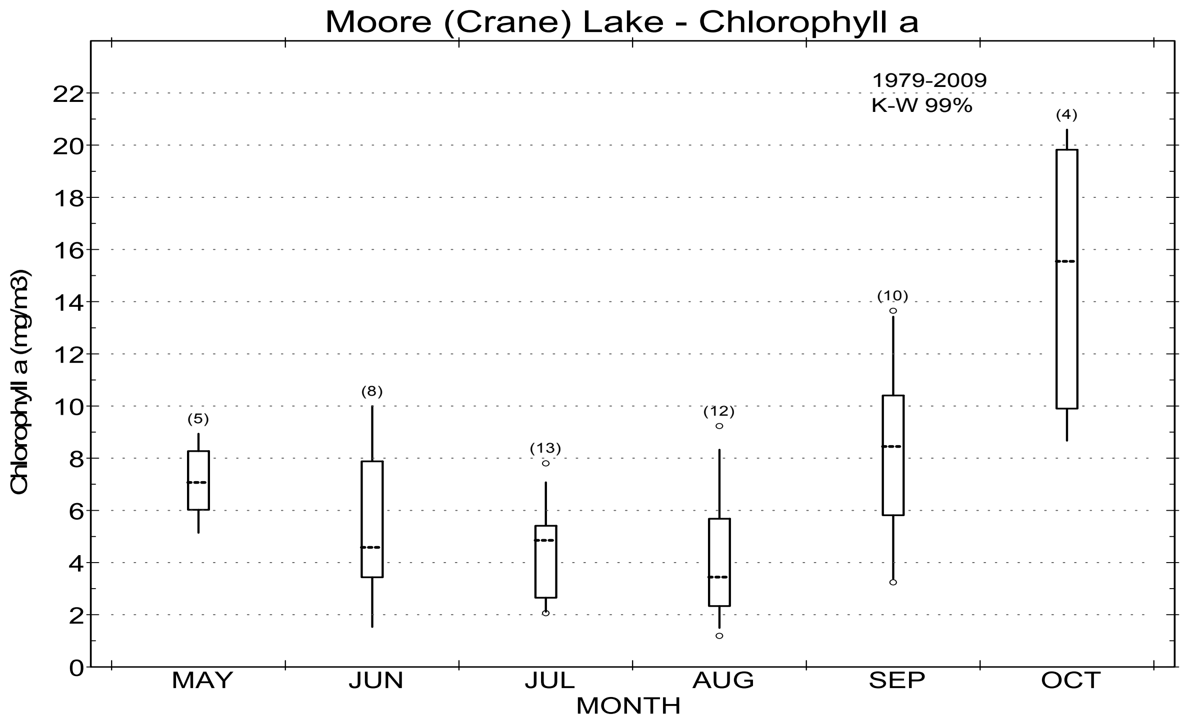


Figure 31 **Moore (Crane) Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



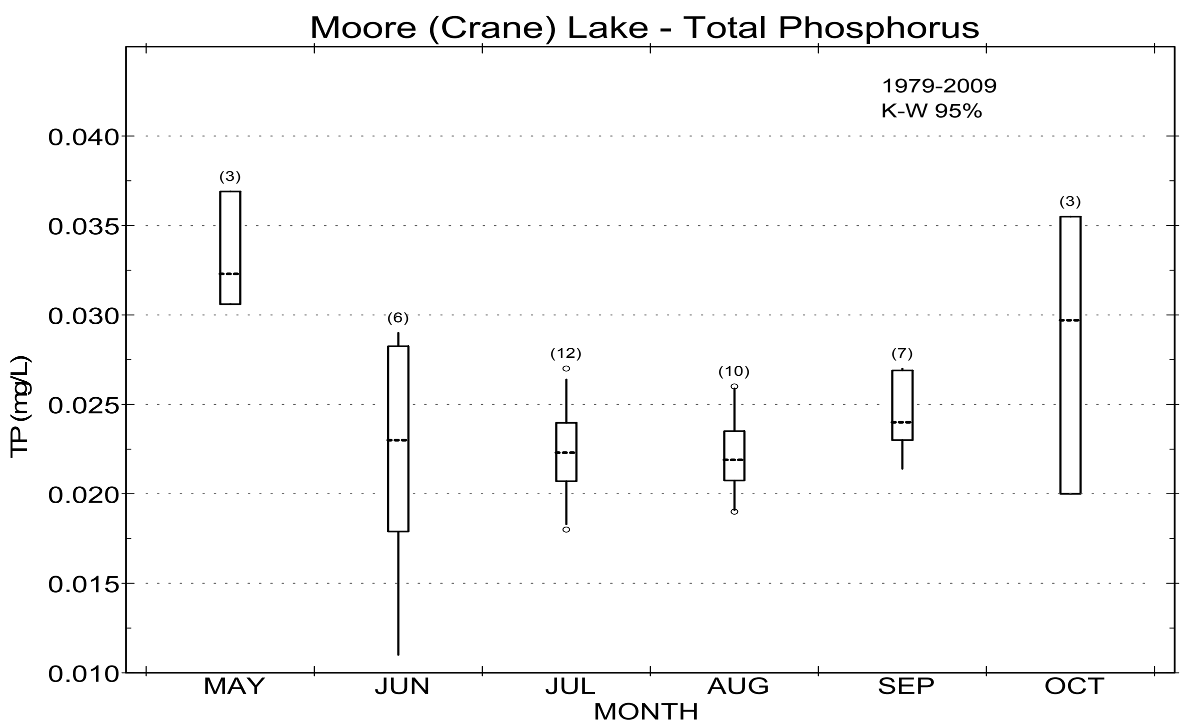
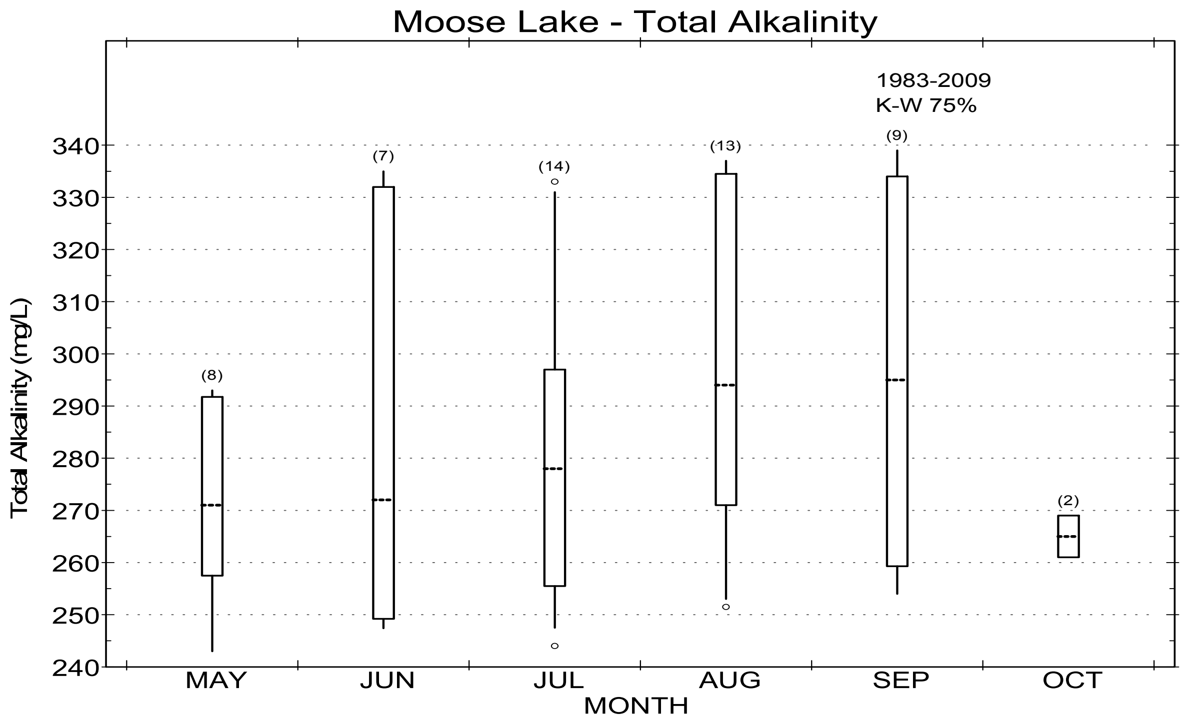


Figure 31 **Moore (Crane) Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



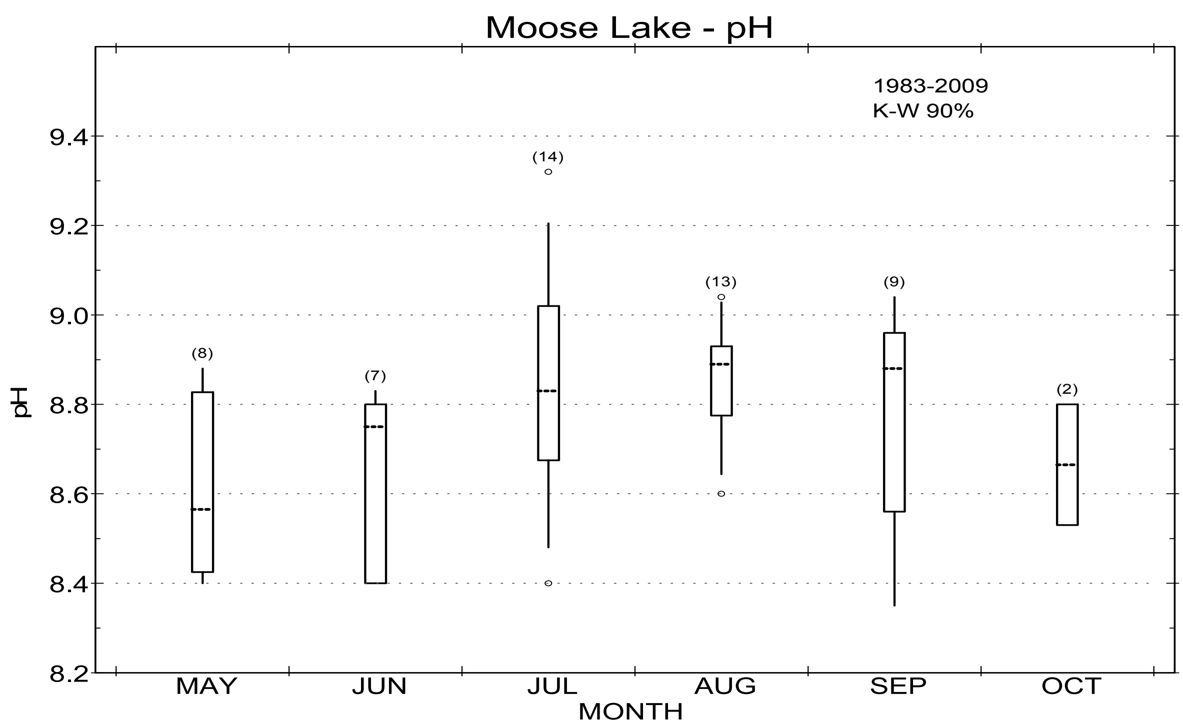
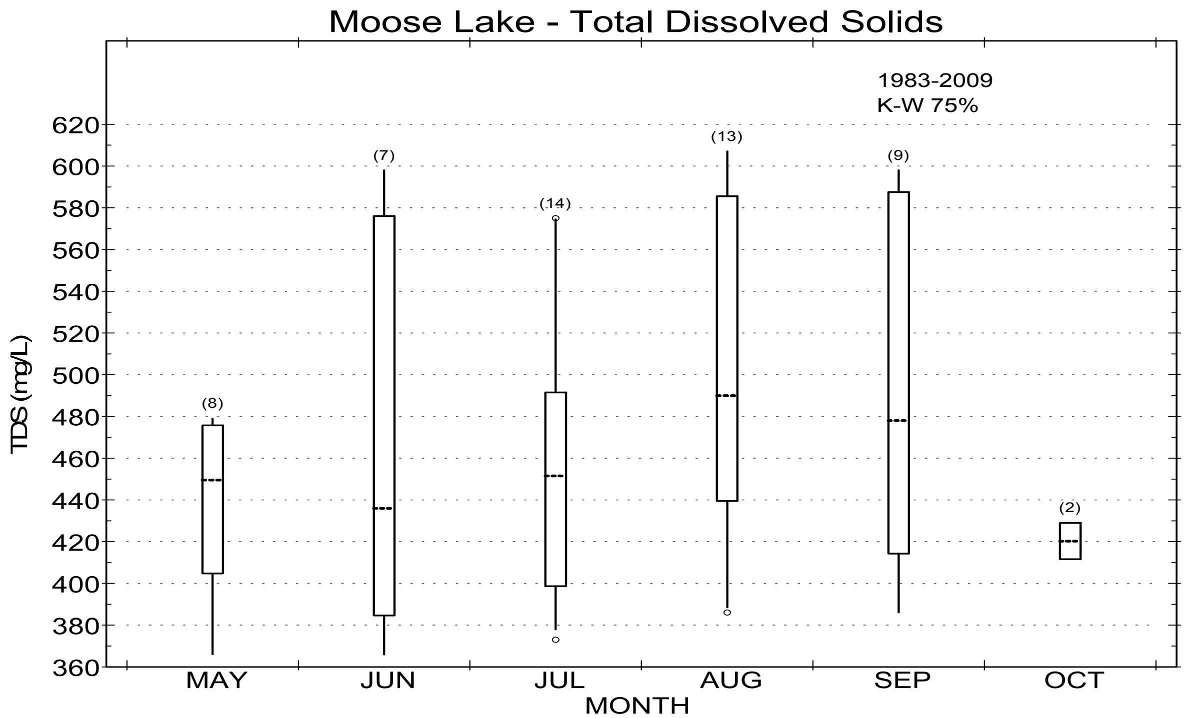


Figure 32 **Moose Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



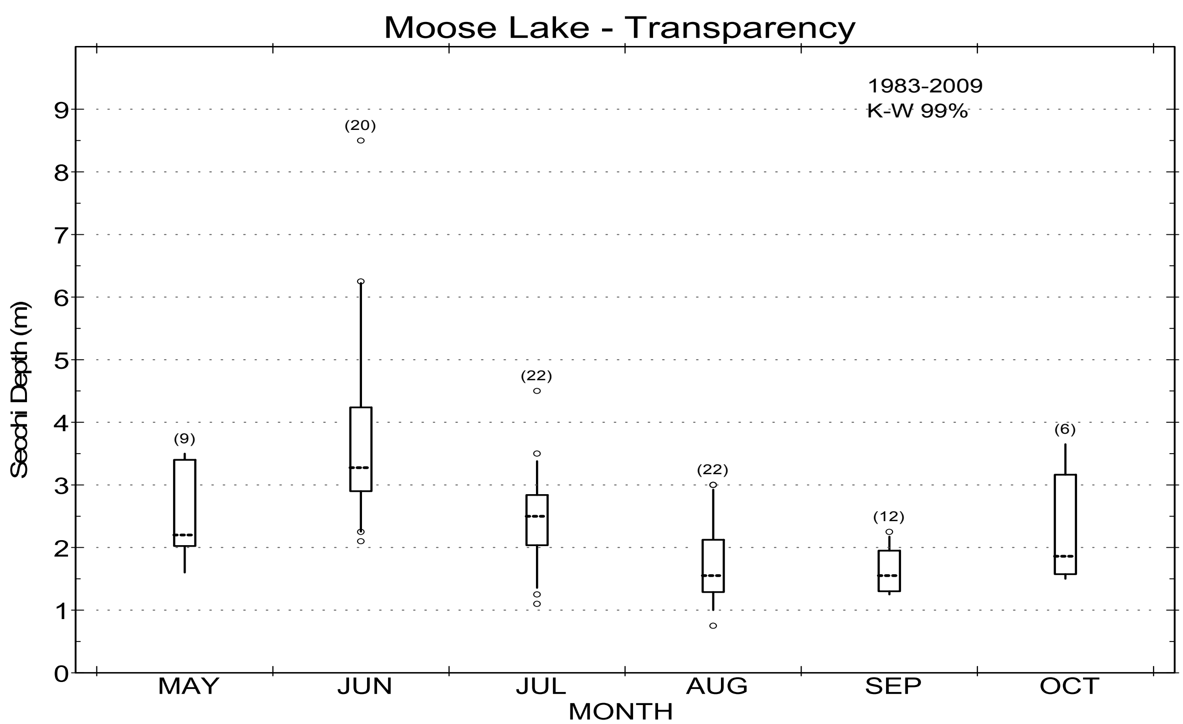
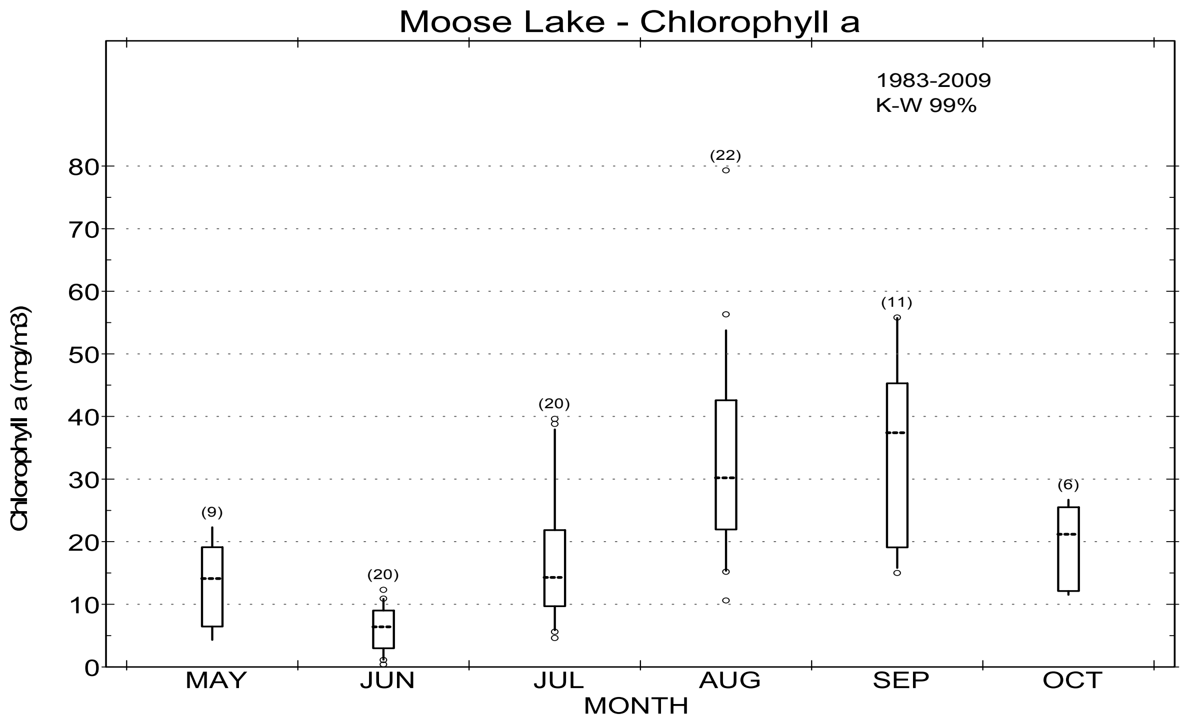


Figure 32 **Moose Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



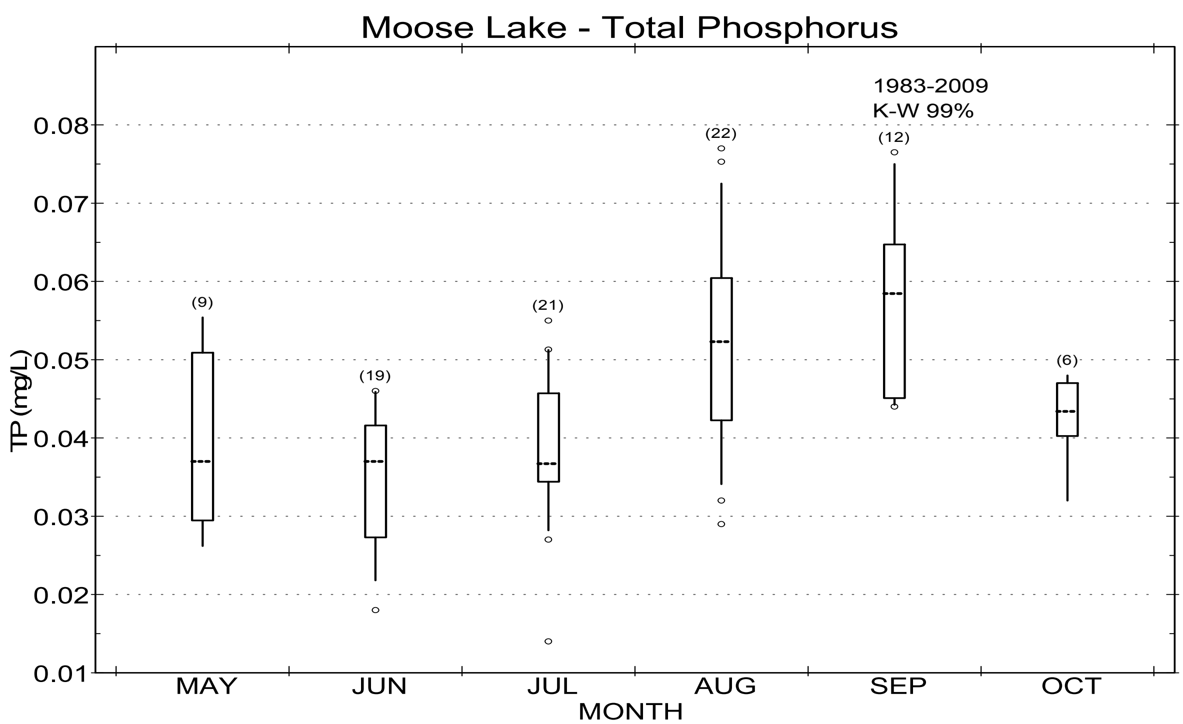
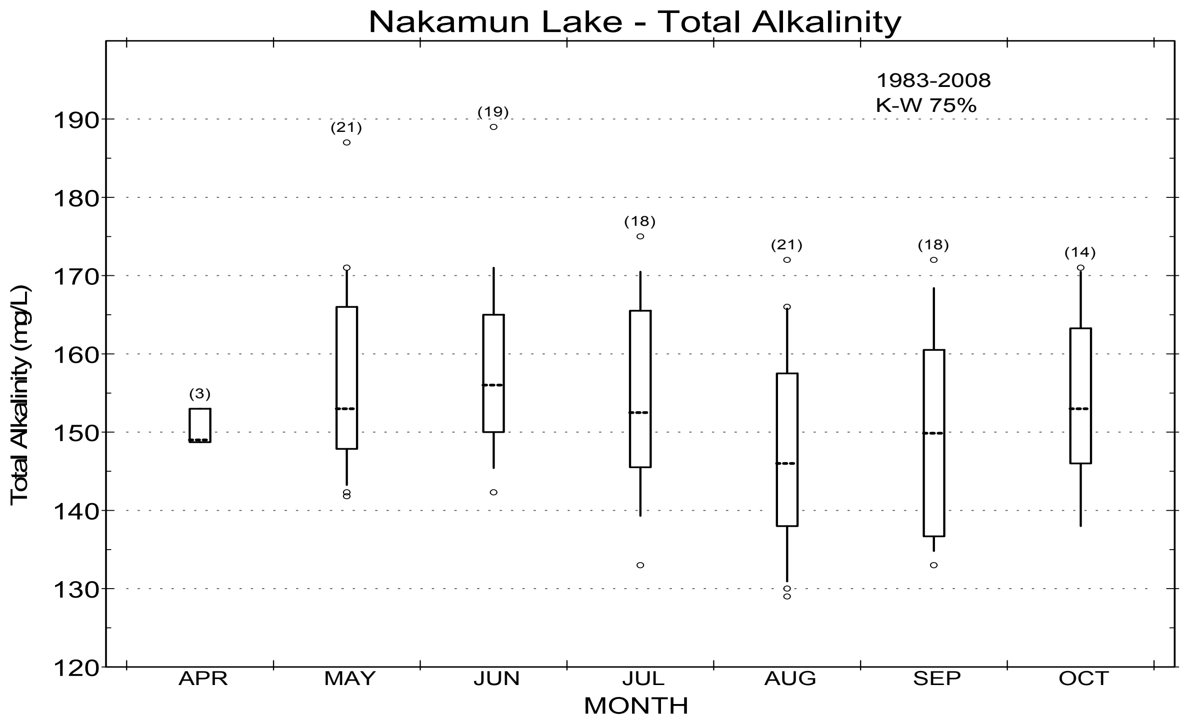


Figure 32 **Moose Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



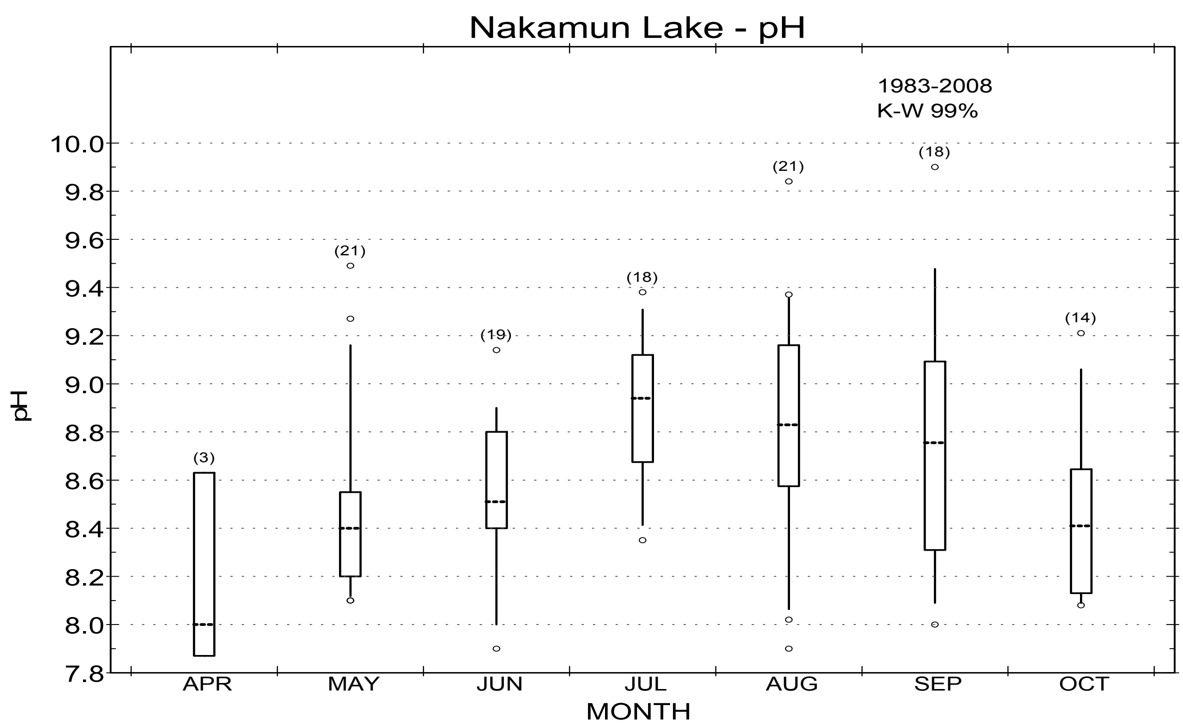
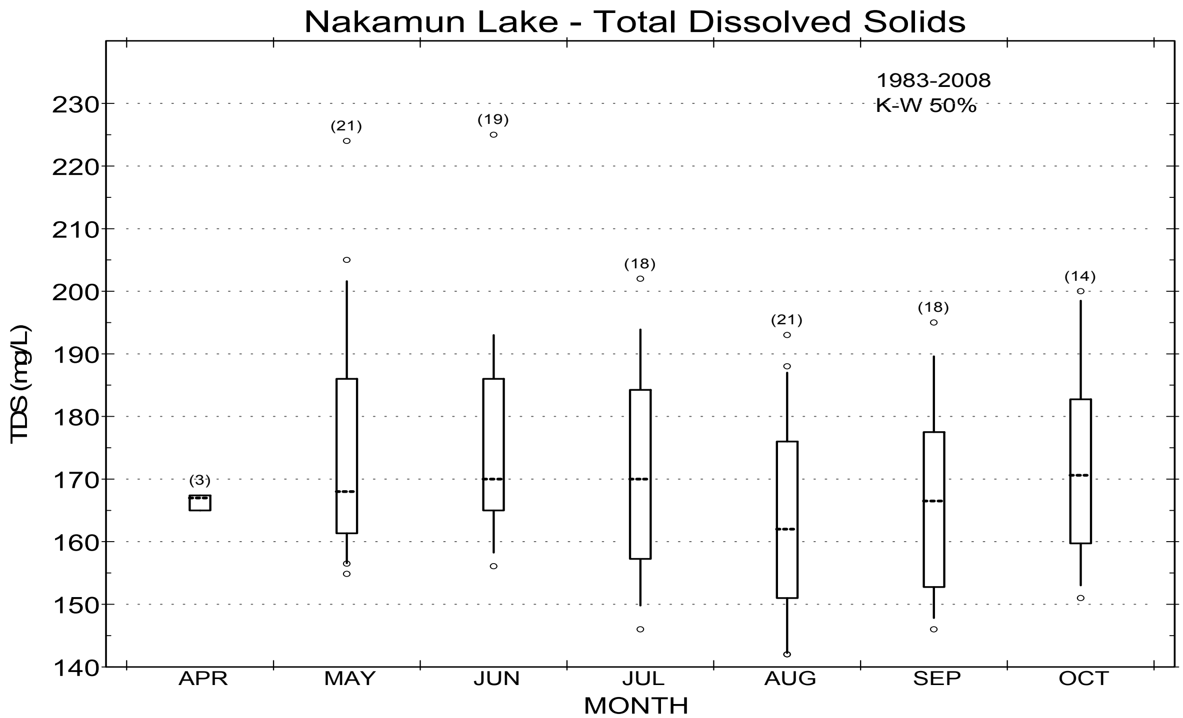


Figure 33a **Nakamun Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



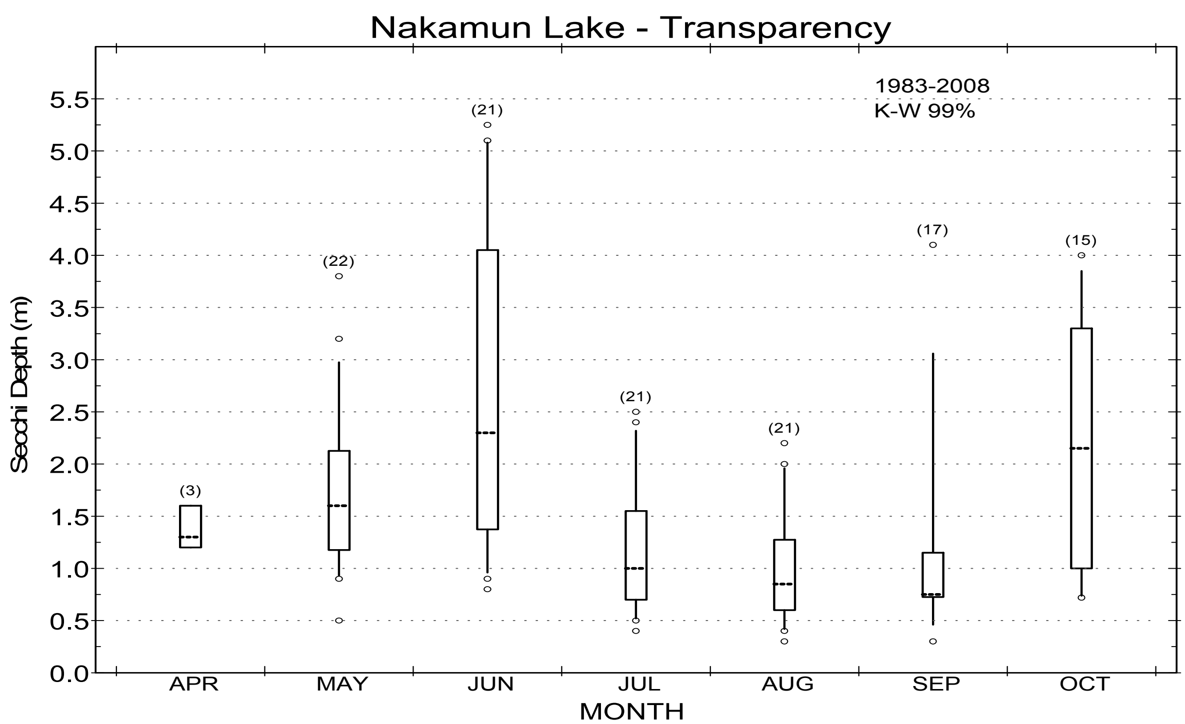
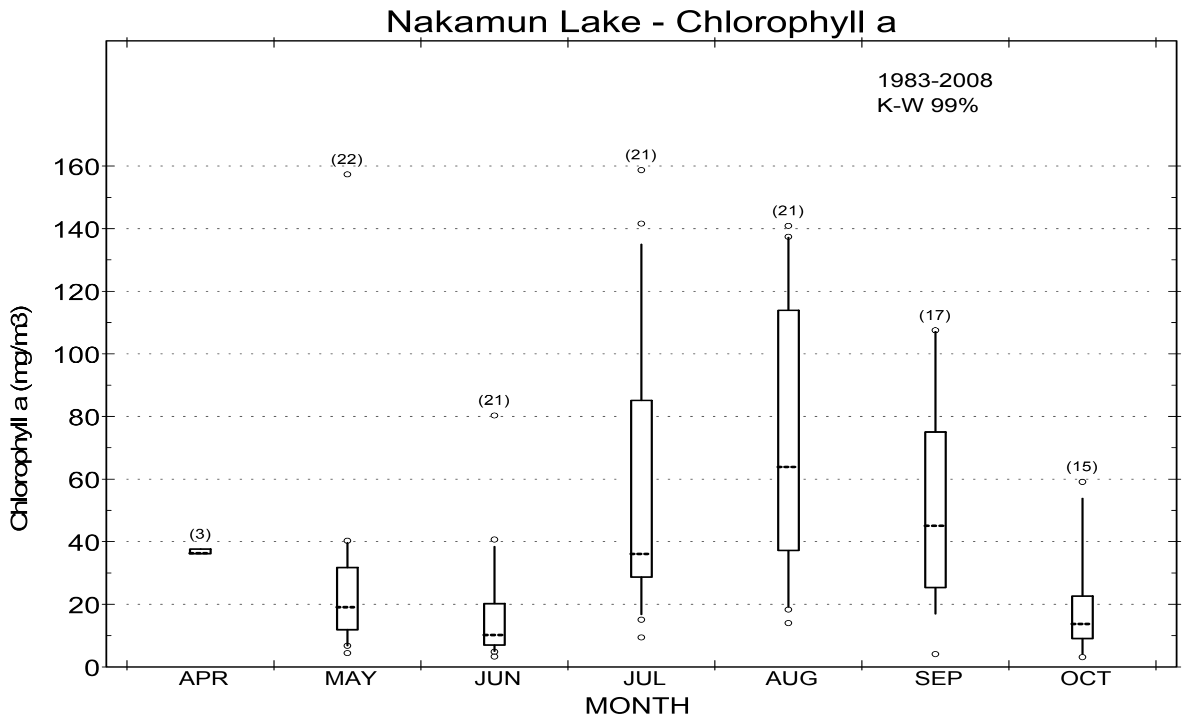


Figure 33a **Nakamun Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



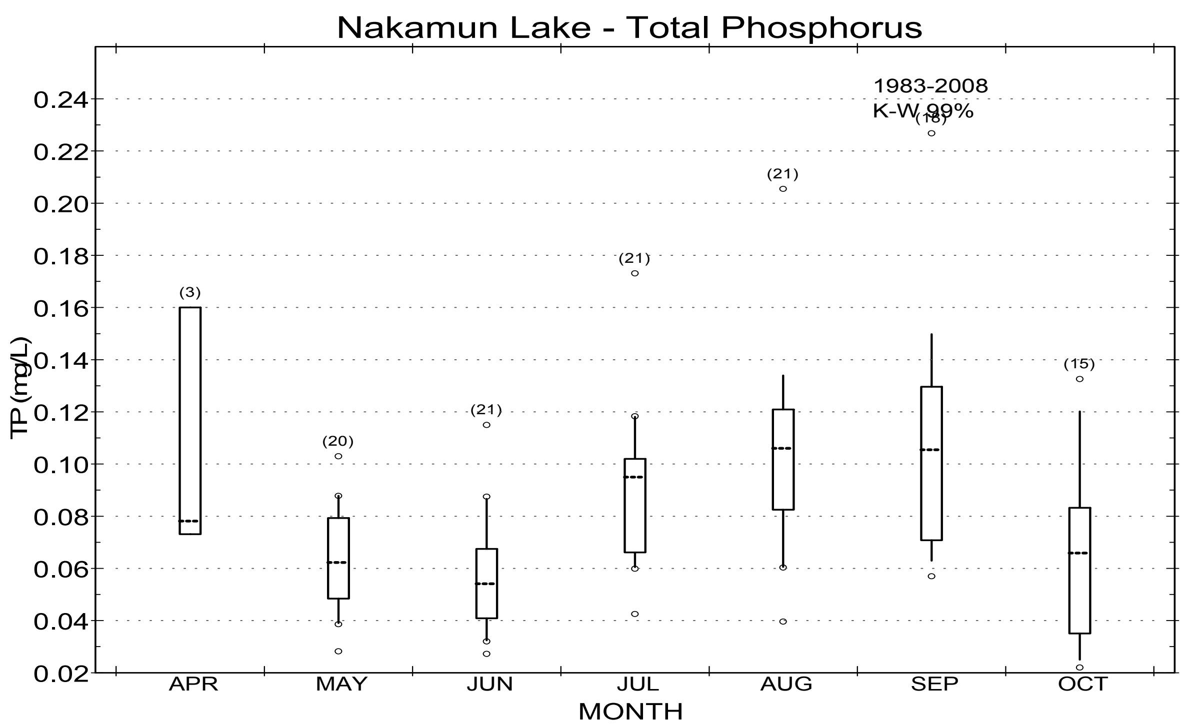
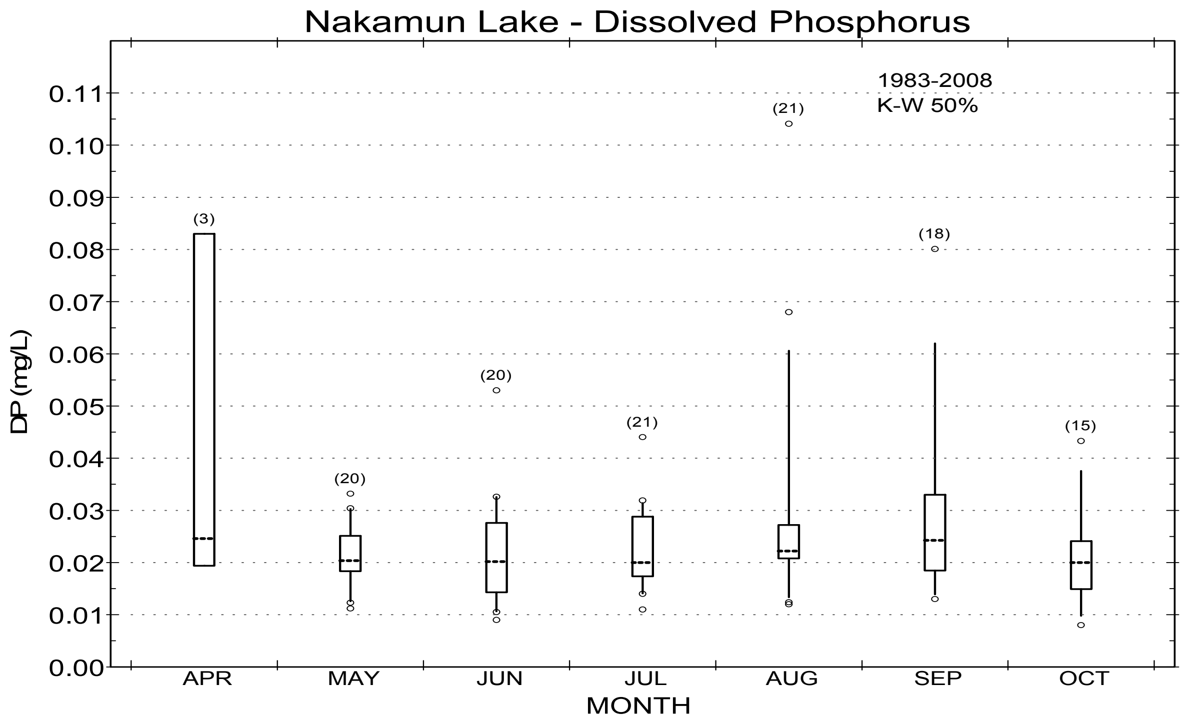


Figure 33a **Nakamun Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



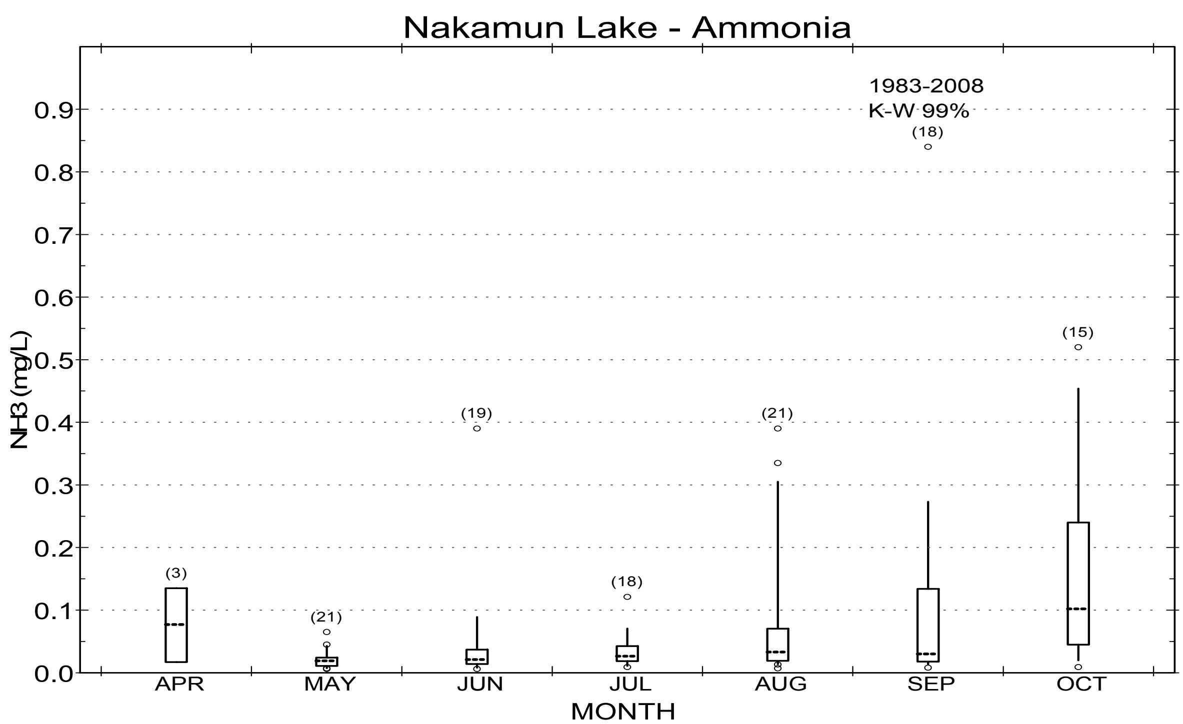
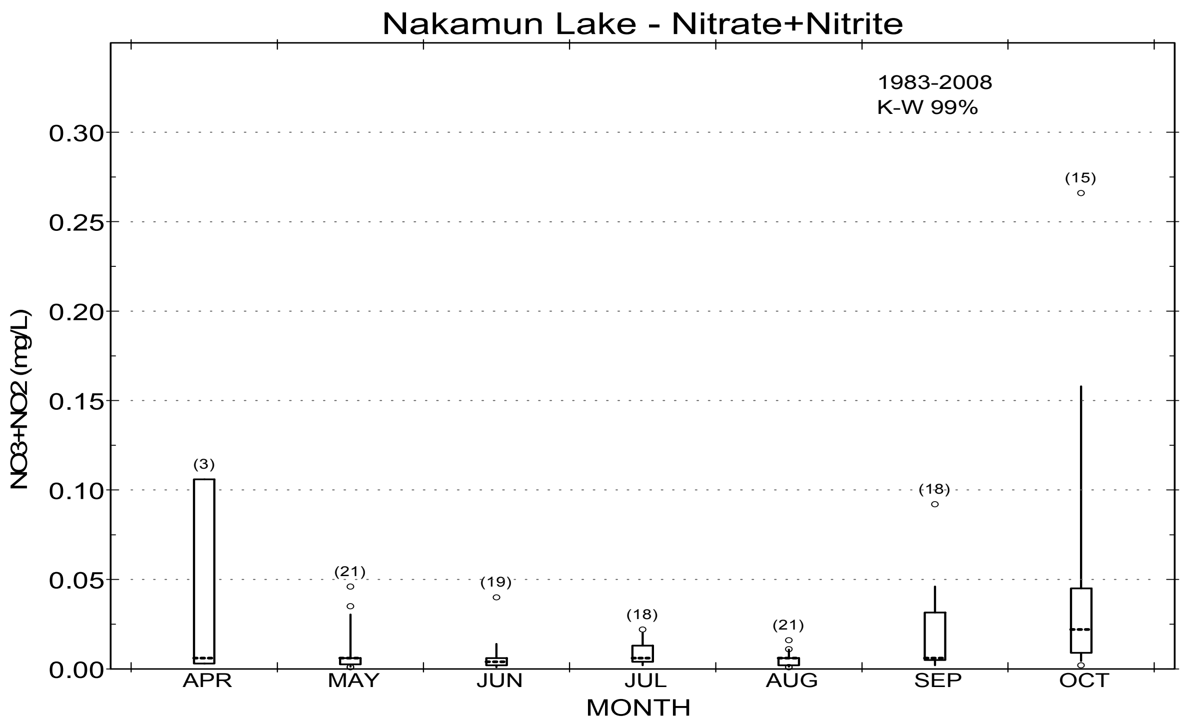


Figure 33b **Nakamun Lake -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month.



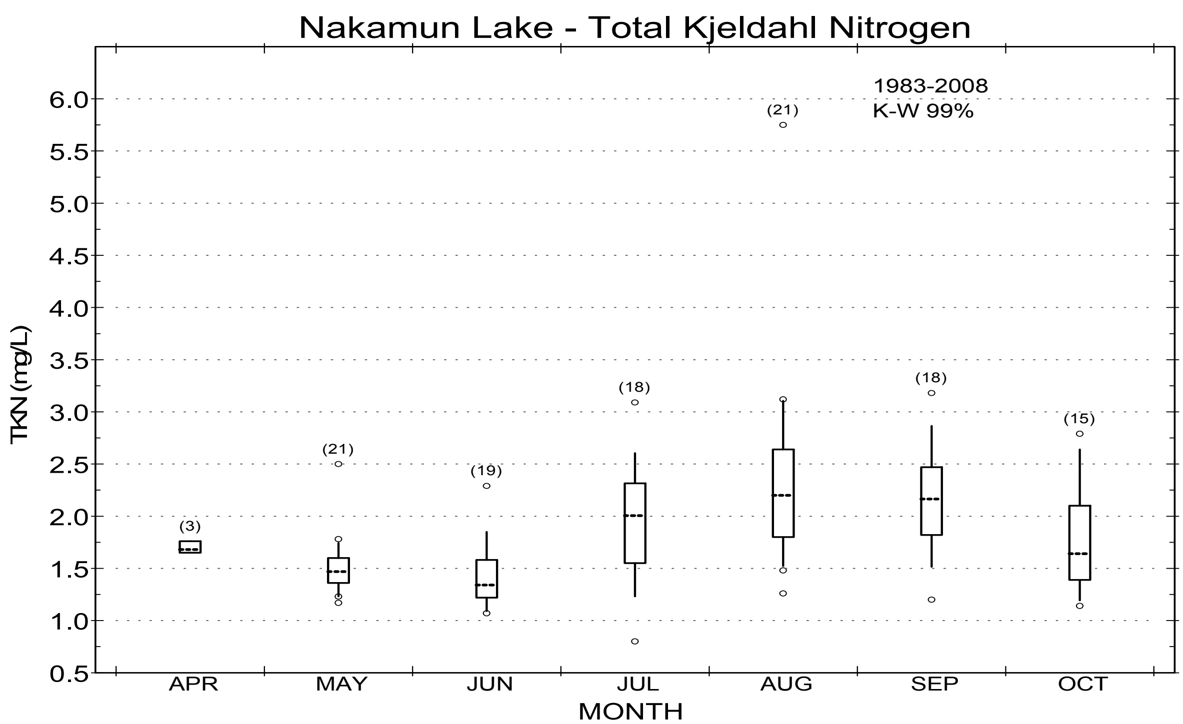
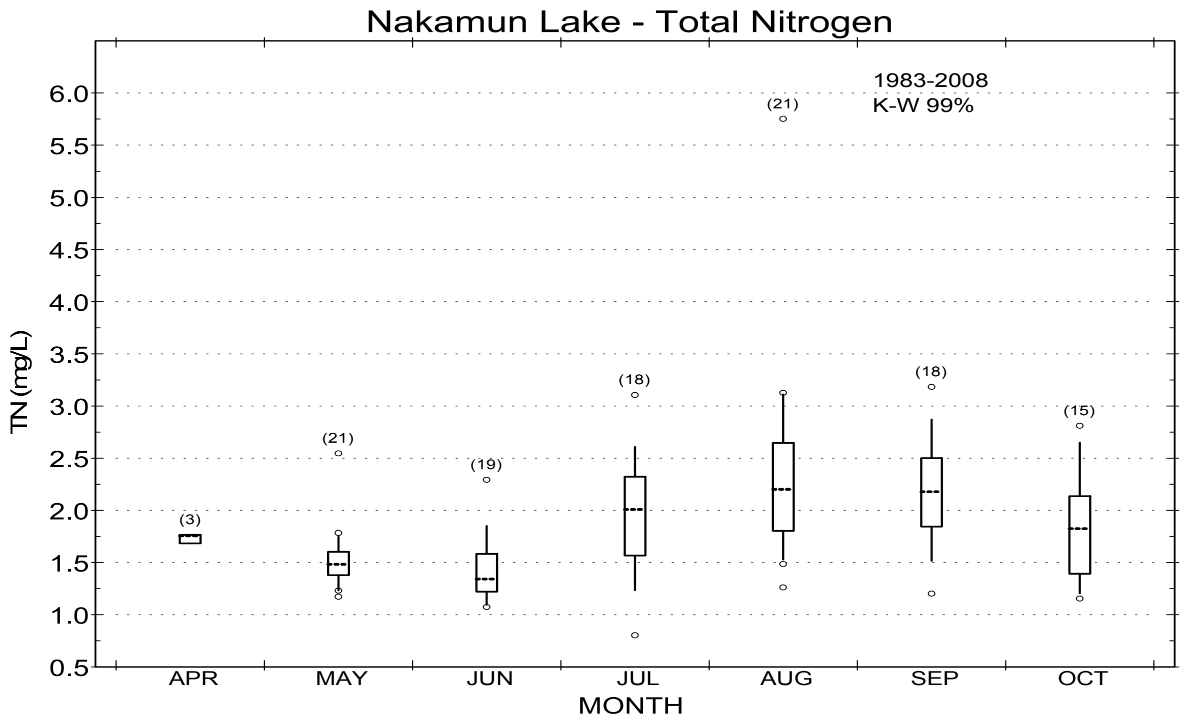


Figure 33b **Nakamun Lake -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)



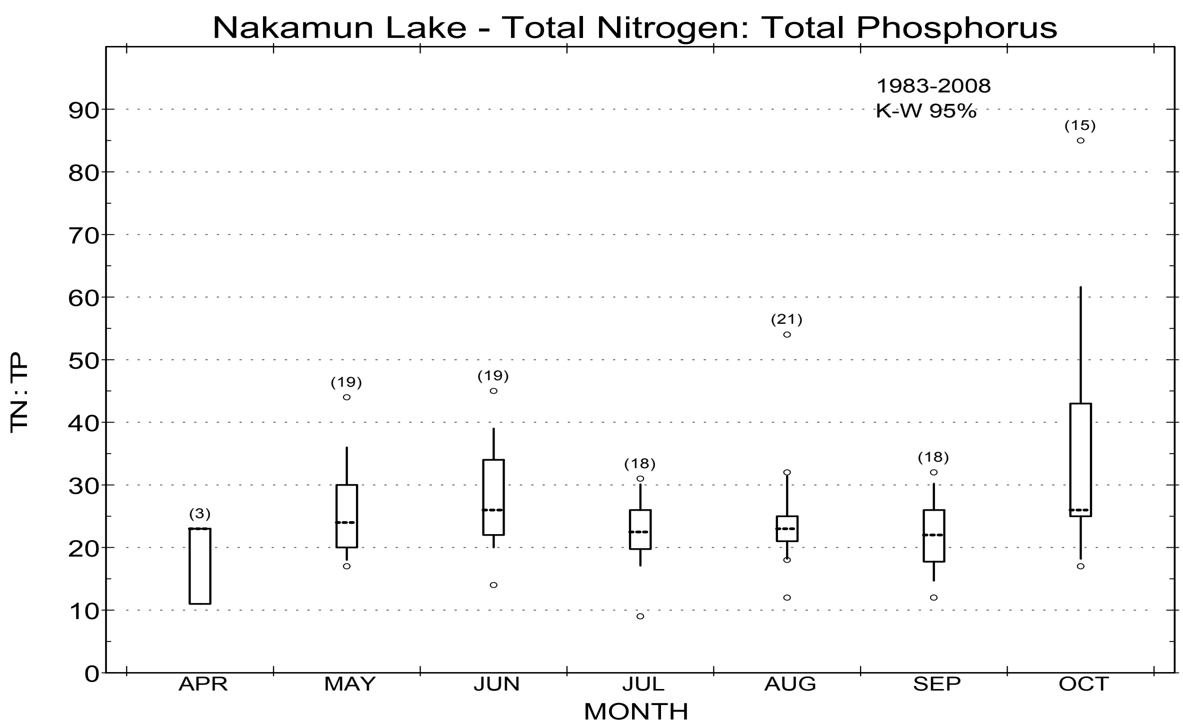
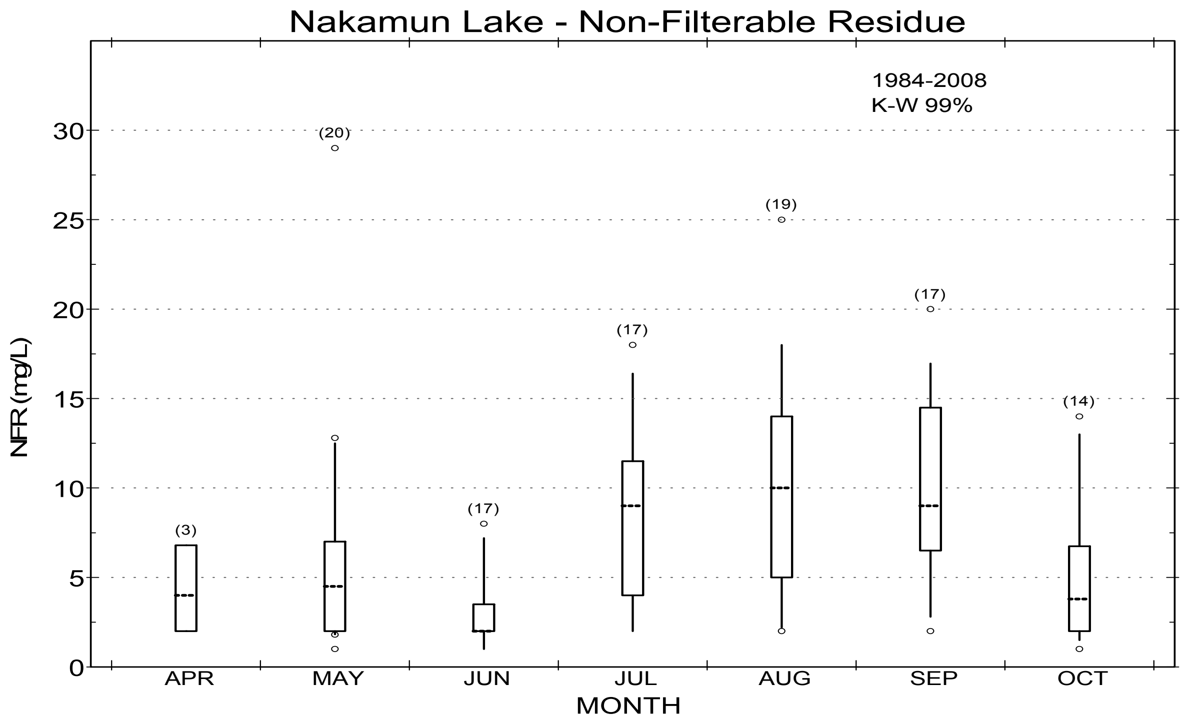


Figure 33b **Nakamun Lake -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)



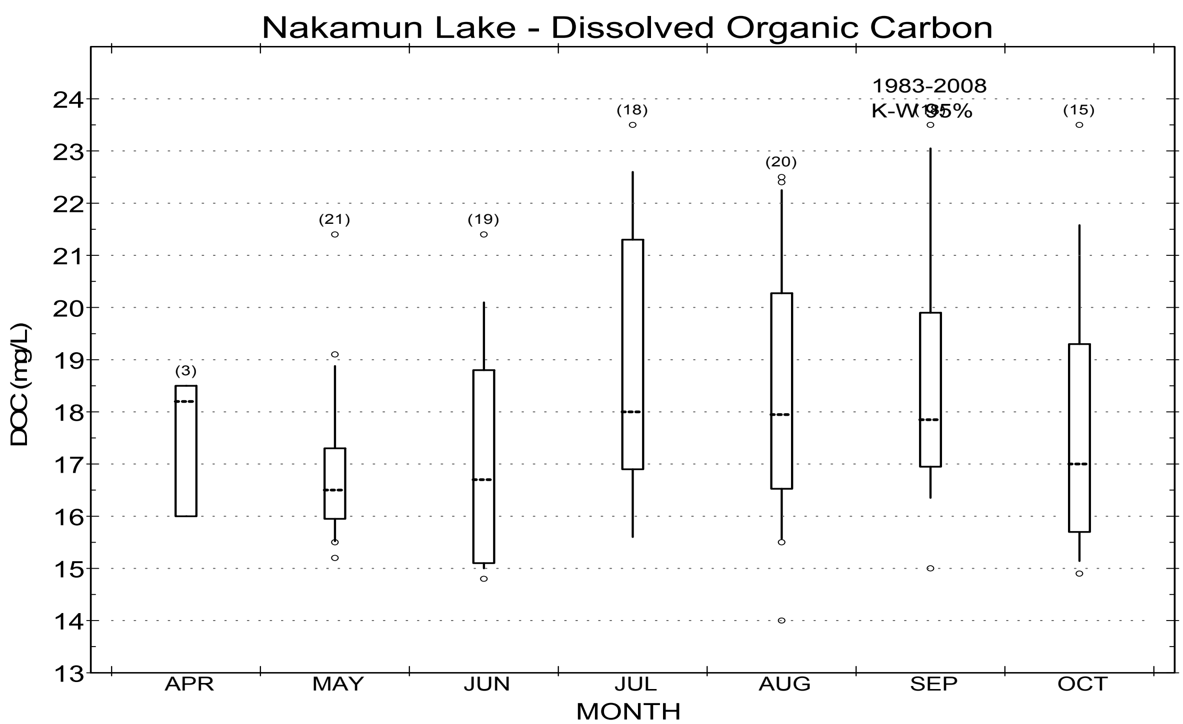


Figure 33b **Nakamun Lake -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)

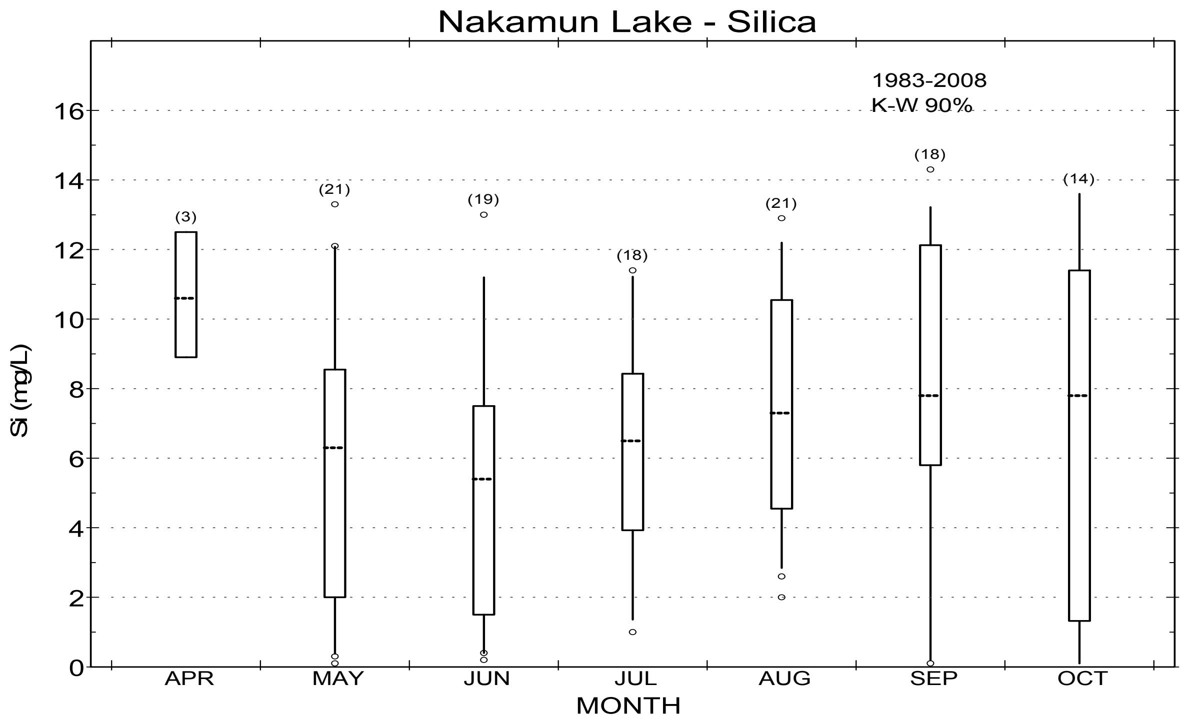
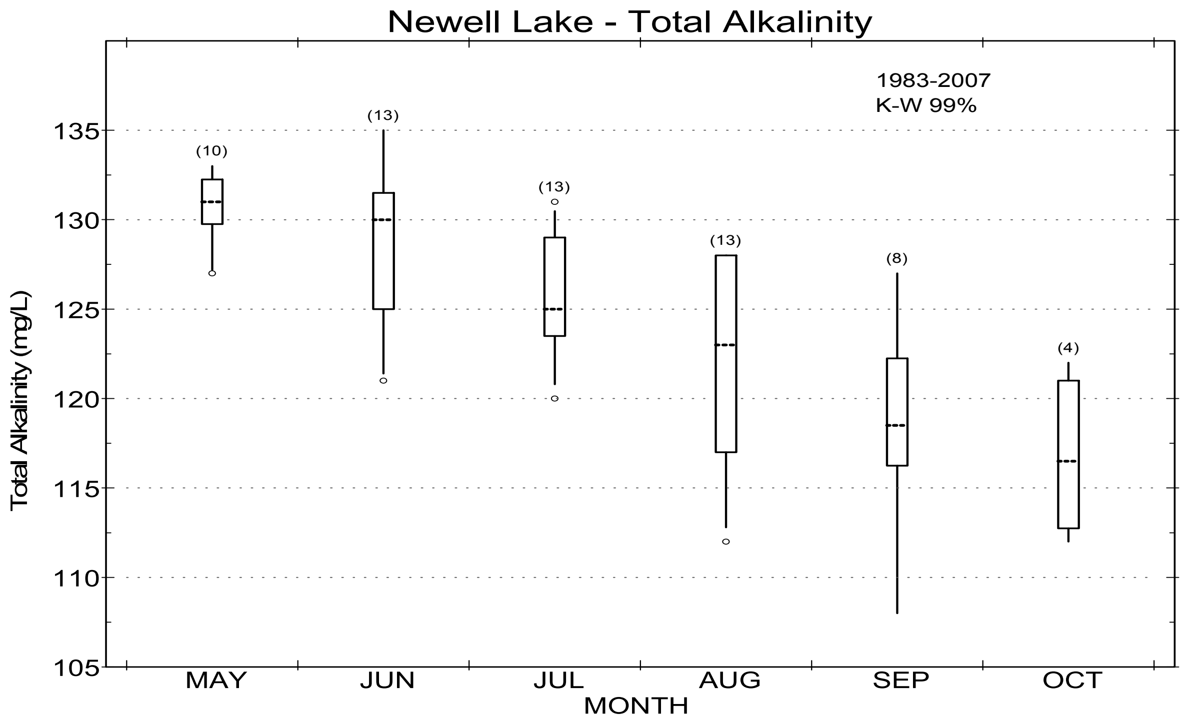


Figure 33b **Nakamun Lake -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (concluded)



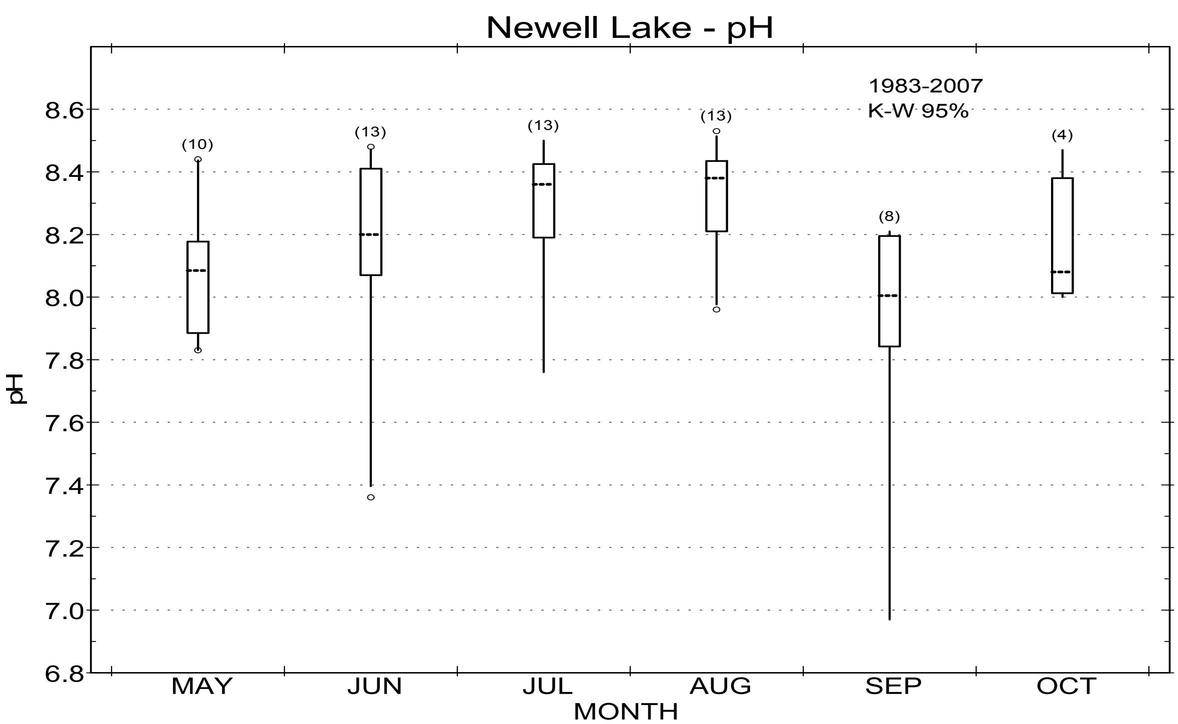
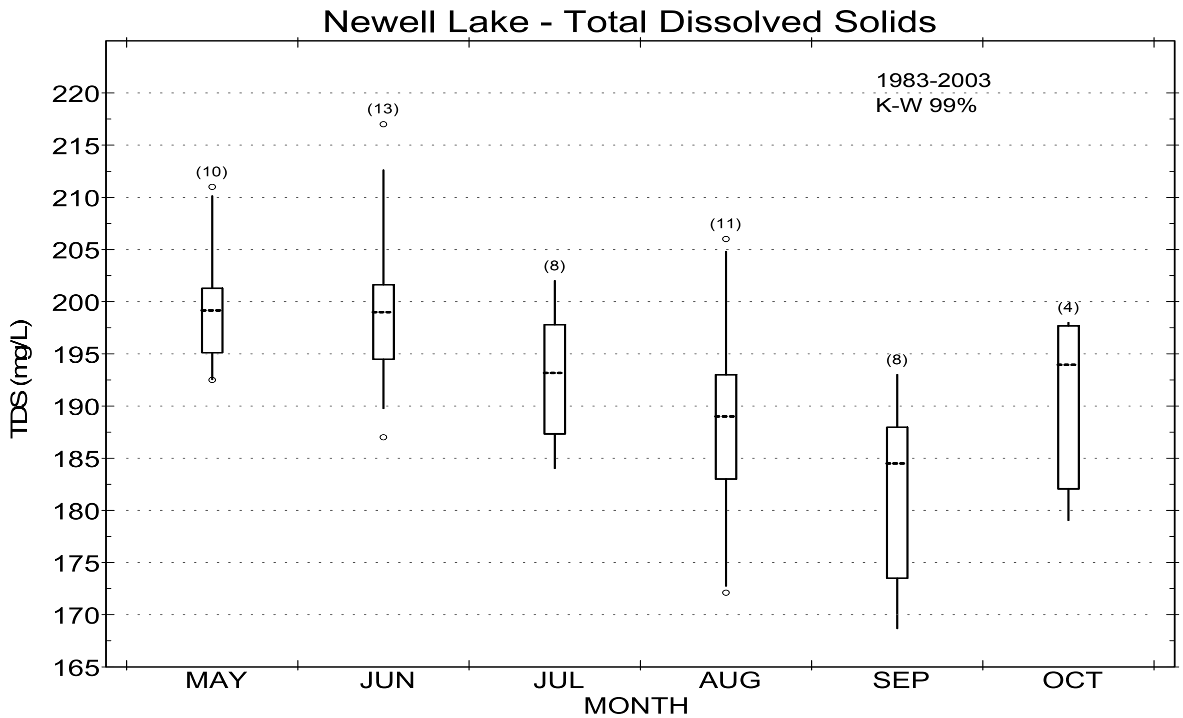


Figure 34 **Newell Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



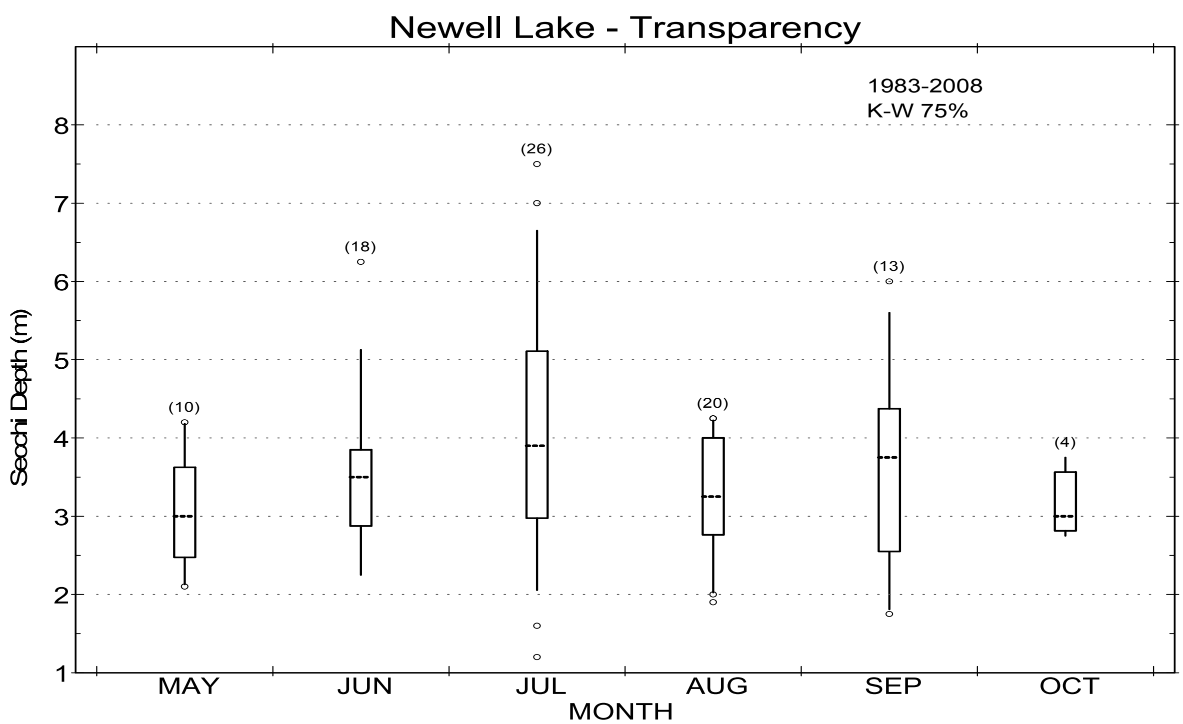
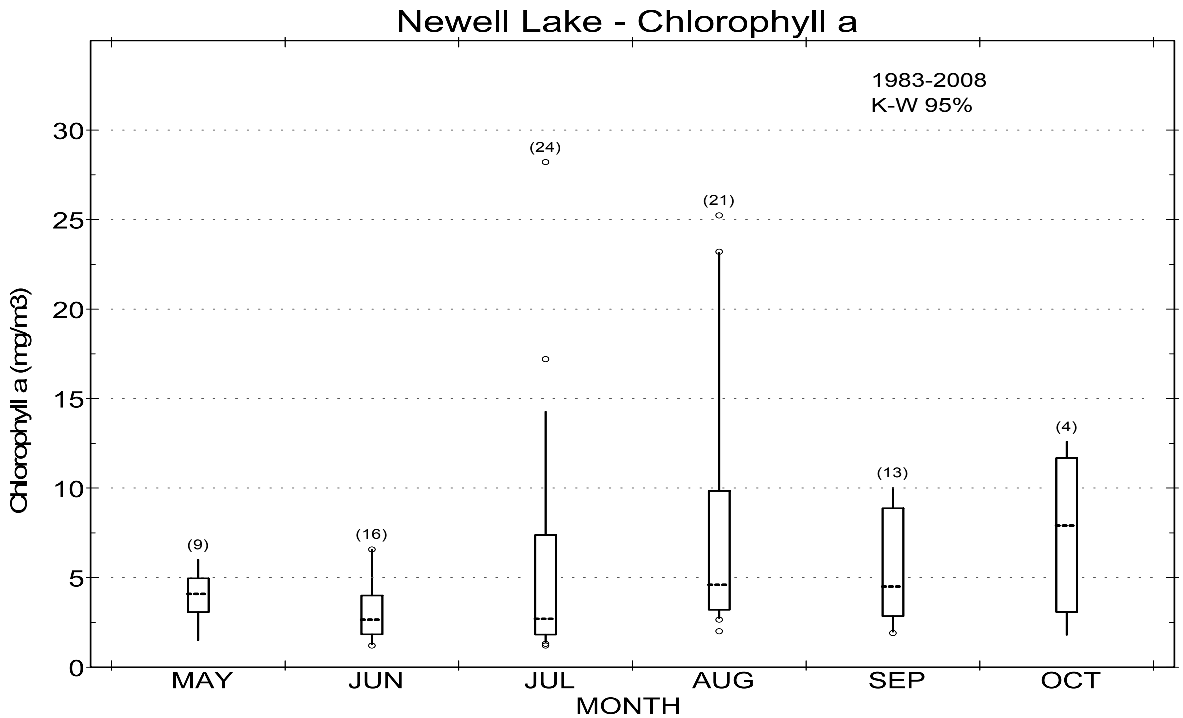


Figure 34 **Newell Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



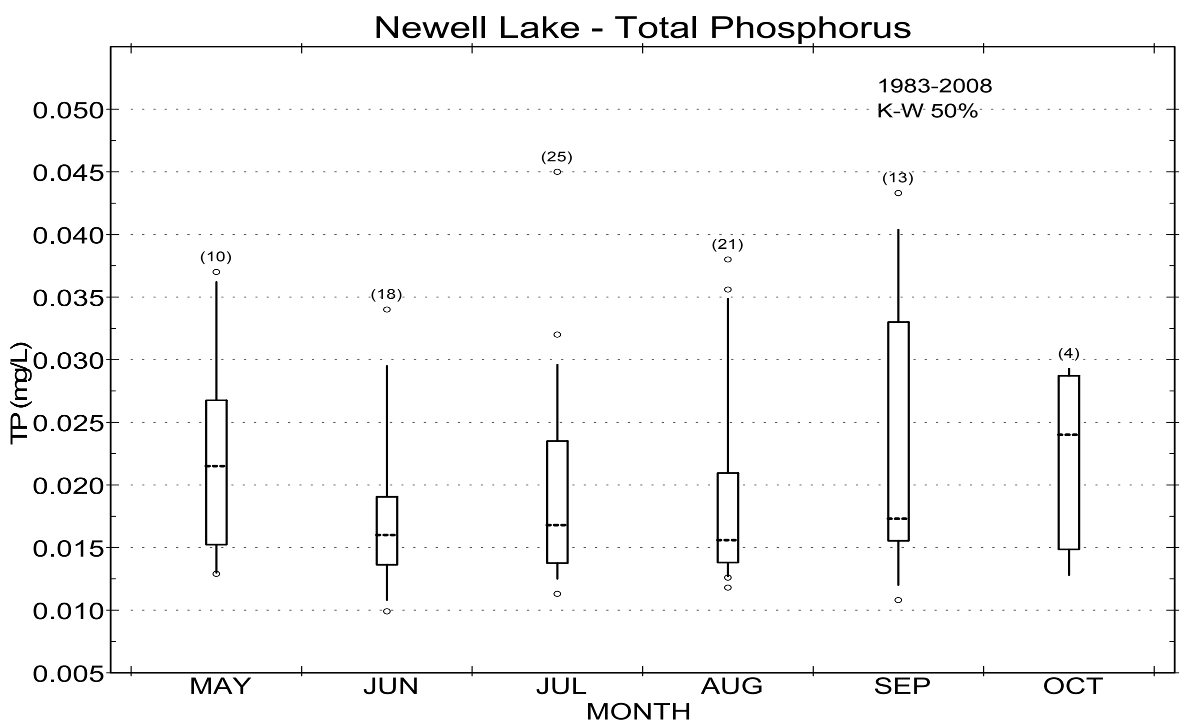
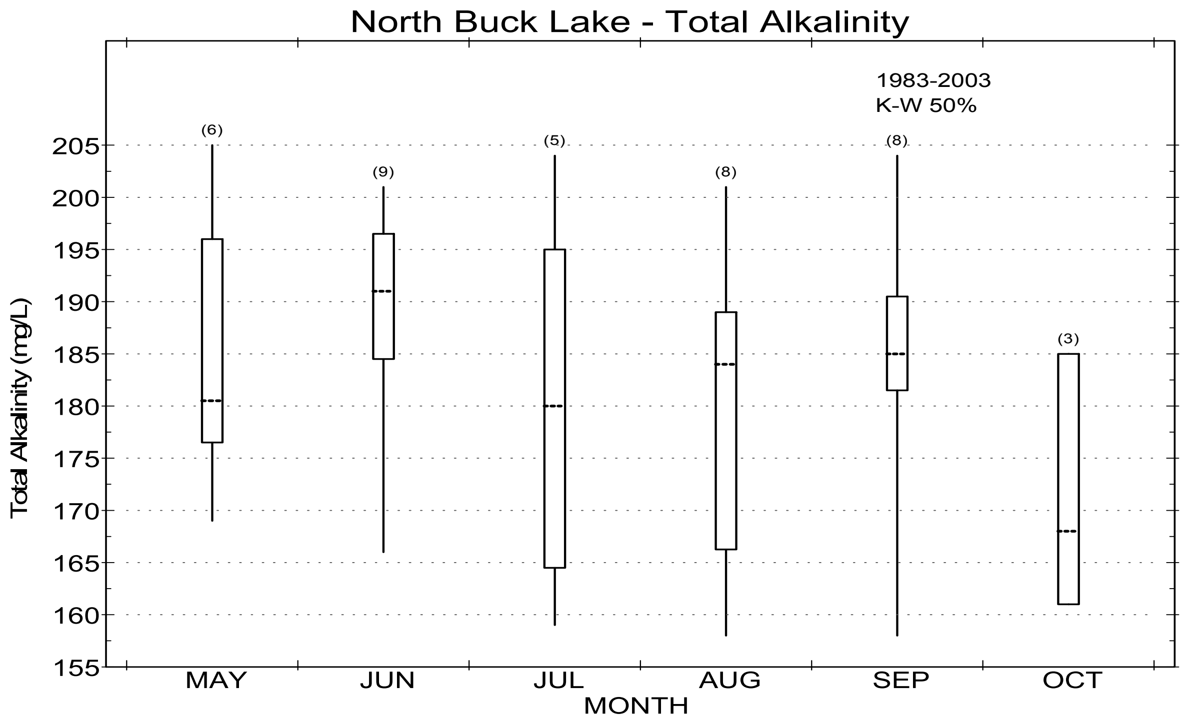


Figure 34 **Newell Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month. (concluded)



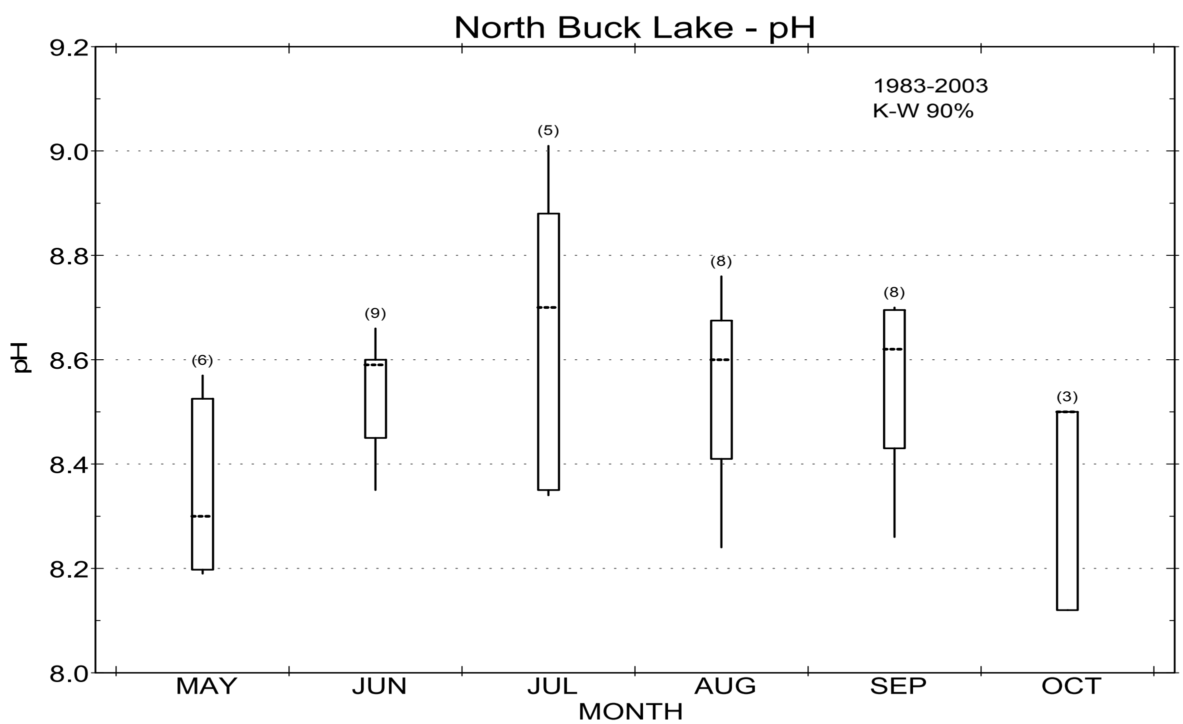
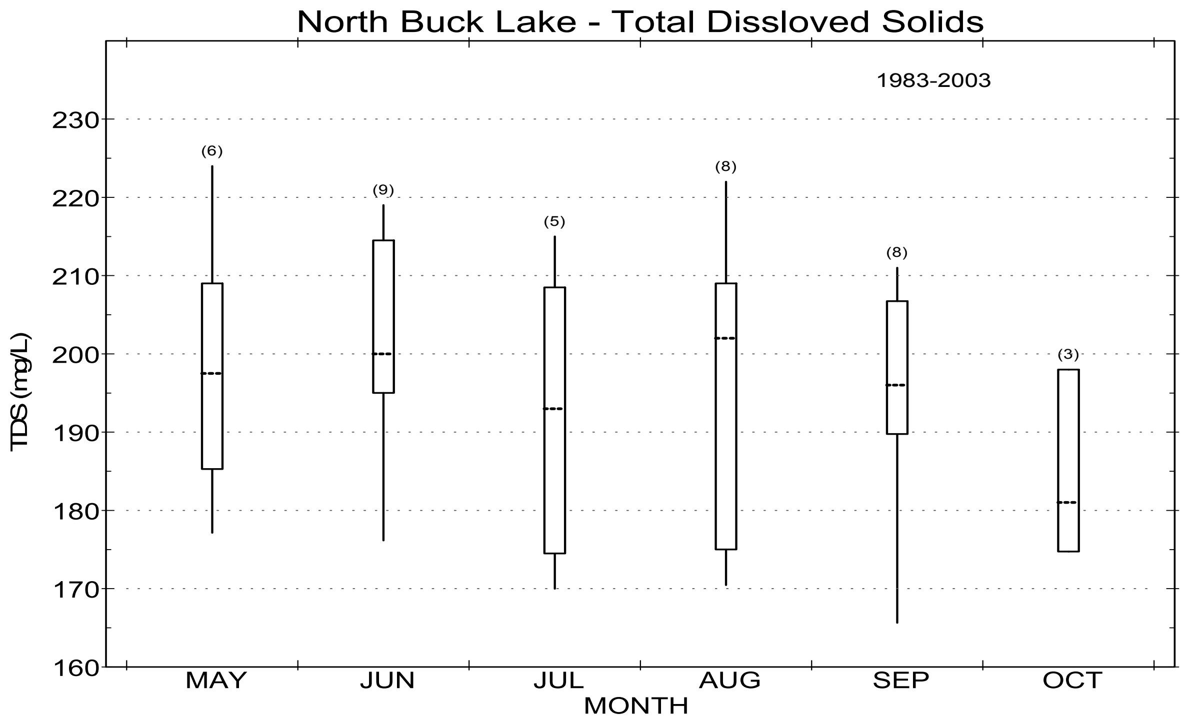


Figure 35 **North Buck Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



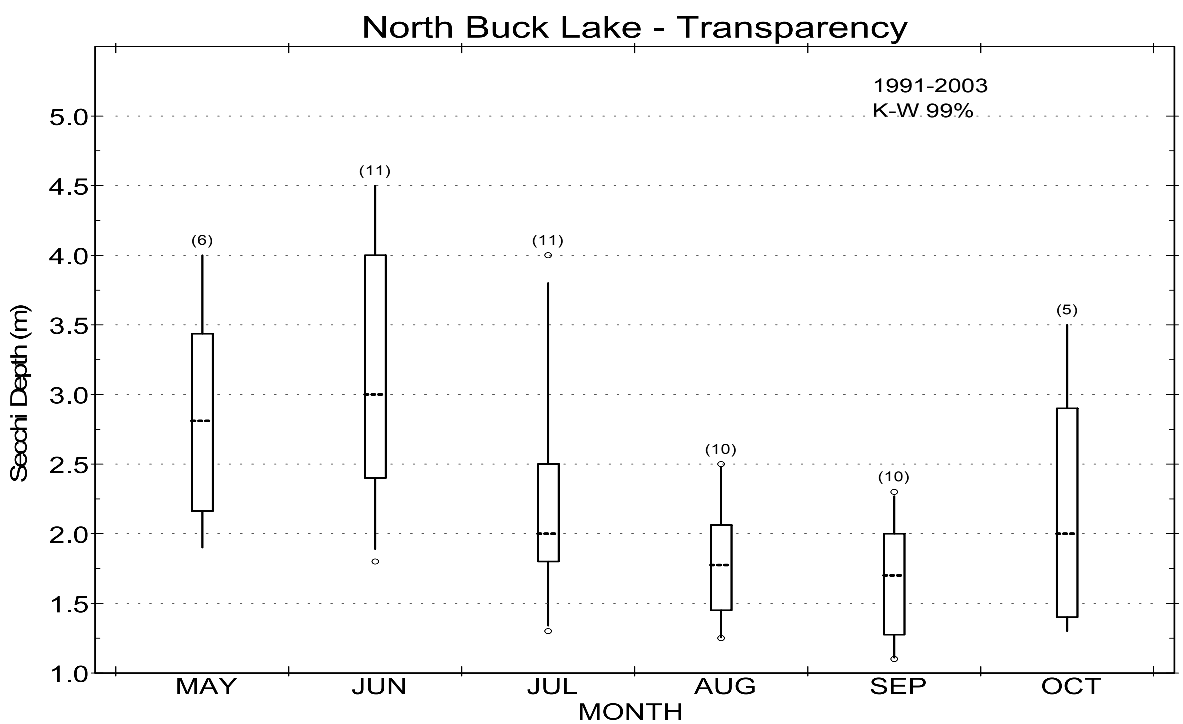


Figure 35 **North Buck Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)

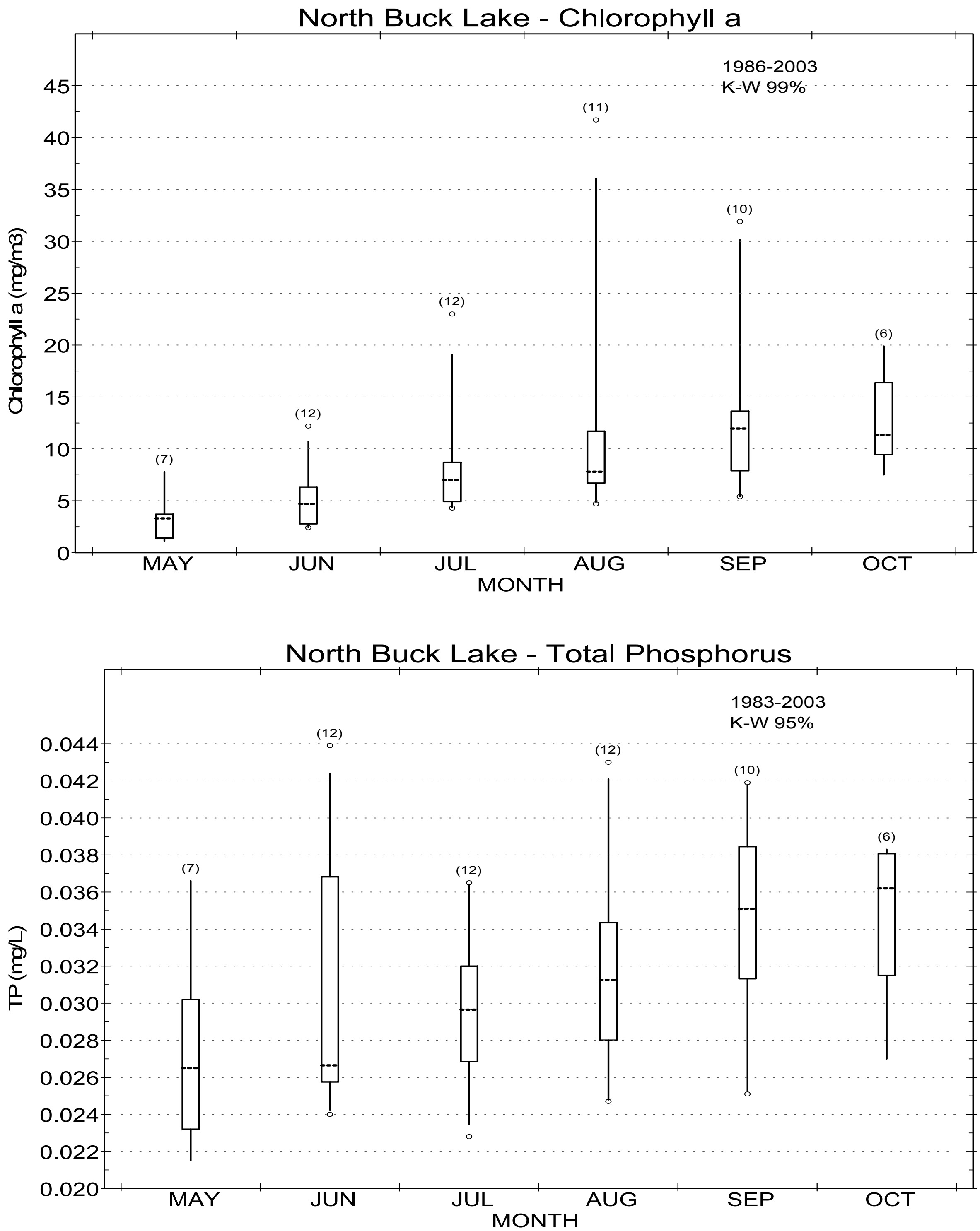
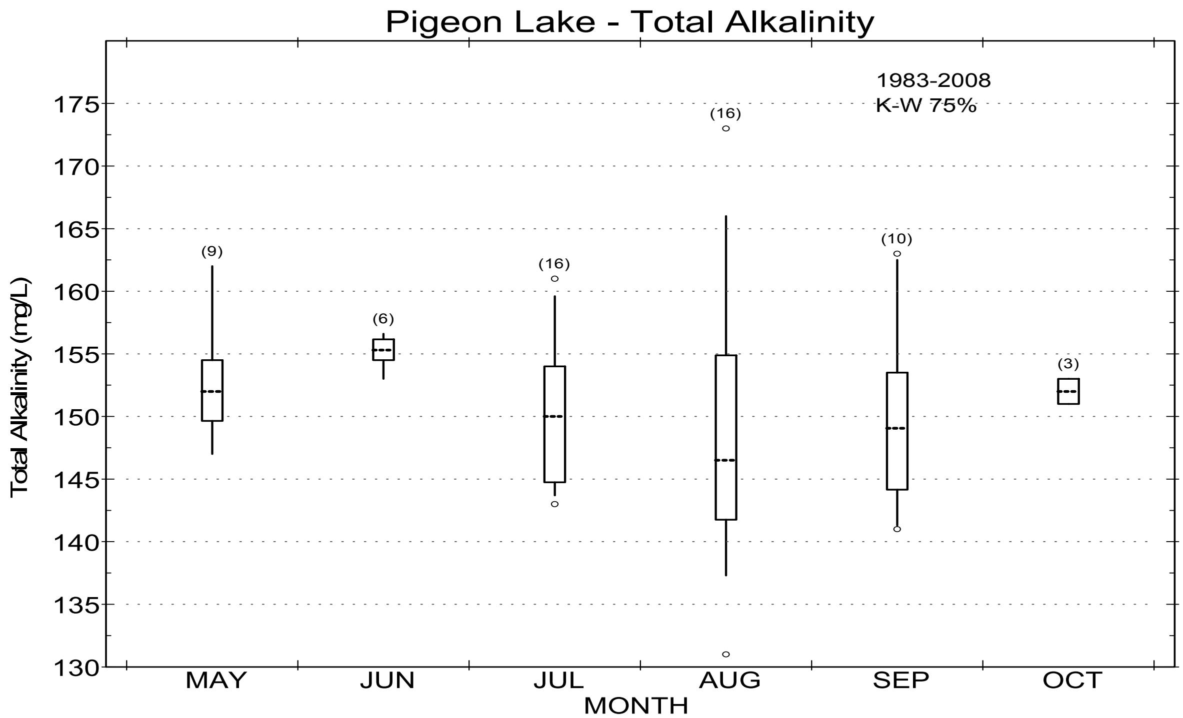


Figure 35 **North Buck Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



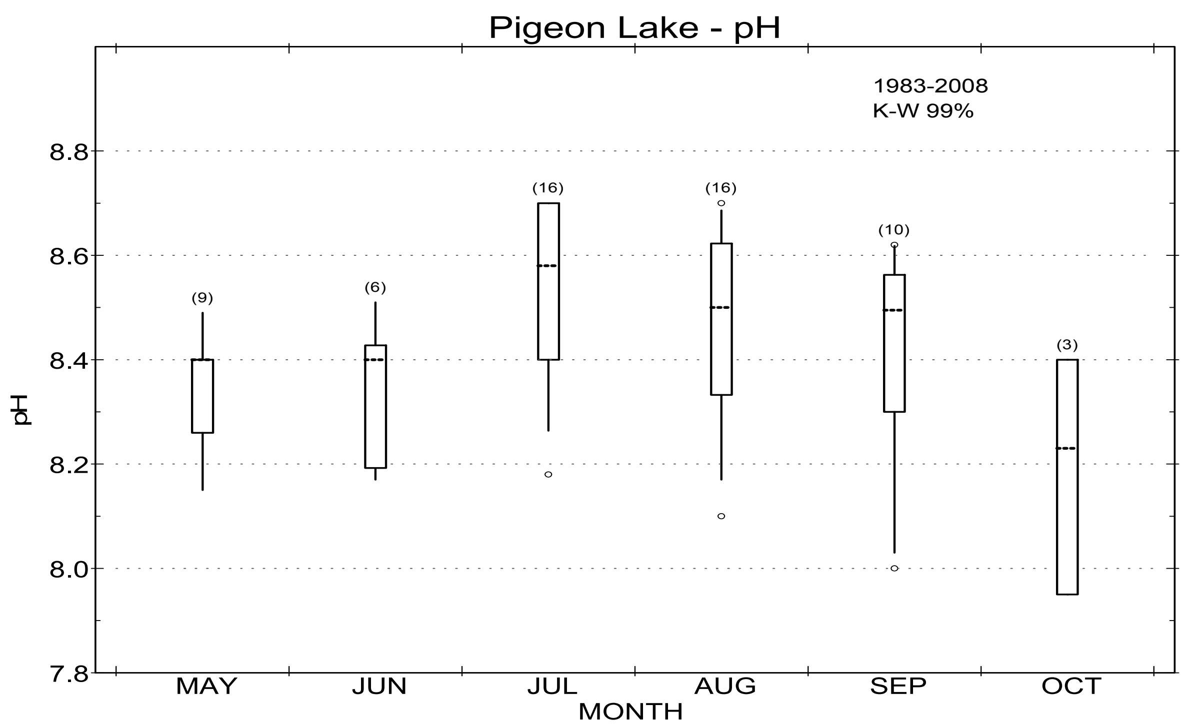
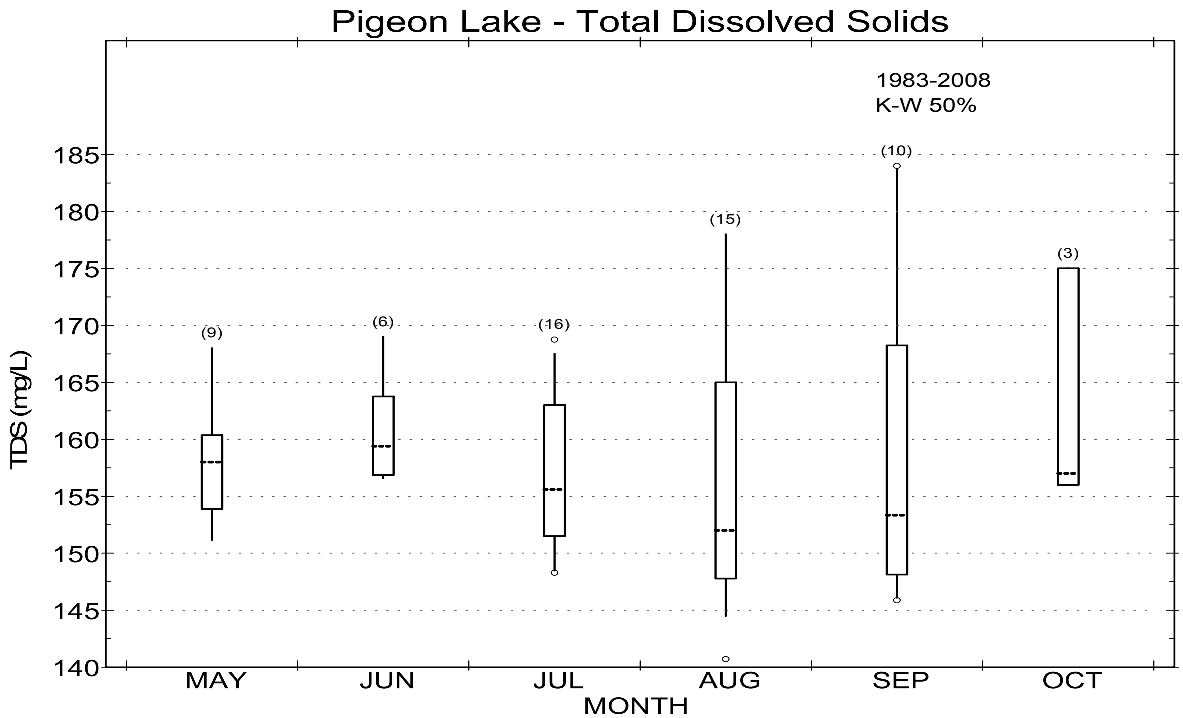


Figure 36 **Pigeon Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



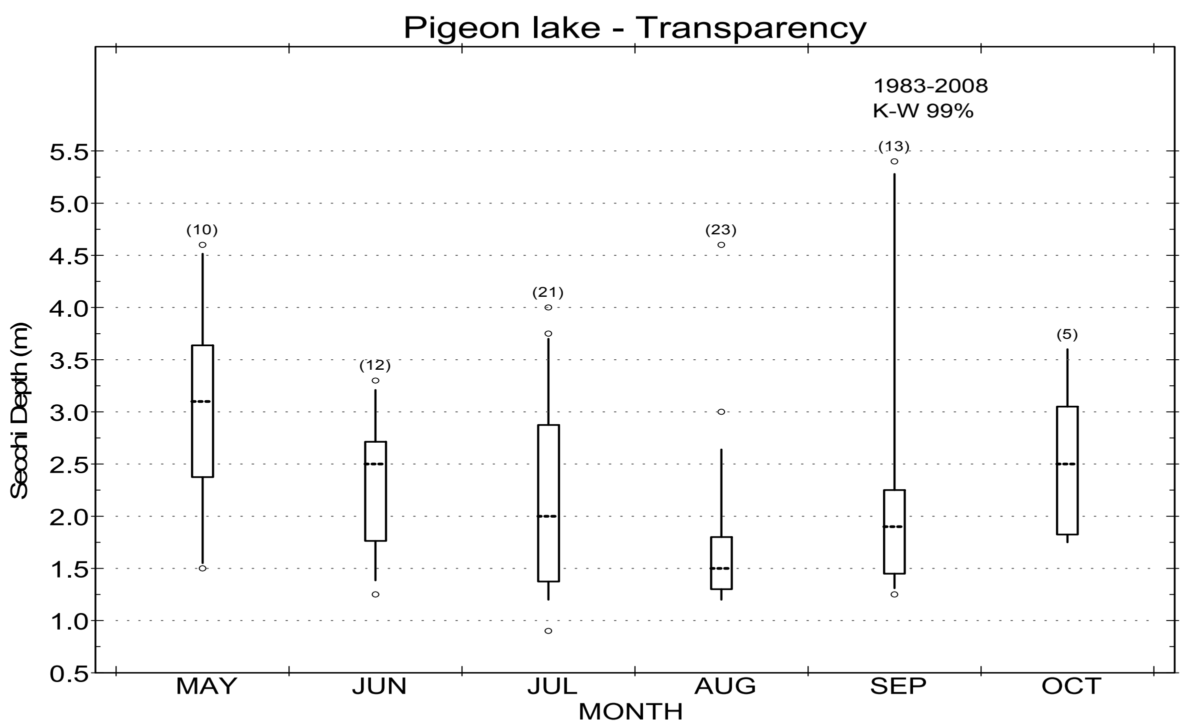
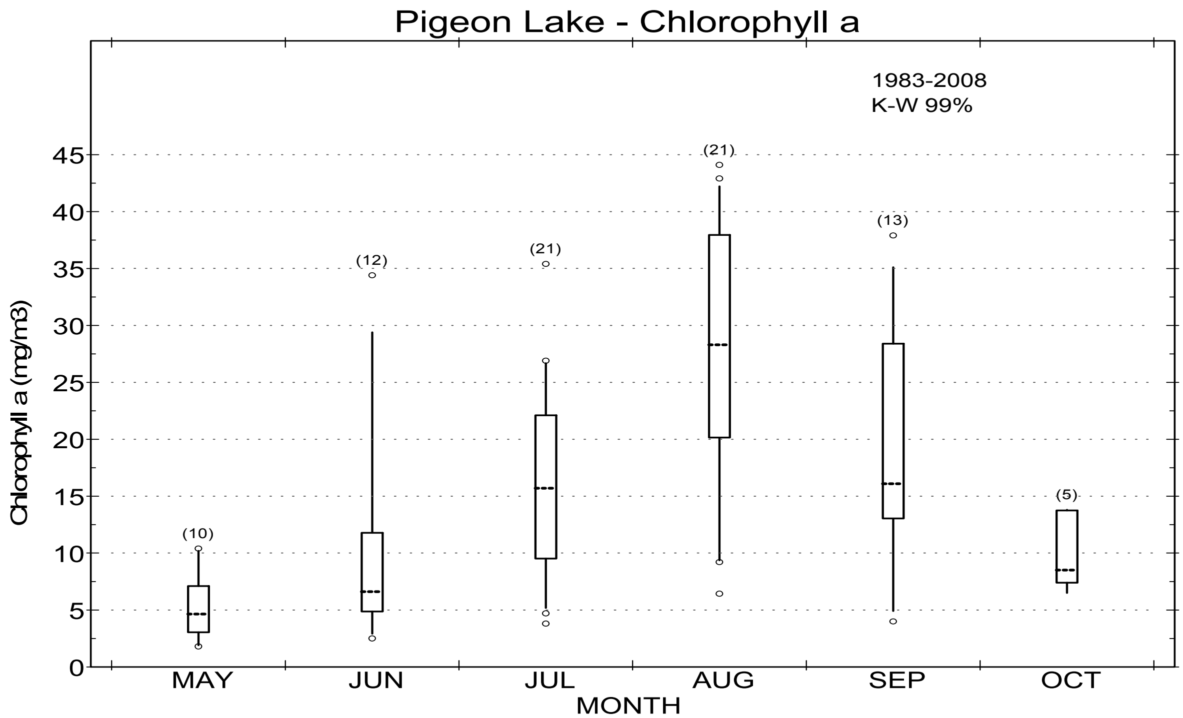


Figure 36 **Pigeon Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



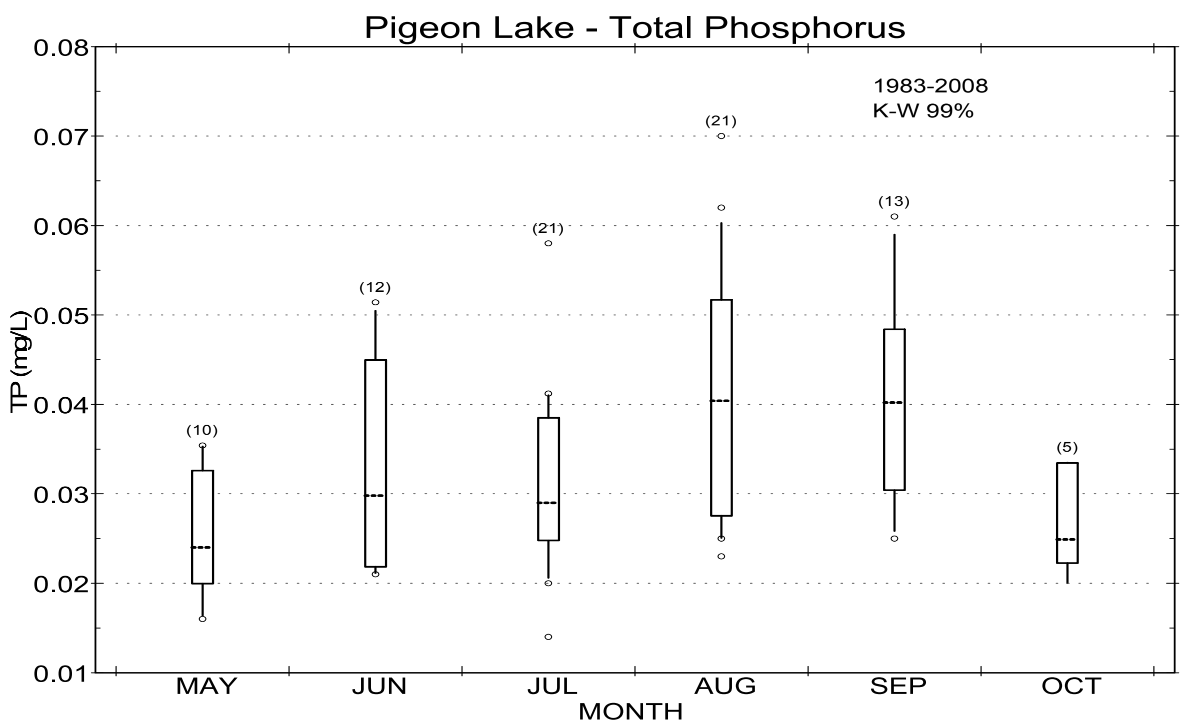
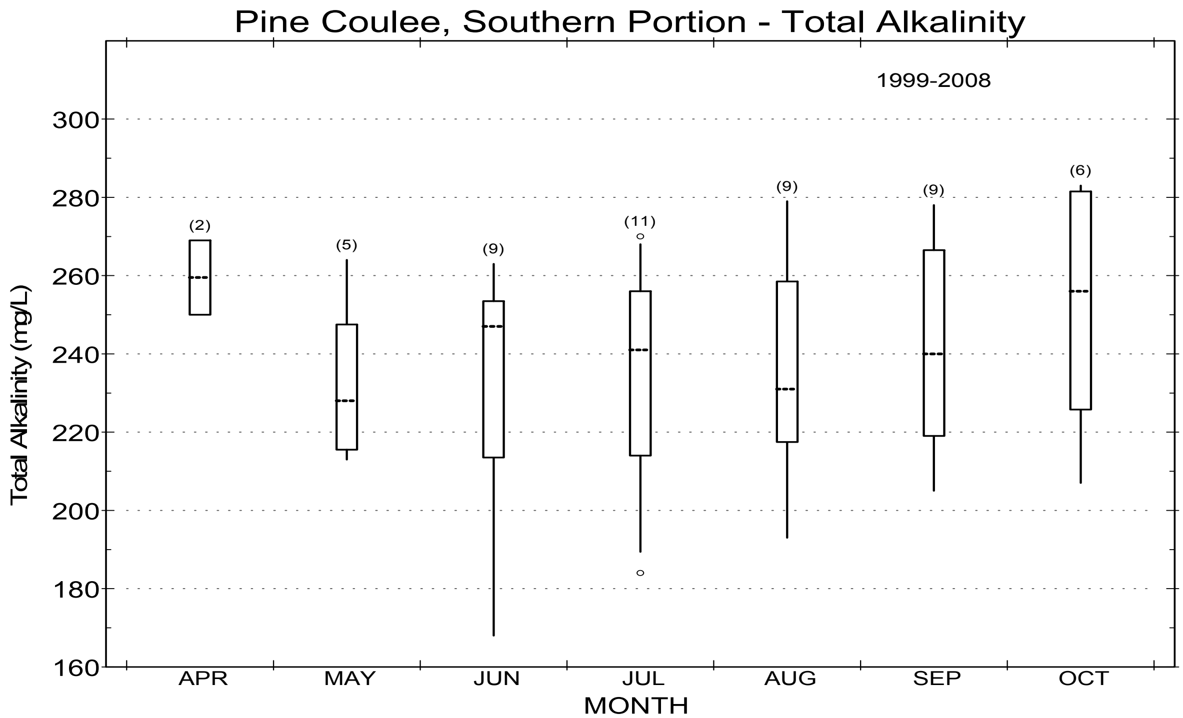


Figure 36 **Pigeon Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



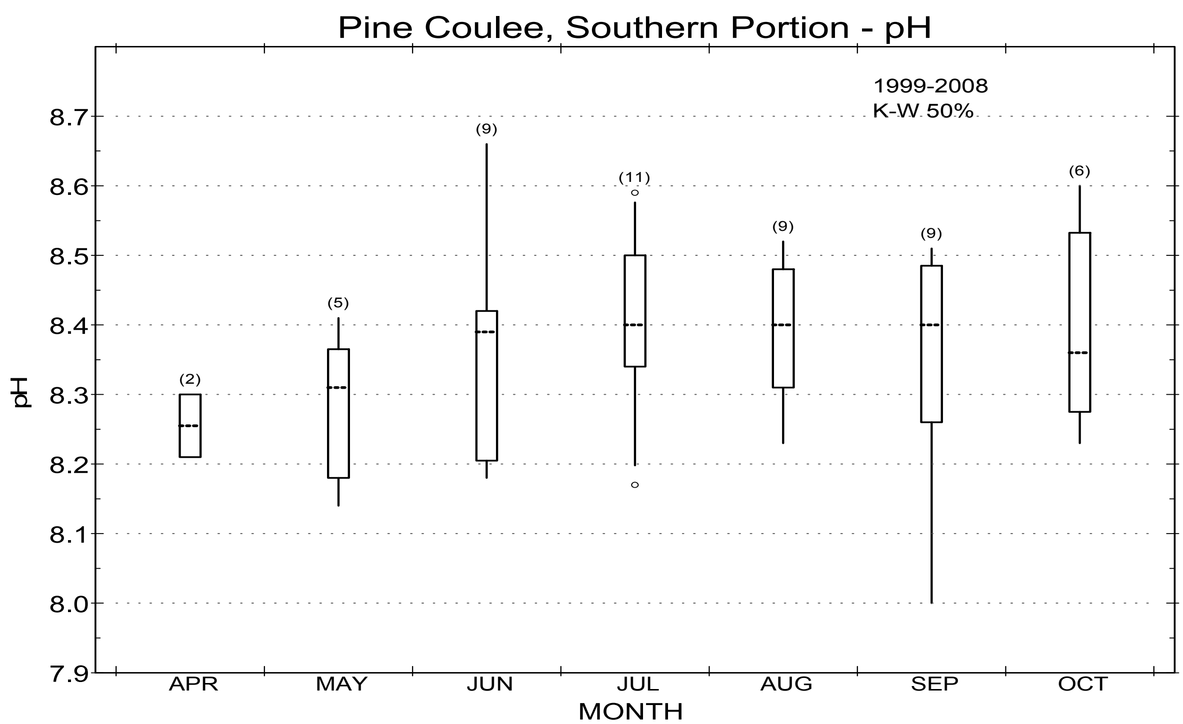
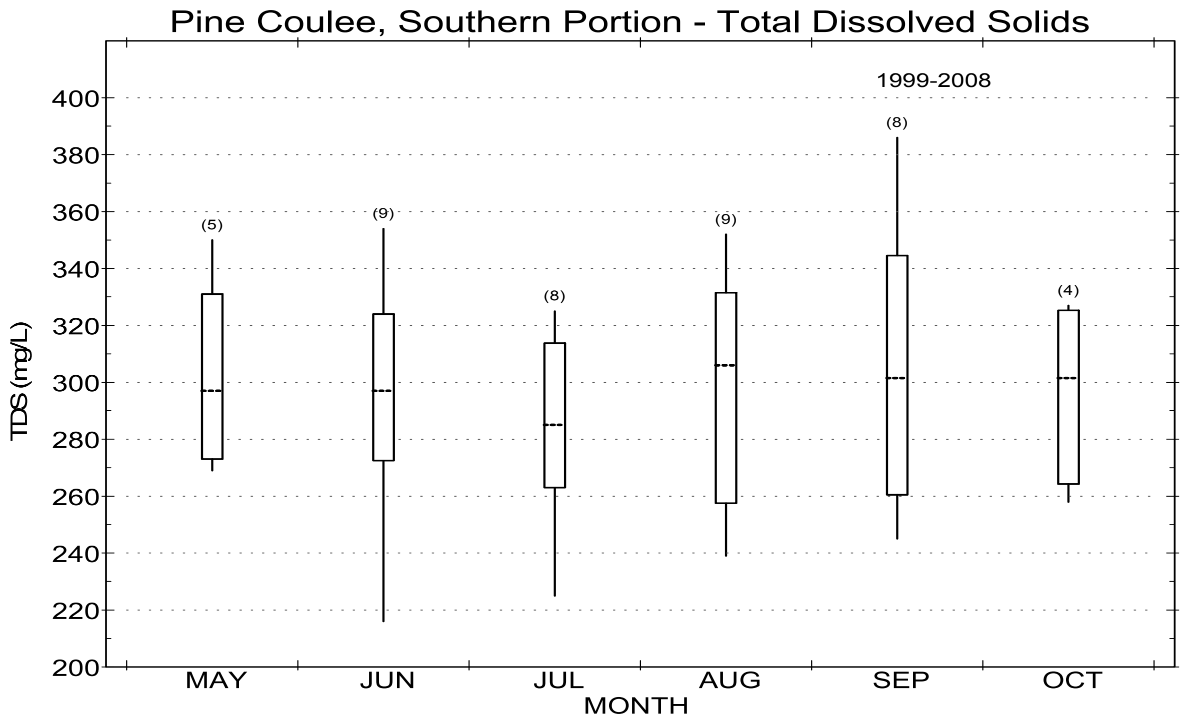


Figure 37 **Pine Coulee, Southern Portion -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



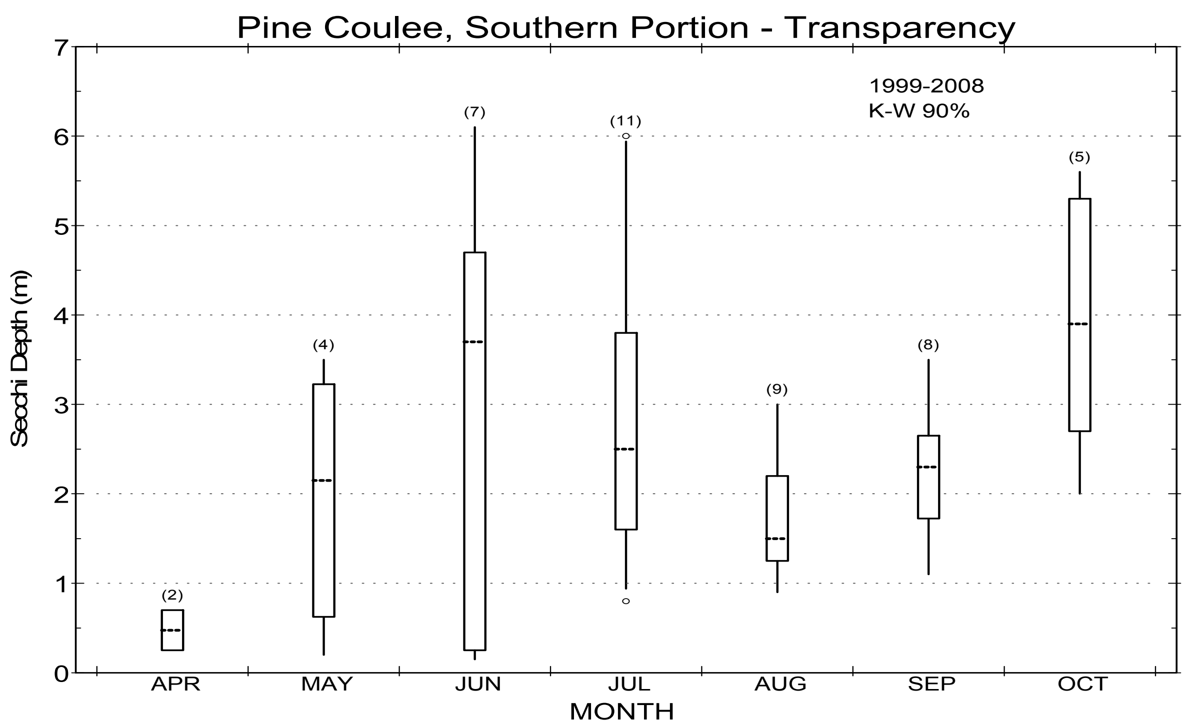
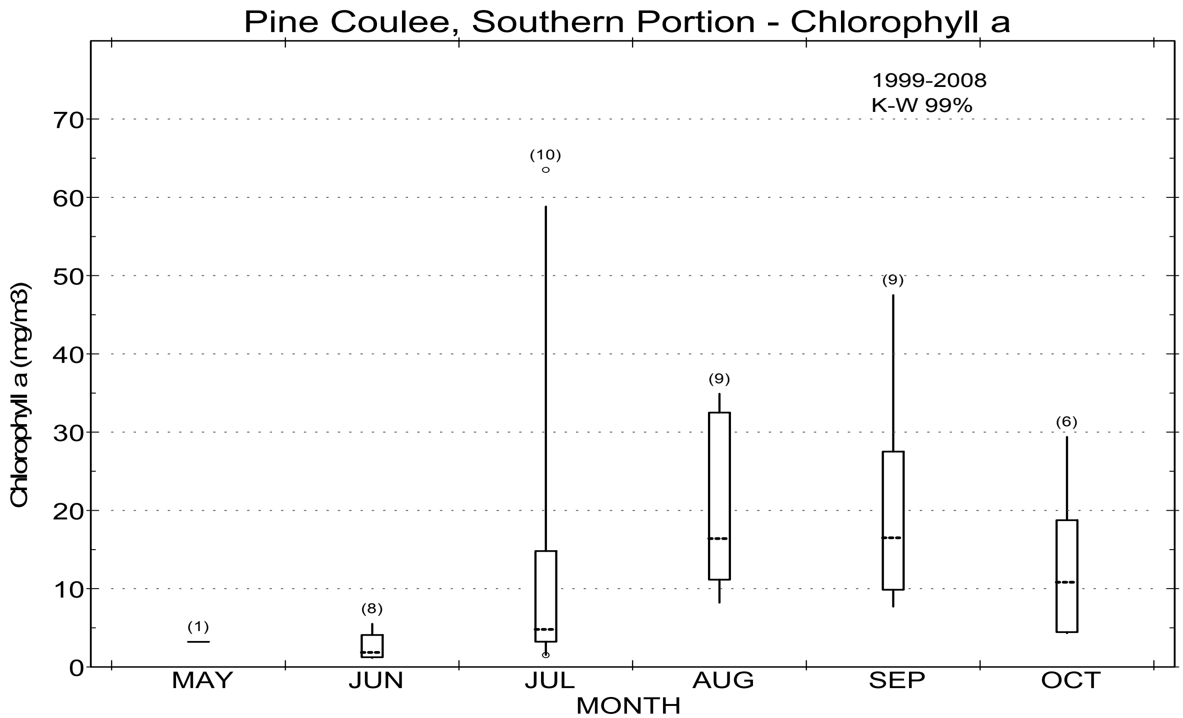


Figure 37 **Pine Coulee, Southern Portion -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



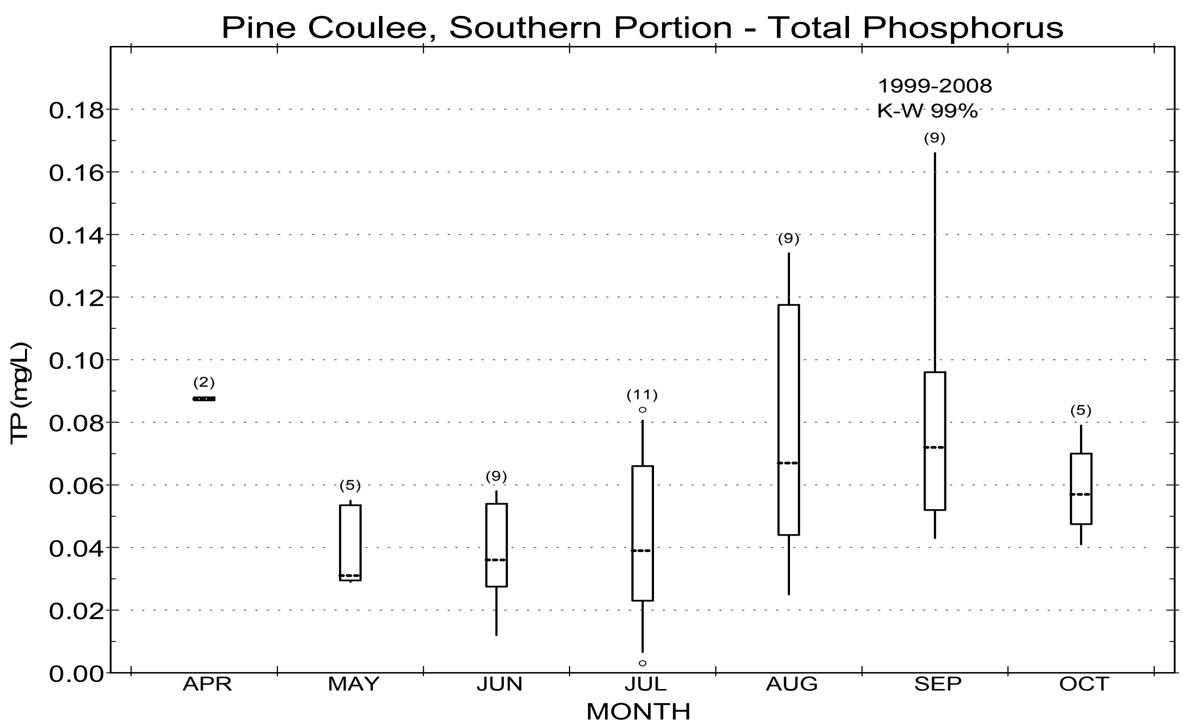
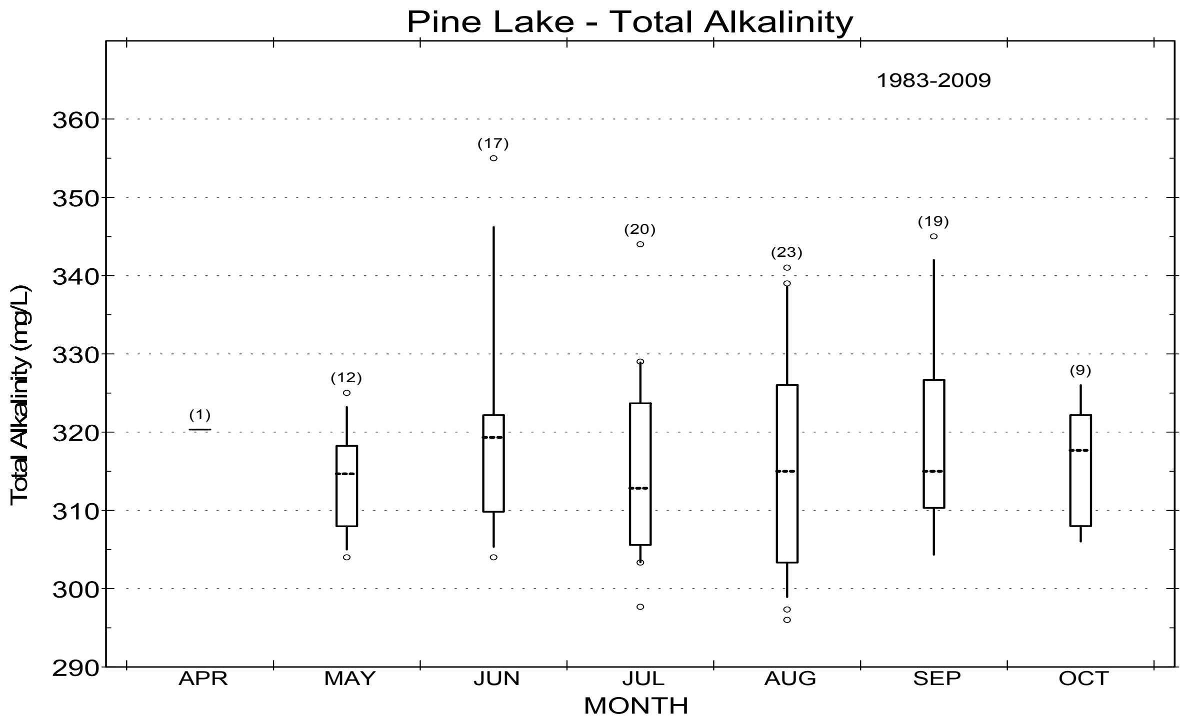


Figure 37 **Pine Coulee, Southern Portion -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



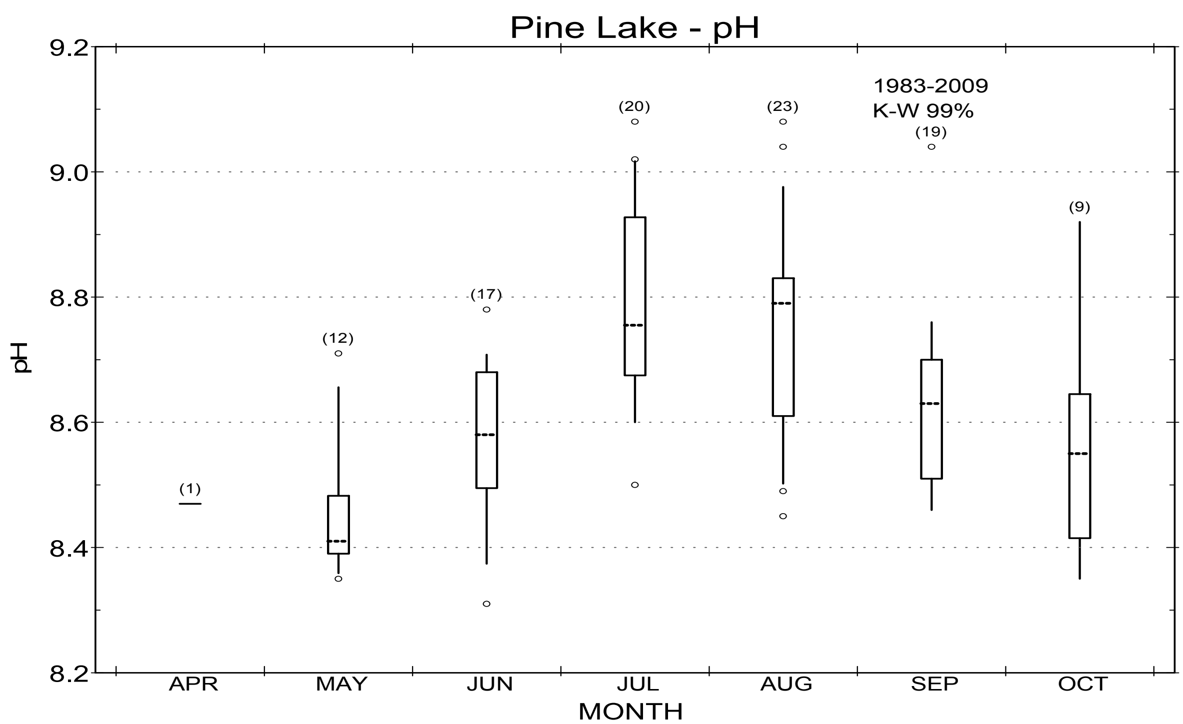
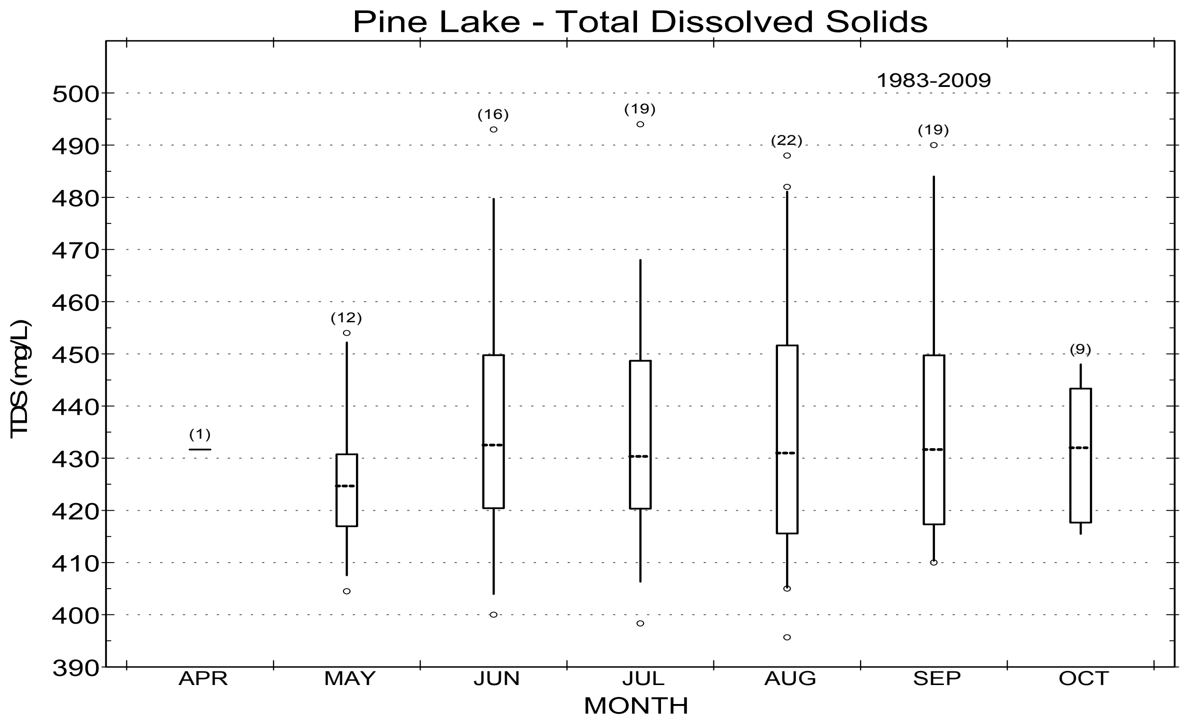


Figure 38a **Pine Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



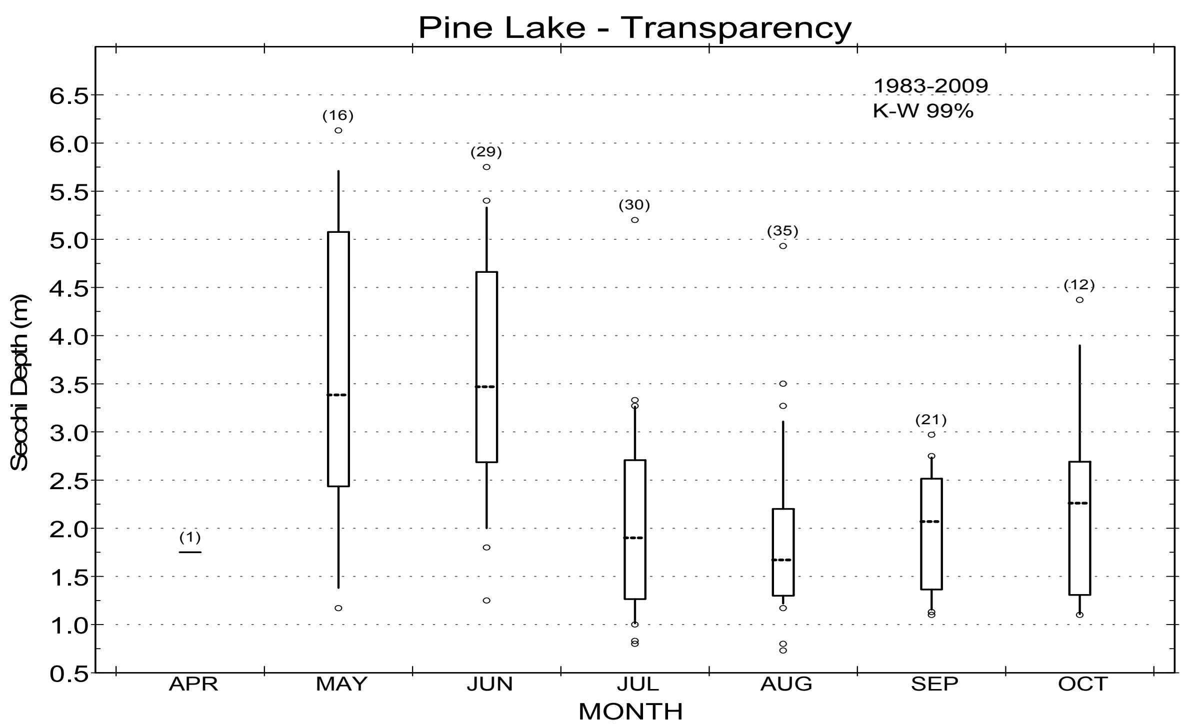
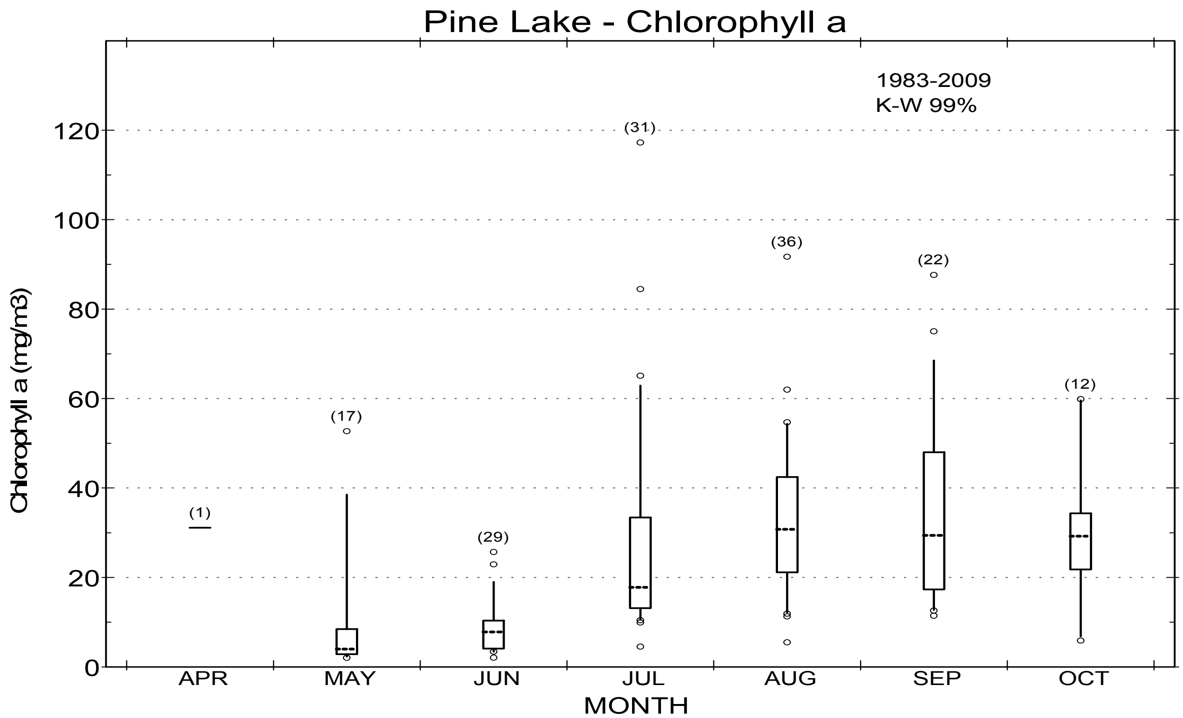


Figure 38a **Pine Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



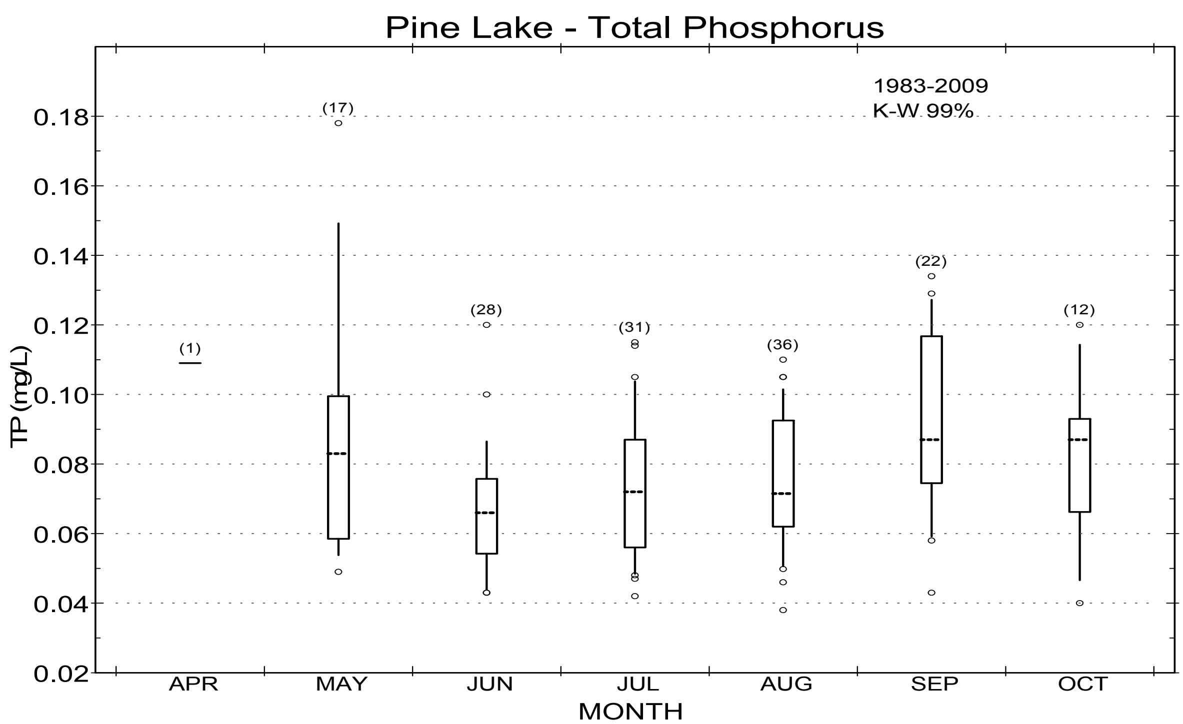
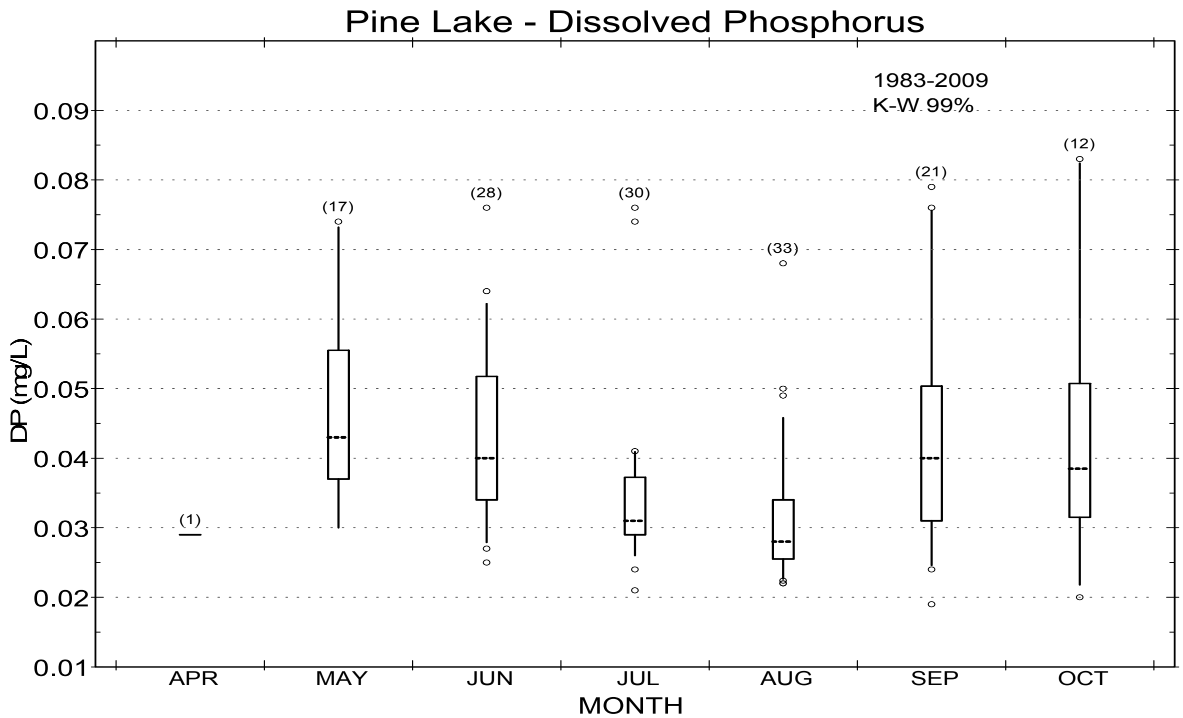


Figure 38a **Pine Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



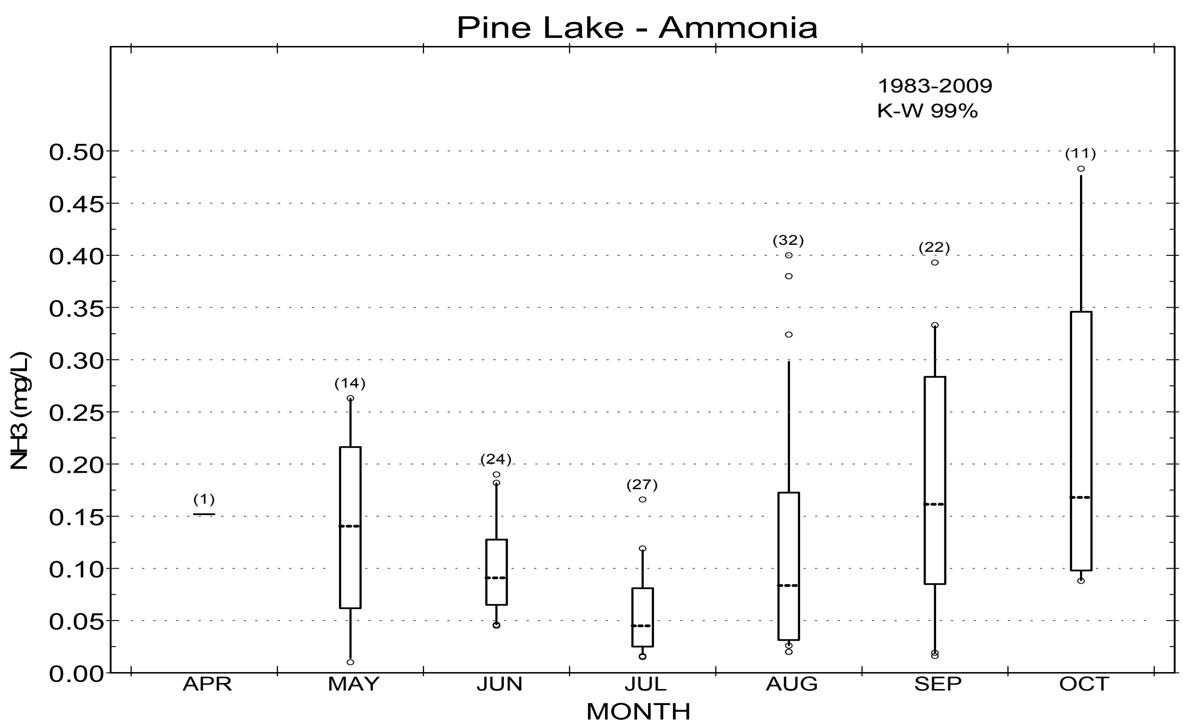
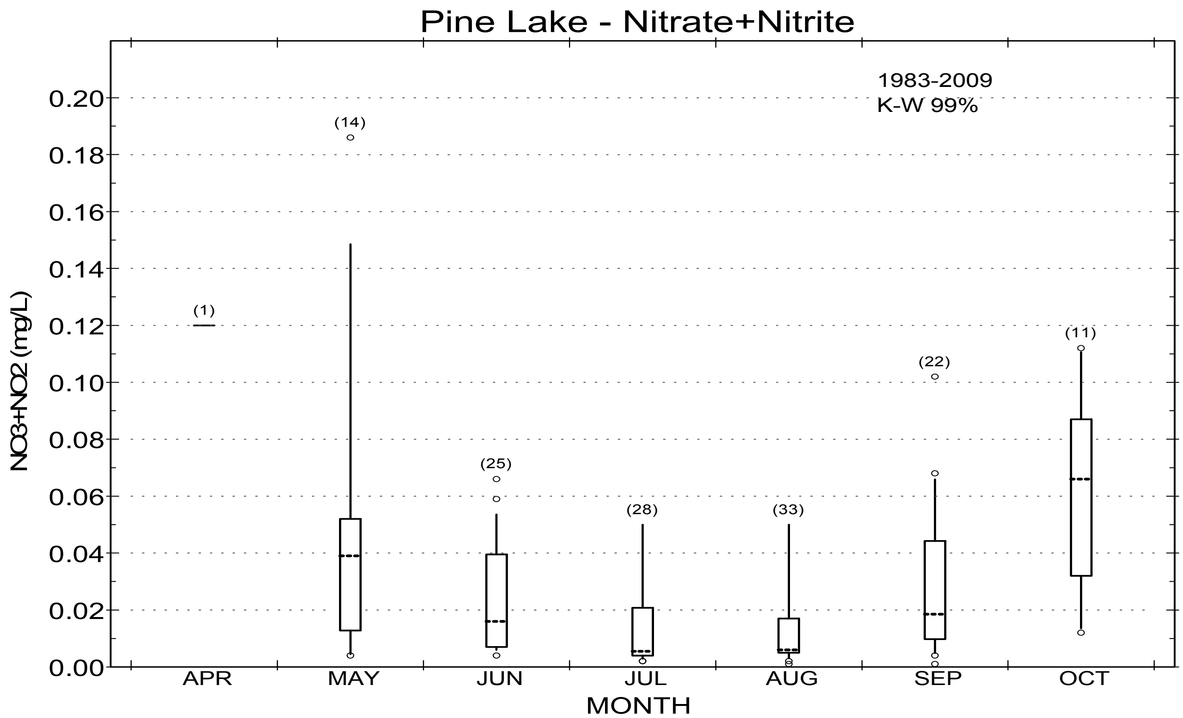


Figure 38b **Pine Lake** - Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month



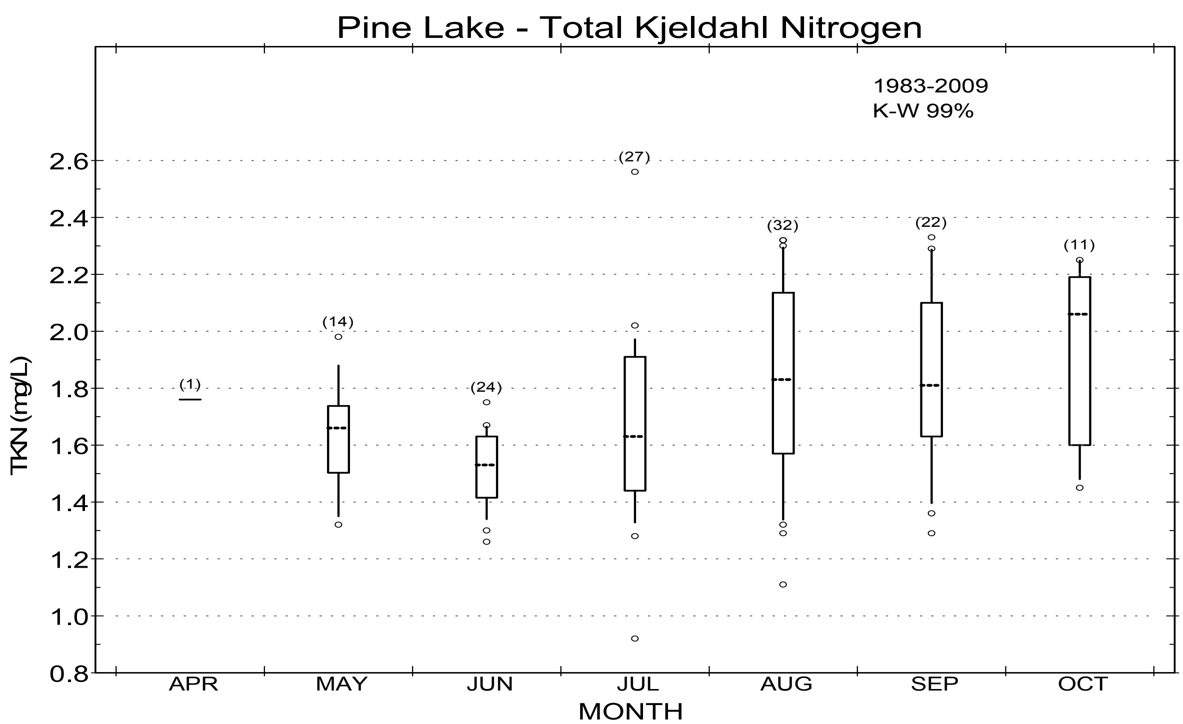
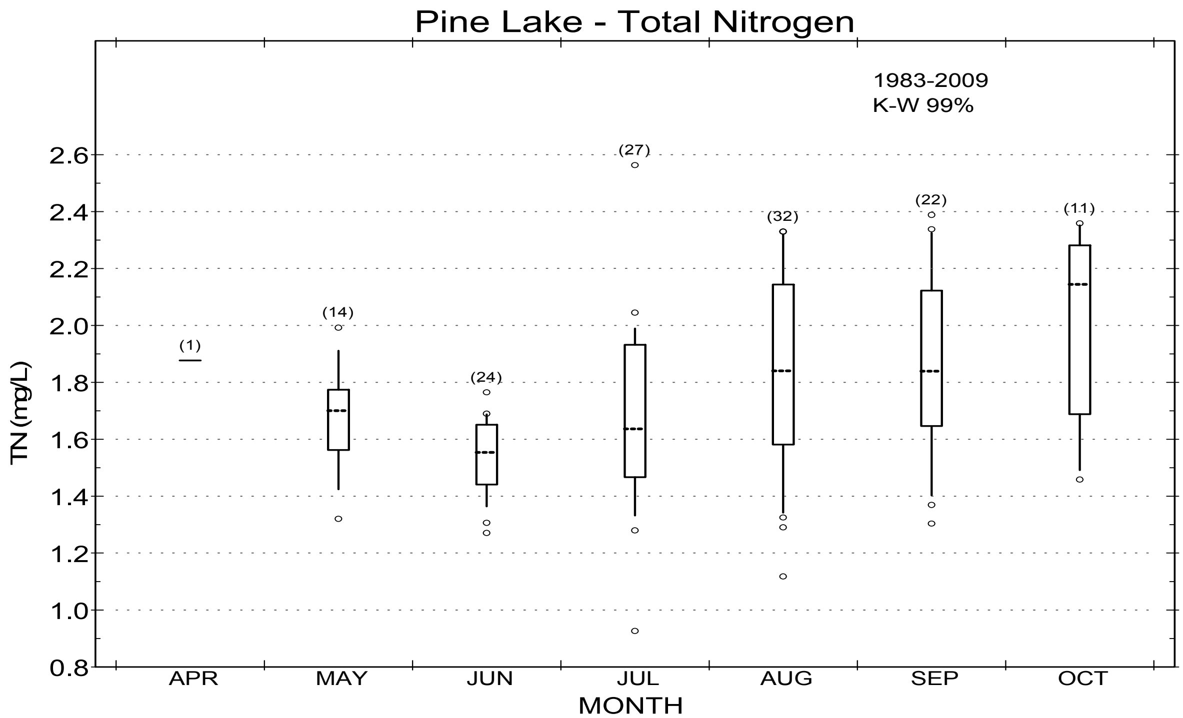


Figure 38b **Pine Lake -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)



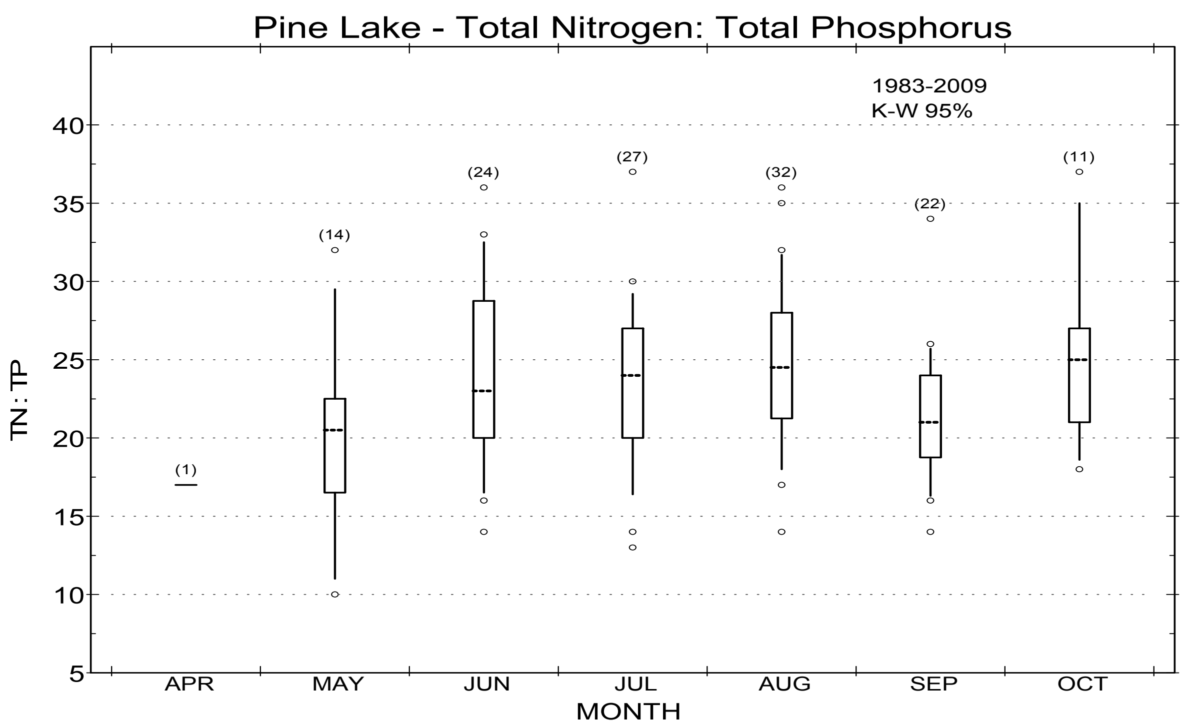
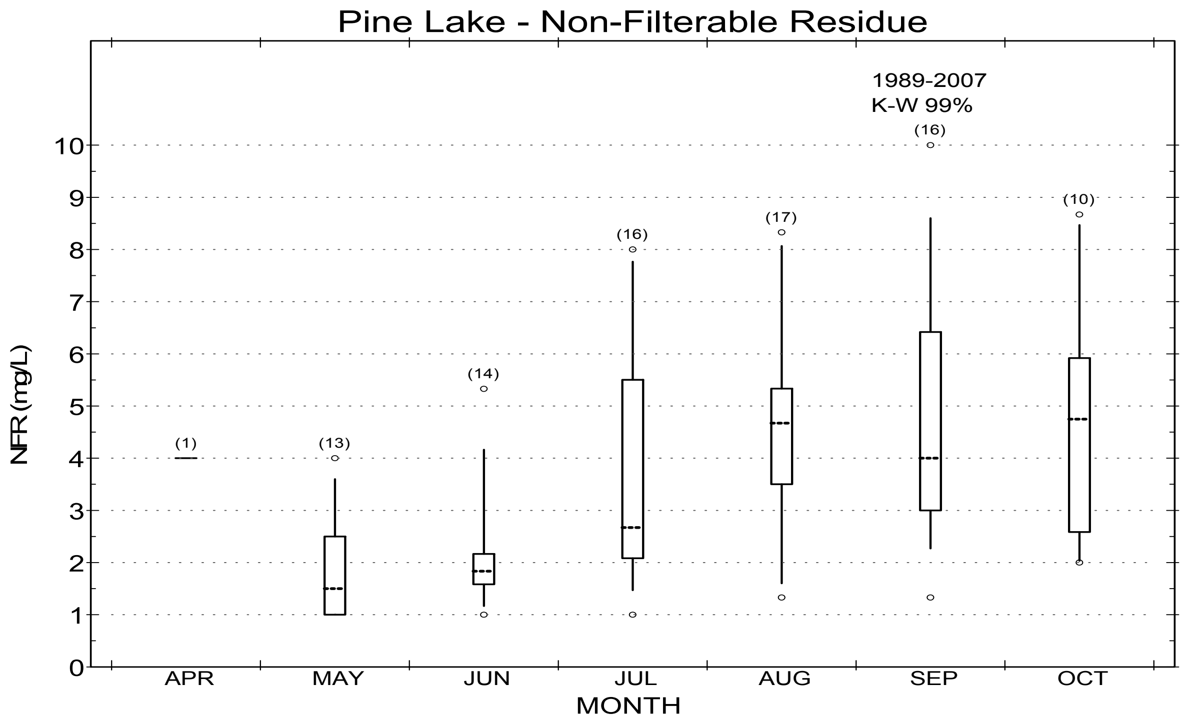


Figure 38b **Pine Lake** - Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)



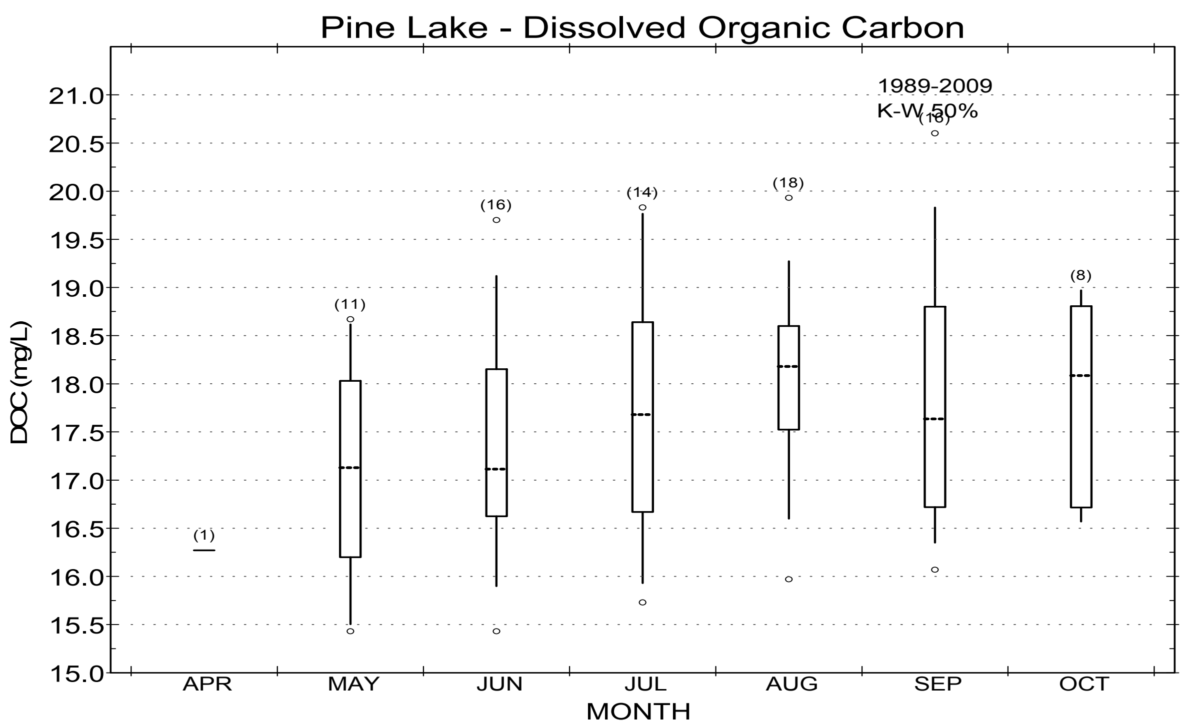


Figure 38b **Pine Lake -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)

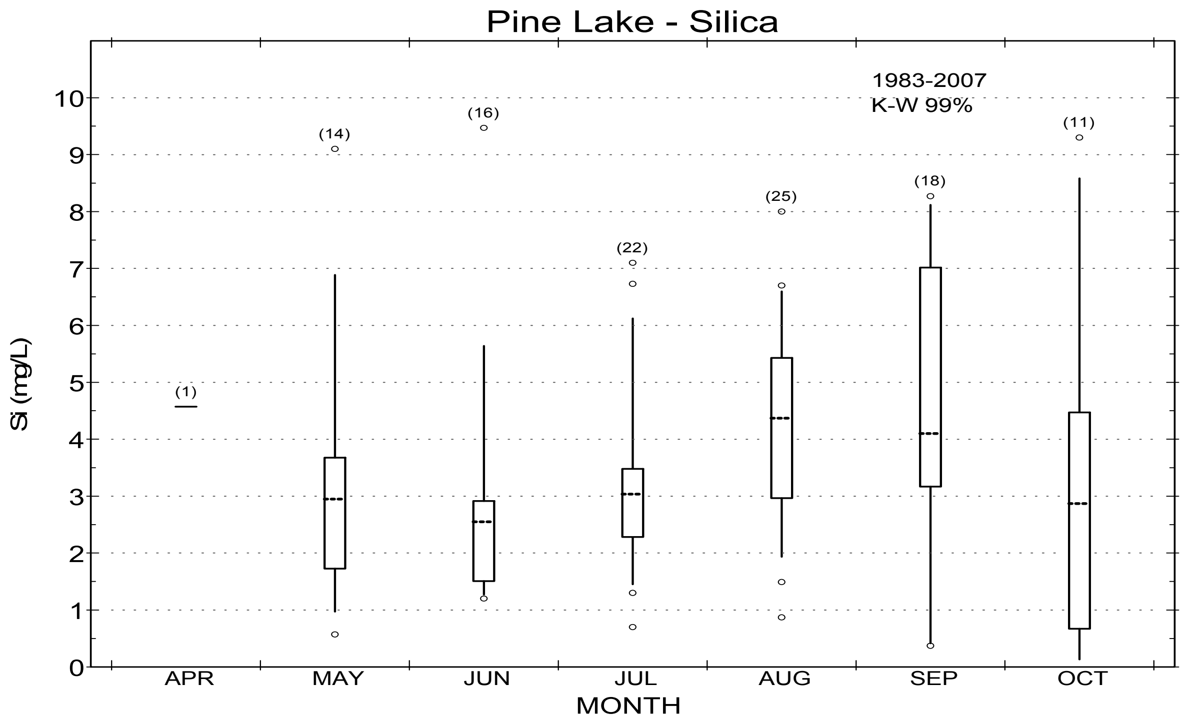
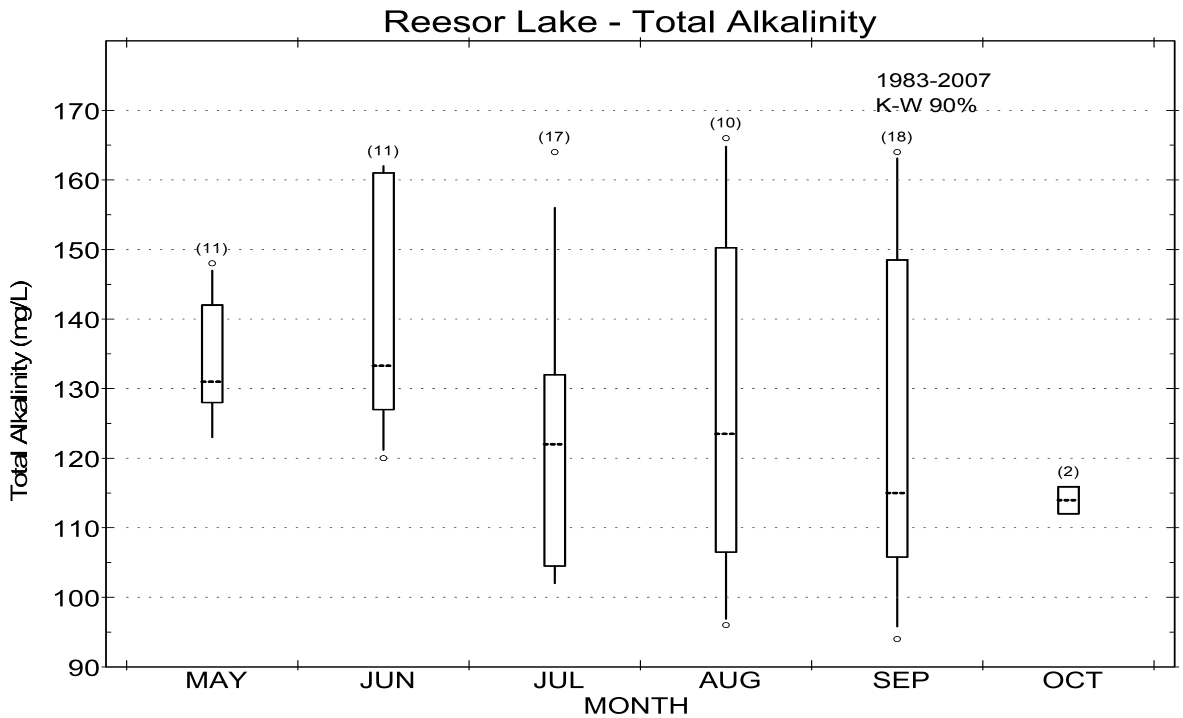


Figure 38b **Pine Lake -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (concluded)



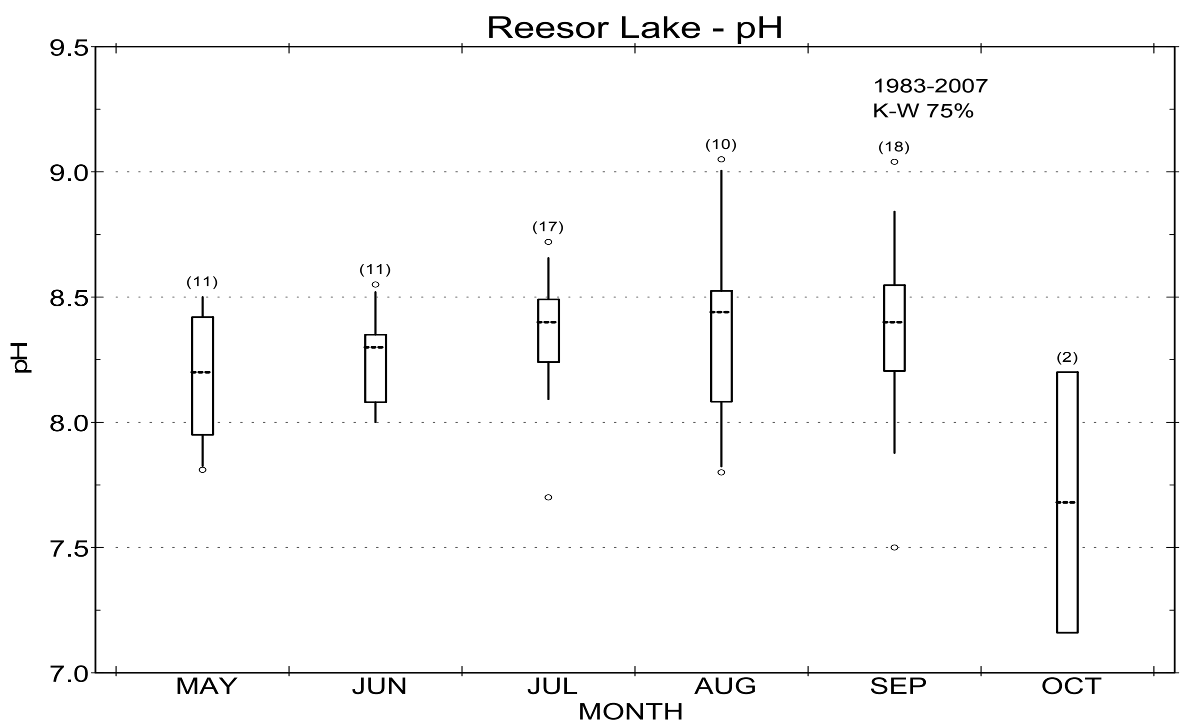
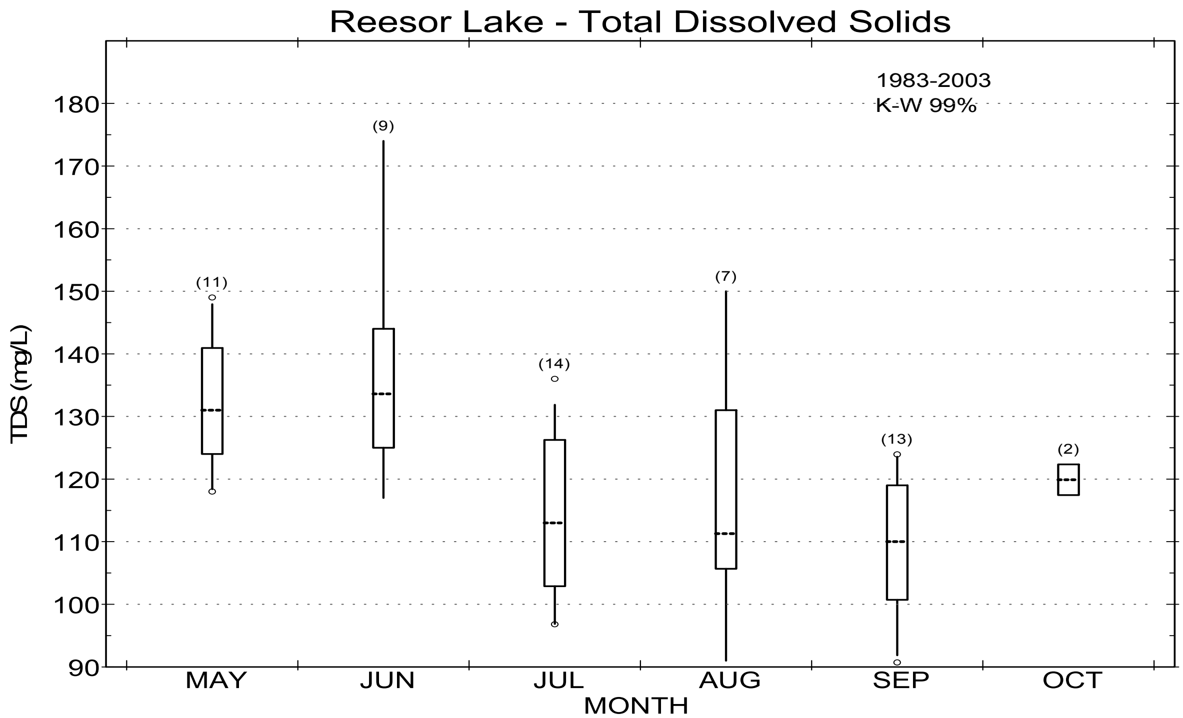


Figure 39 **Reesor Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



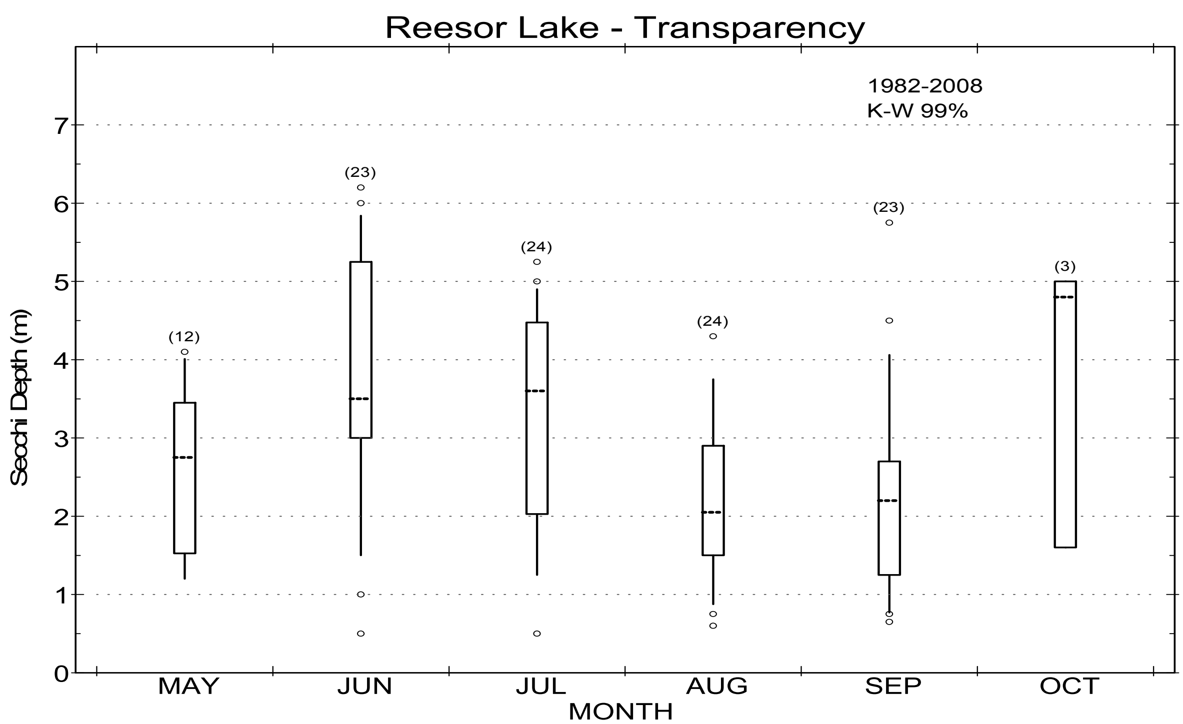
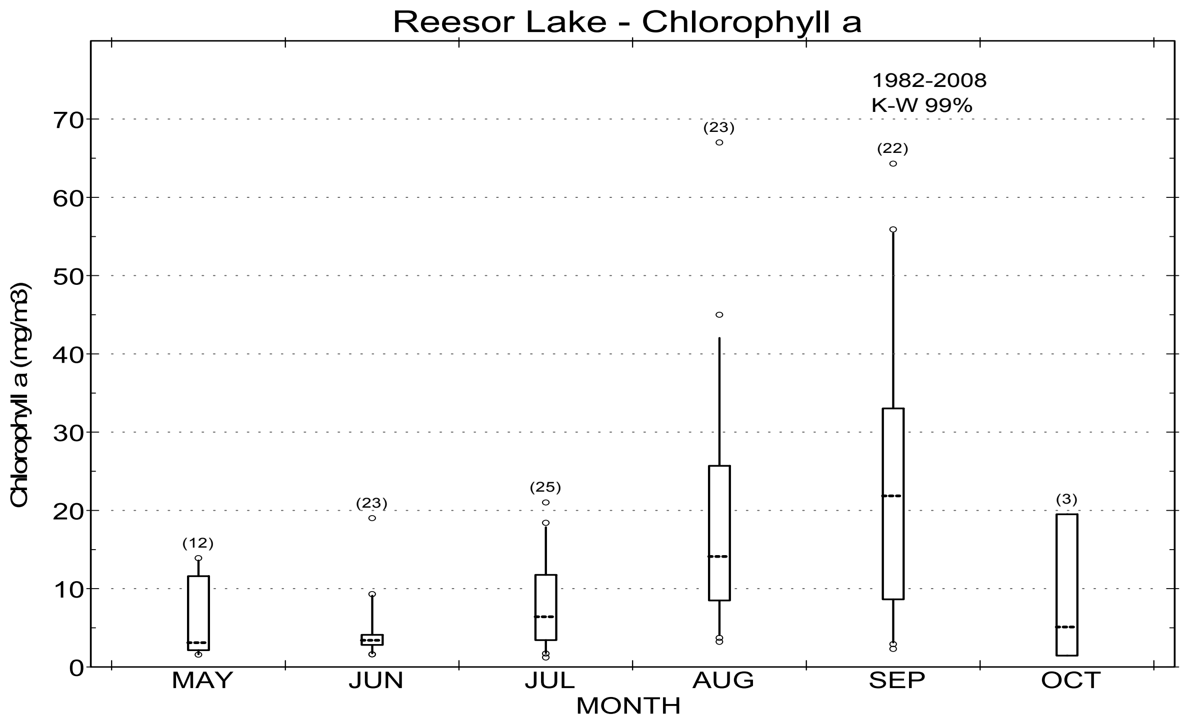


Figure 39 **Reesor Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



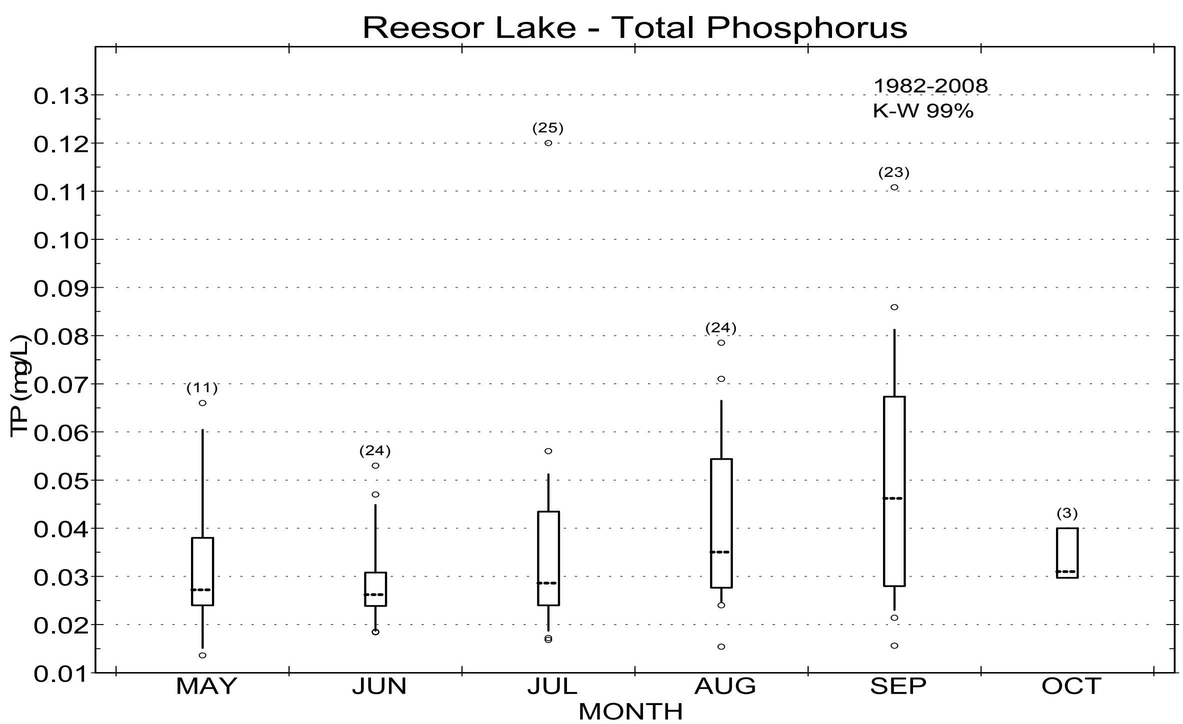
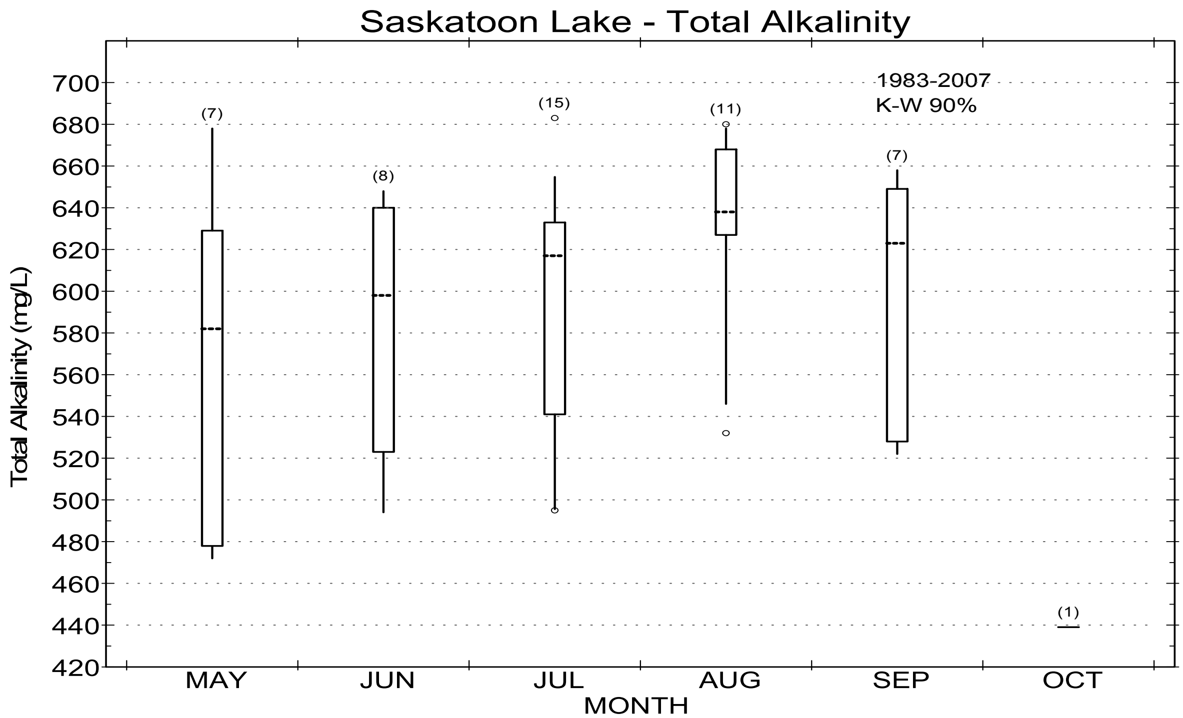


Figure 39 **Reesor Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



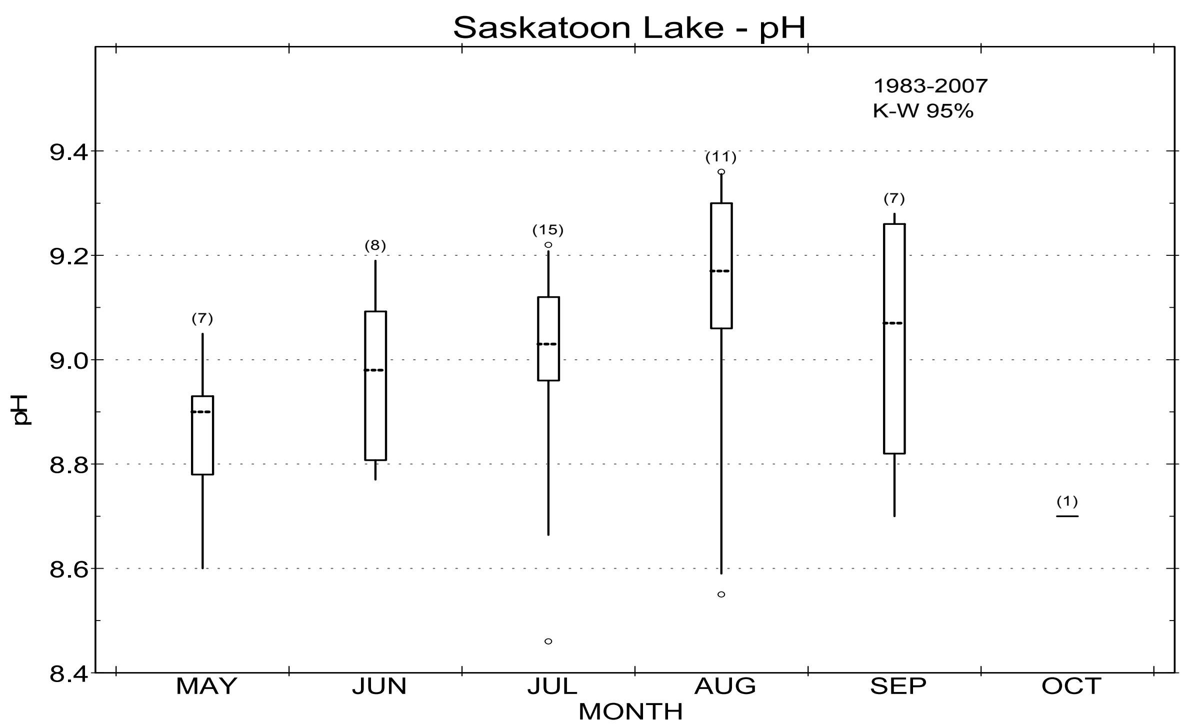
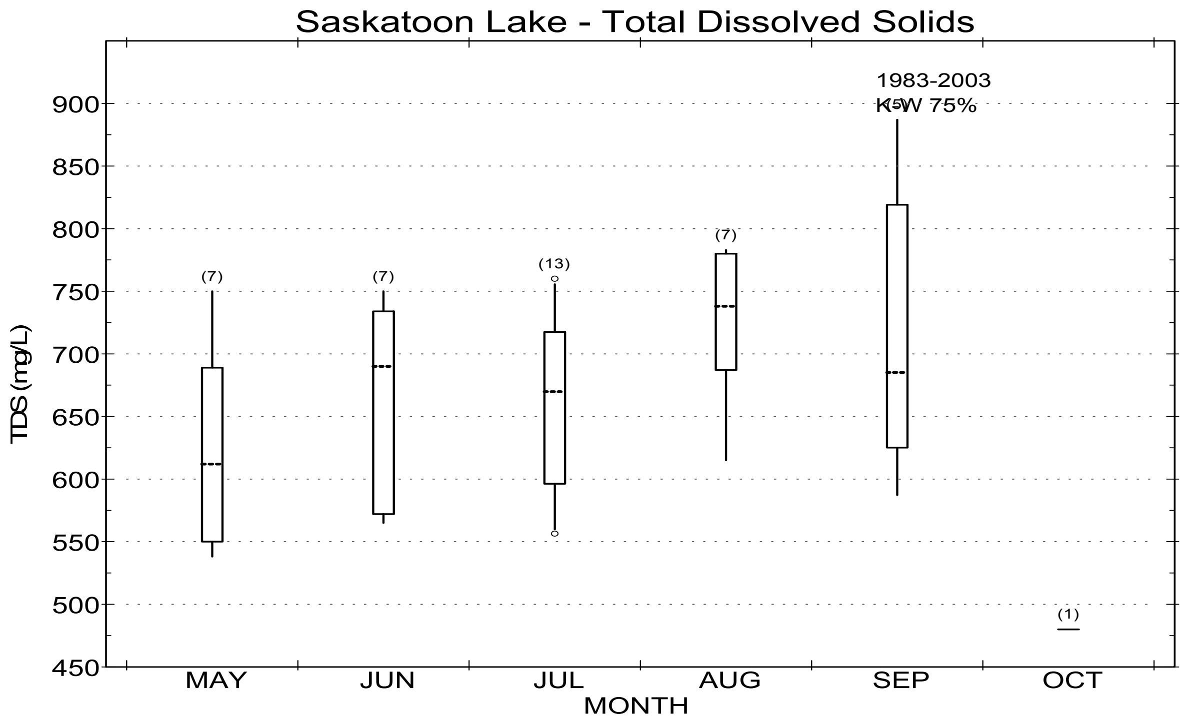


Figure 40 **Saskatoon Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



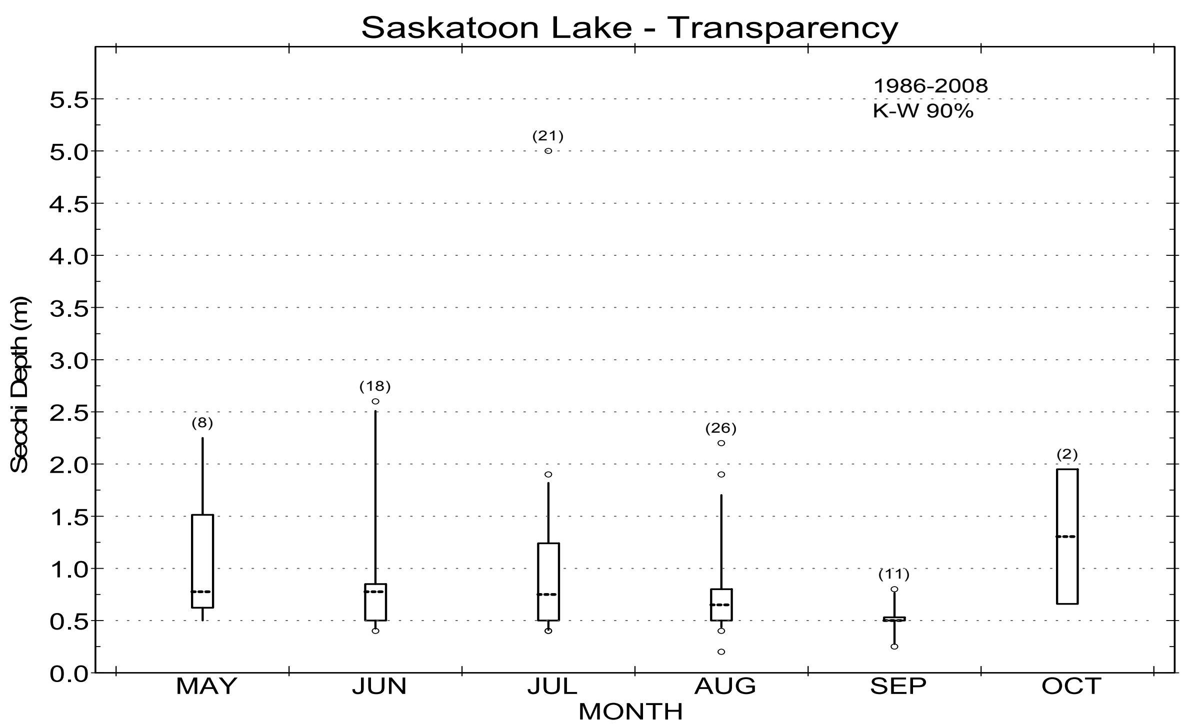
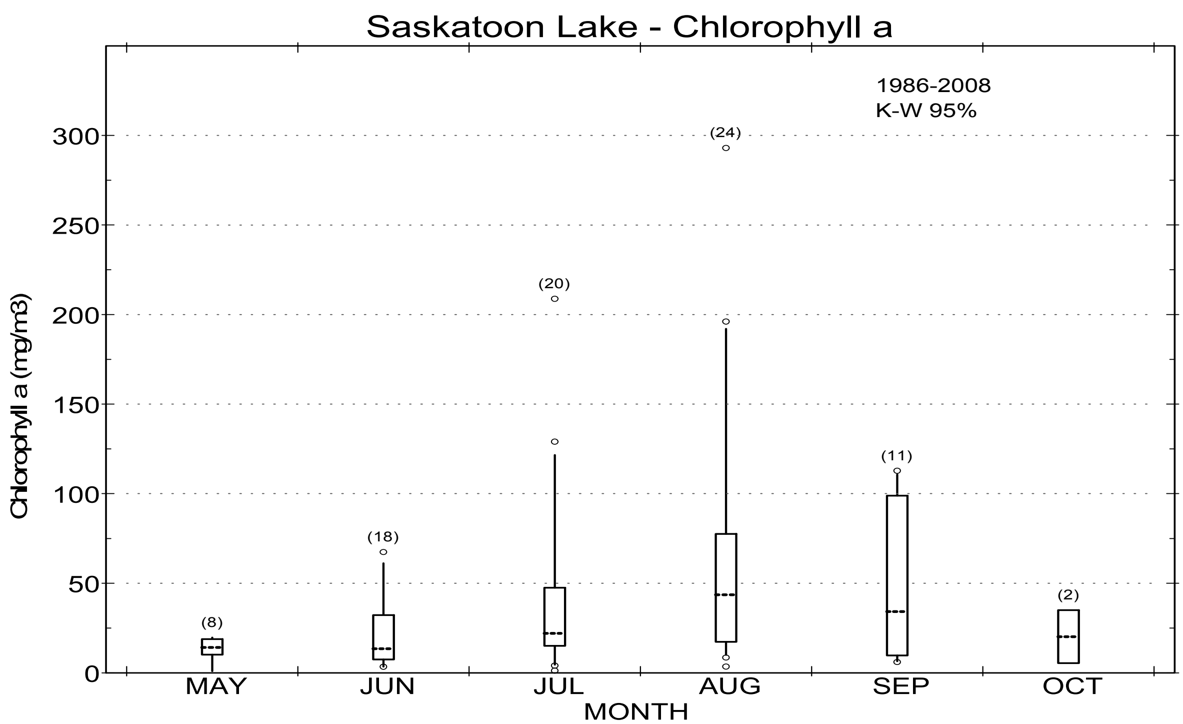


Figure 40 **Saskatoon Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



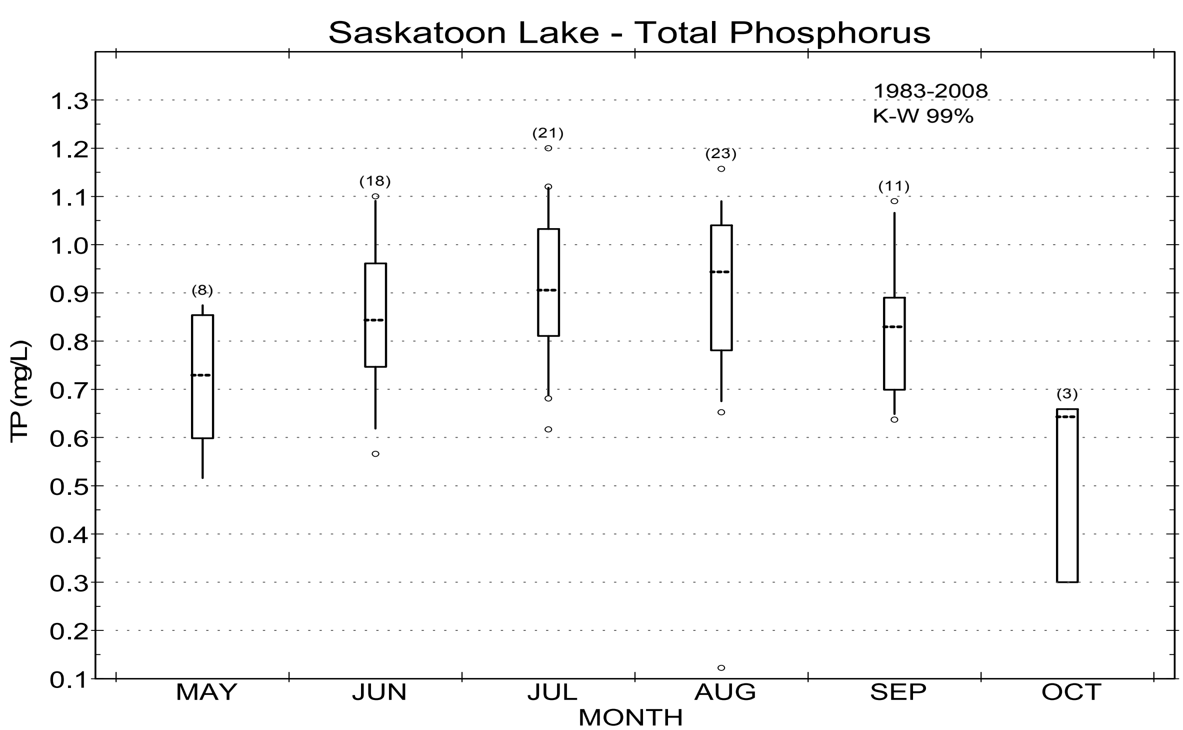
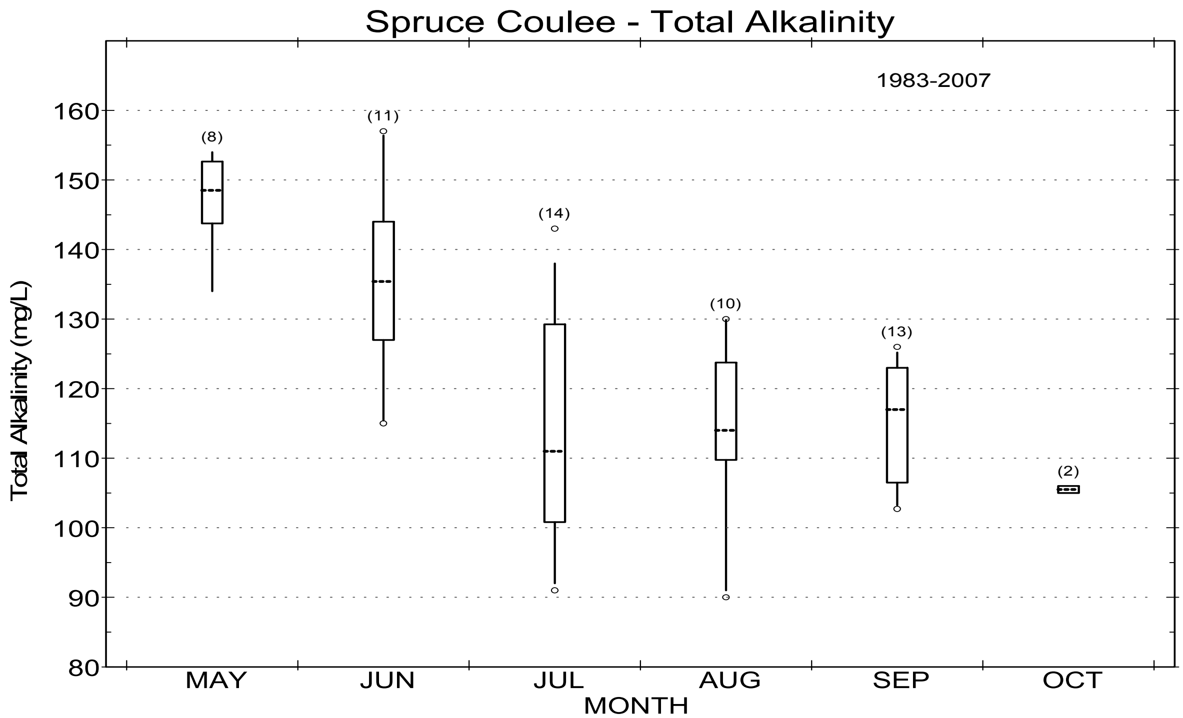


Figure 40 **Saskatoon Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



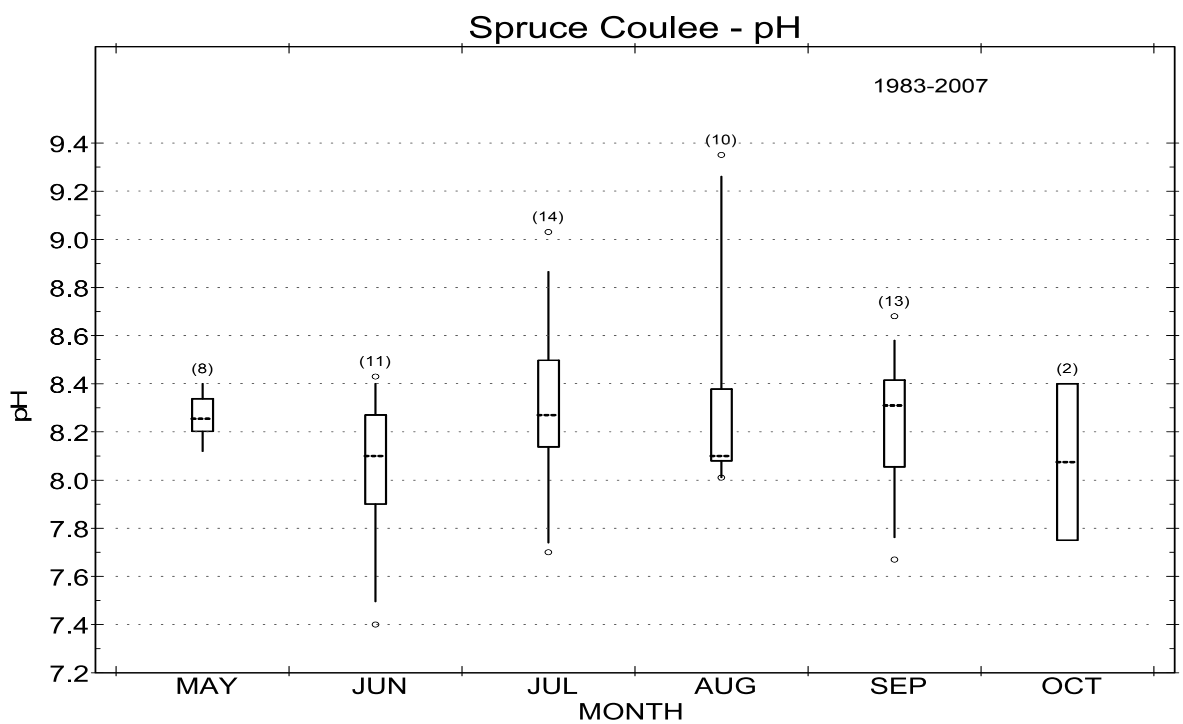
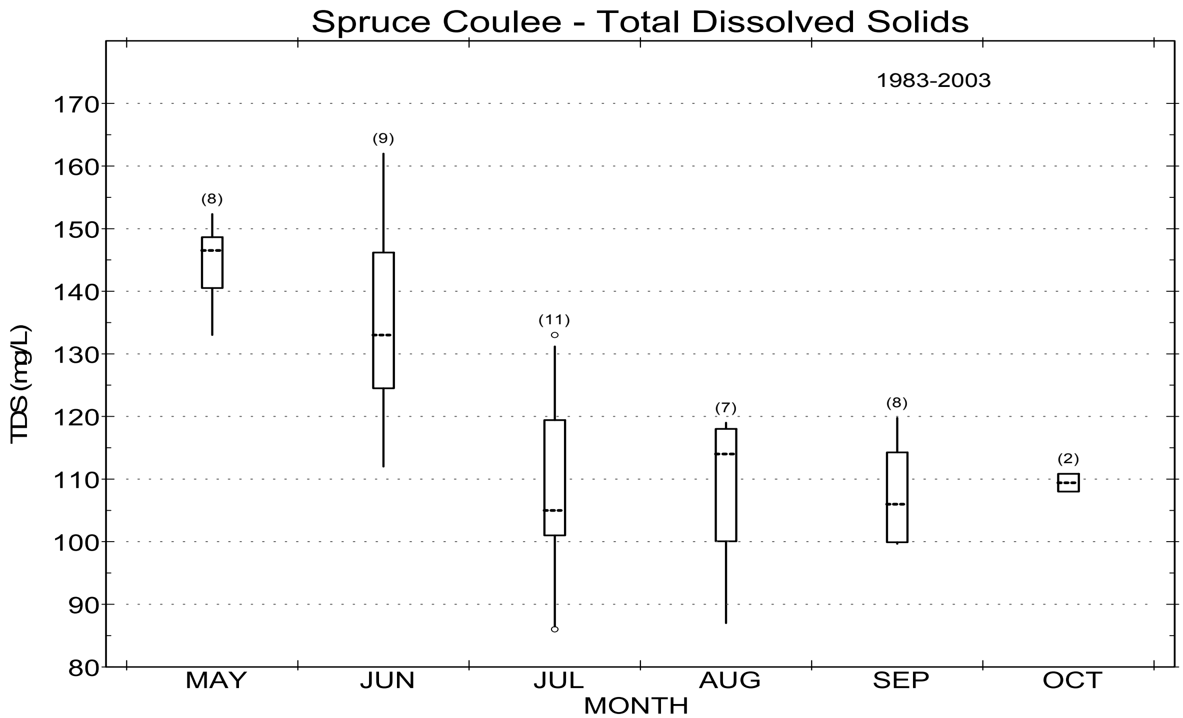


Figure 41 **Spruce Coulee -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



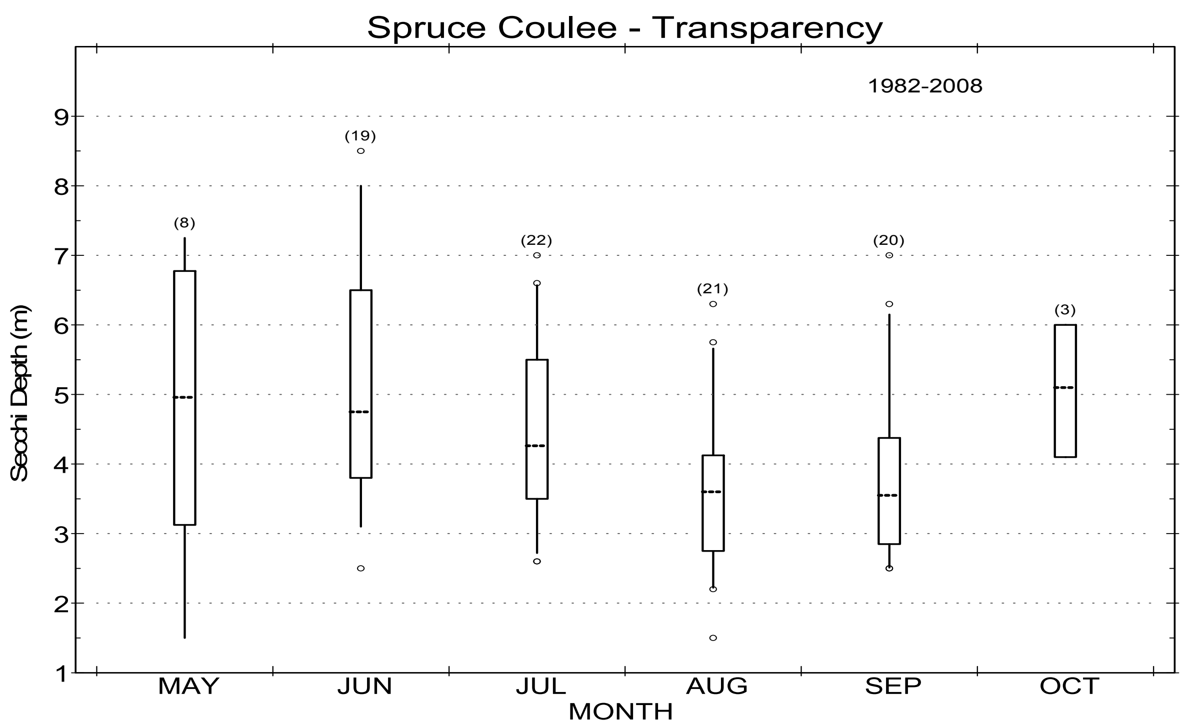
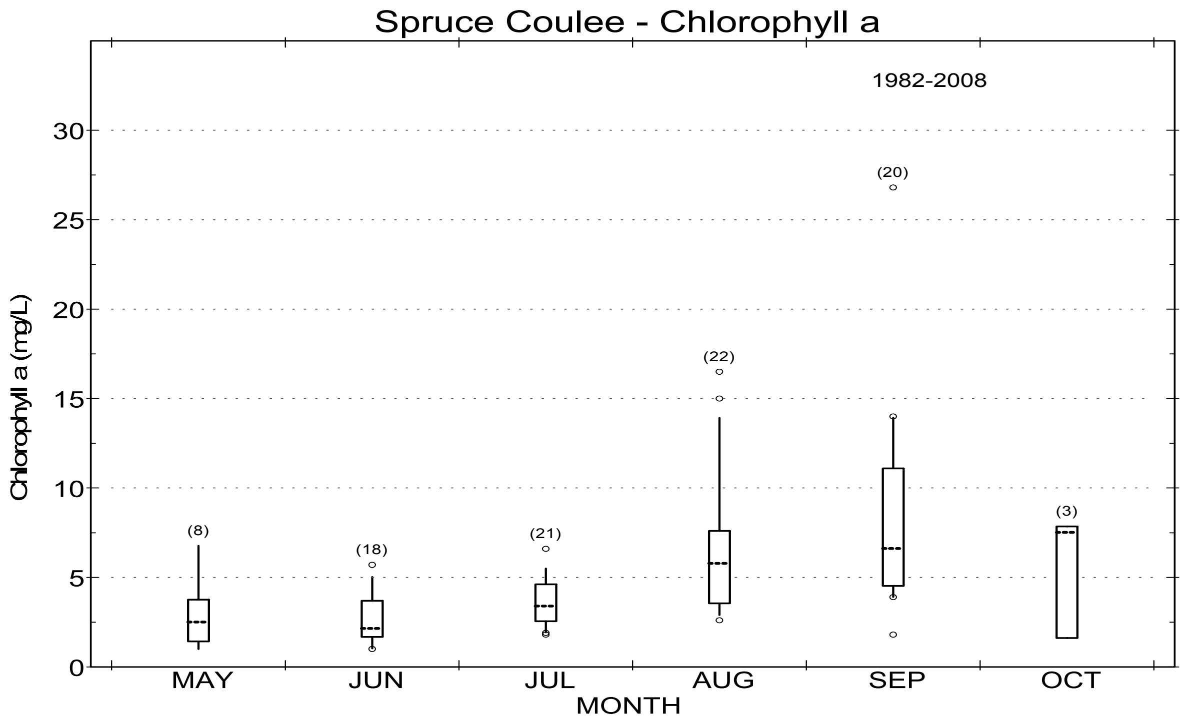


Figure 41 **Spruce Coulee -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



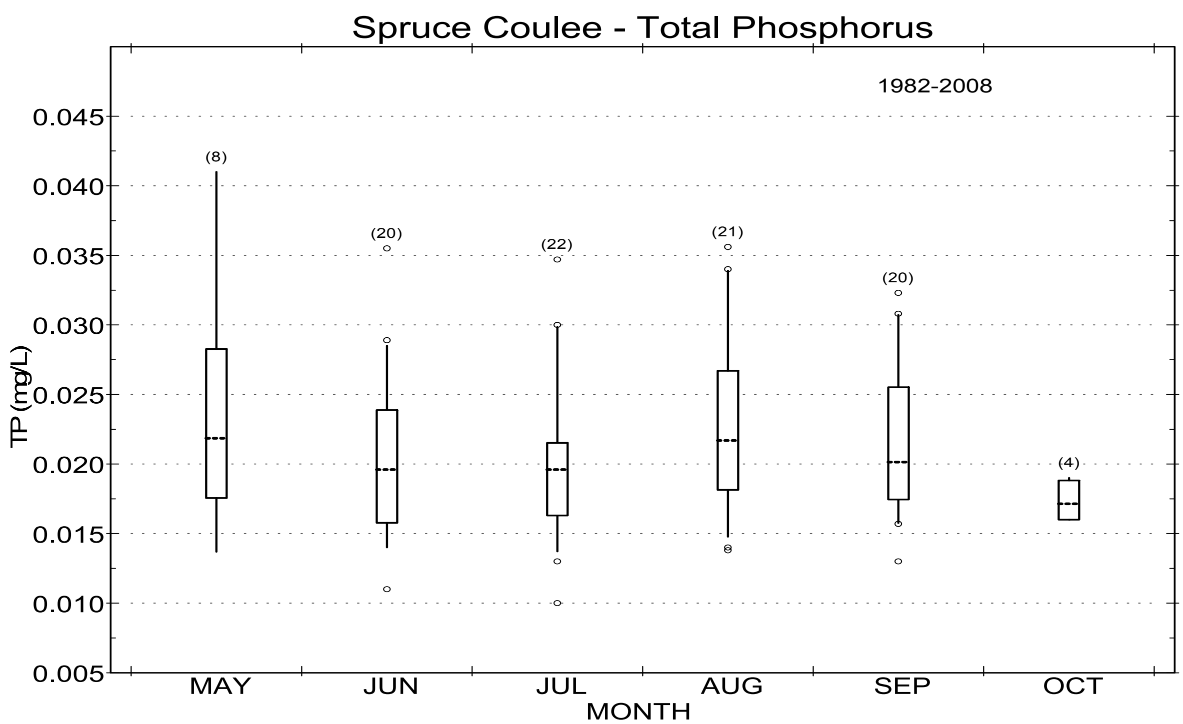
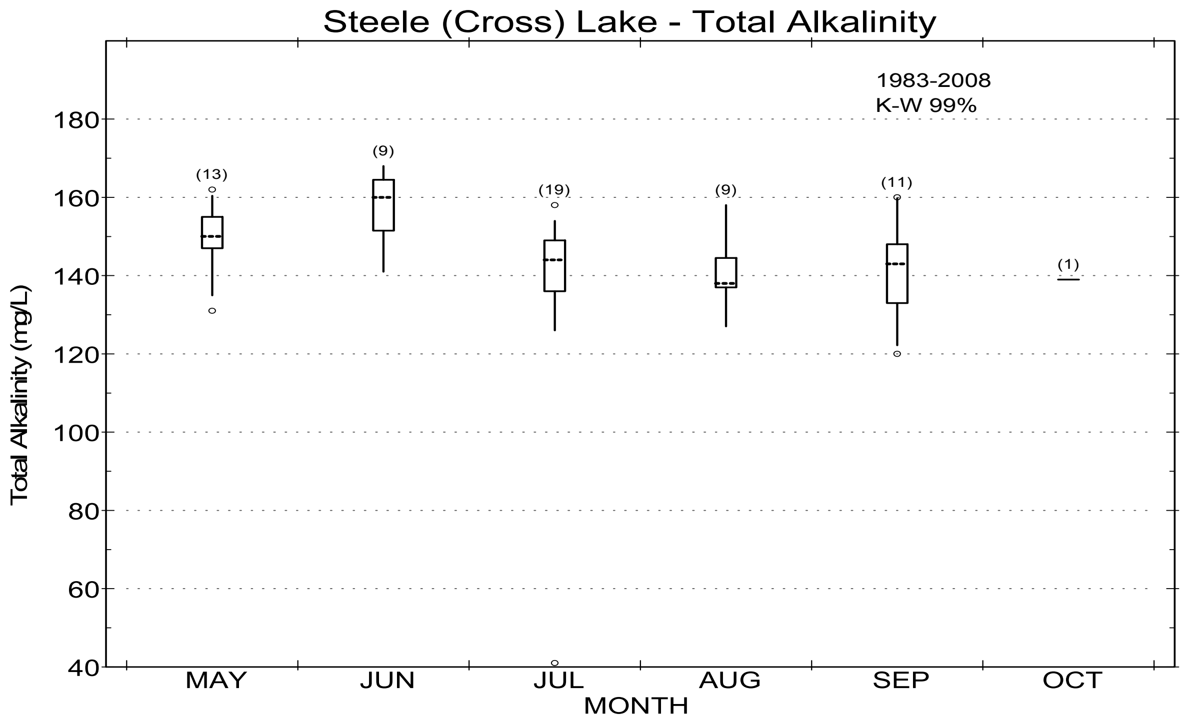


Figure 41 **Spruce Coulee -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



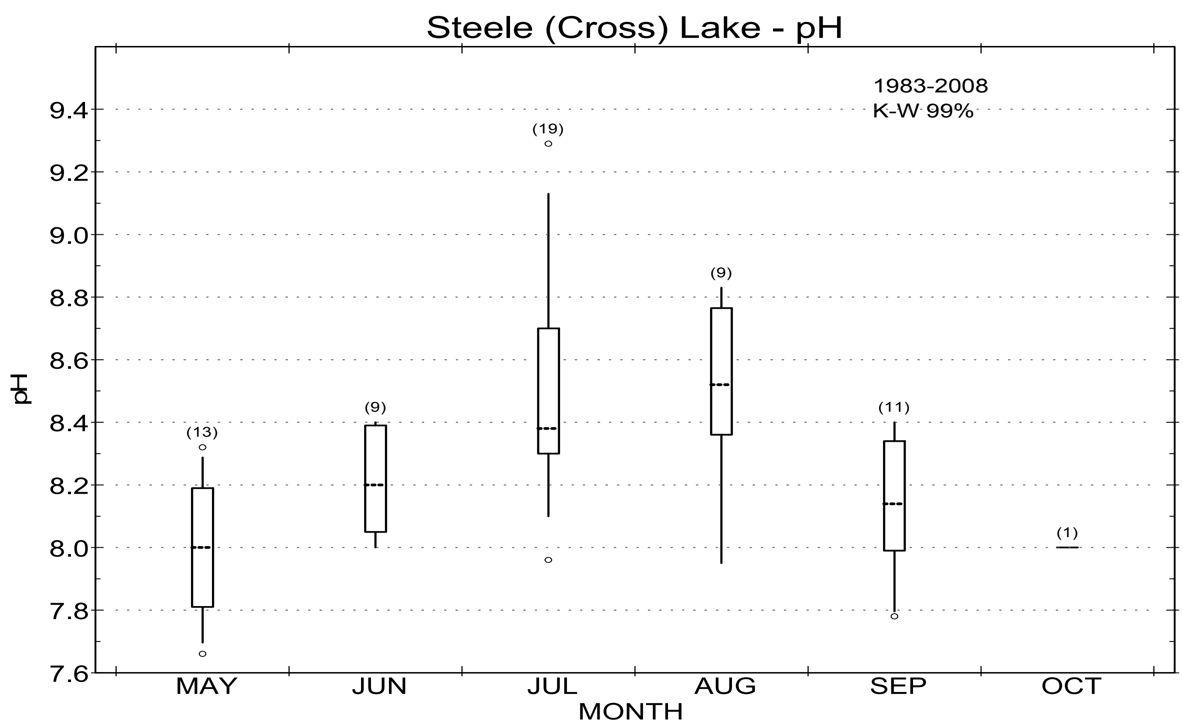
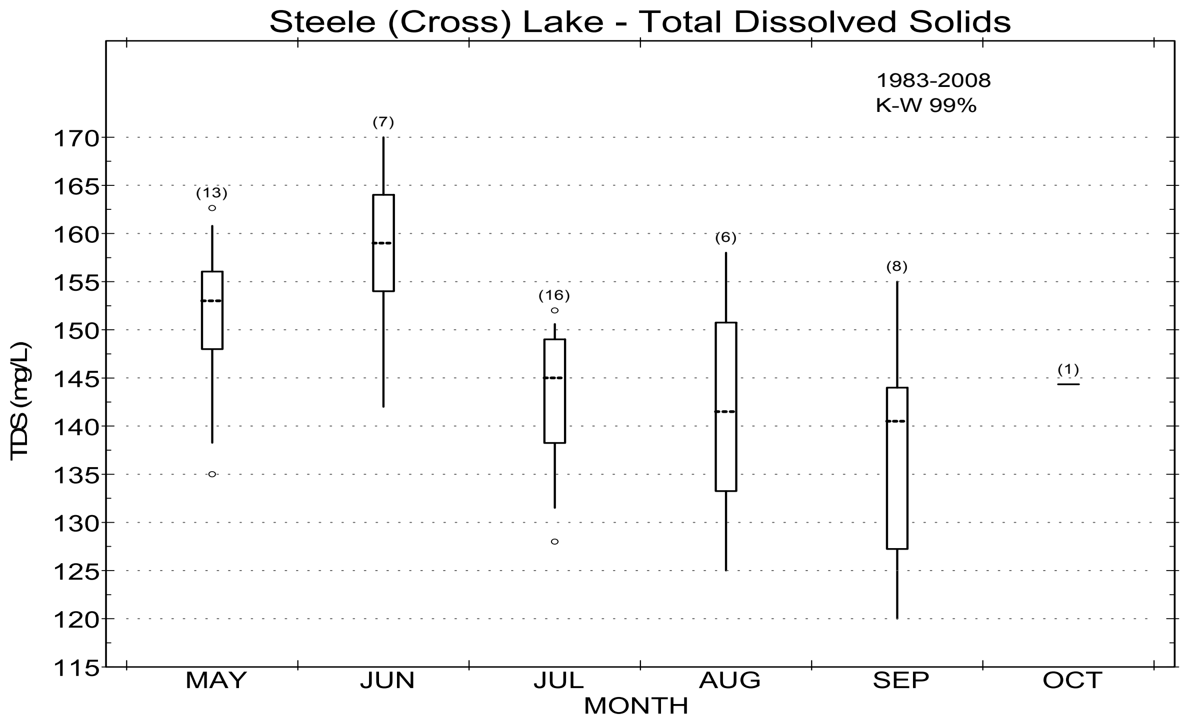


Figure 42 **Steele (Cross) Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



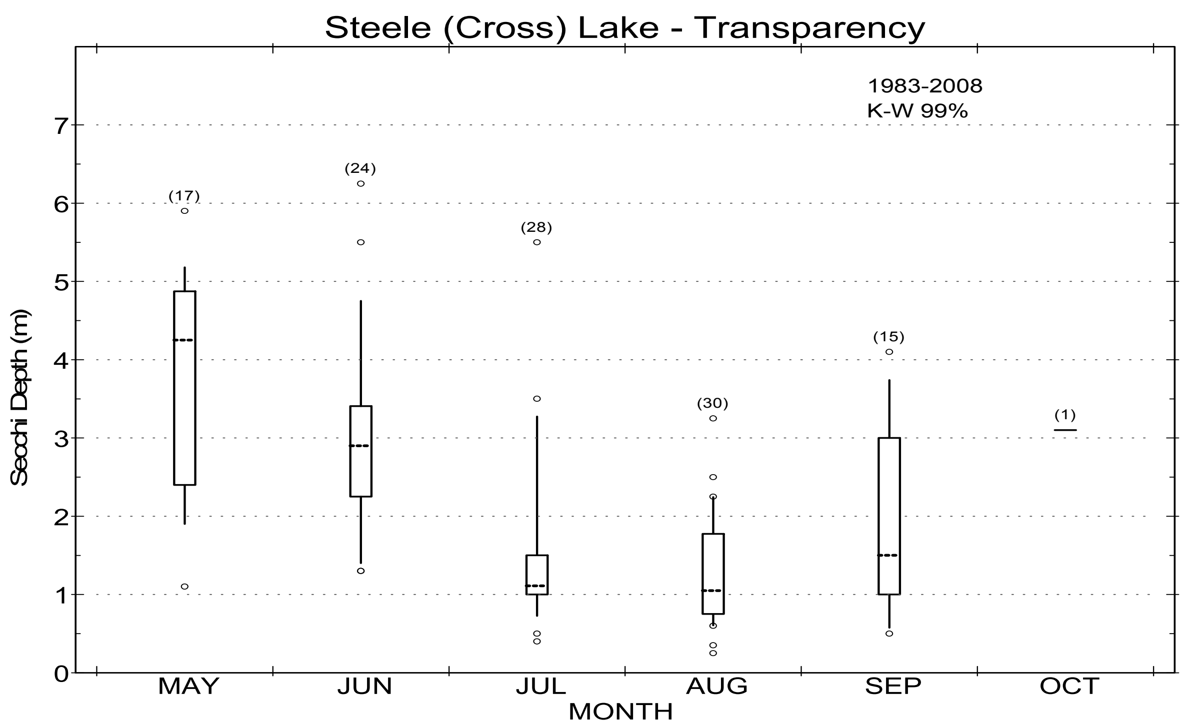
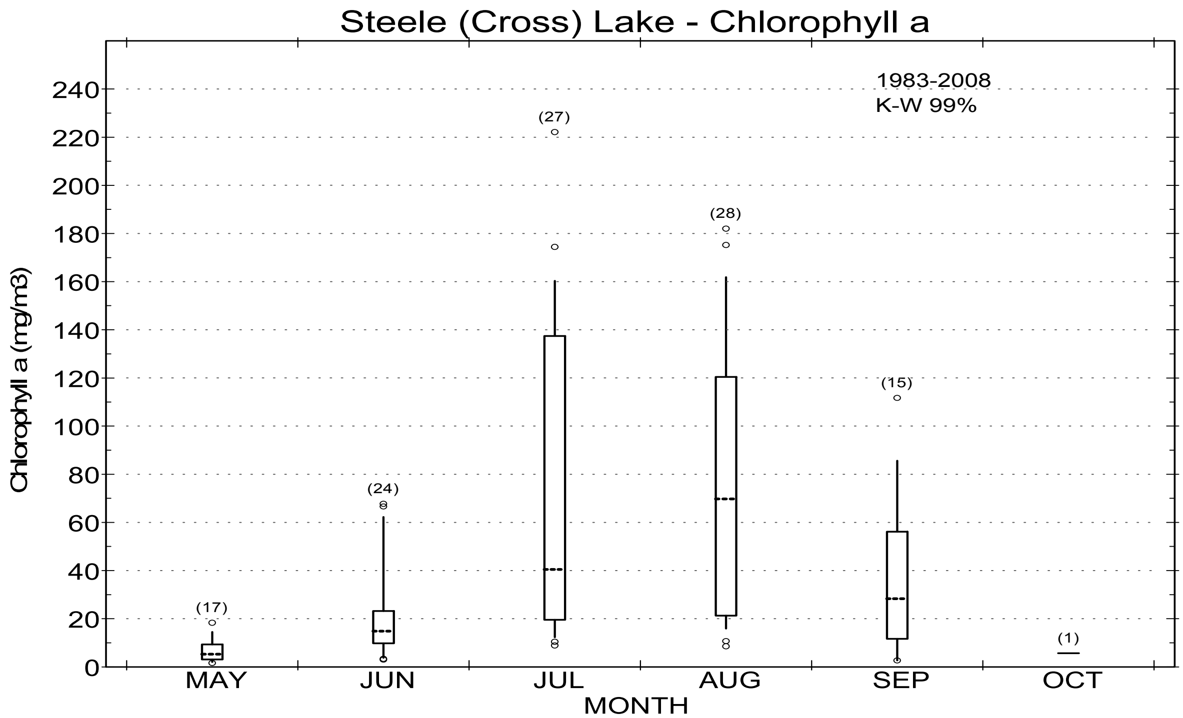


Figure 42 **Steele (Cross) Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



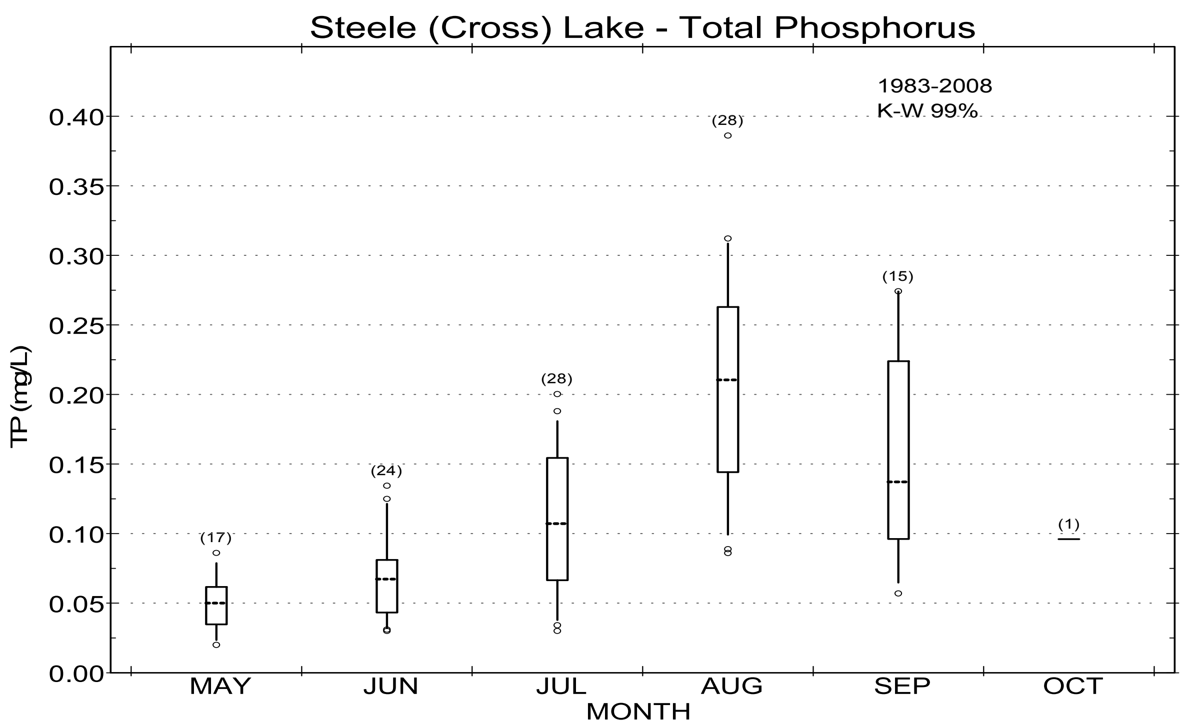
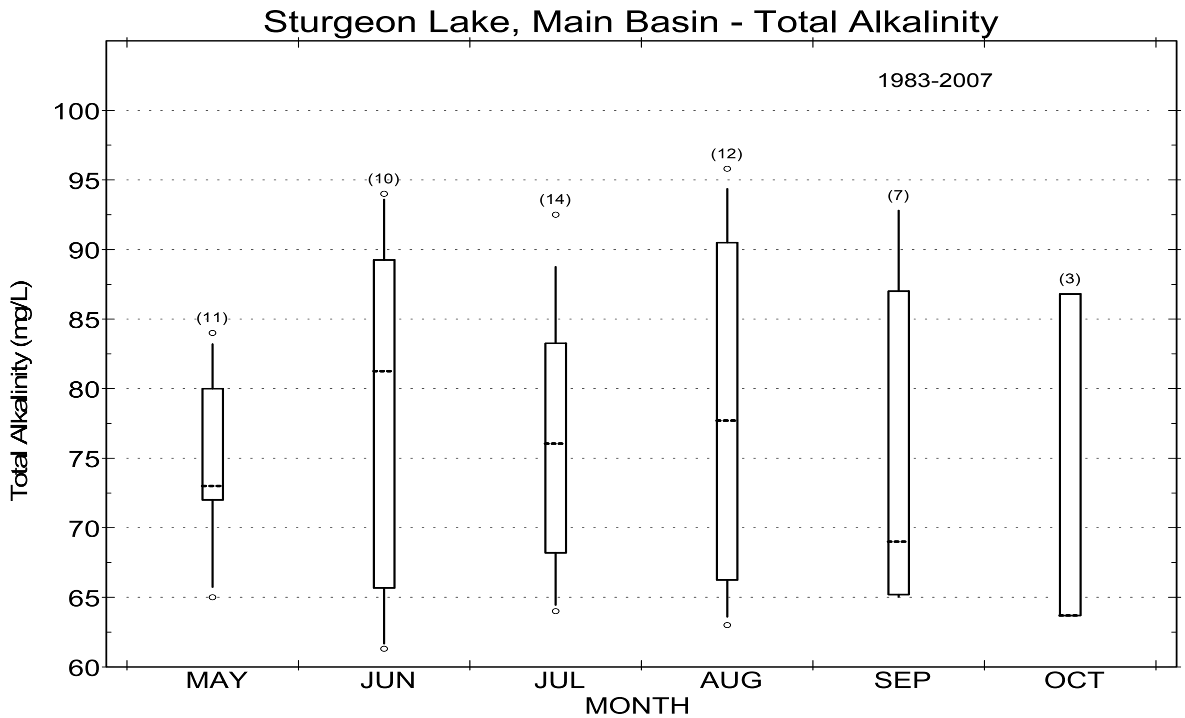


Figure 42 **Steele (Cross) Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



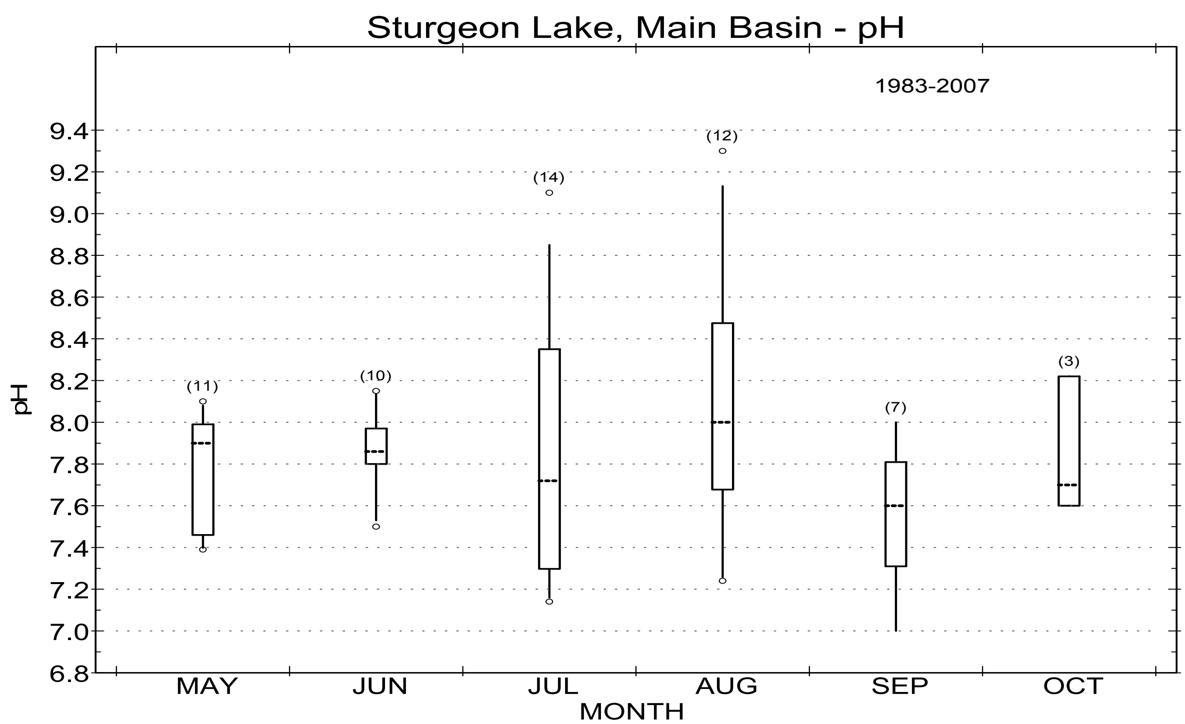
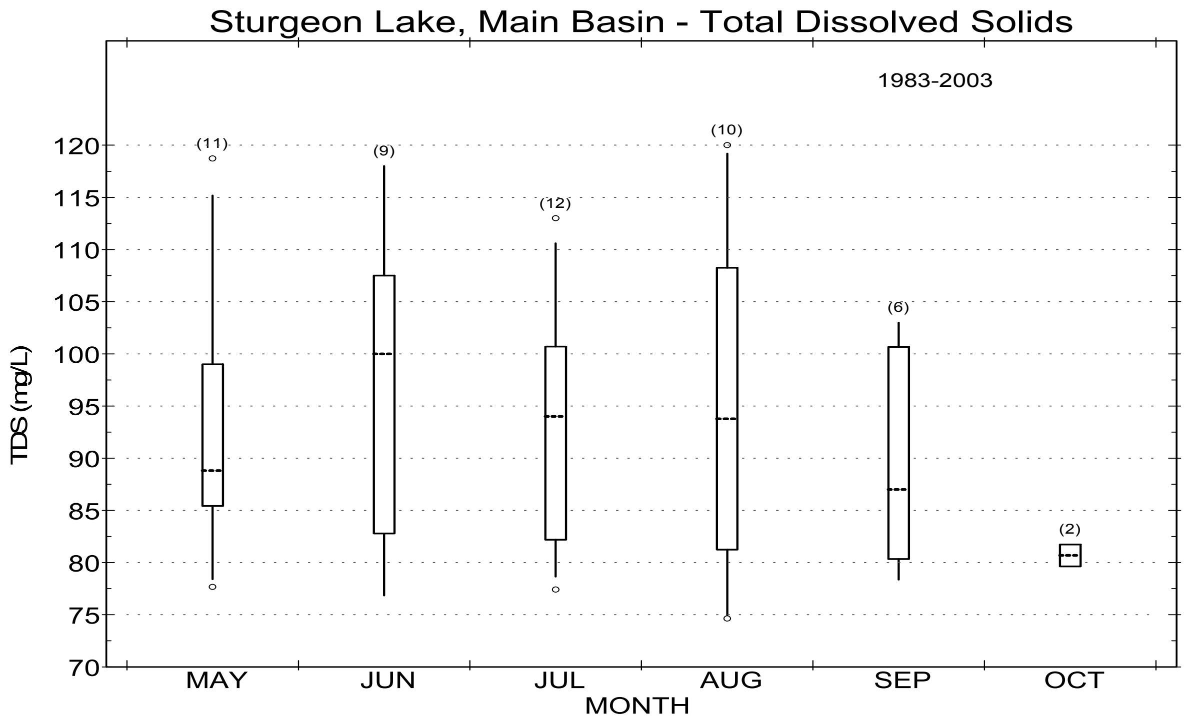


Figure 43 **Sturgeon Lake, Main Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



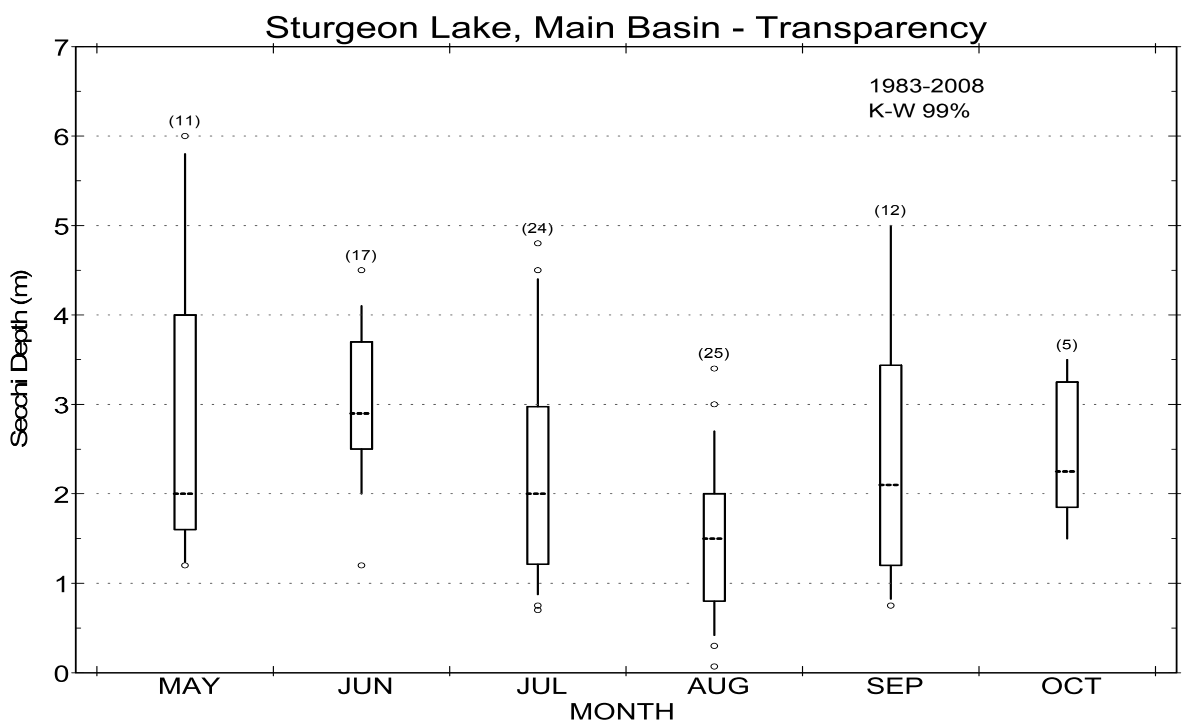
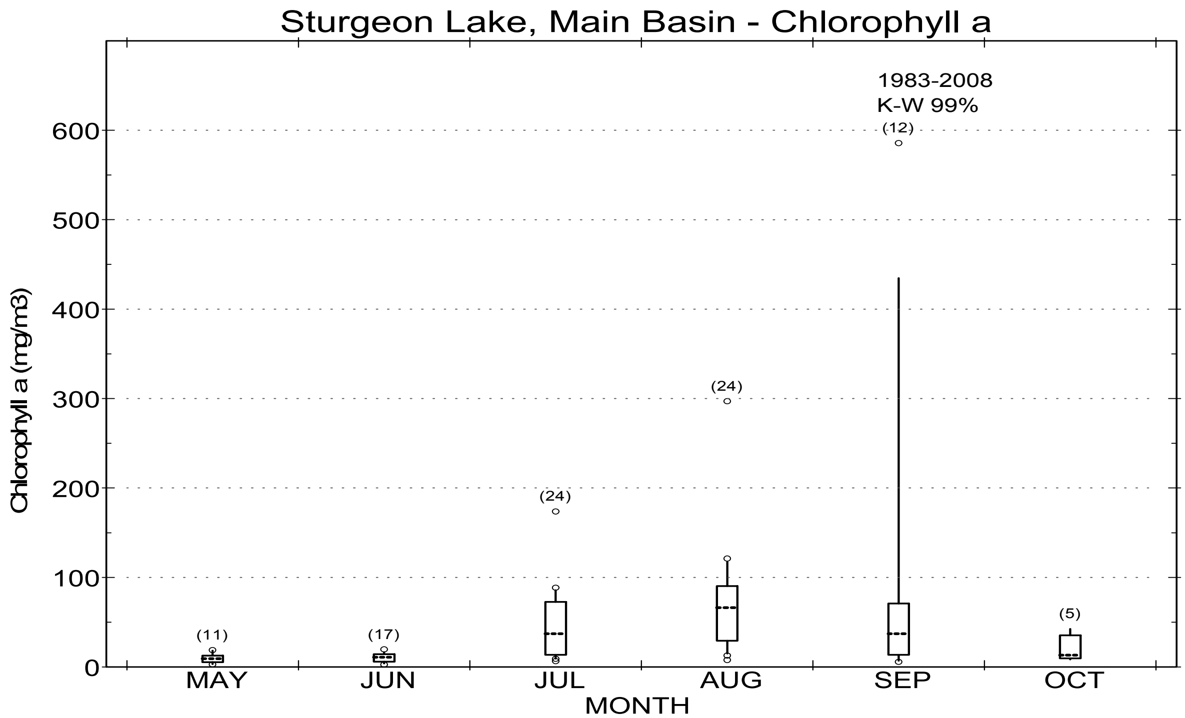


Figure 43 **Sturgeon Lake, Main Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



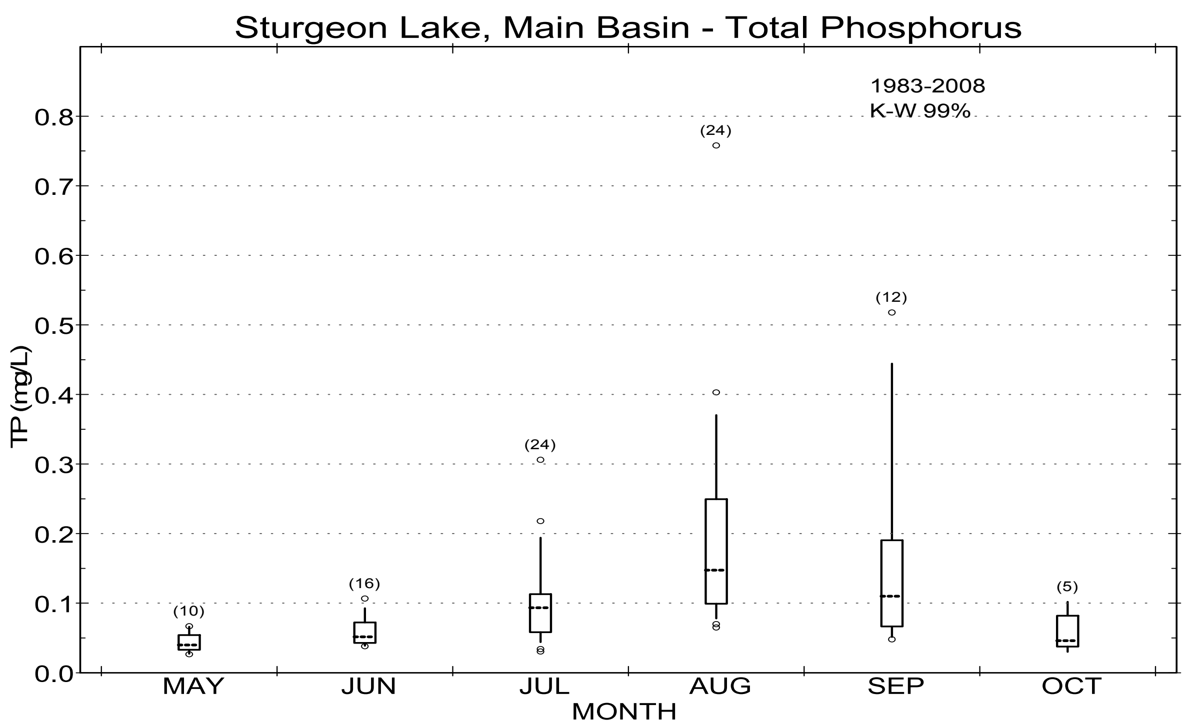
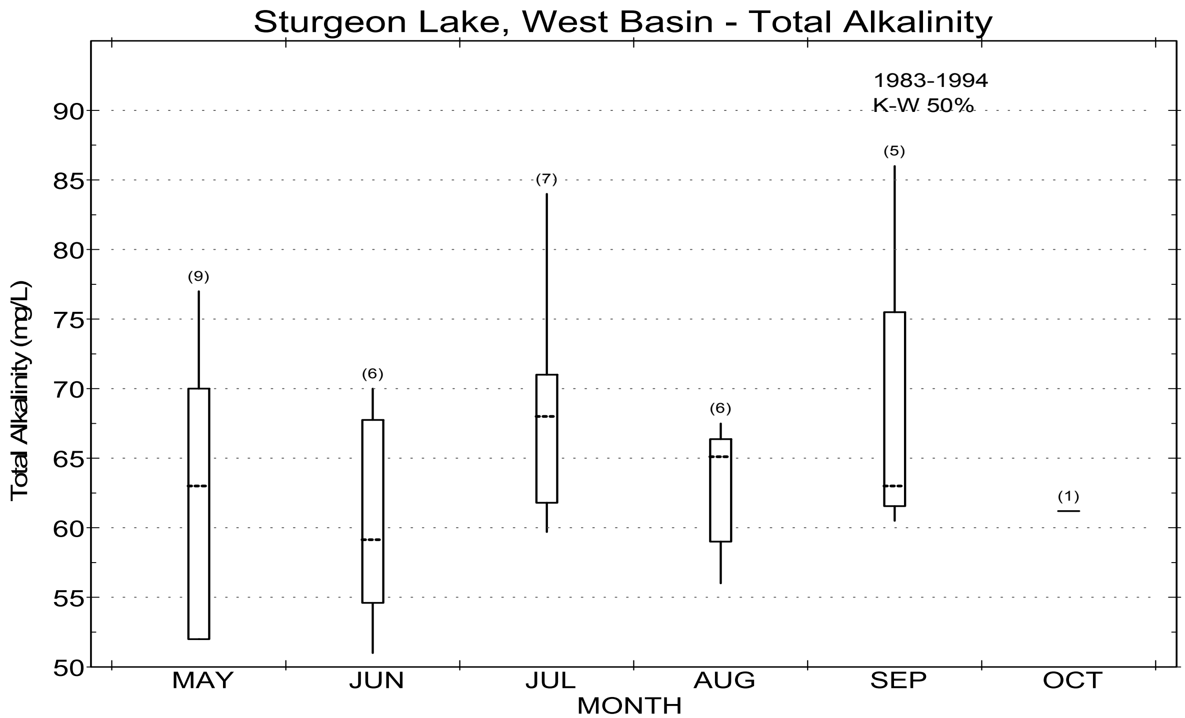


Figure 43 **Sturgeon Lake, Main Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



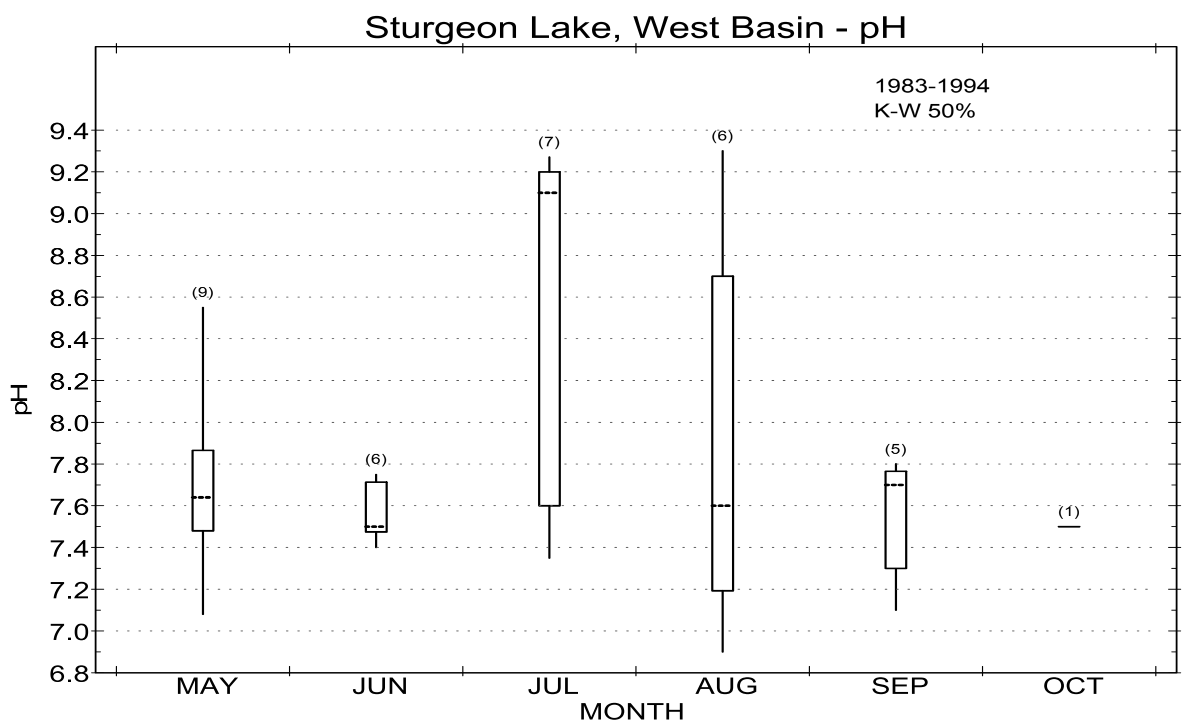
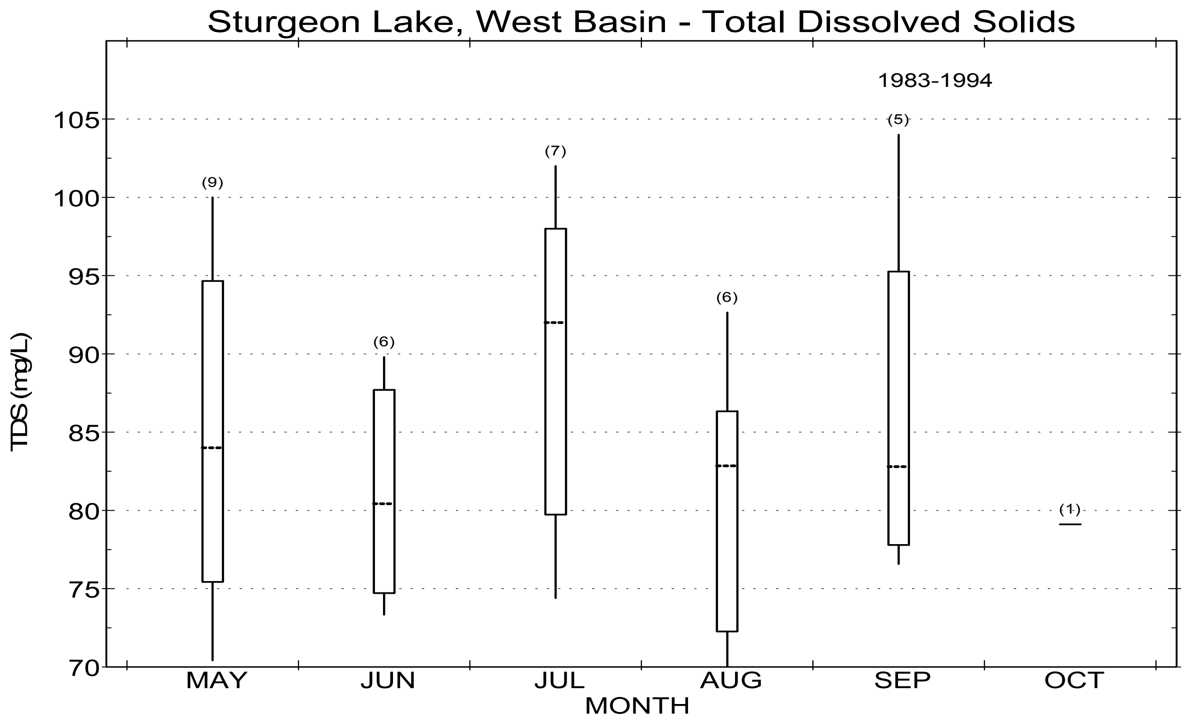


Figure 44 **Sturgeon Lake, West Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



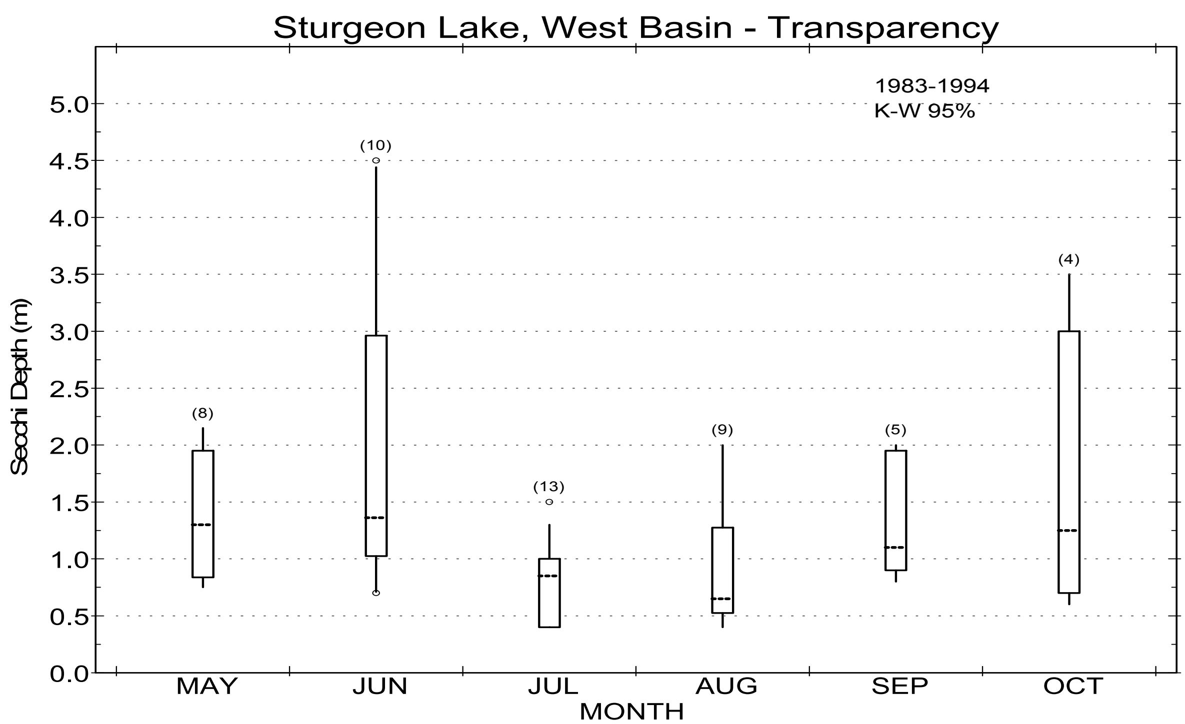
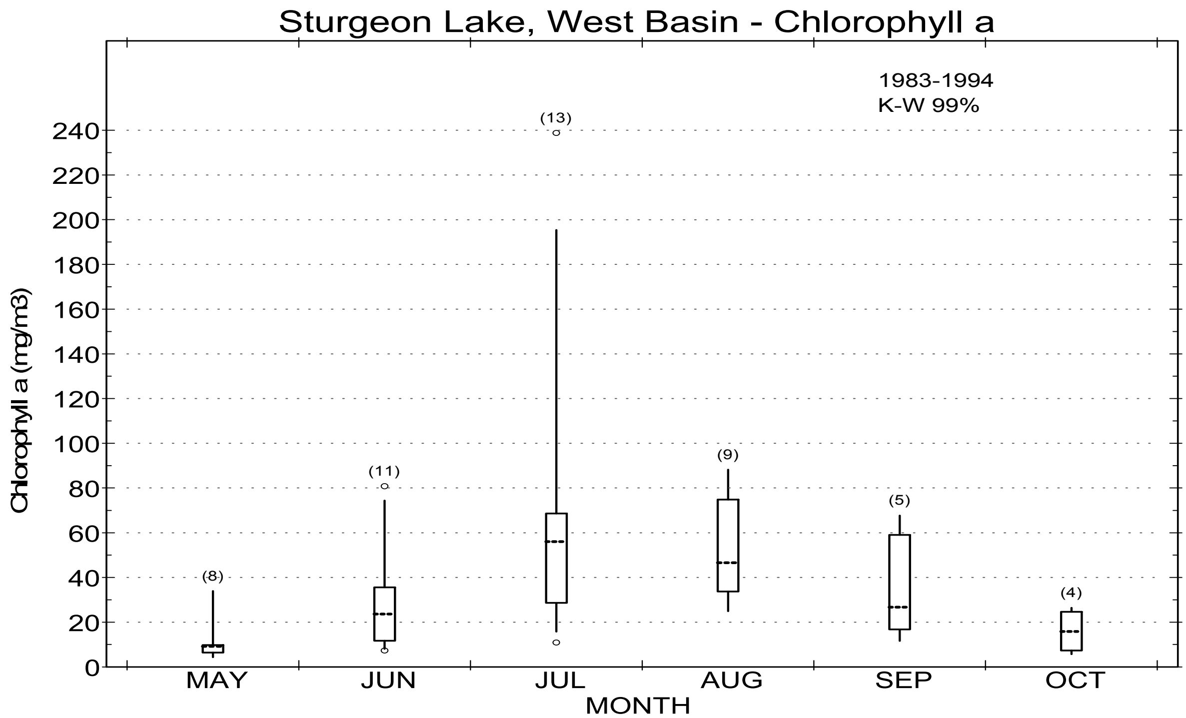


Figure 44 **Sturgeon Lake, West Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



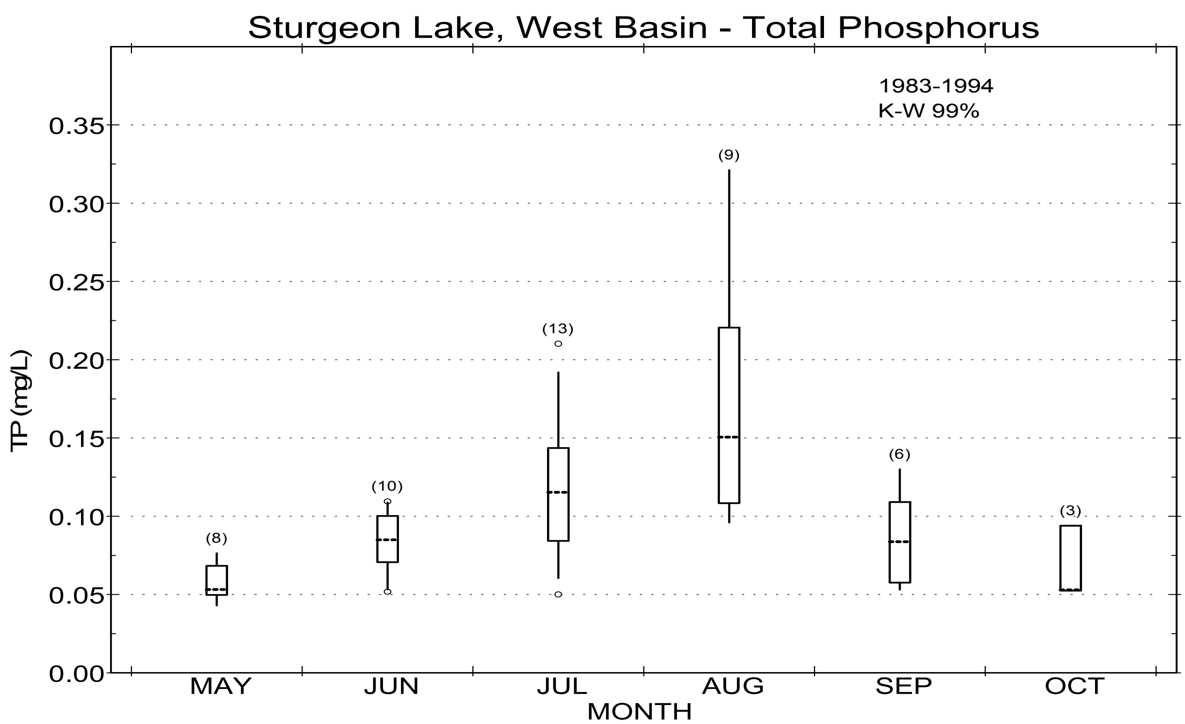
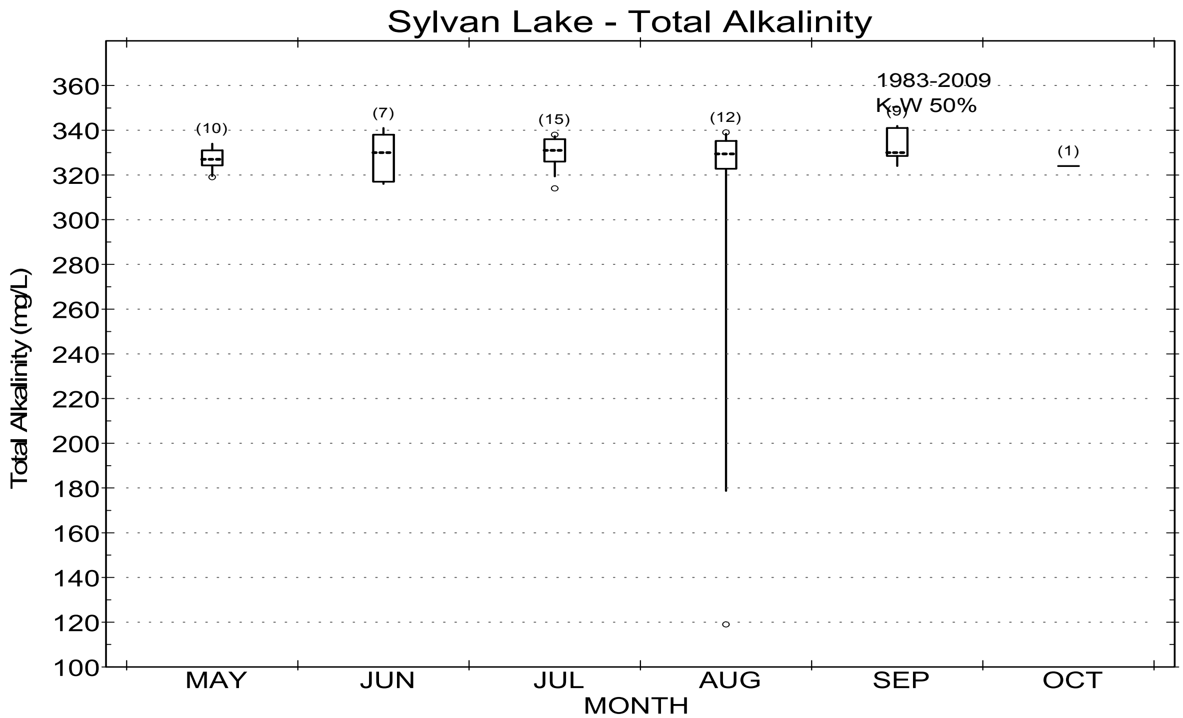


Figure 44 **Sturgeon Lake, West Basin -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



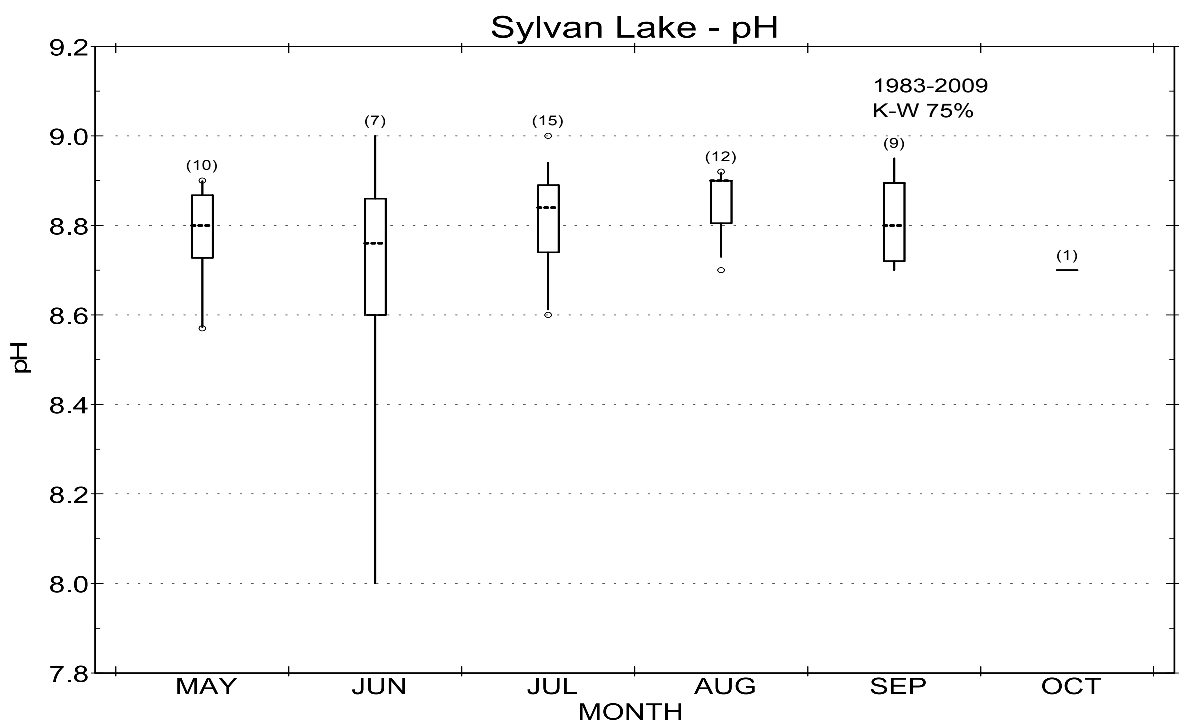
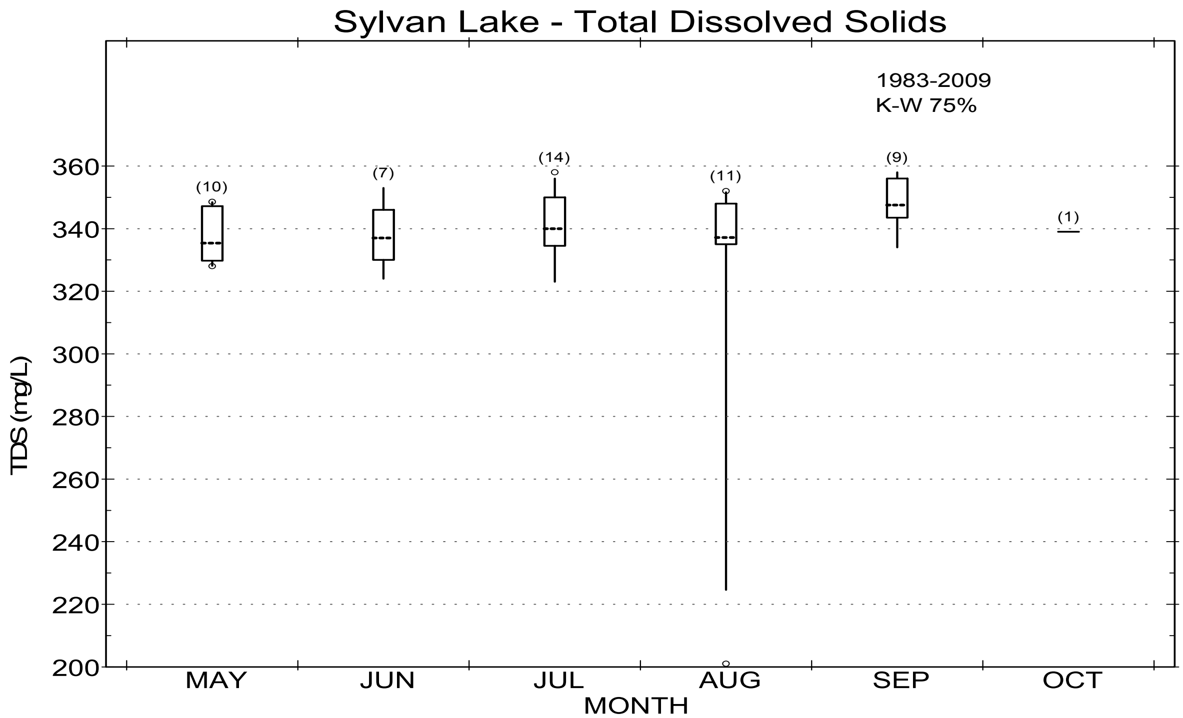


Figure 45 **Sylvan Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



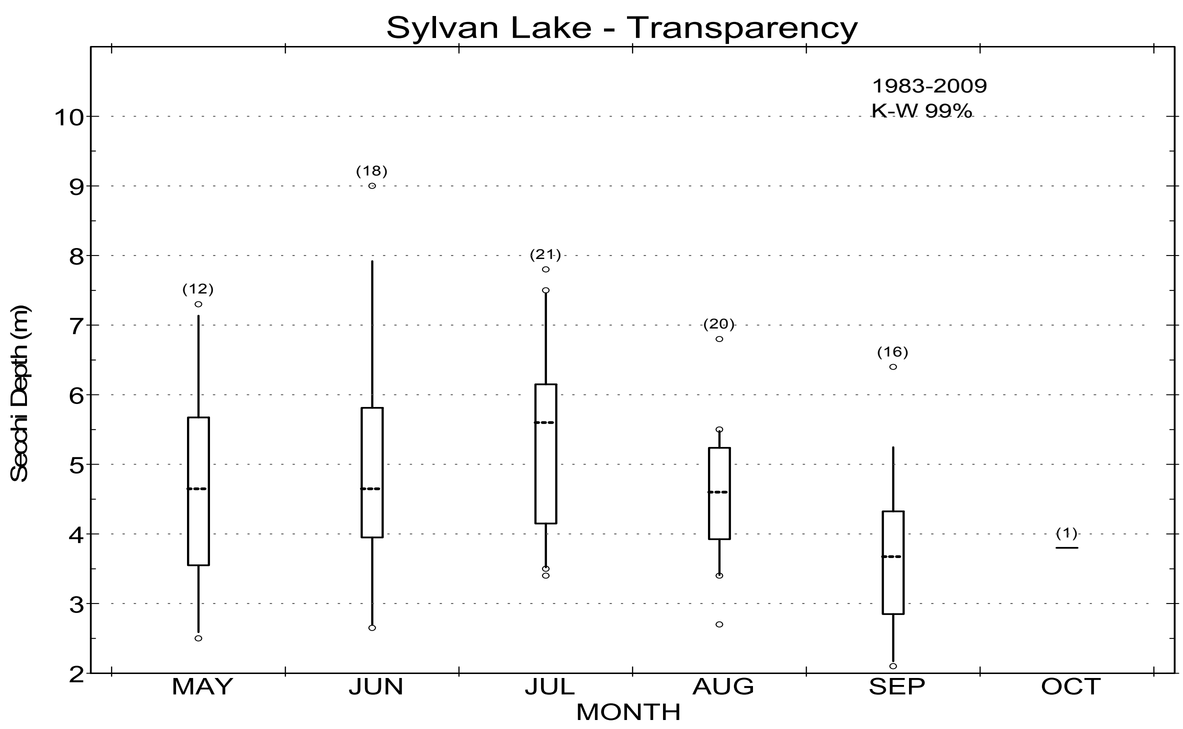
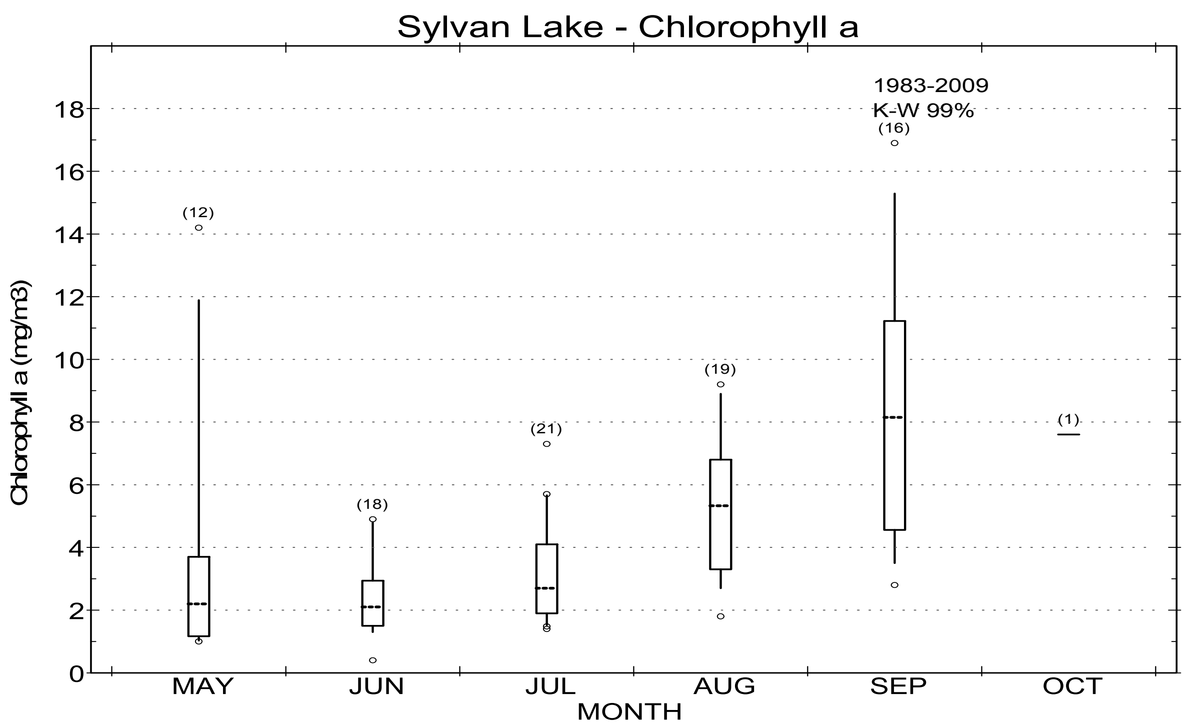


Figure 45 **Sylvan Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



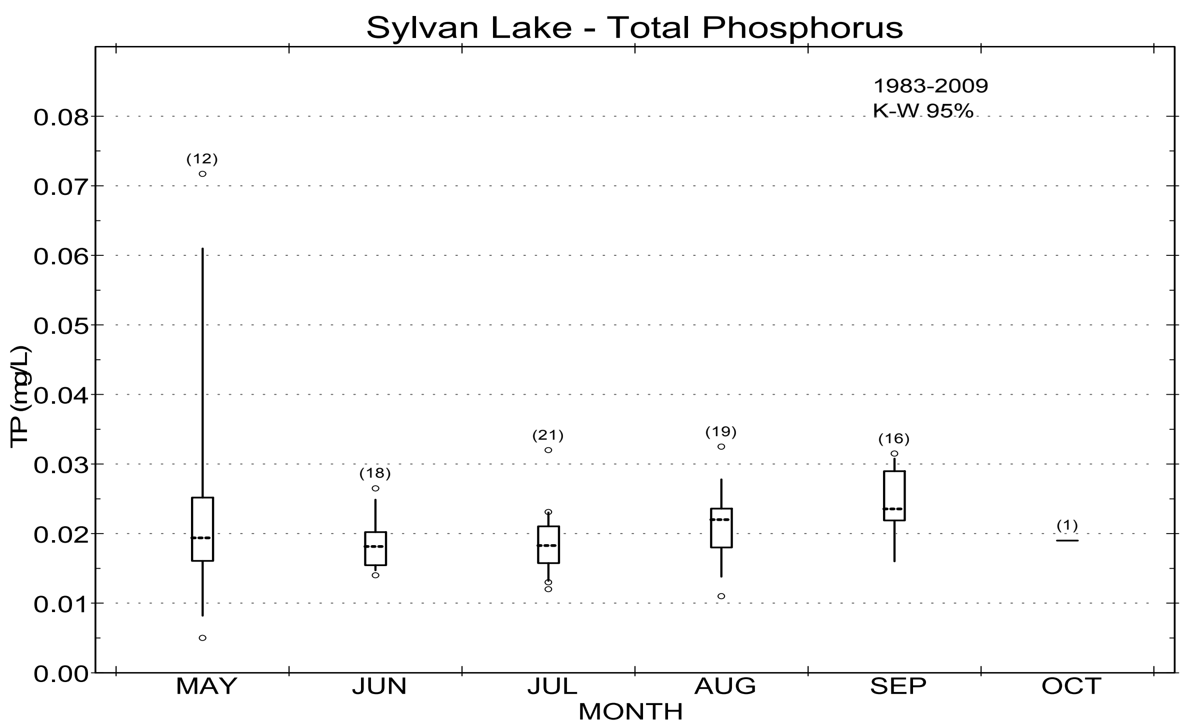
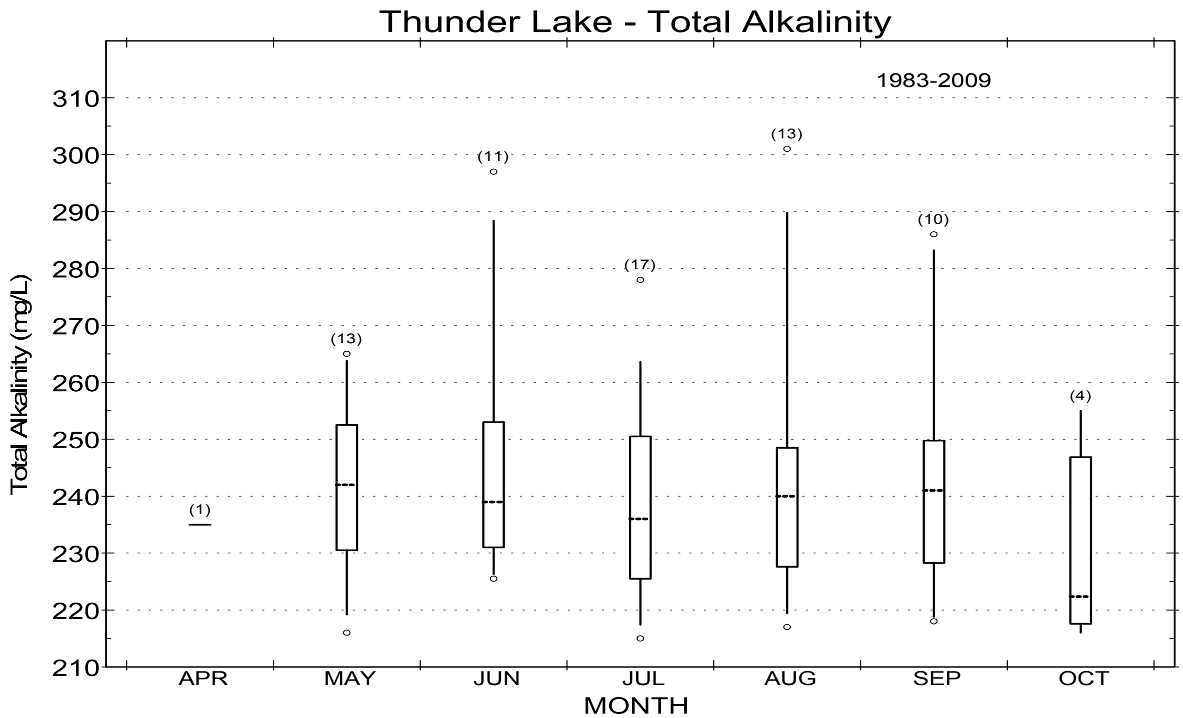


Figure 45 **Sylvan Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



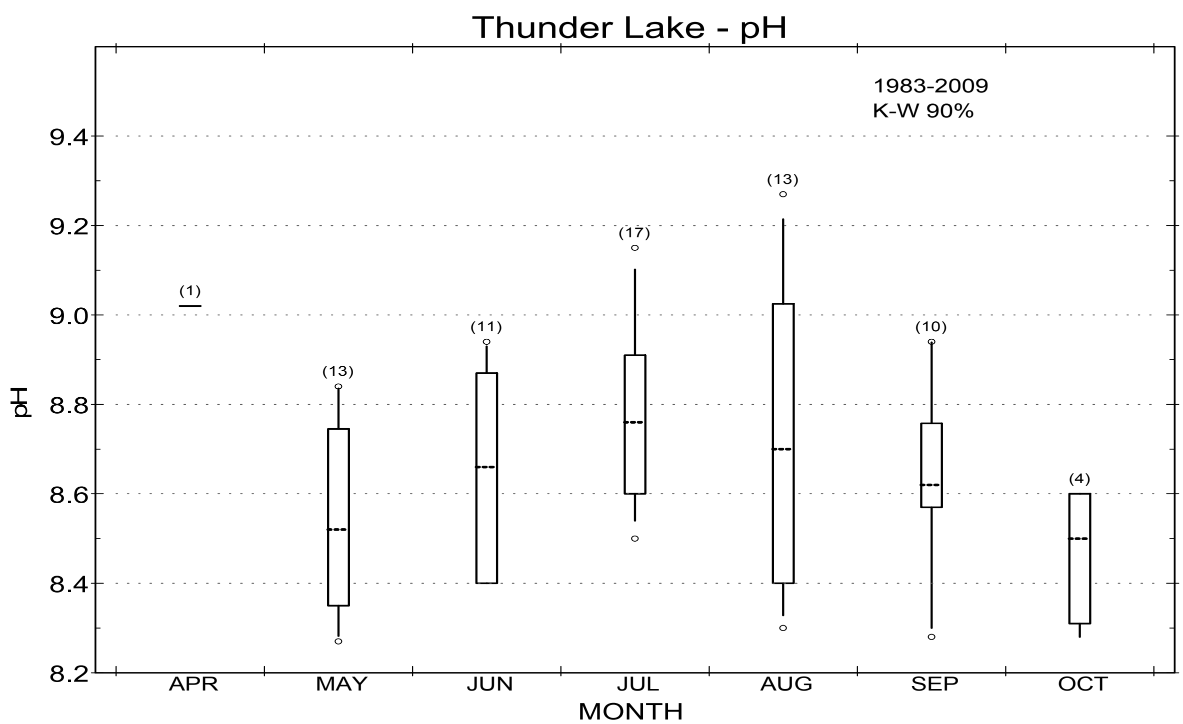
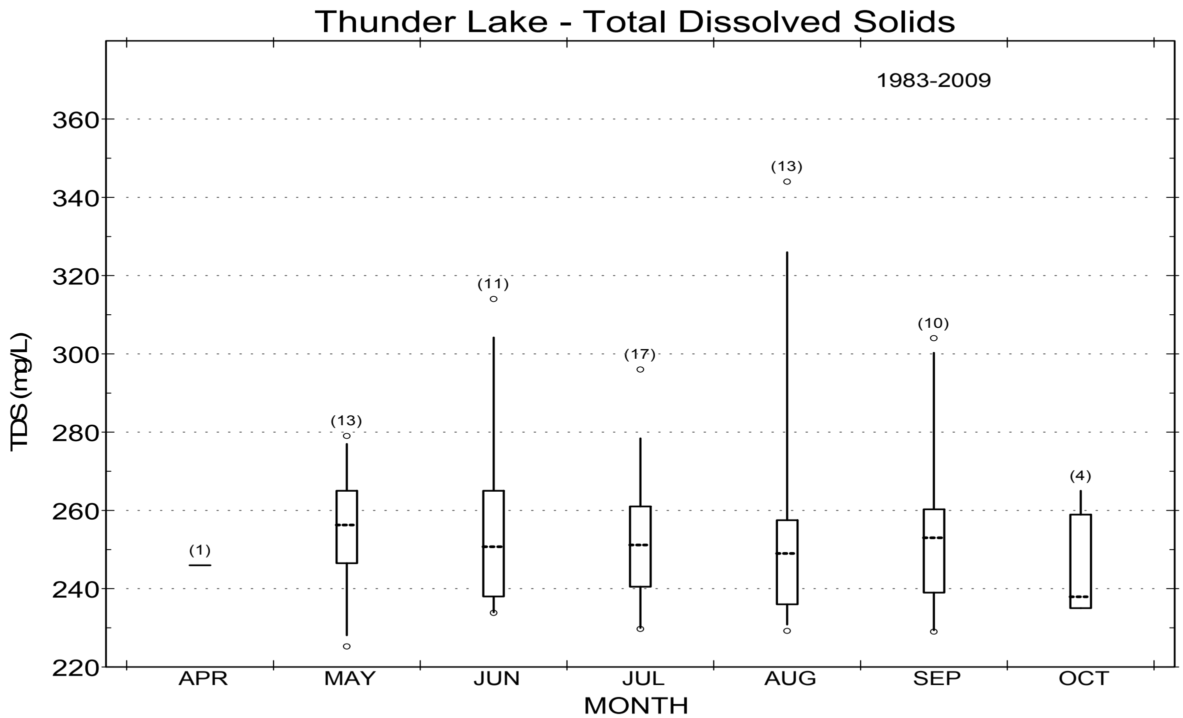


Figure 46 **Thunder Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



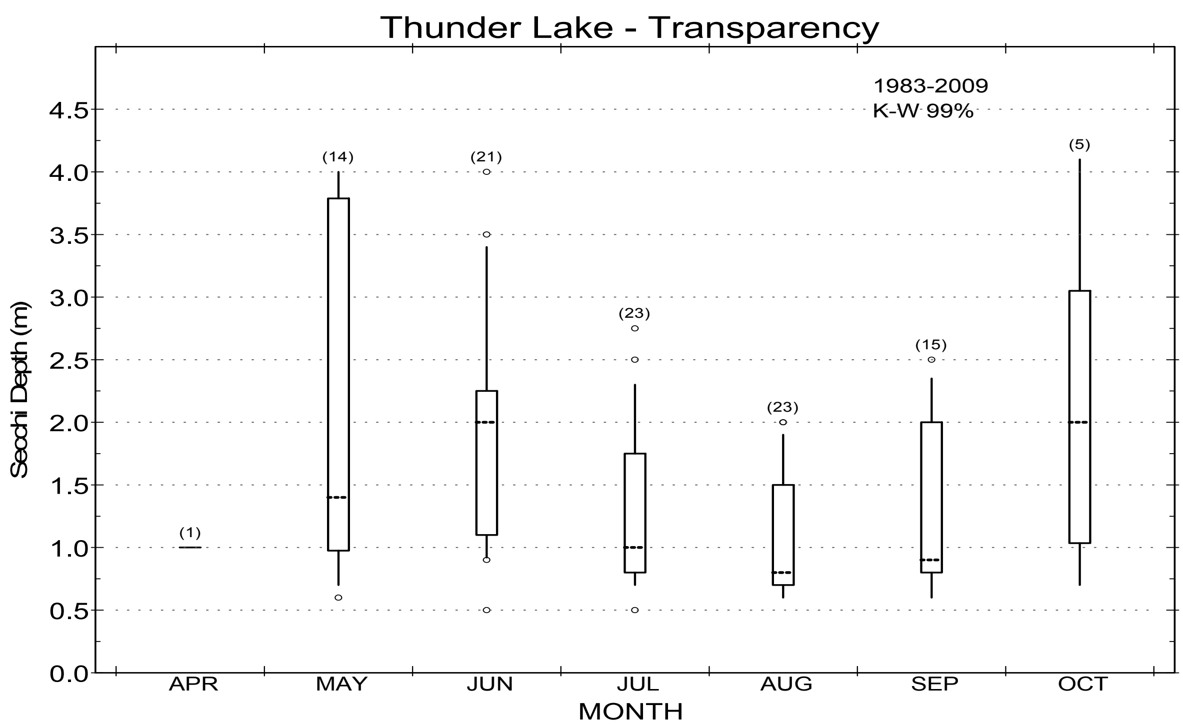
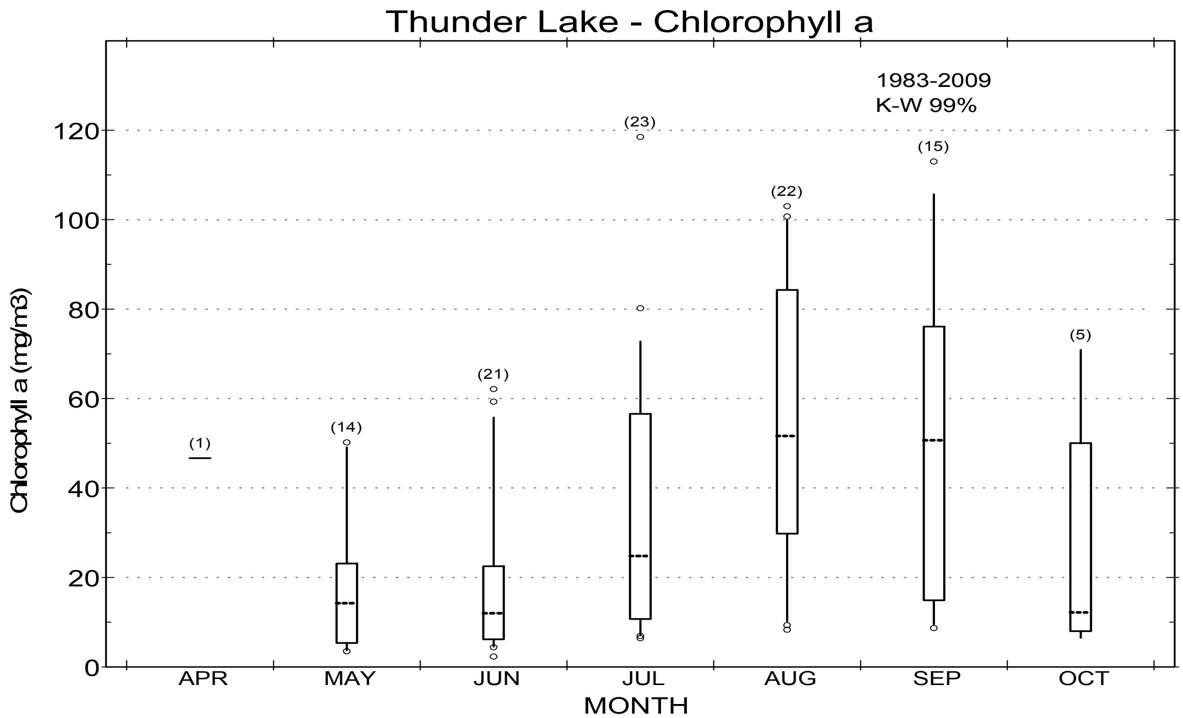


Figure 46 **Thunder Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



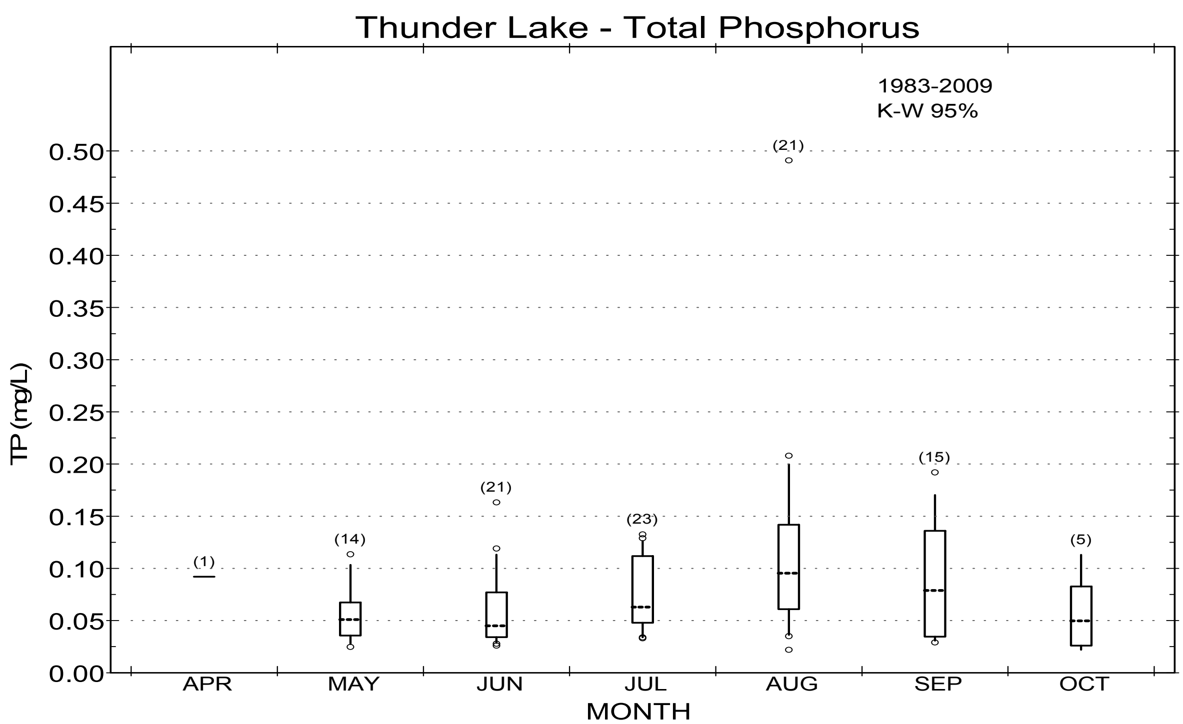
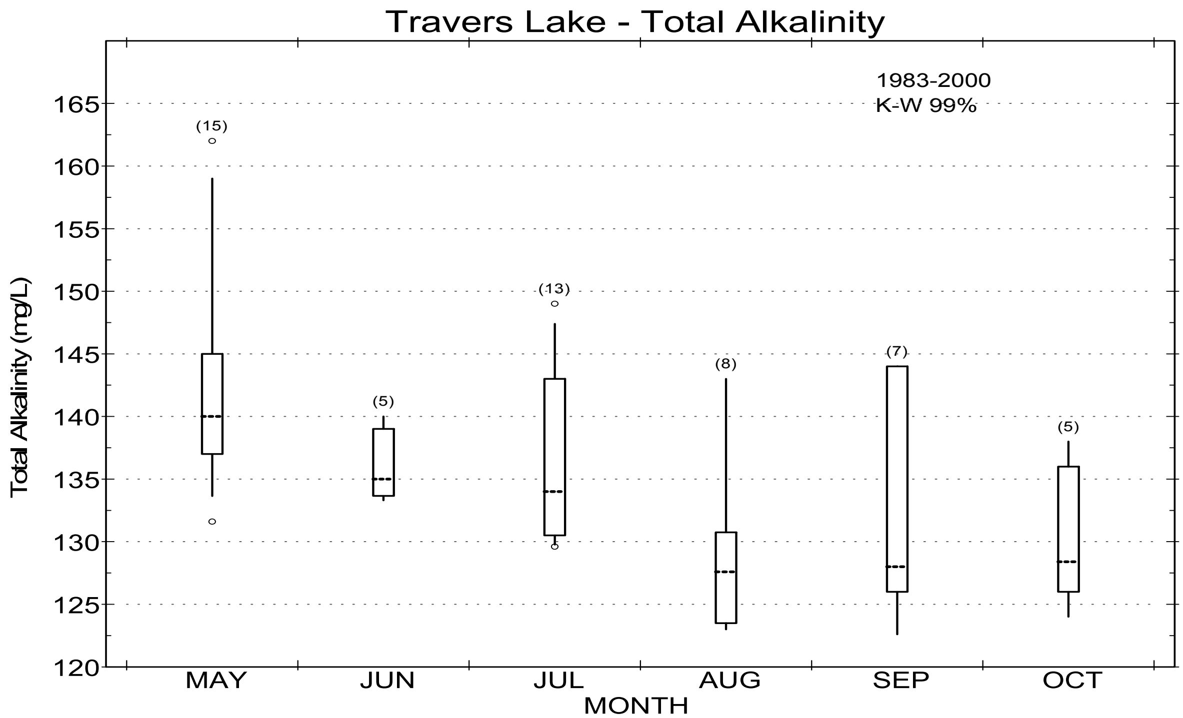


Figure 46 **Thunder Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



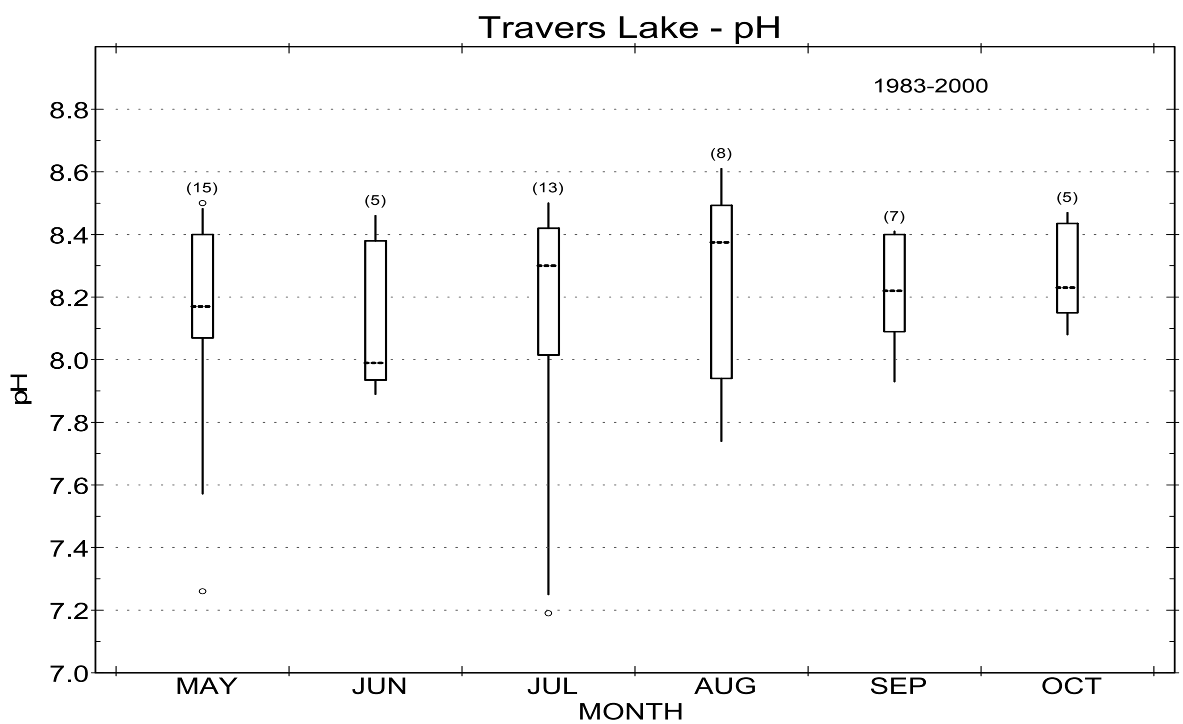
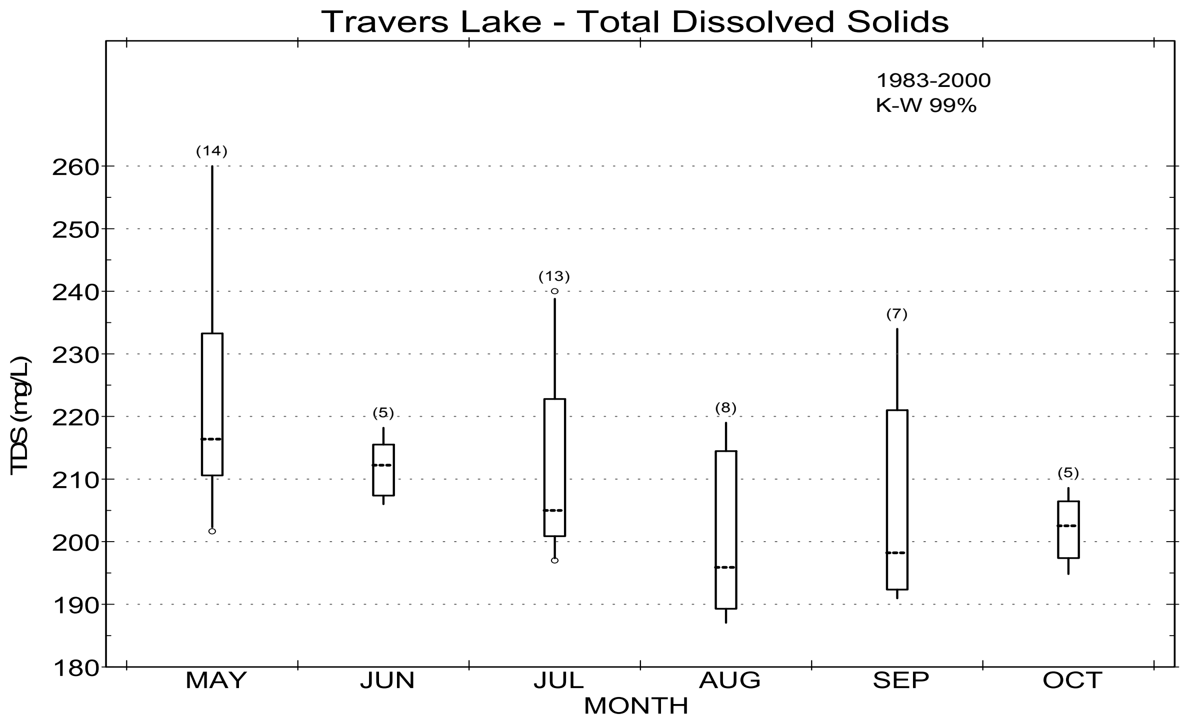


Figure 47 **Travers Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



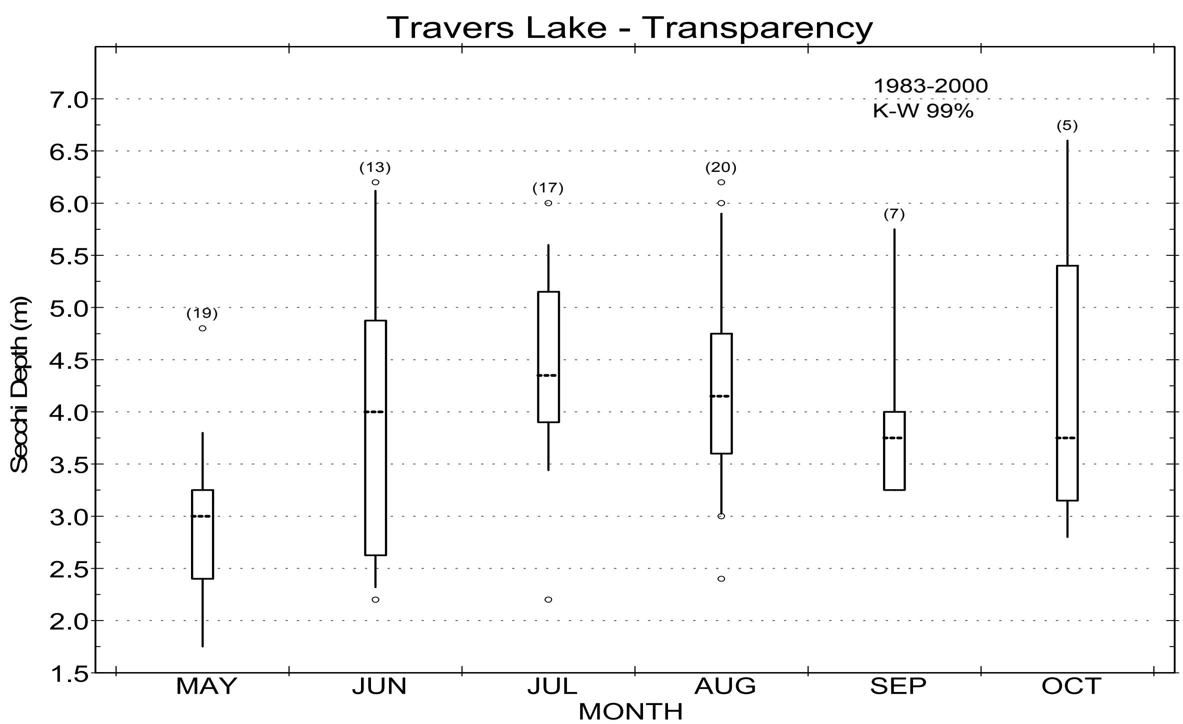
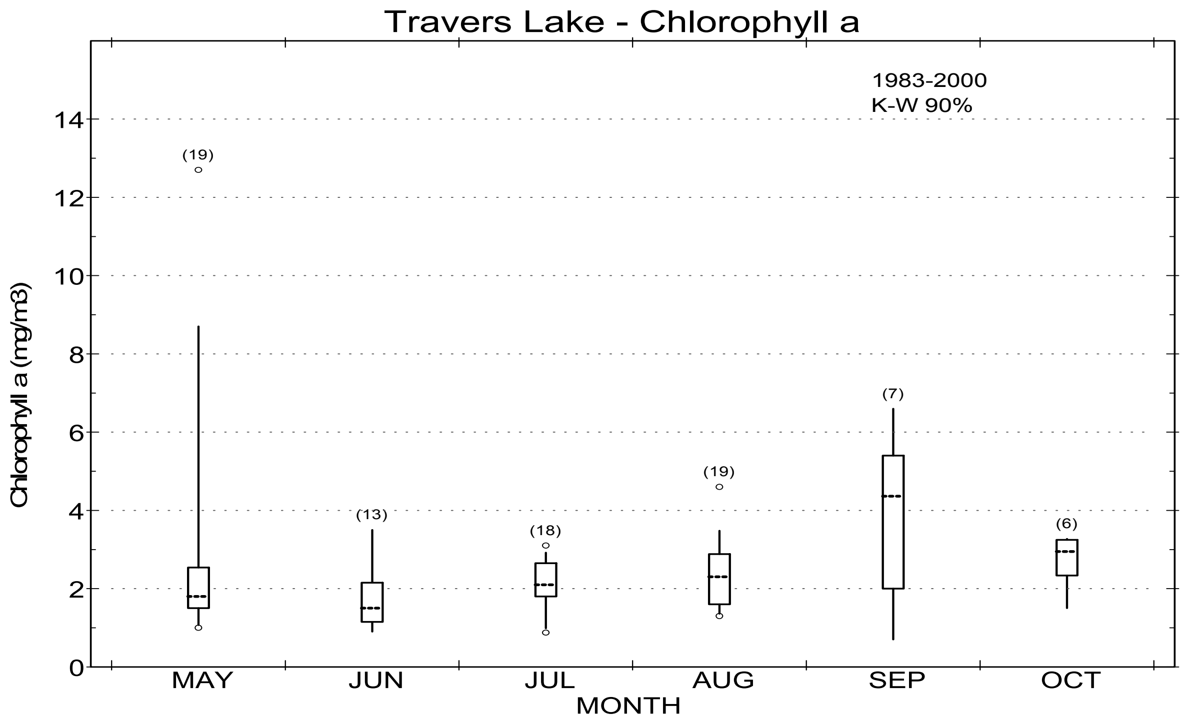


Figure 47 **Travers Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



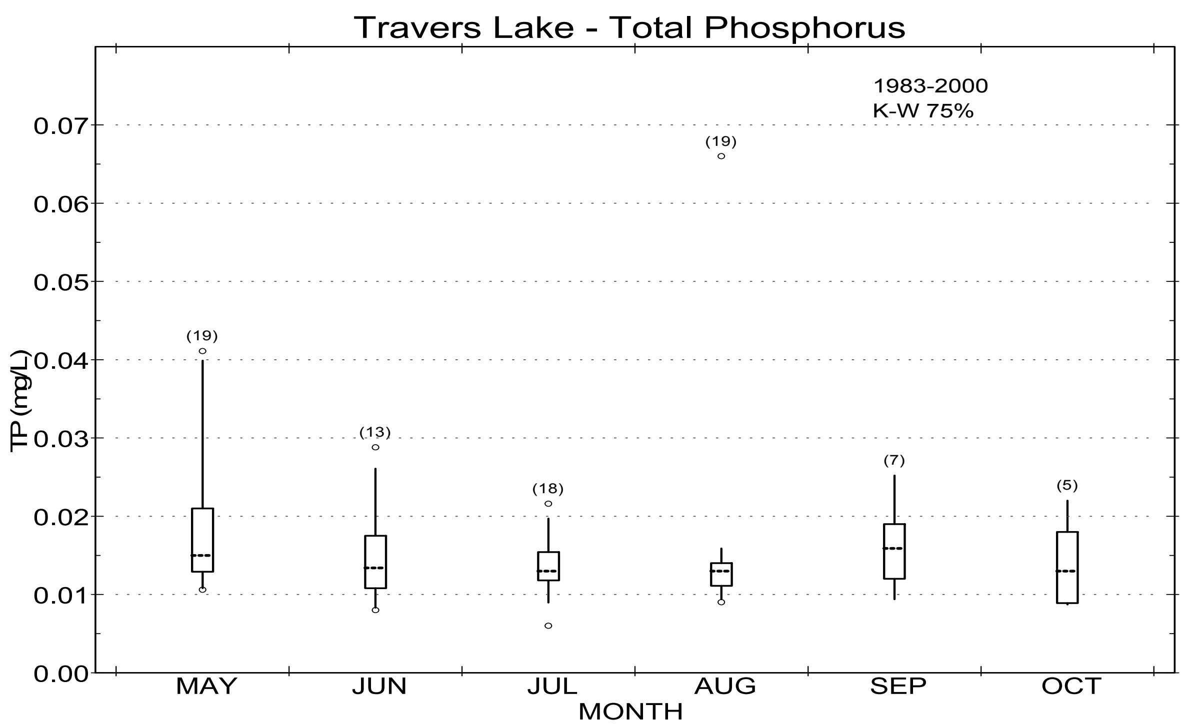
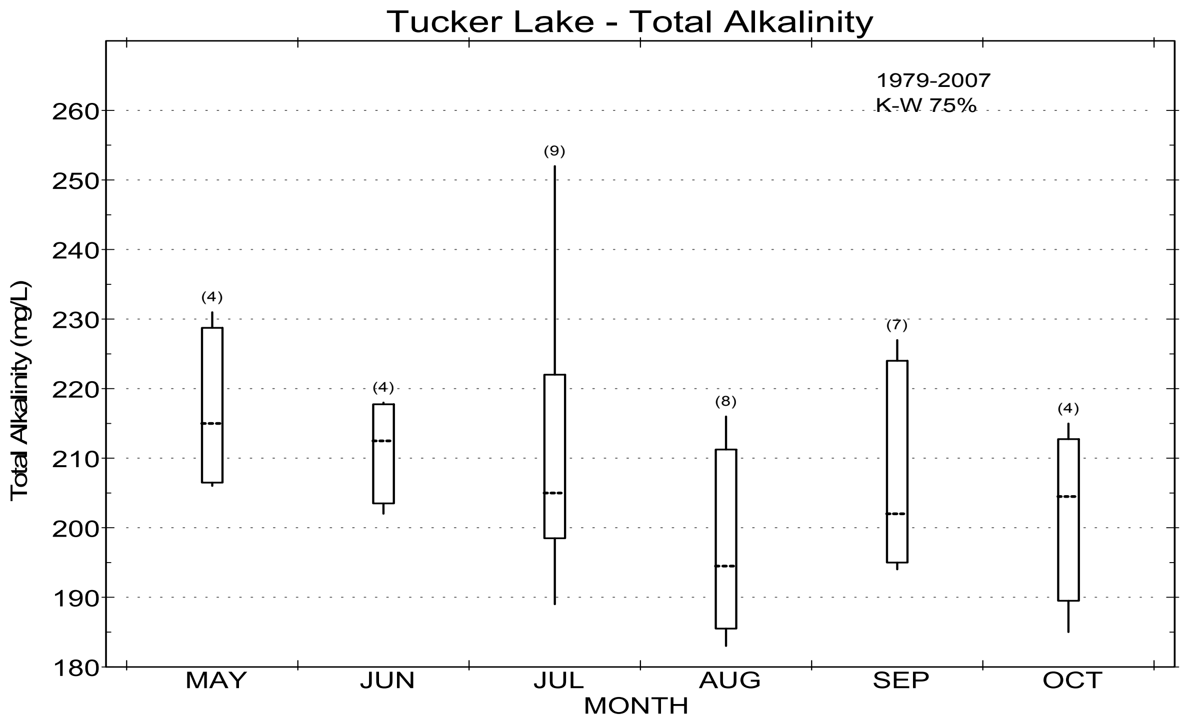


Figure 47 **Travers Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



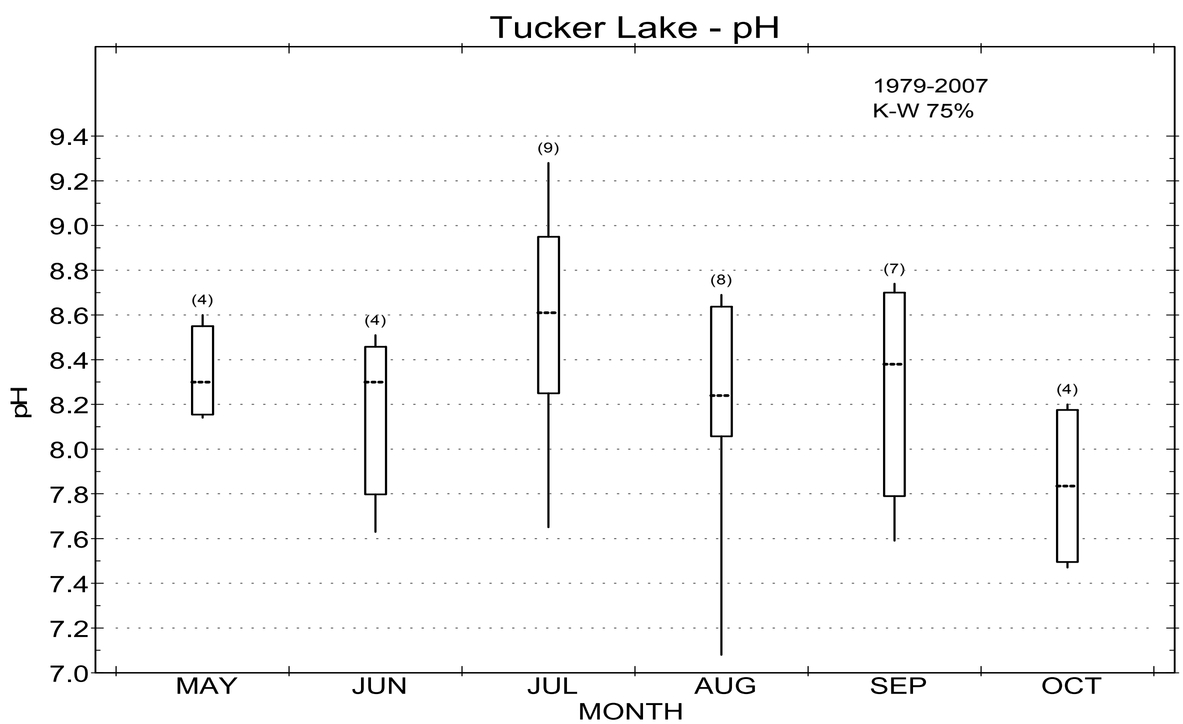
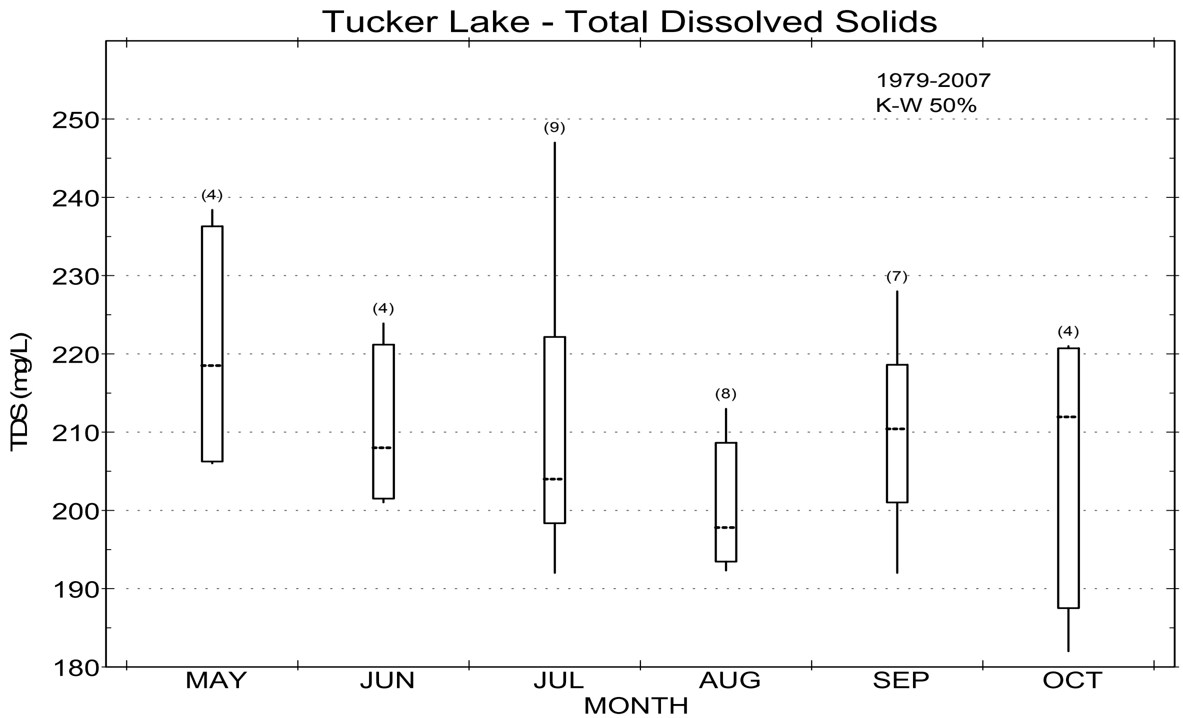


Figure 48 **Tucker Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



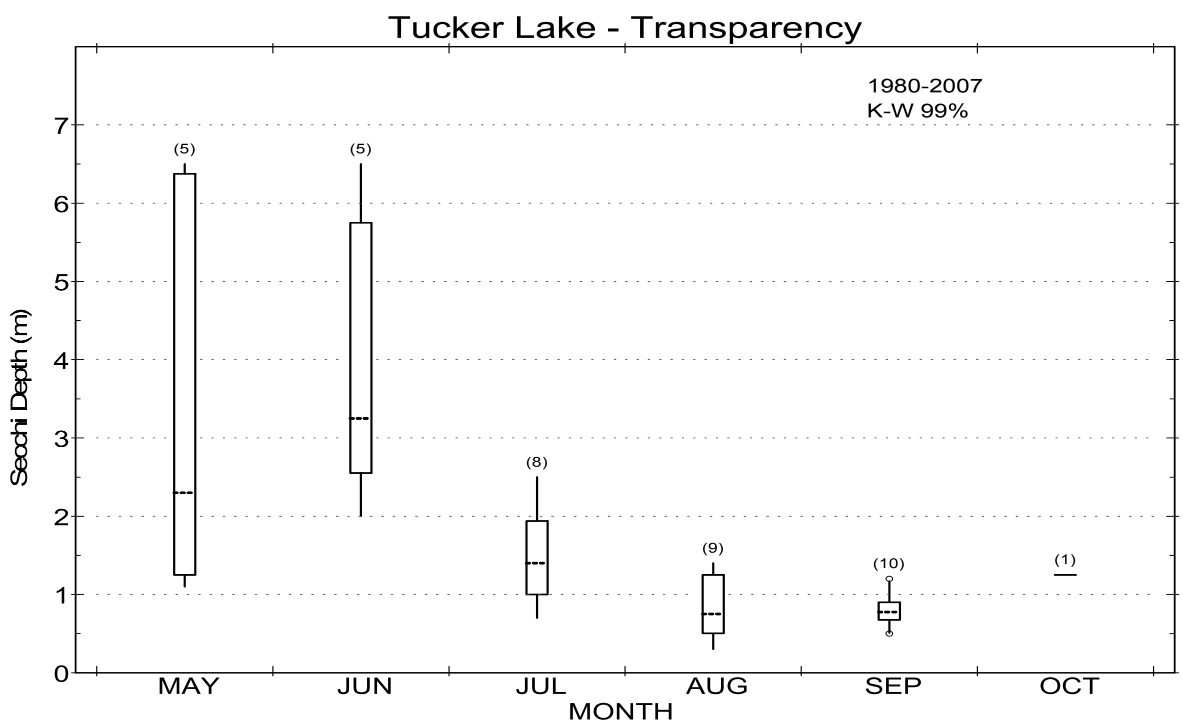
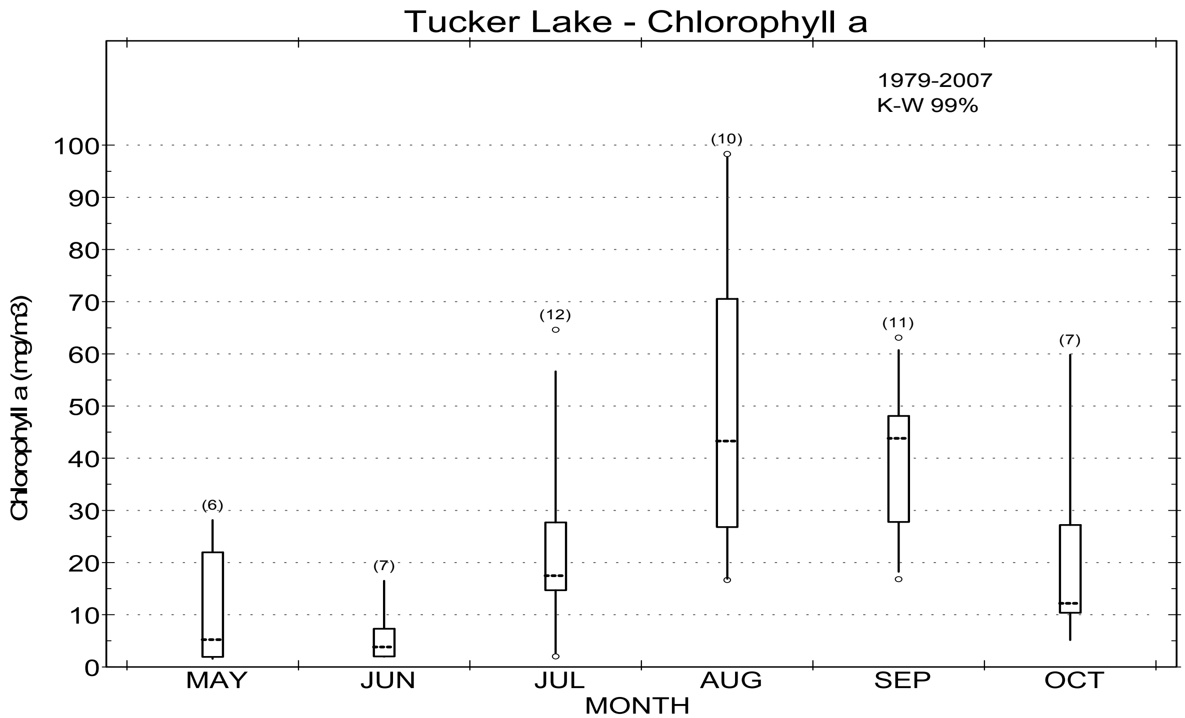


Figure 48 **Tucker Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



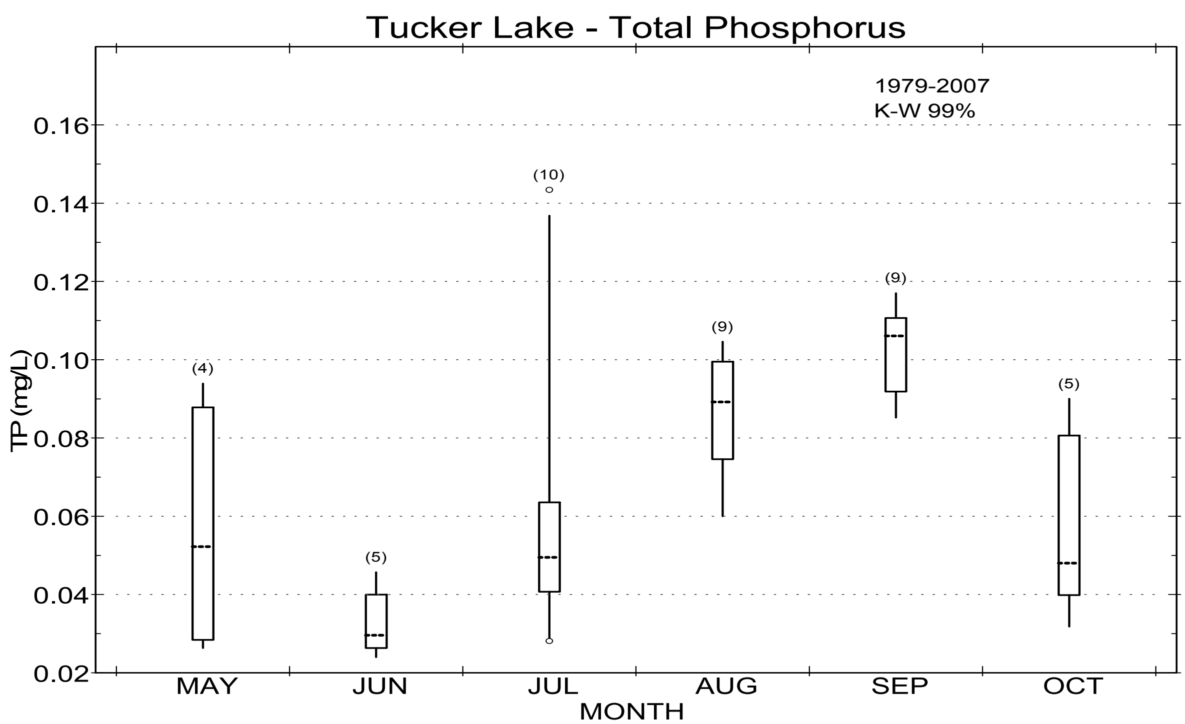
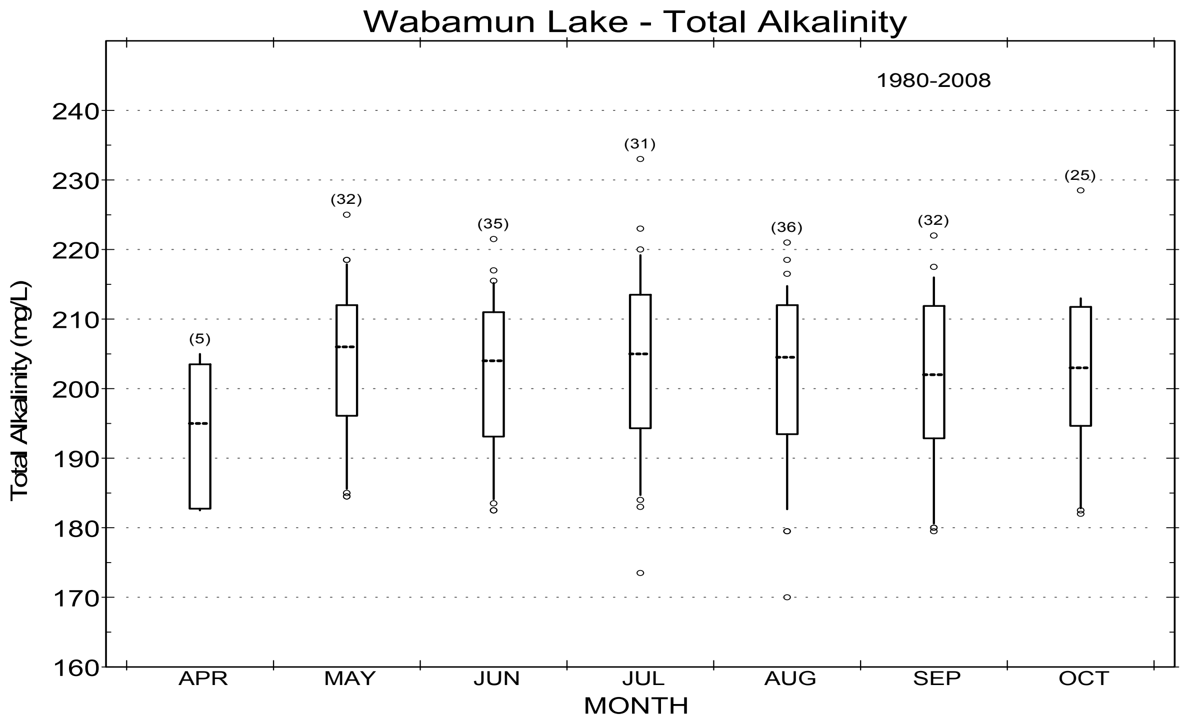


Figure 48 **Tucker Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



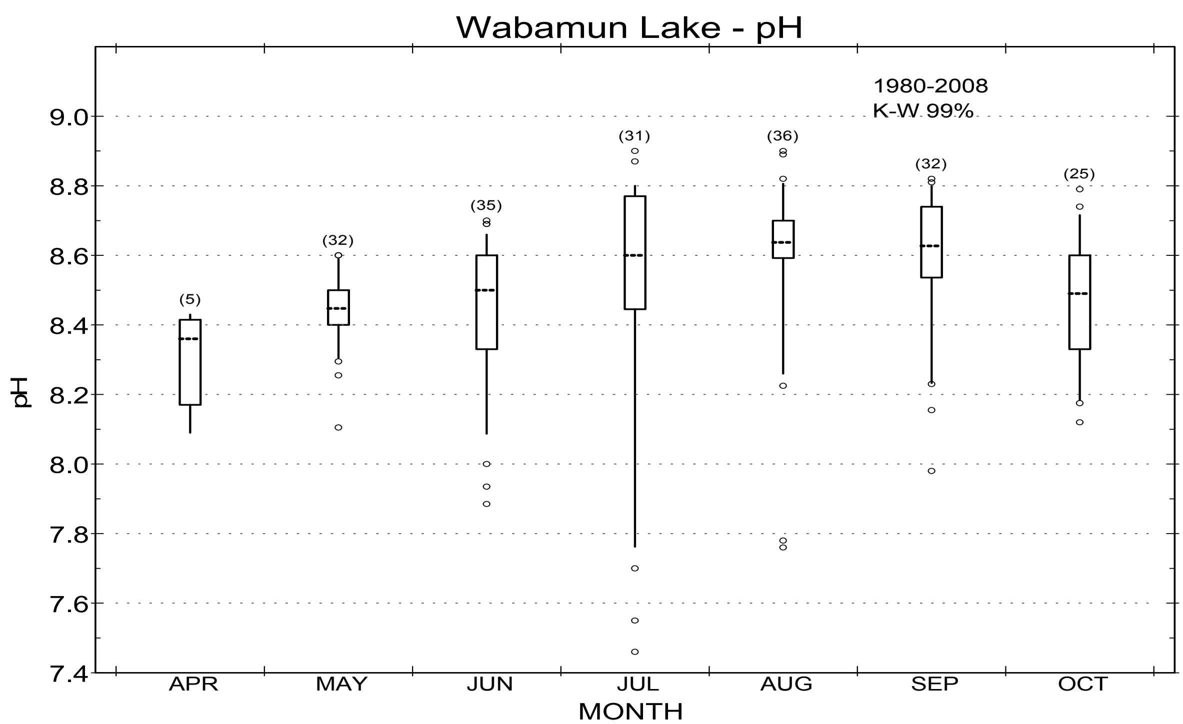
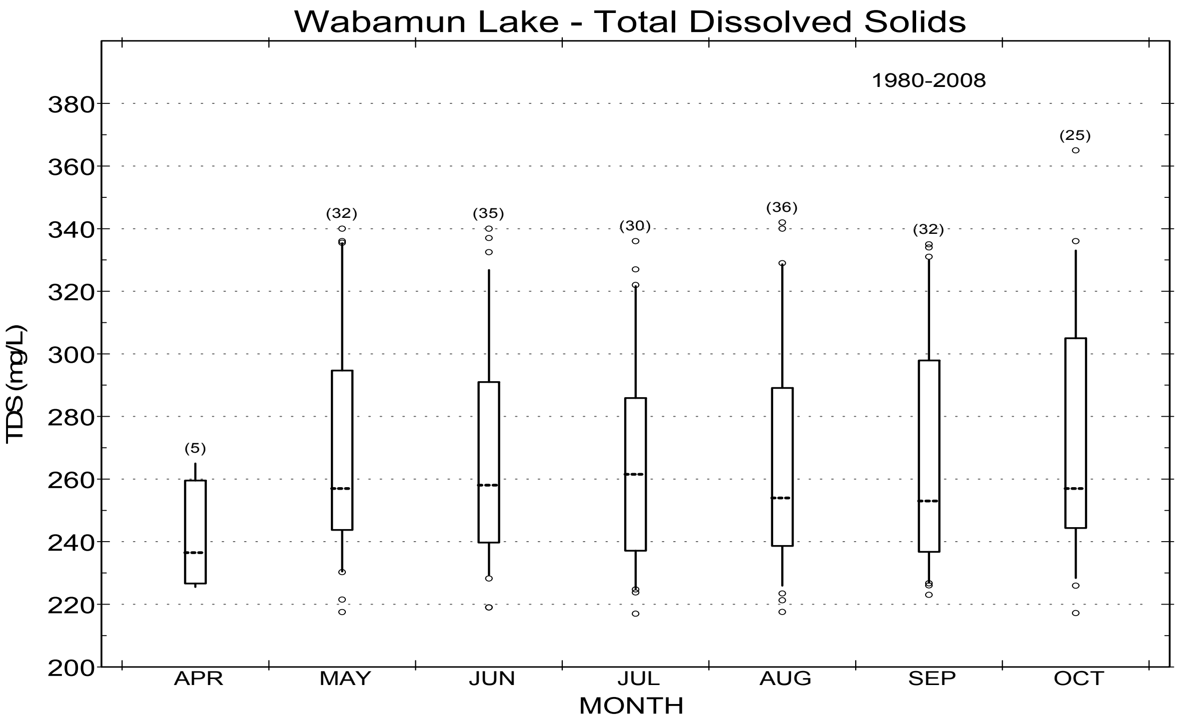


Figure 49a **Wabamun Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



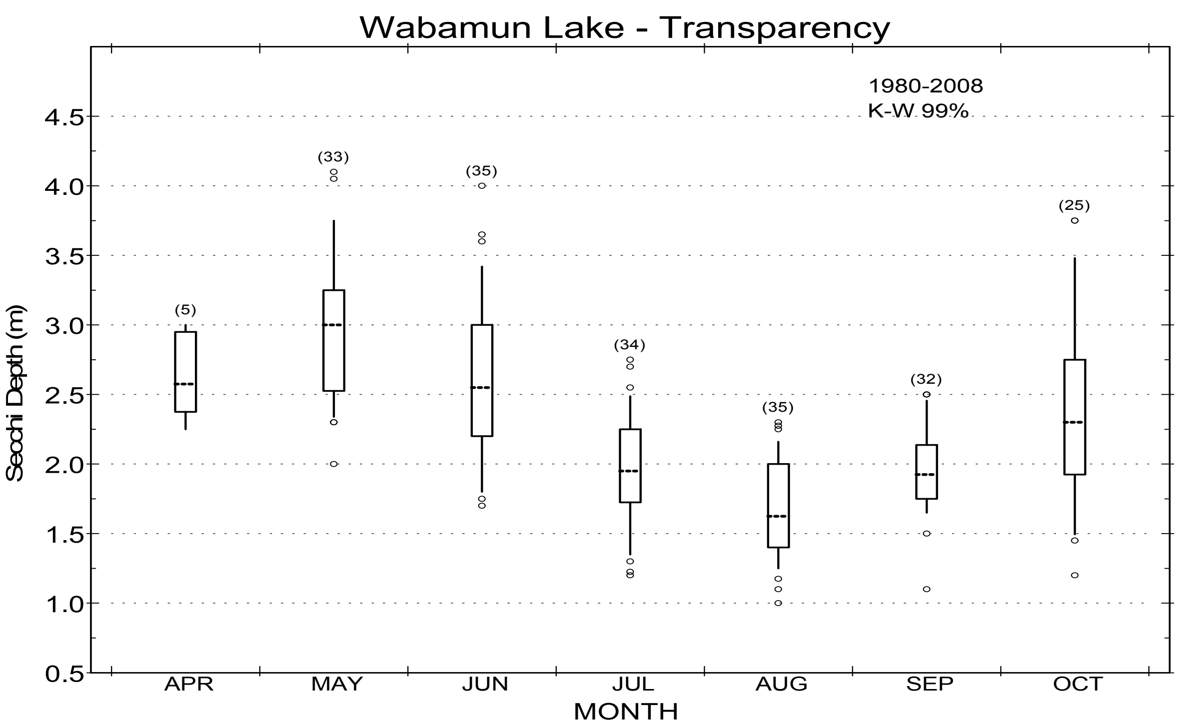
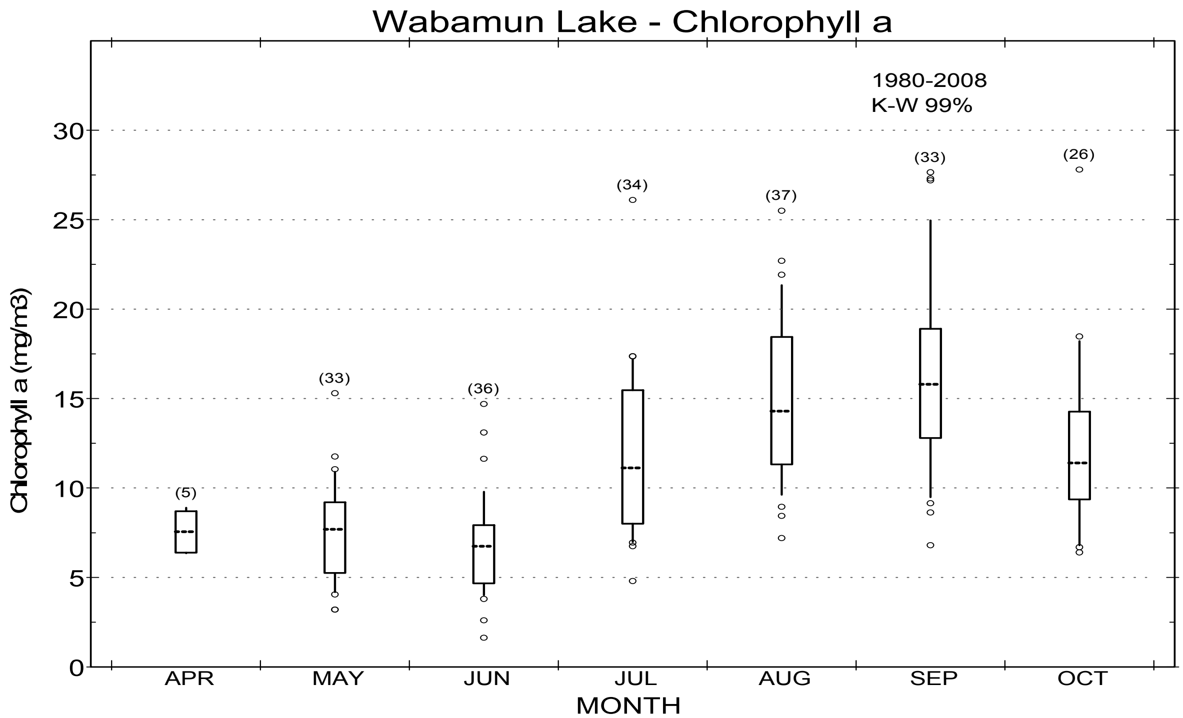


Figure 49a **Wabamun Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



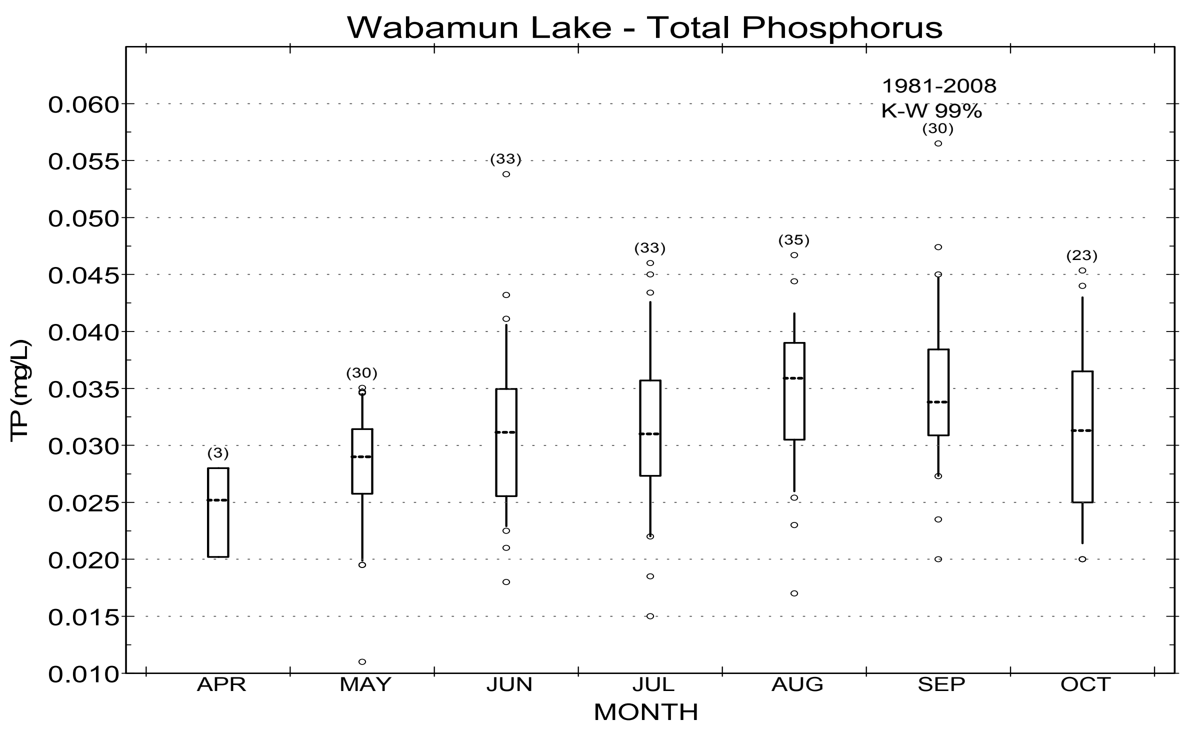
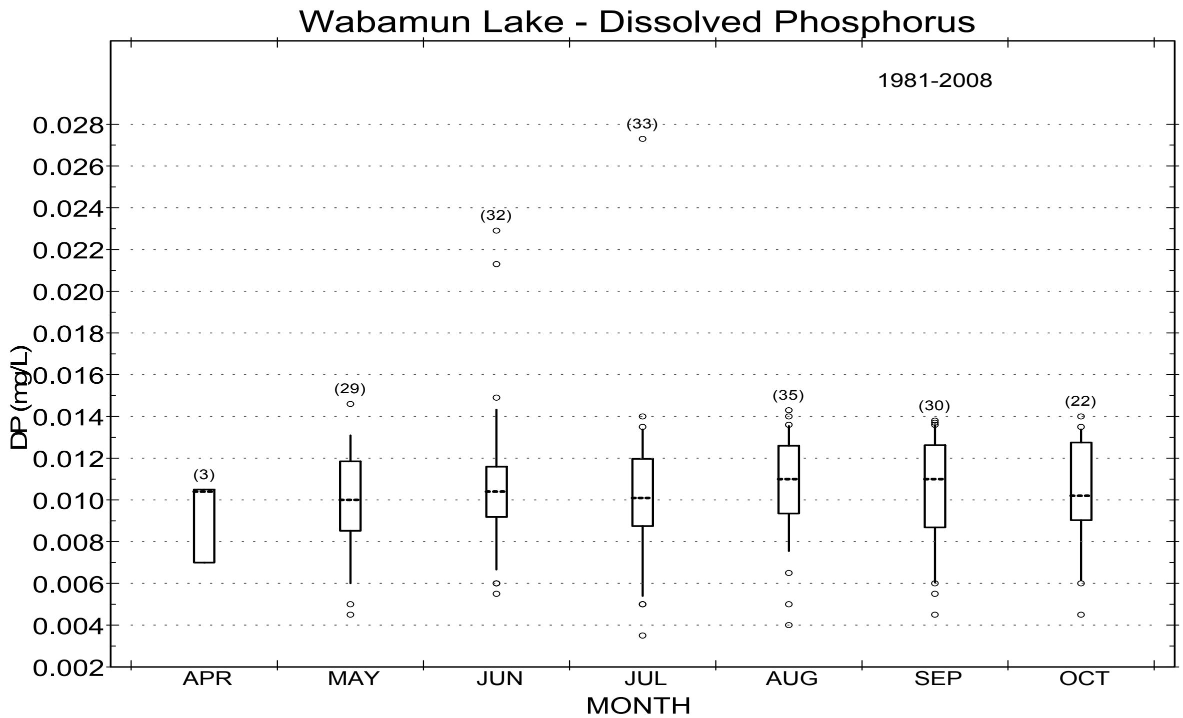


Figure 49a **Wabamun Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)



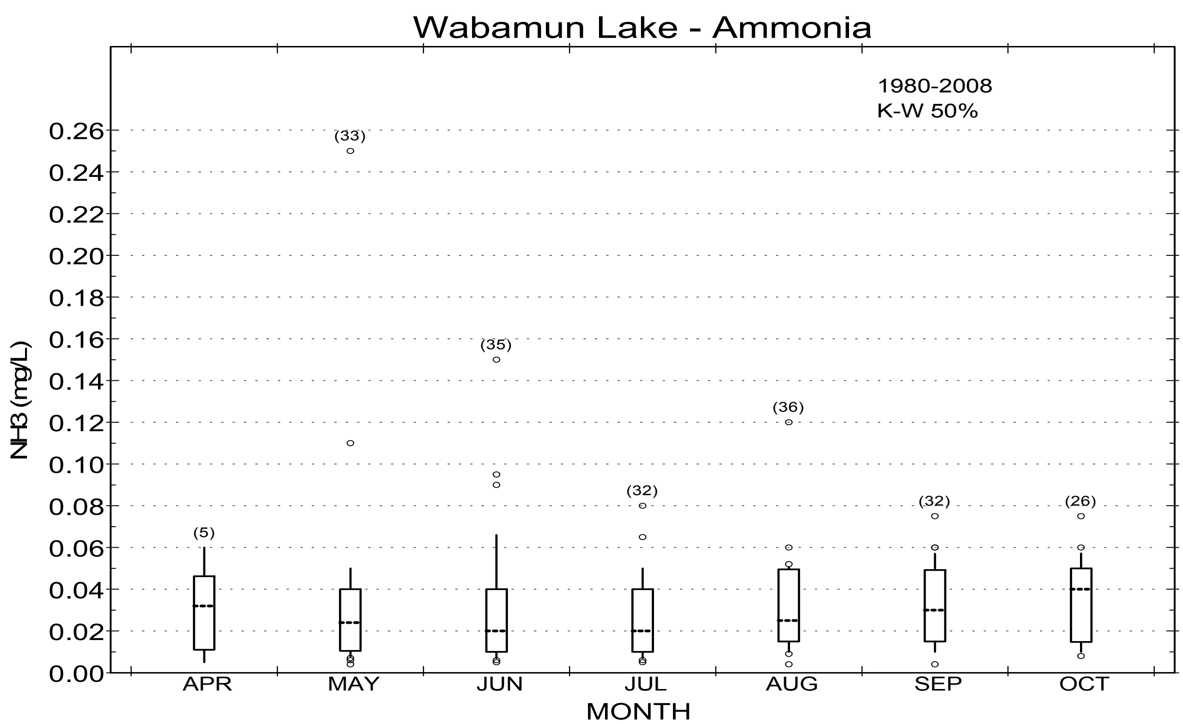
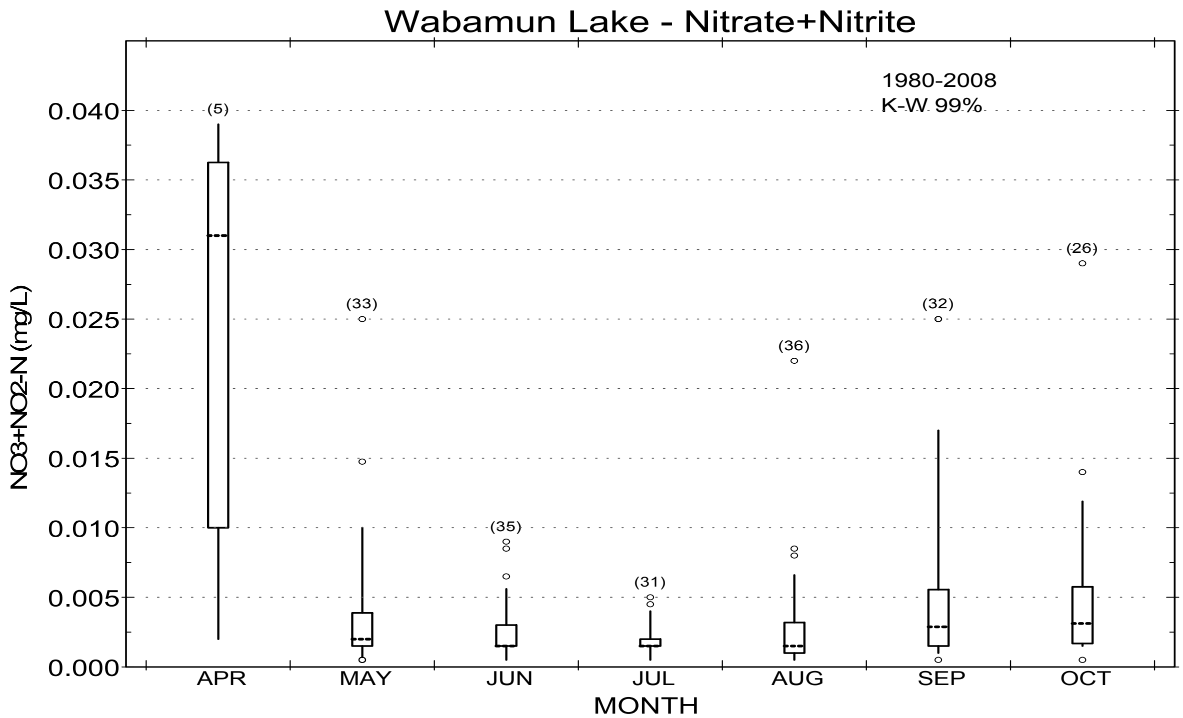


Figure 49b **Wabamun Lake** - Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month



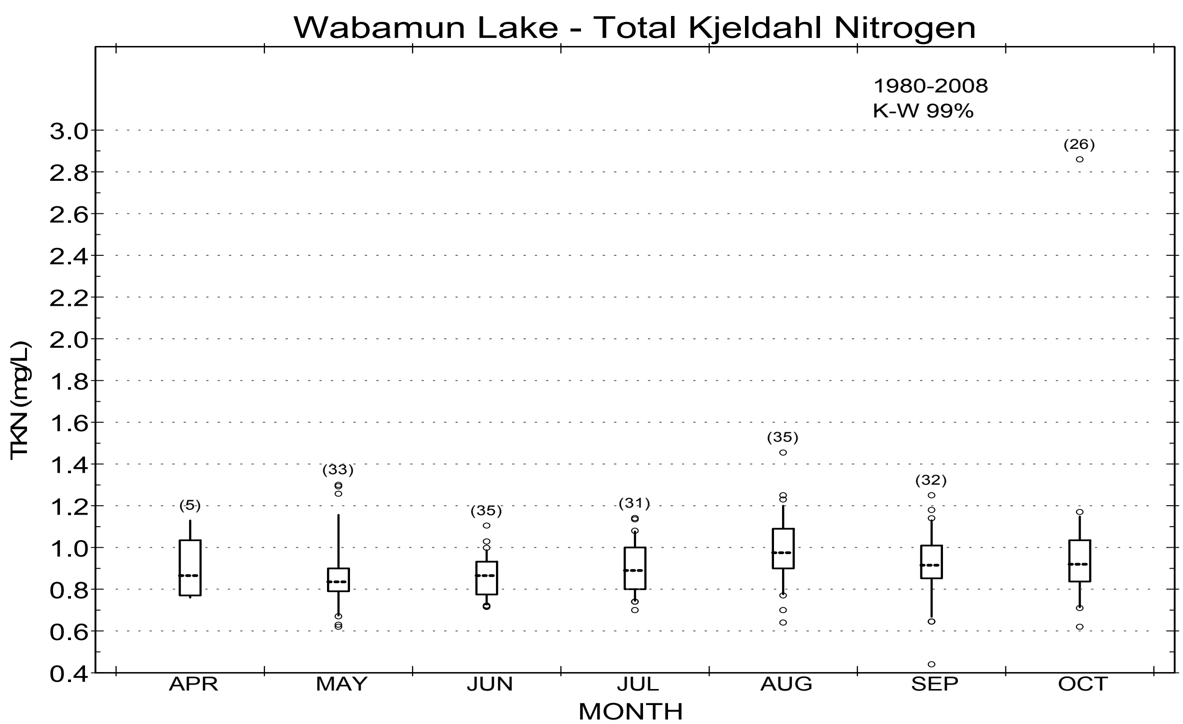
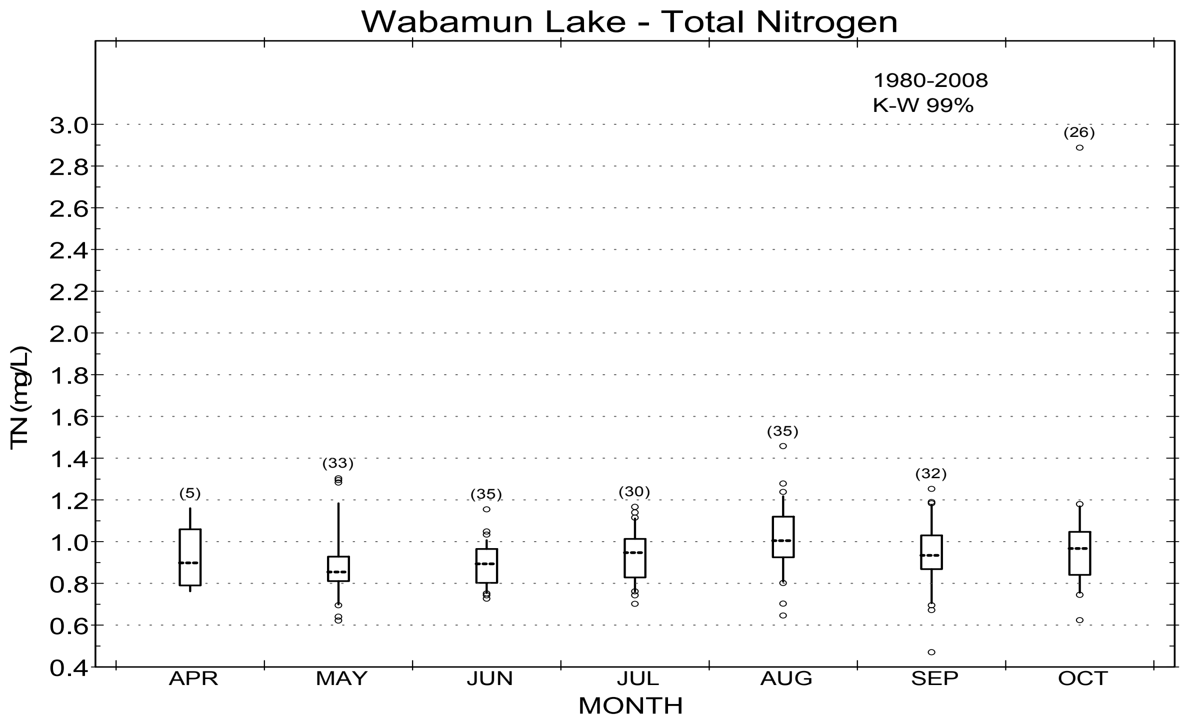


Figure 49b **Wabamun Lake** - Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month. Note that 46% of the nitrate+nitrite-N samples were <MDL and the MDL concentration was used for these data (continued)



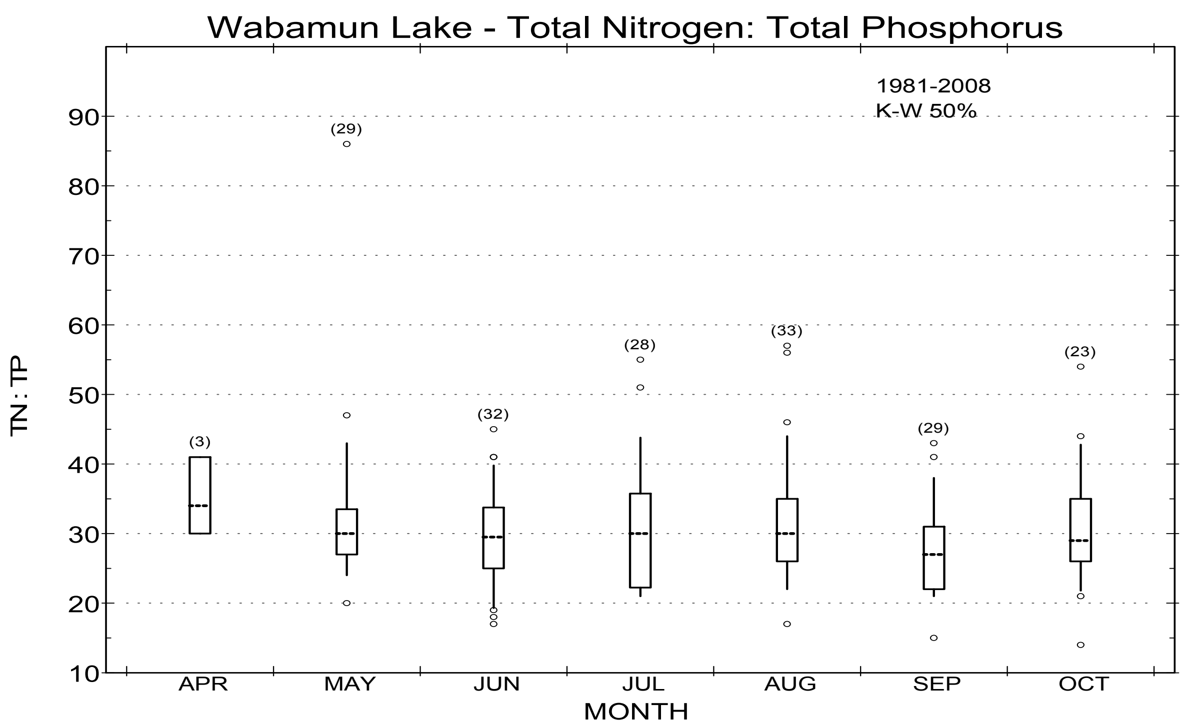
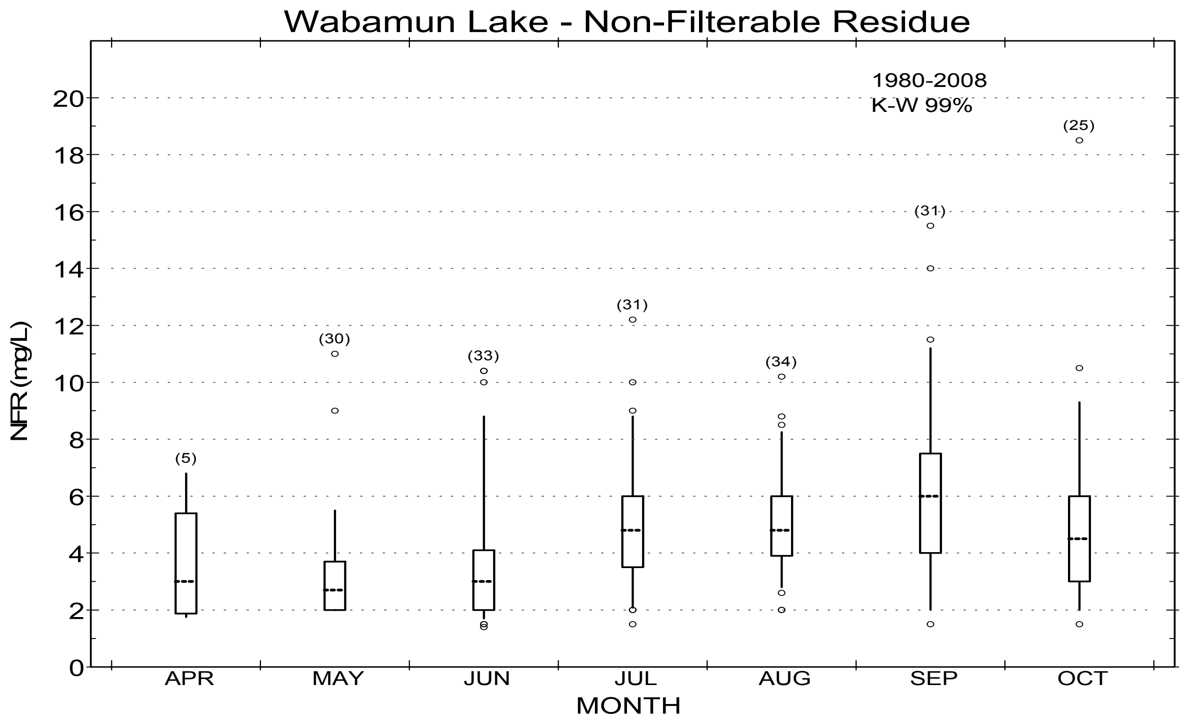


Figure 49b **Wabamun Lake** - Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)



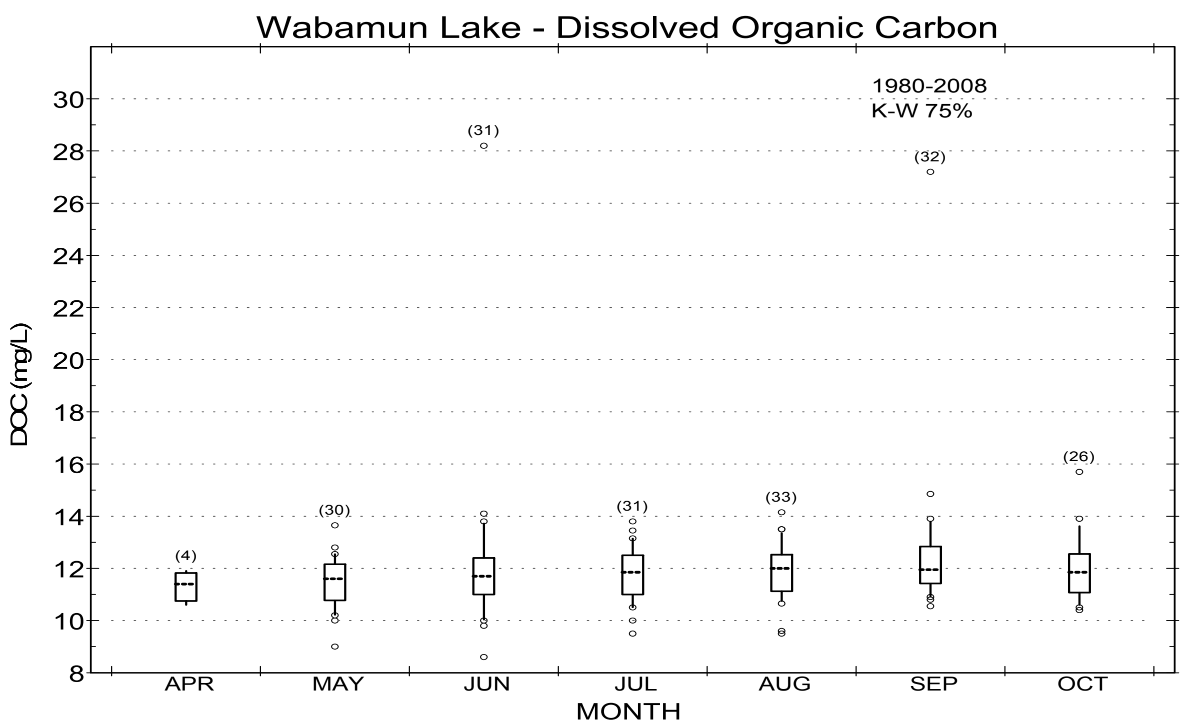


Figure 49b **Wabamun Lake -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (continued)

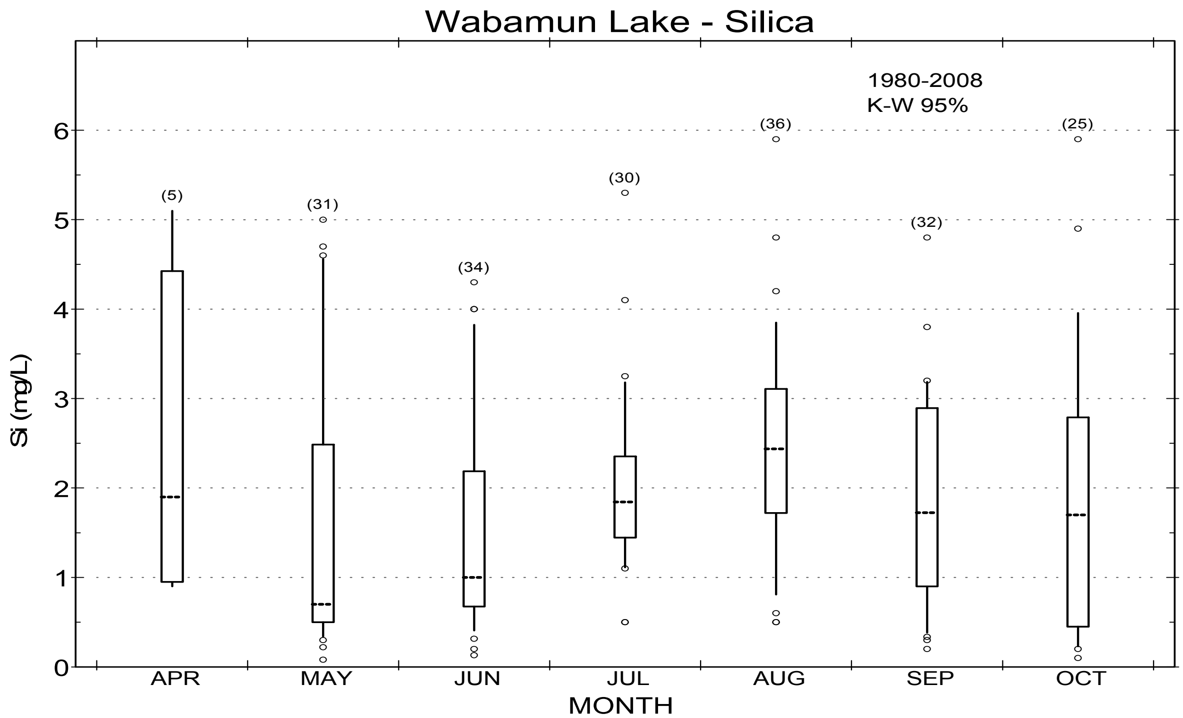
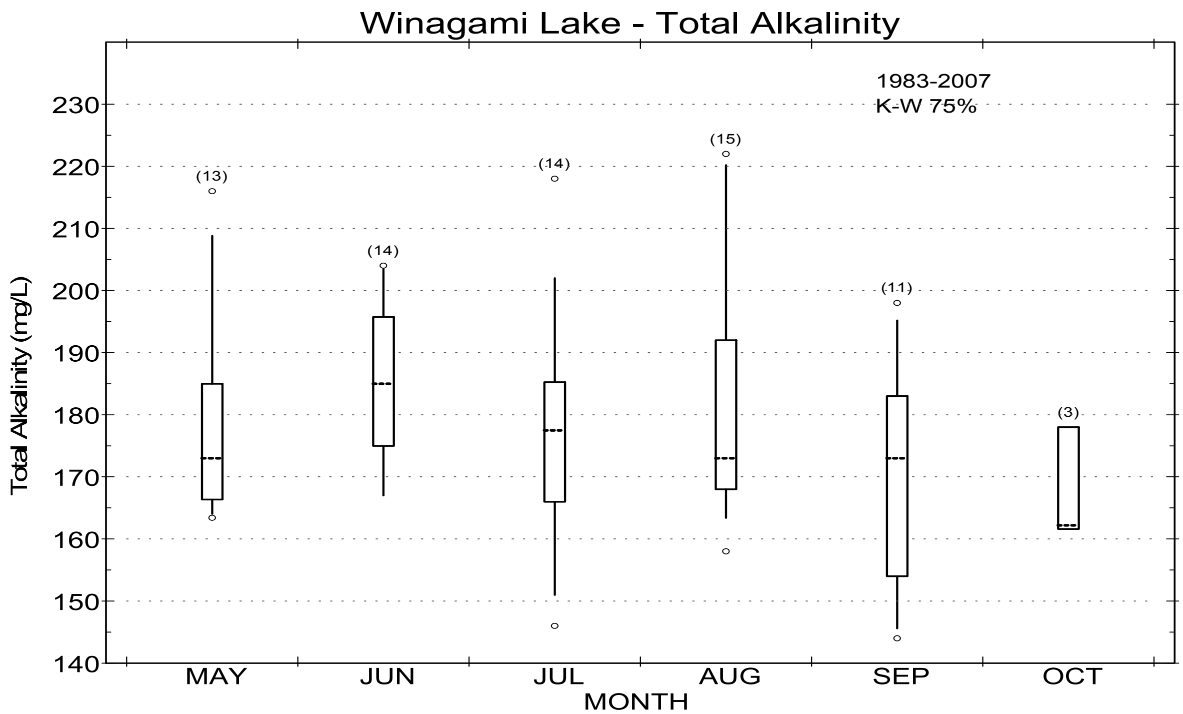


Figure 49b **Wabamun Lake -** Box plots of dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels per month (concluded)



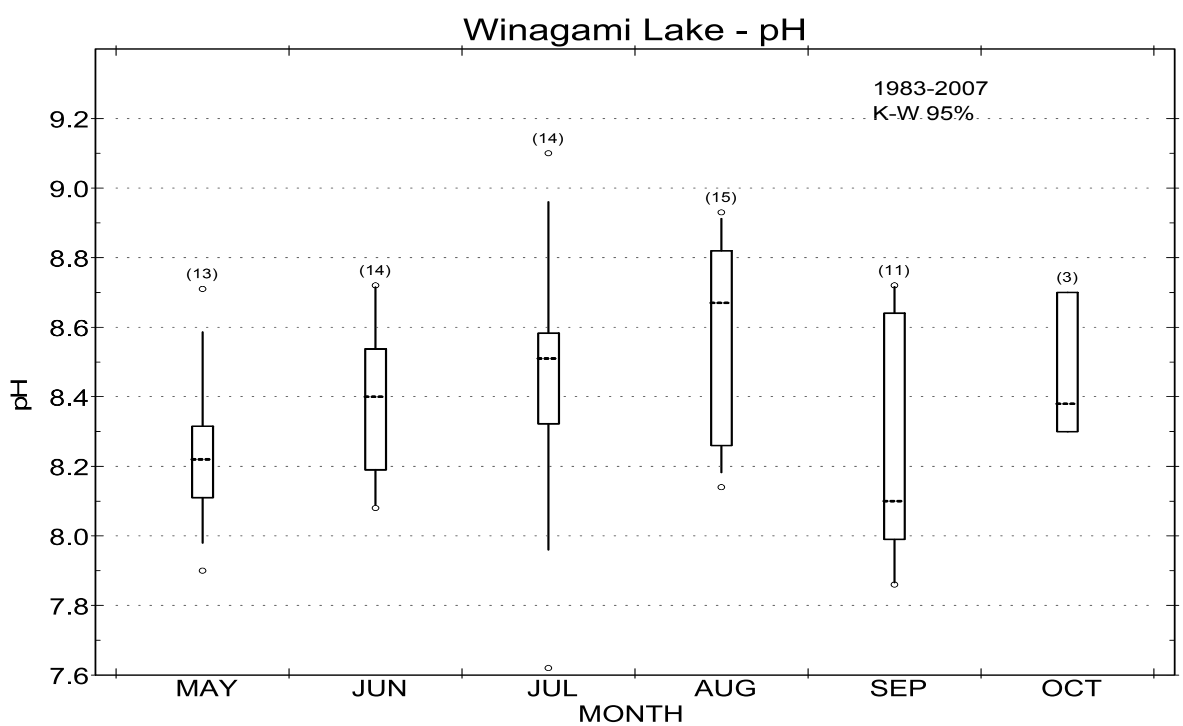
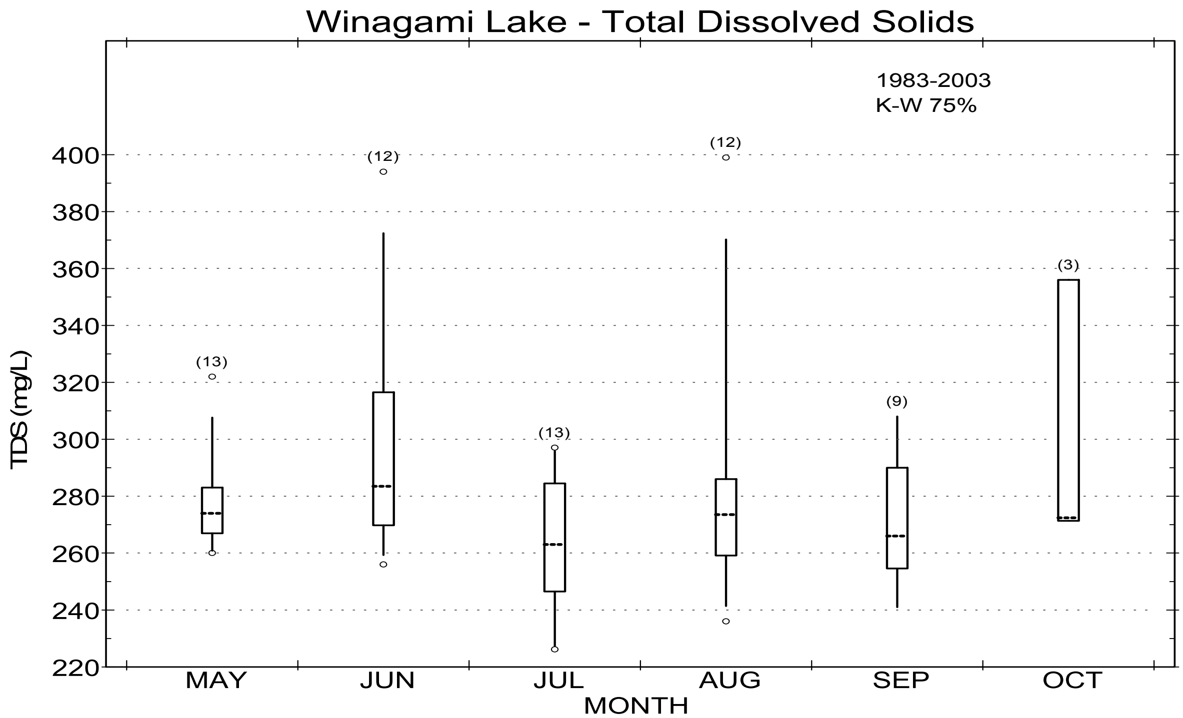


Figure 50 **Winagami Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month



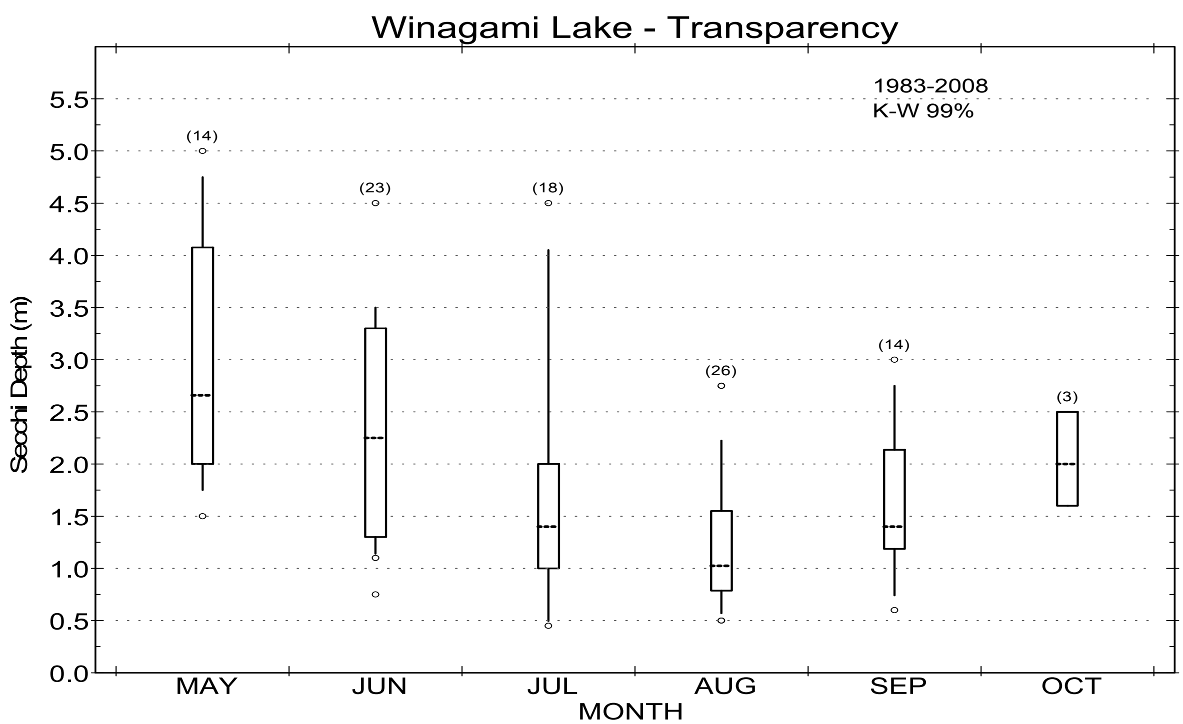
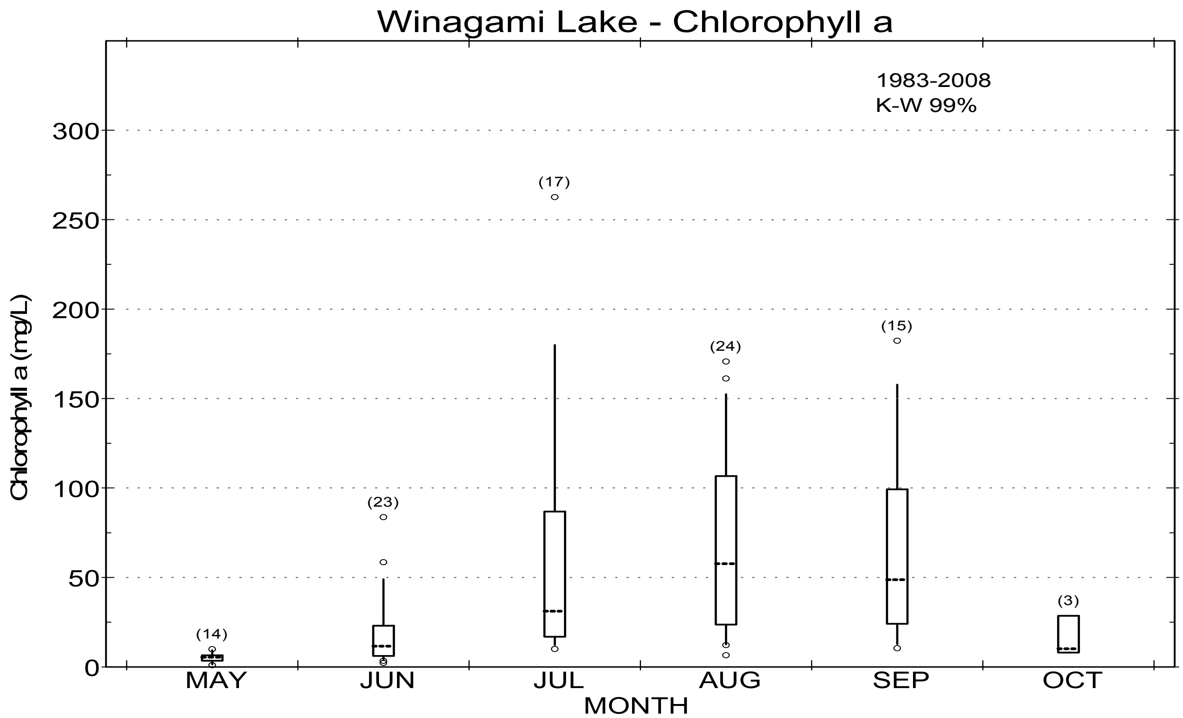


Figure 50 **Winagami Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (continued)



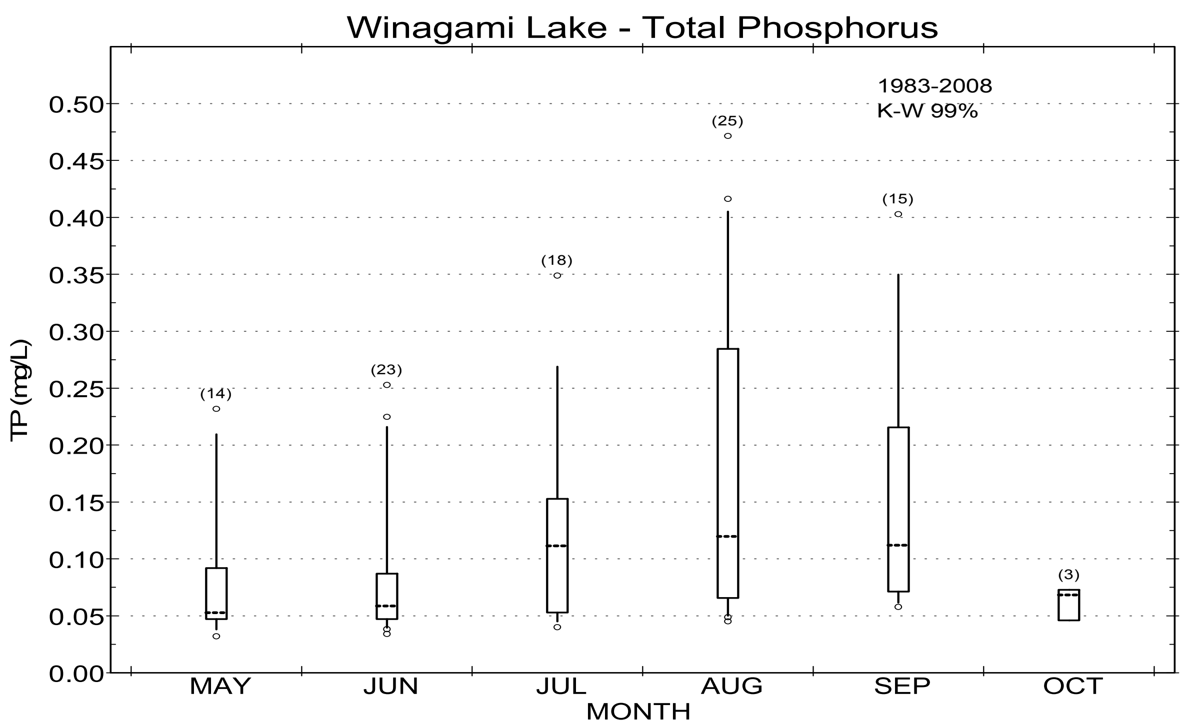
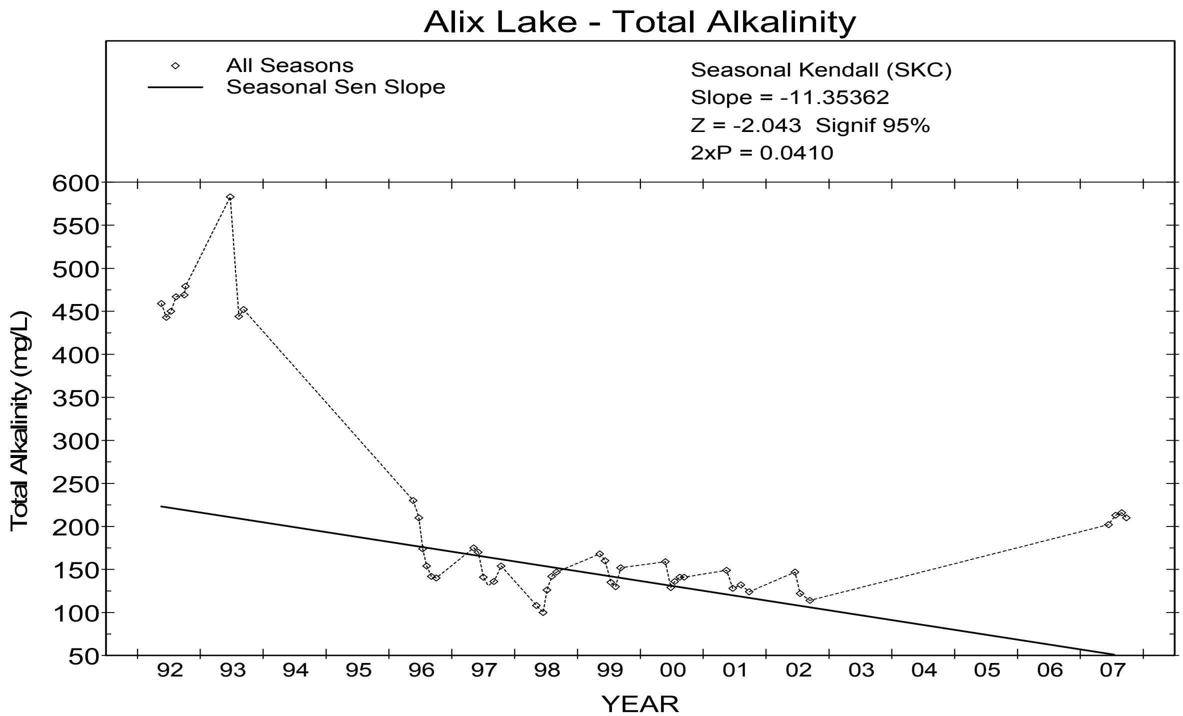


Figure 50 **Winagami Lake -** Box plots of total alkalinity, pH, total dissolved solids, transparency, chlorophyll-*a* and total phosphorus levels per month (concluded)

D. LONG-TERM TRENDS IN WATER QUALITY

This section includes the time series graphs and trend results (seasonal Kendall or Mann-Kendall test) for the water quality variables in the 43 lake basins. Lakes are listed in alphabetical order. Each graph shows the data analysed (open circles), trend line, Sen slope, test statistic (Z) and two-tailed probability value (2XP). The hatched line represents all samples before they were combined into monthly data (seasonal Kendall test) or annual medians (Mann-Kendall test). For seasonal Kendall results, the test is corrected for autocorrelation (SKC) or unadjusted (SK). See Section 2.3 for more detail.



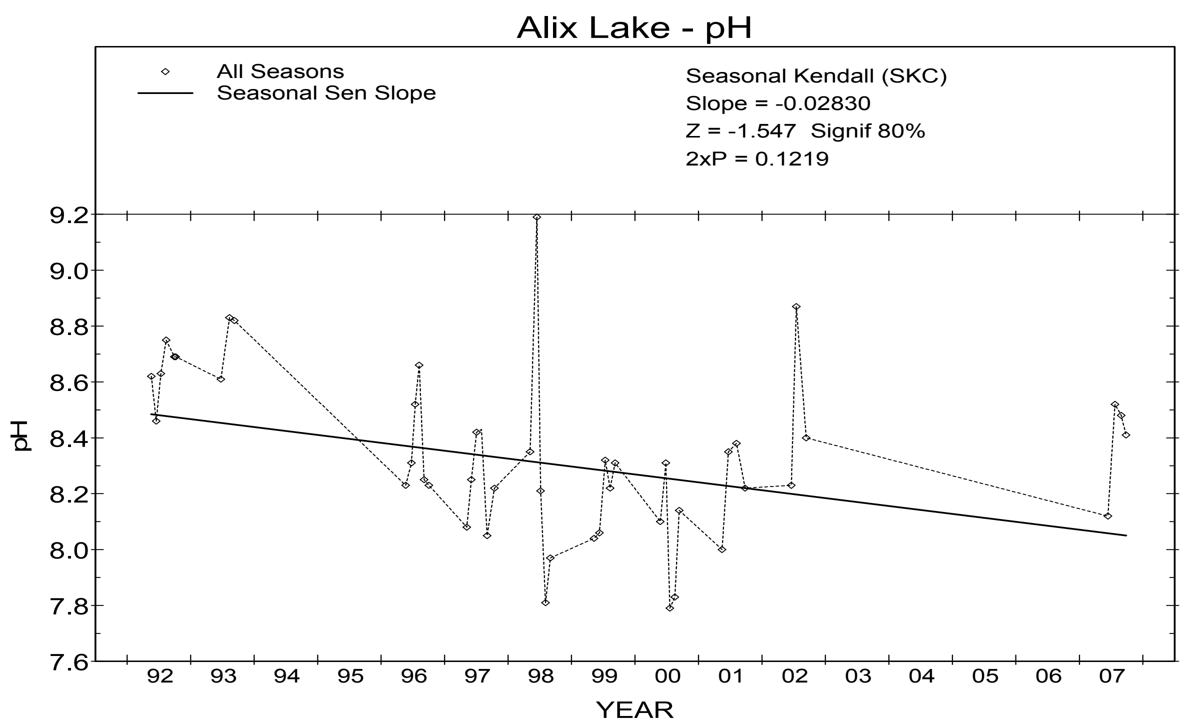
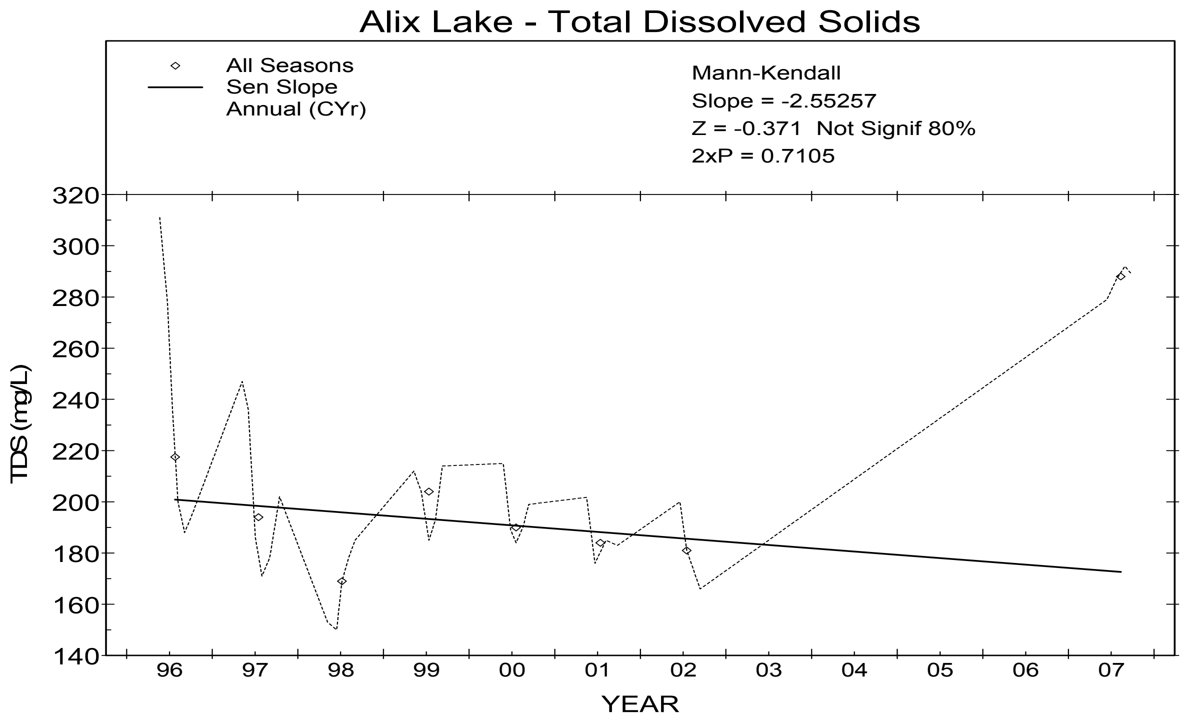


Figure 51 **Alix Lake –** Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



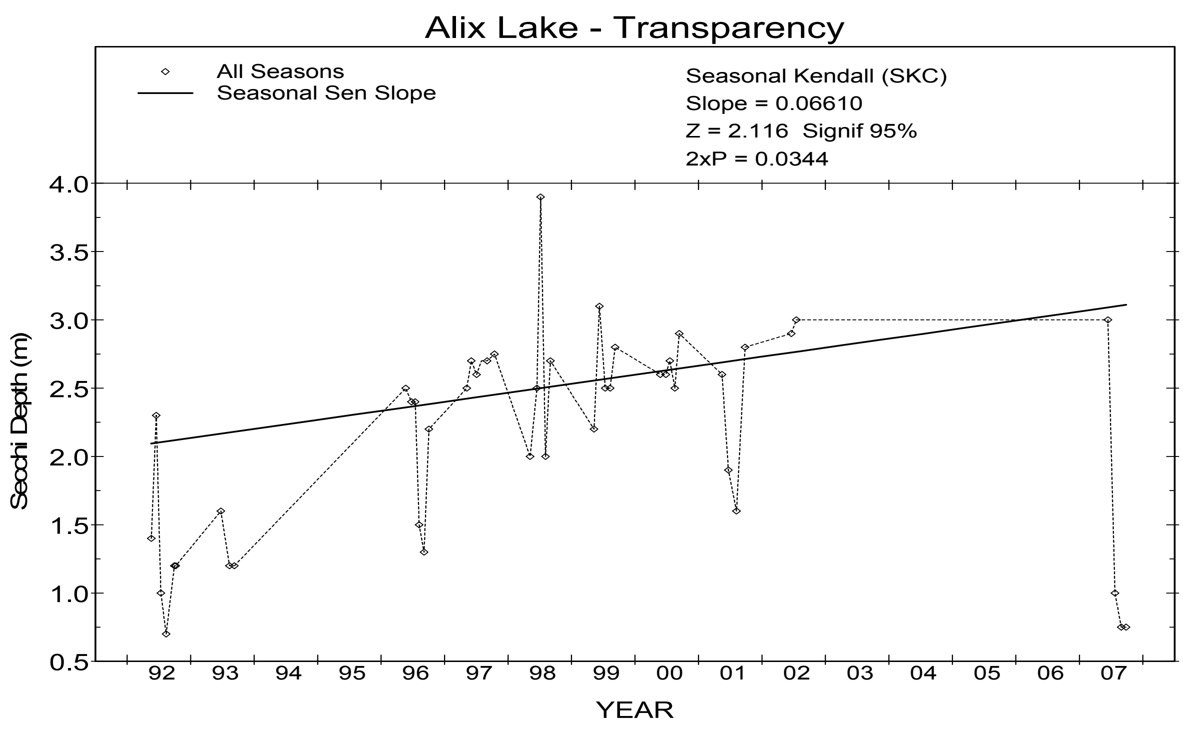
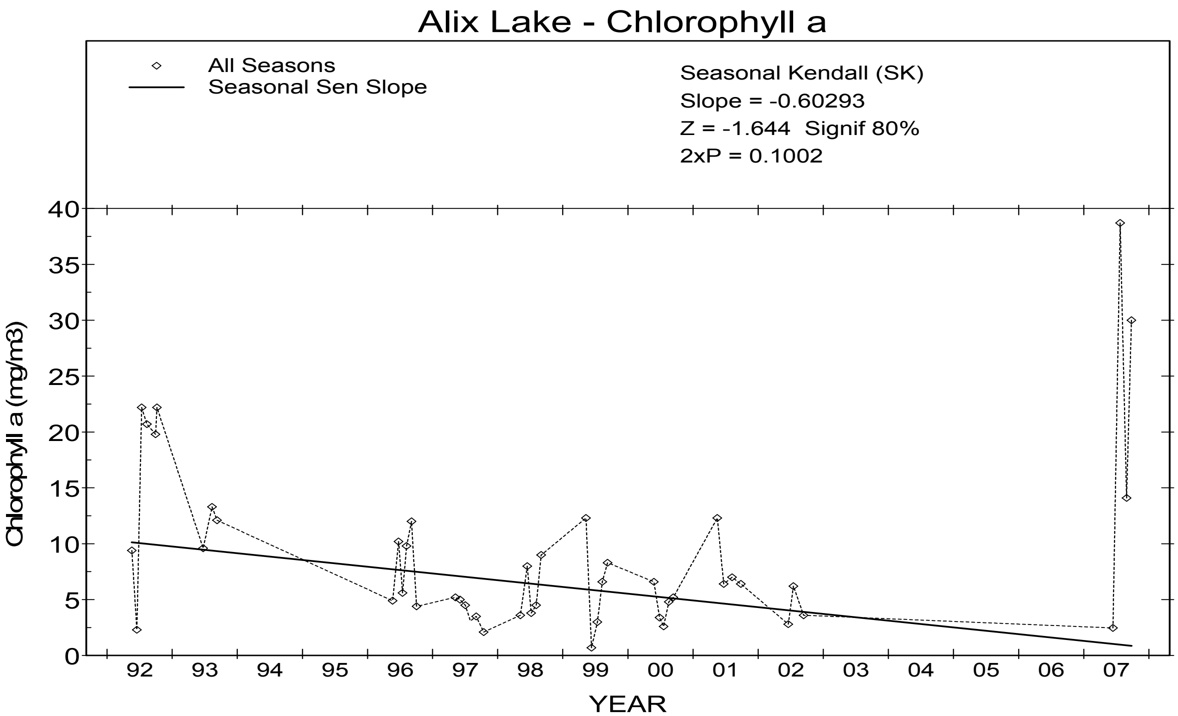


Figure 51 **Alix Lake –** Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



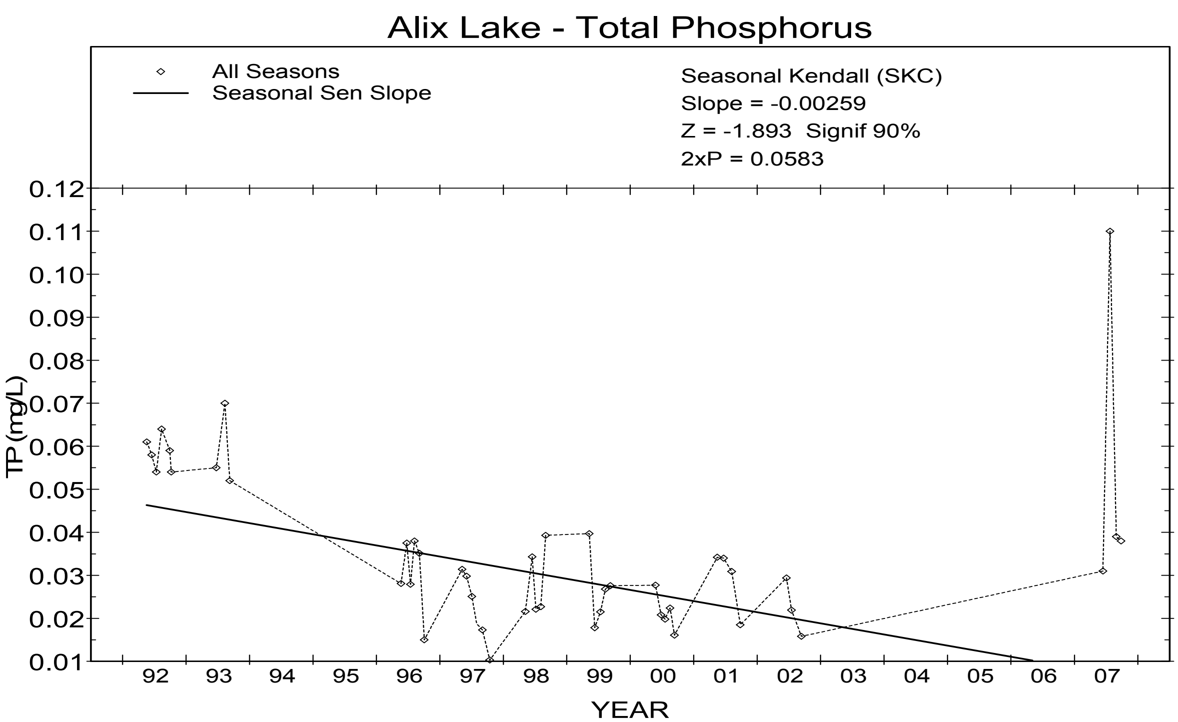
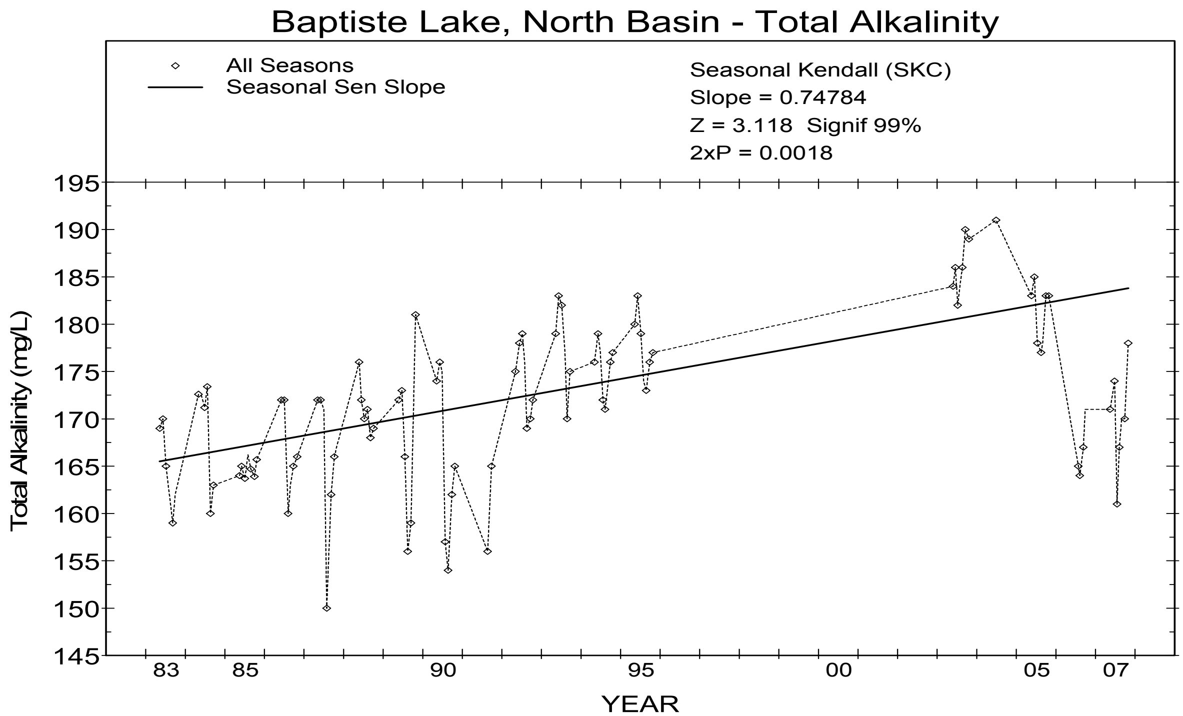


Figure 51 **Alix Lake –** Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



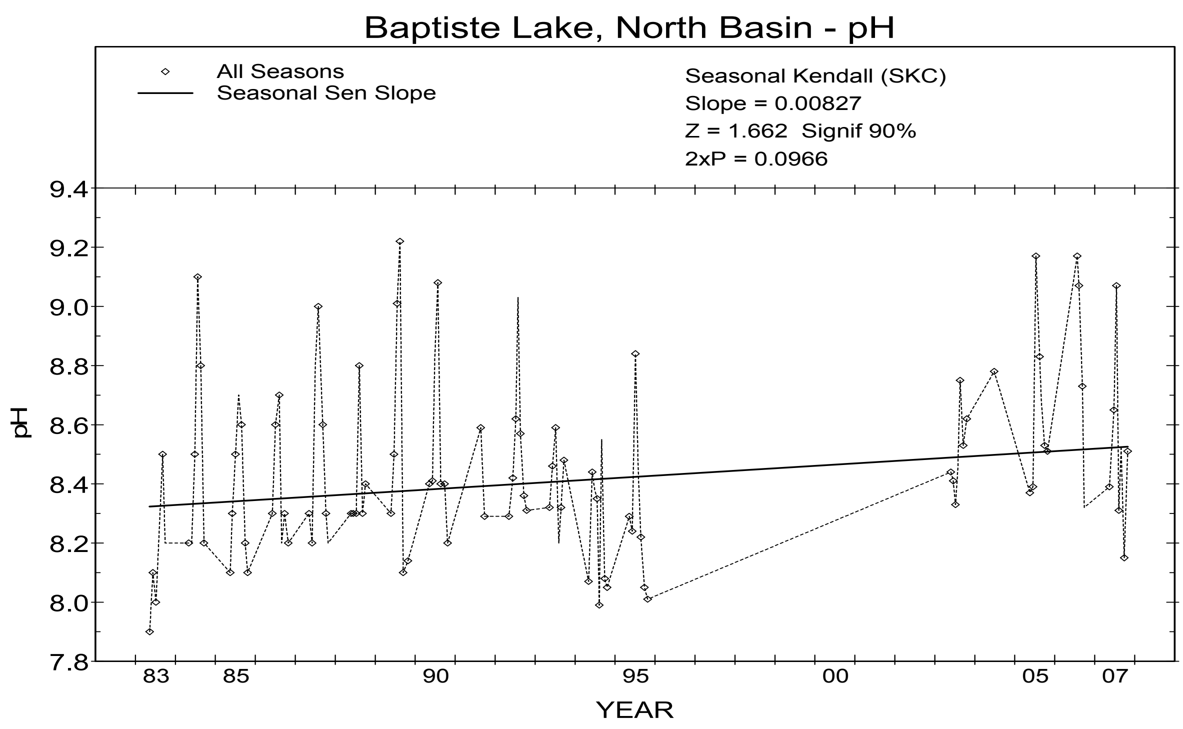
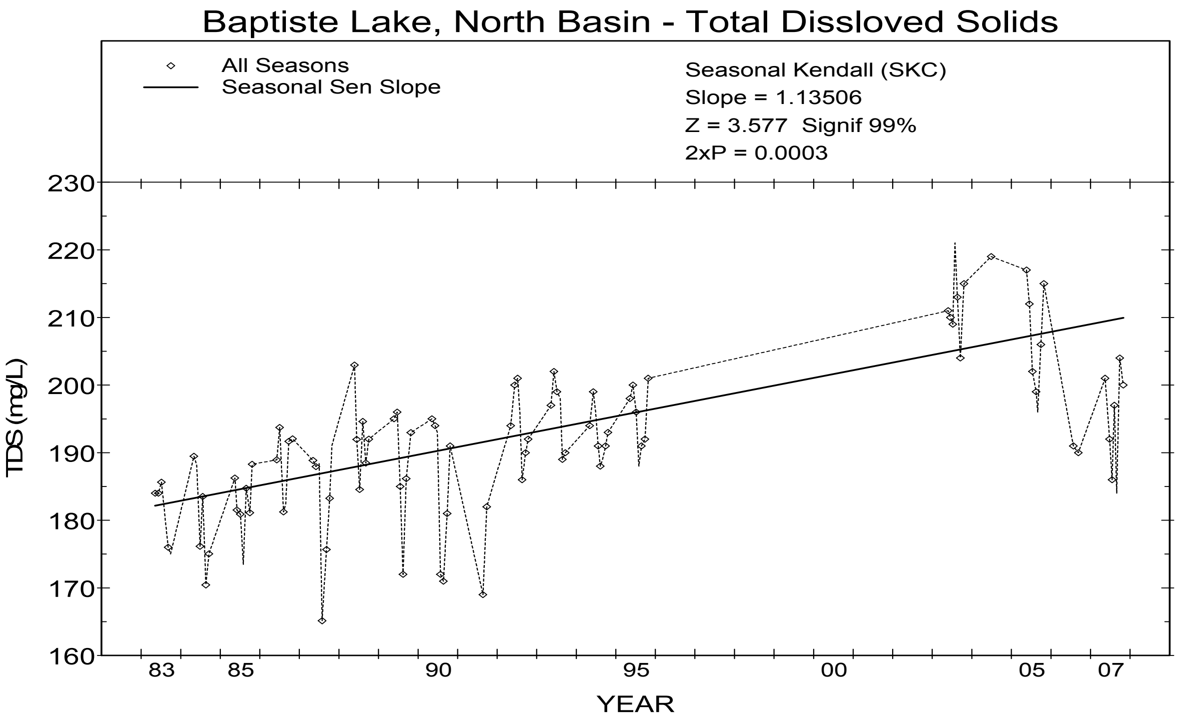


Figure 52a **Baptiste Lake, North Basin –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



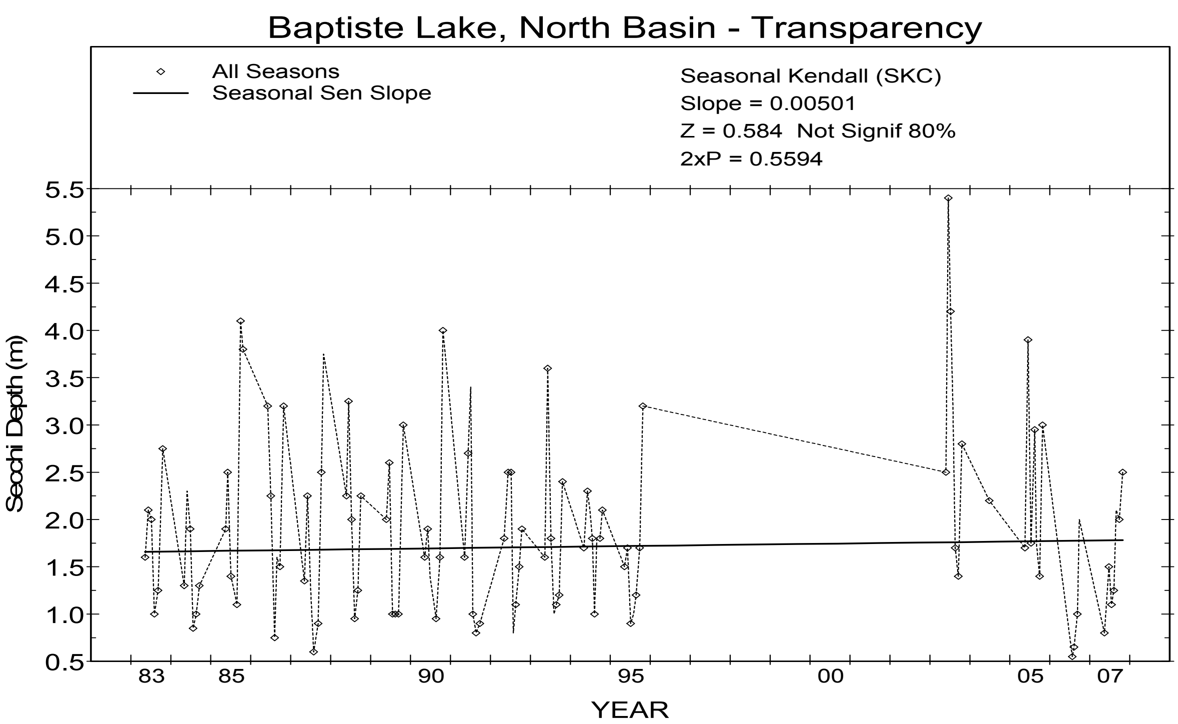
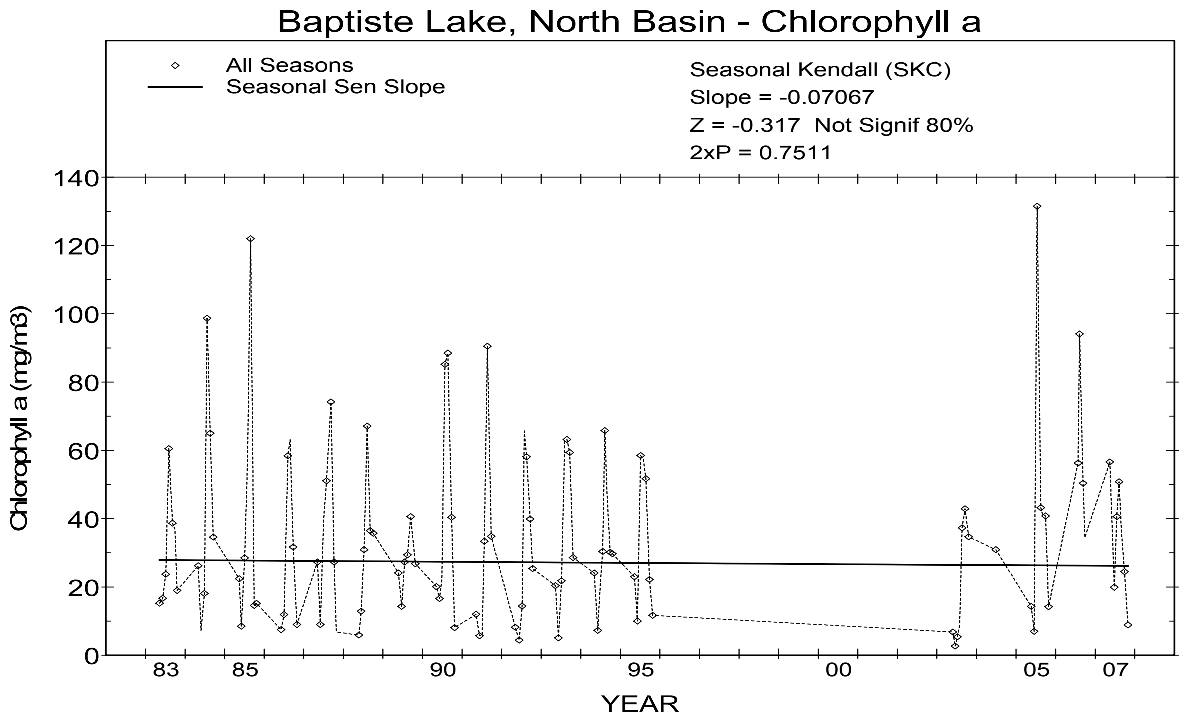


Figure 52a **Baptiste Lake, North Basin –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



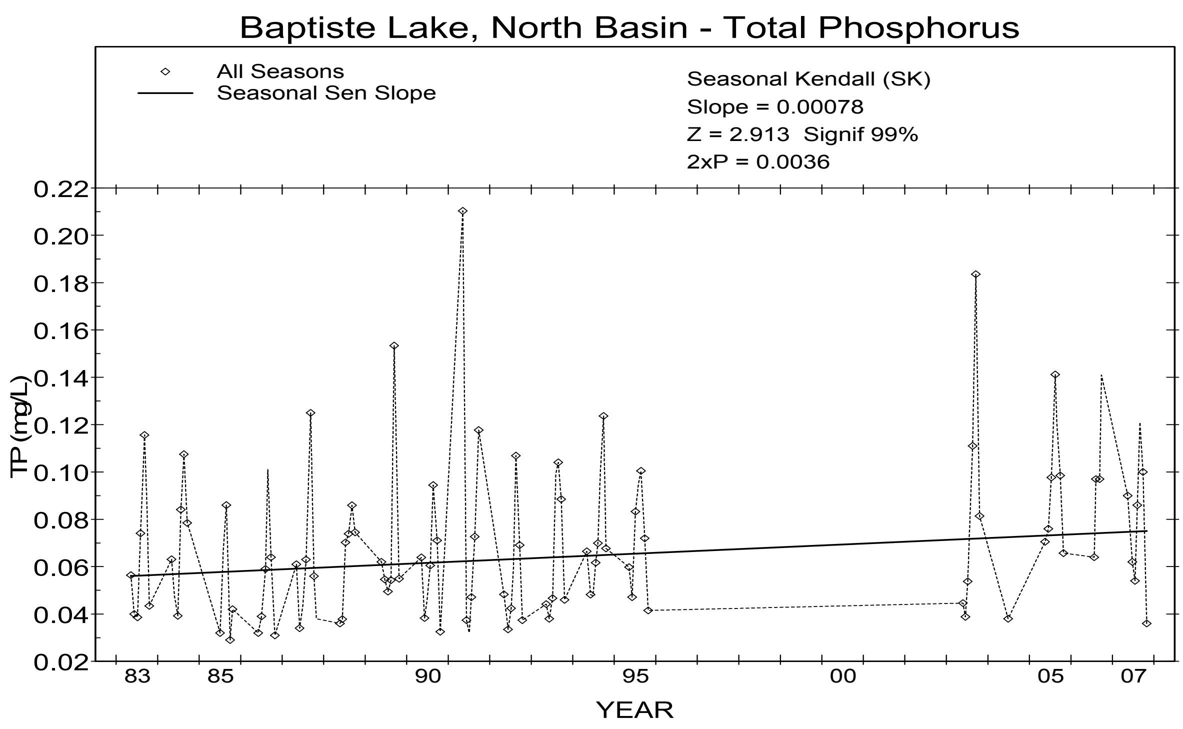
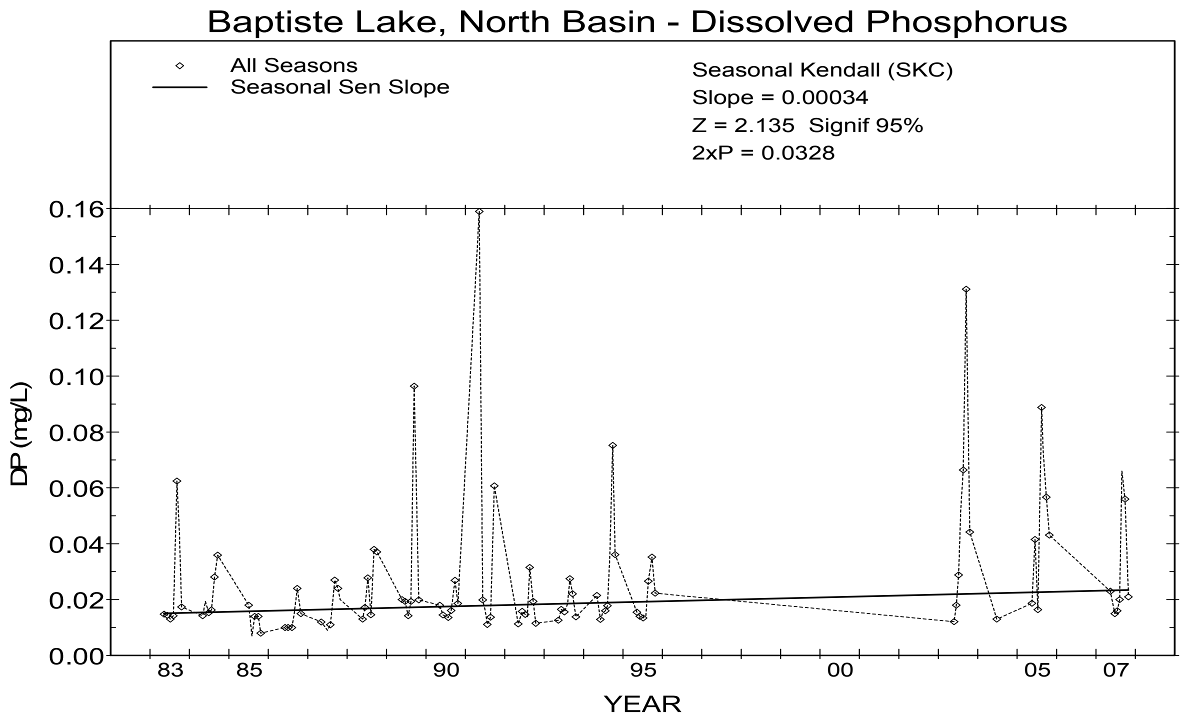


Figure 52a **Baptiste Lake, North Basin –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



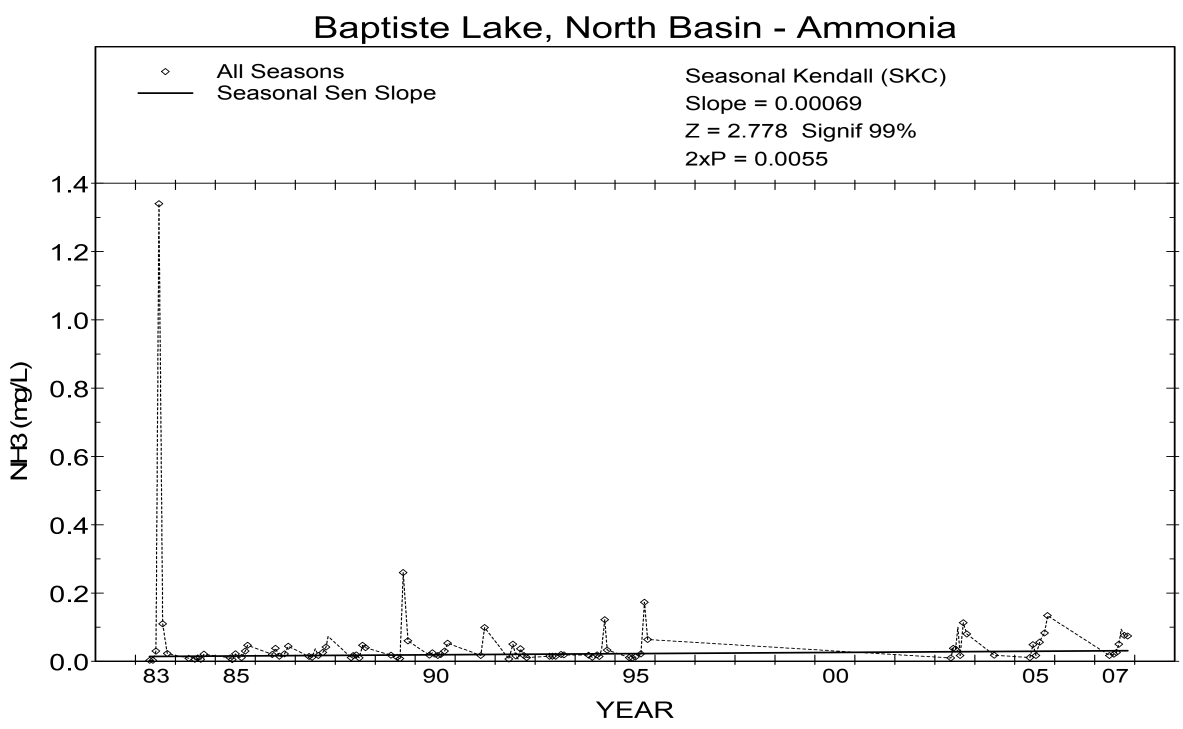
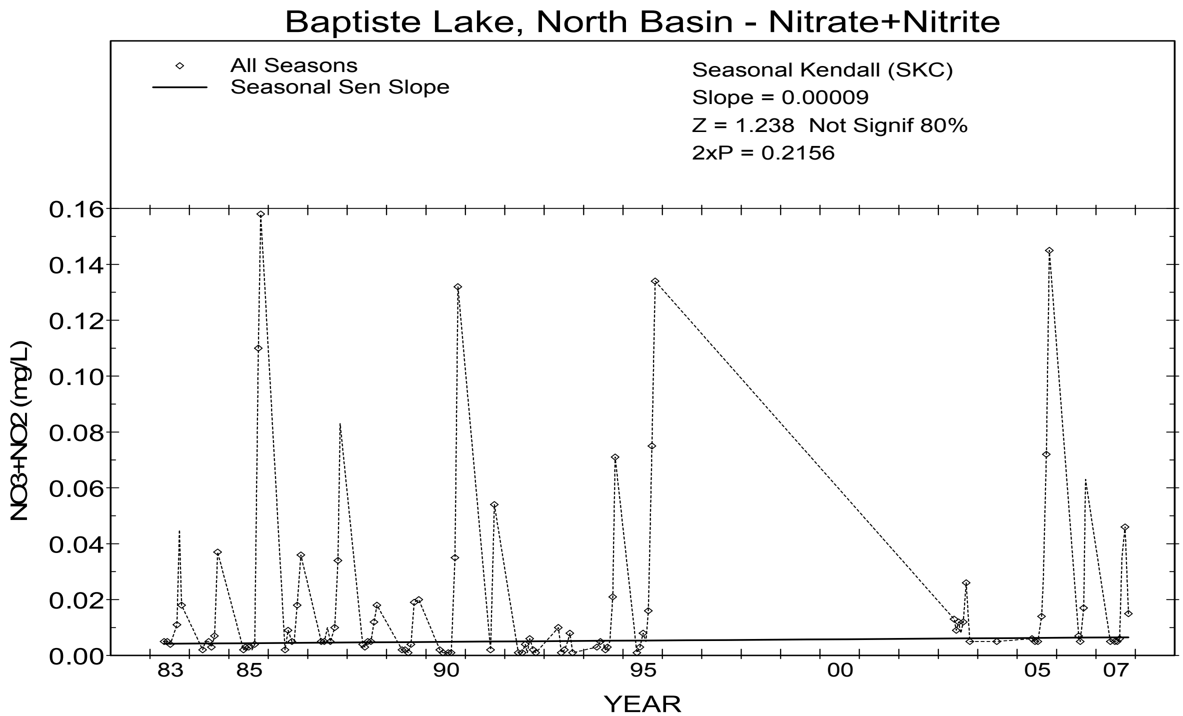


Figure 52b **Baptiste Lake, North Basin –** Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record



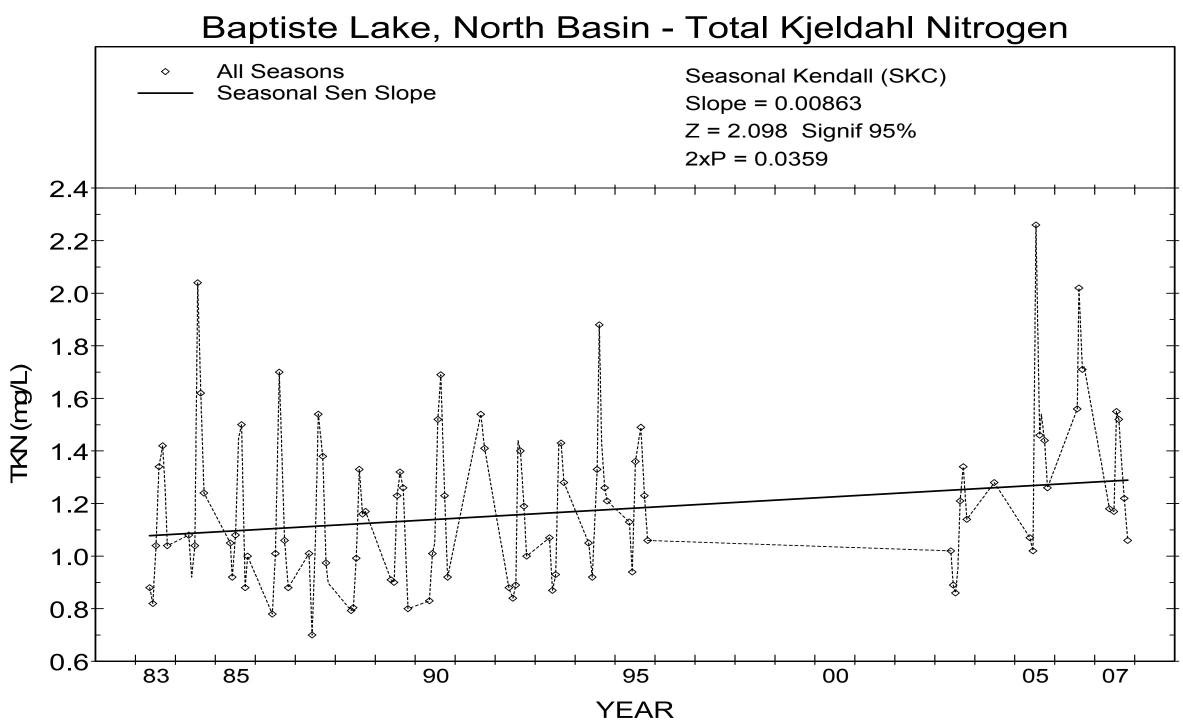
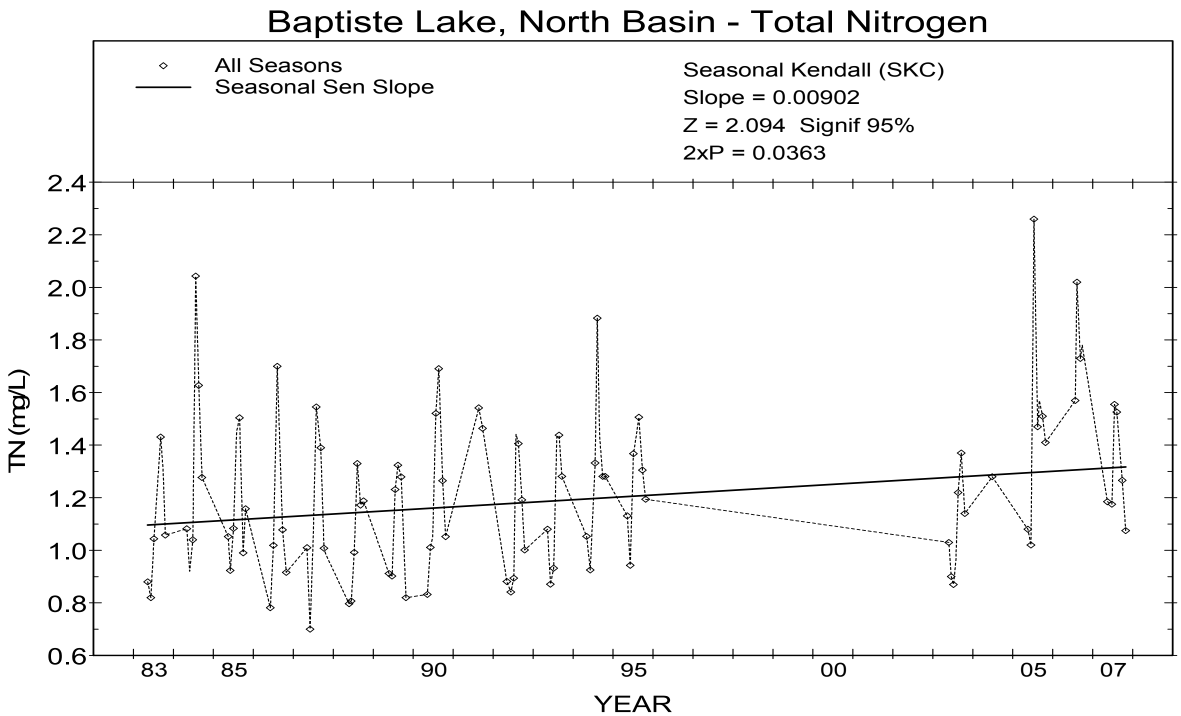


Figure 52b **Baptiste Lake, North Basin –** Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)



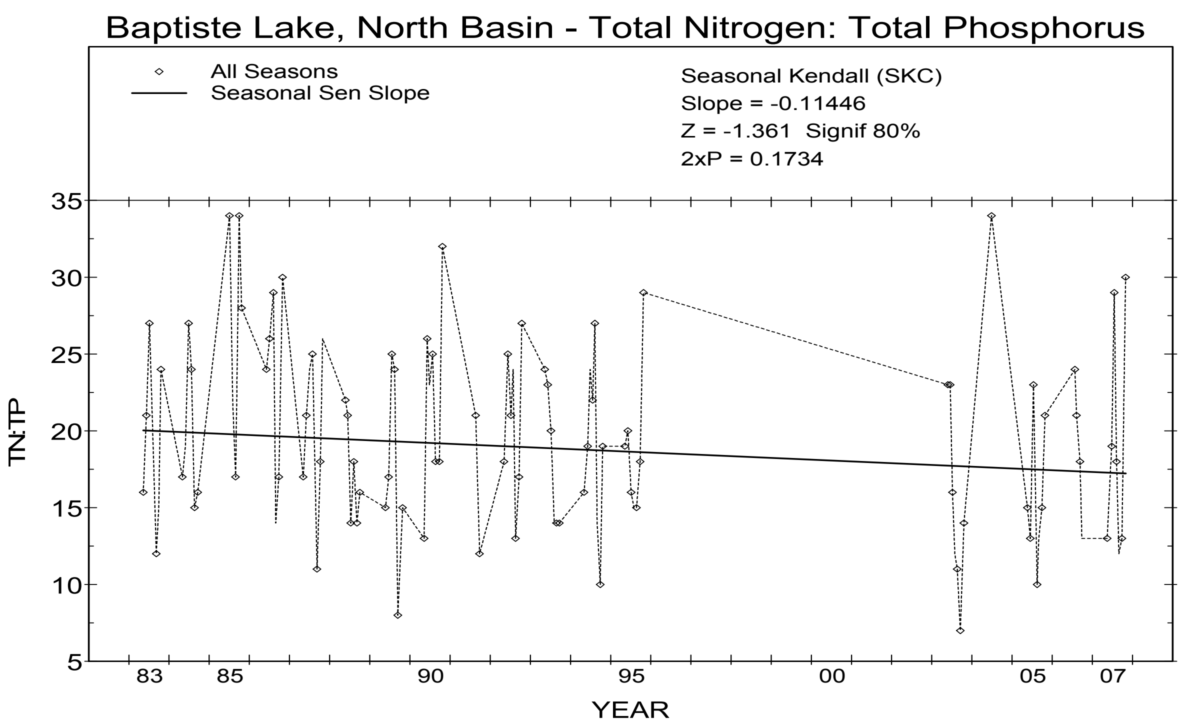
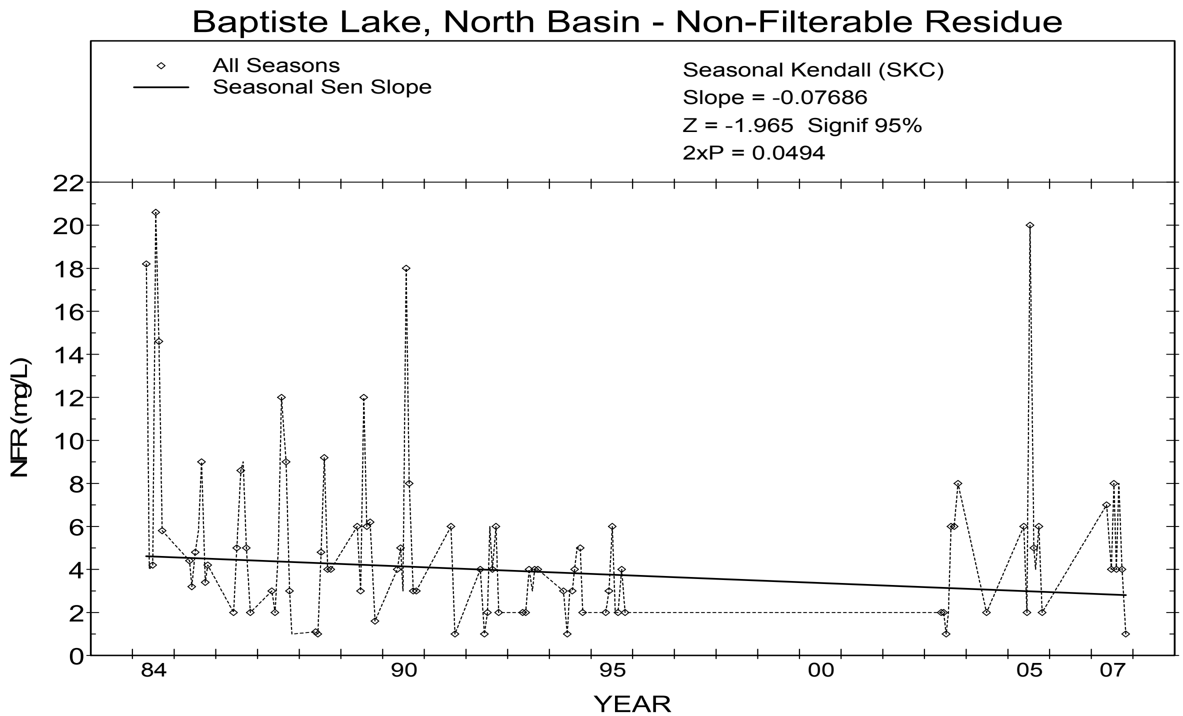


Figure 52b **Baptiste Lake, North Basin –** Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)



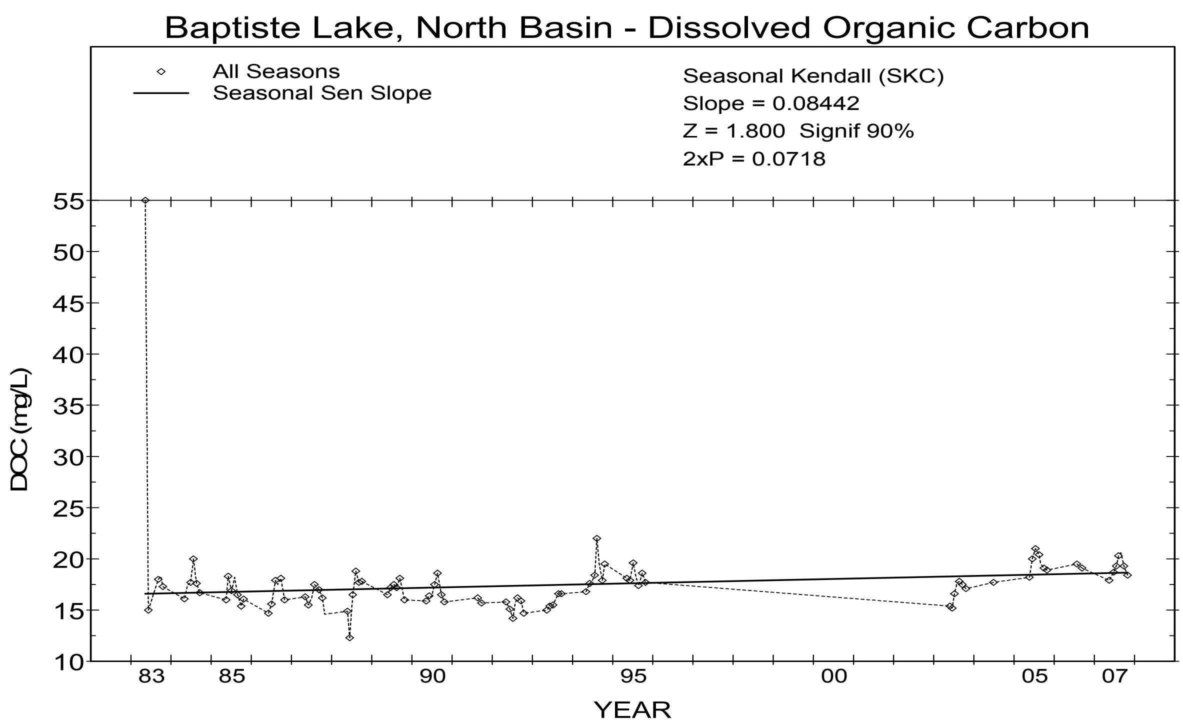


Figure 52b **Baptiste Lake, North Basin –** Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)

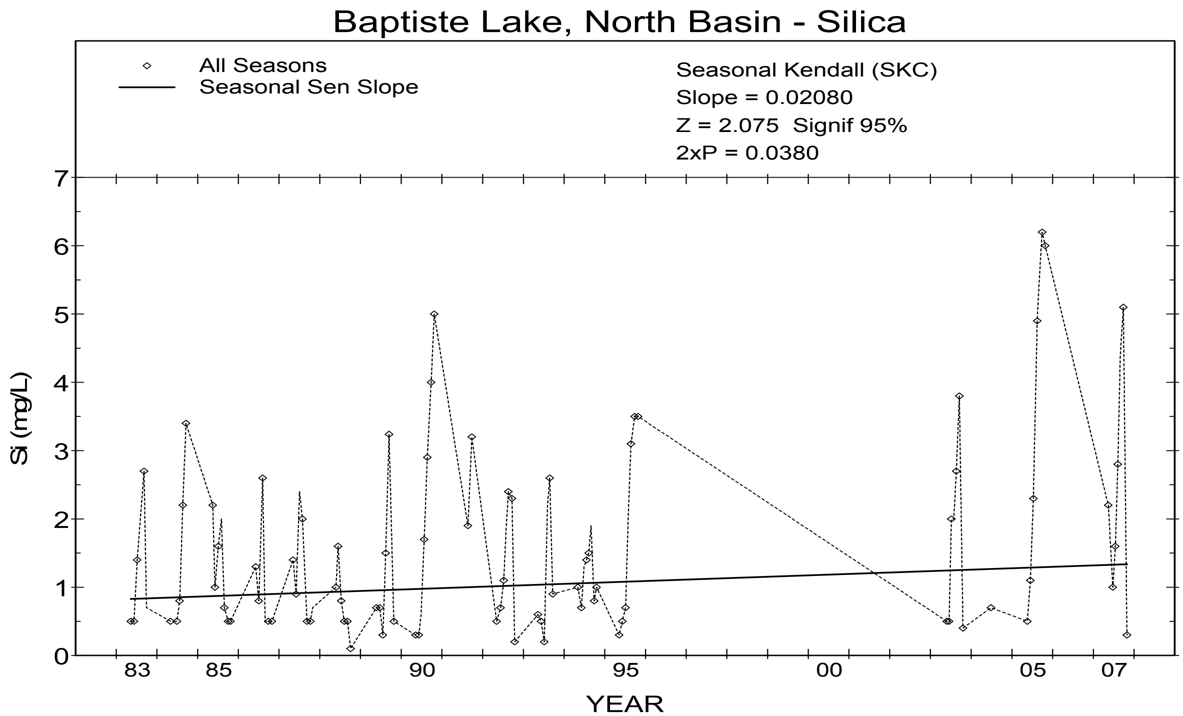
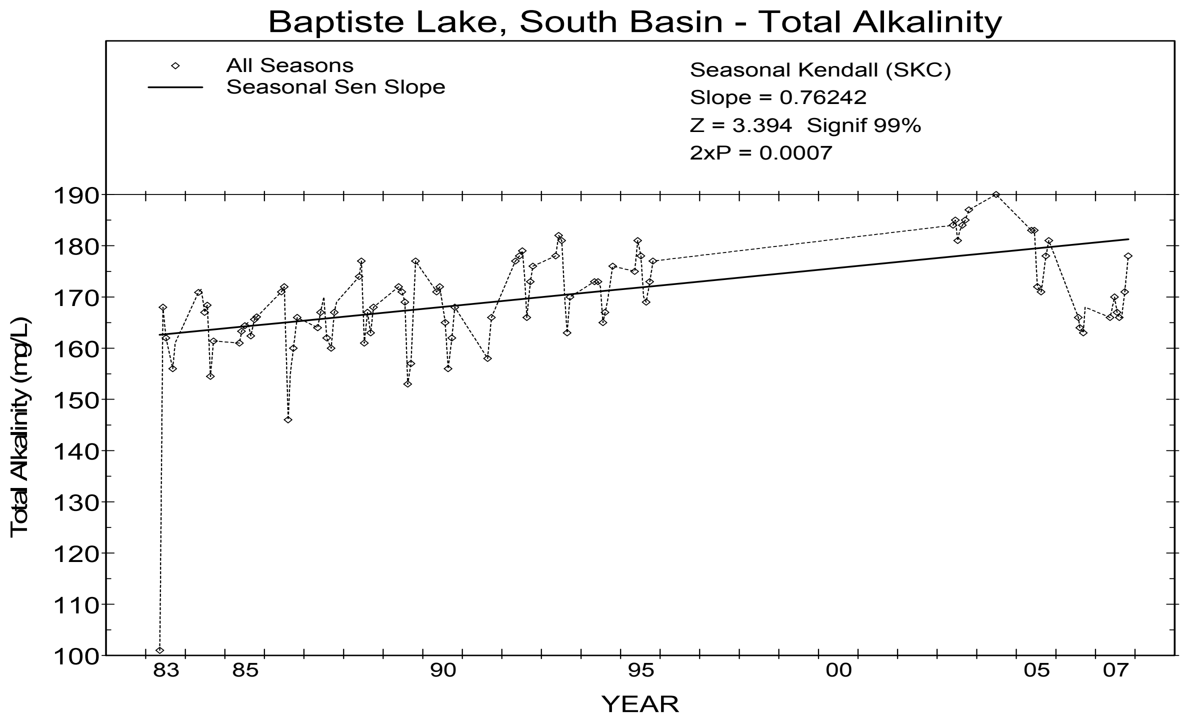


Figure 52b **Baptiste Lake, North Basin –** Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (concluded)



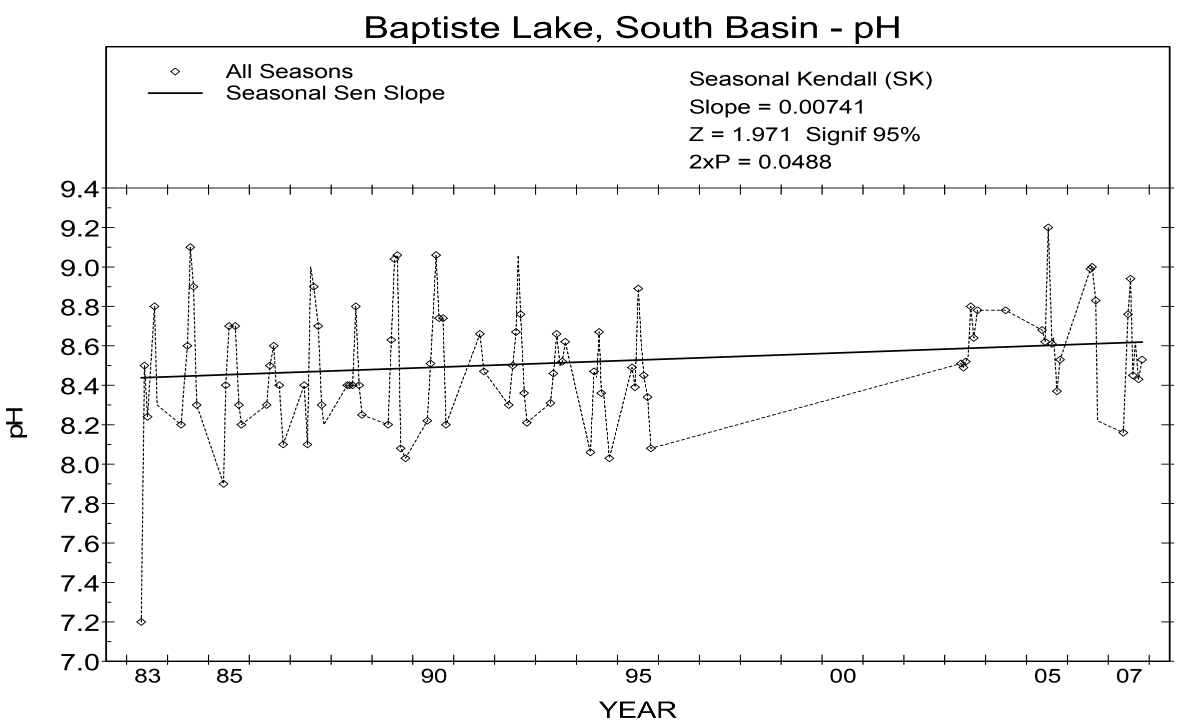
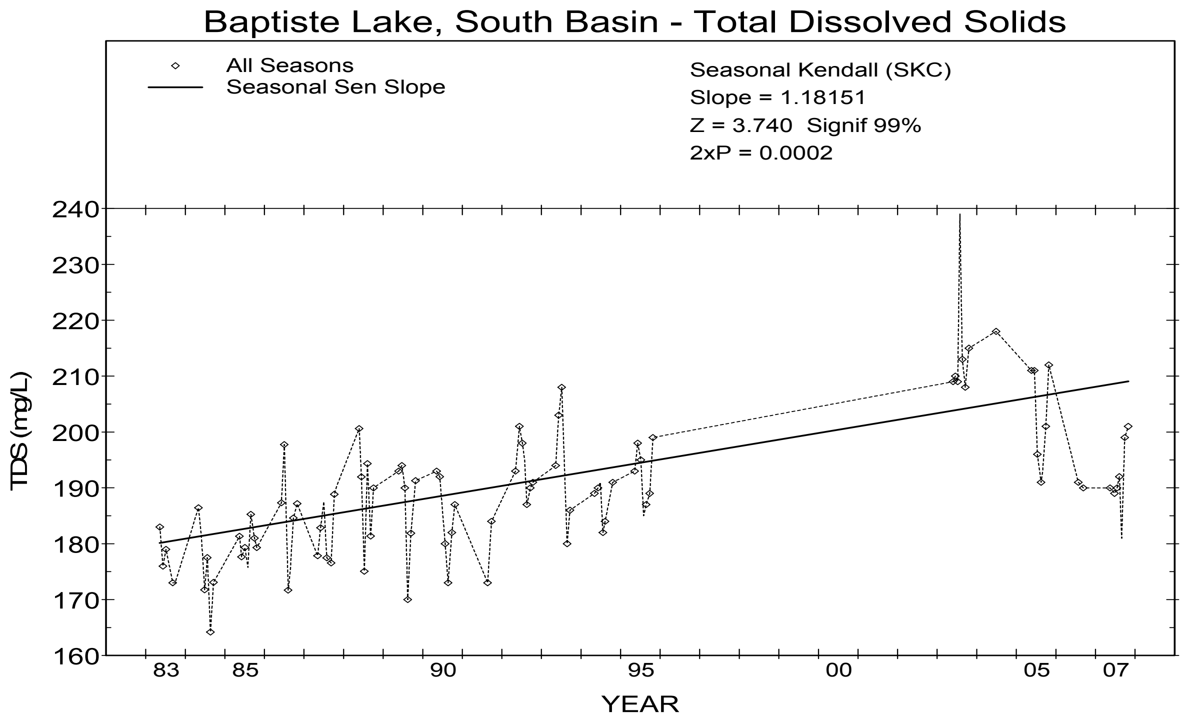


Figure 53a **Baptiste Lake, South Basin** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



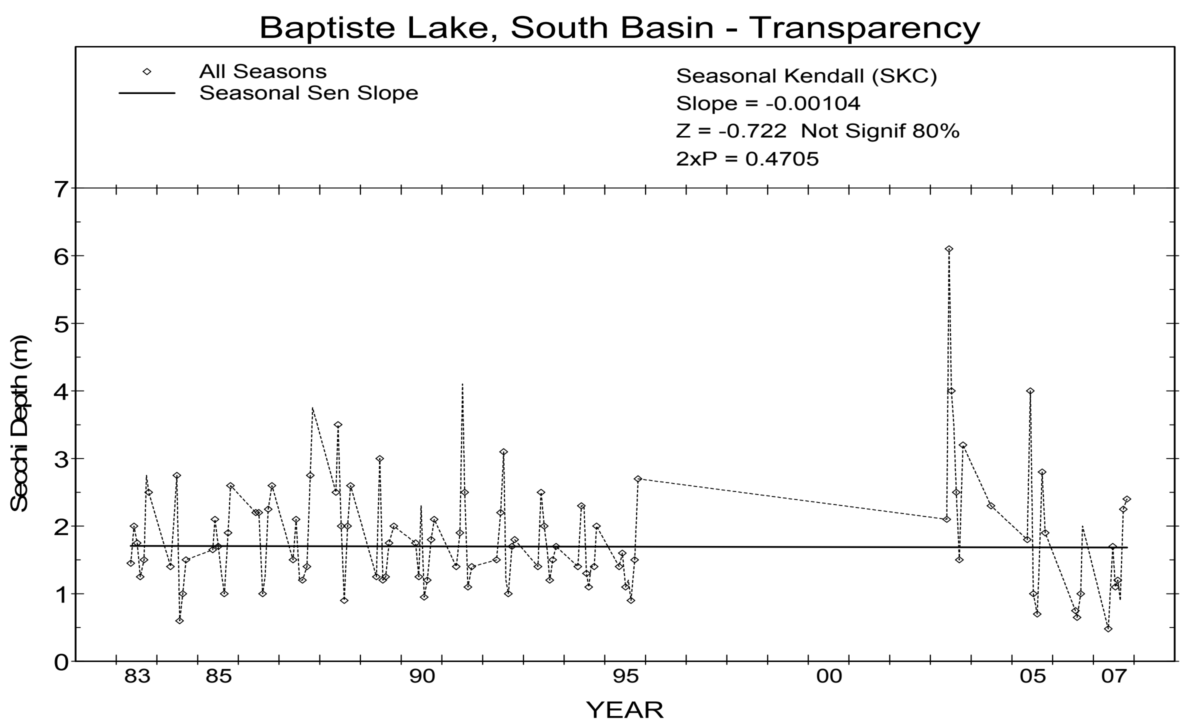
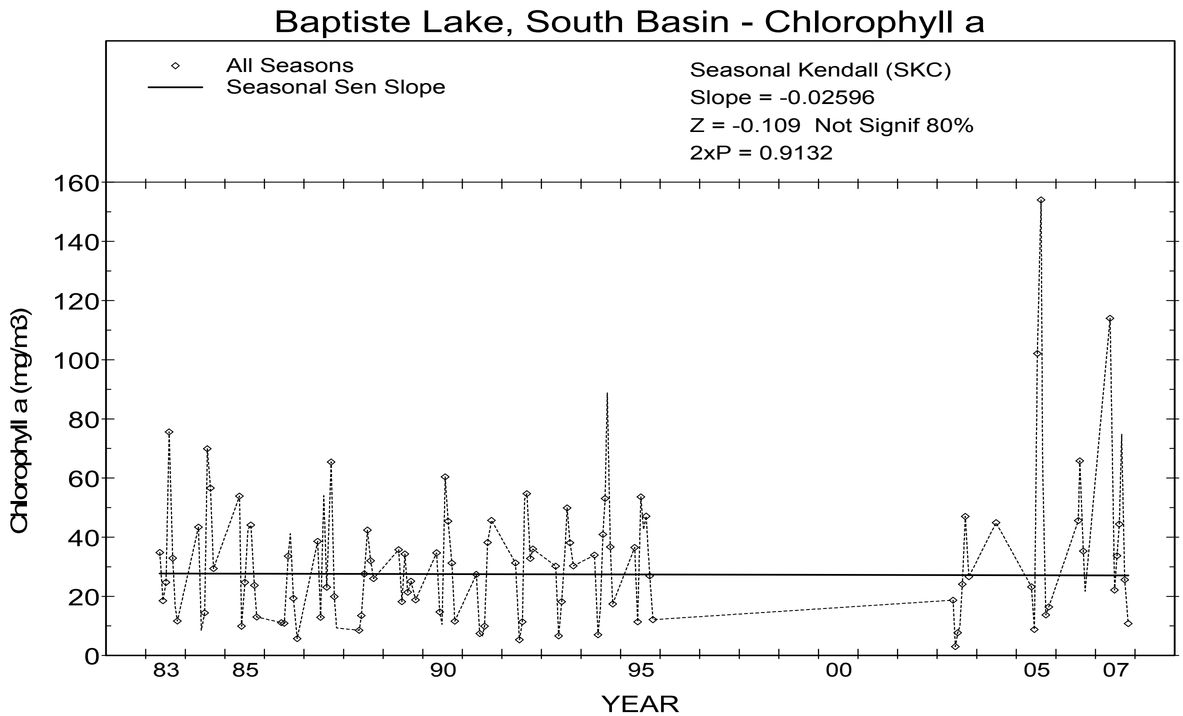


Figure 53a **Baptiste Lake, South Basin** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



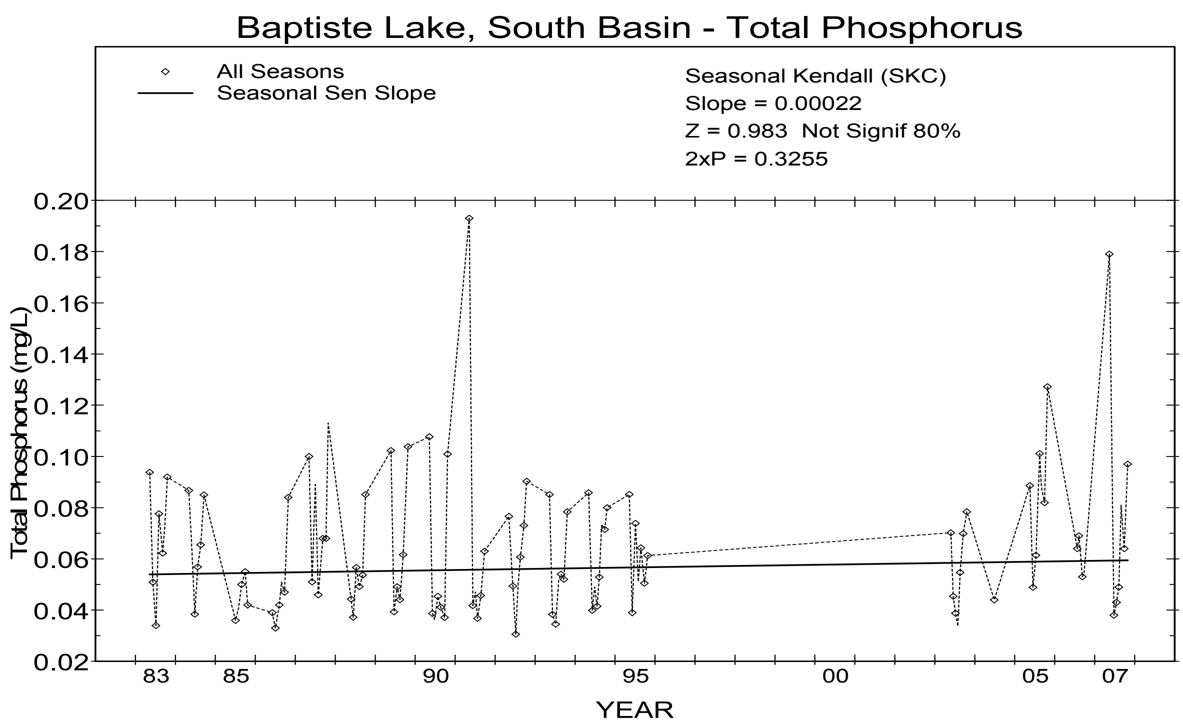
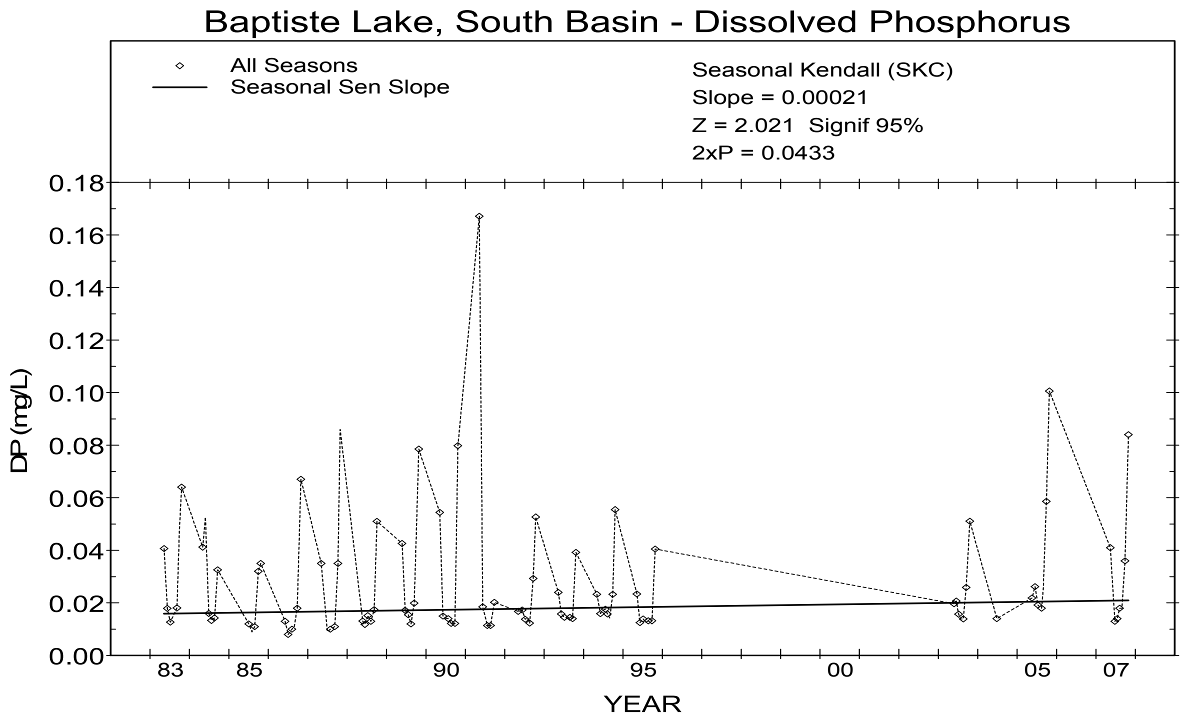


Figure 53a **Baptiste Lake, South Basin** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



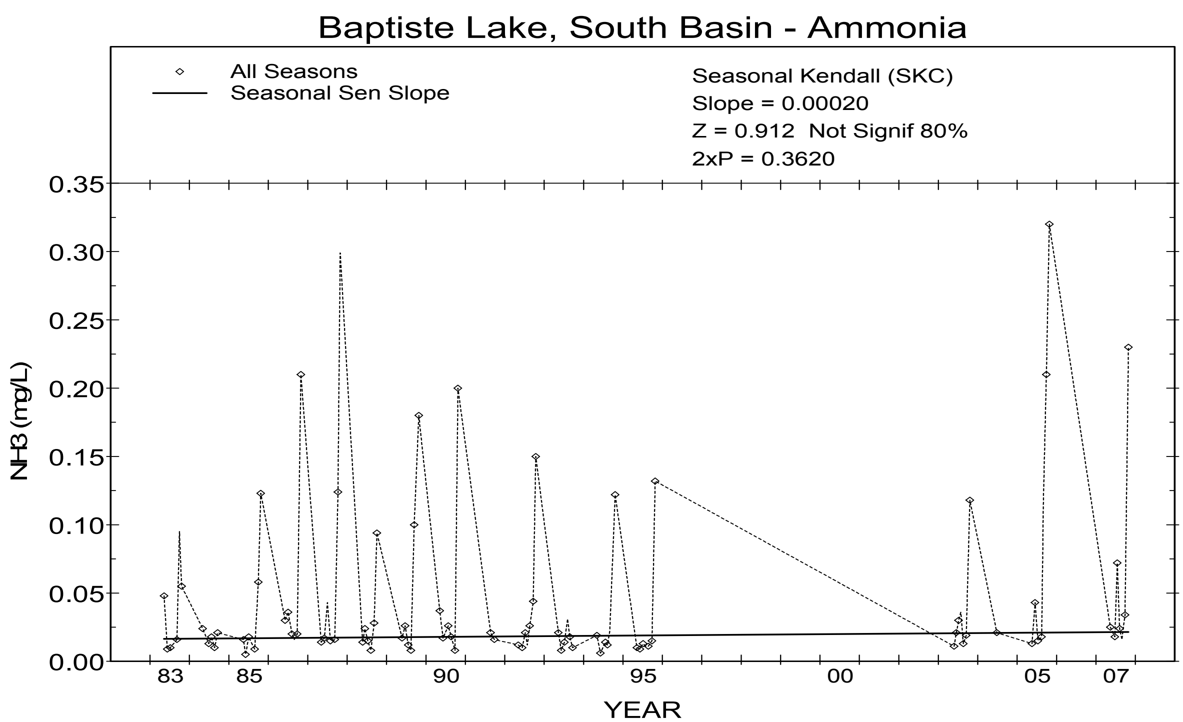
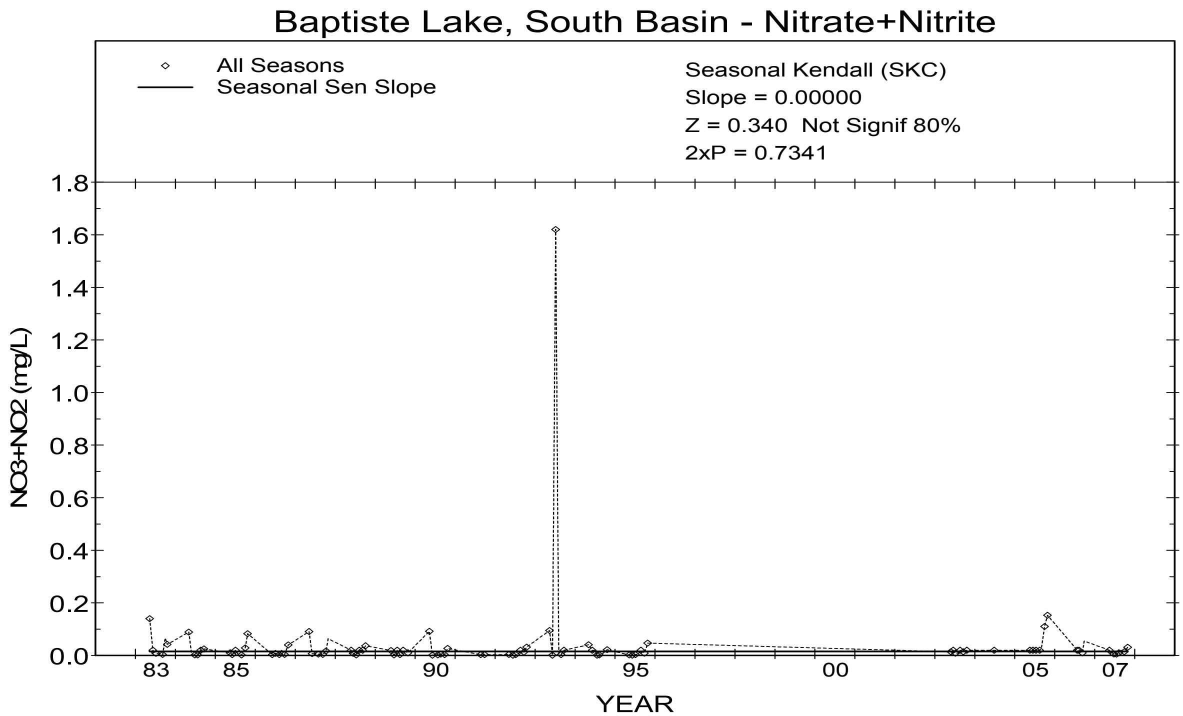


Figure 53b **Baptiste Lake, South Basin** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record



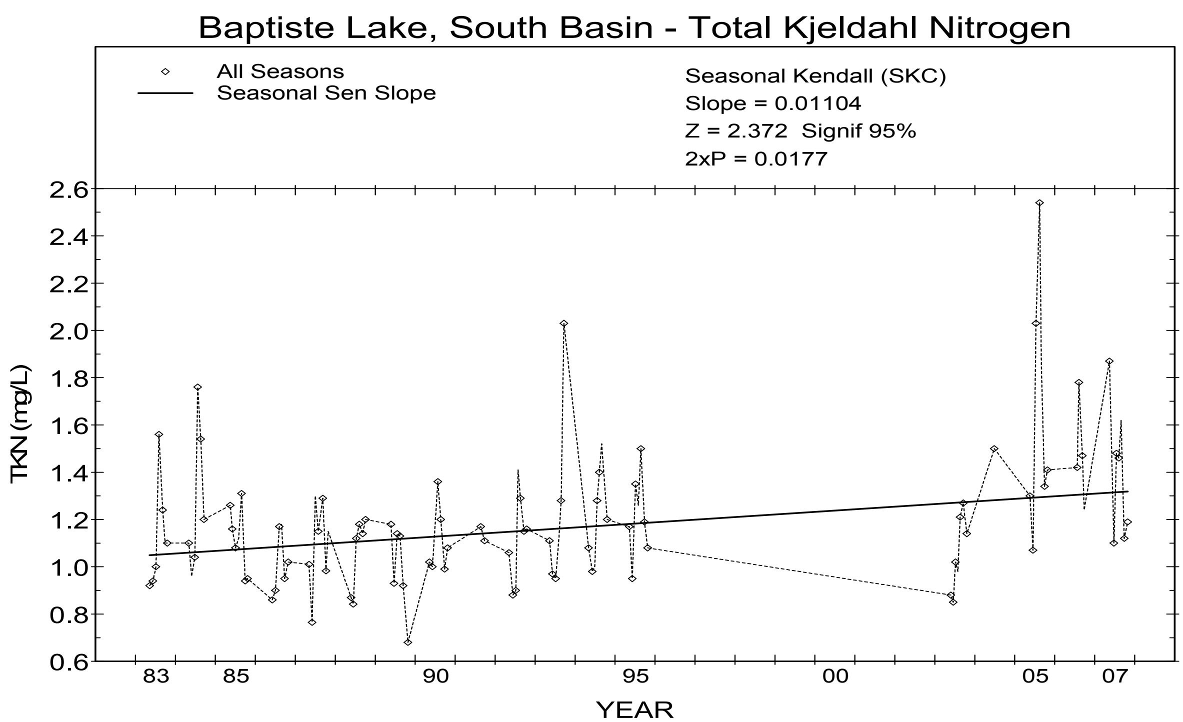
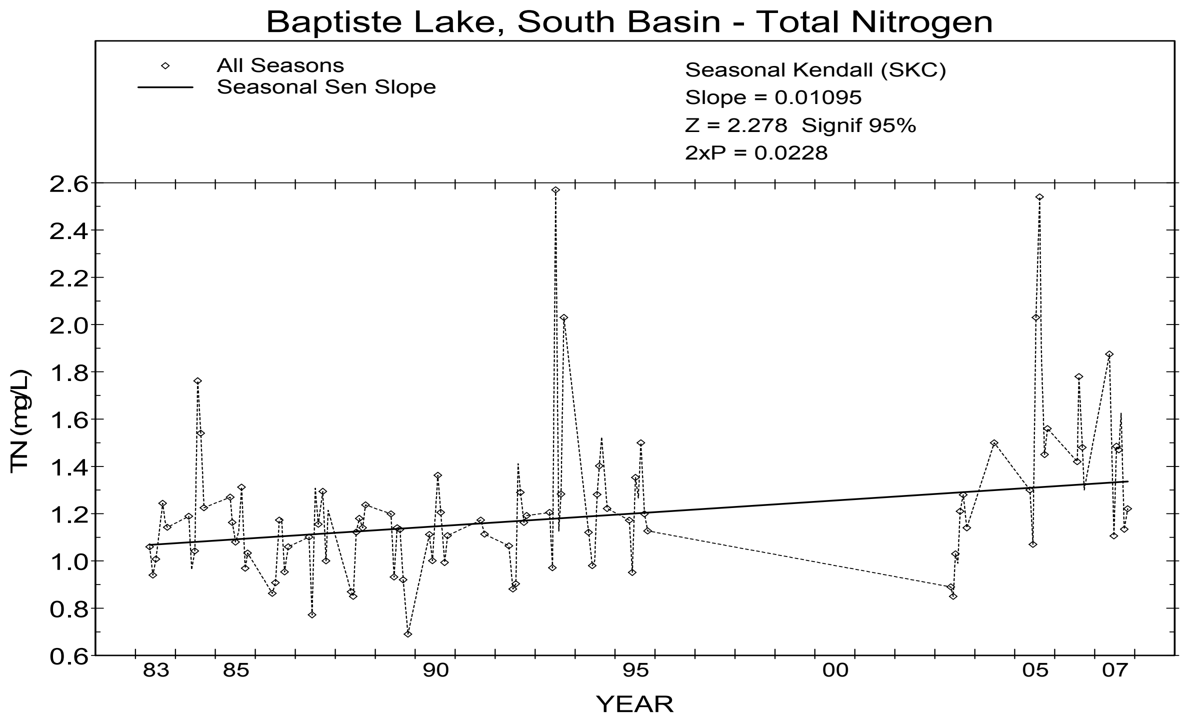


Figure 53b **Baptiste Lake, South Basin** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)



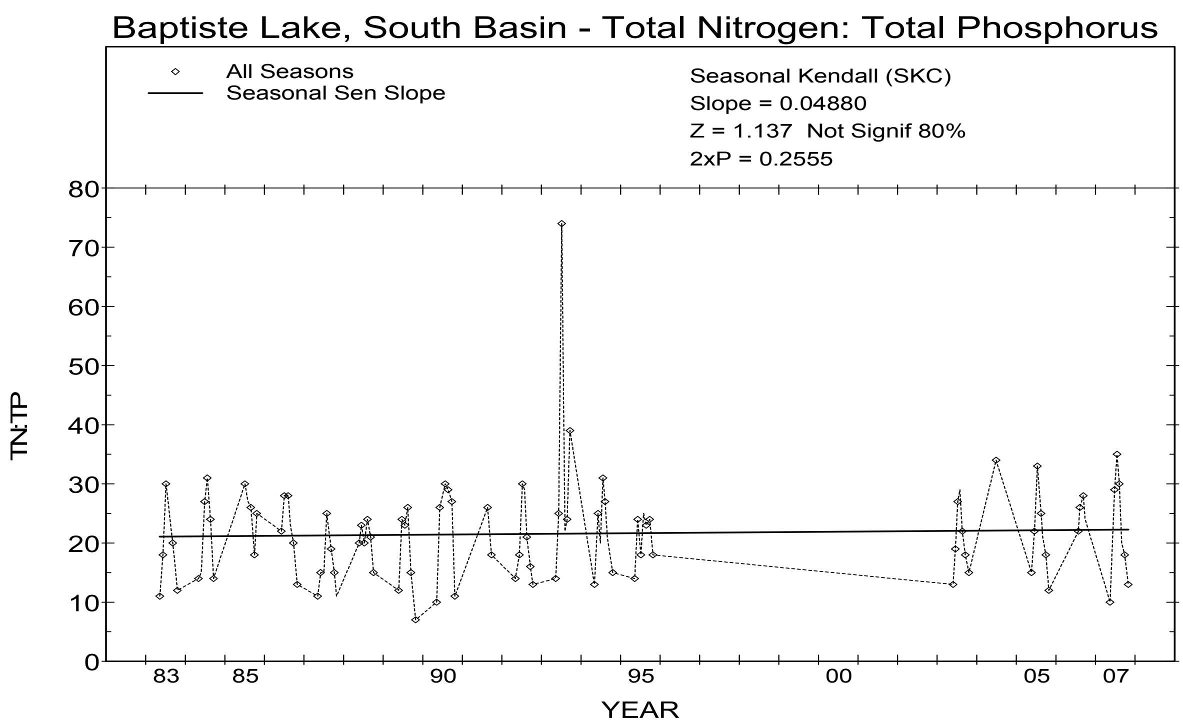
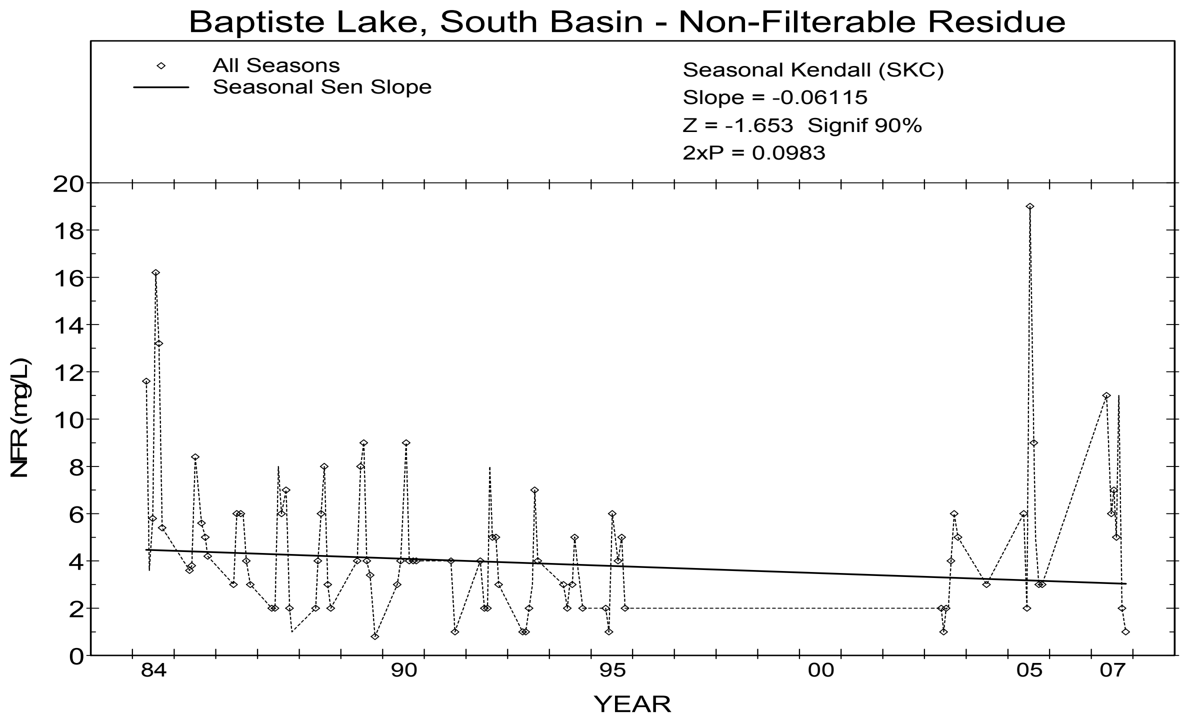


Figure 53b **Baptiste Lake, South Basin** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)



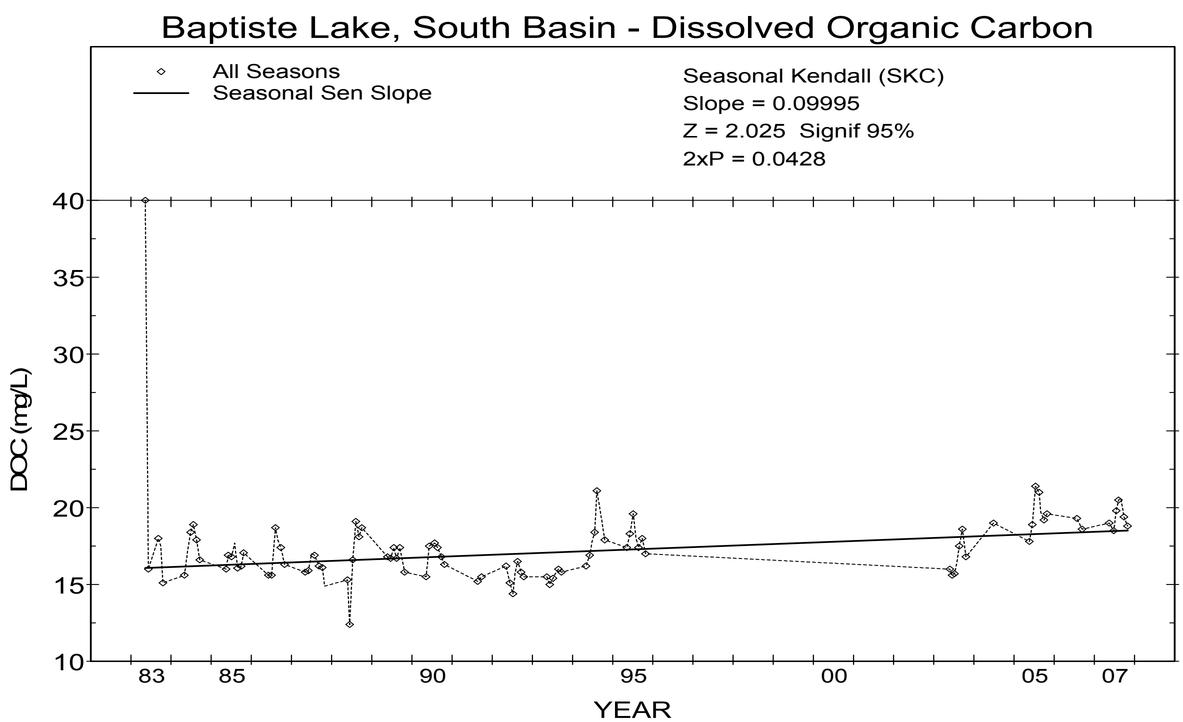


Figure 53b **Baptiste Lake, South Basin** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)

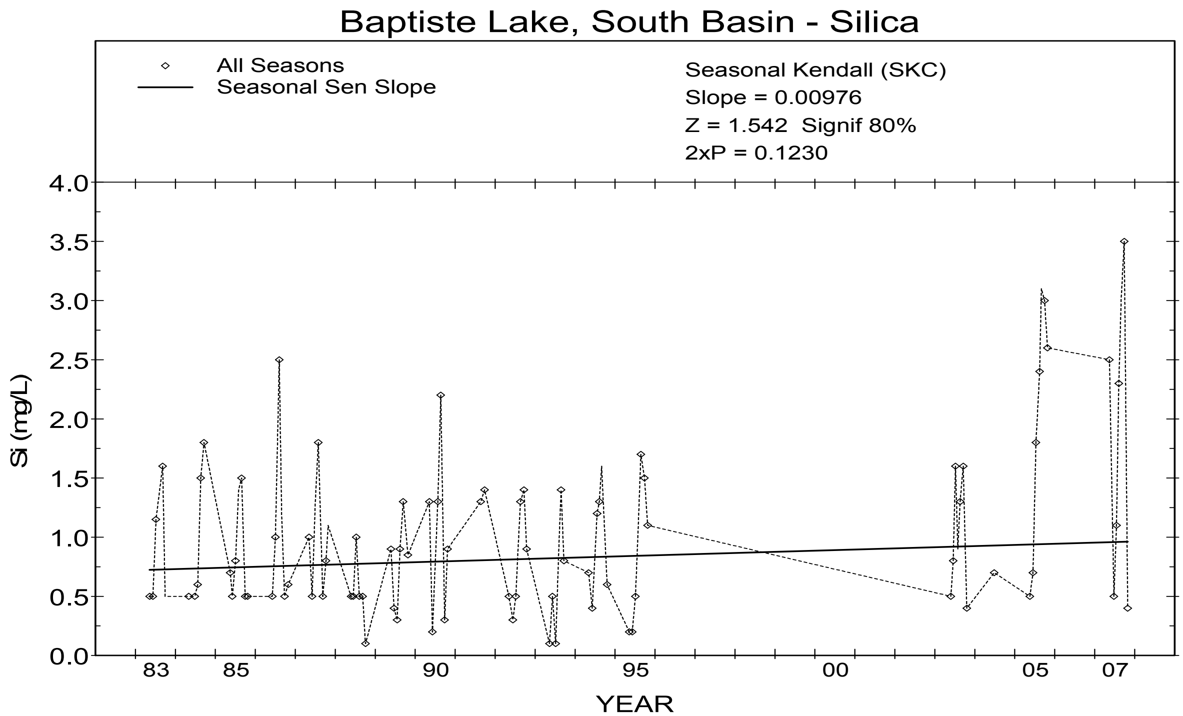
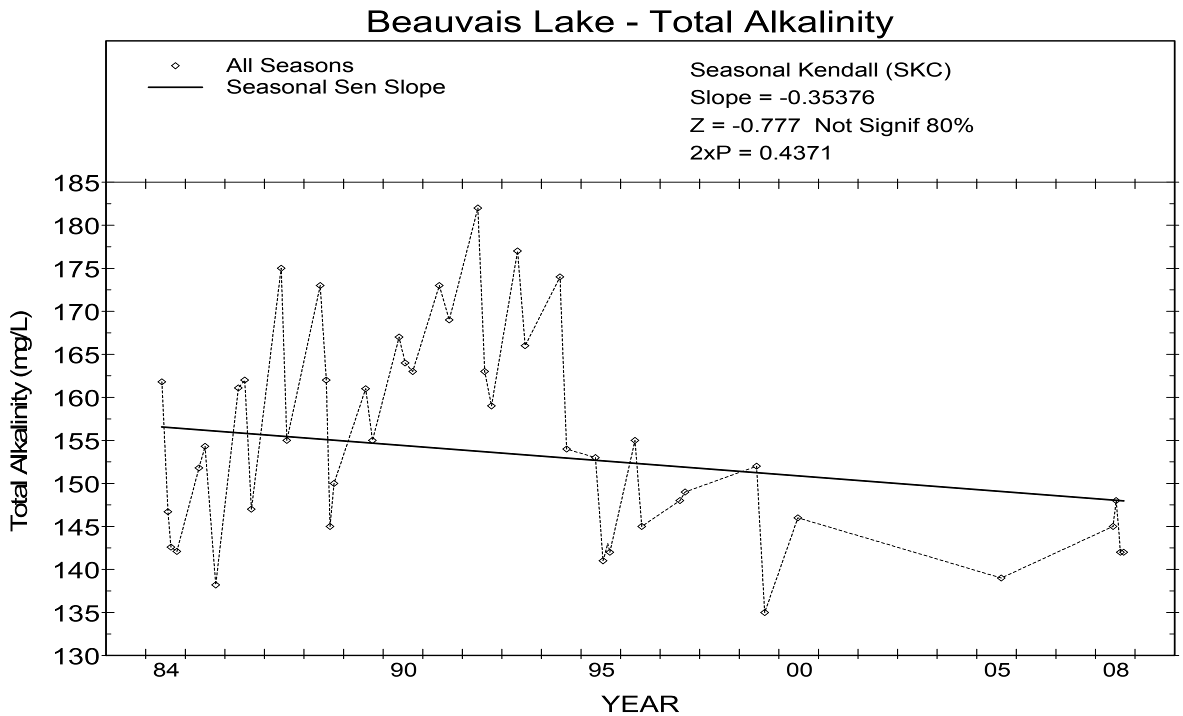


Figure 53b **Baptiste Lake, South Basin** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (concluded)



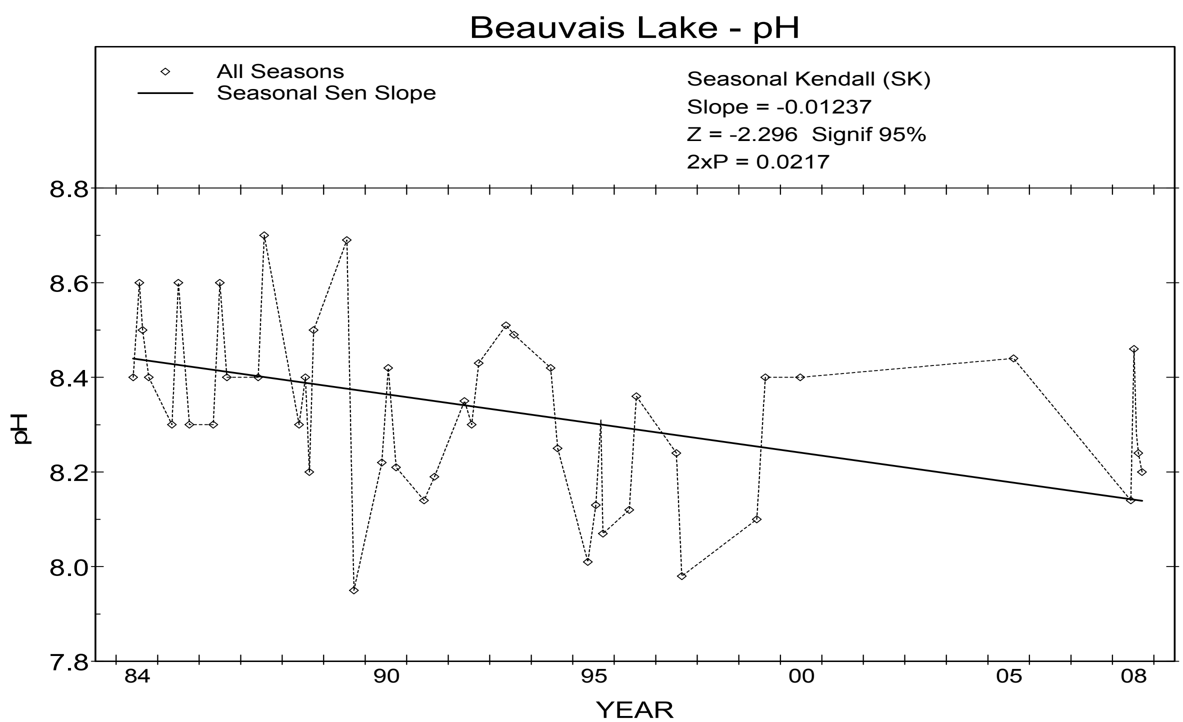
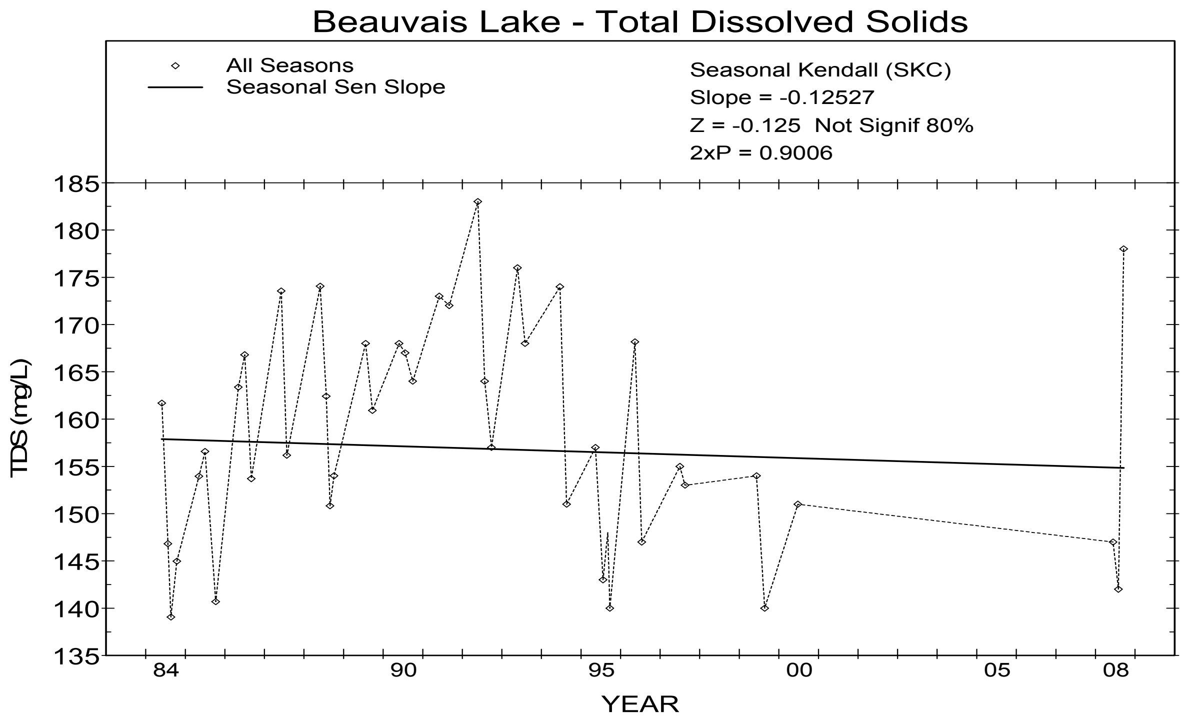


Figure 54 **Beauvais Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



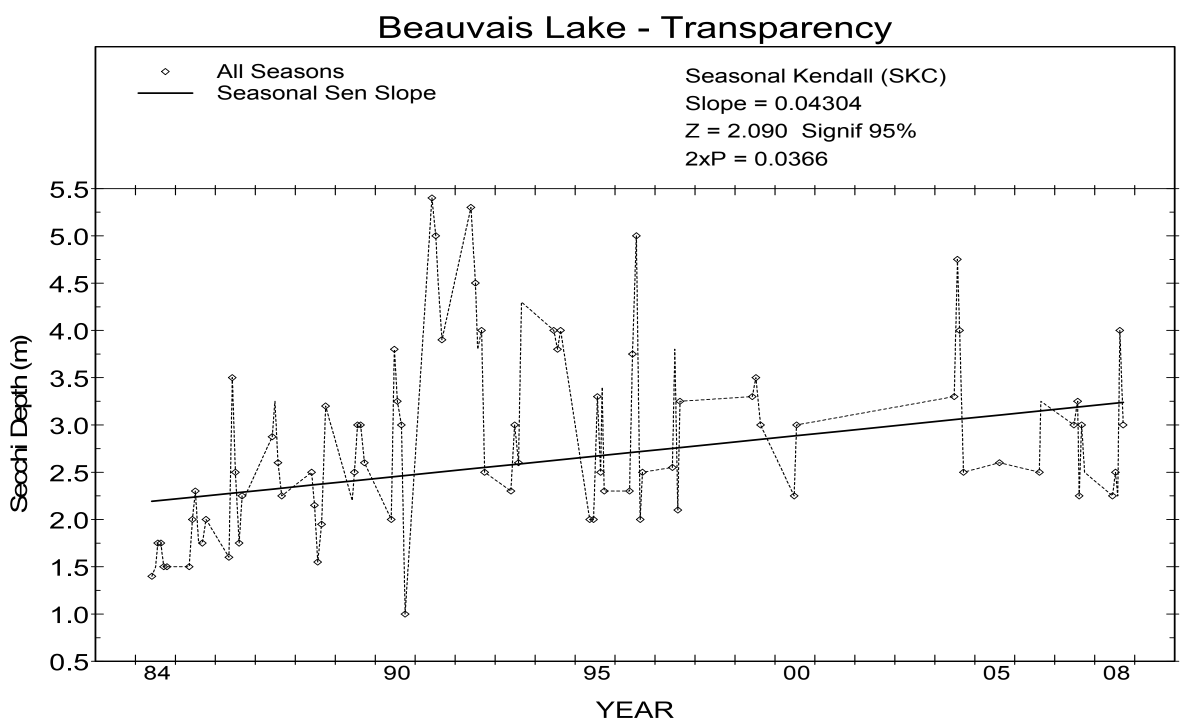
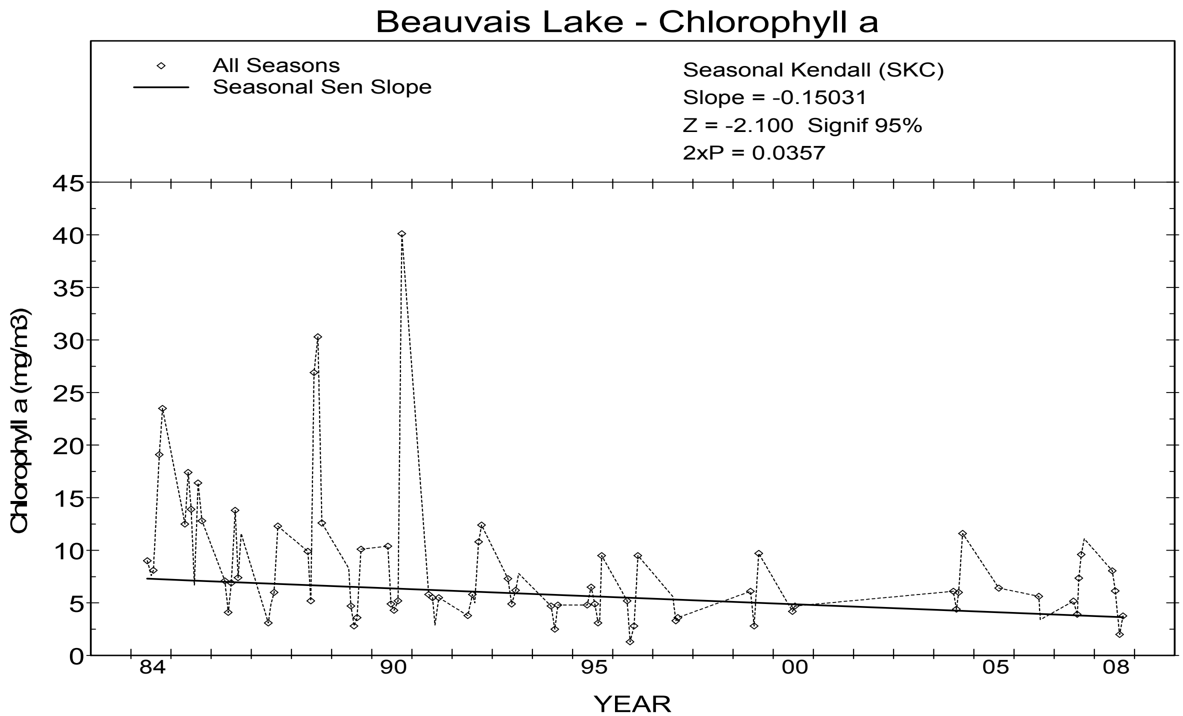


Figure 54 **Beauvais Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



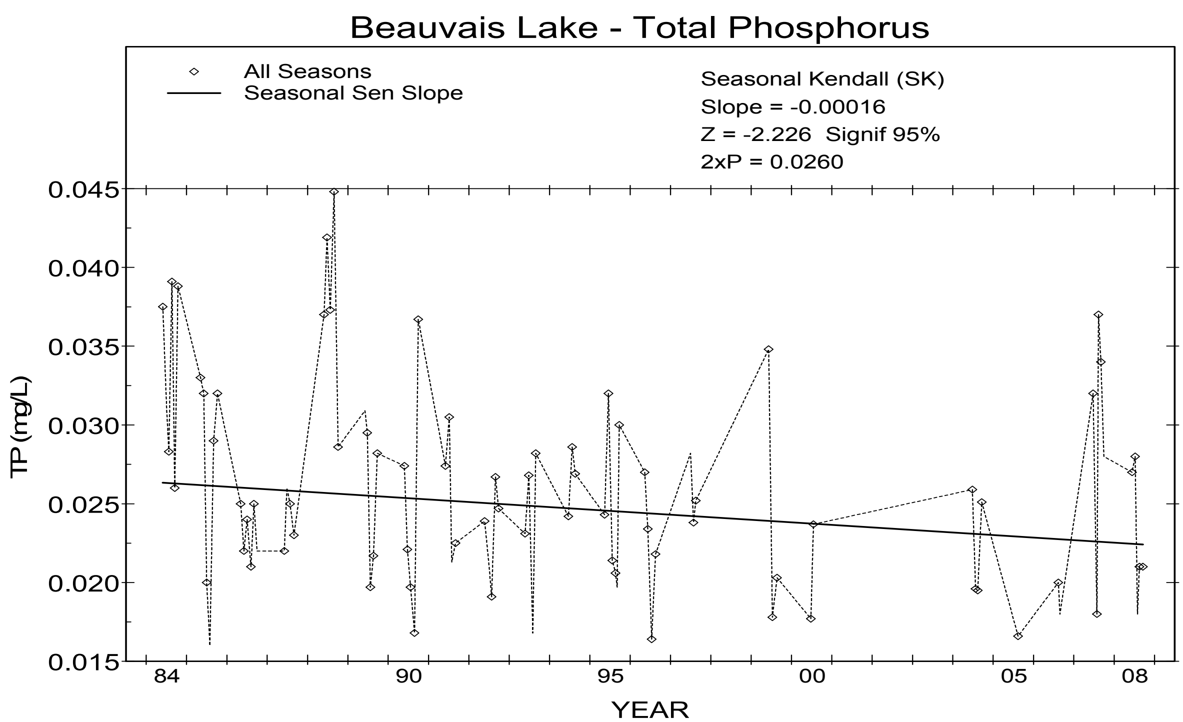
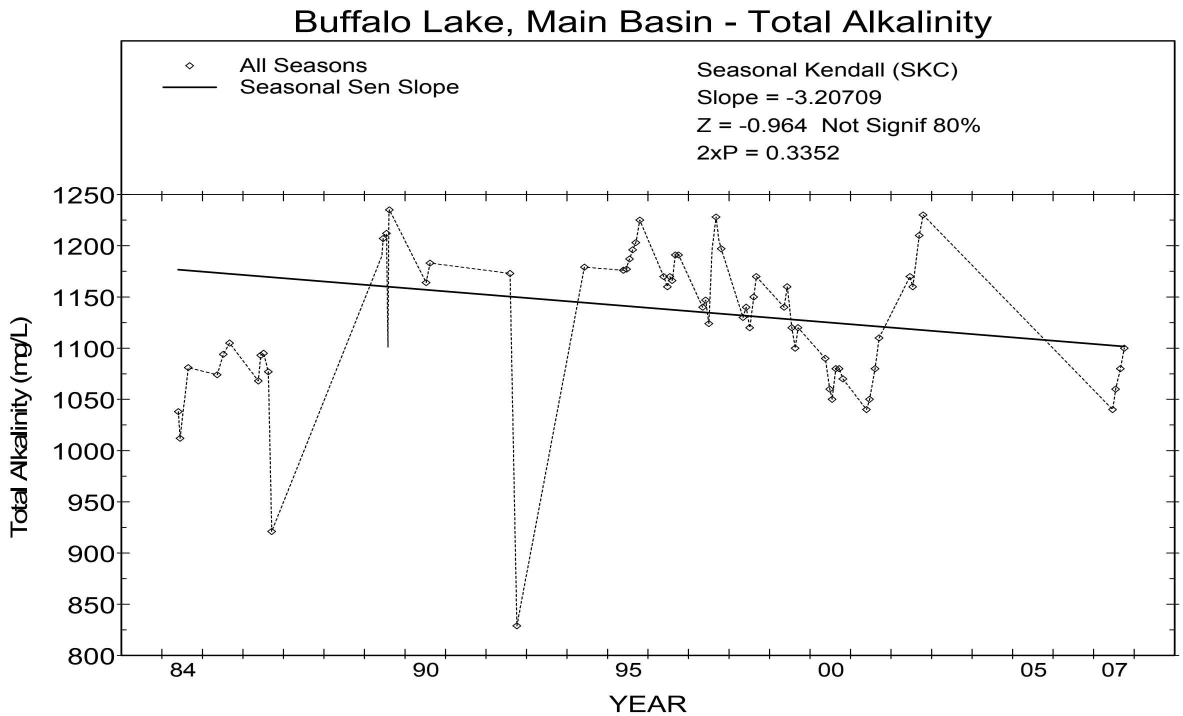


Figure 54 **Beauvais Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



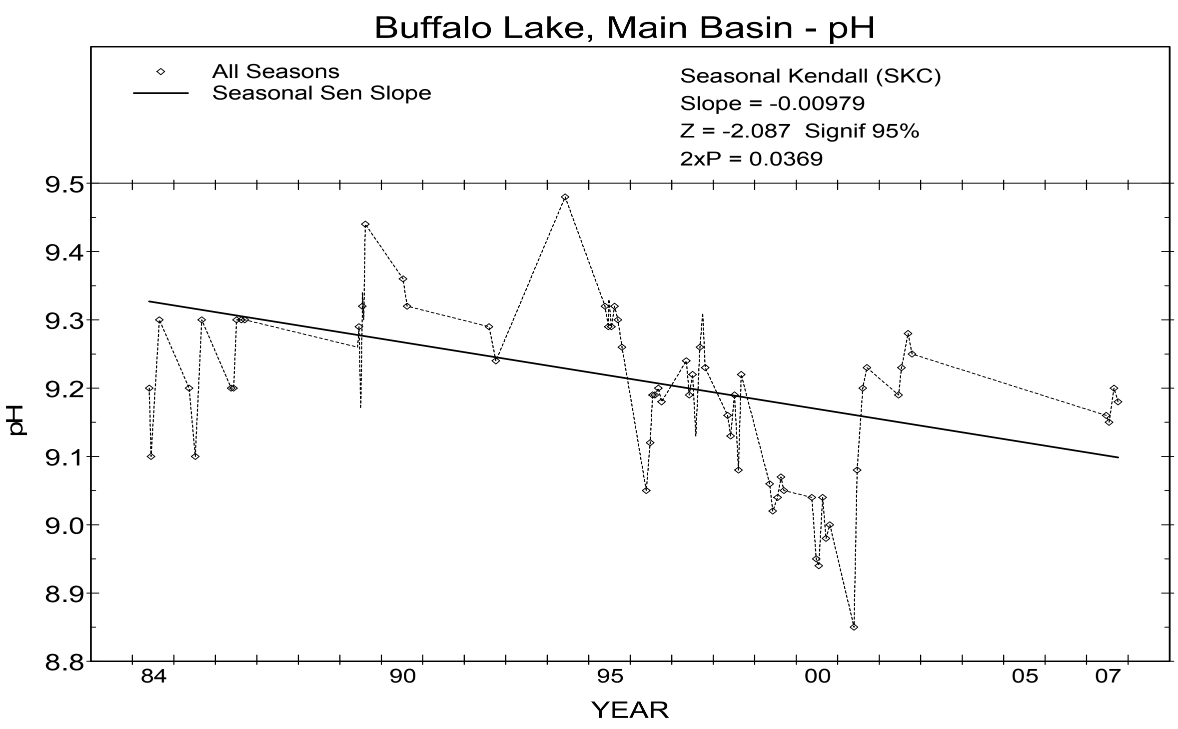
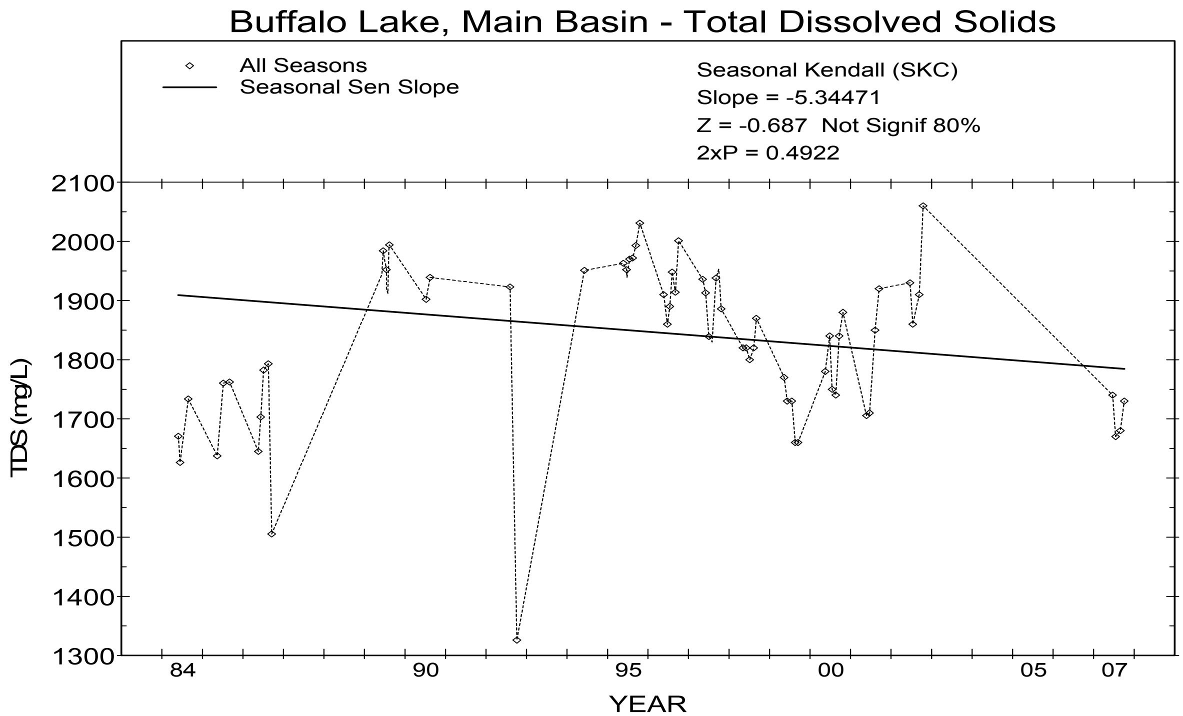


Figure 55 **Buffalo Lake, Main Basin** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



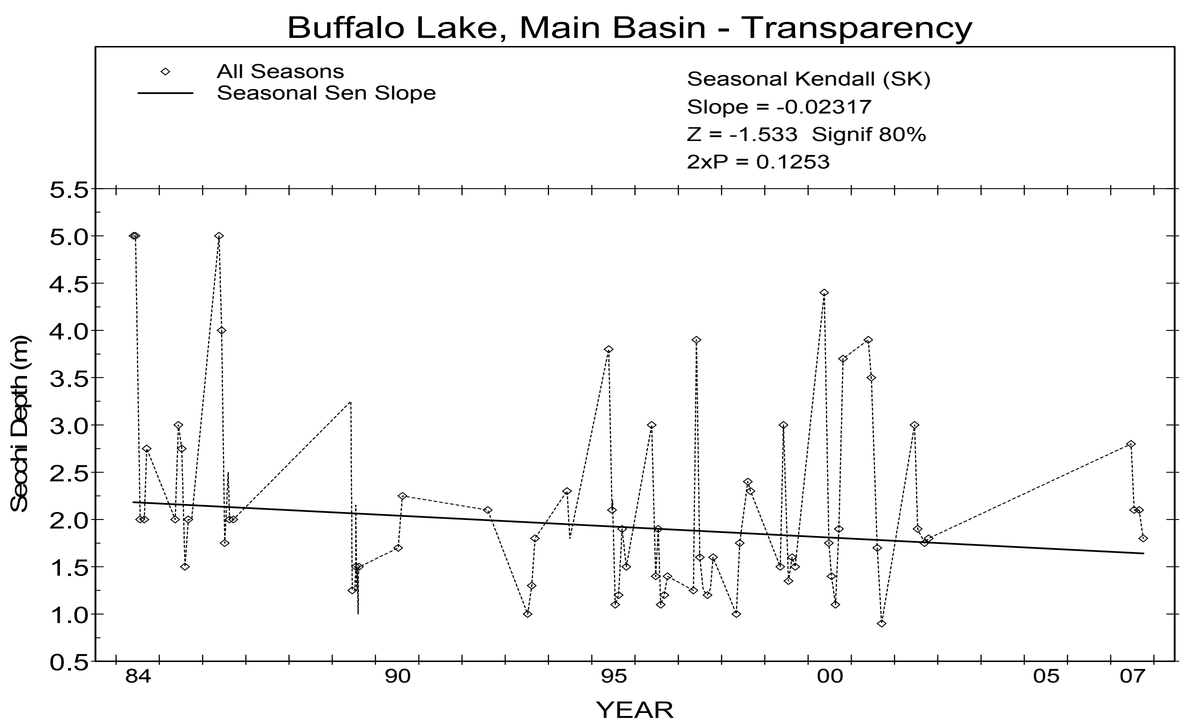
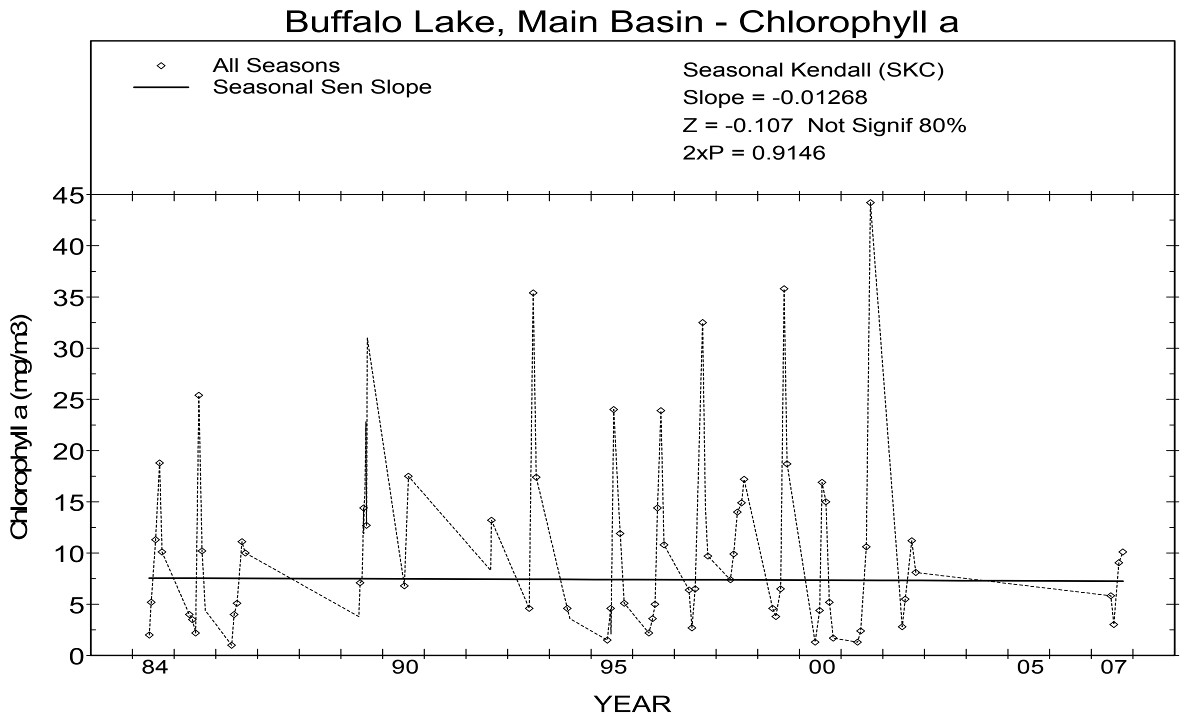


Figure 55 **Buffalo Lake, Main Basin –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



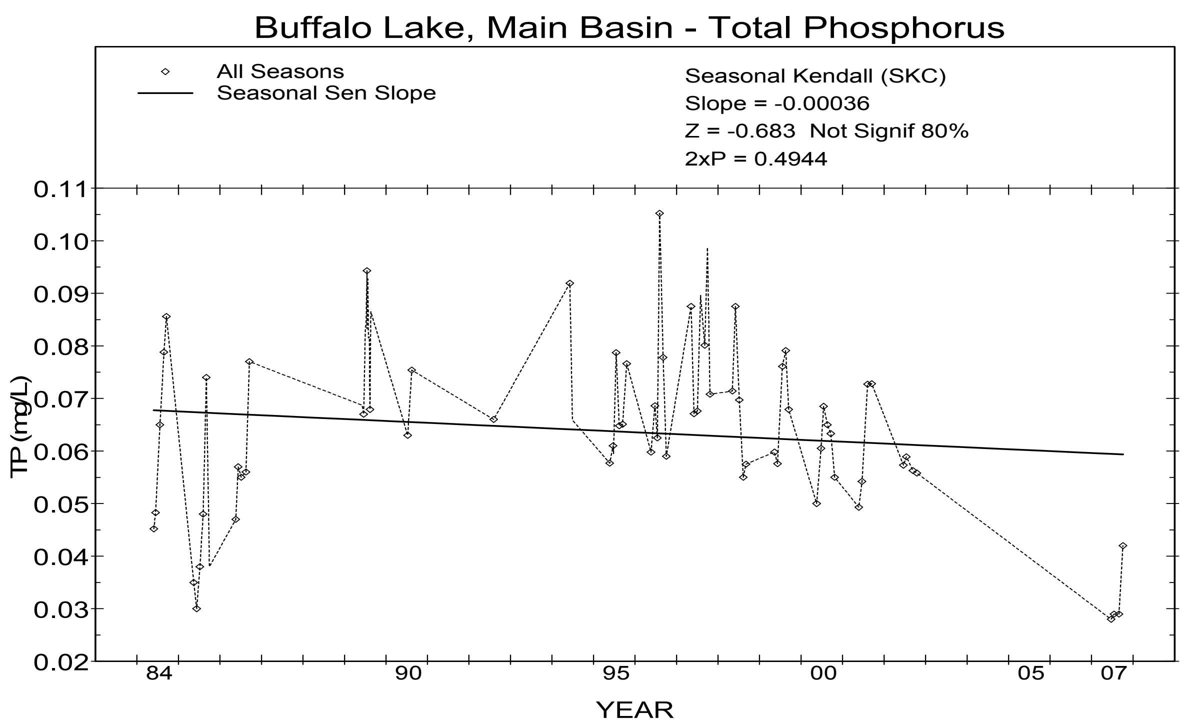
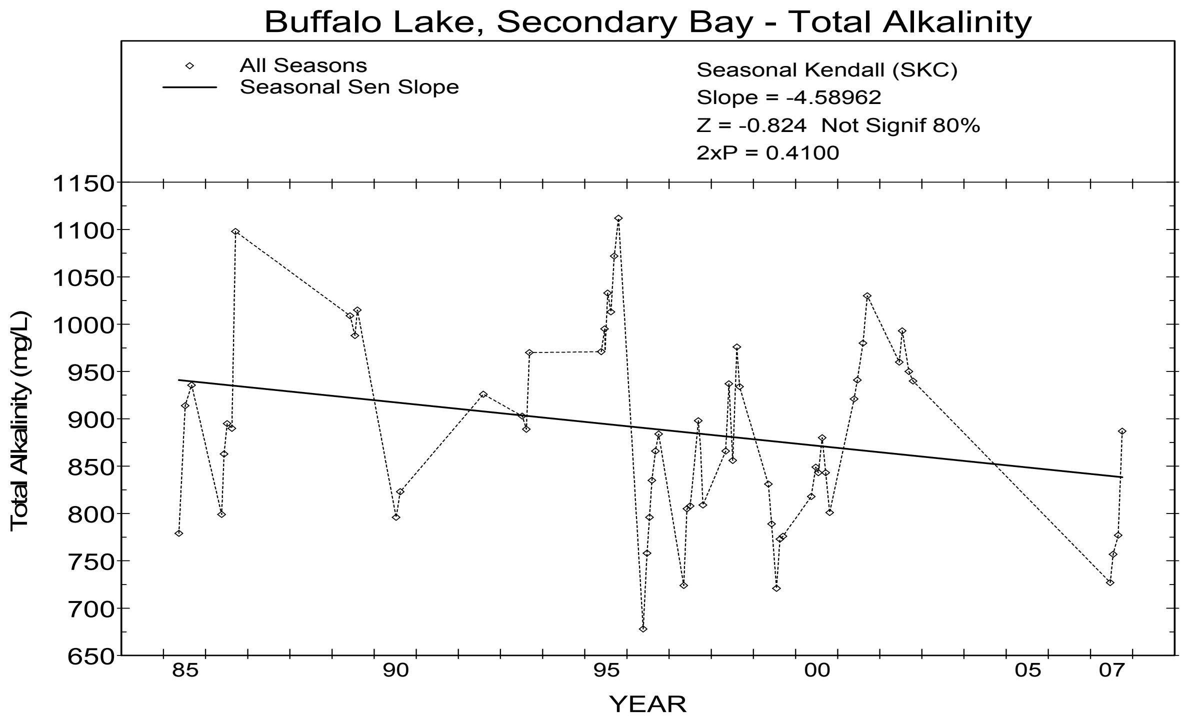


Figure 55 **Buffalo Lake, Main Basin –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



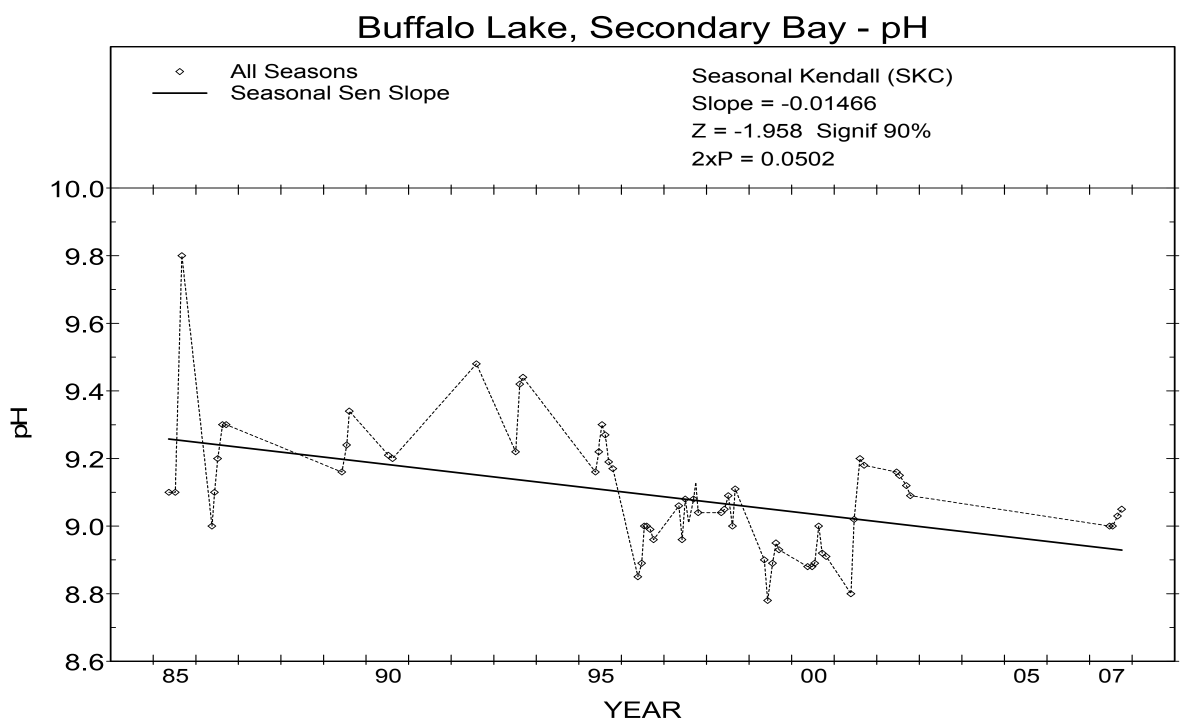
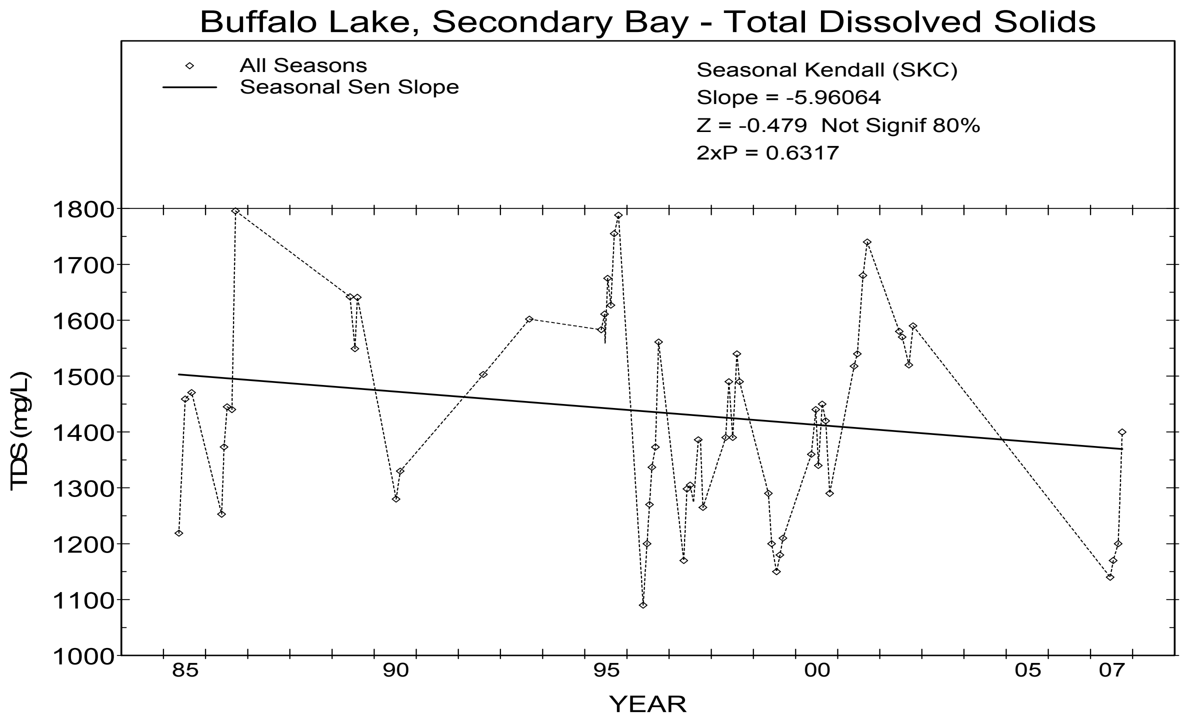


Figure 56 **Buffalo Lake, Secondary Bay** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



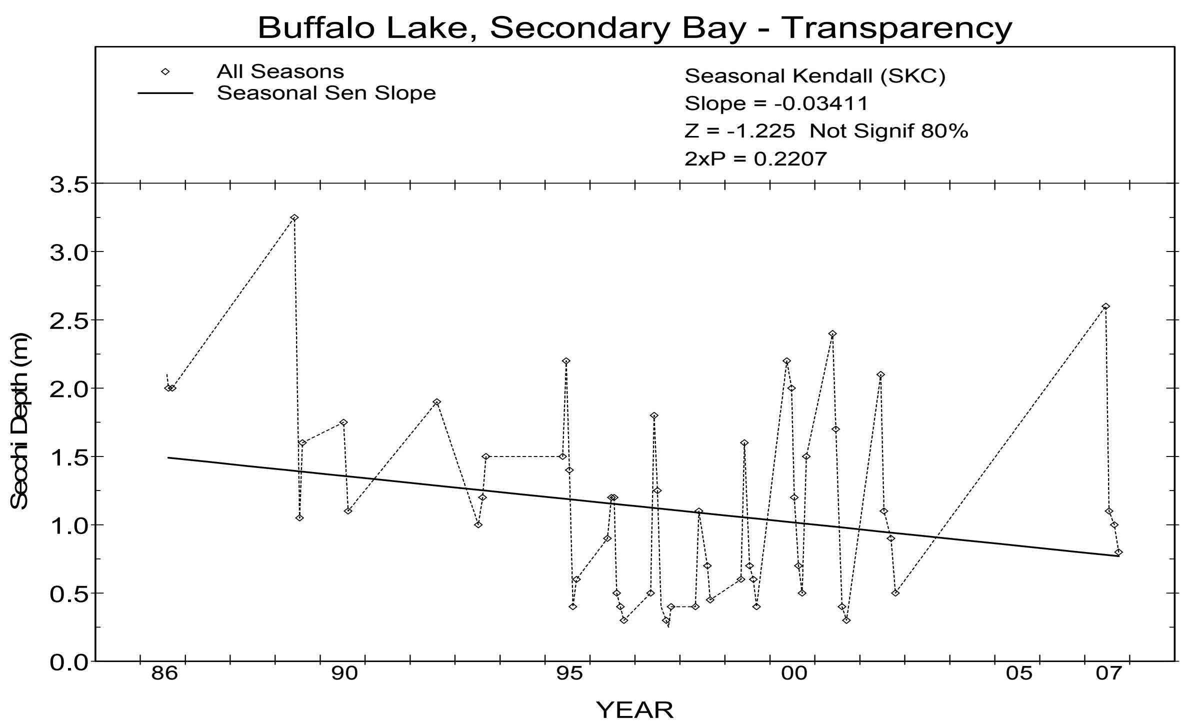
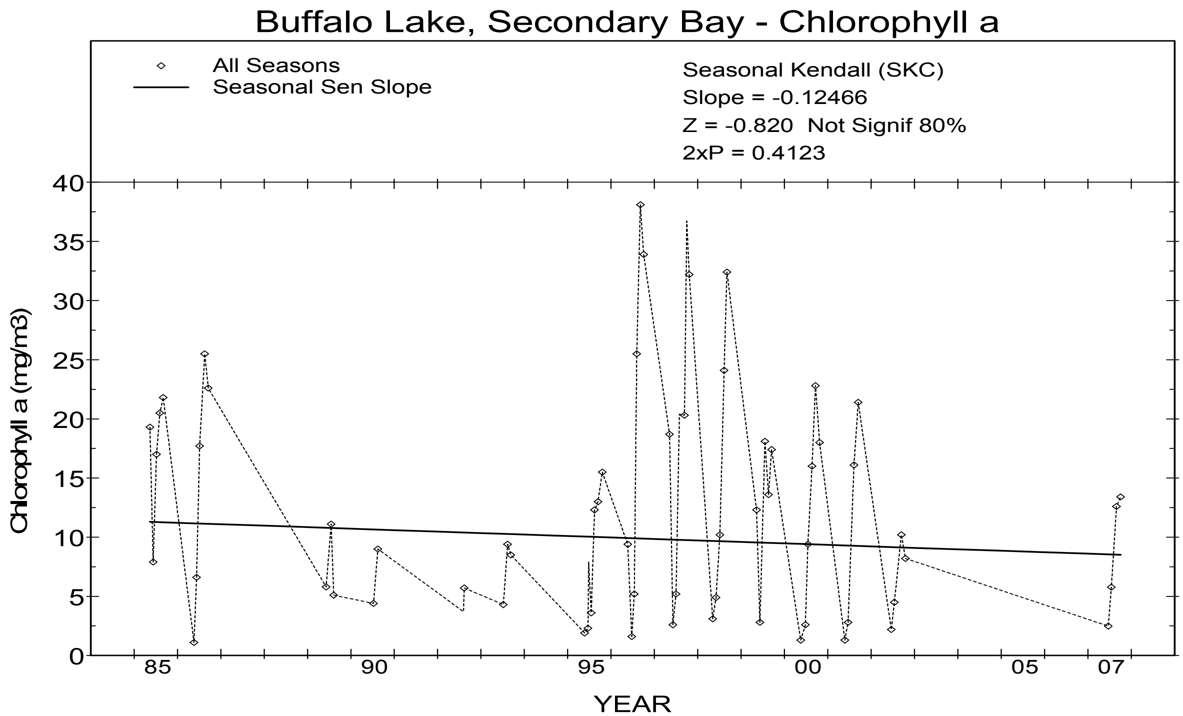


Figure 56 **Buffalo Lake, Secondary Bay** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



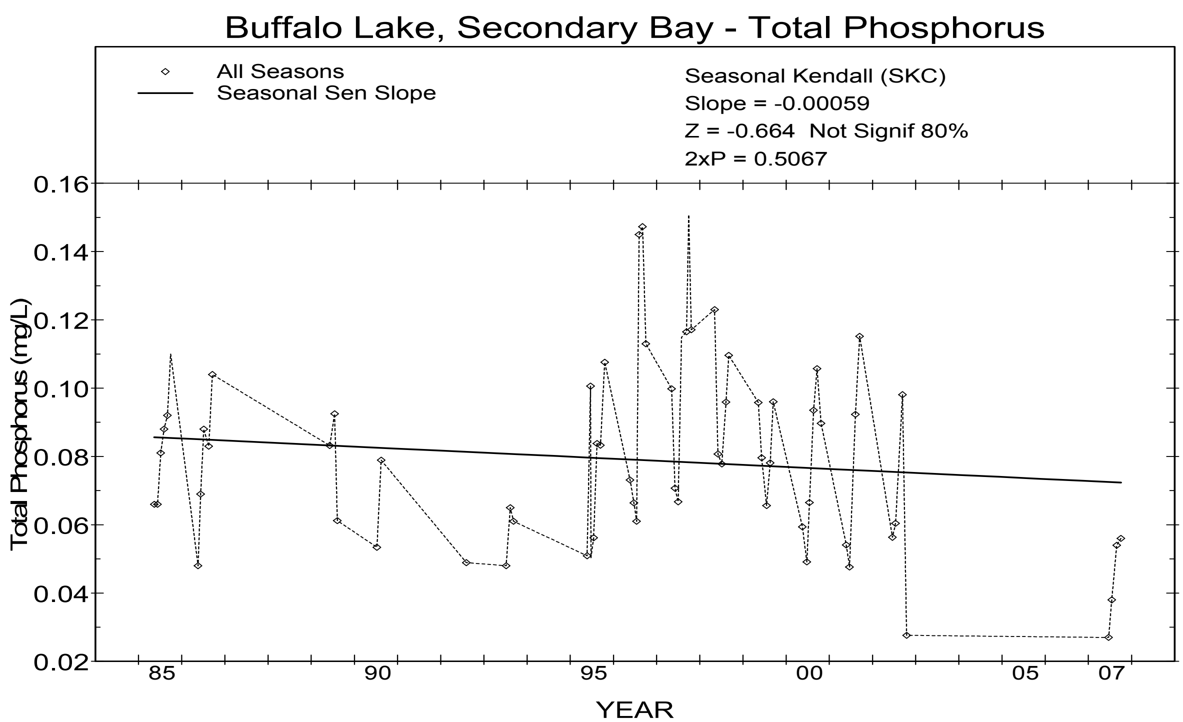
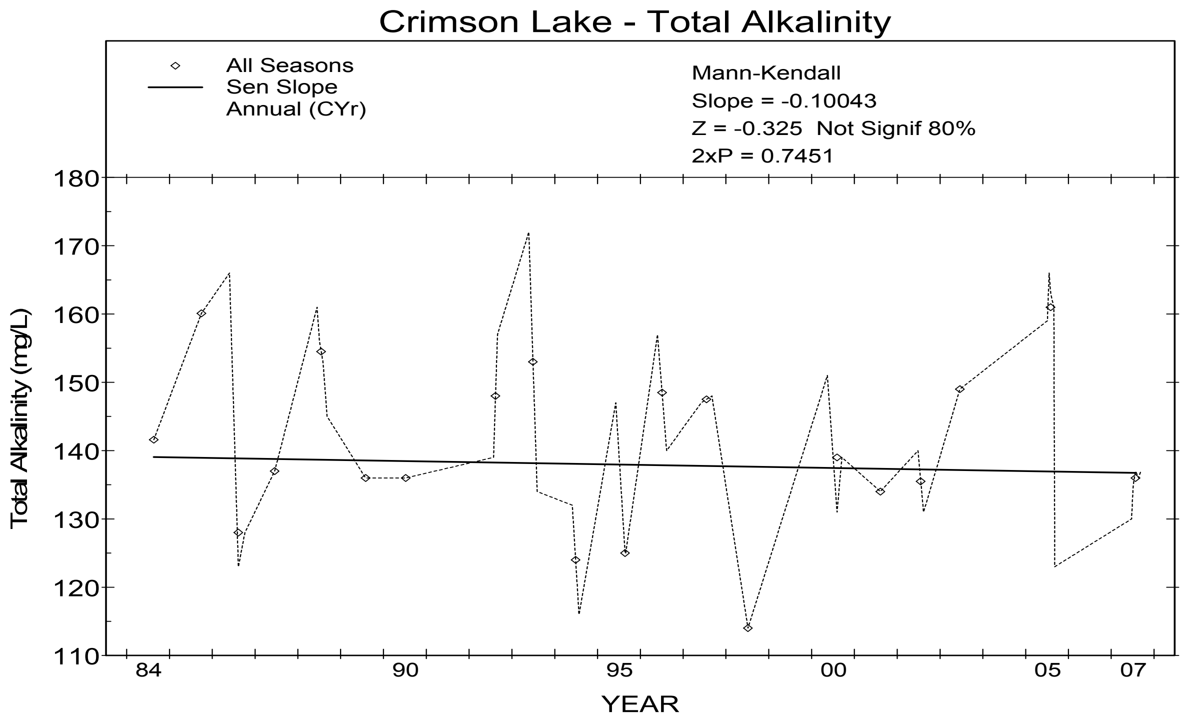


Figure 56 **Buffalo Lake, Secondary Bay** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



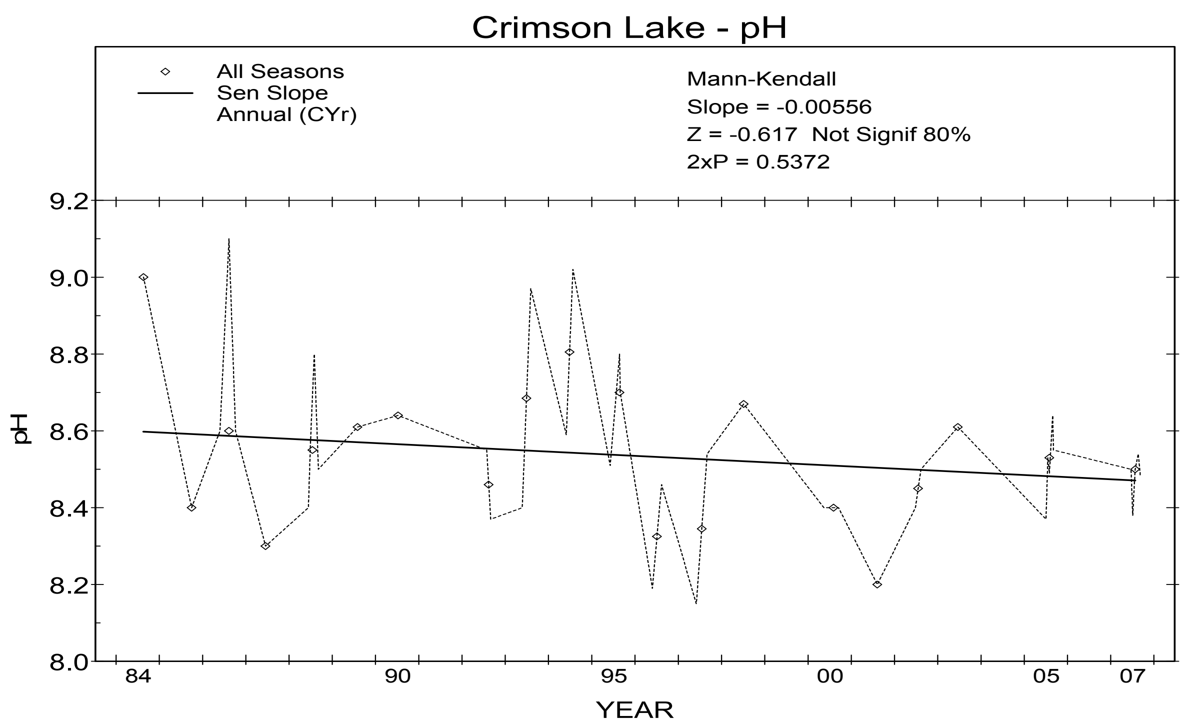
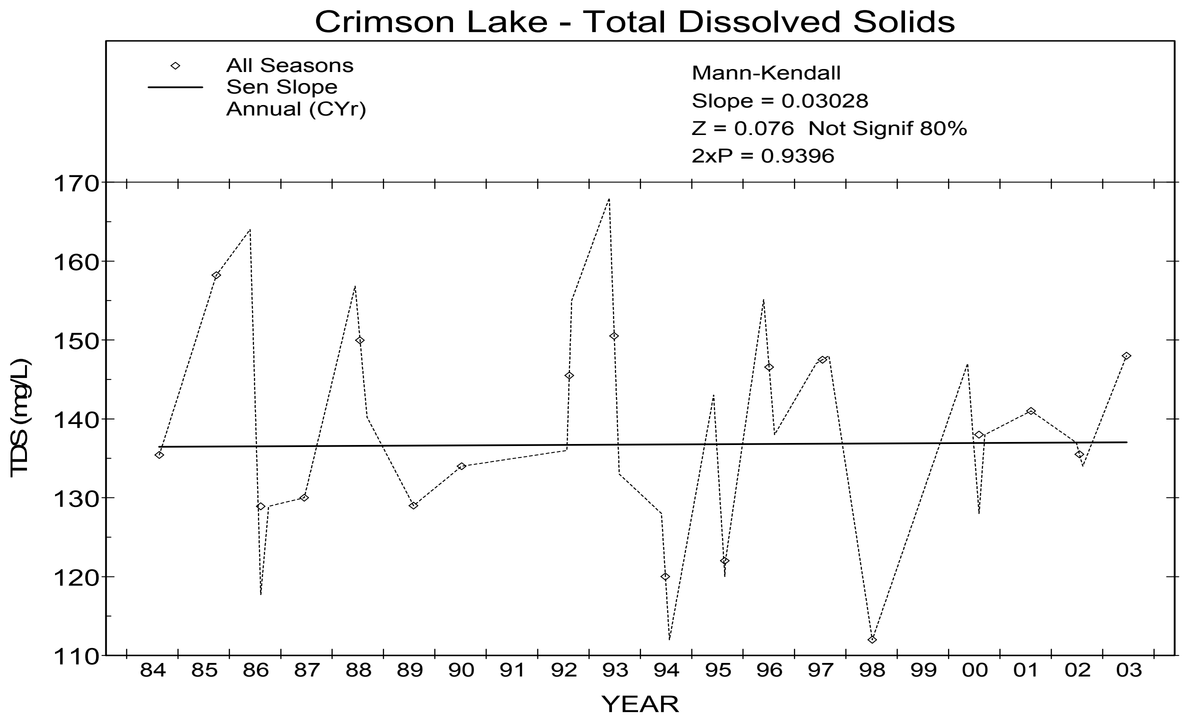


Figure 57 **Crimson Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



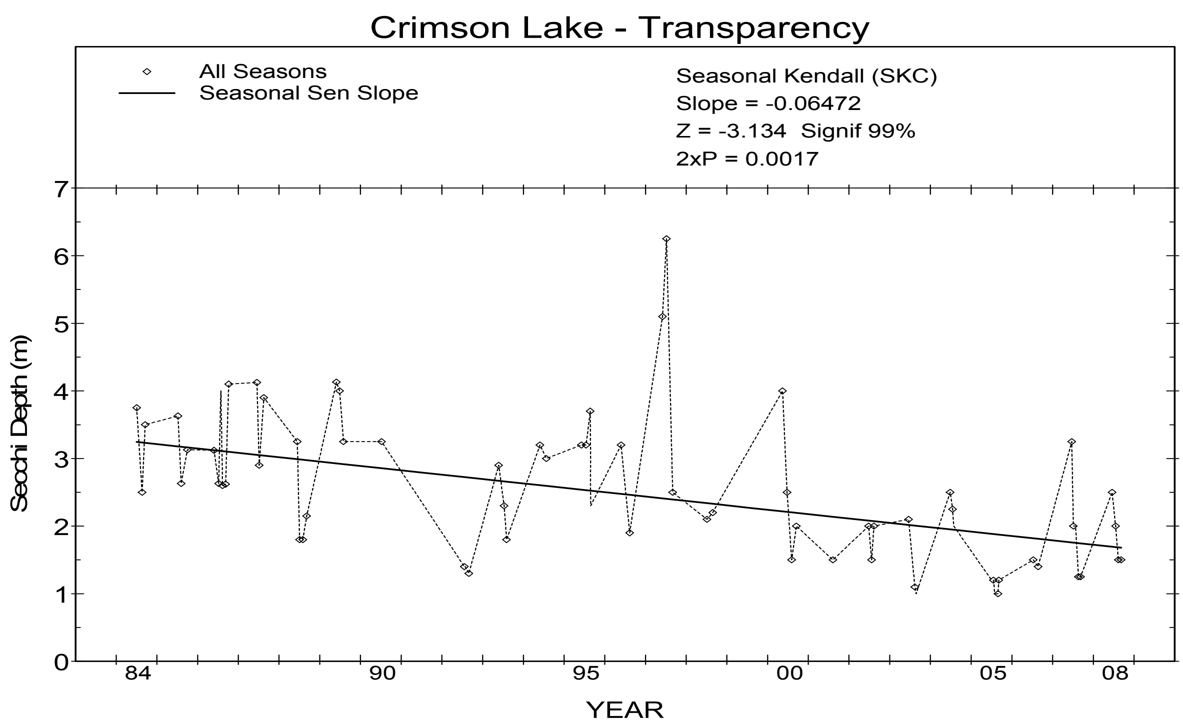
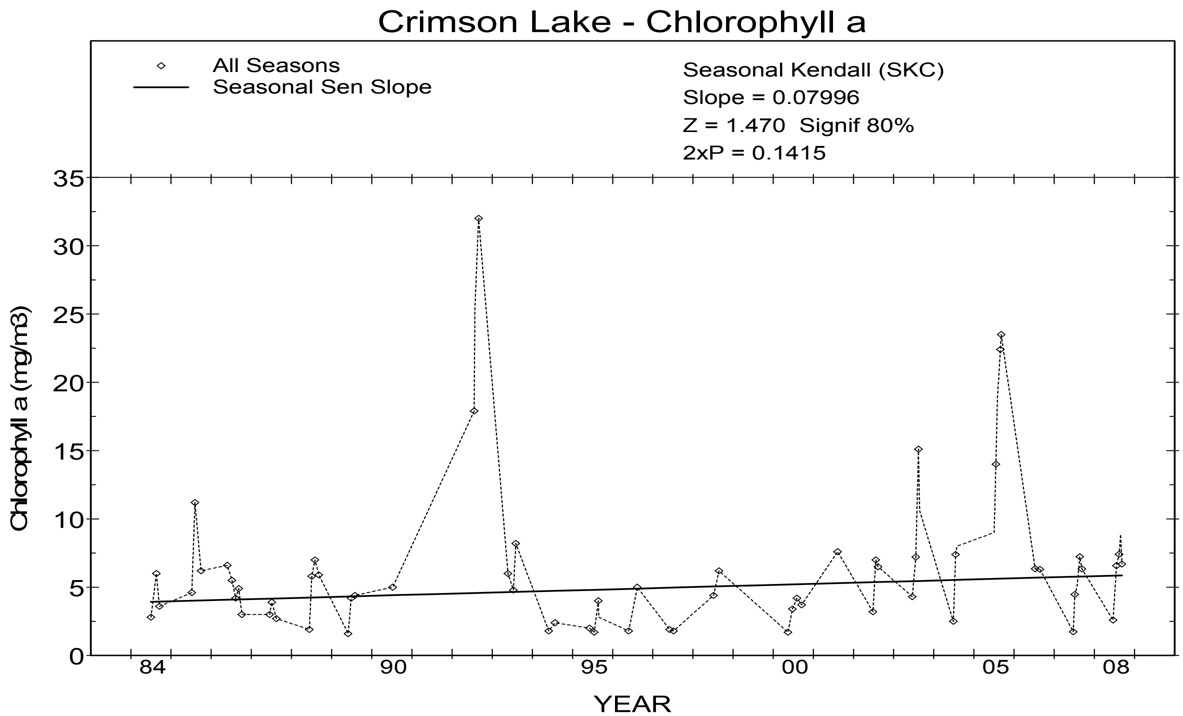


Figure 57 **Crimson Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



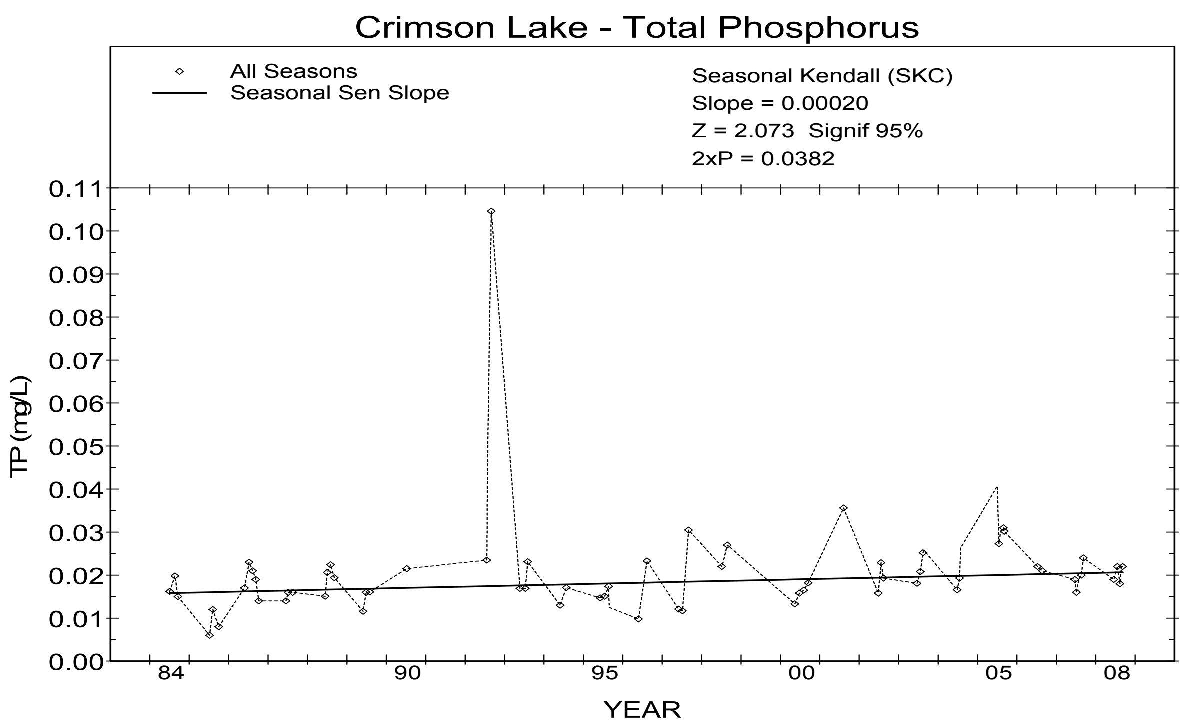
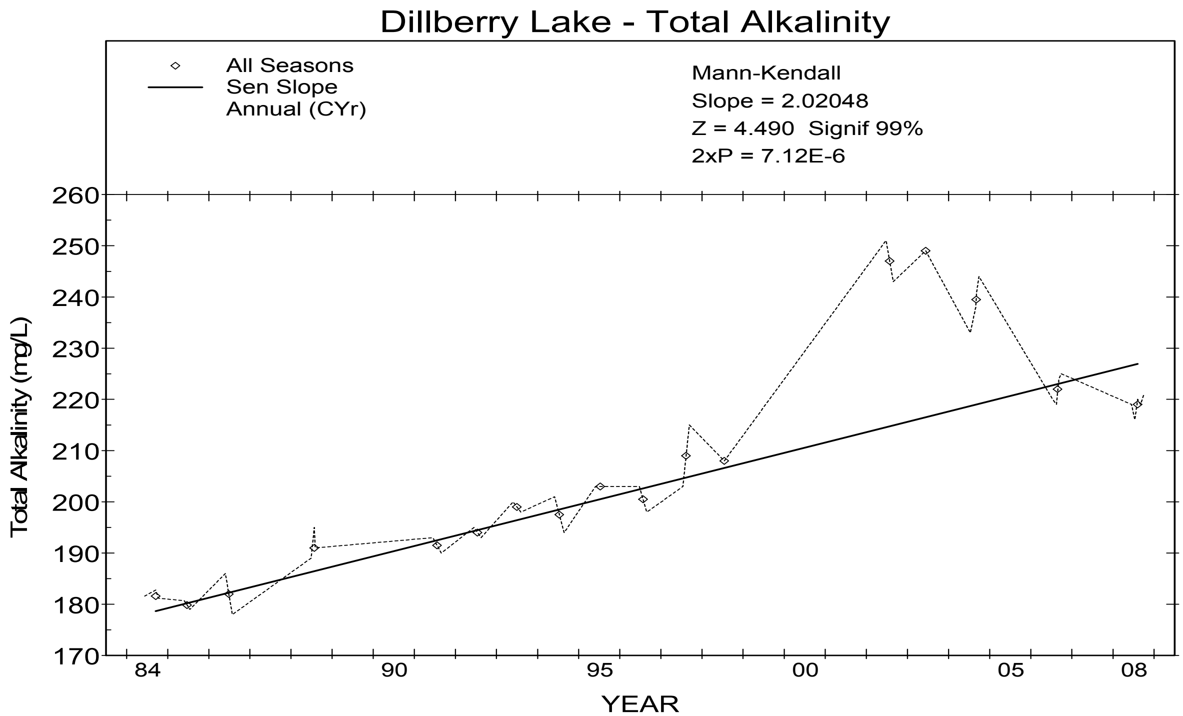


Figure 57 **Crimson Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



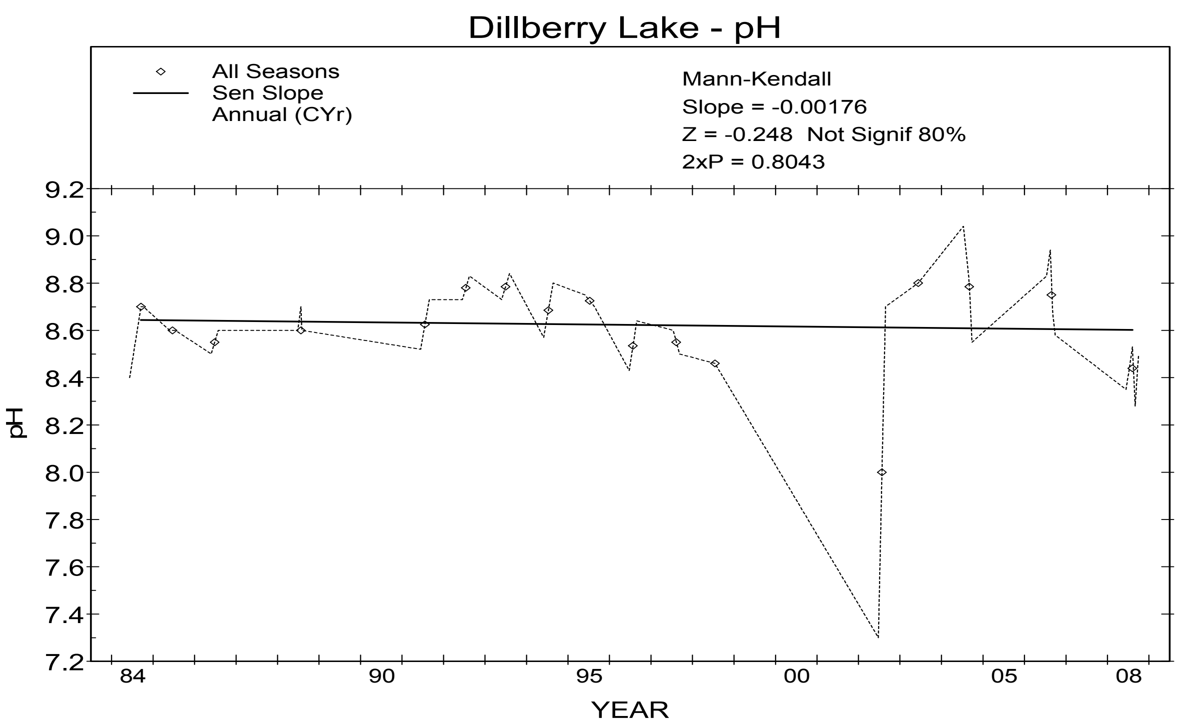
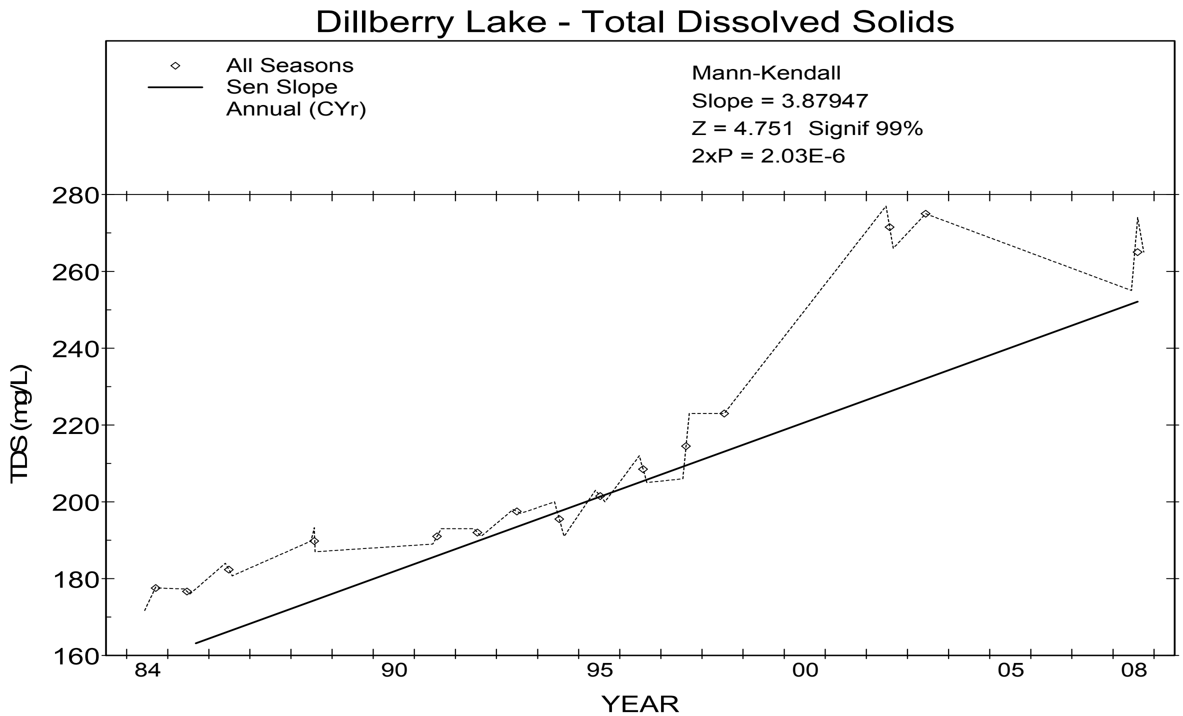


Figure 58 **Dillberry Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



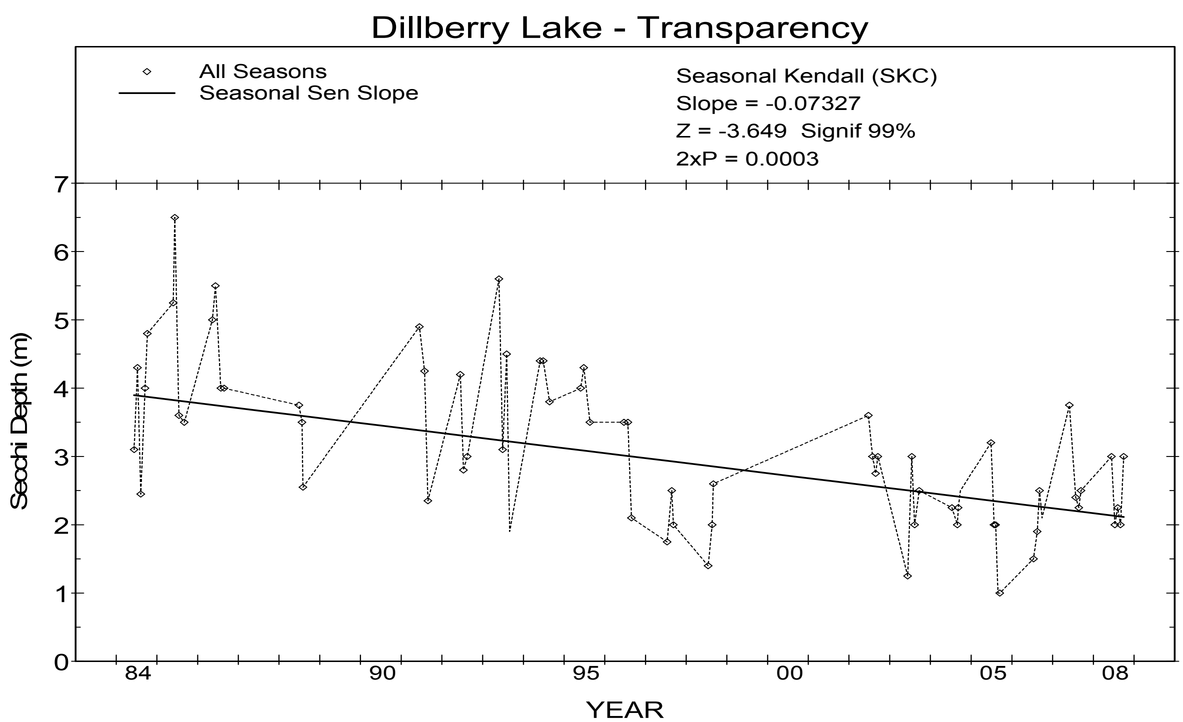
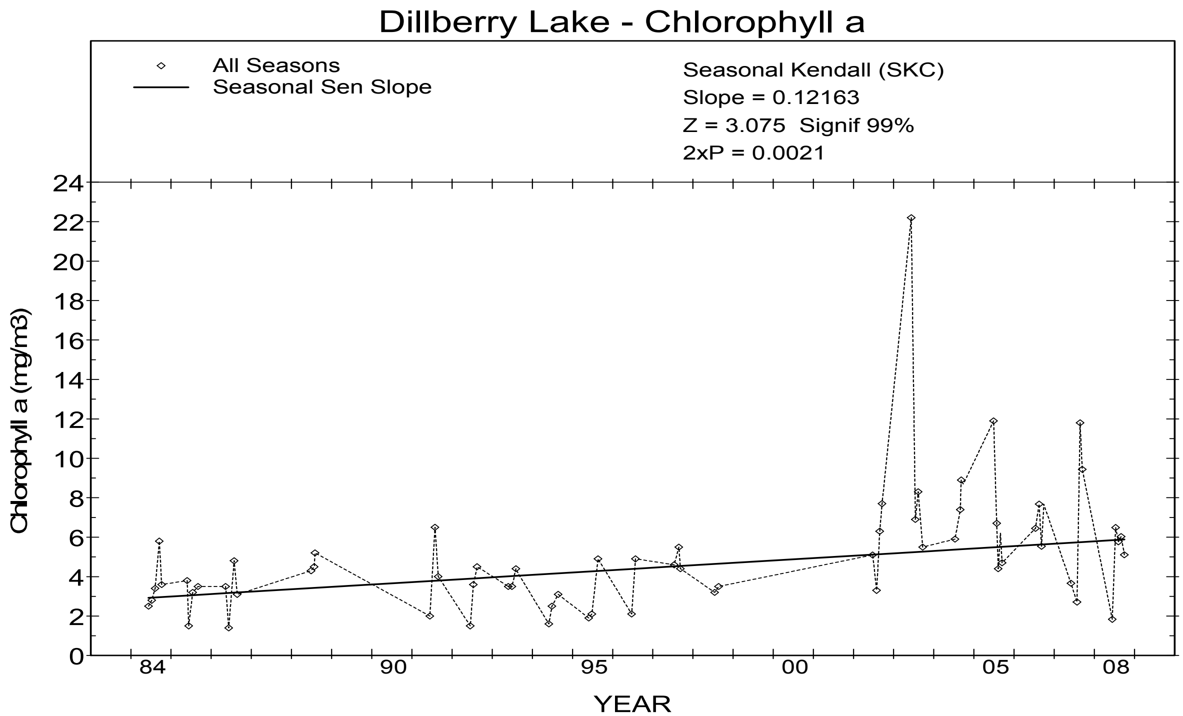


Figure 58 **Dillberry Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



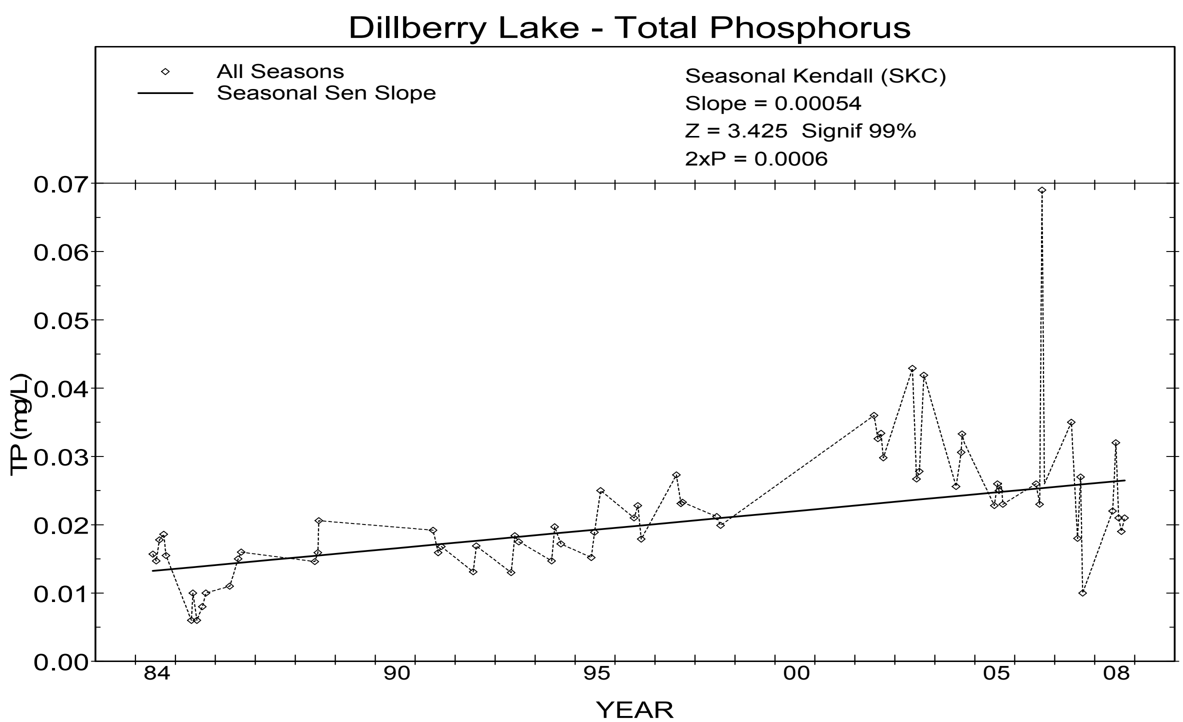
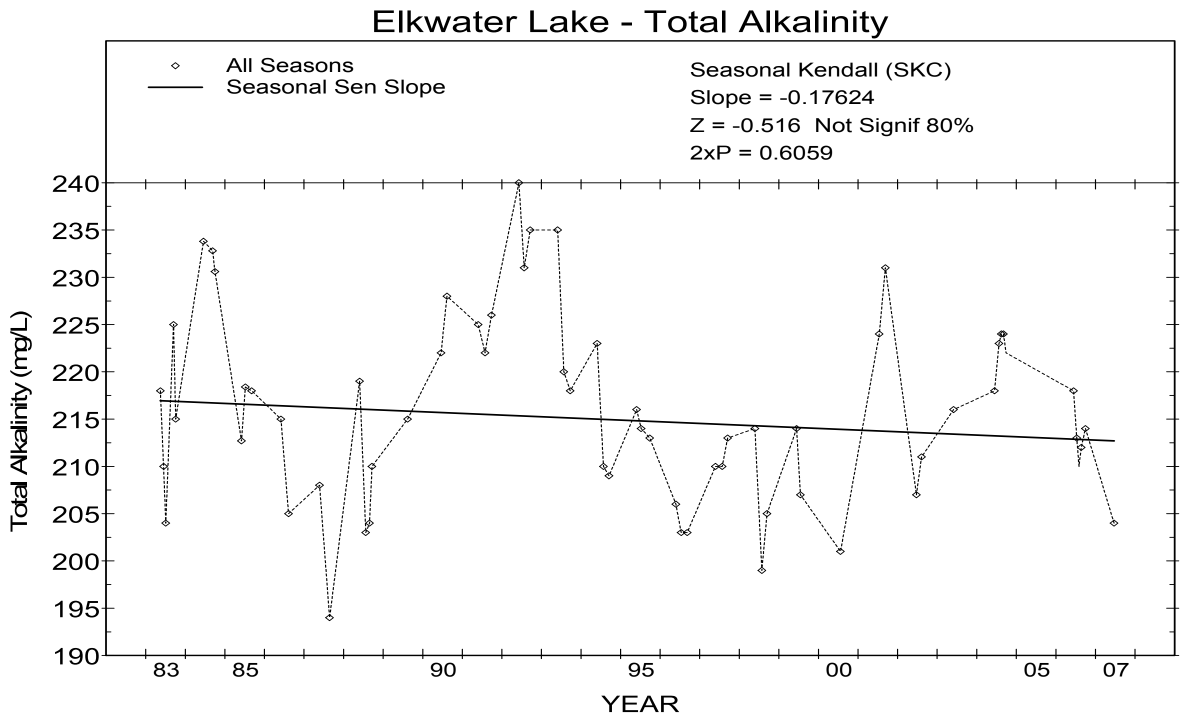


Figure 58 **Dillberry Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



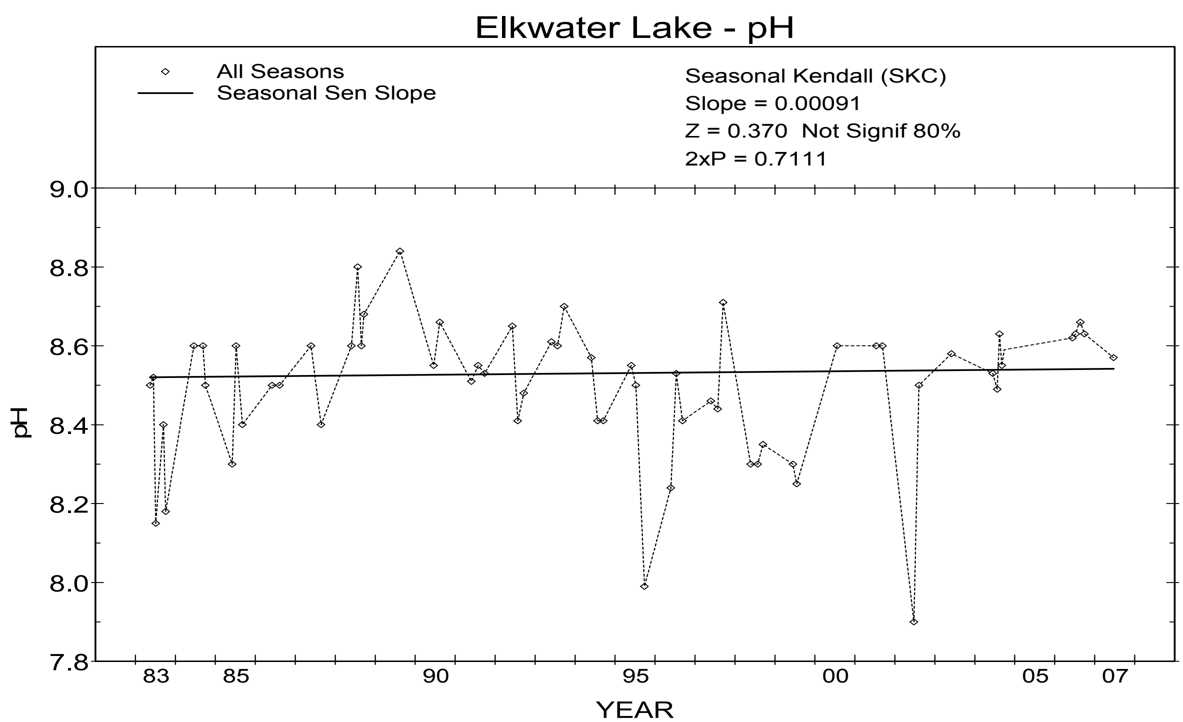
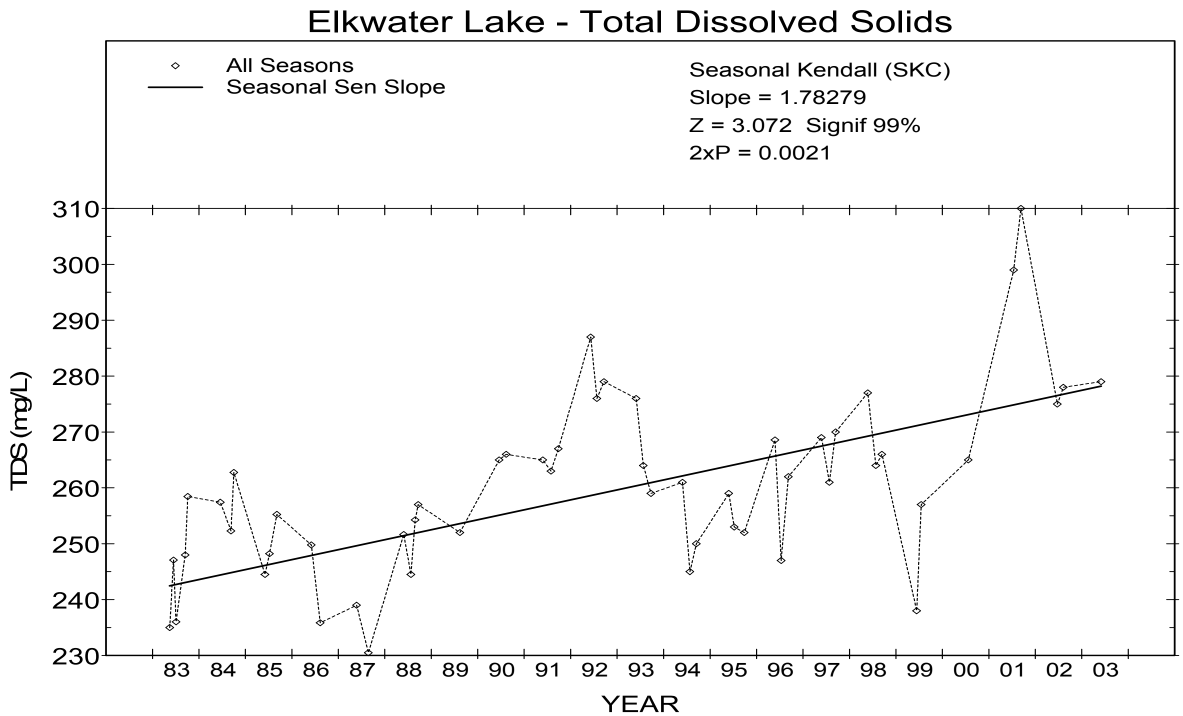


Figure 59 **Elkwater Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



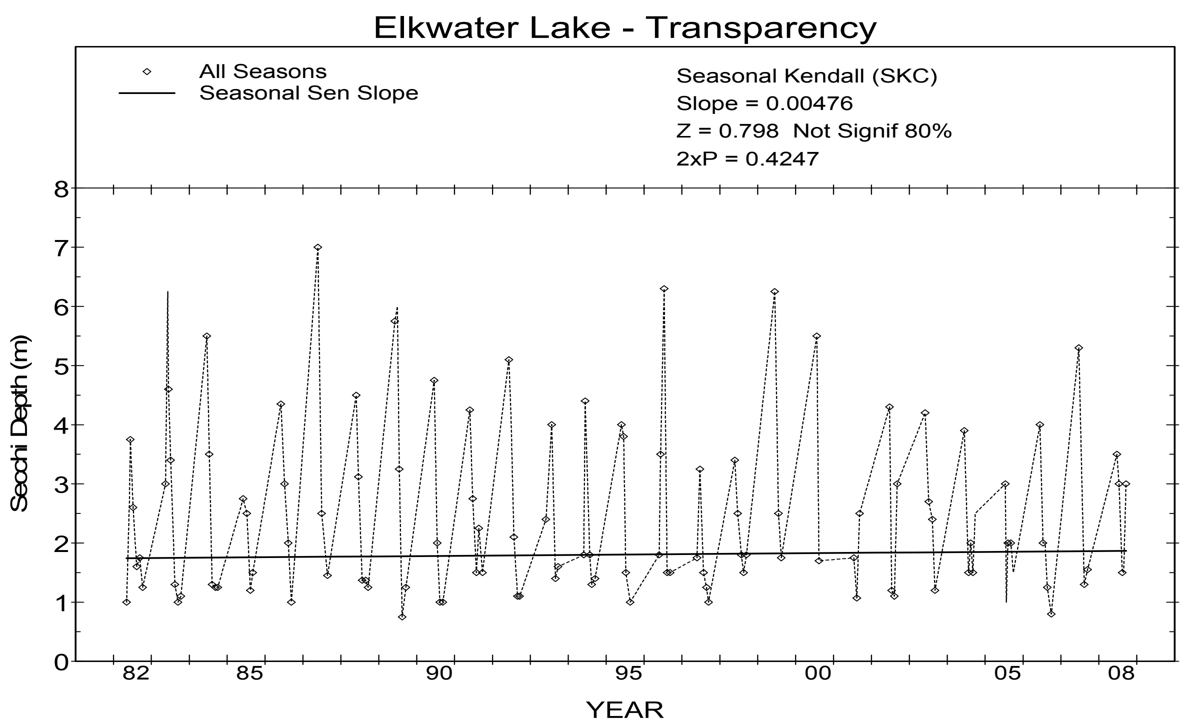
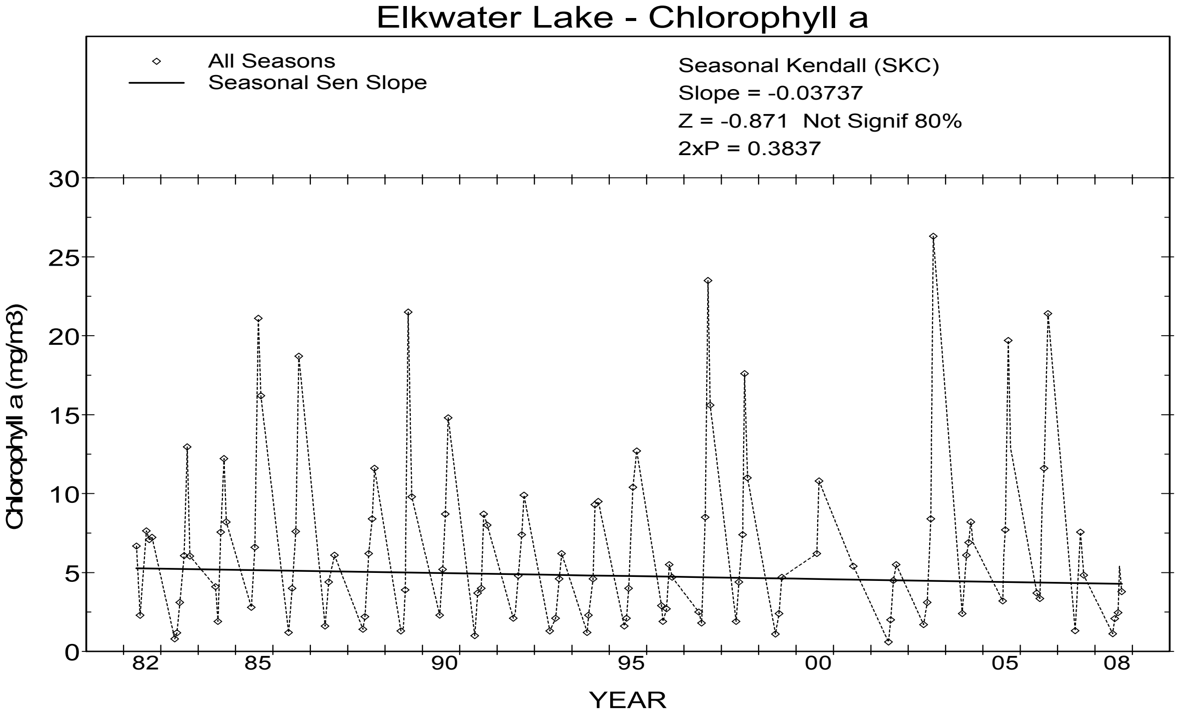


Figure 59 **Elkwater Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



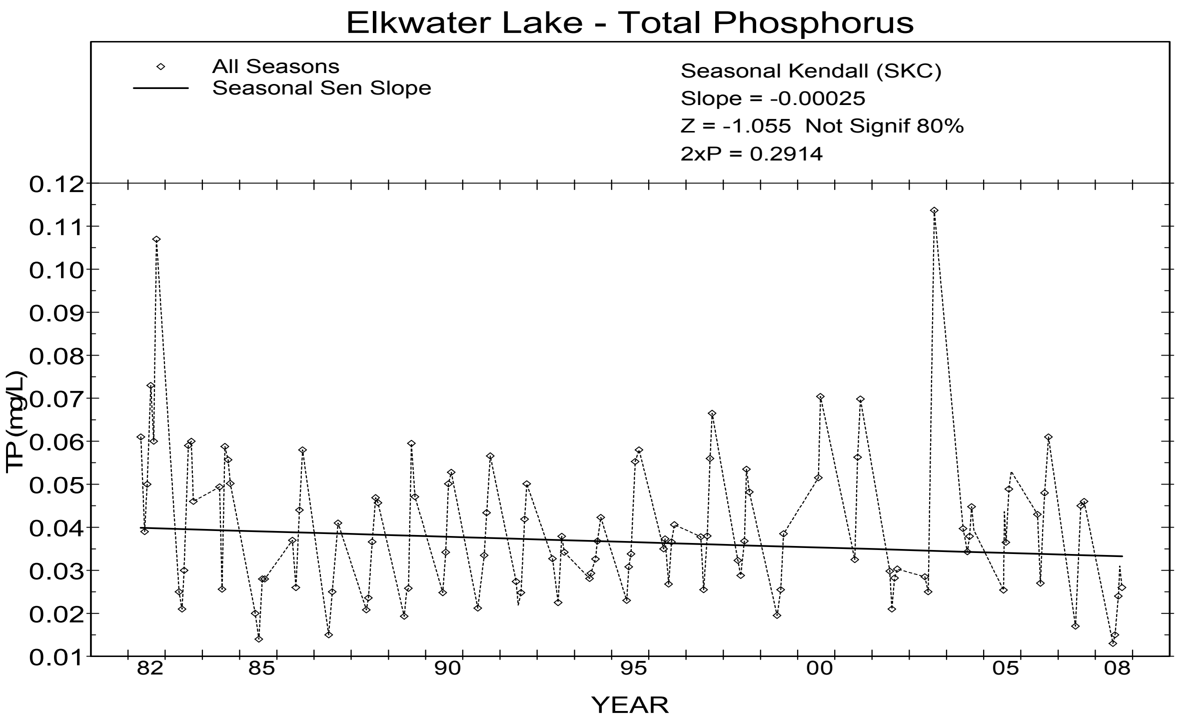
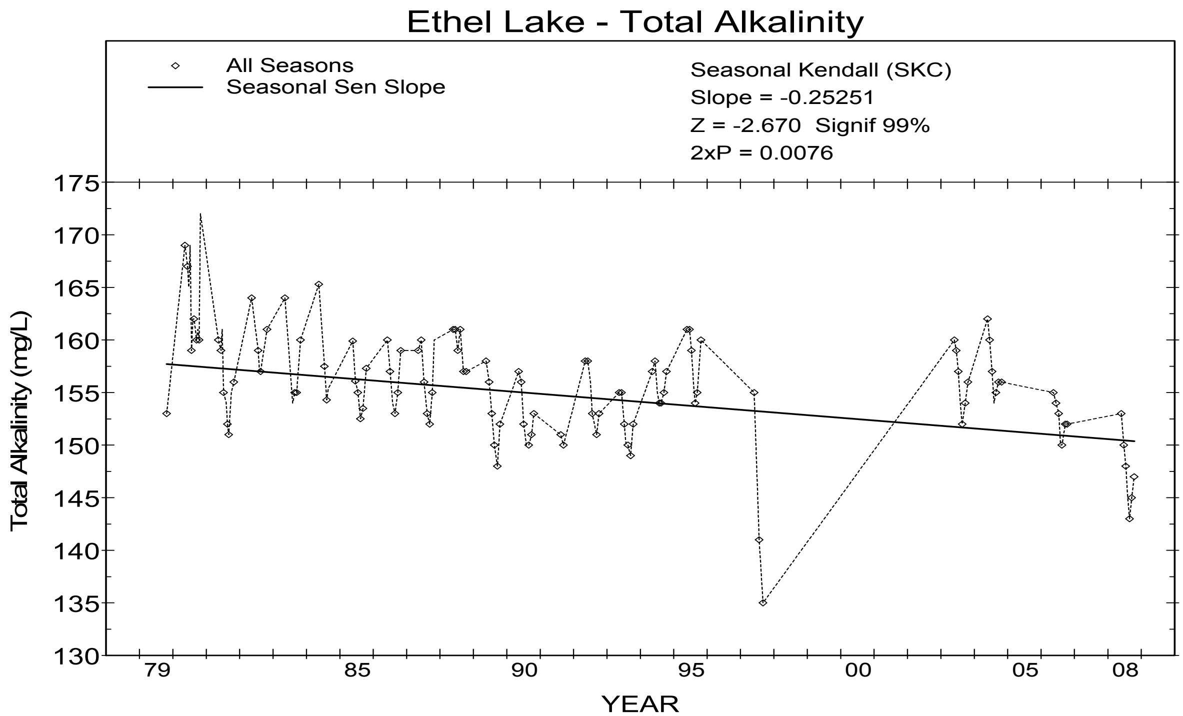


Figure 59 **Elkwater Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



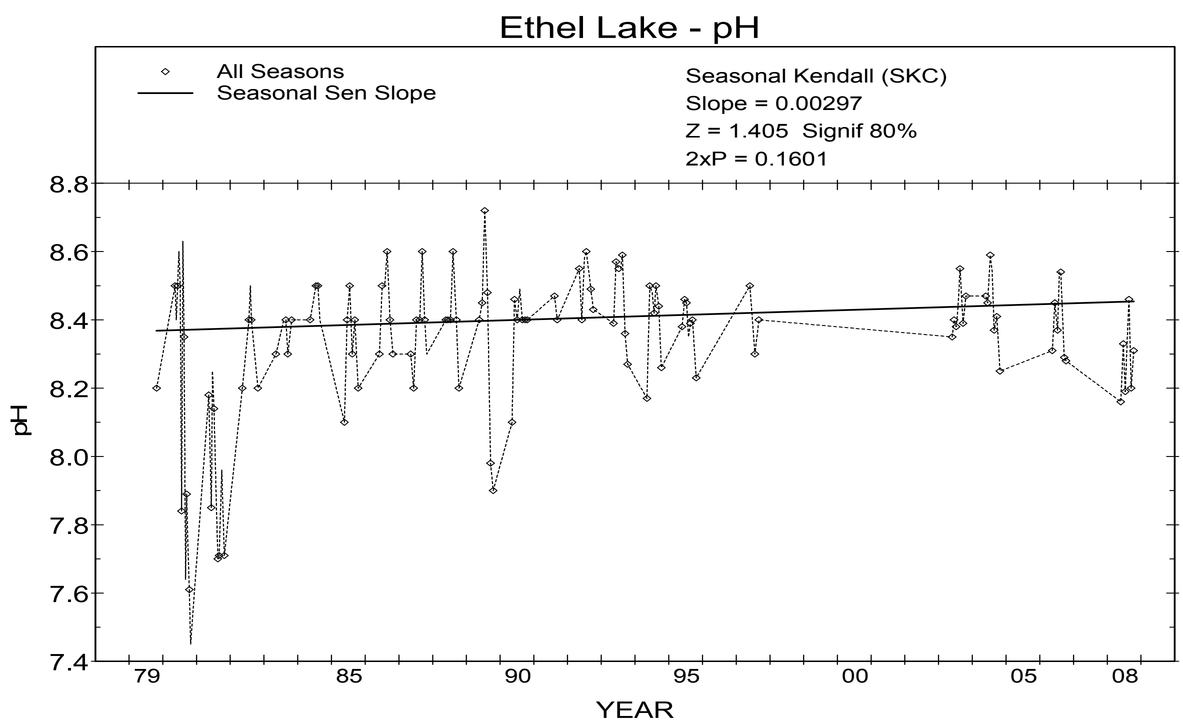
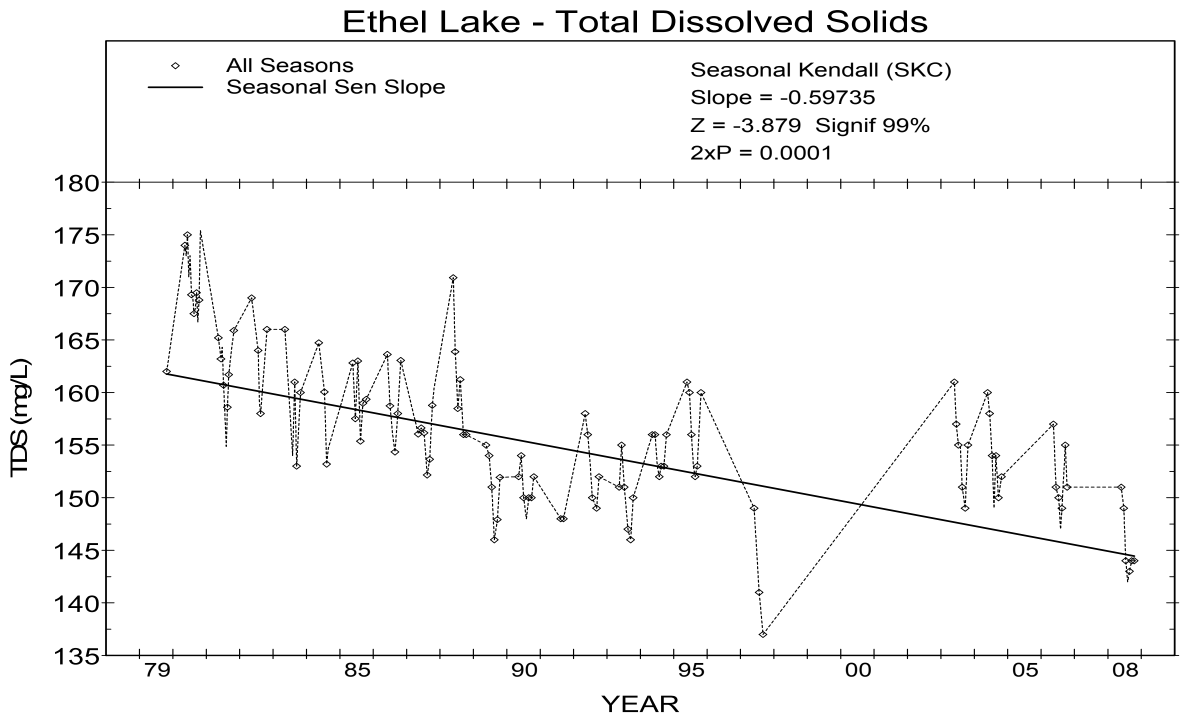


Figure 60a **Ethel Lake (near Cold Lake)** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



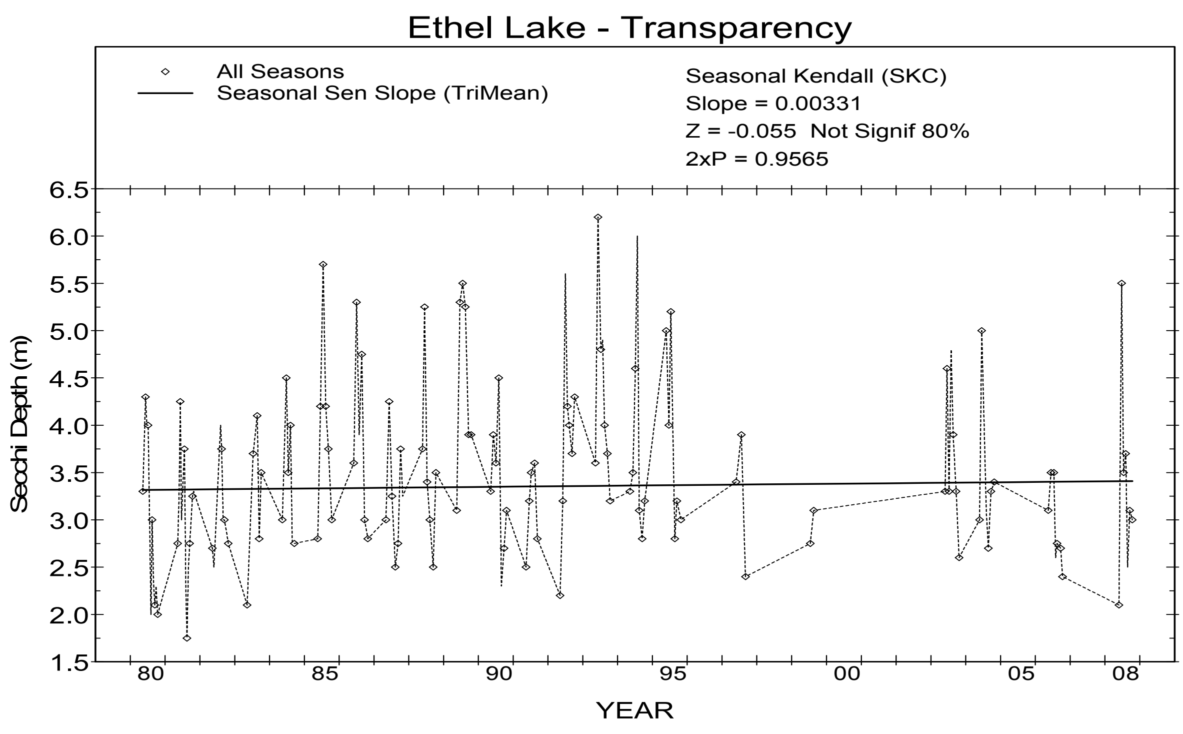
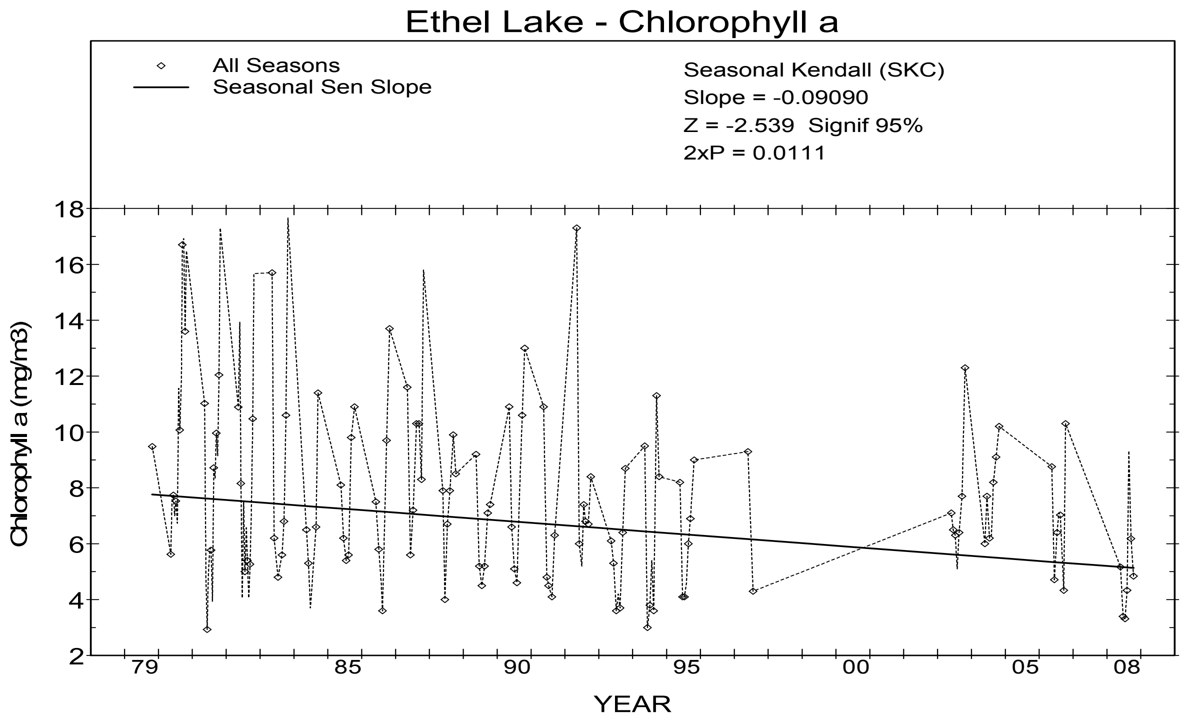


Figure 60a **Ethel Lake (near Cold Lake)** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



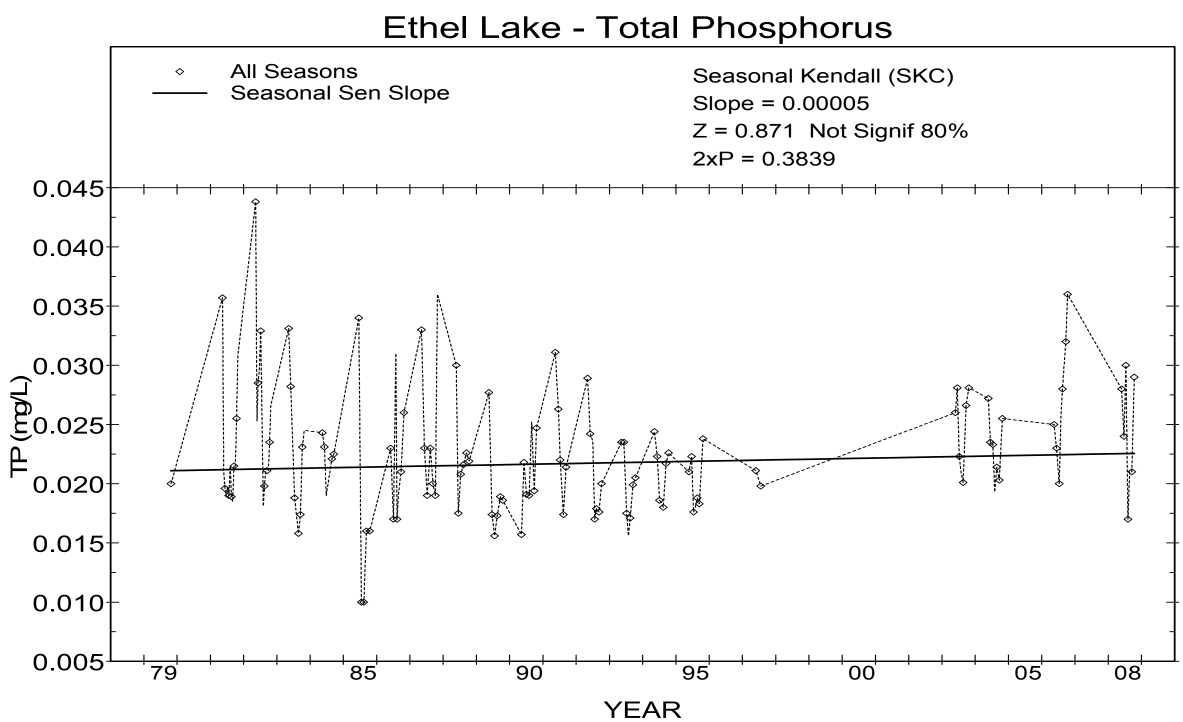
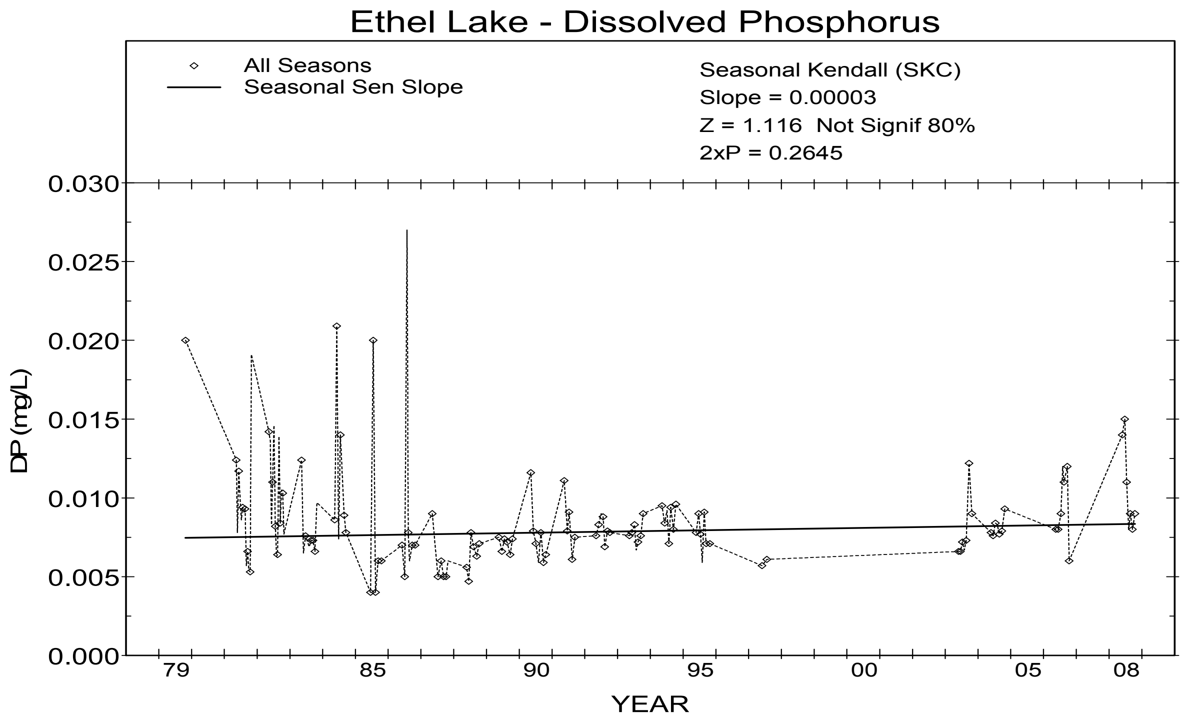


Figure 60a **Ethel Lake (near Cold Lake)** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



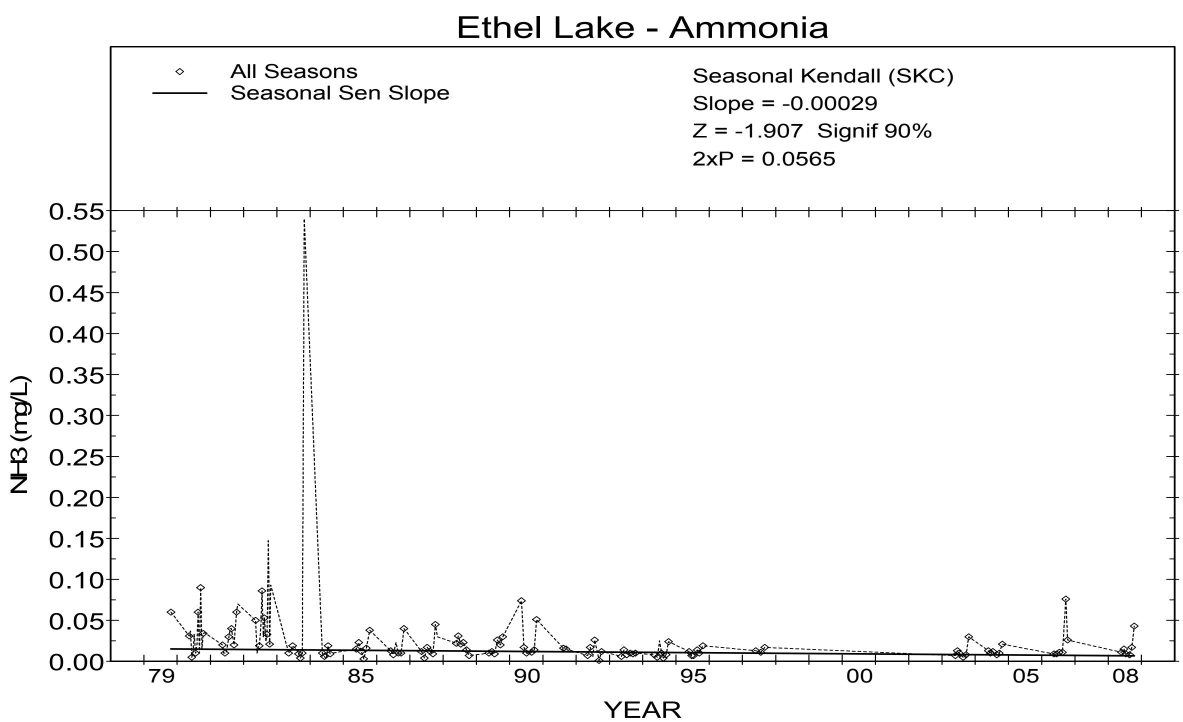
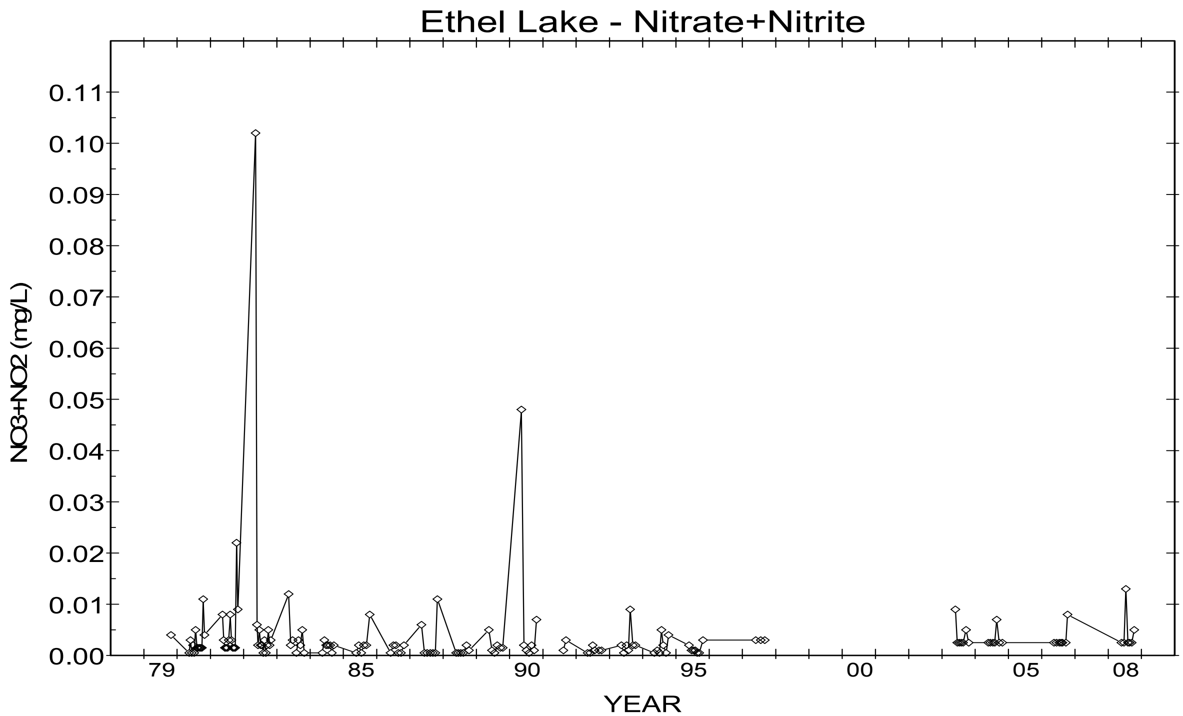


Figure 60b **Ethel Lake (near Cold Lake)** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record



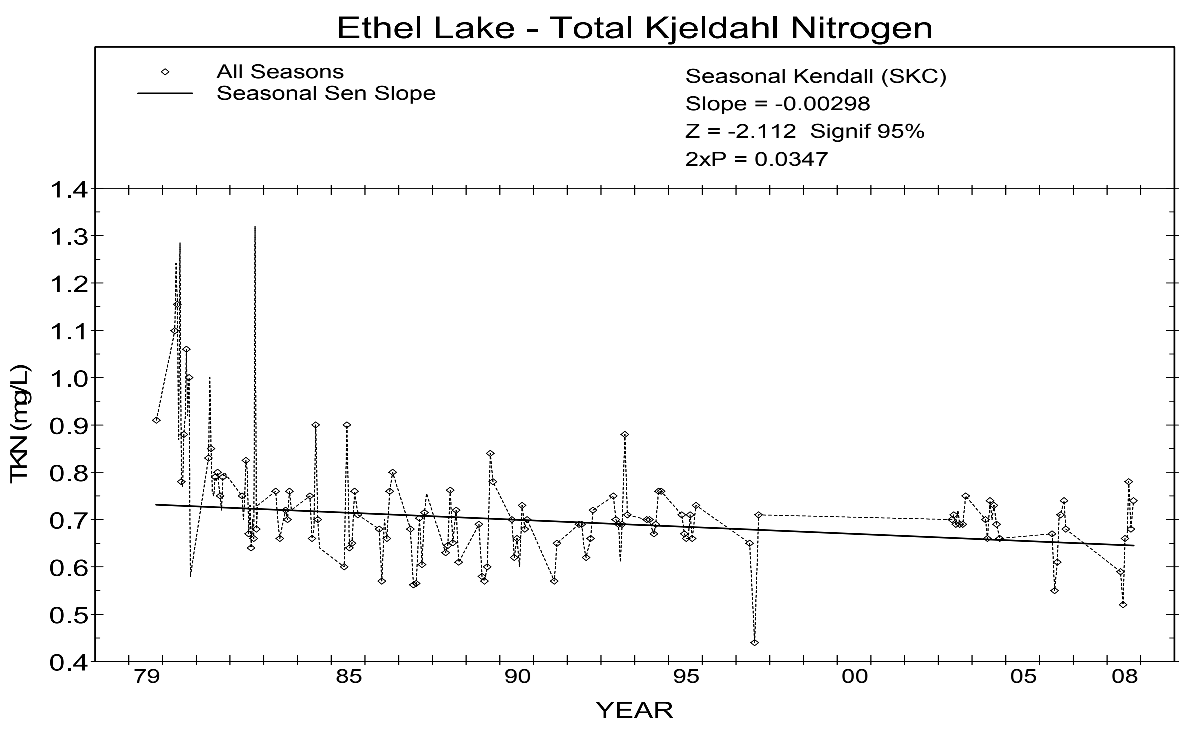
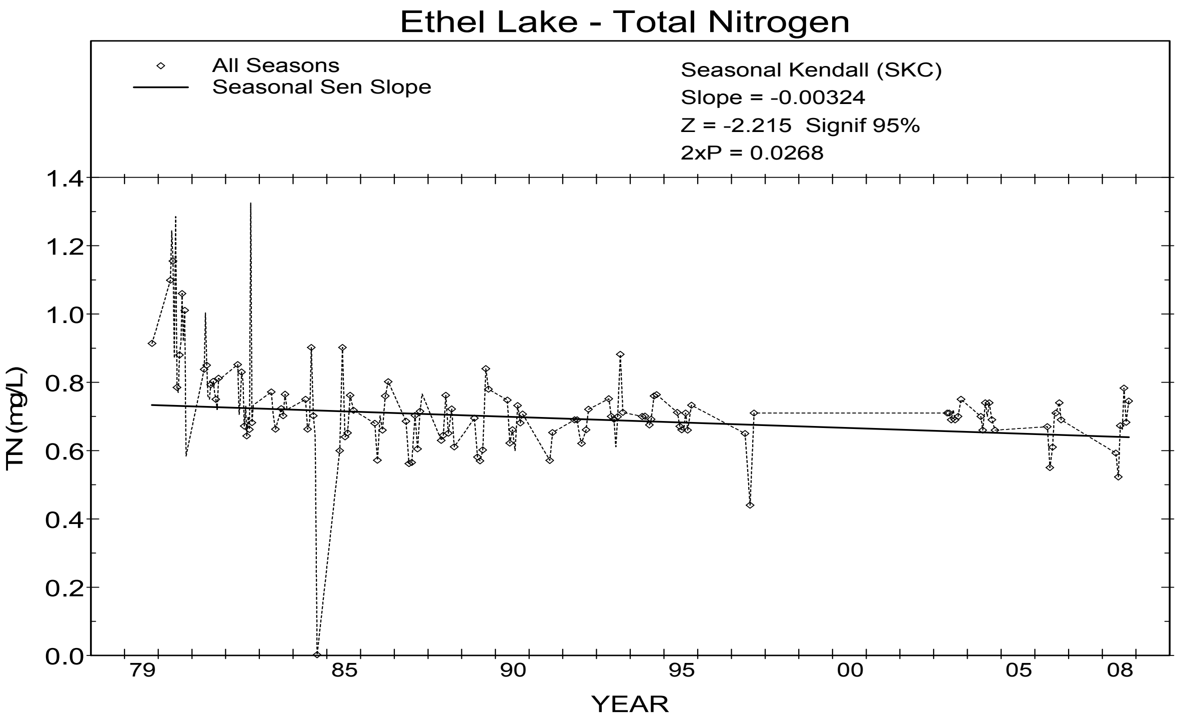


Figure 60b **Ethel Lake (near Cold Lake)** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record. Trends were not evaluated for nitrate+nitrite-N due to excessive censored data (46% of the samples) (continued)



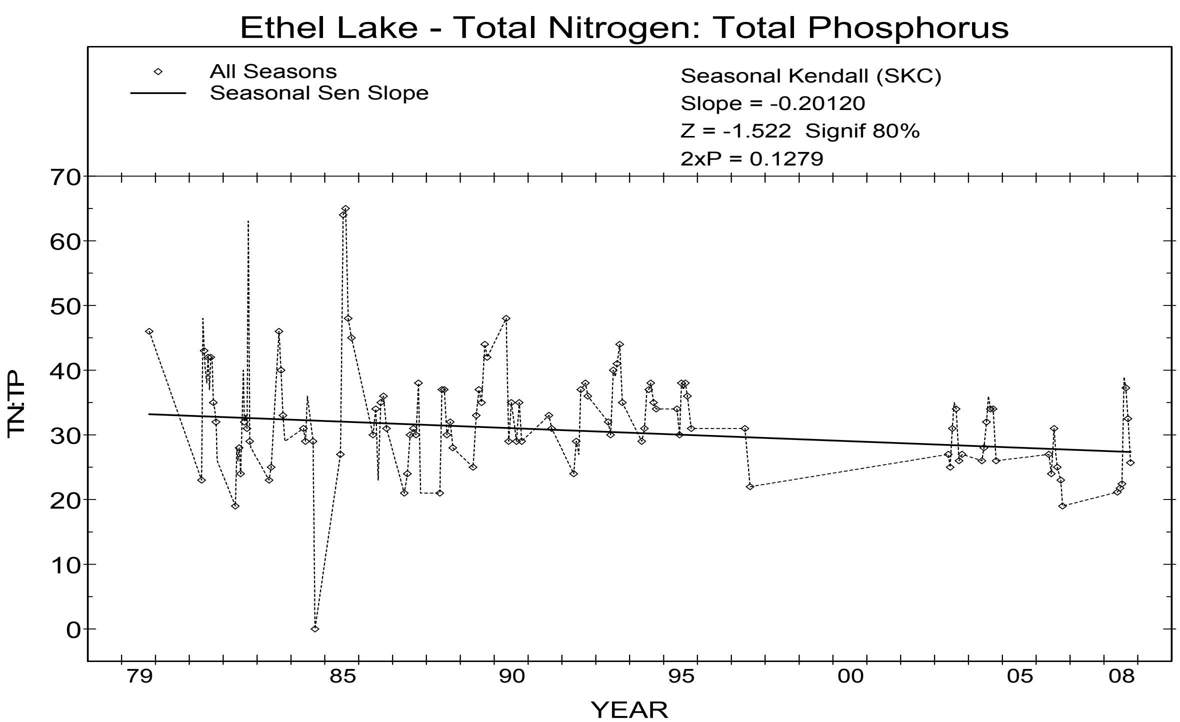
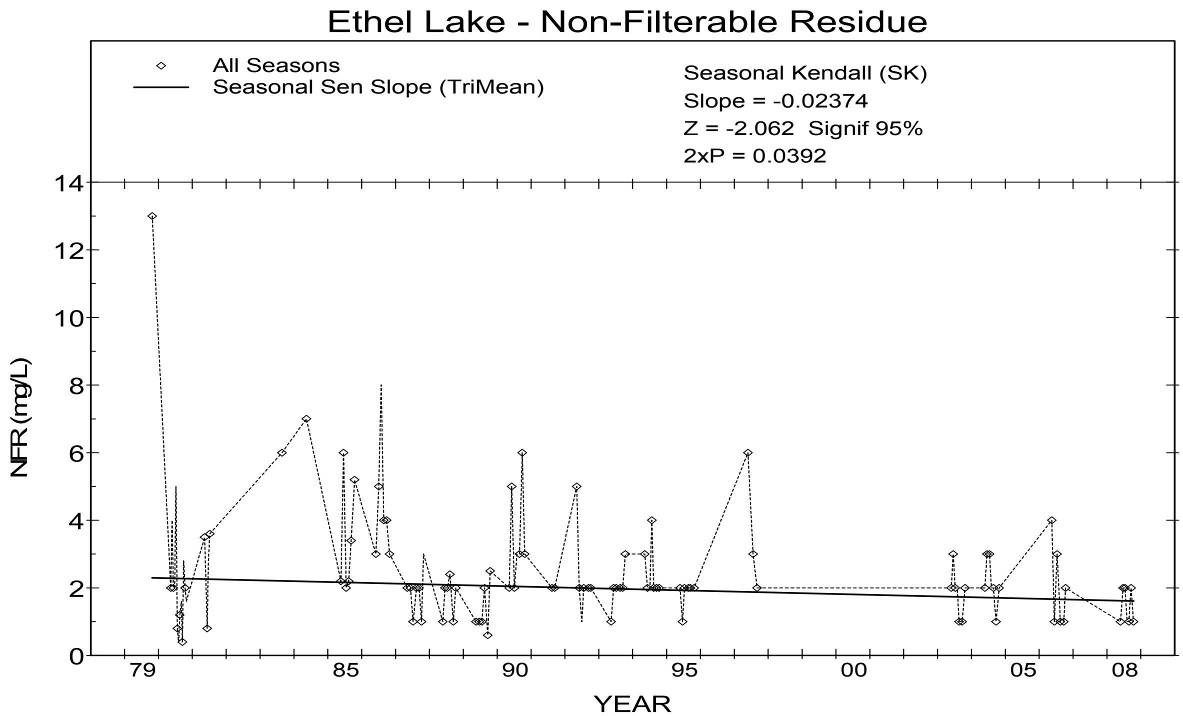


Figure 60b **Ethel Lake (near Cold Lake)** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)



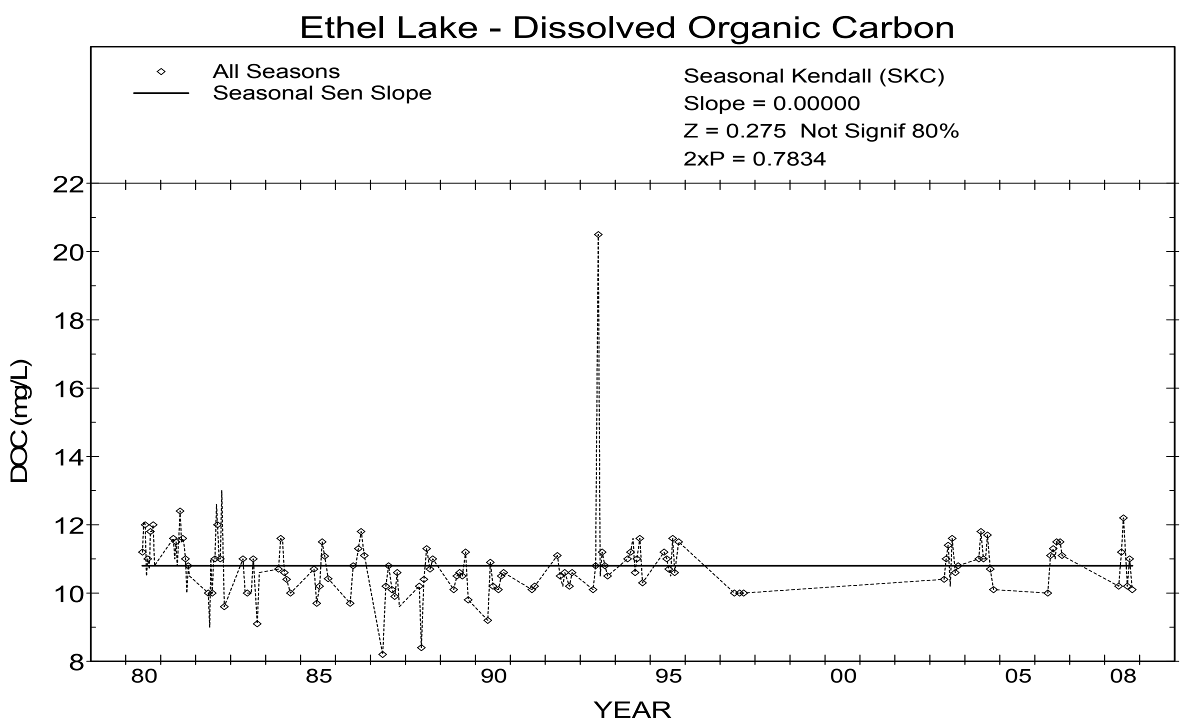


Figure 60b **Ethel Lake (near Cold Lake)** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)

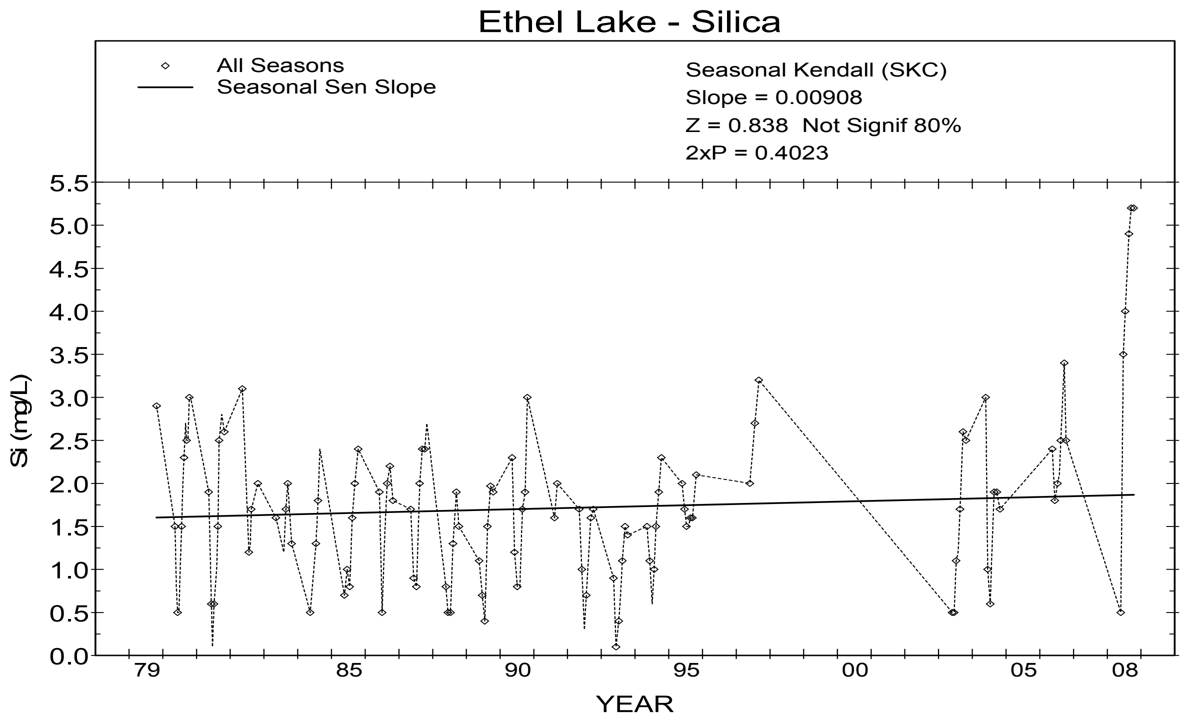
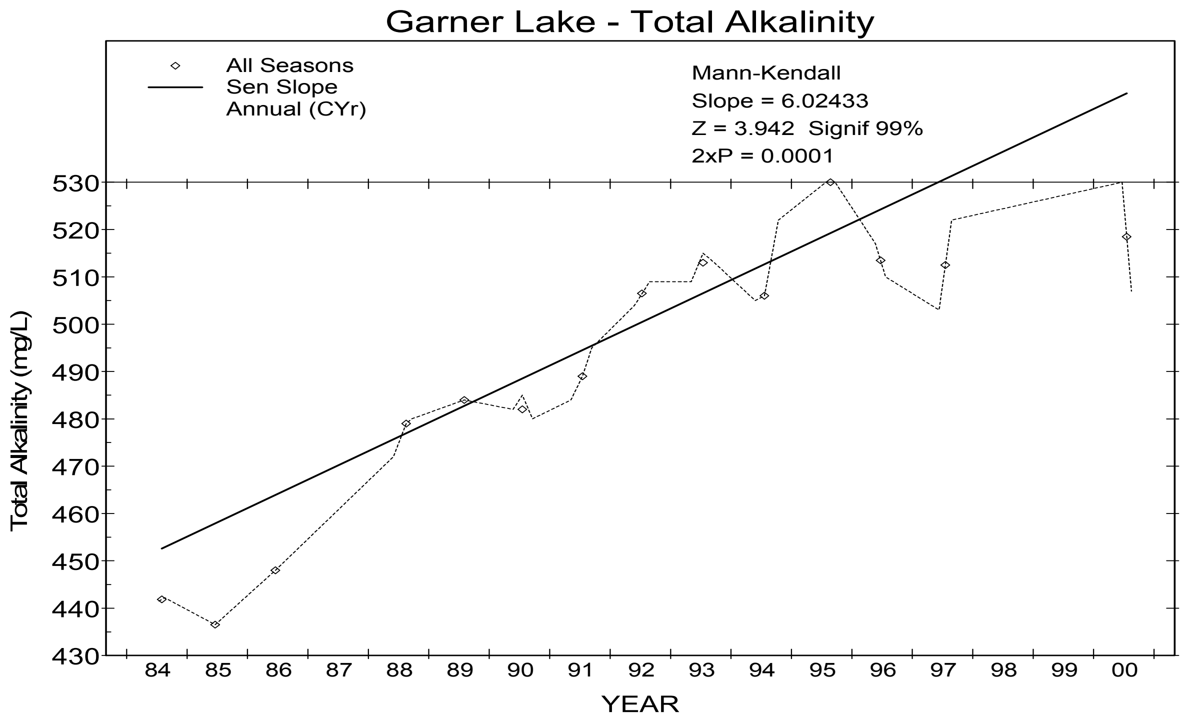


Figure 60b **Ethel Lake (near Cold Lake)** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (concluded)



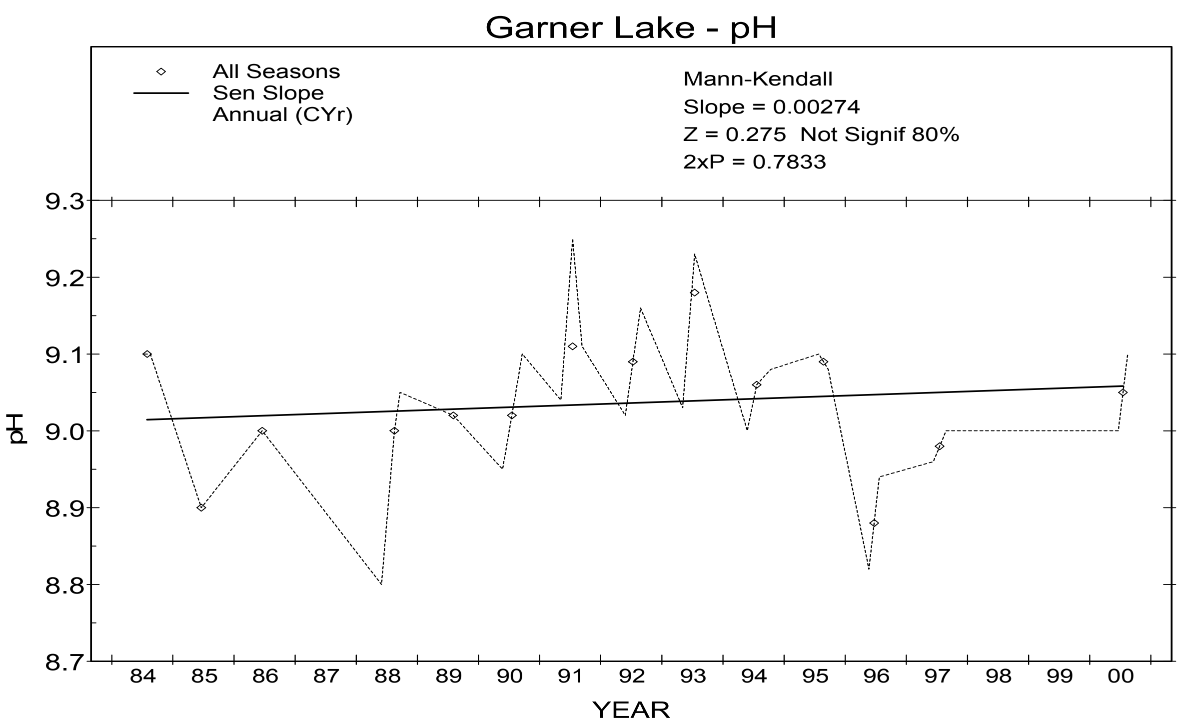
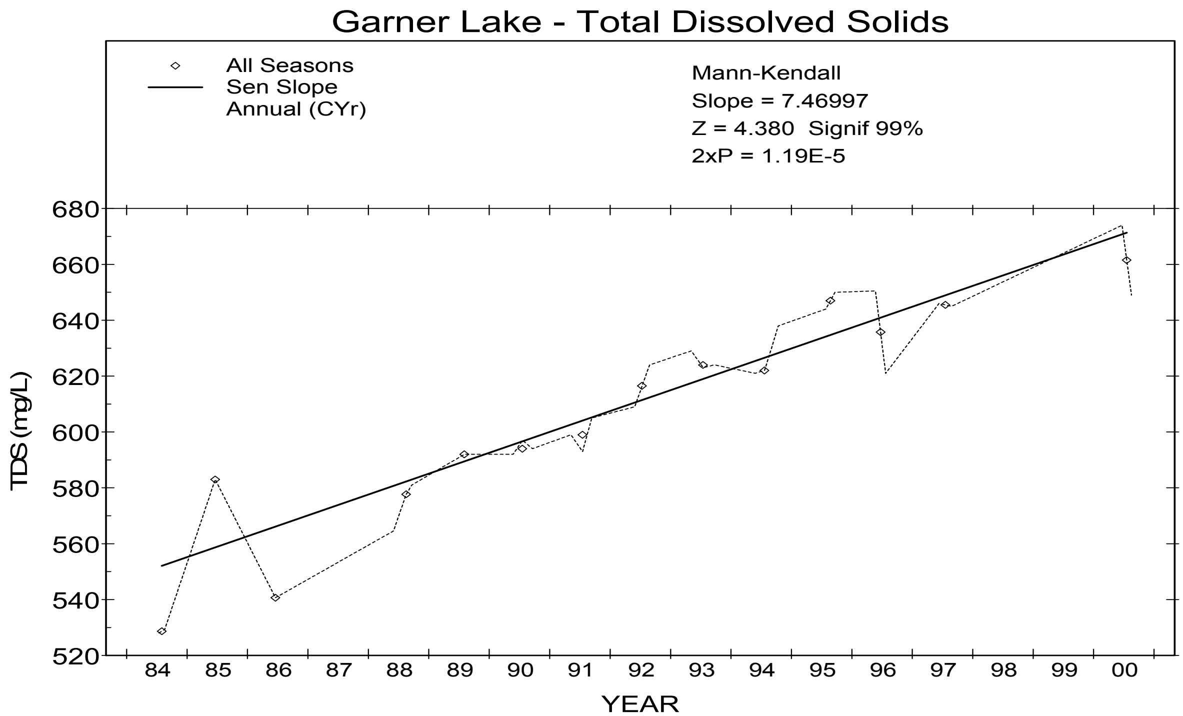


Figure 61 **Garner Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



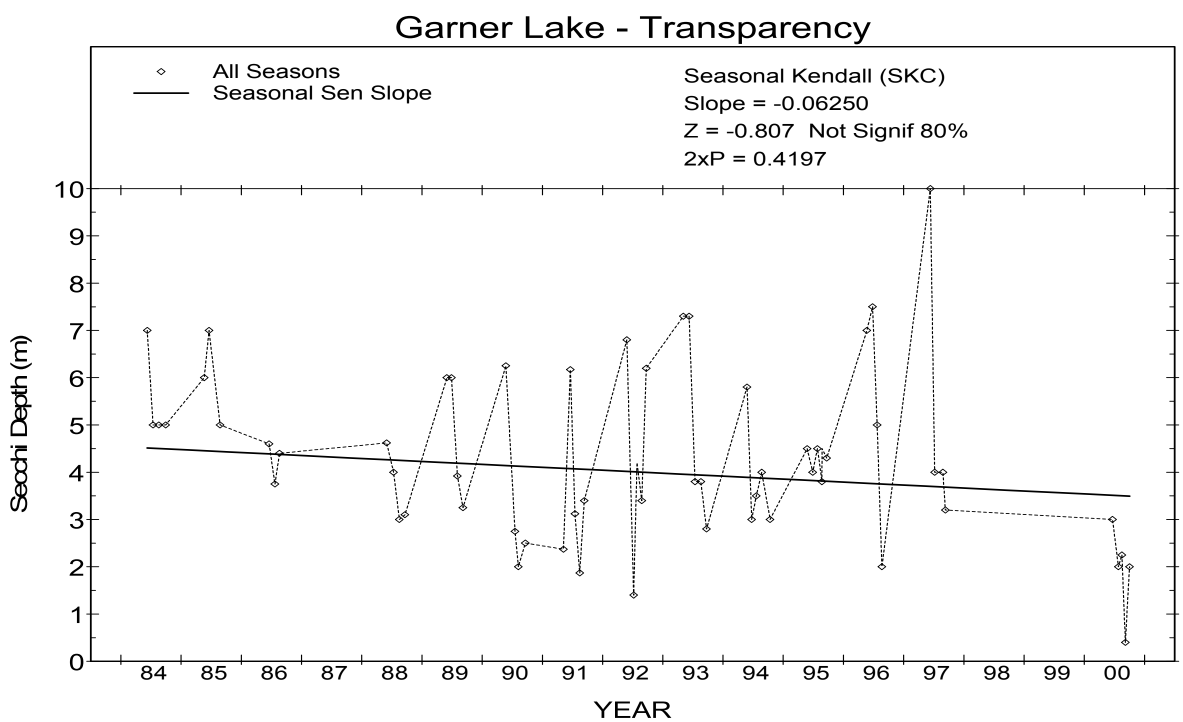
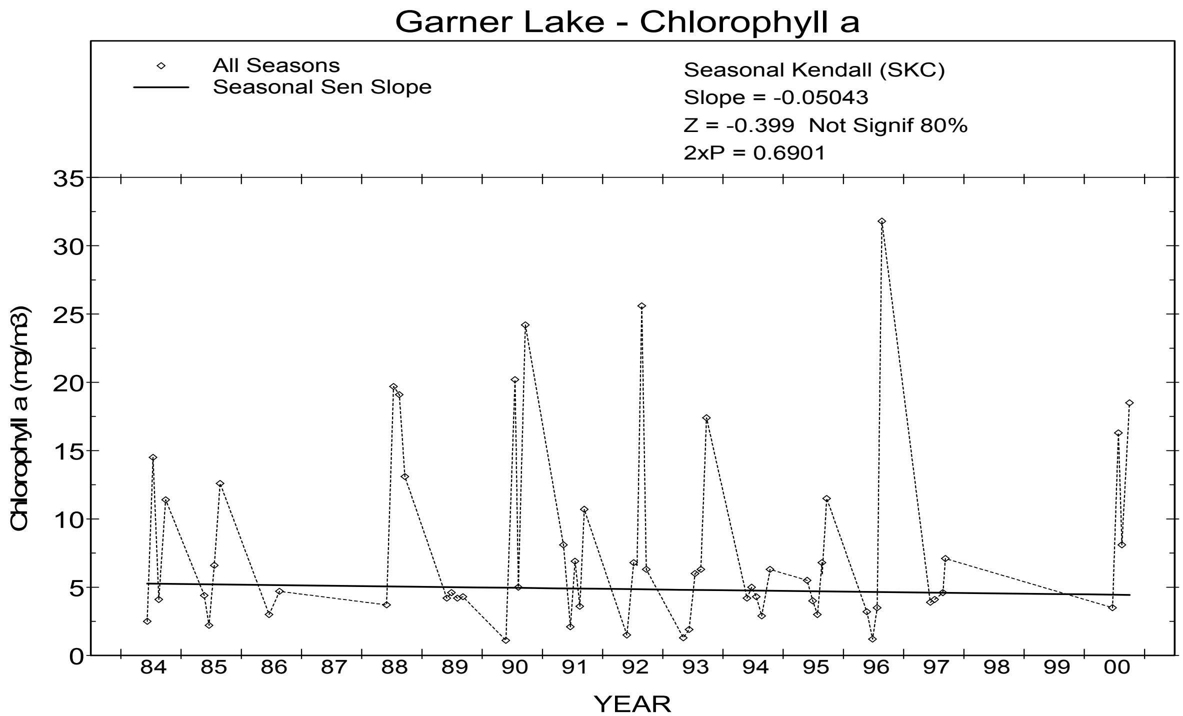


Figure 61 **Garner Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



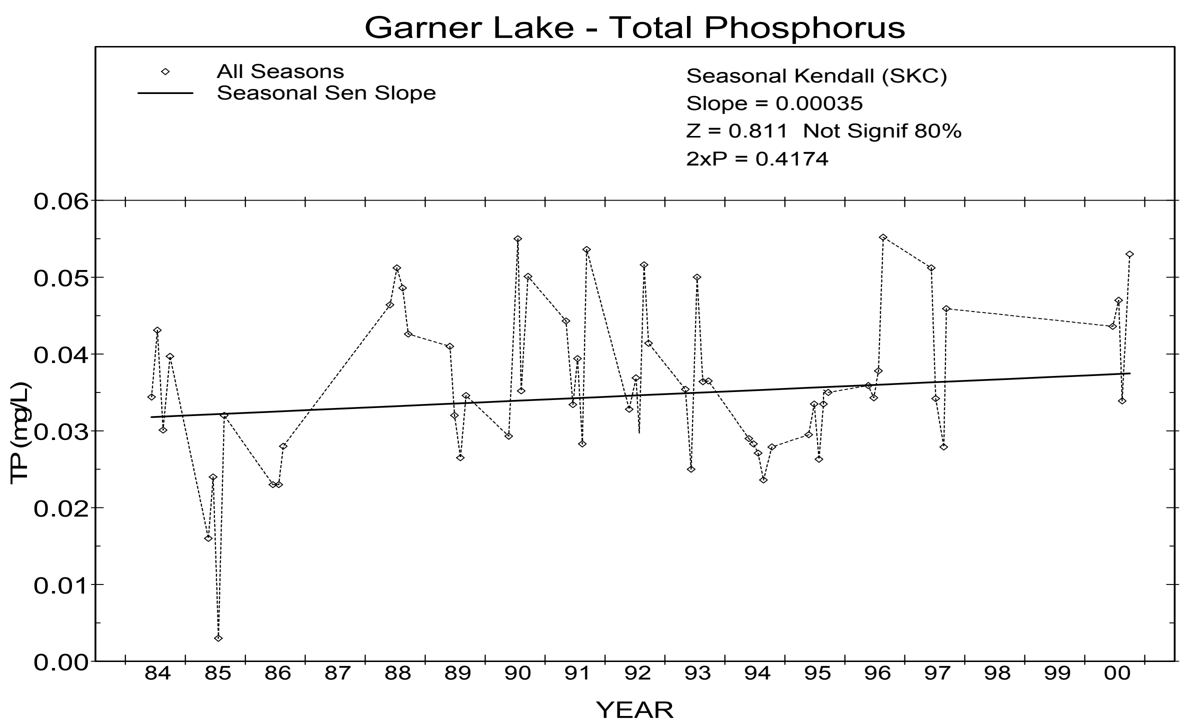
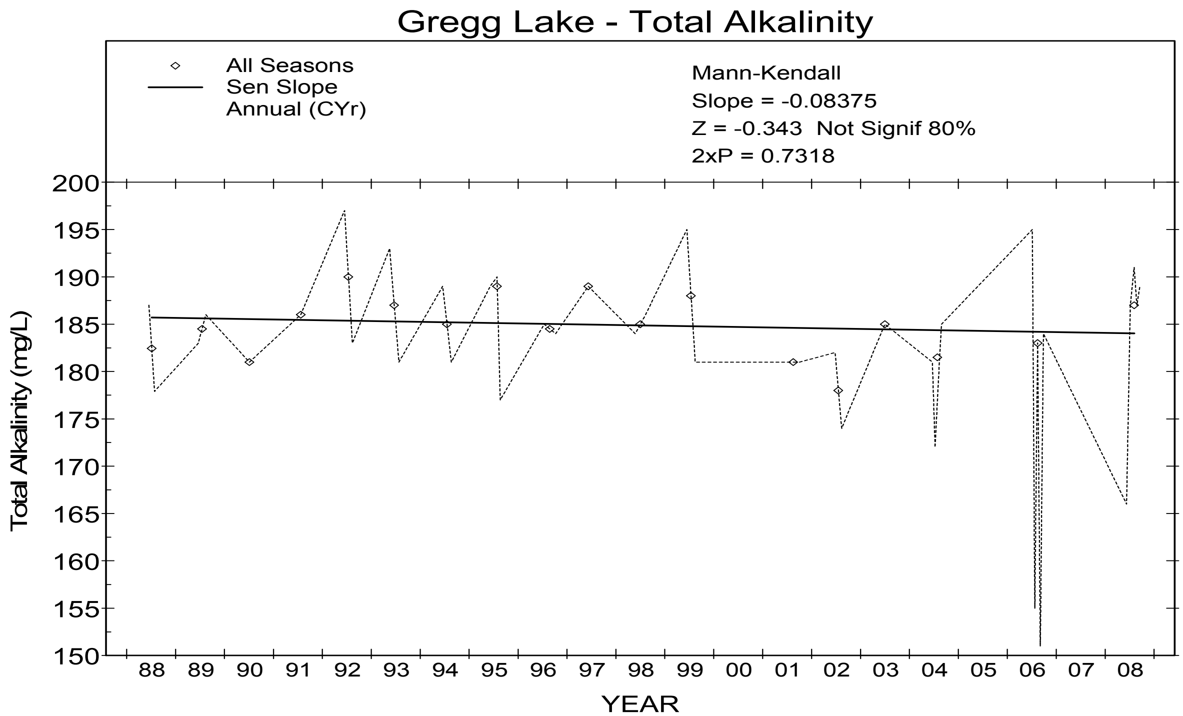


Figure 61 **Garner Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



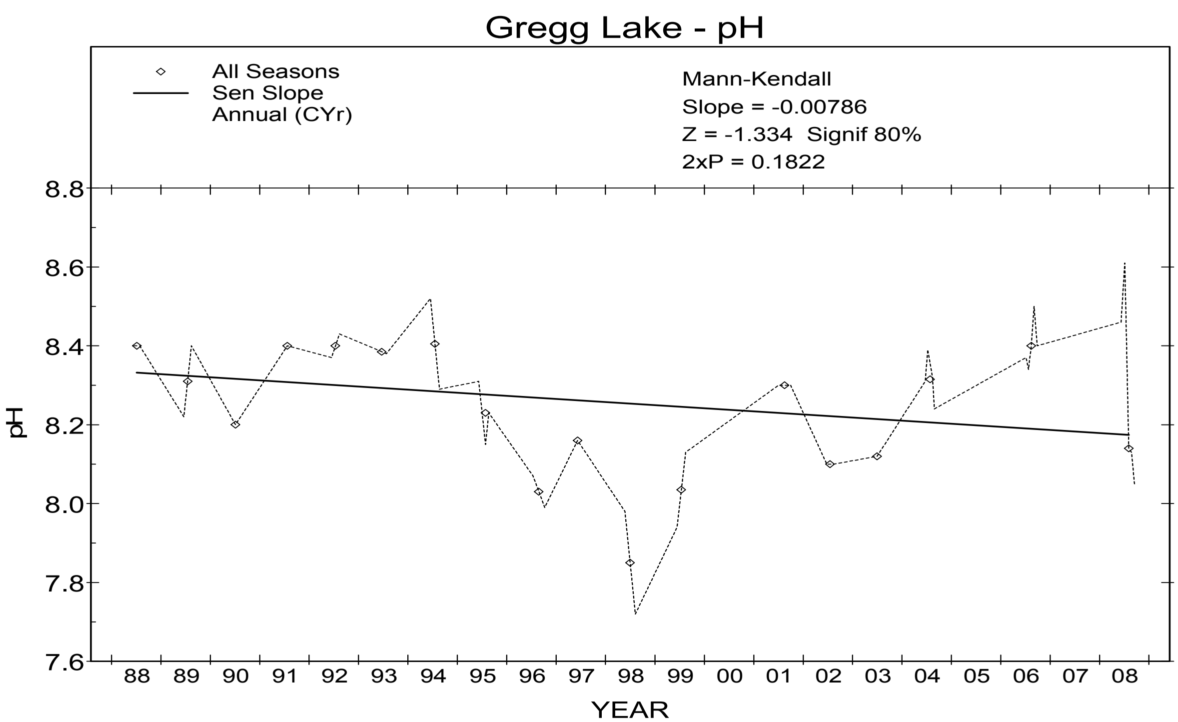
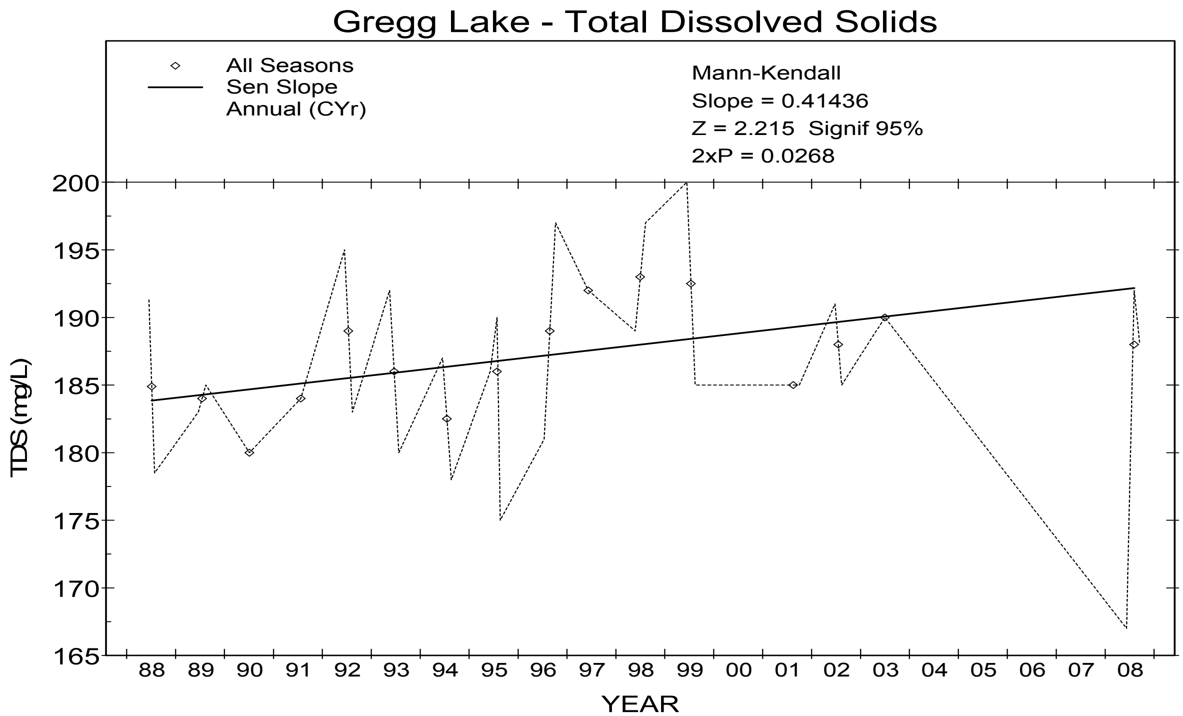


Figure 62 **Gregg Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



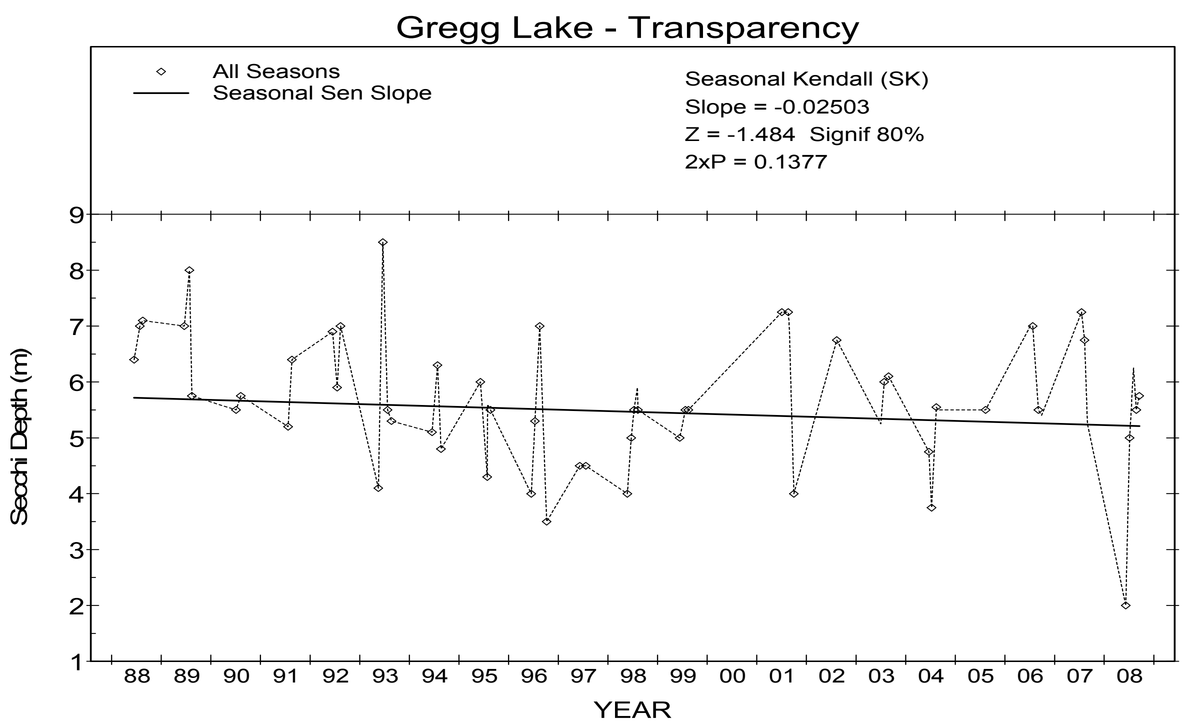
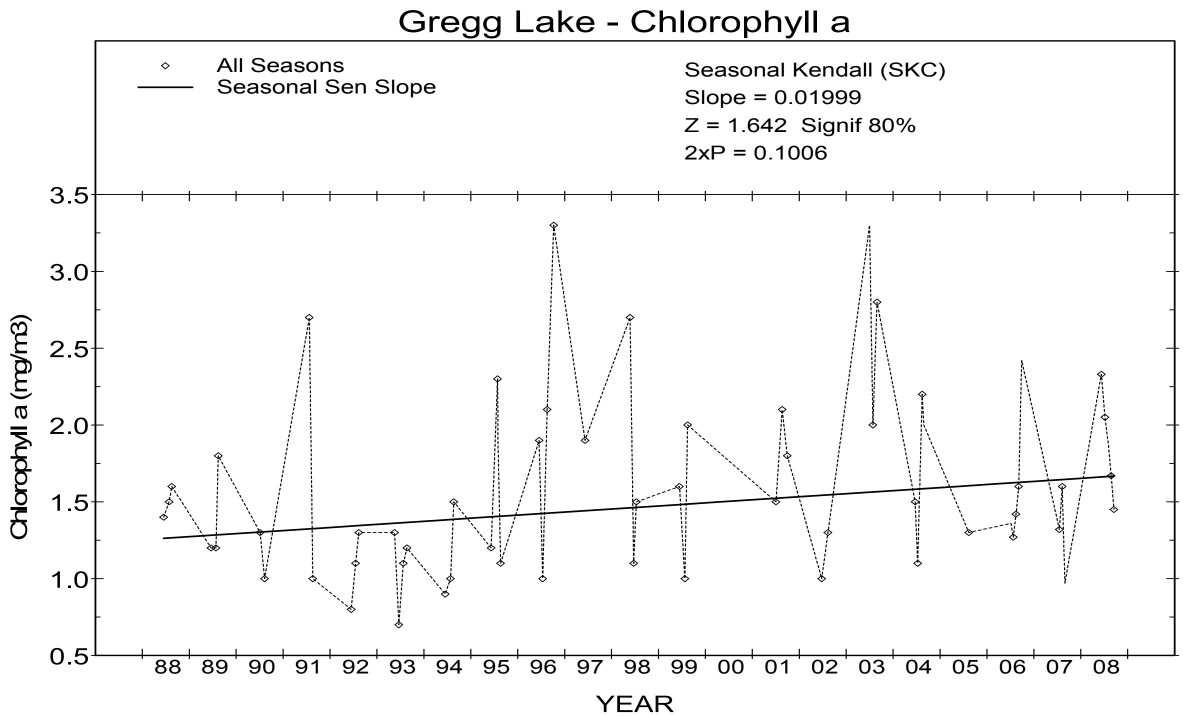


Figure 62 **Gregg Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



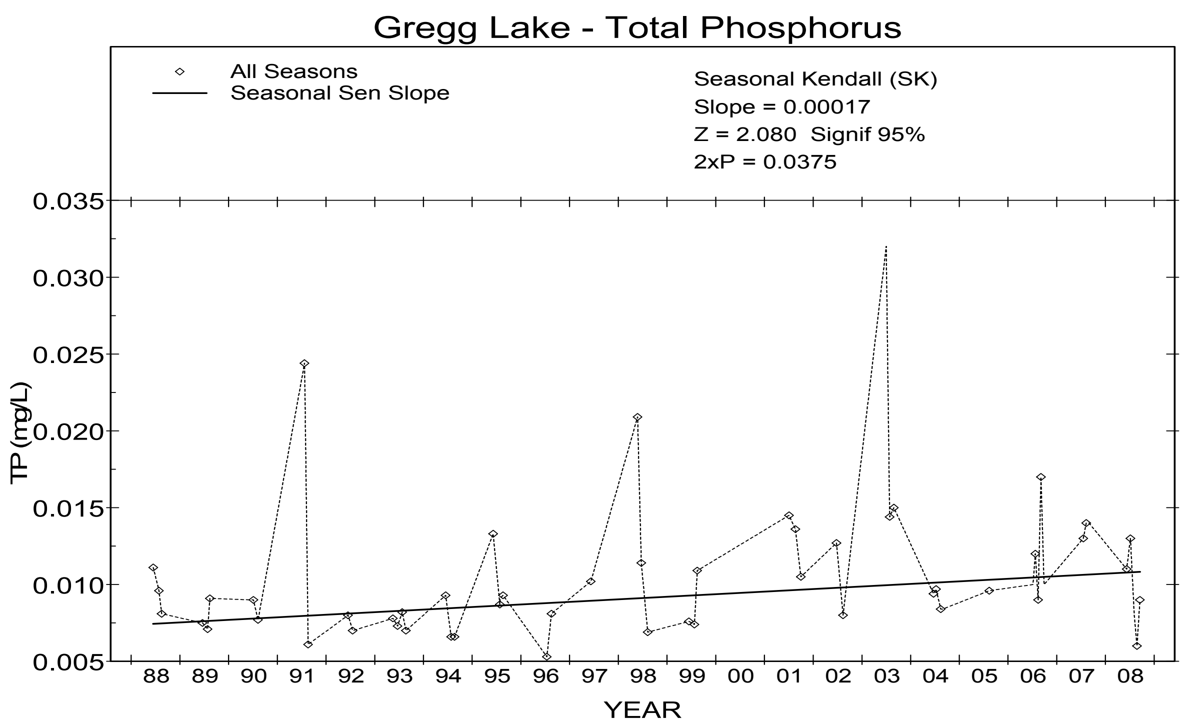
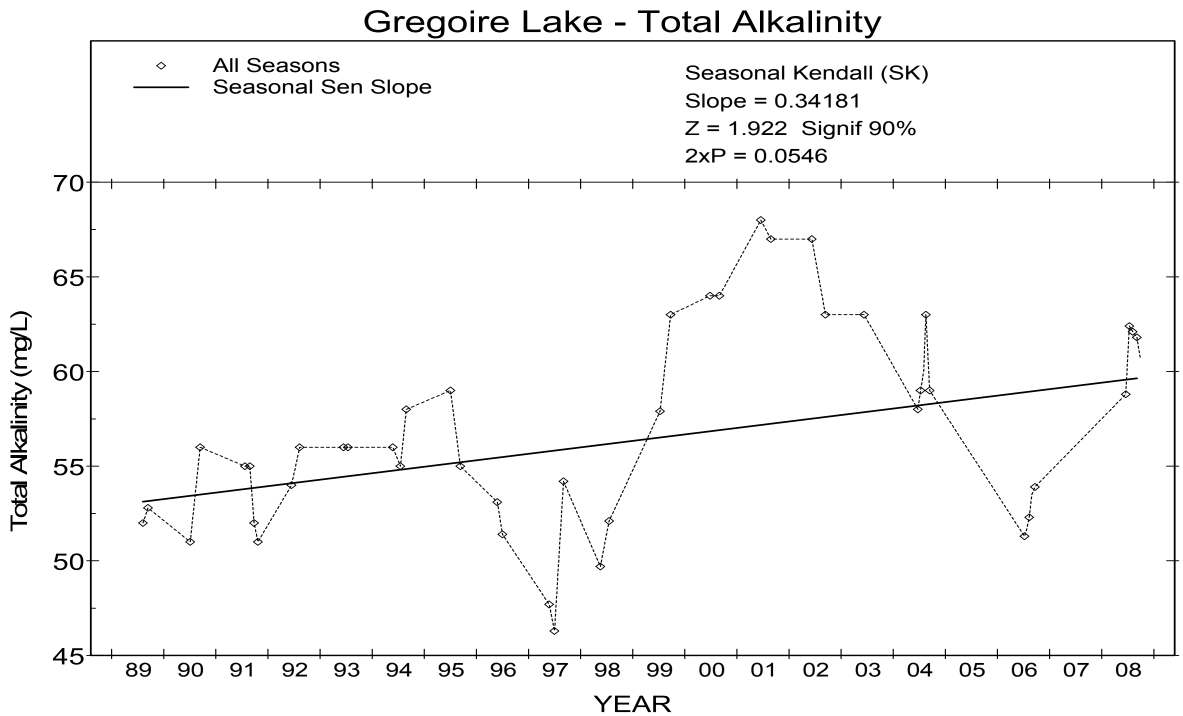


Figure 62 **Gregg Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



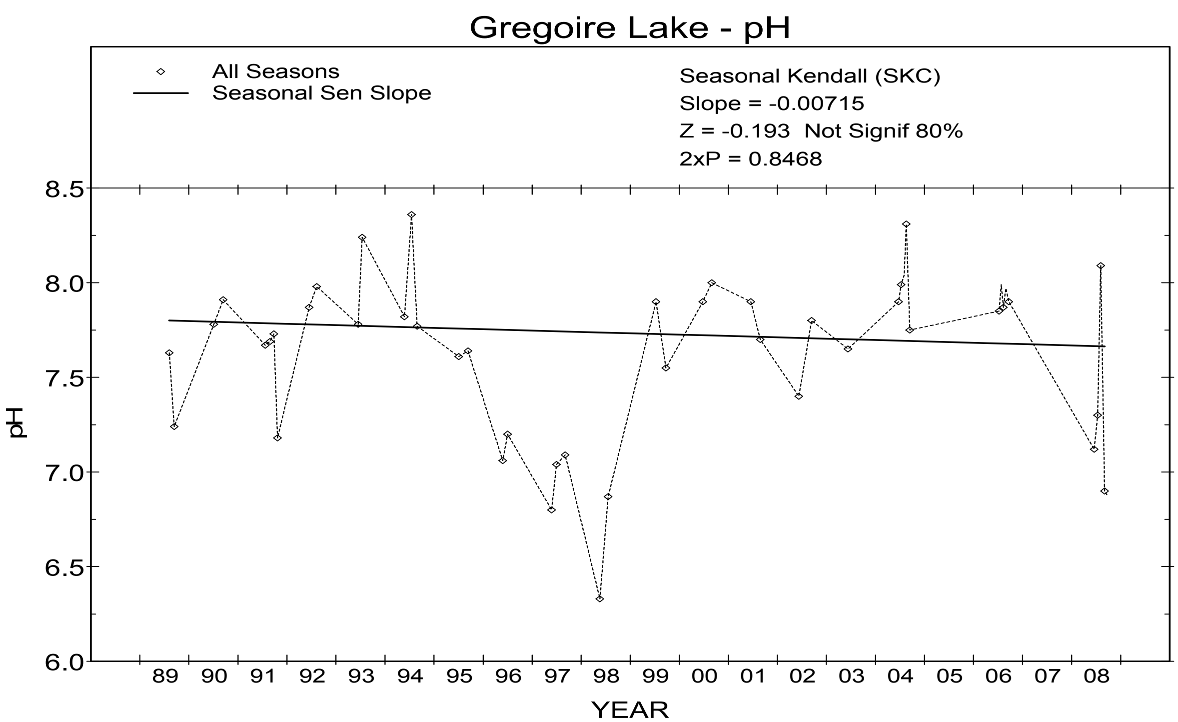
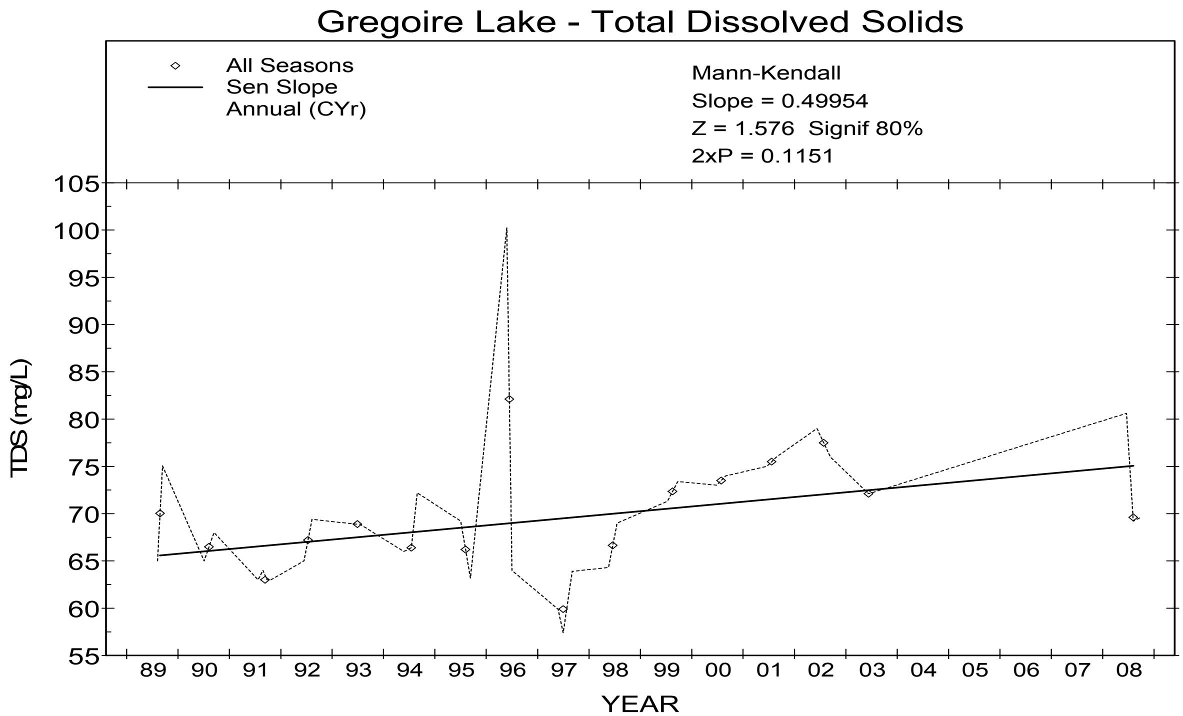


Figure 63 **Gregoire Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



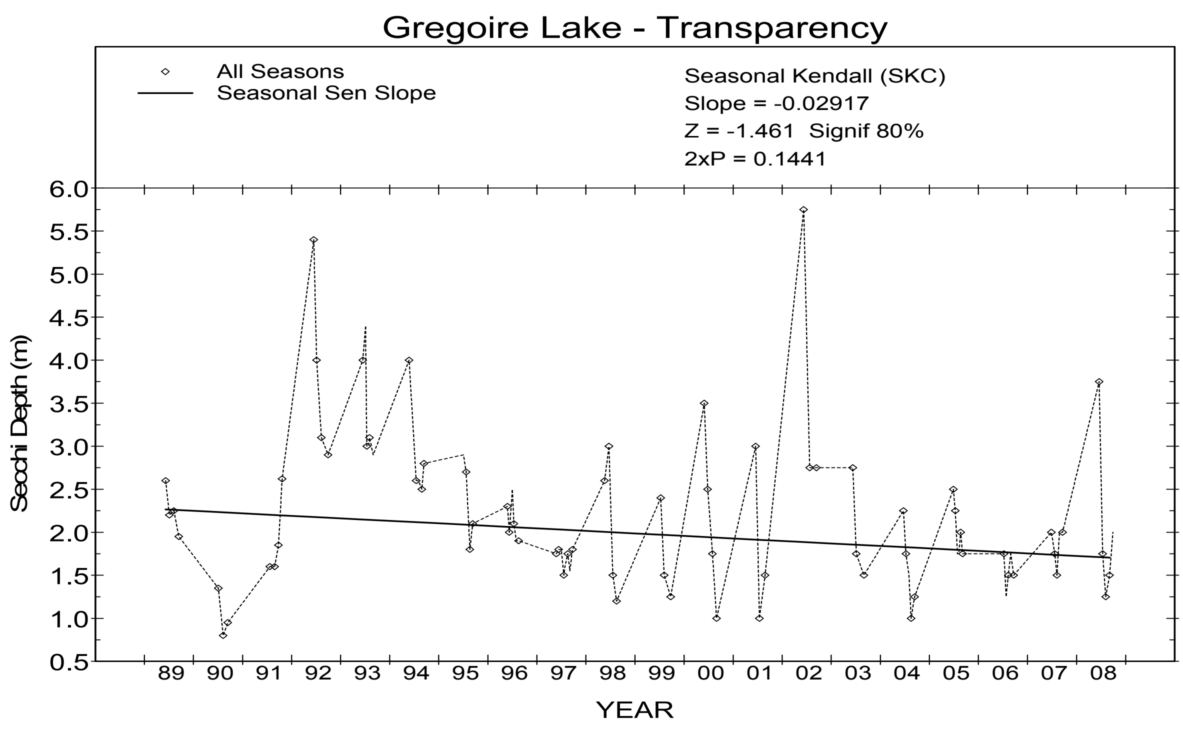
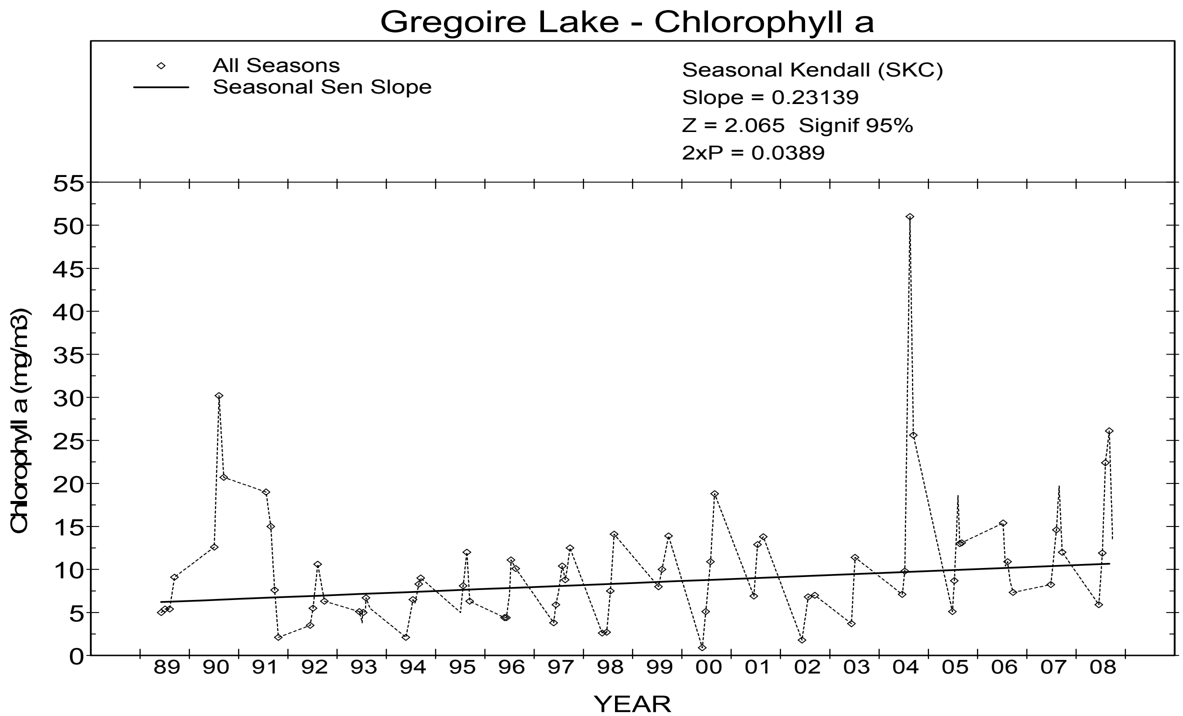


Figure 63 **Gregoire Lake –** Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



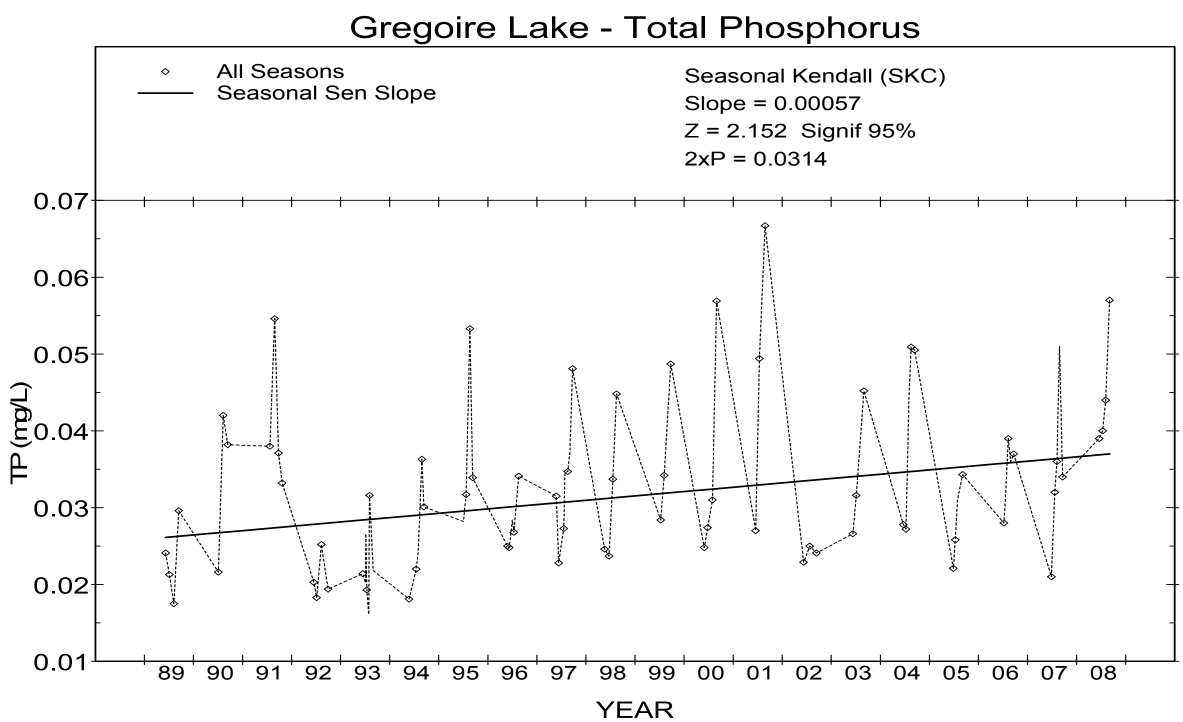
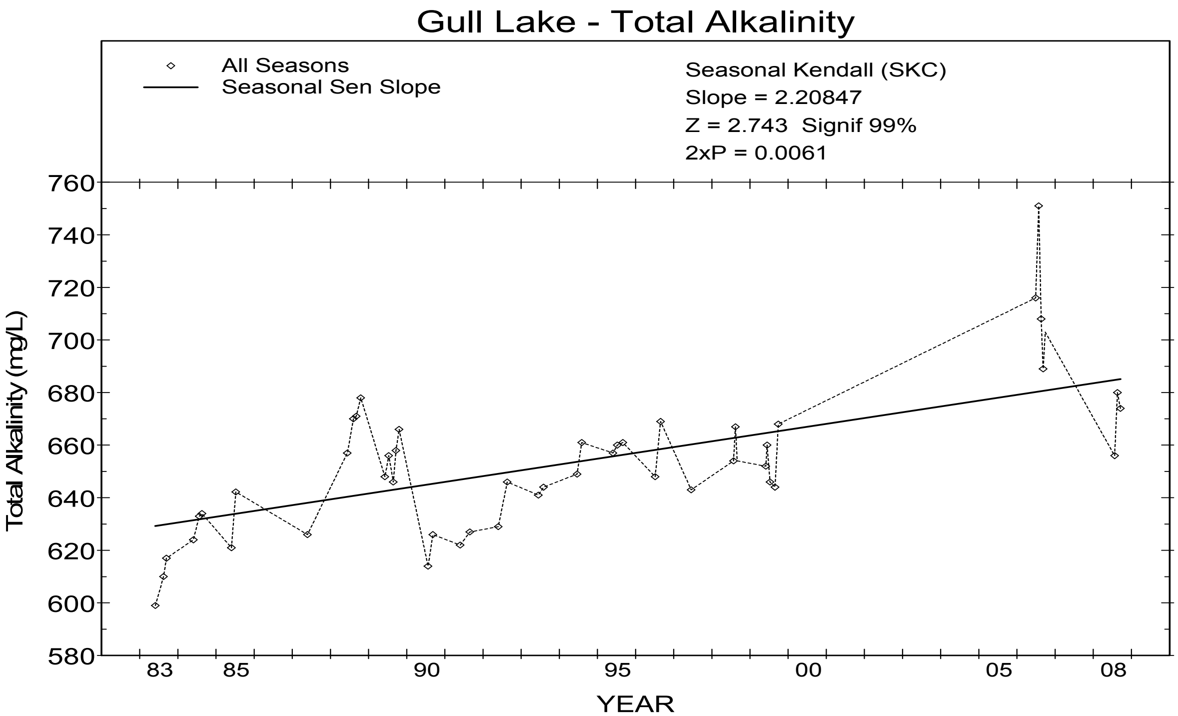


Figure 63 **Gregoire Lake –** Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



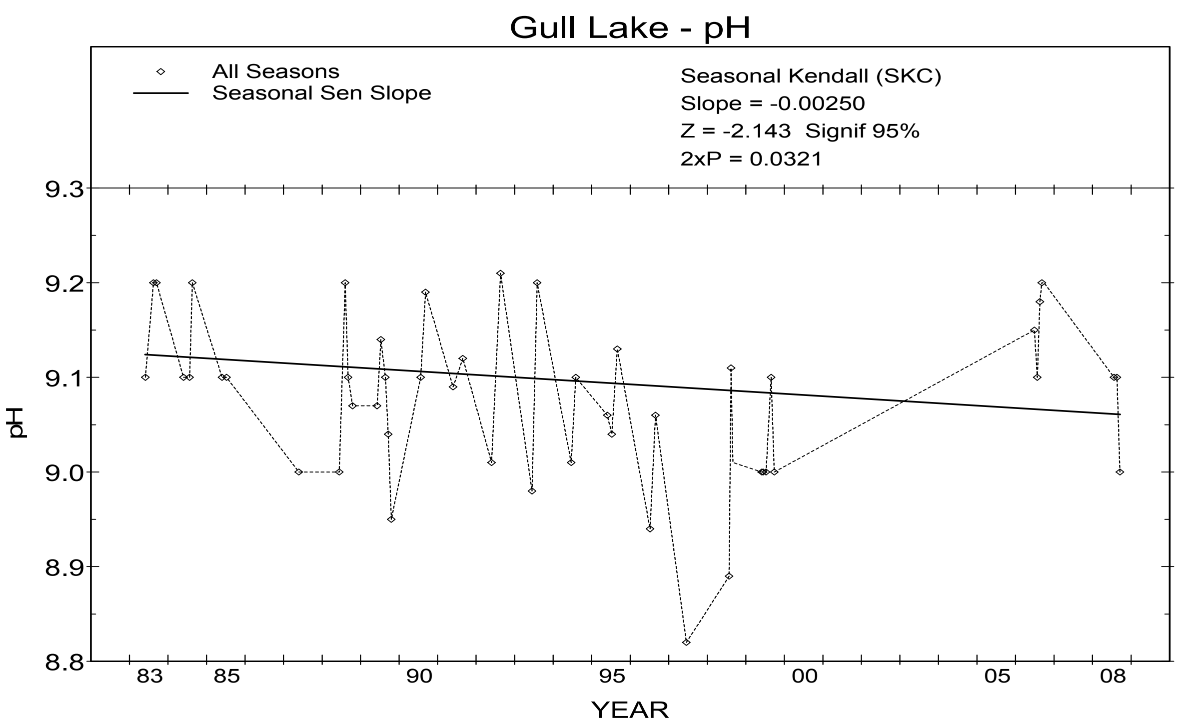
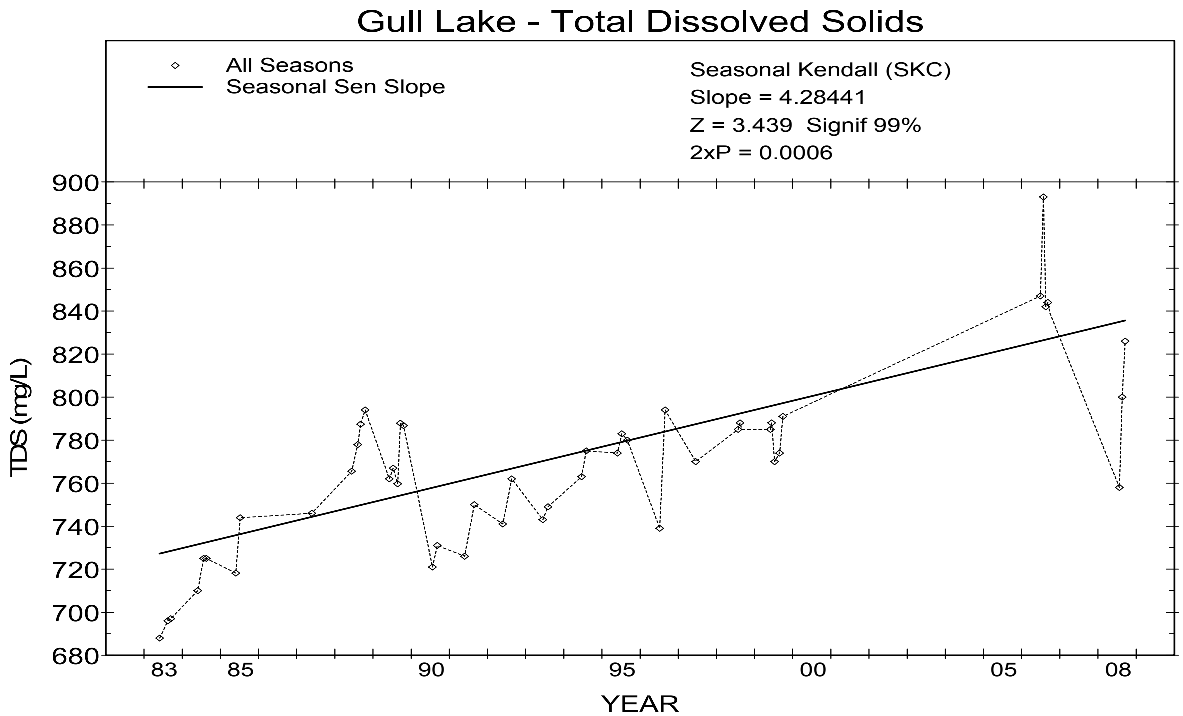


Figure 64 **Gull Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



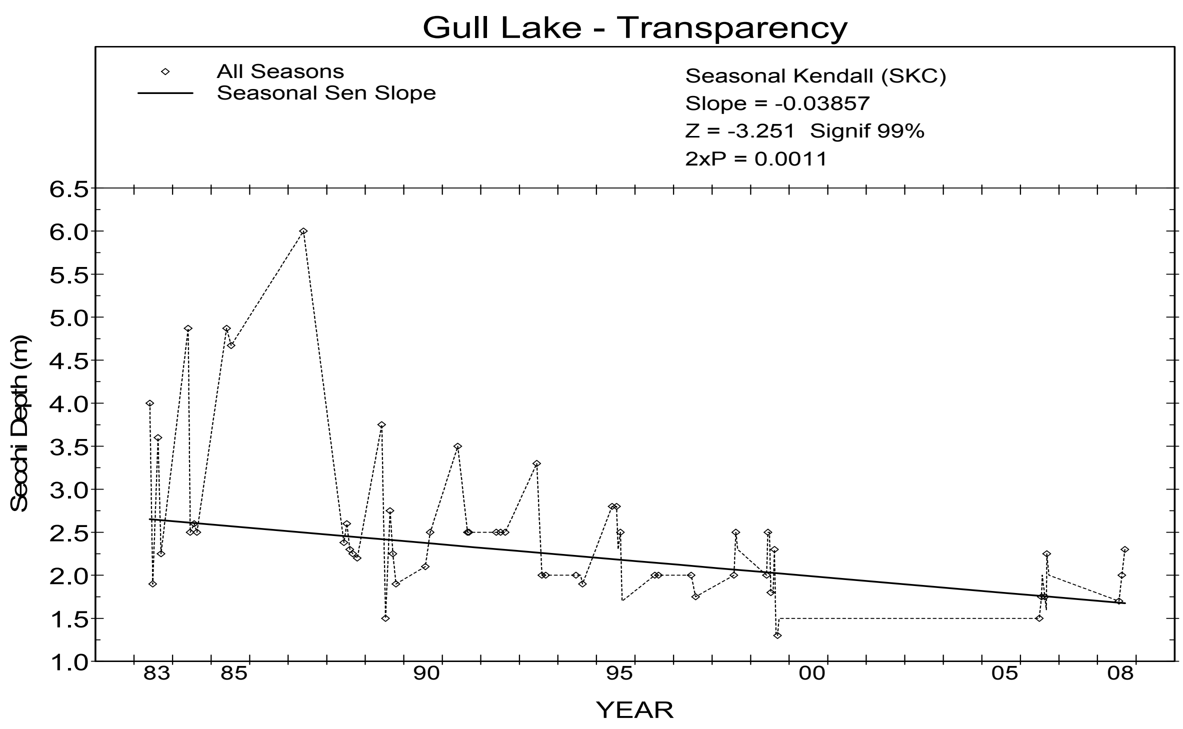
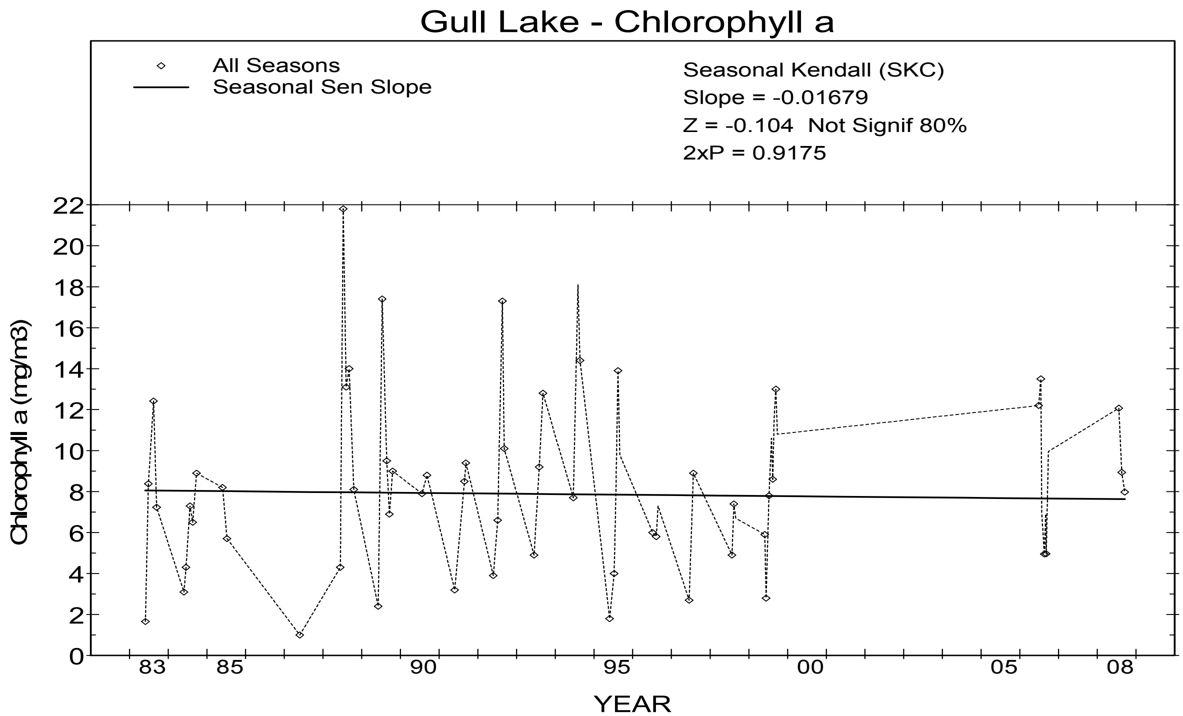


Figure 64 **Gull Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



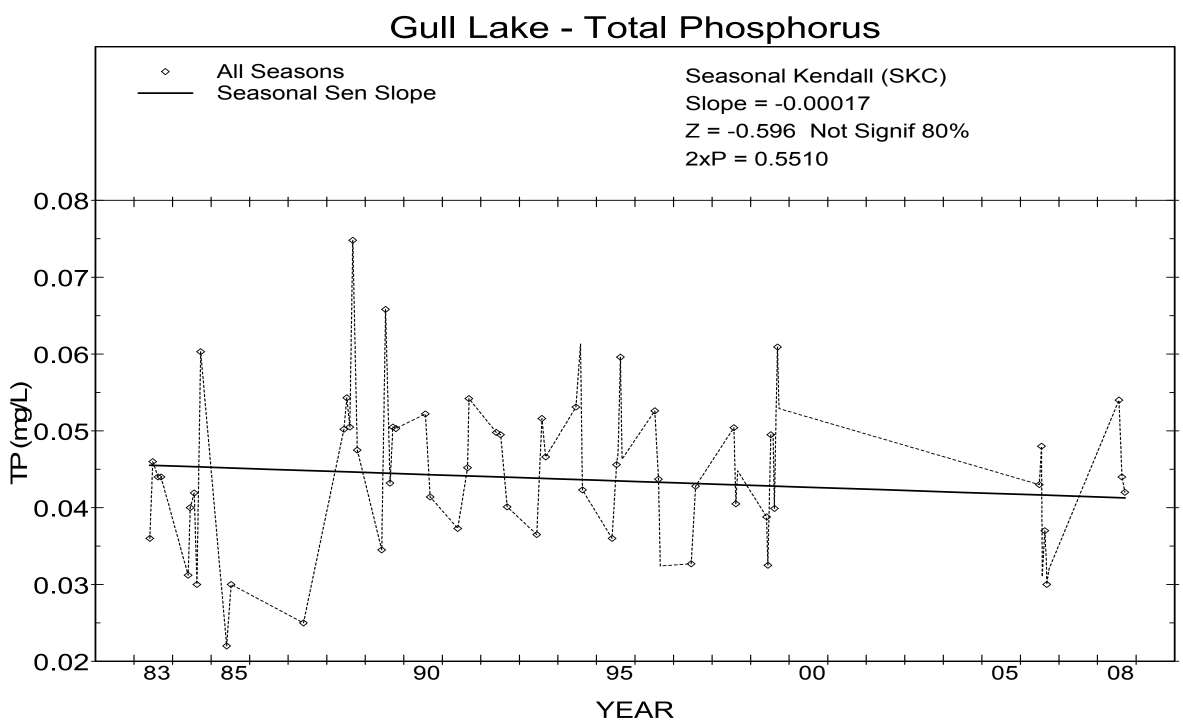
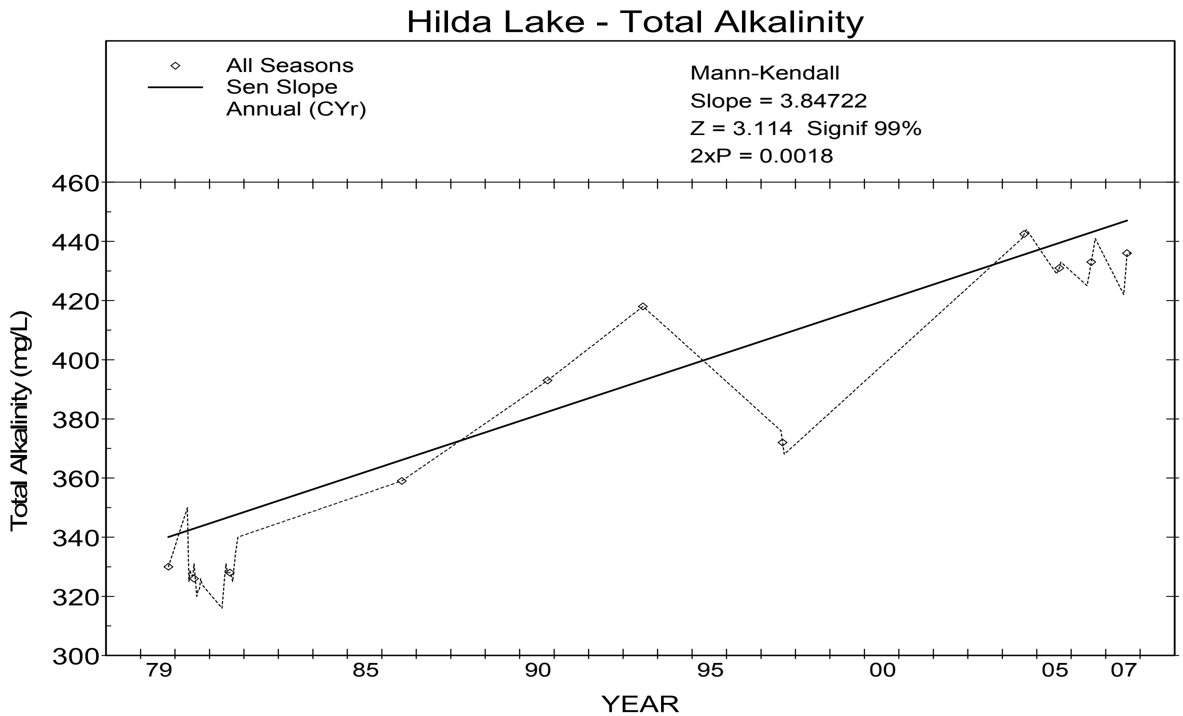


Figure 64 **Gull Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



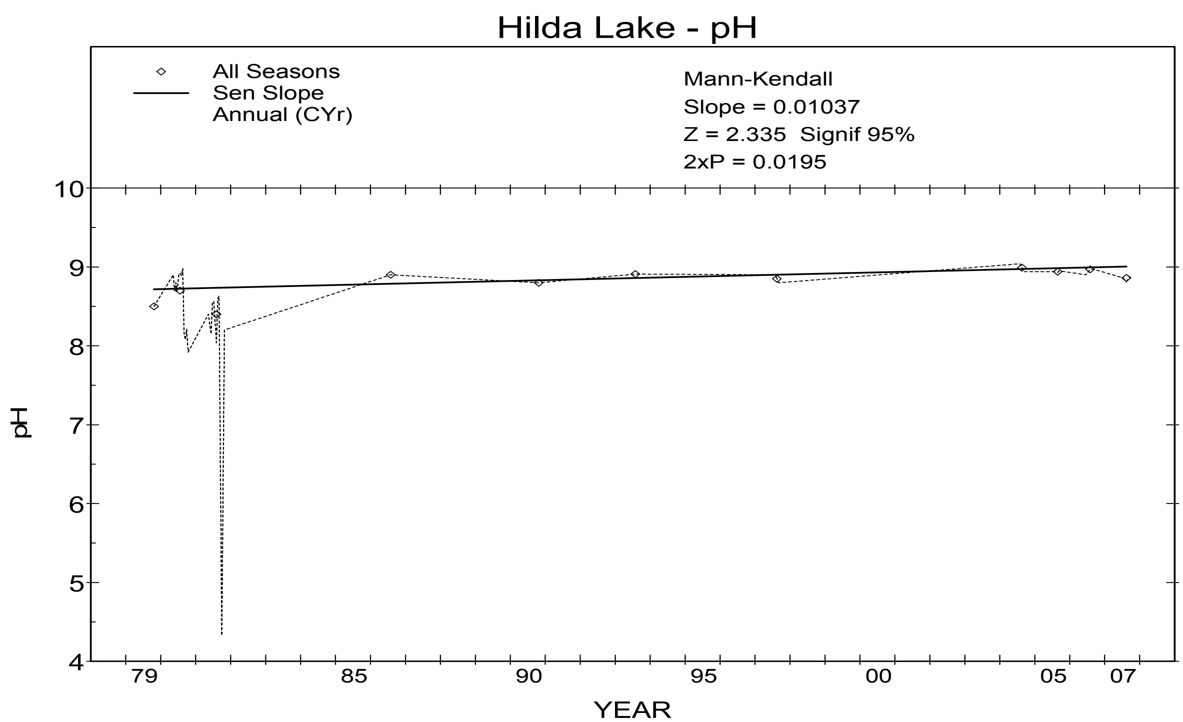
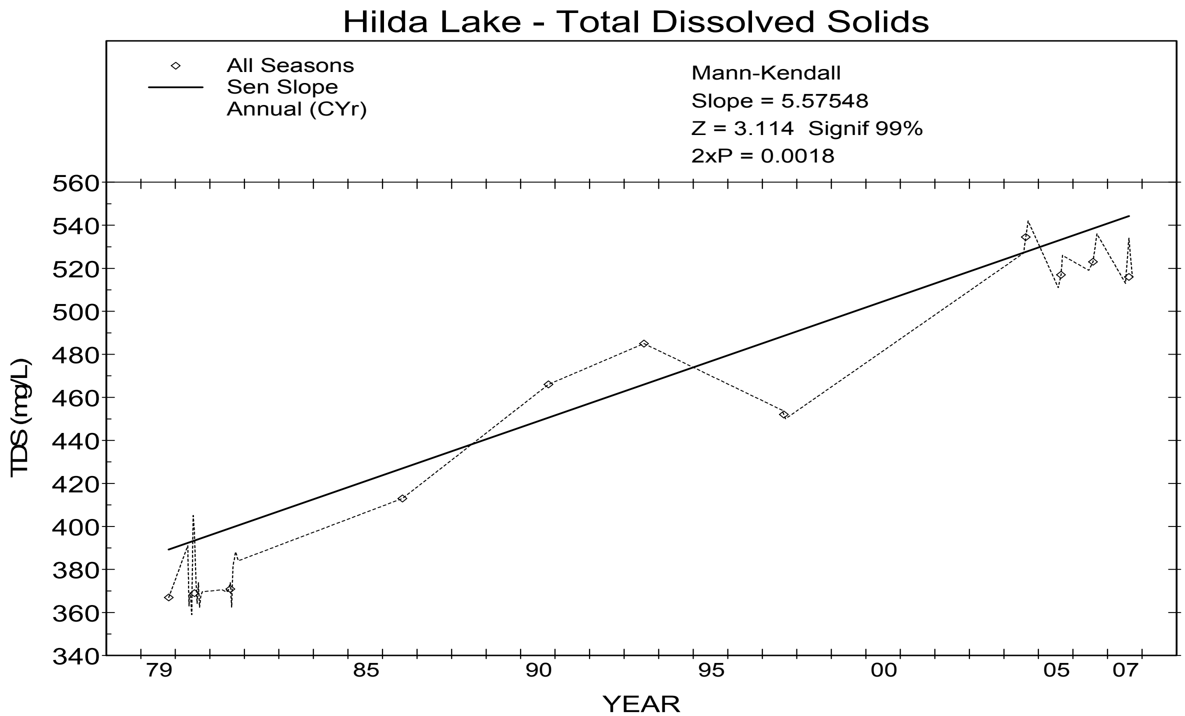


Figure 65 **Hilda Lake** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



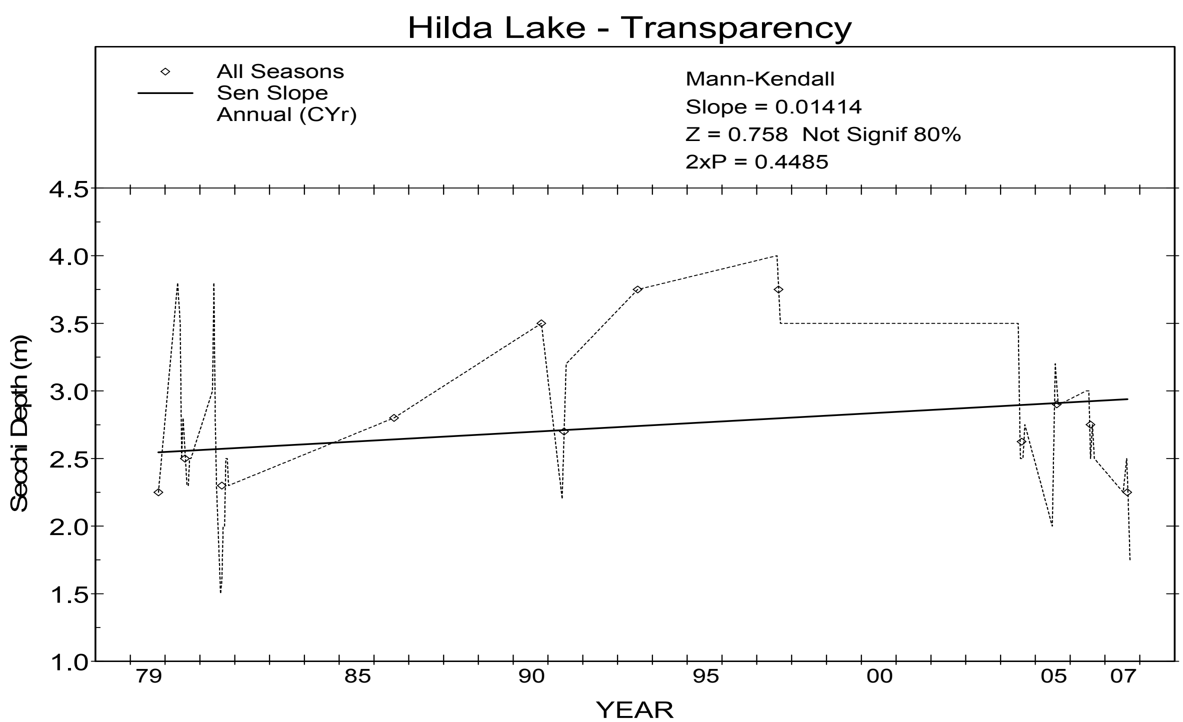
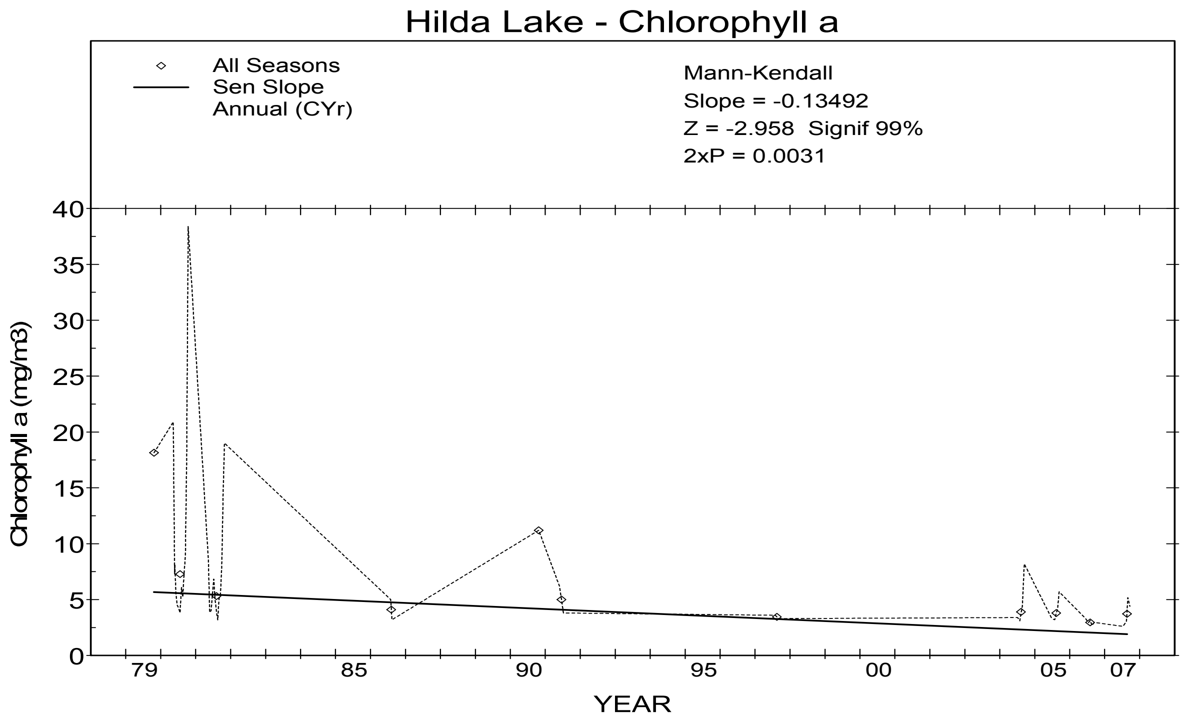


Figure 65 **Hilda Lake** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record. (continued)



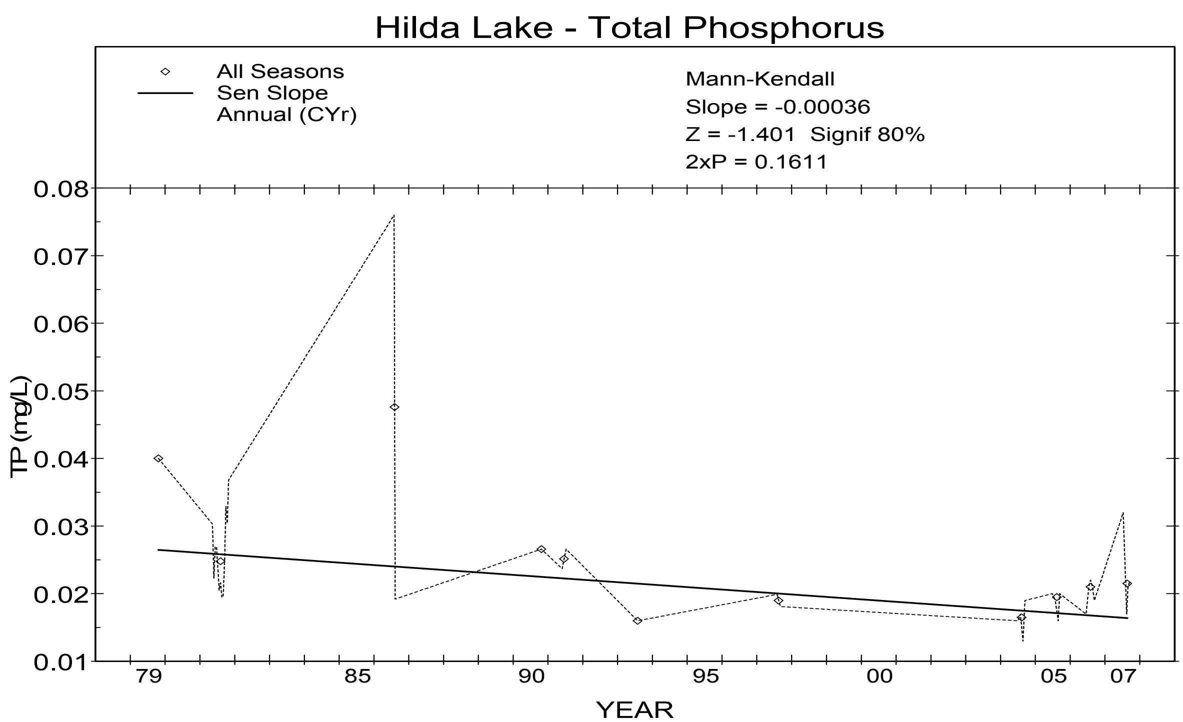
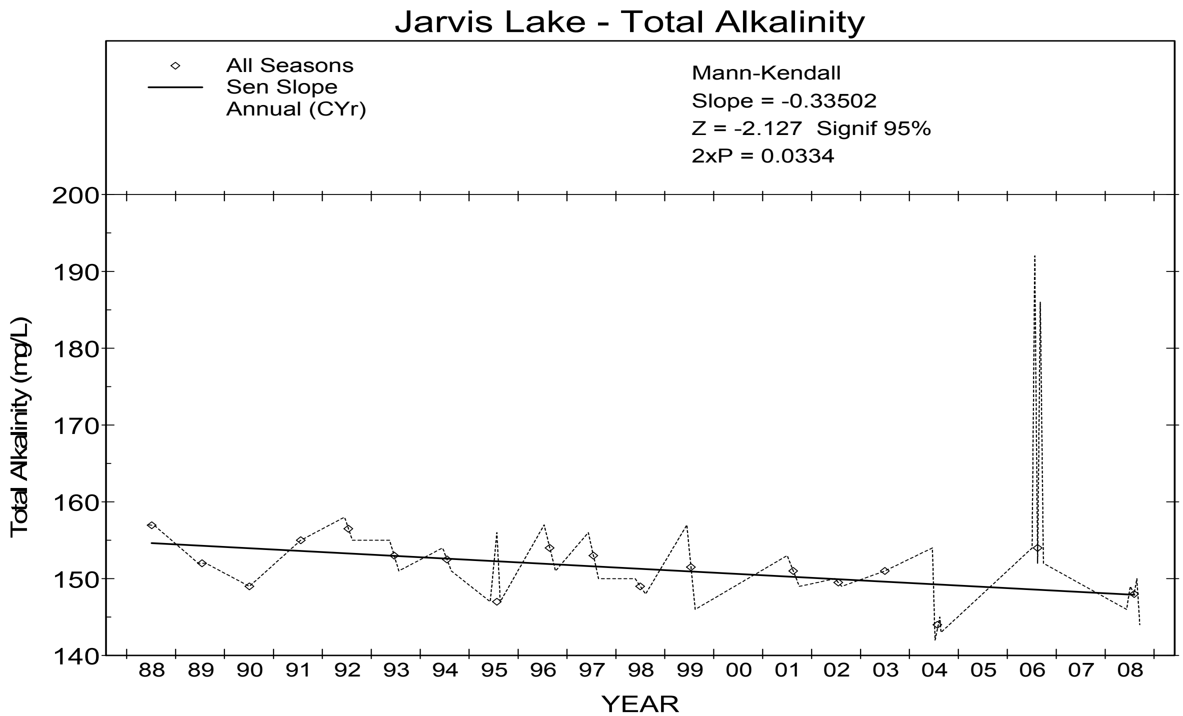


Figure 65 **Hilda Lake** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



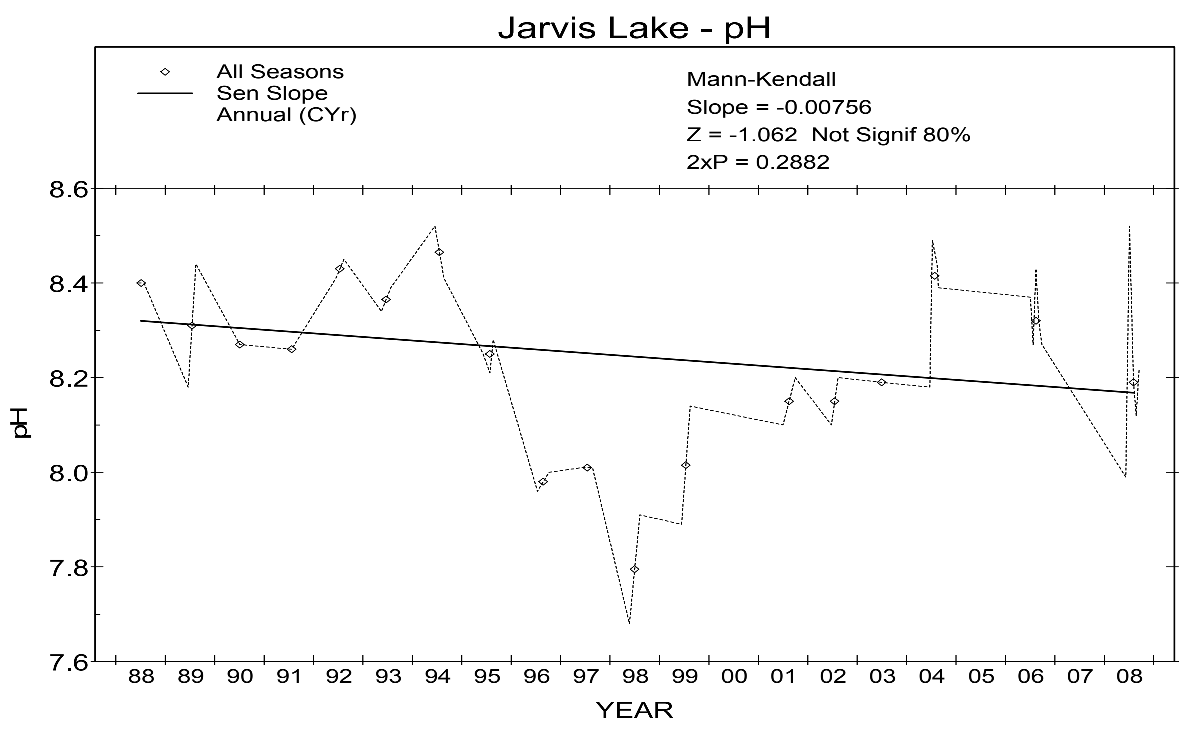
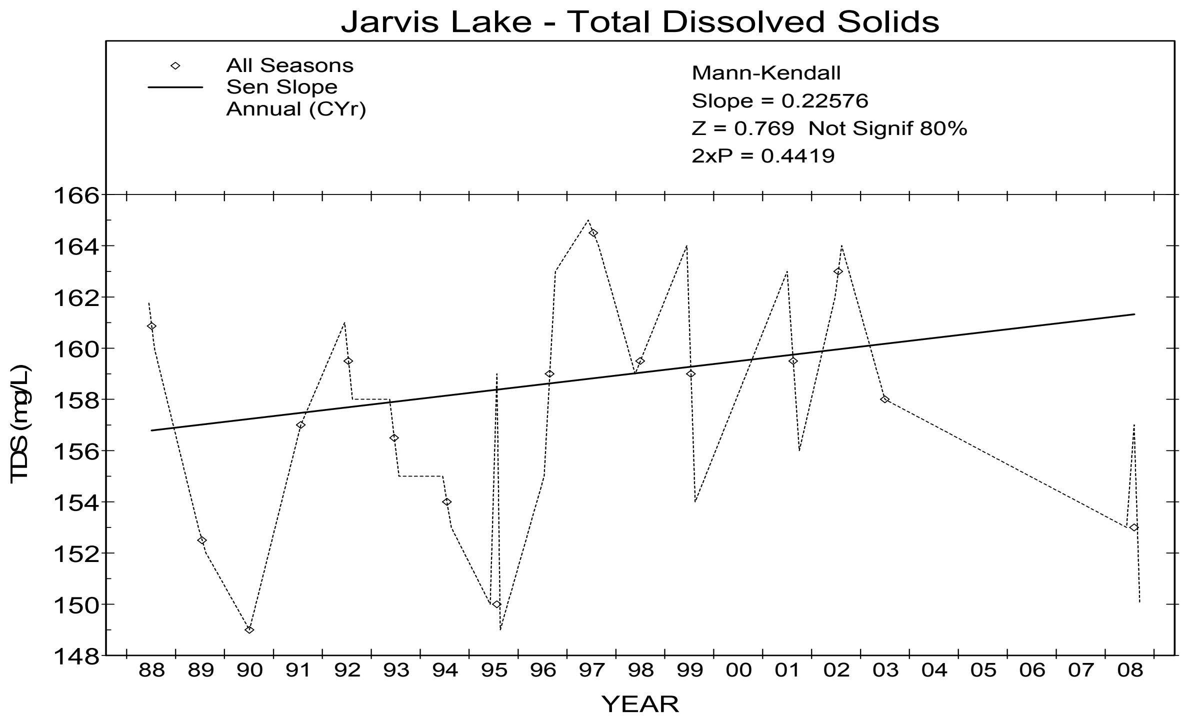


Figure 66 **Jarvis Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



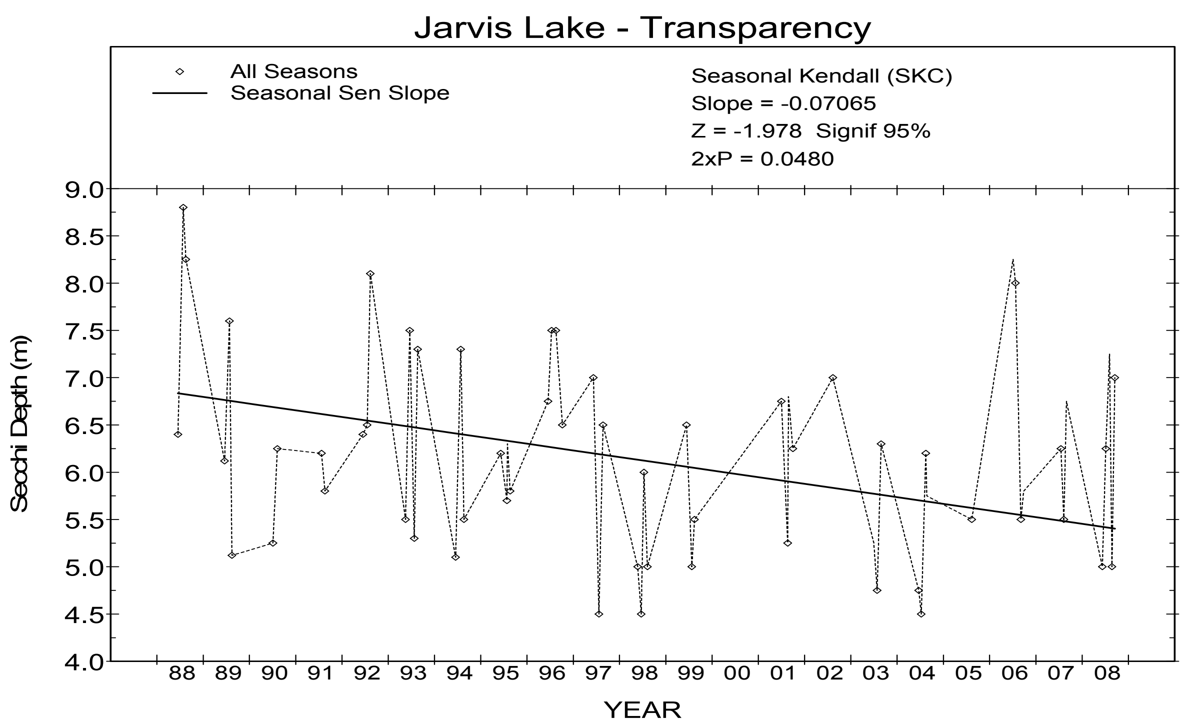
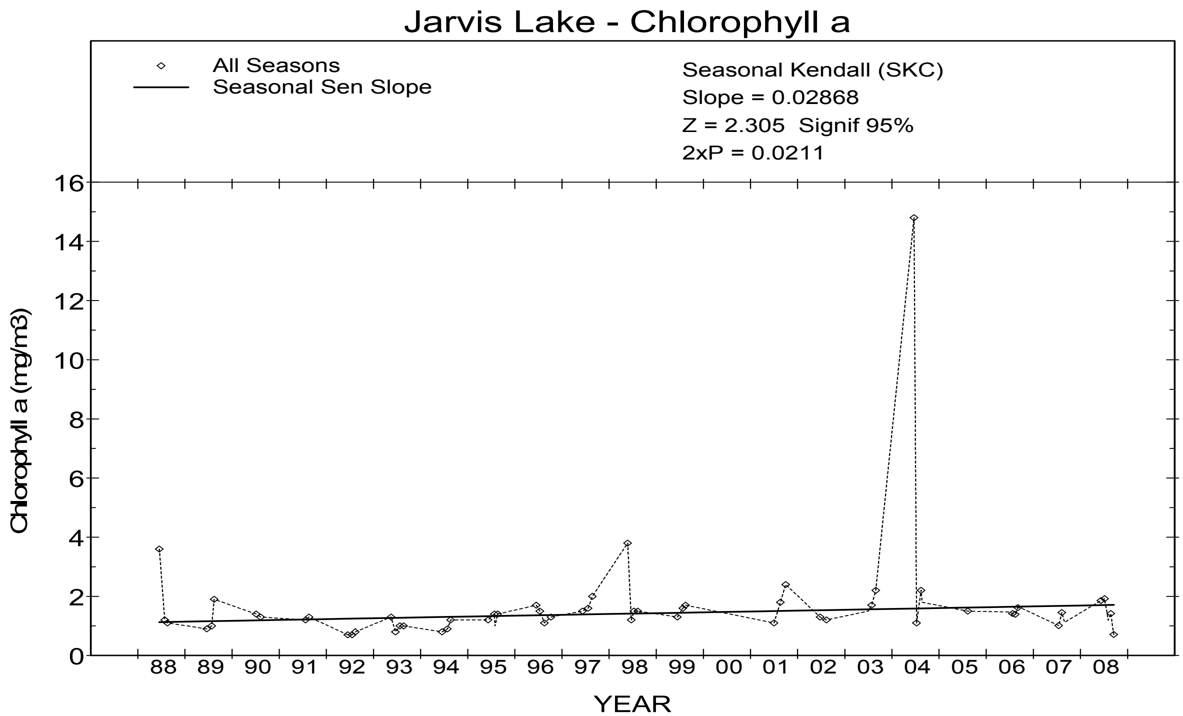


Figure 66 **Jarvis Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



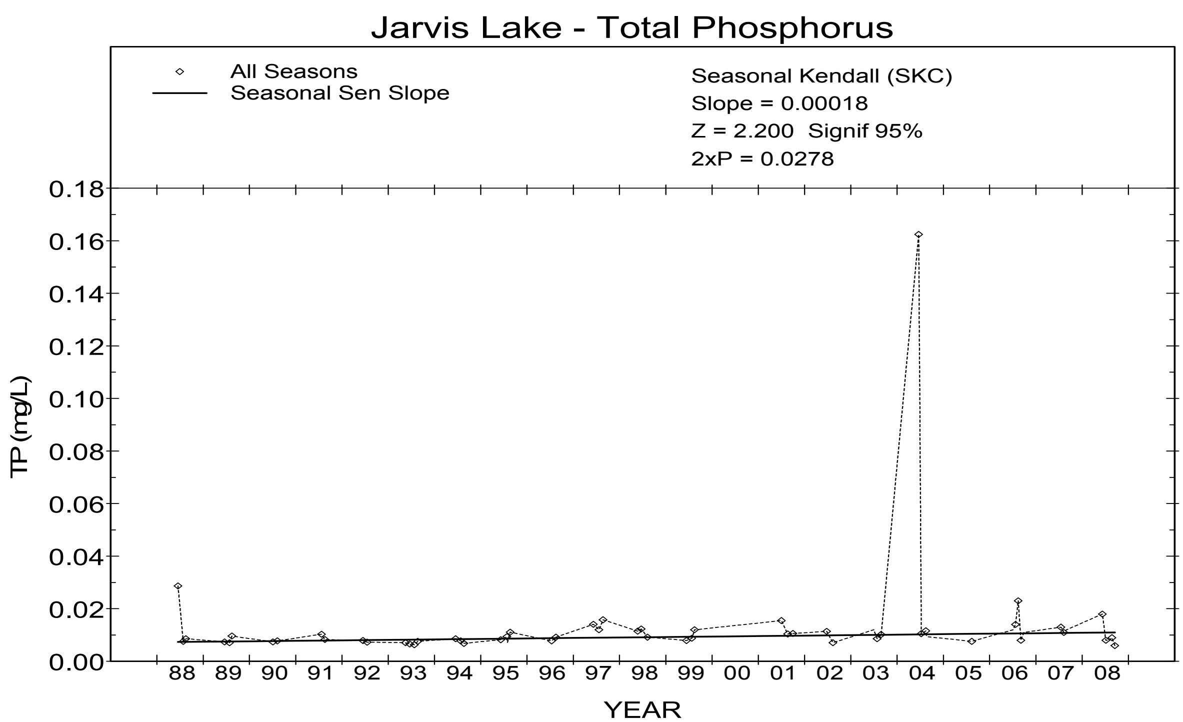
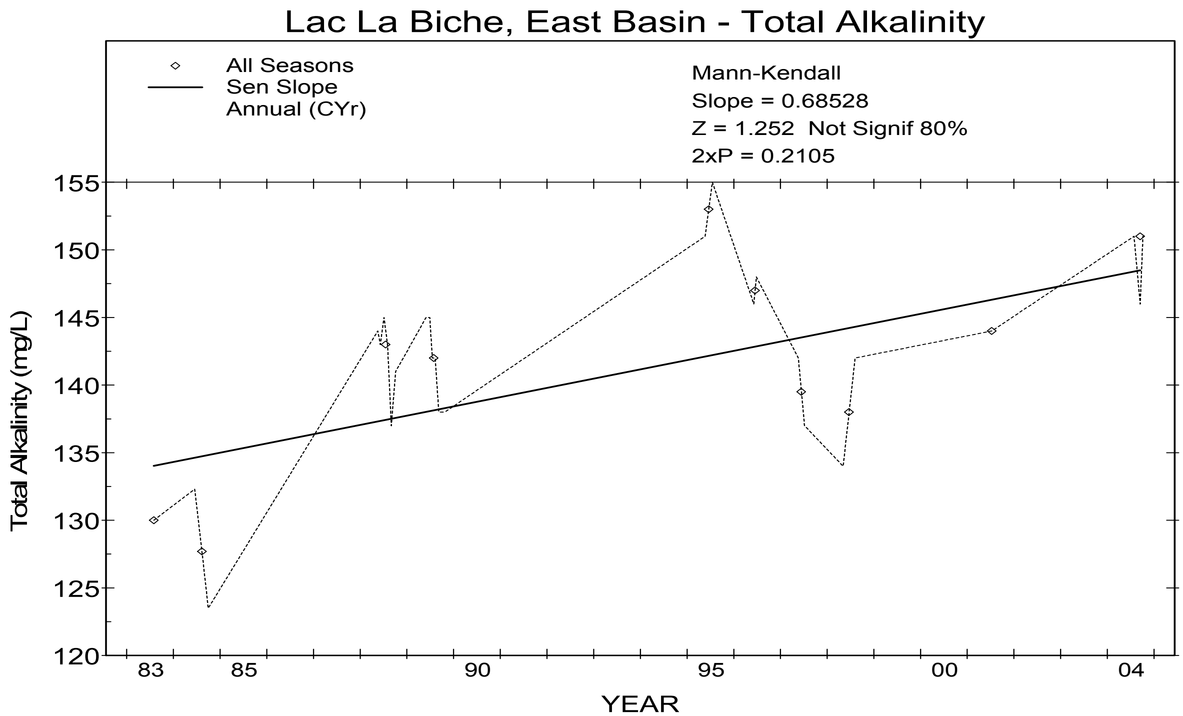


Figure 66 **Jarvis Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



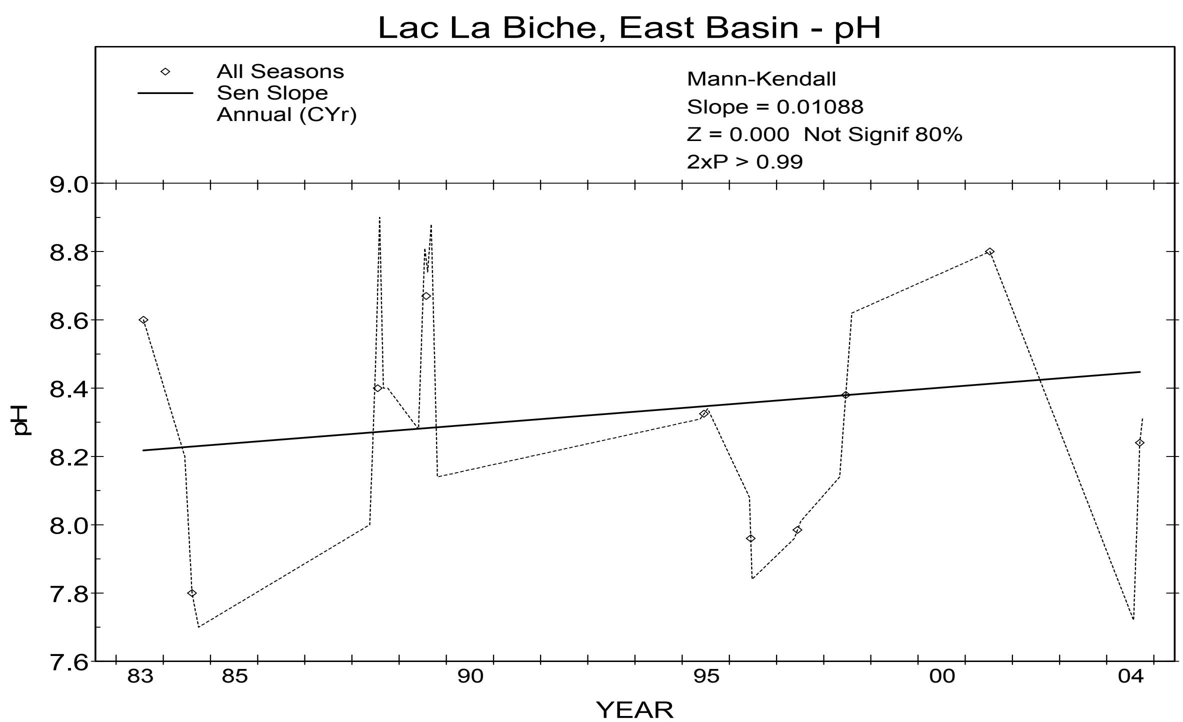
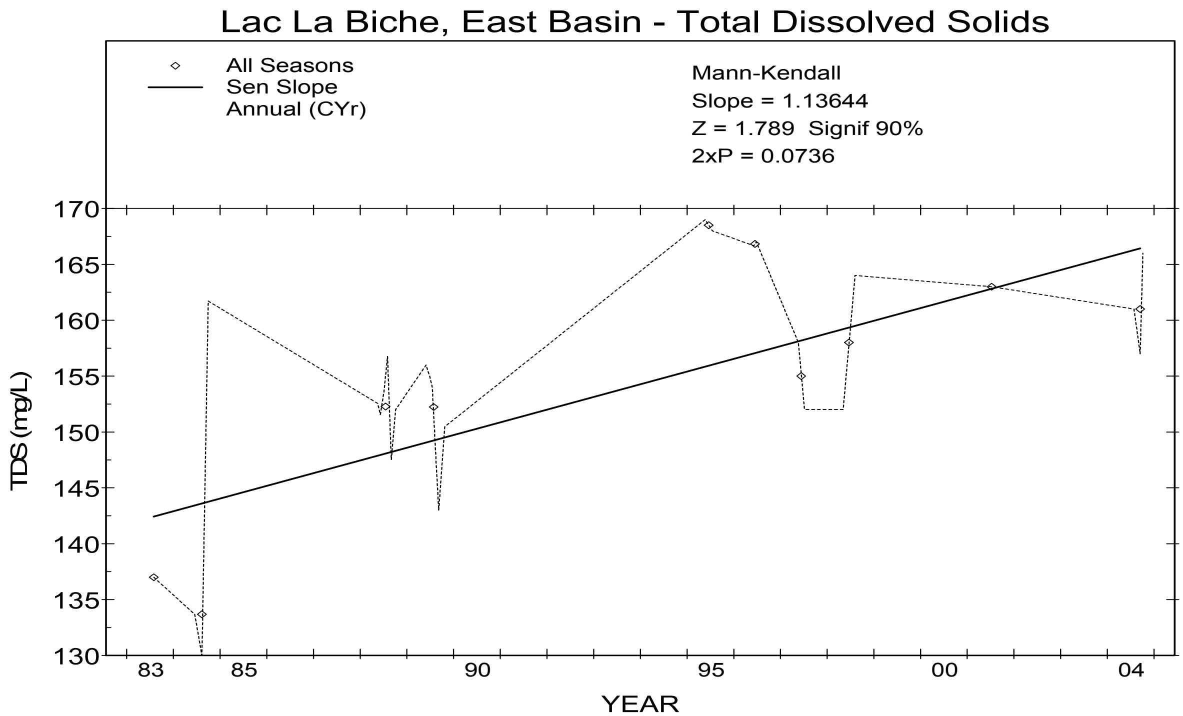


Figure 67 **Lac La Biche, East Basin –** Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



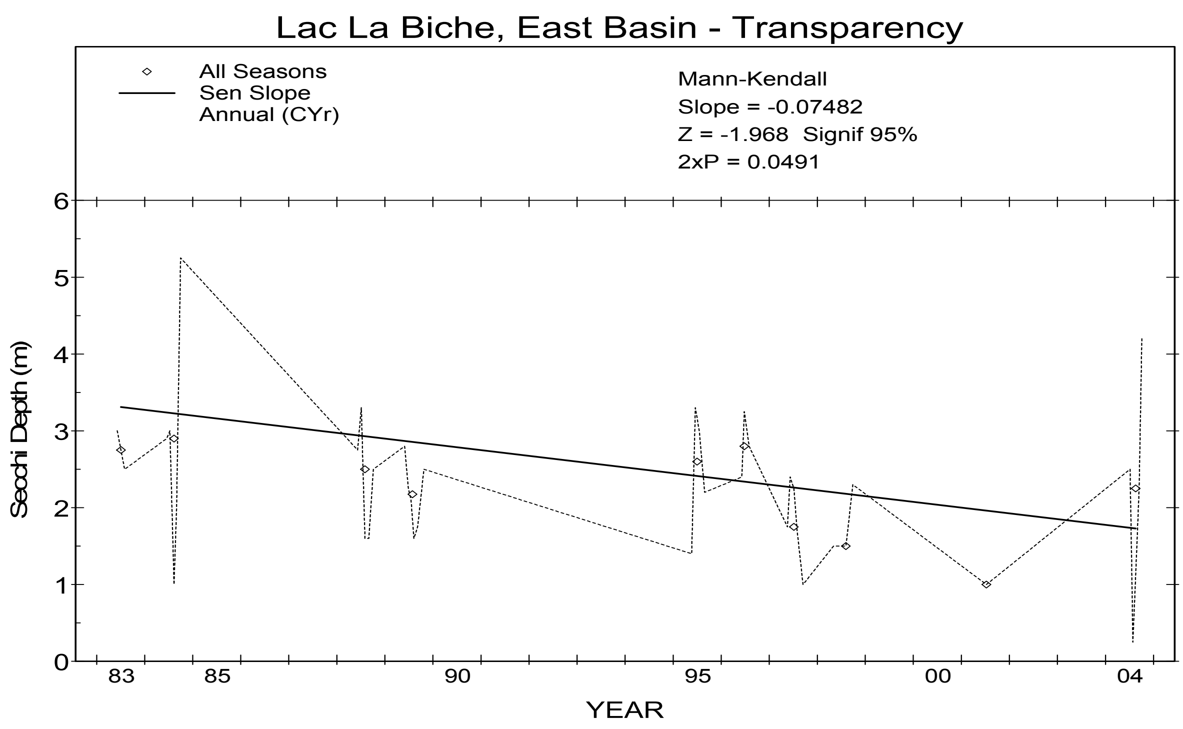
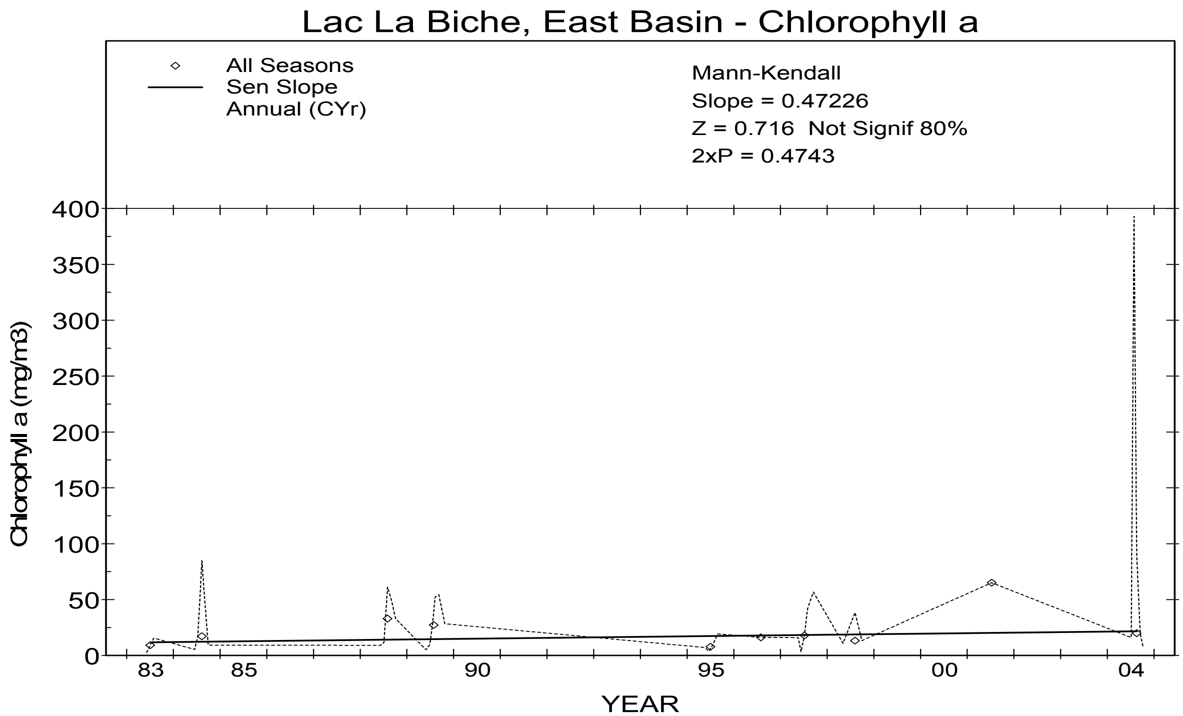


Figure 67 **Lac La Biche, East Basin** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



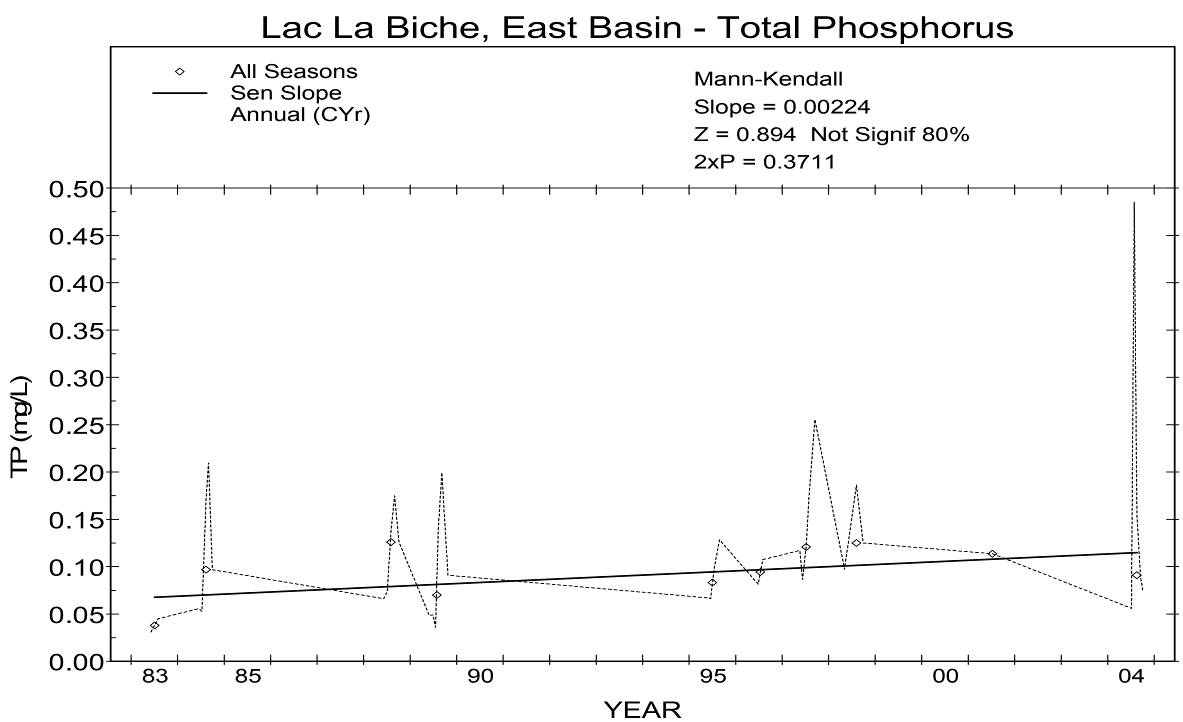
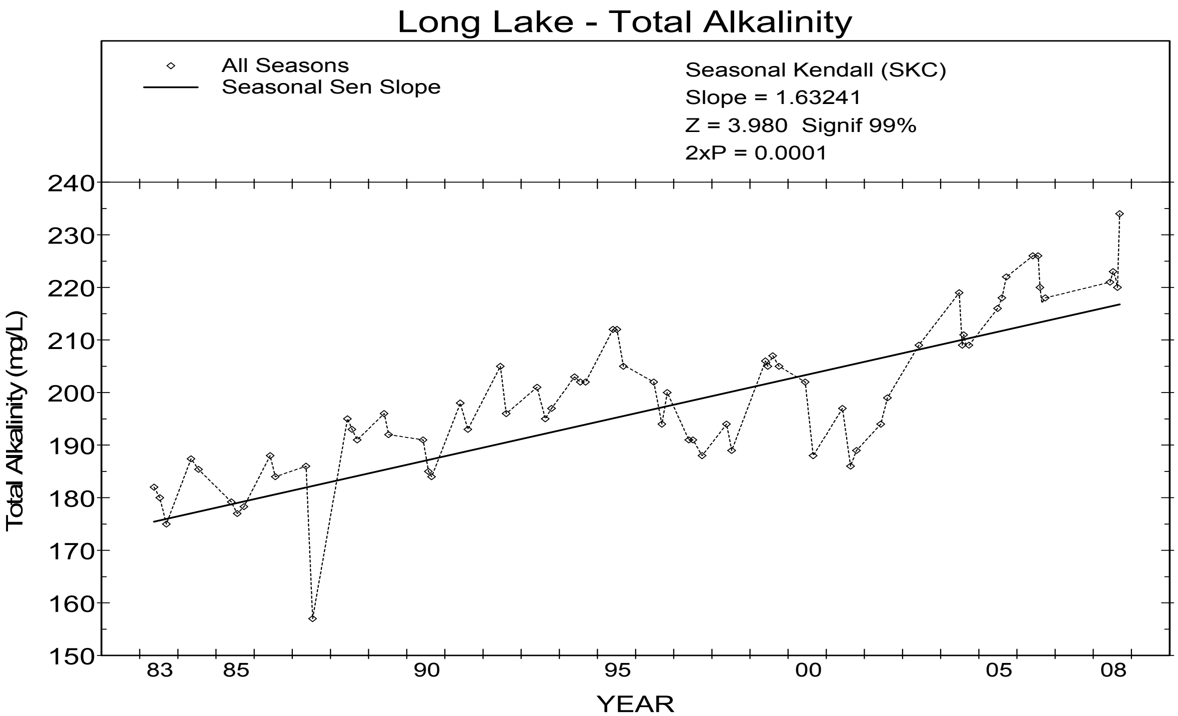


Figure 67 **Lac La Biche, East Basin** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



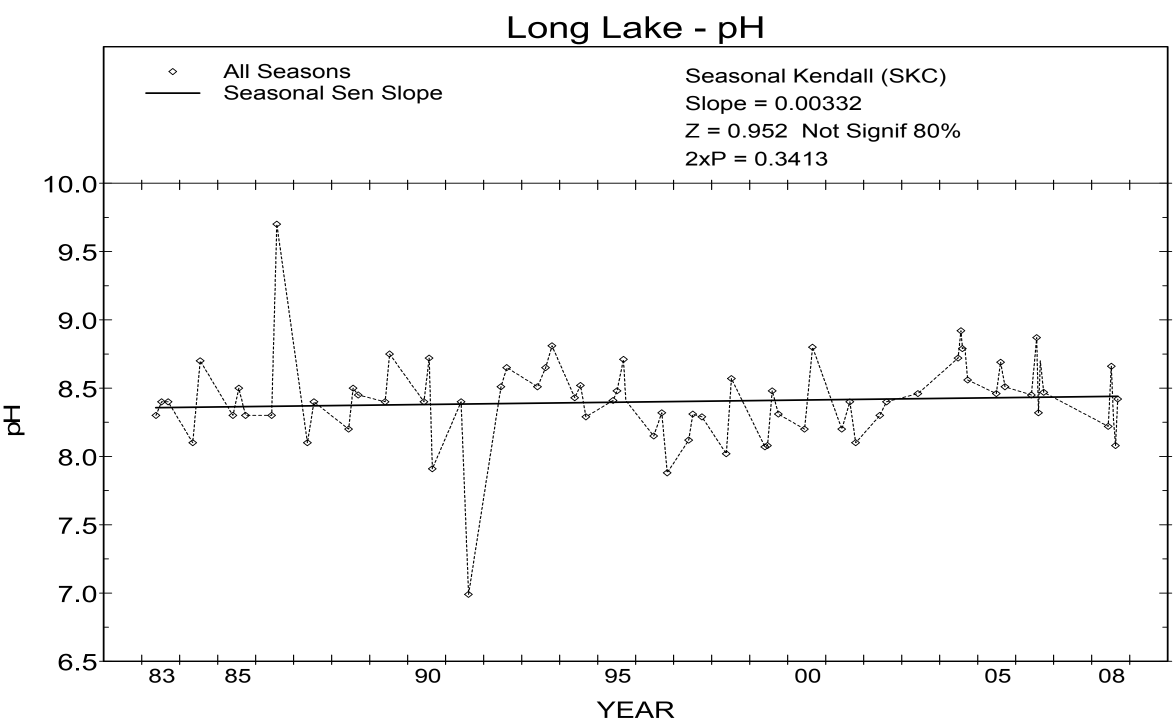
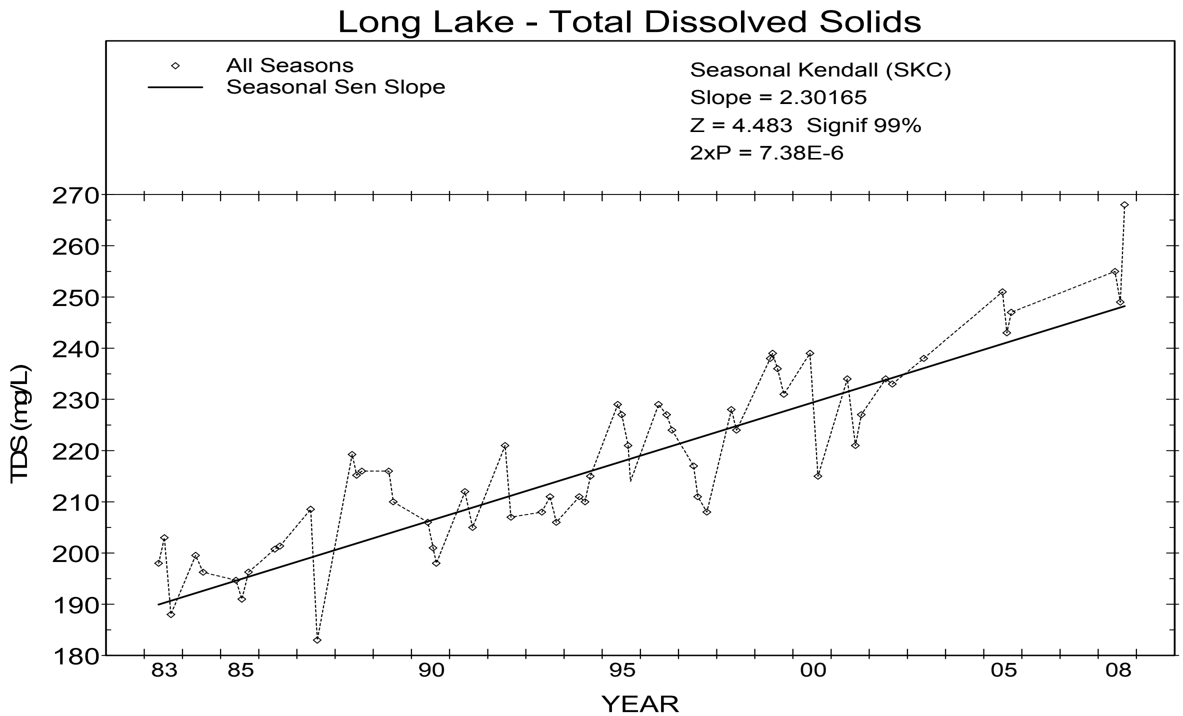


Figure 68 **Long Lake (near Boyle)** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



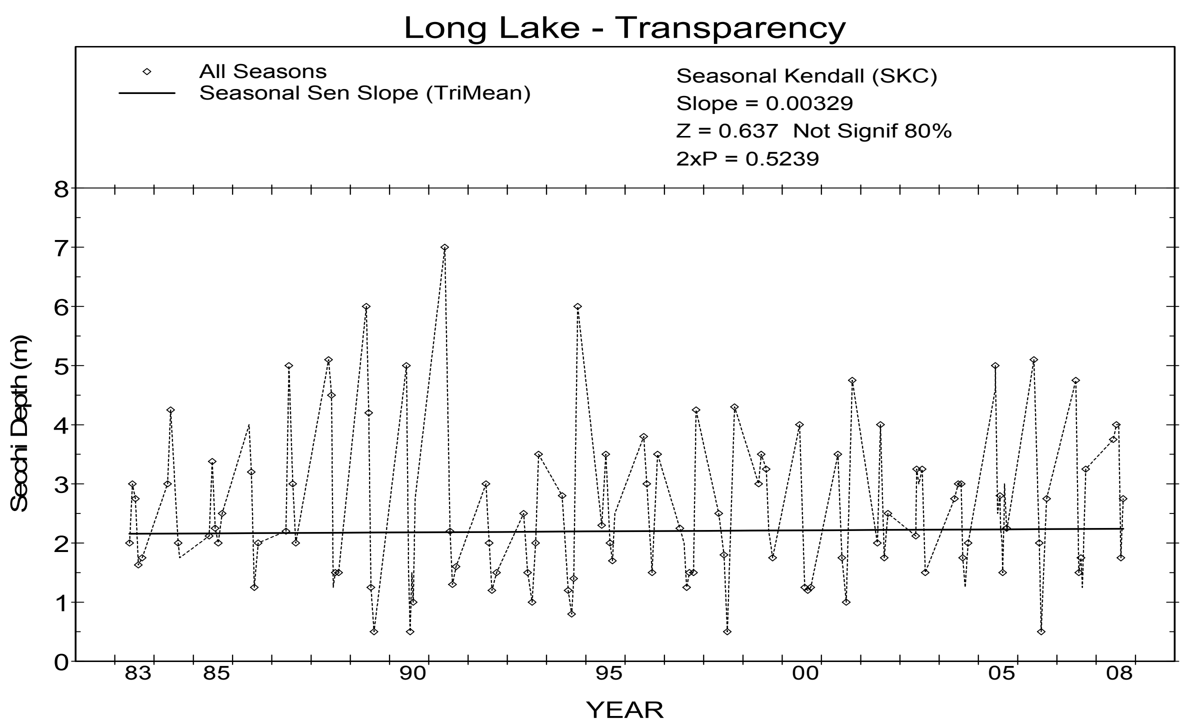
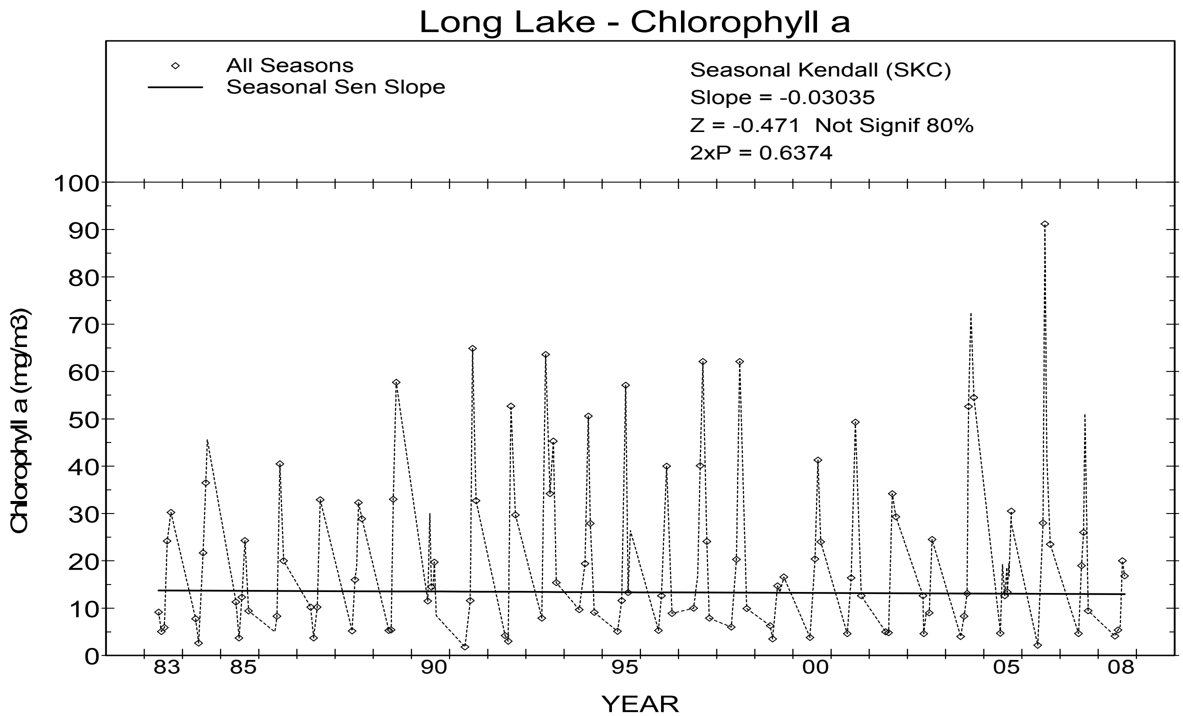


Figure 68 **Long Lake (near Boyle)** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



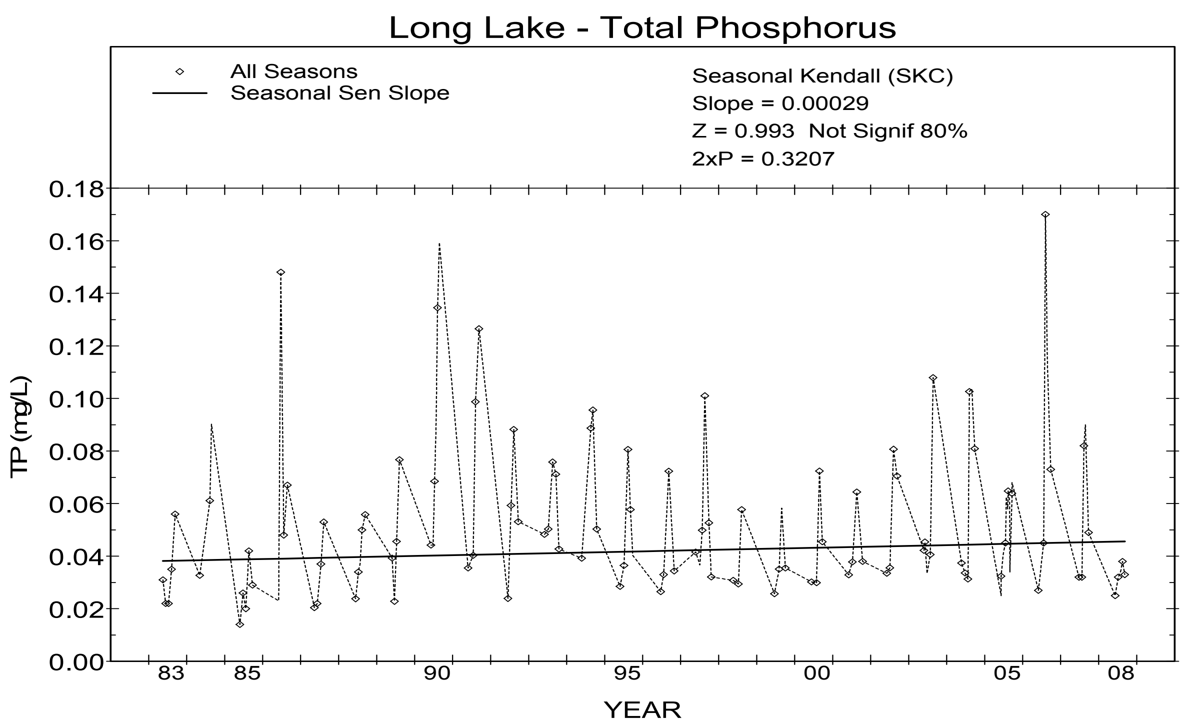
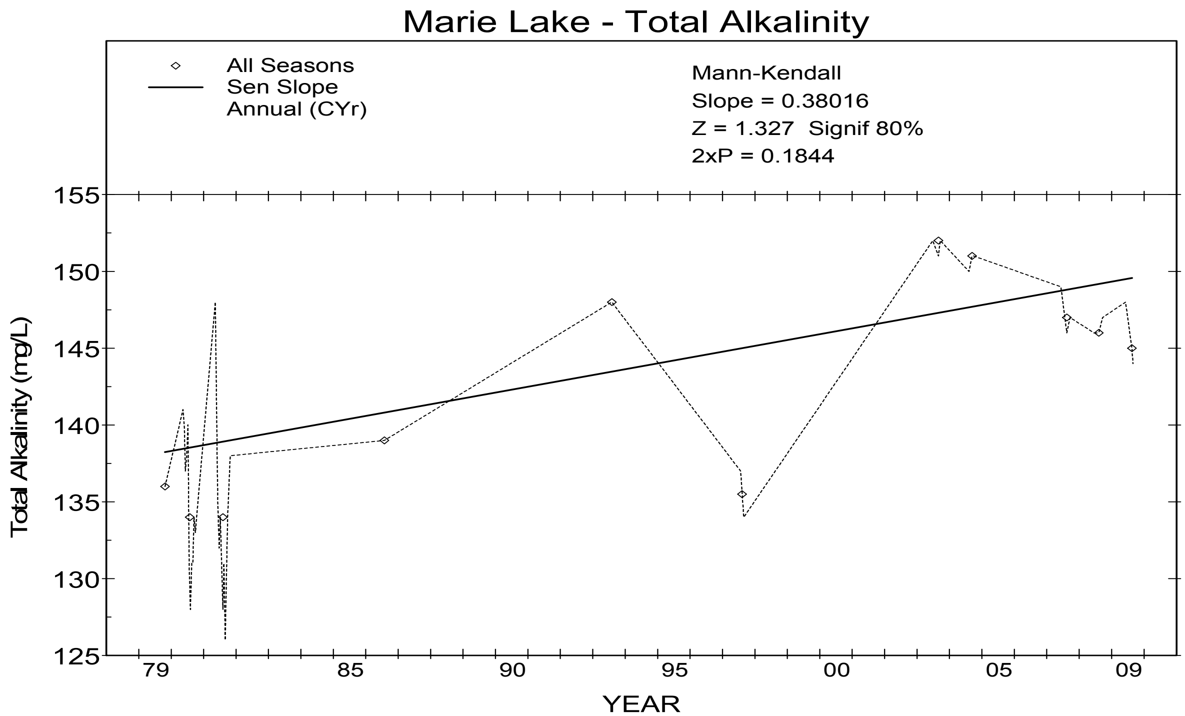


Figure 68 **Long Lake (near Boyle)** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



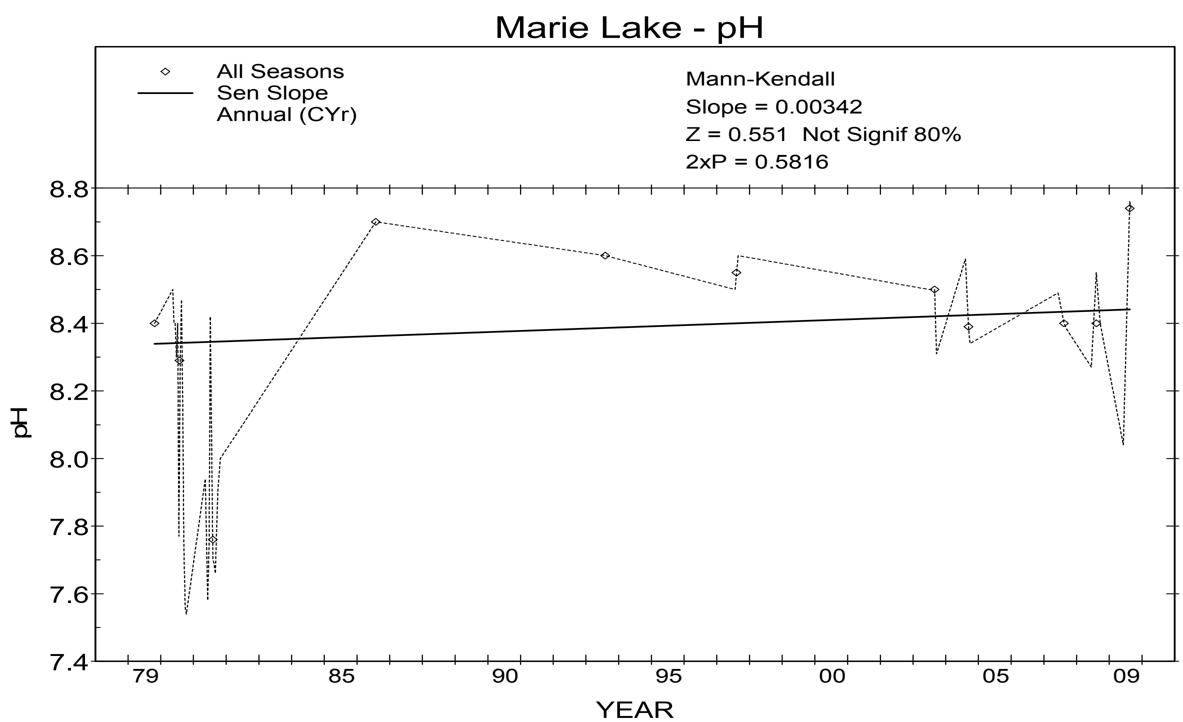
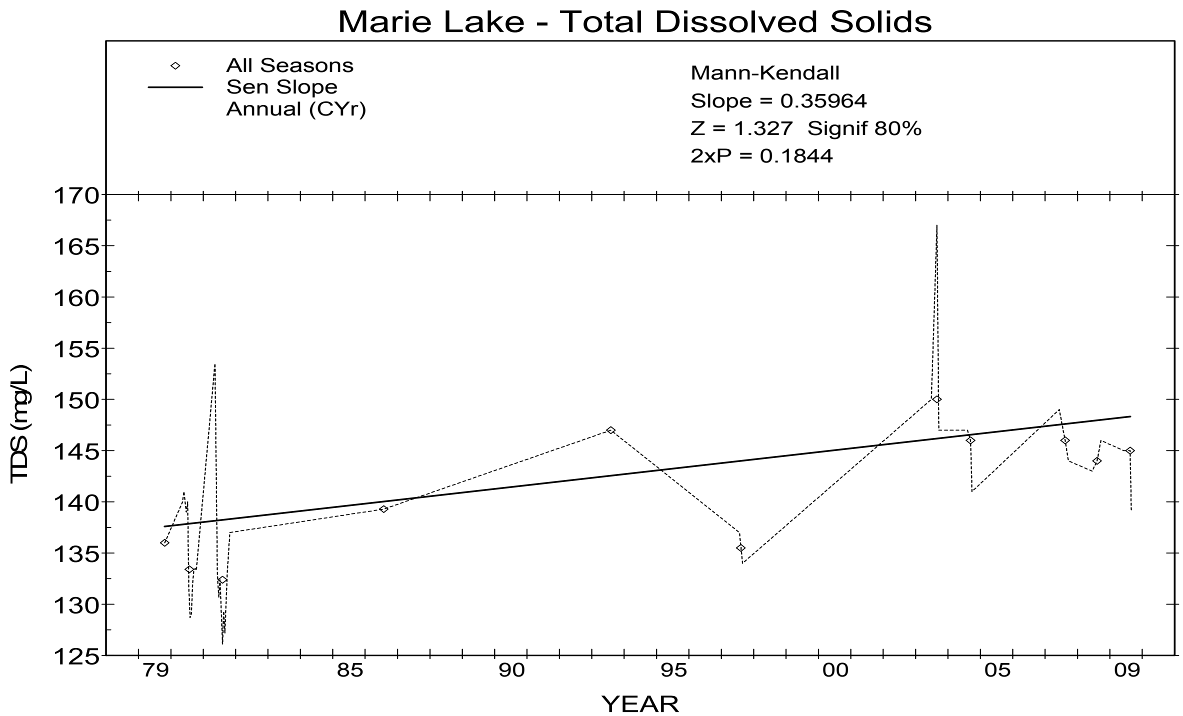


Figure 69 **Marie Lake –** Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



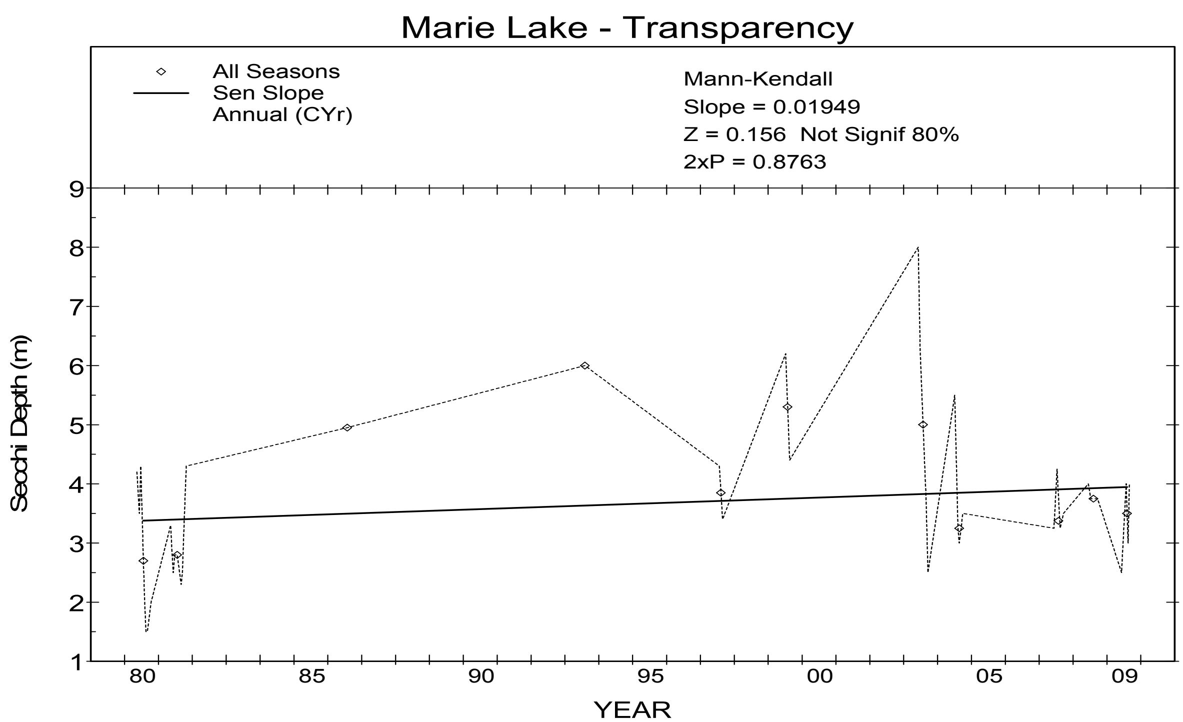
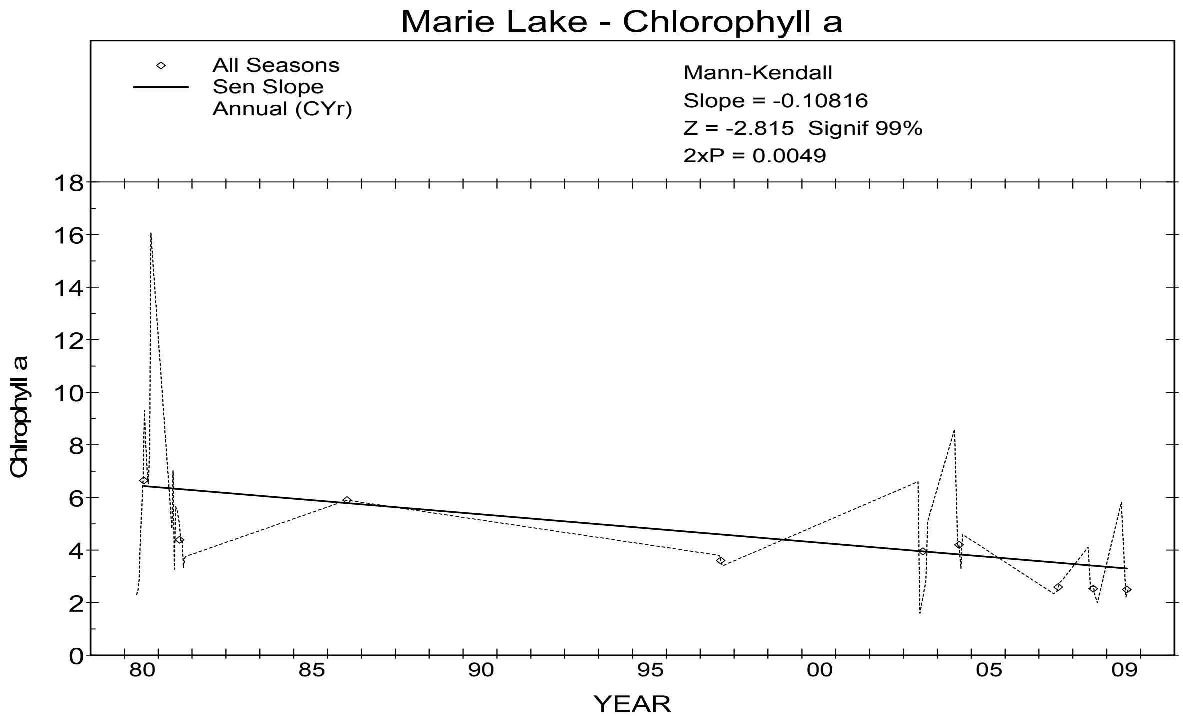


Figure 69 **Marie Lake –** Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



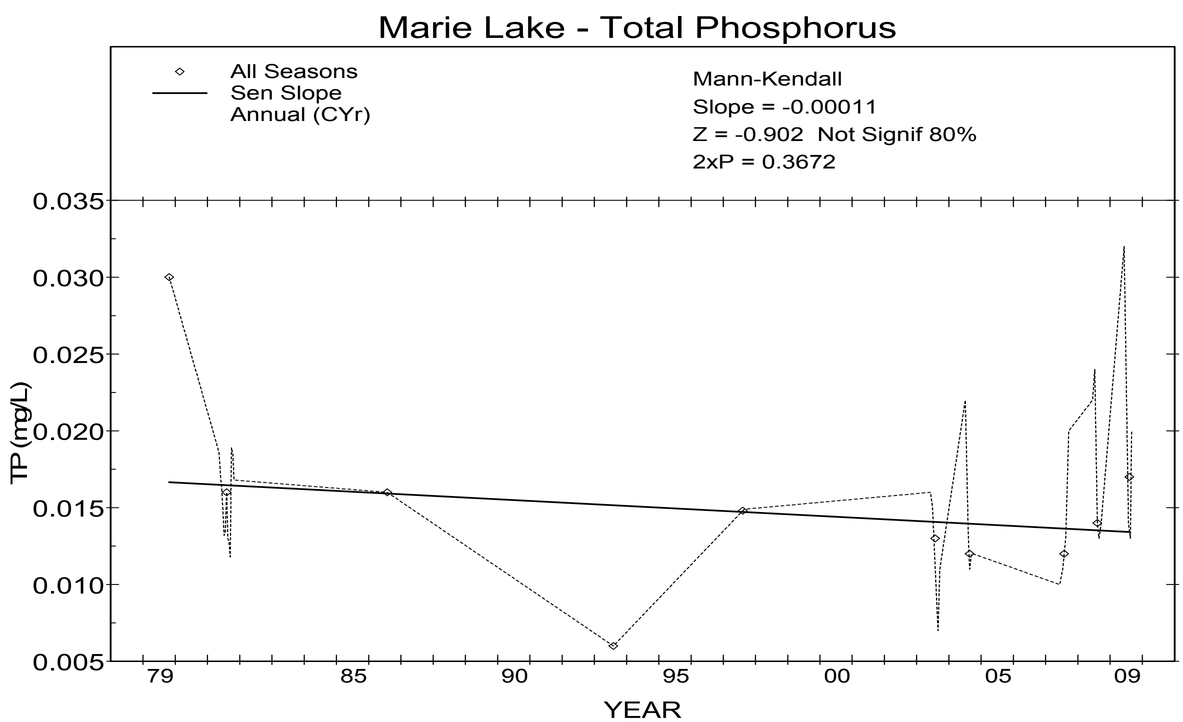
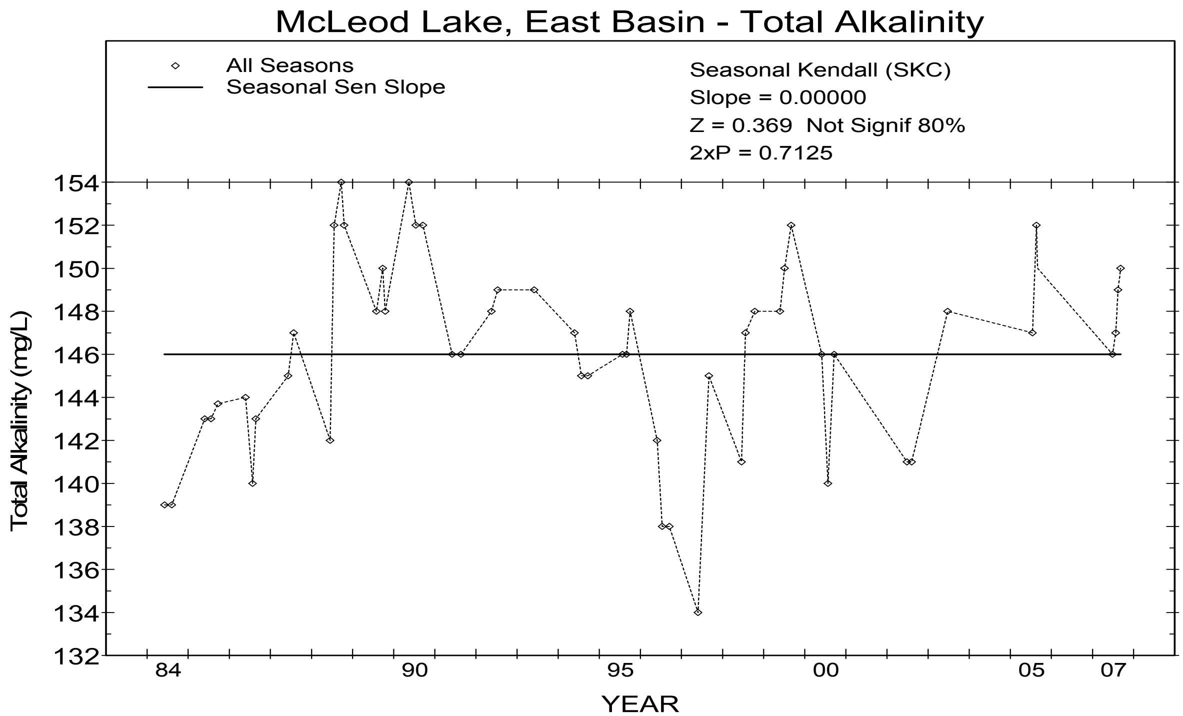


Figure 69 **Marie Lake –** Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



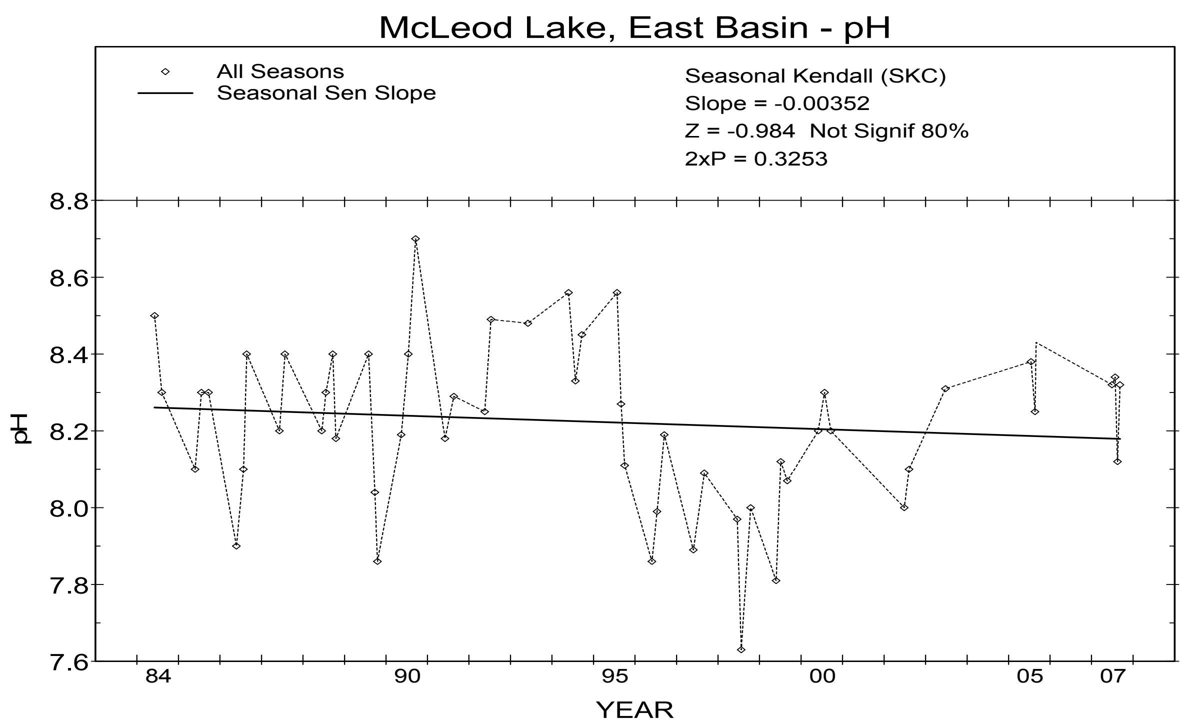
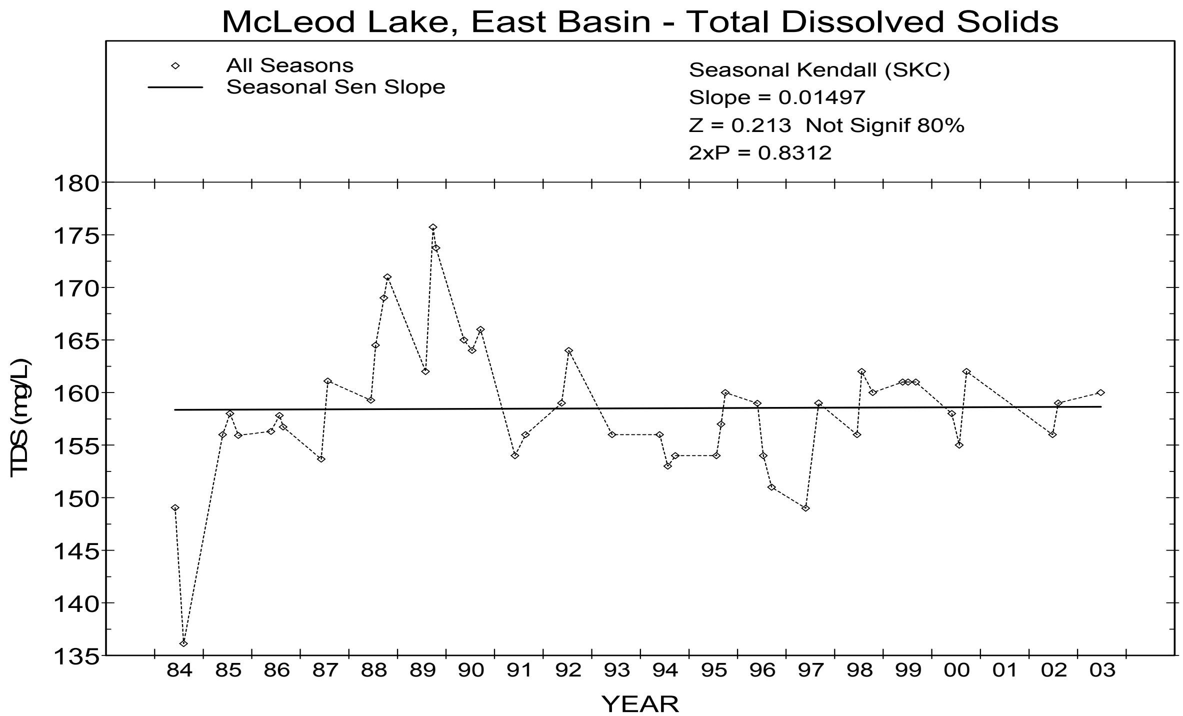


Figure 70 **McLeod Lake, East Basin** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



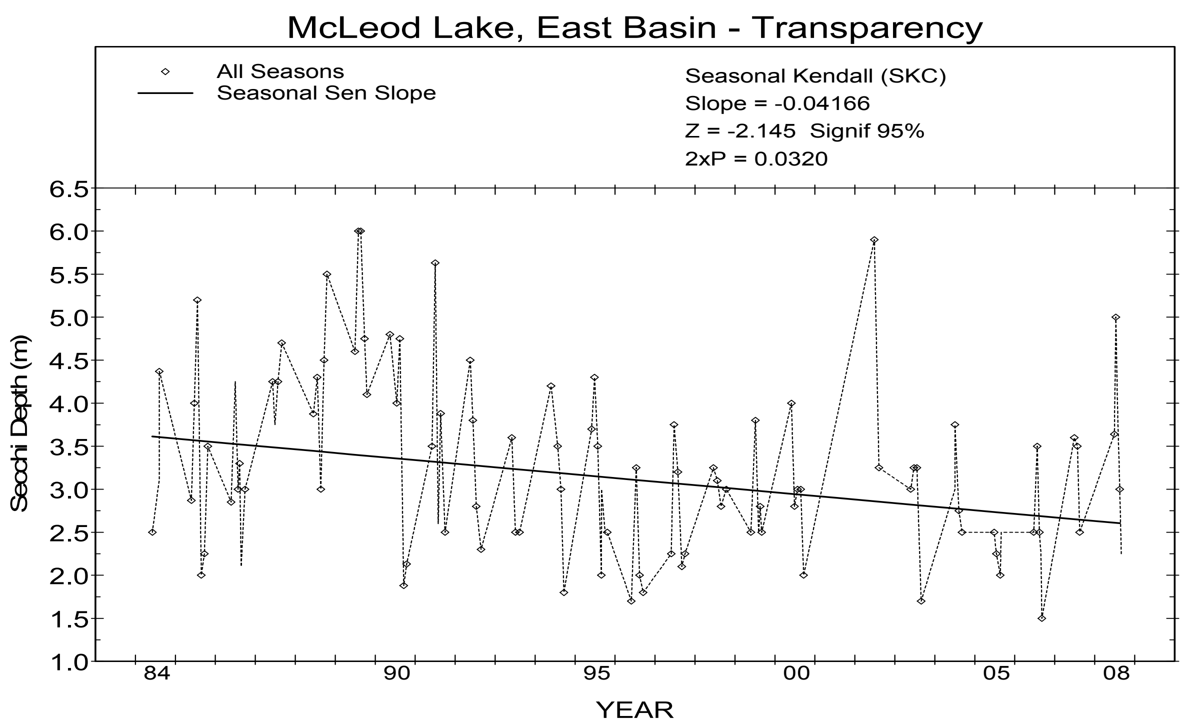
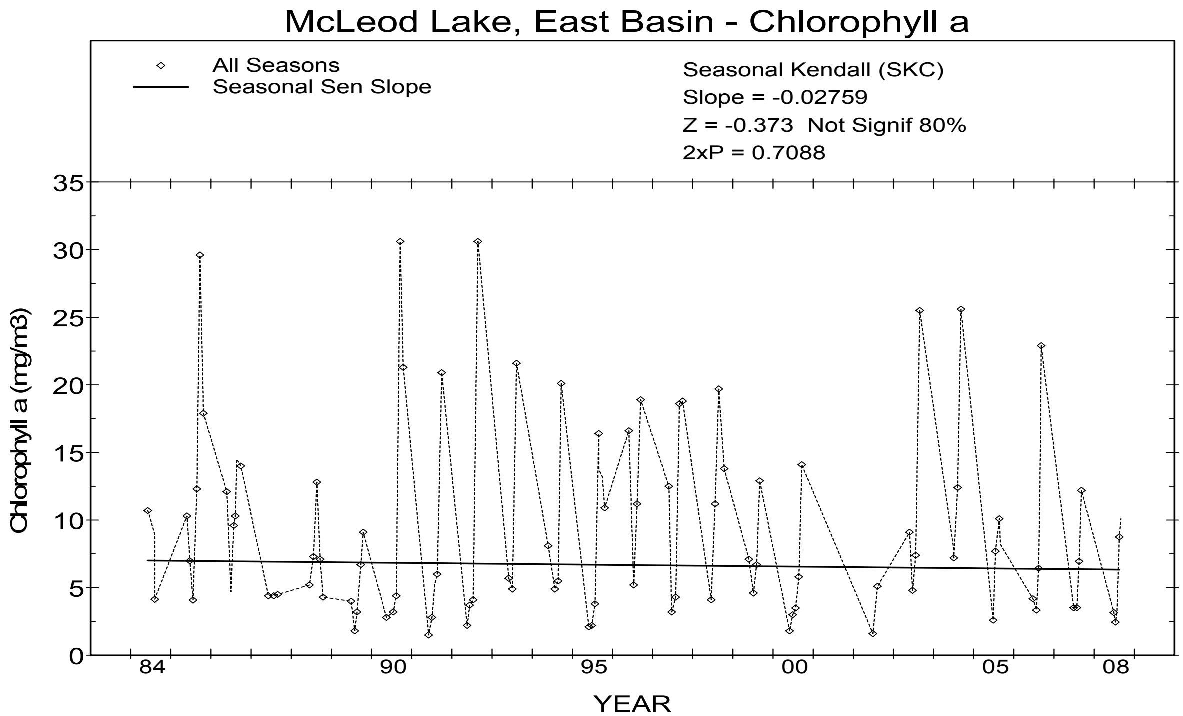


Figure 70 **McLeod Lake, East Basin** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



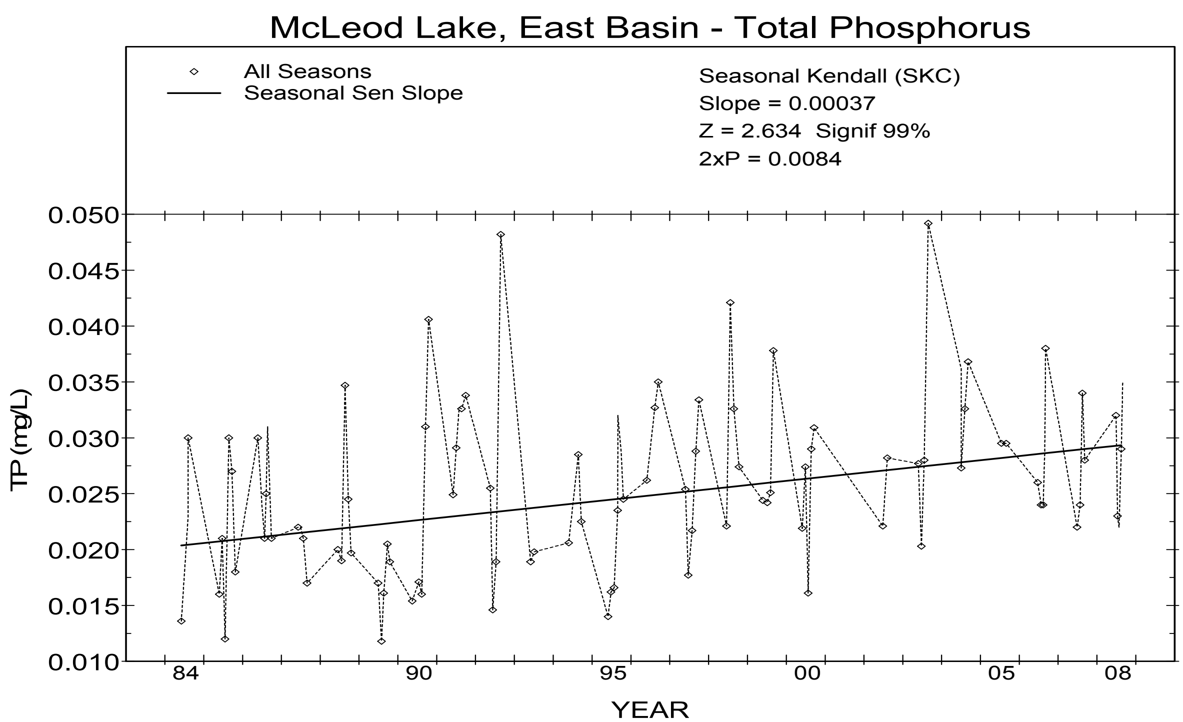
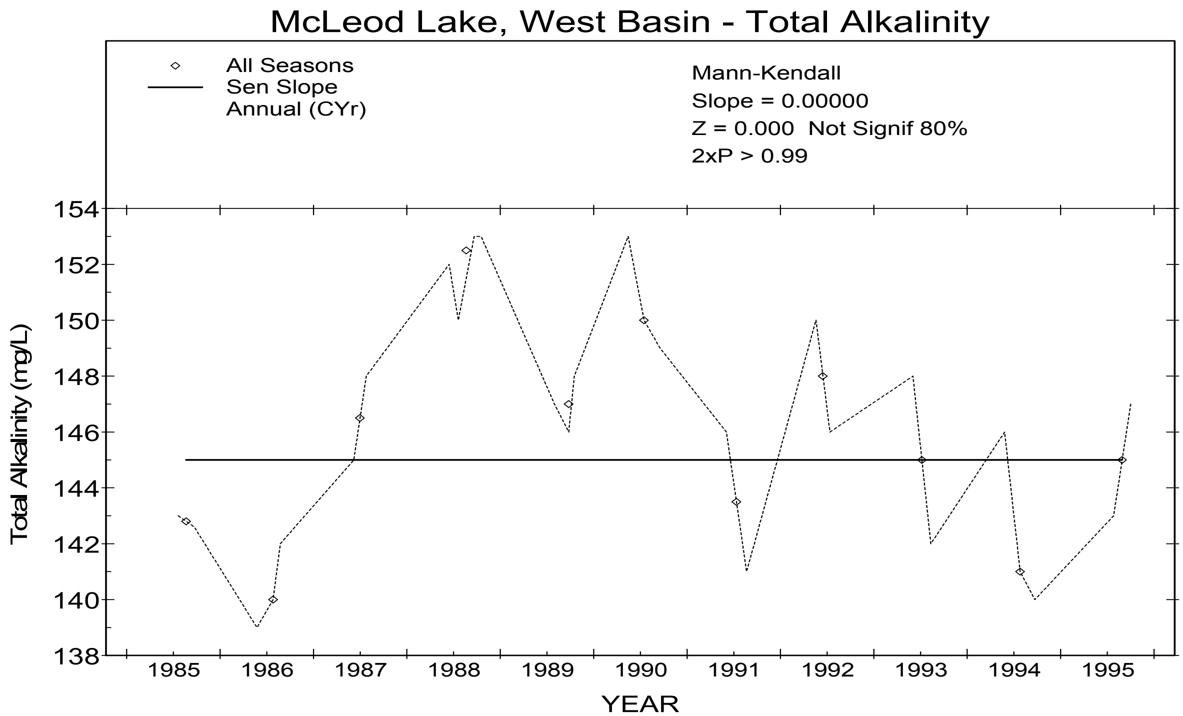


Figure 70 **McLeod Lake, East Basin** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



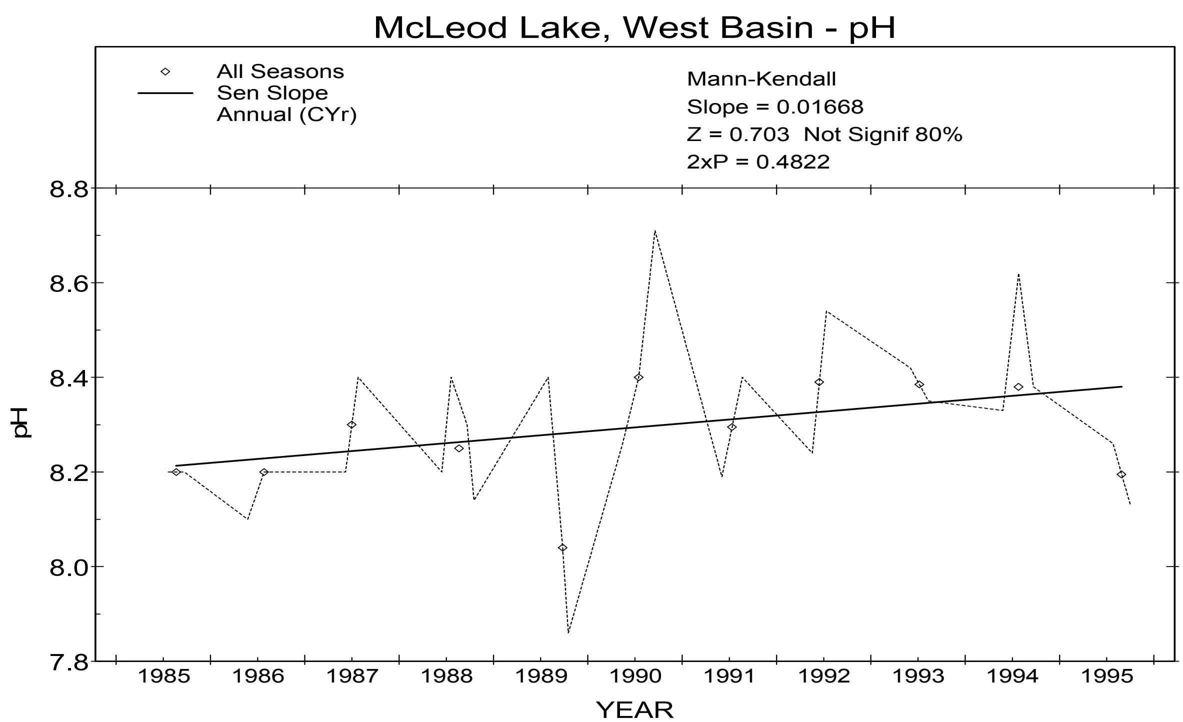
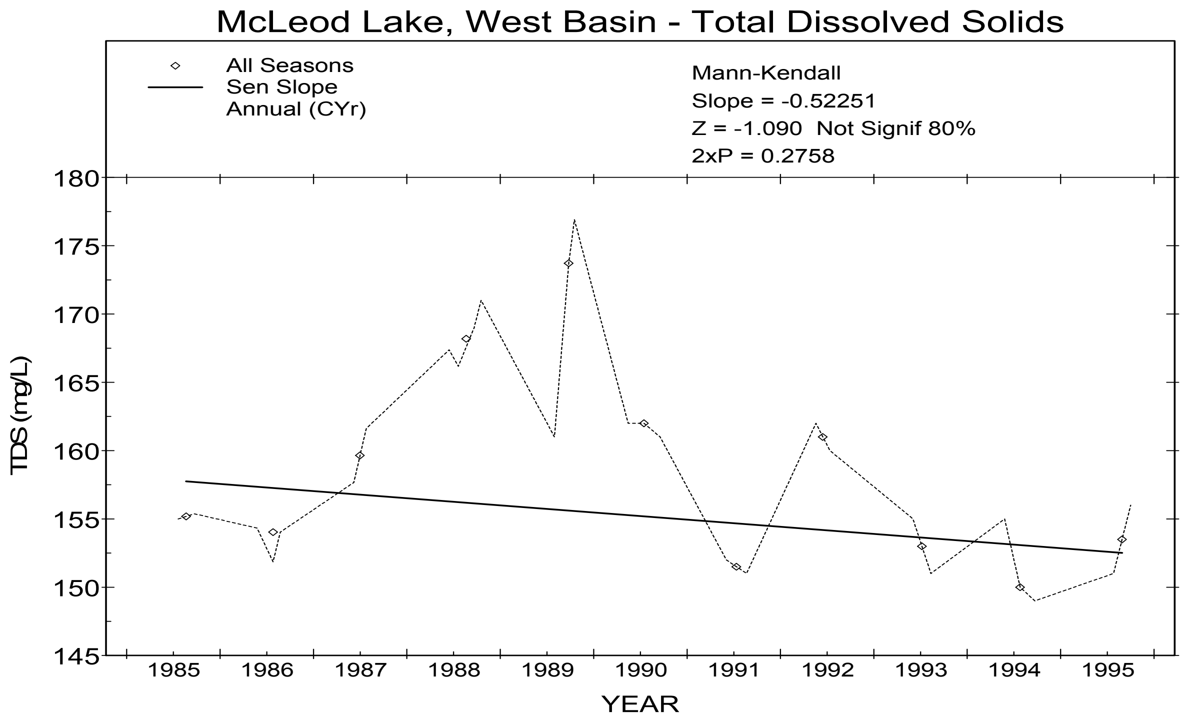


Figure 71 **McLeod Lake, West Basin** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



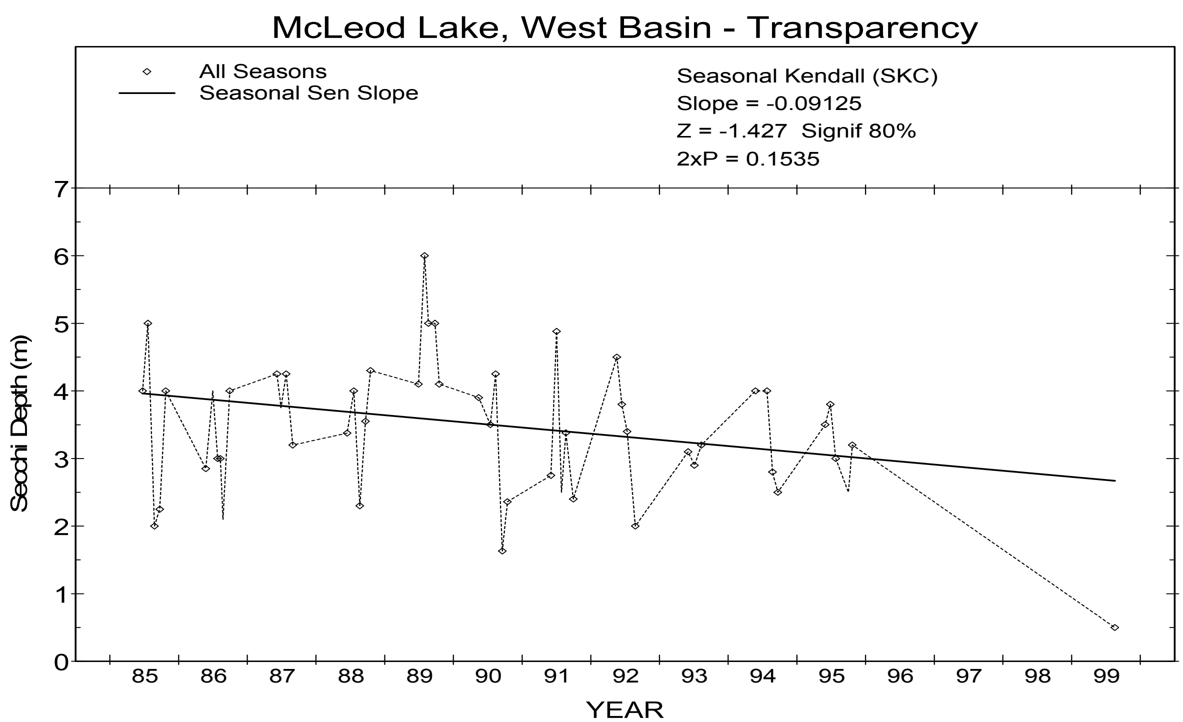
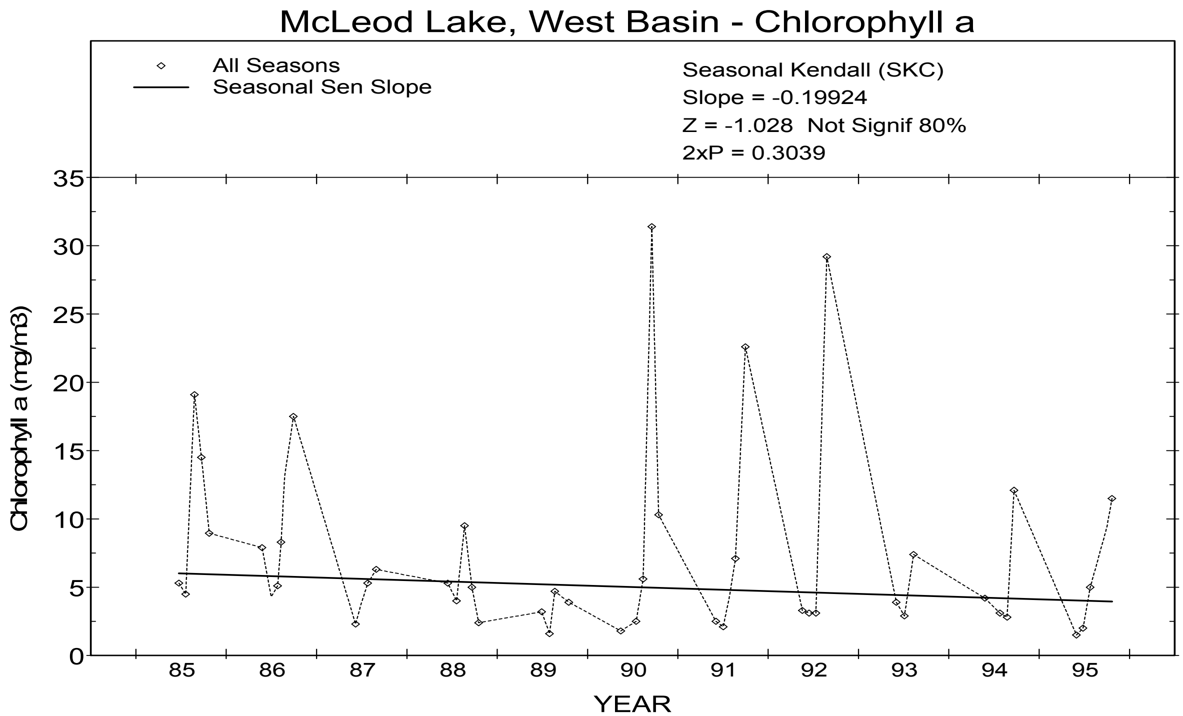


Figure 71 **McLeod Lake, West Basin** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



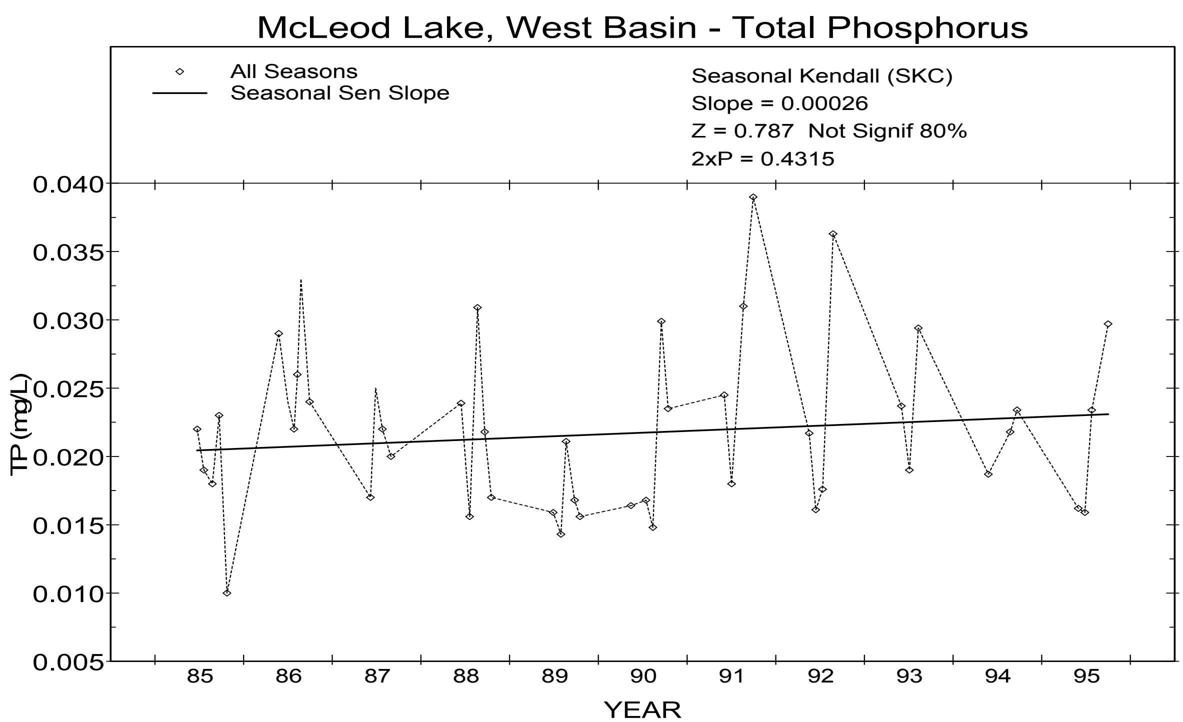
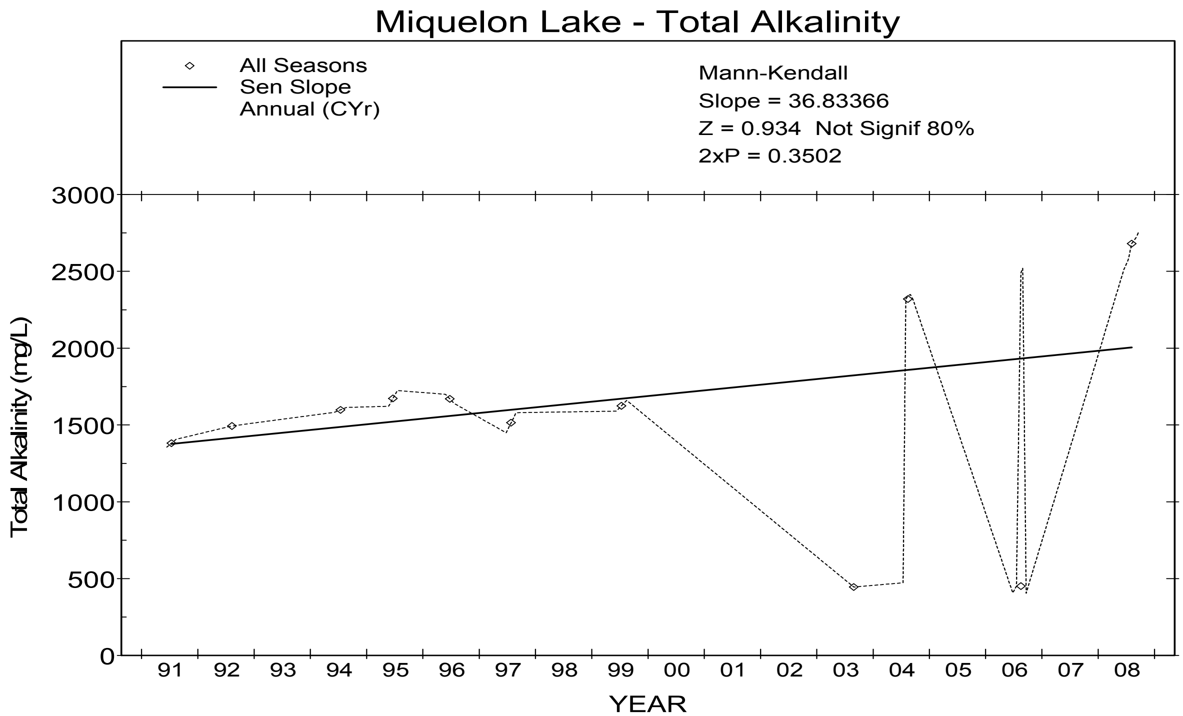


Figure 71 **McLeod Lake, West Basin** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



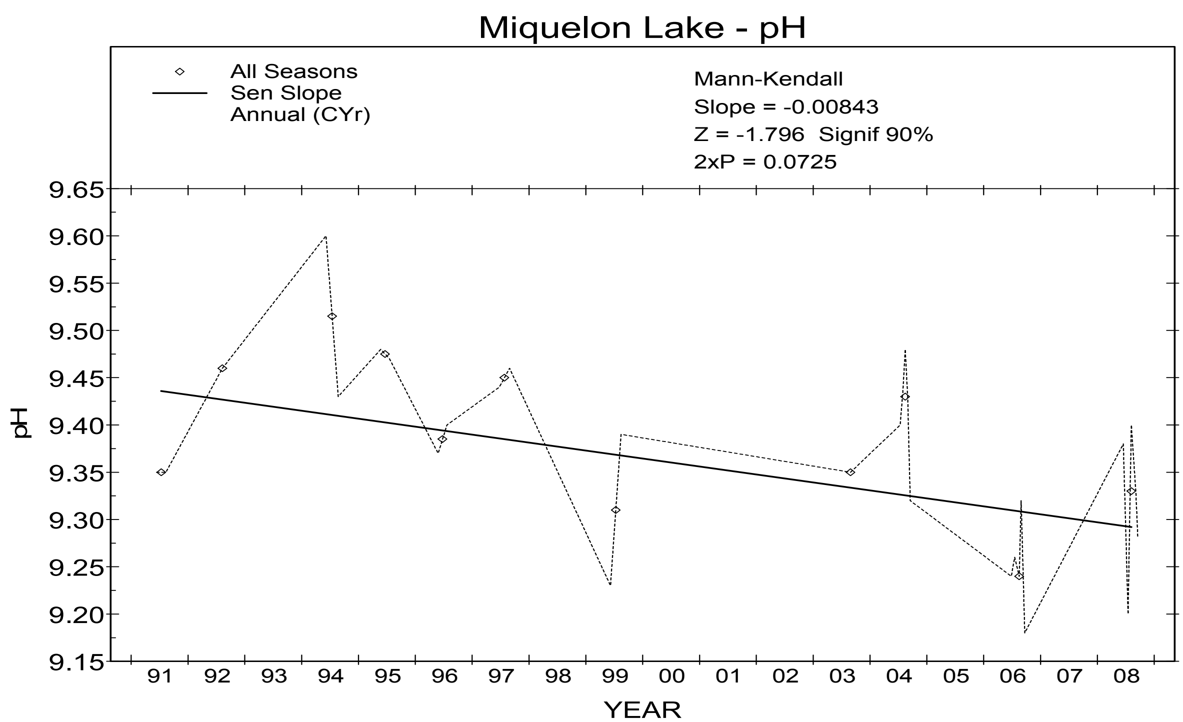
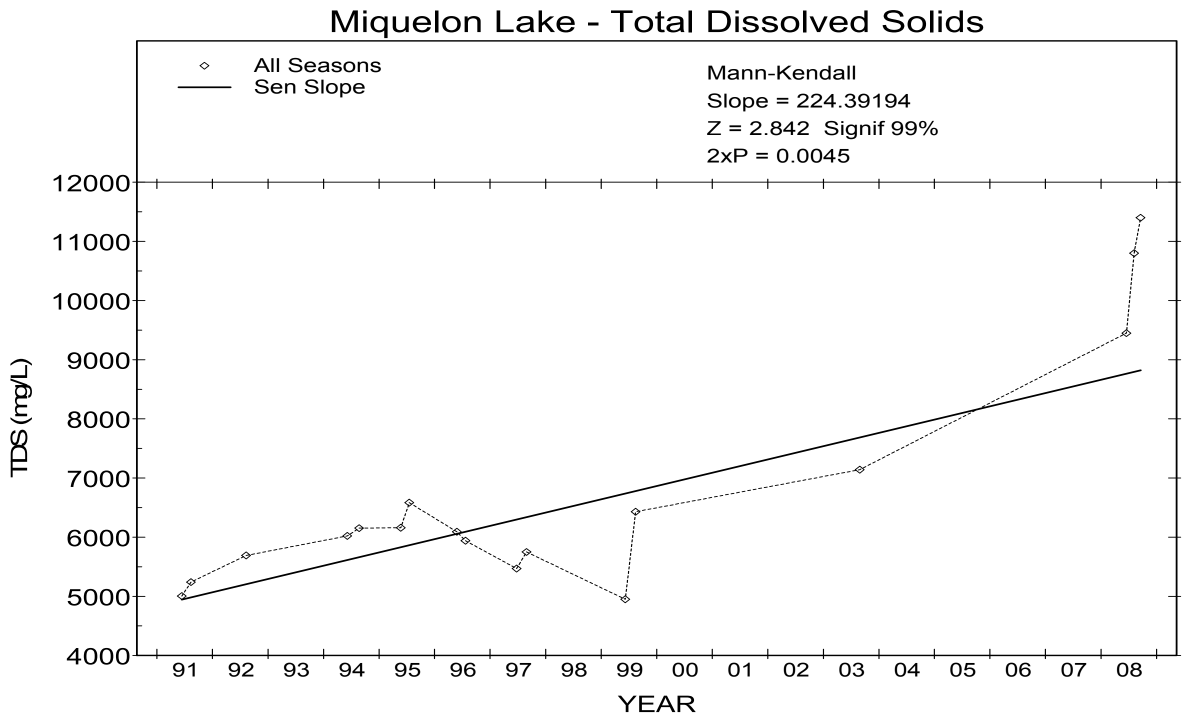


Figure 72 **Miquelon Lake** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



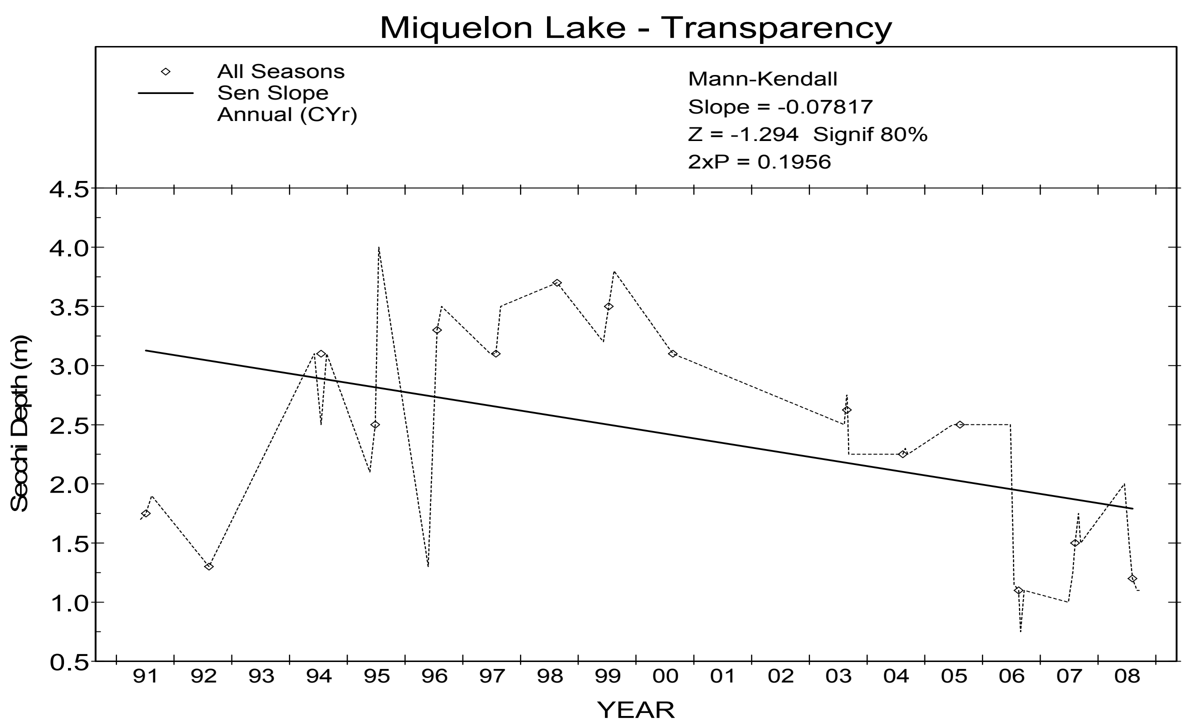
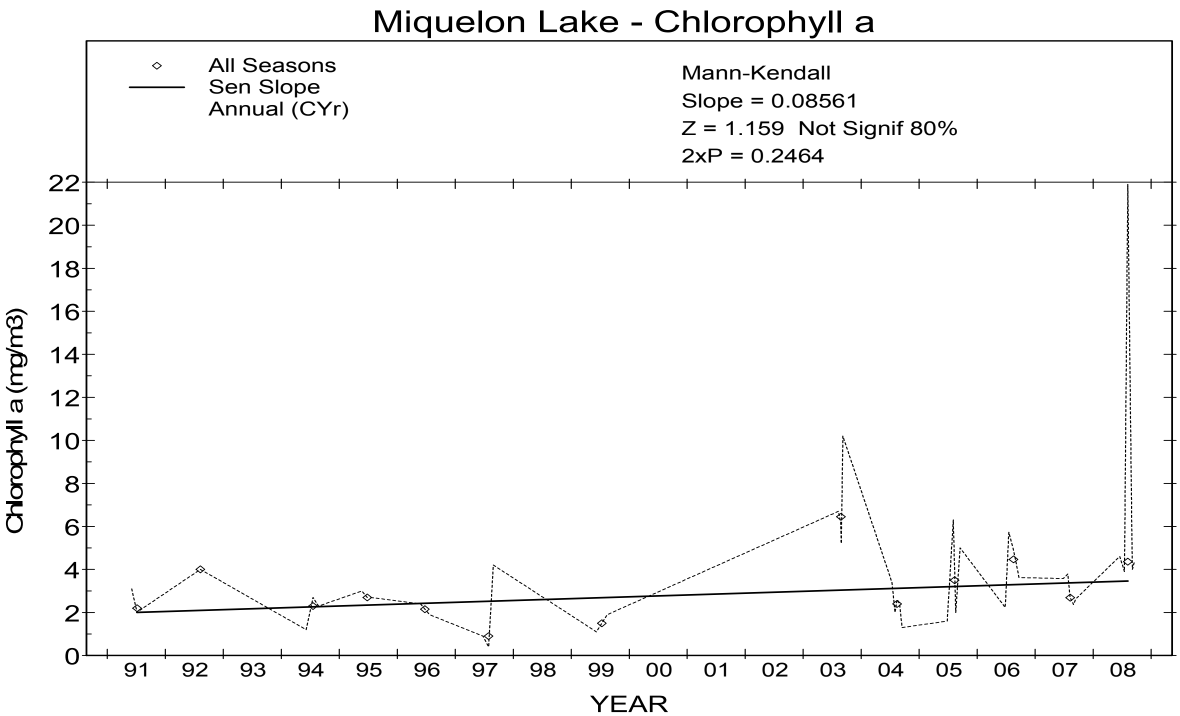


Figure 72 **Miquelon Lake** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record. Note that monthly instead of annual values were used for TDS (Sections 2.3 and 3.3.3) (continued)



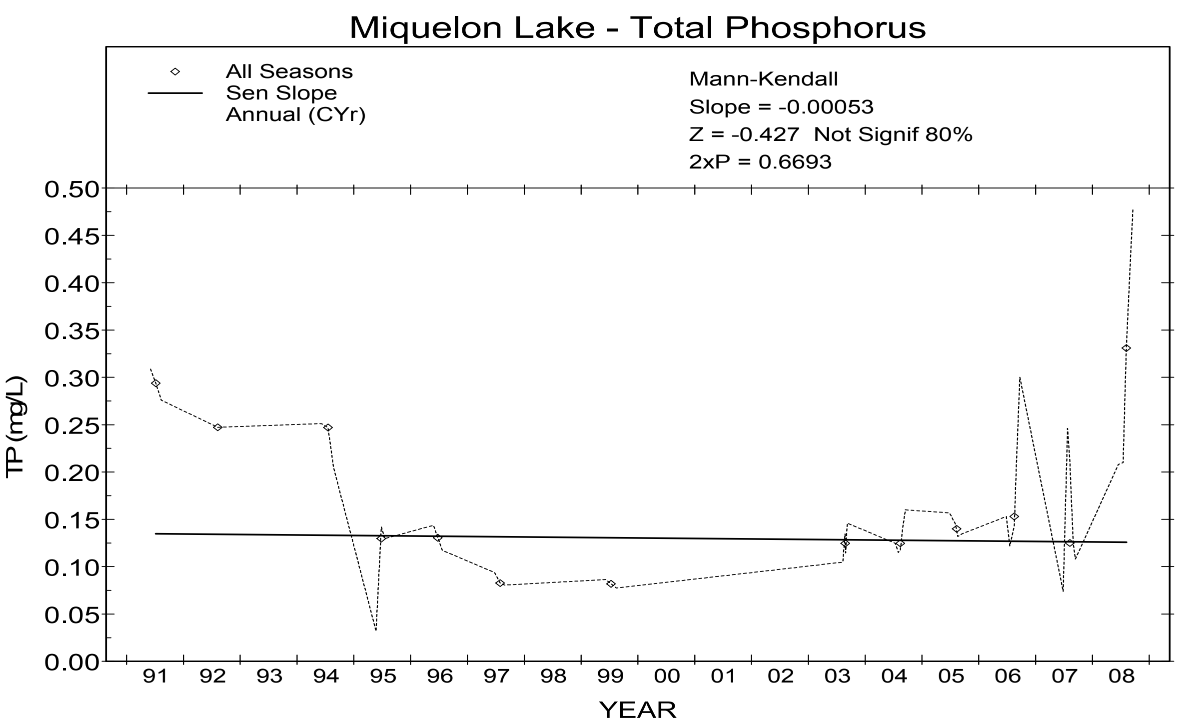
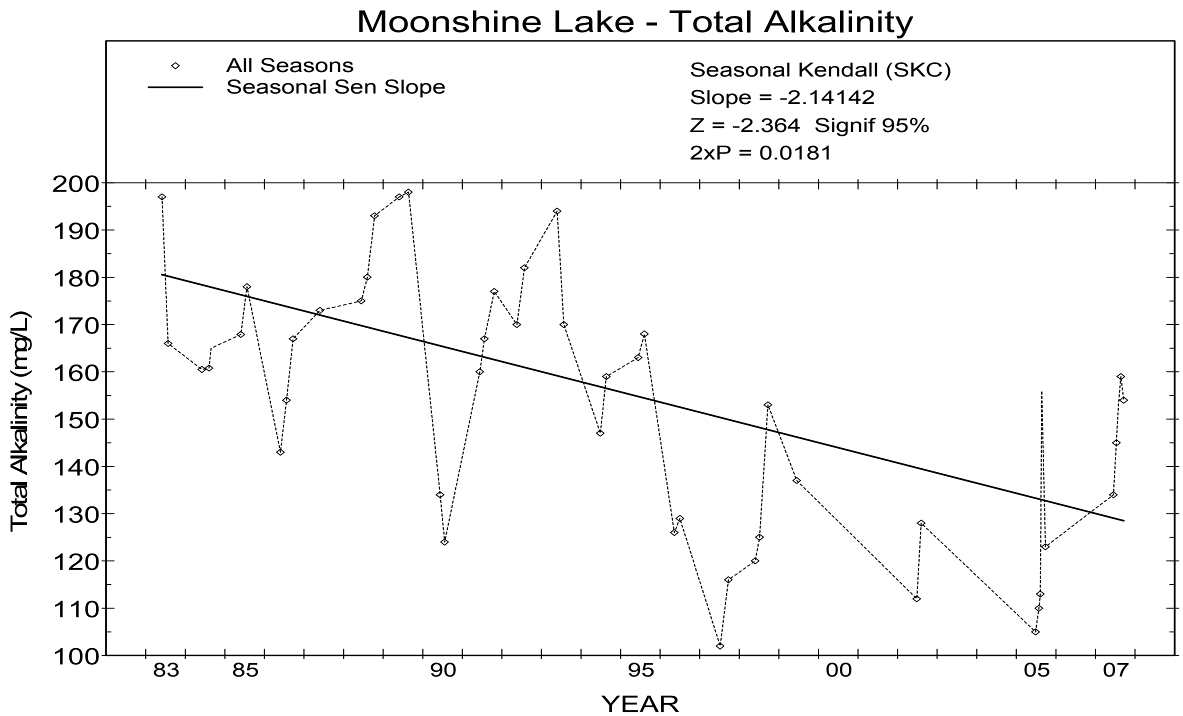


Figure 72 **Miquelon Lake** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



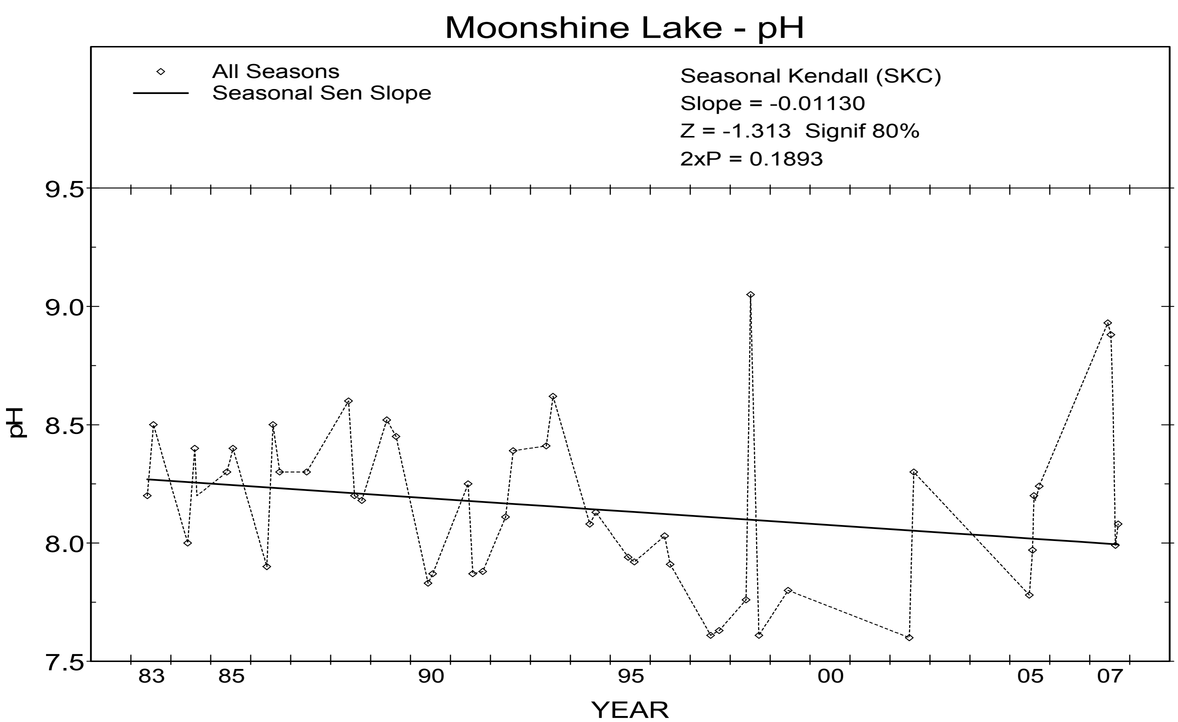
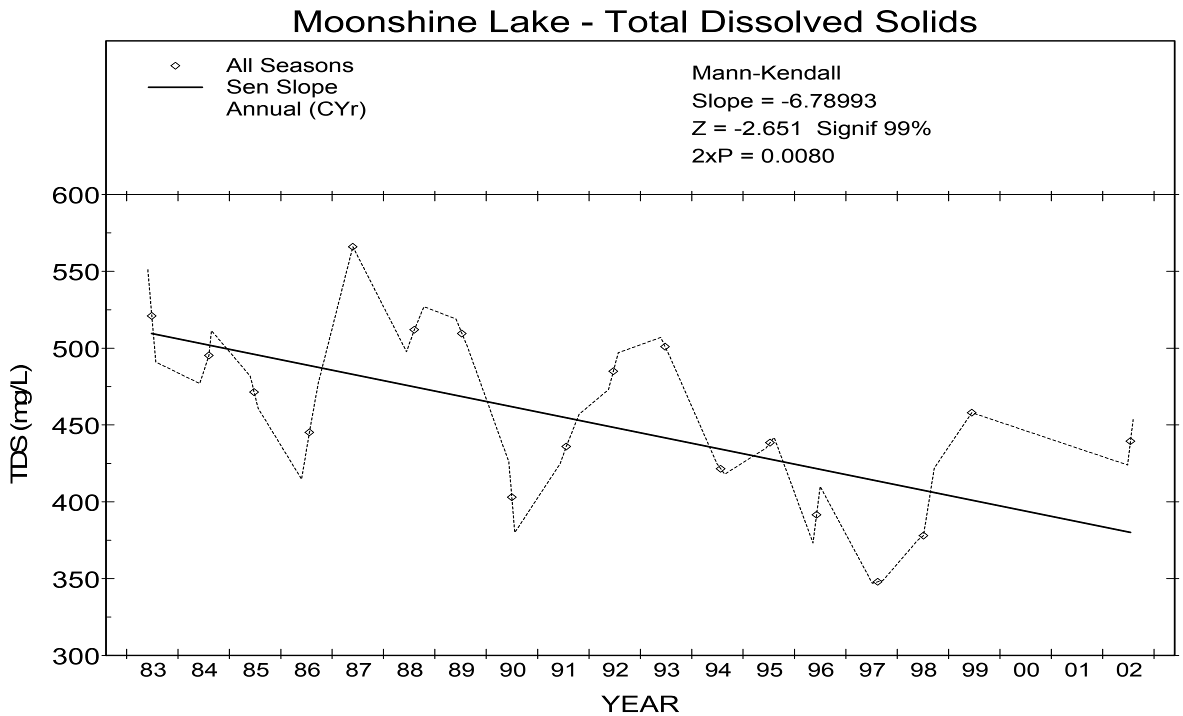


Figure 73 **Moonshine Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



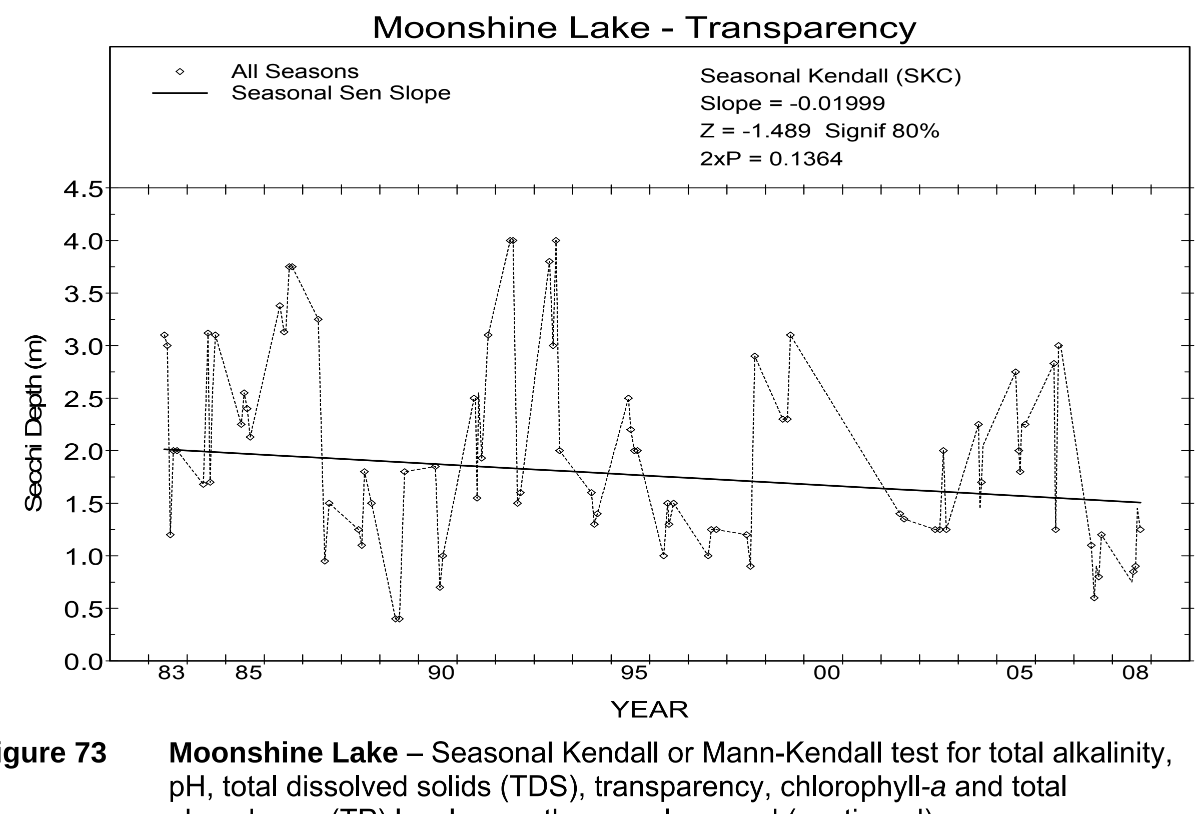
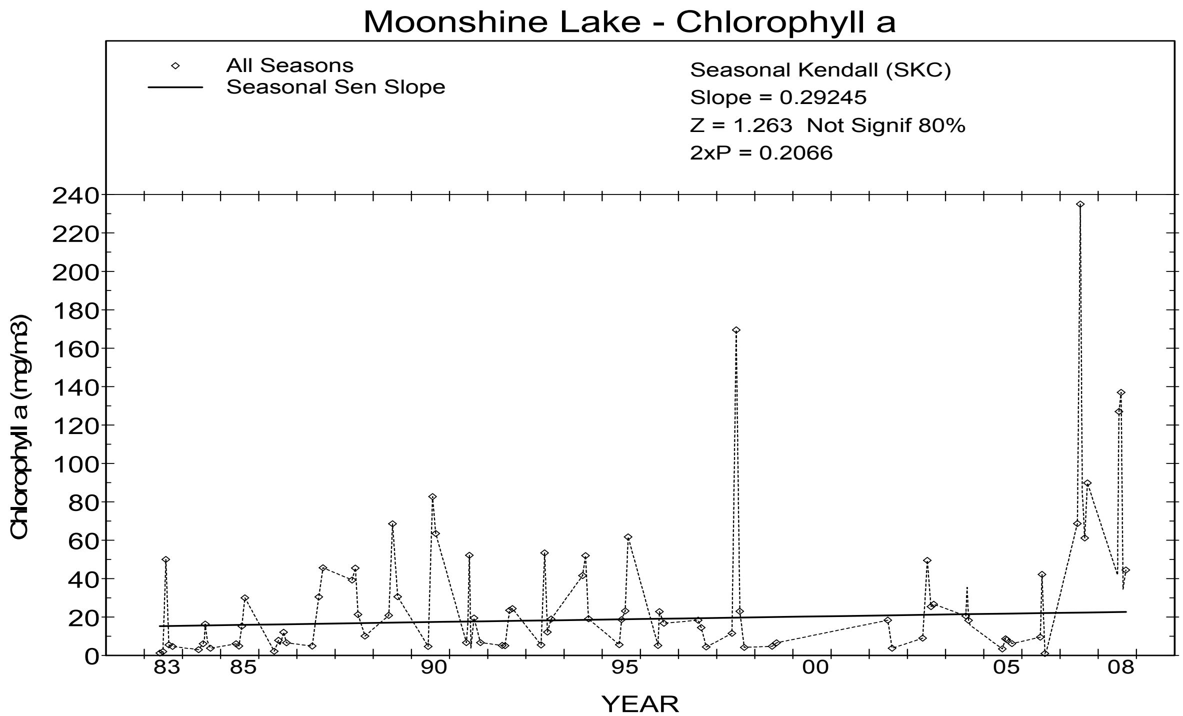


Figure 73 **Moonshine Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



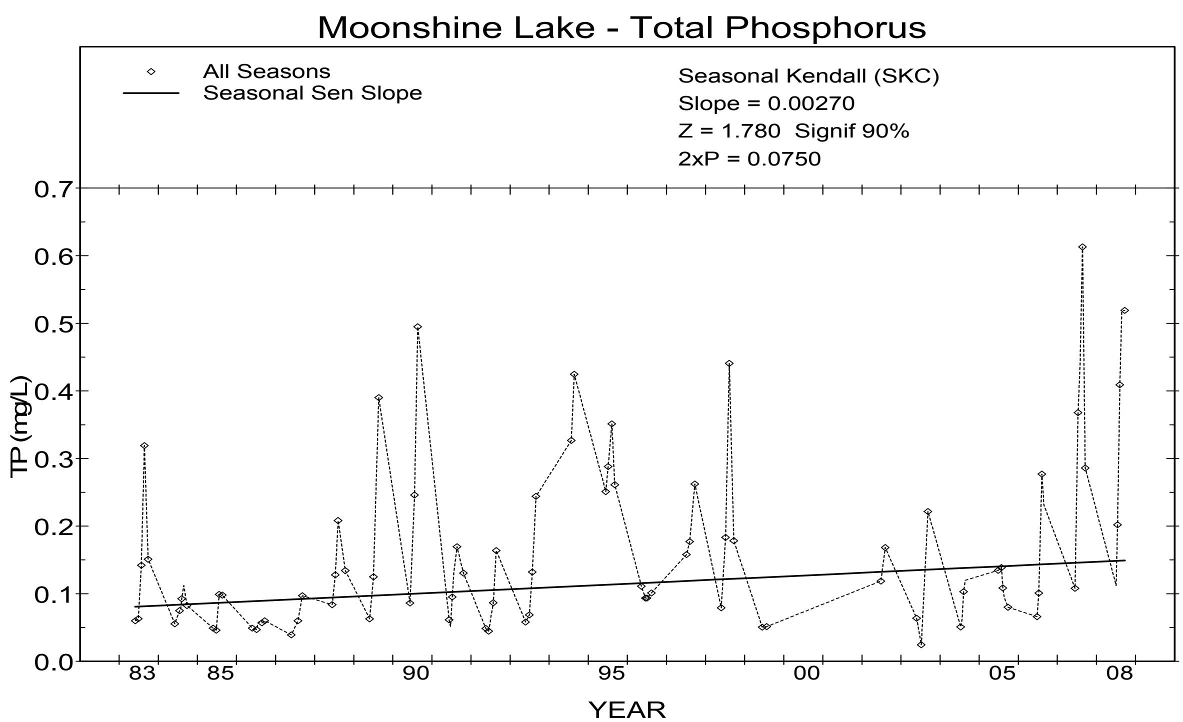
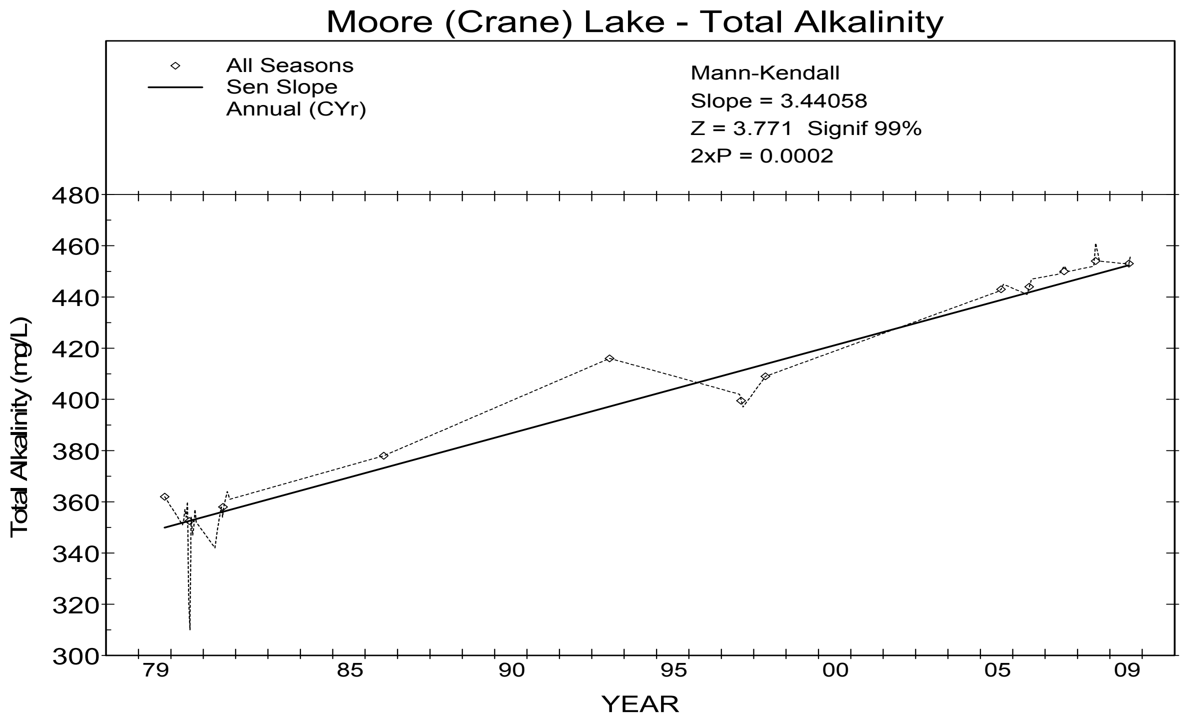


Figure 73 **Moonshine Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



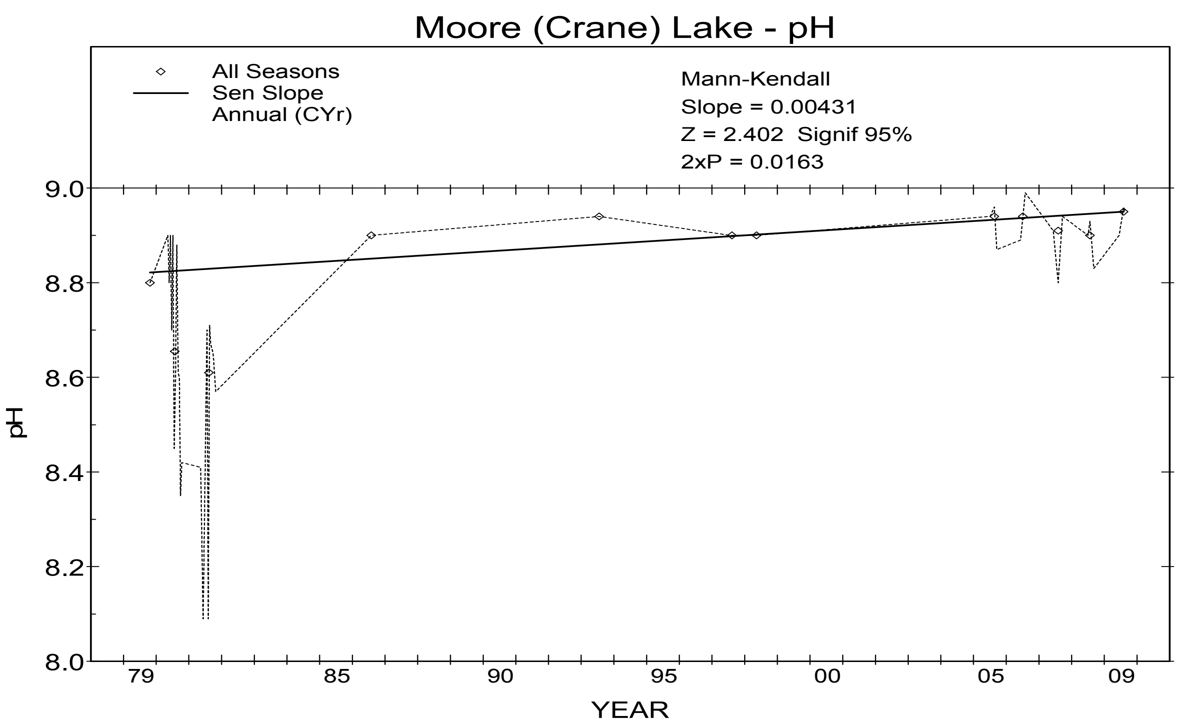
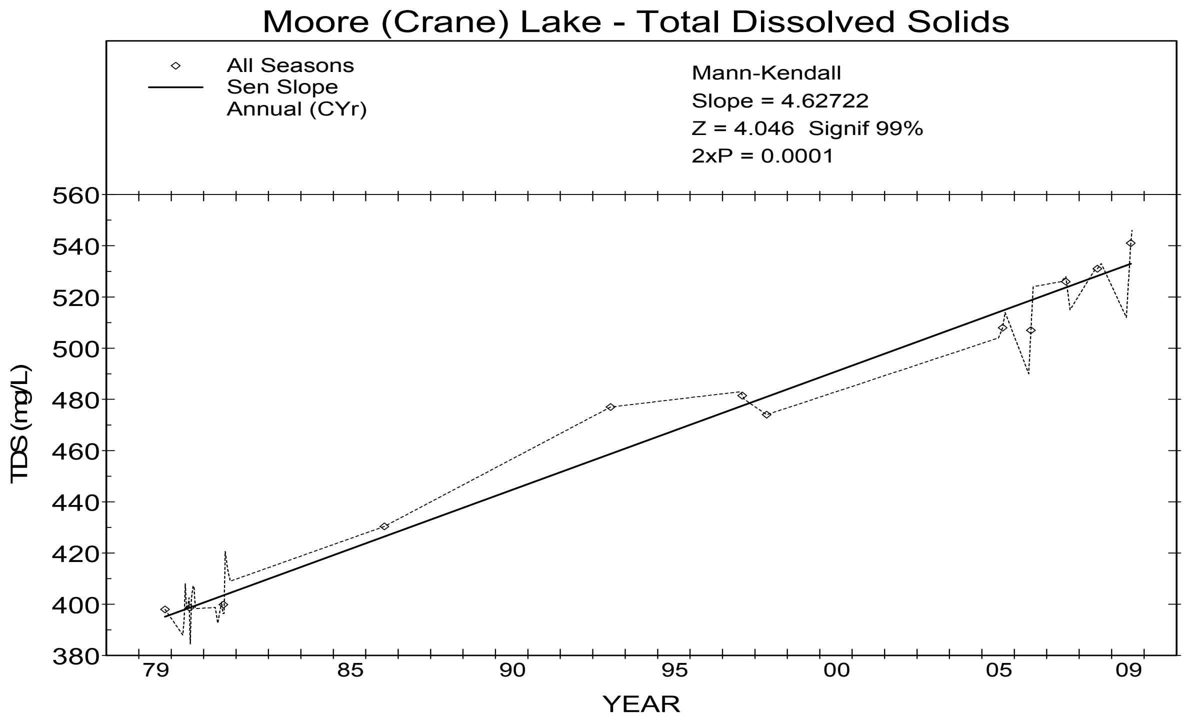


Figure 74 **Moore (Crane) Lake –** Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



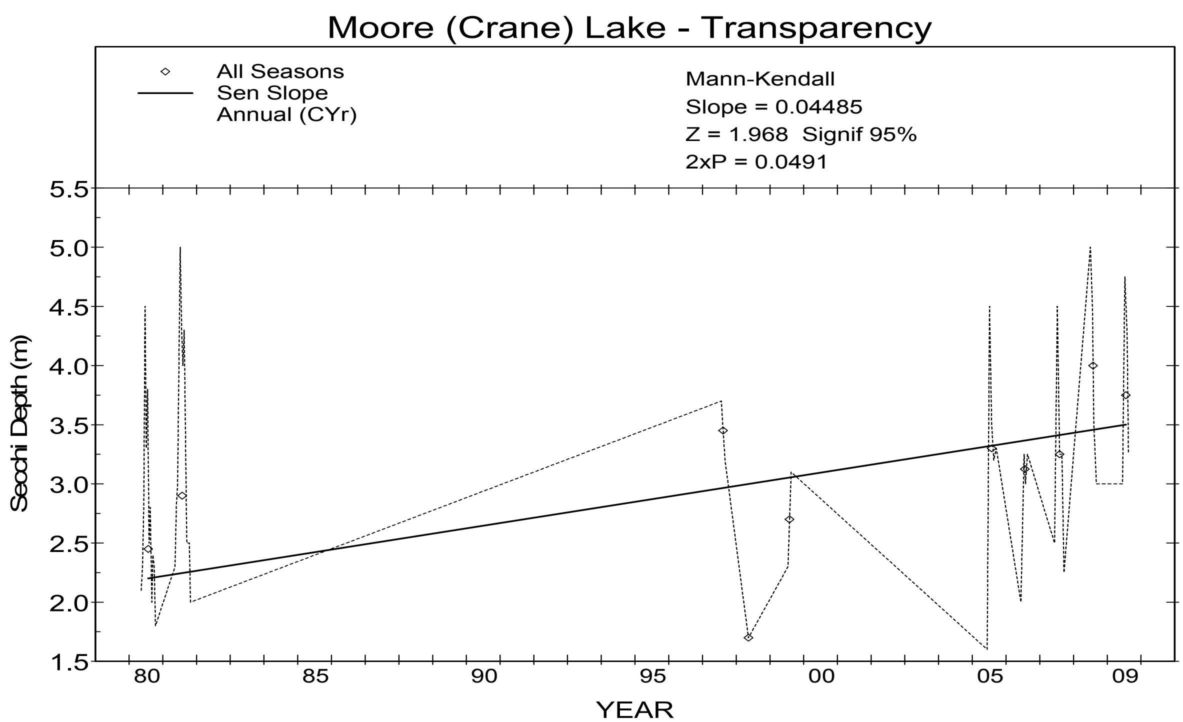
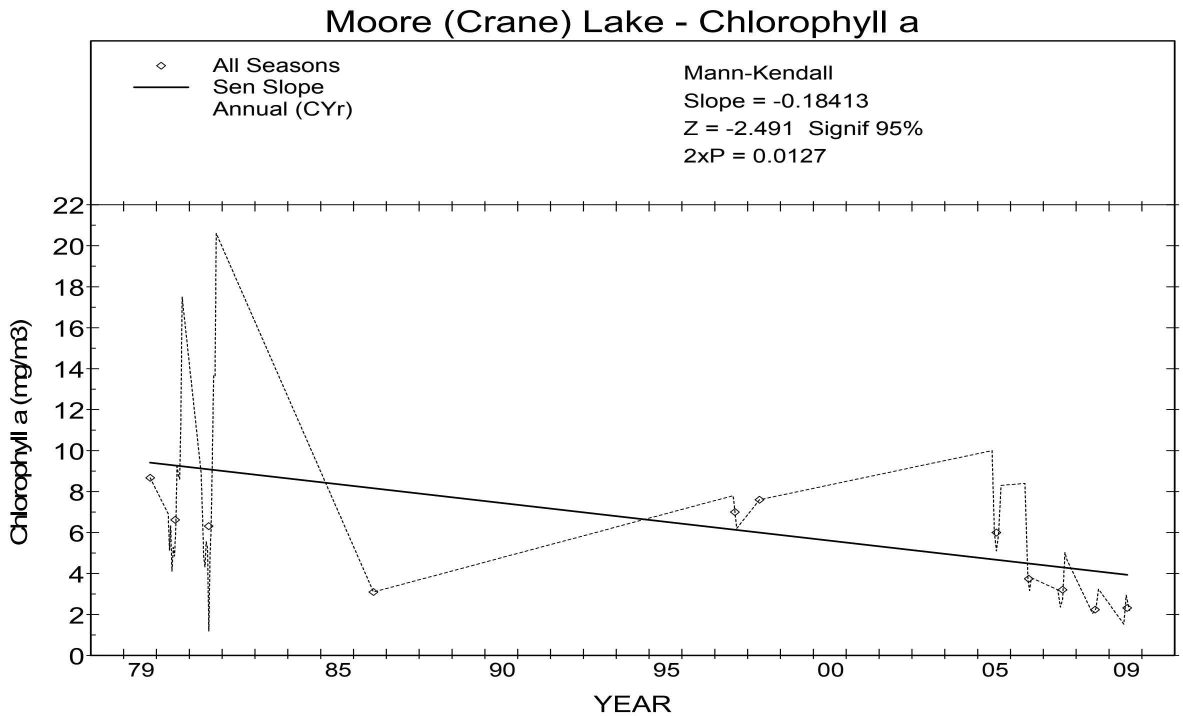


Figure 74 **Moore (Crane) Lake –** Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



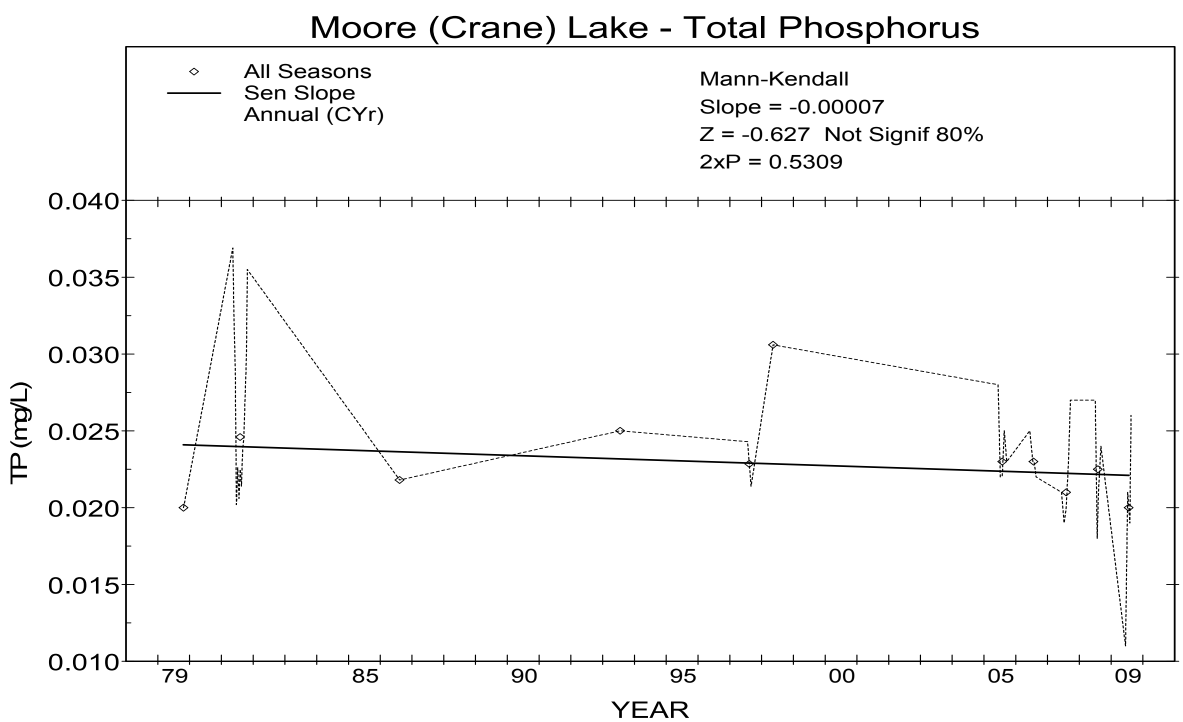
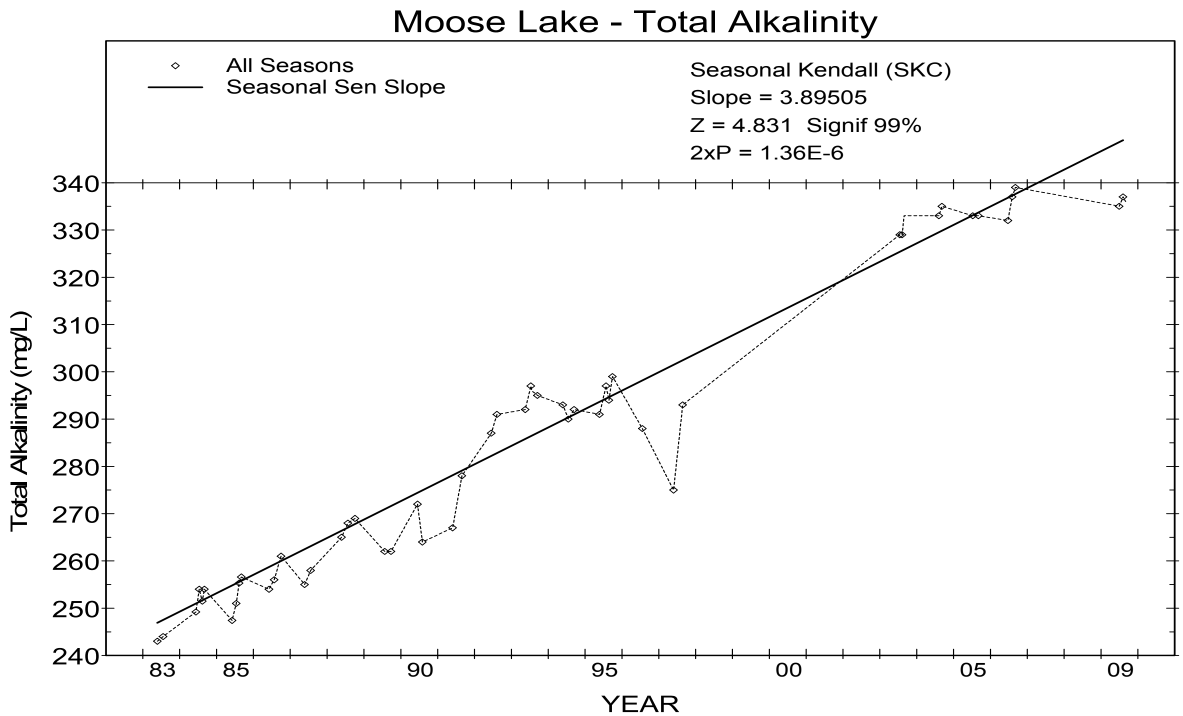


Figure 74 **Moore (Crane) Lake –** Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



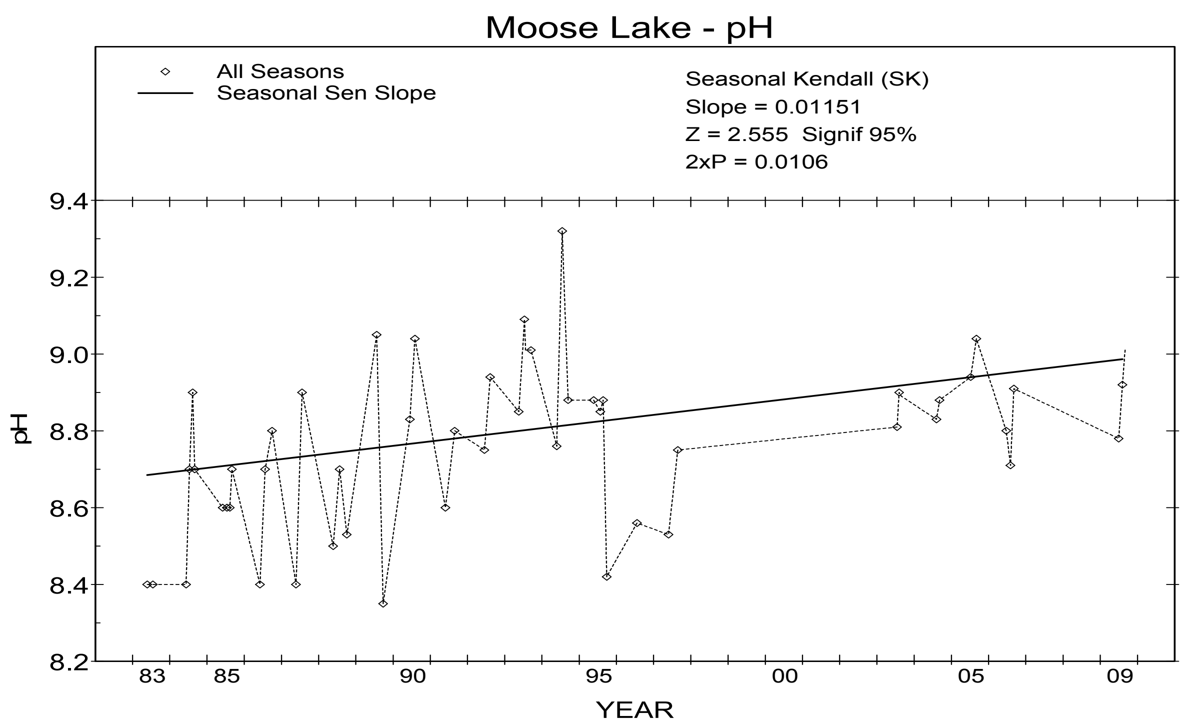
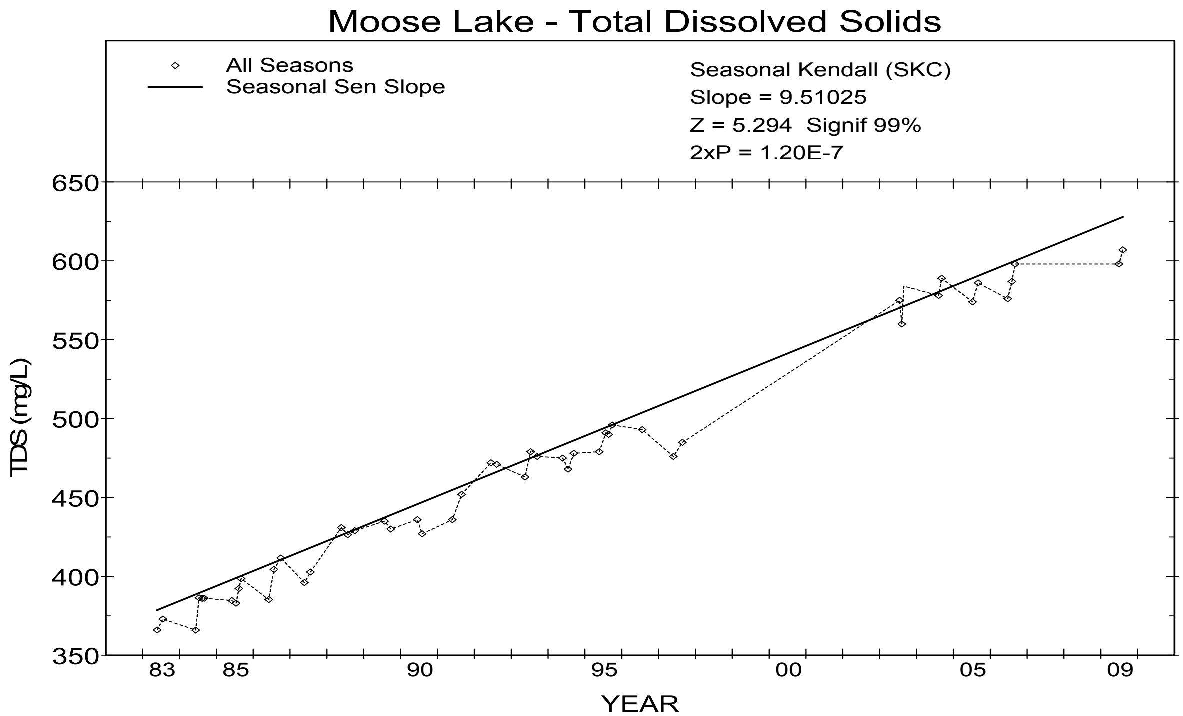


Figure 75 **Moose Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



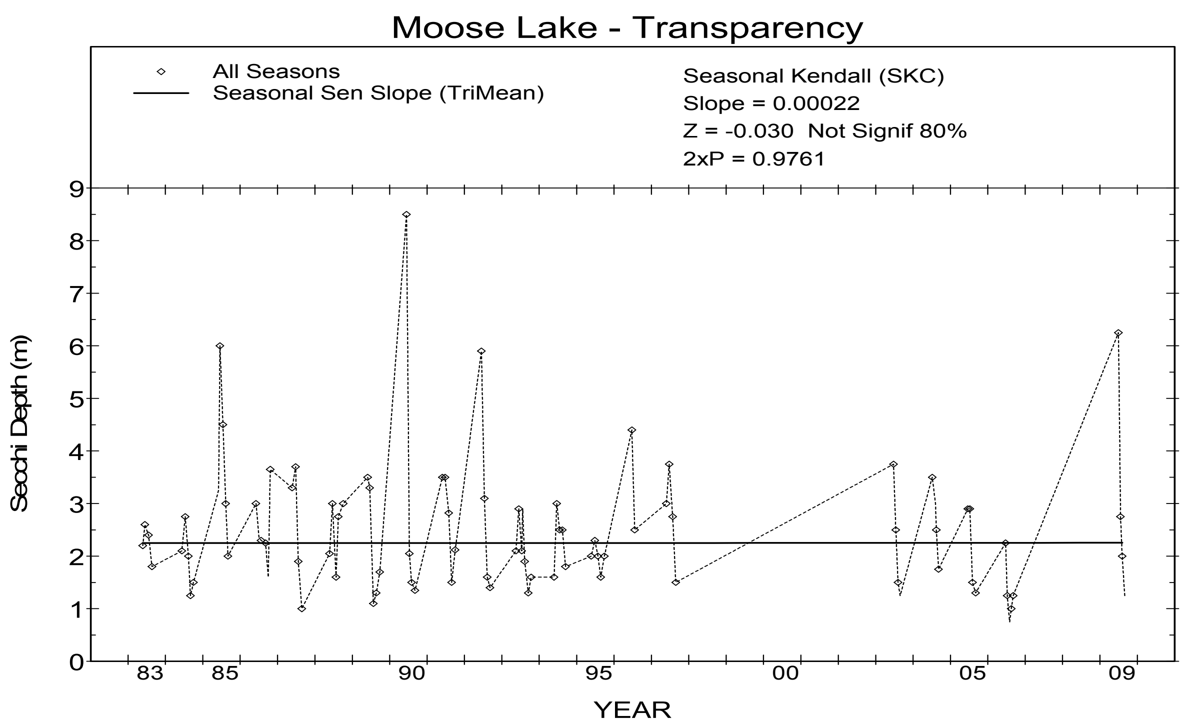
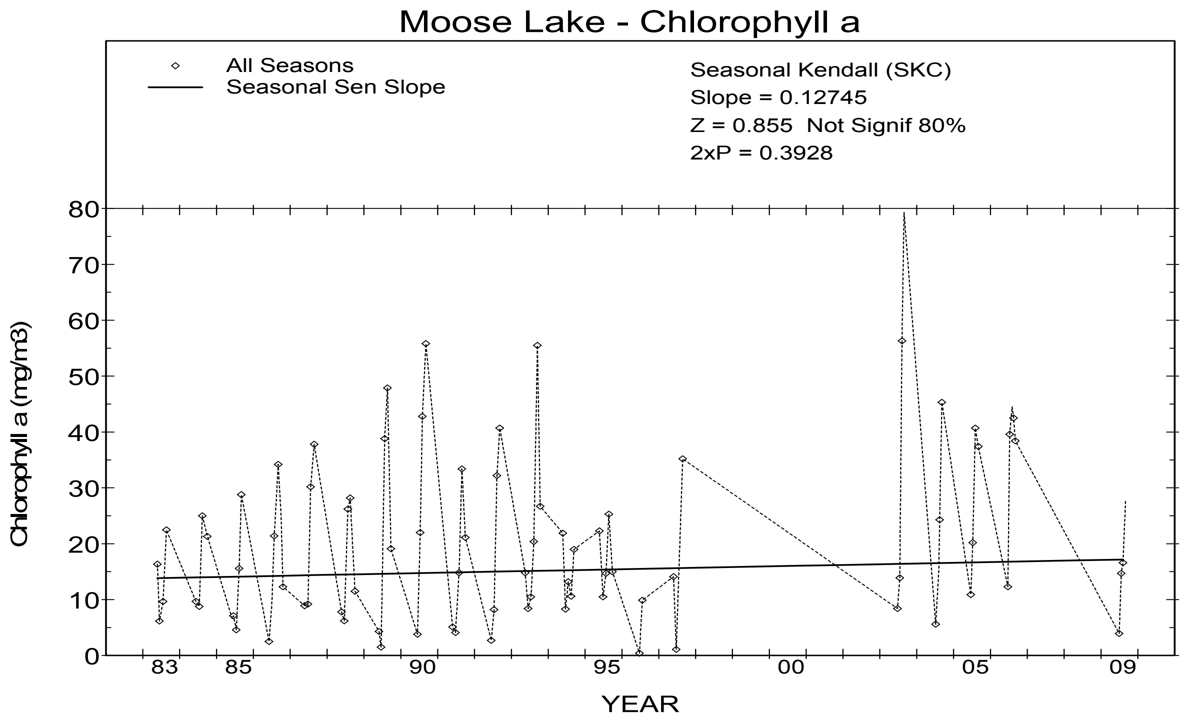


Figure 75 **Moose Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



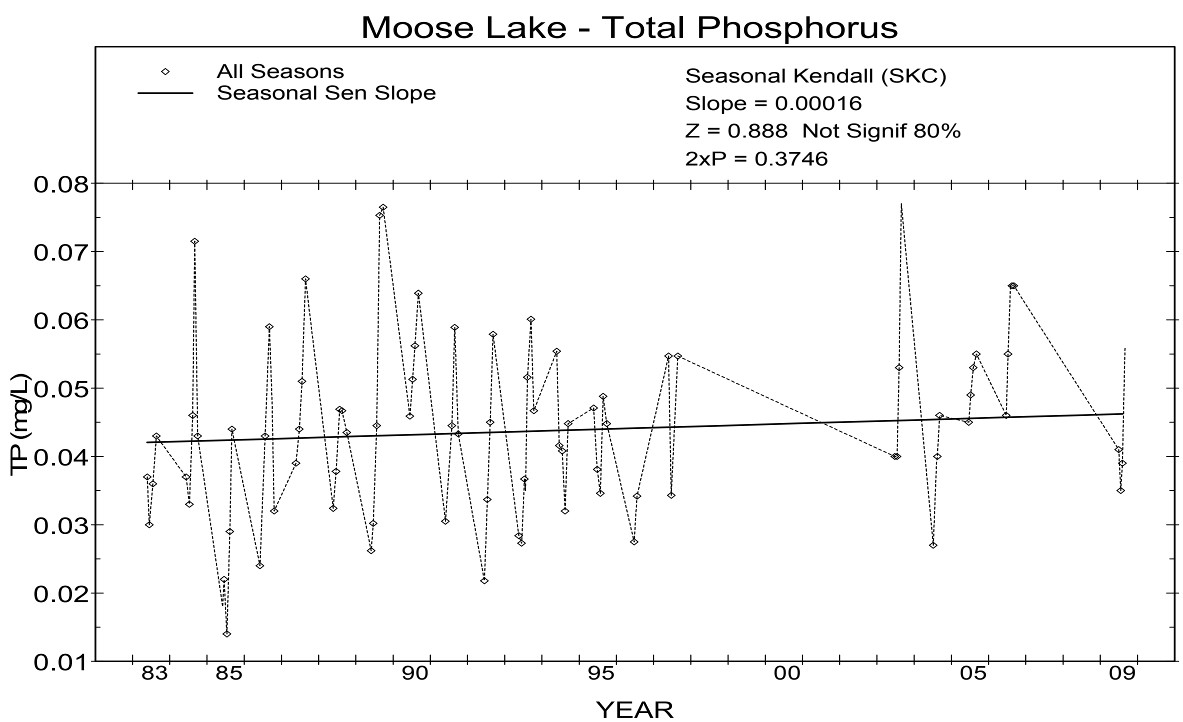
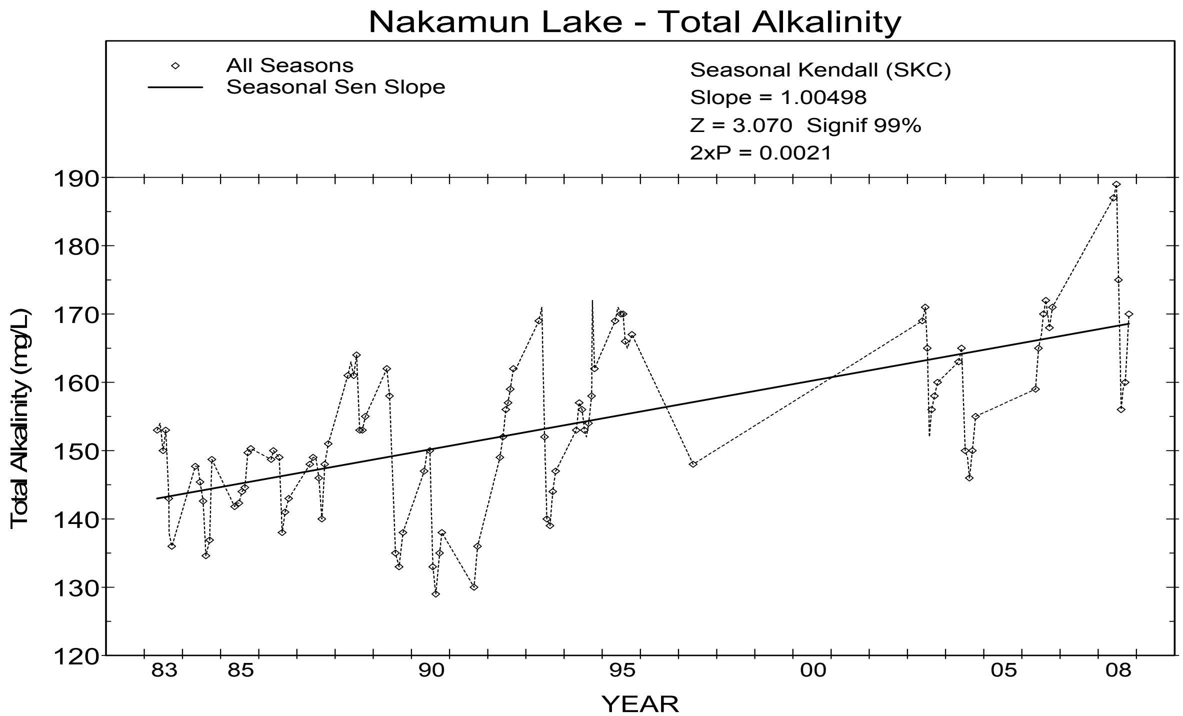


Figure 75 **Moose Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



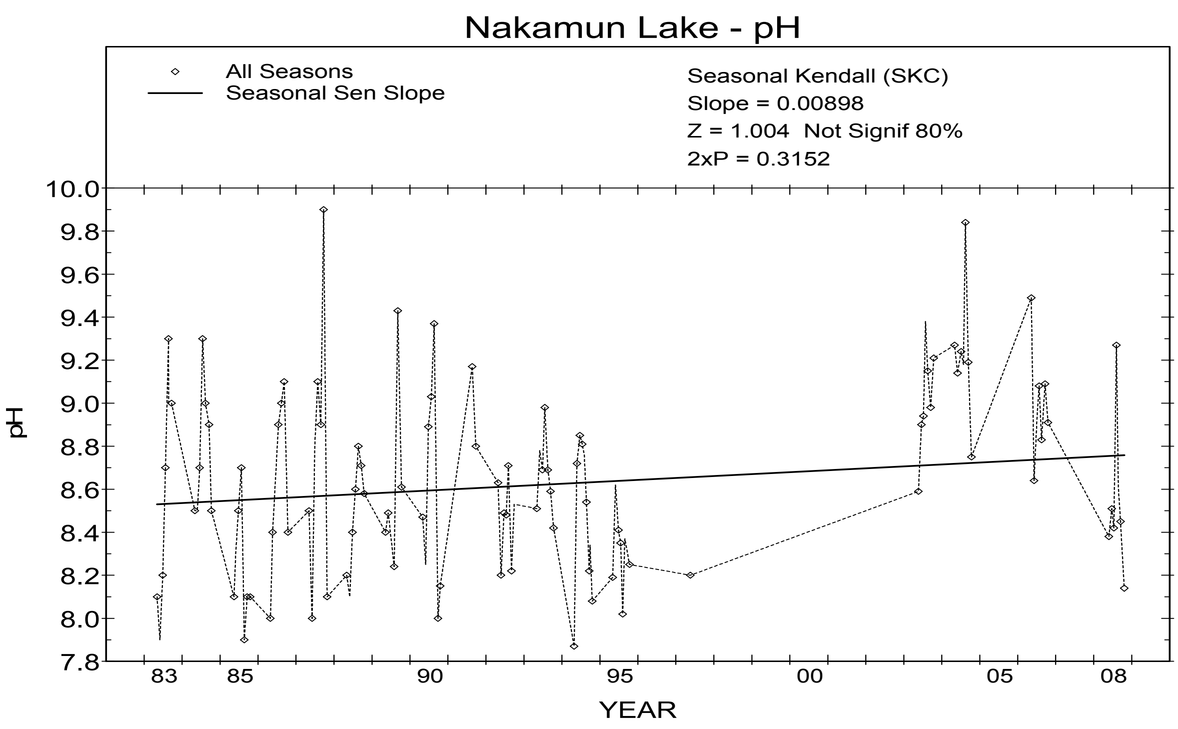
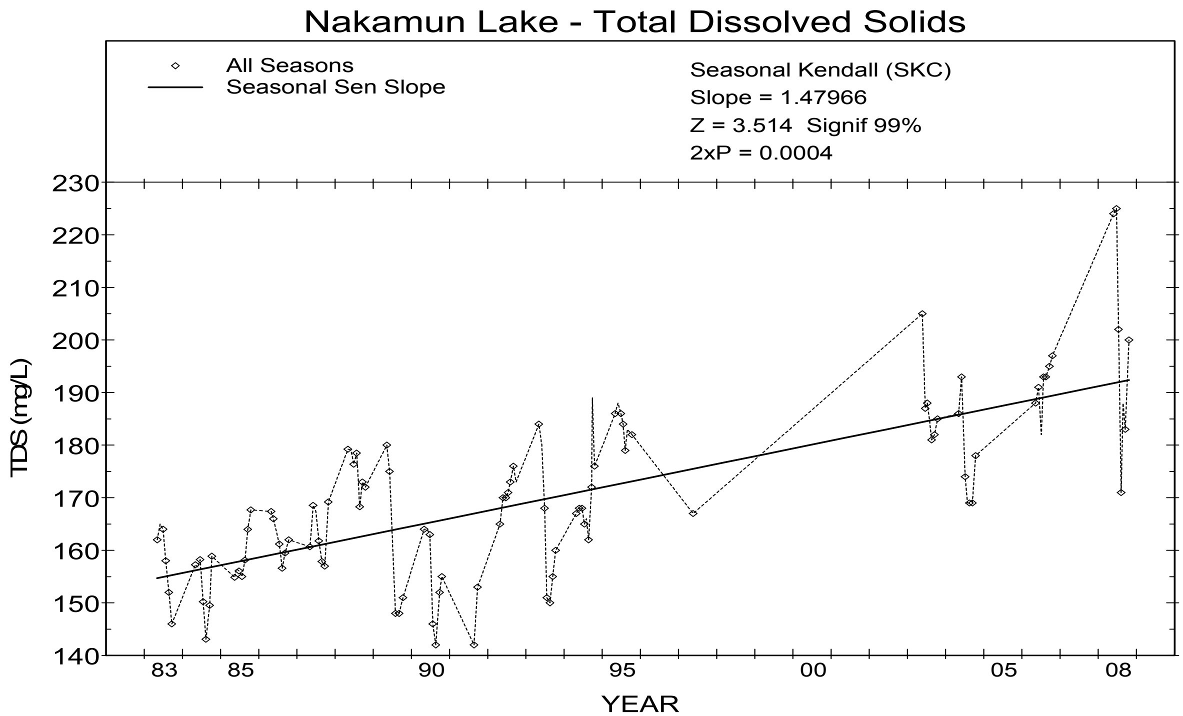


Figure 76a **Nakamun Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



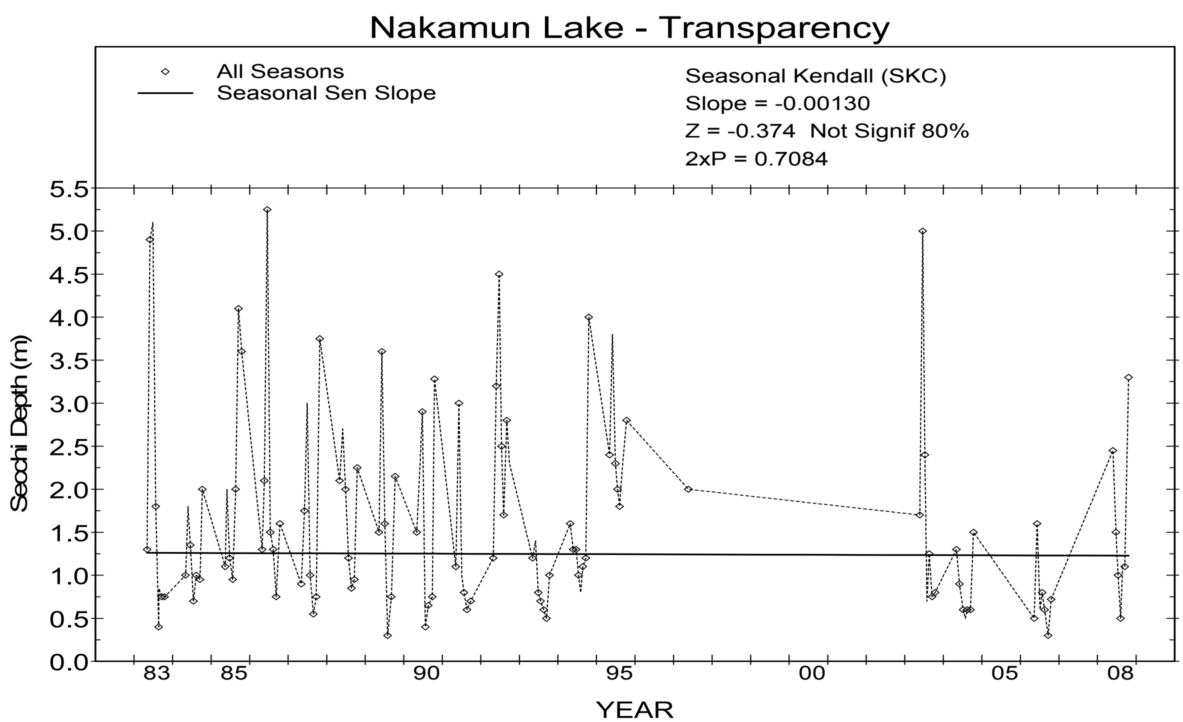
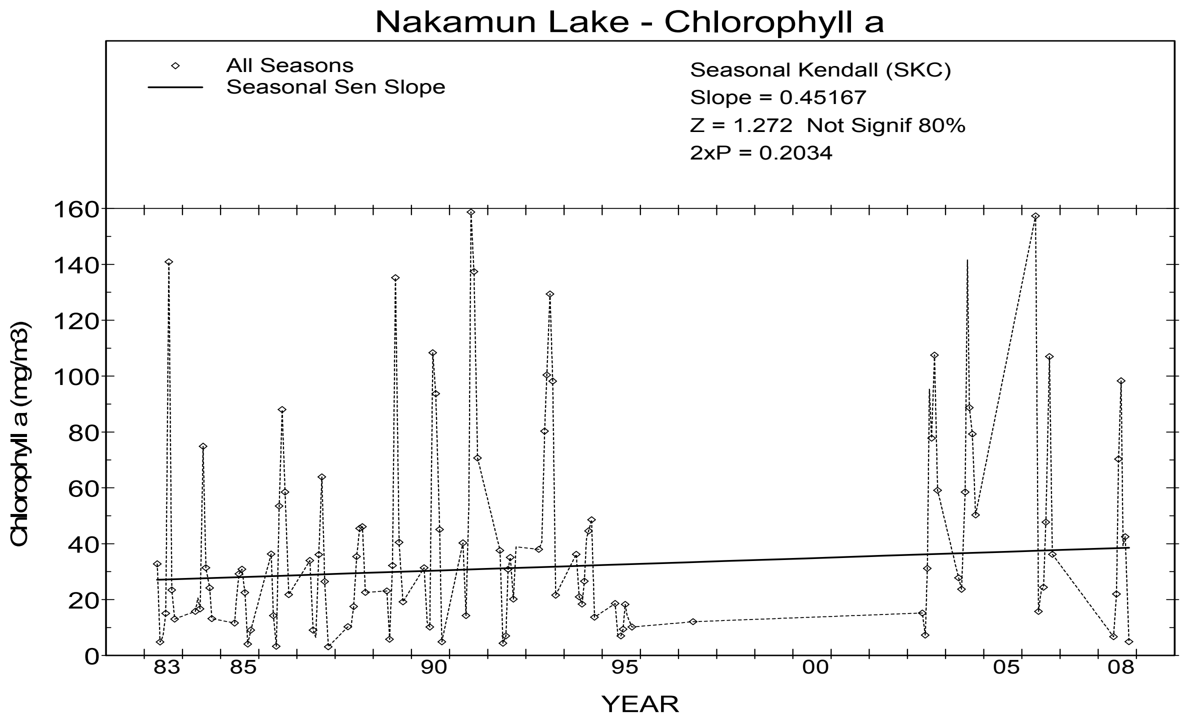


Figure 76a **Nakamun Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



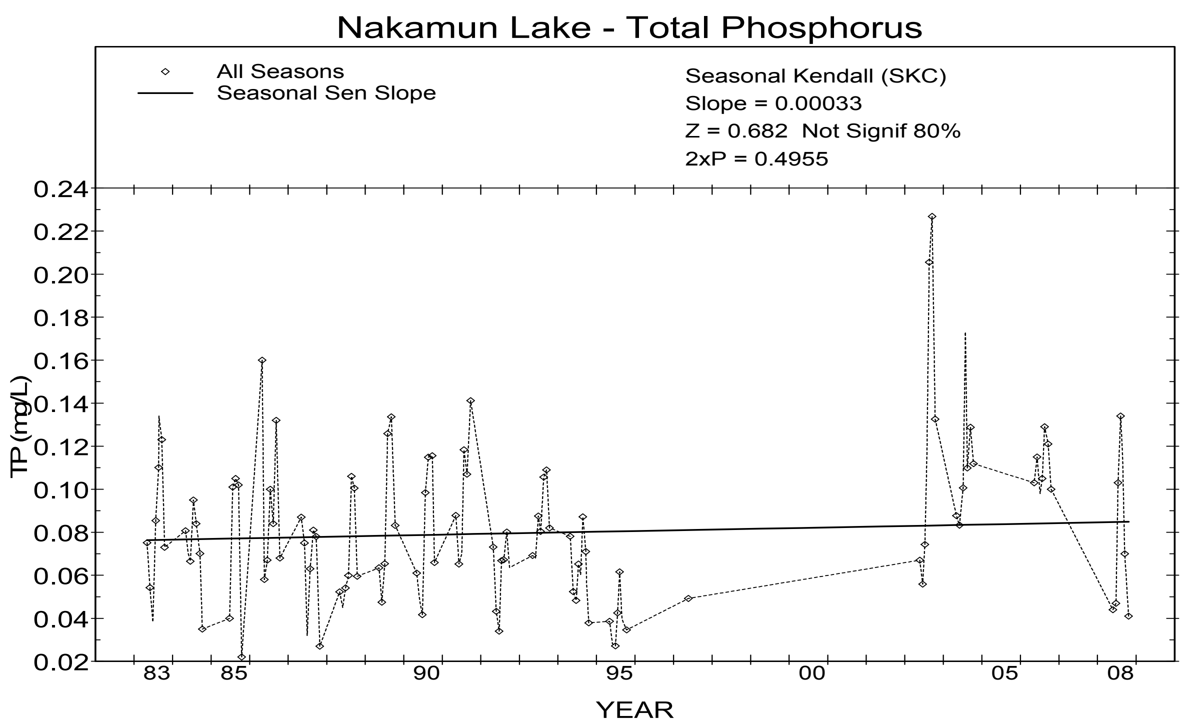
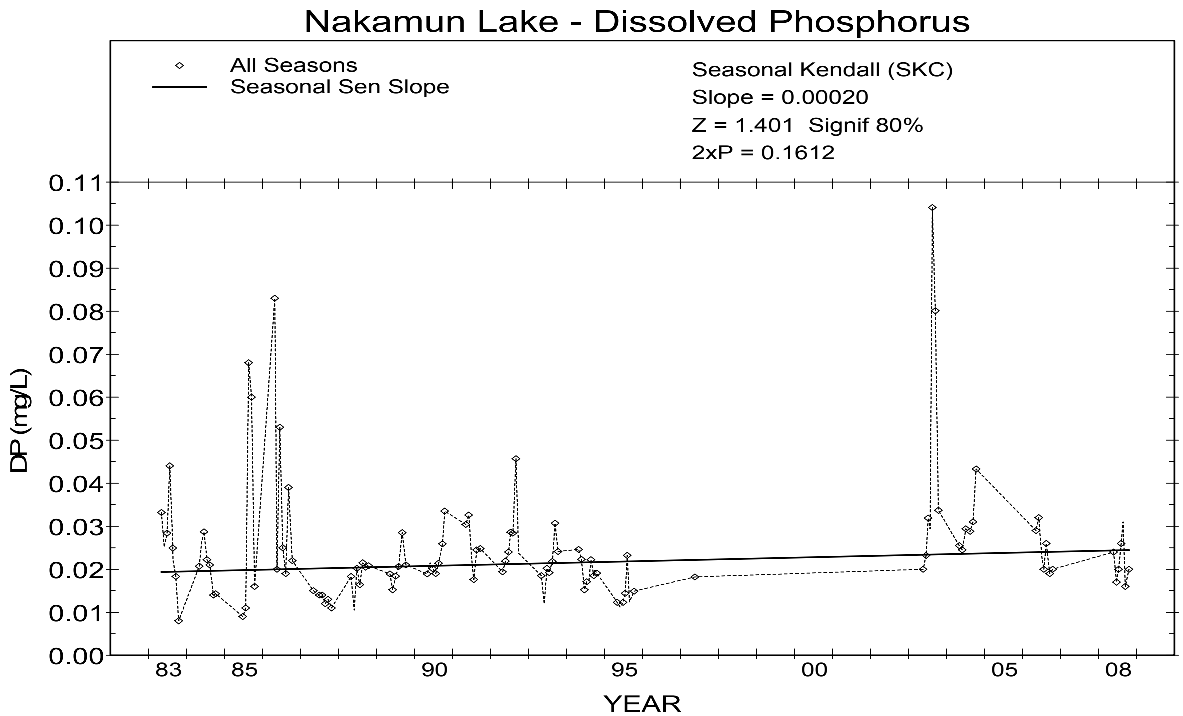


Figure 76a **Nakamun Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



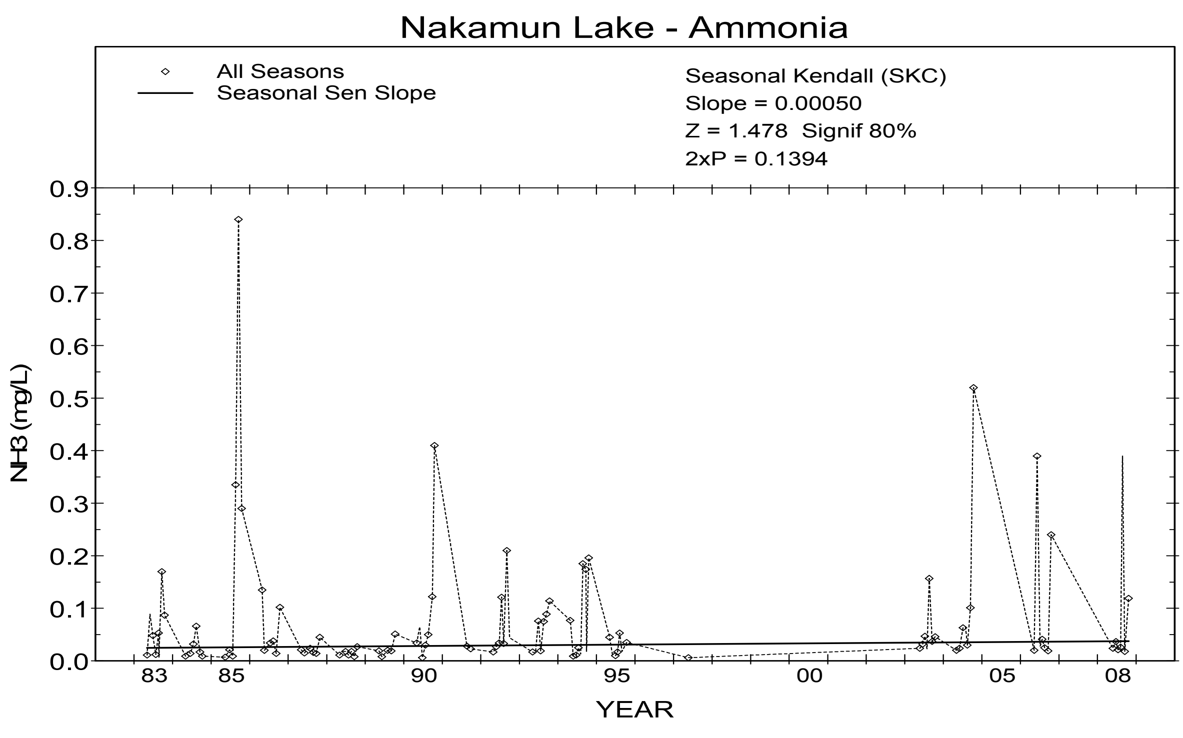
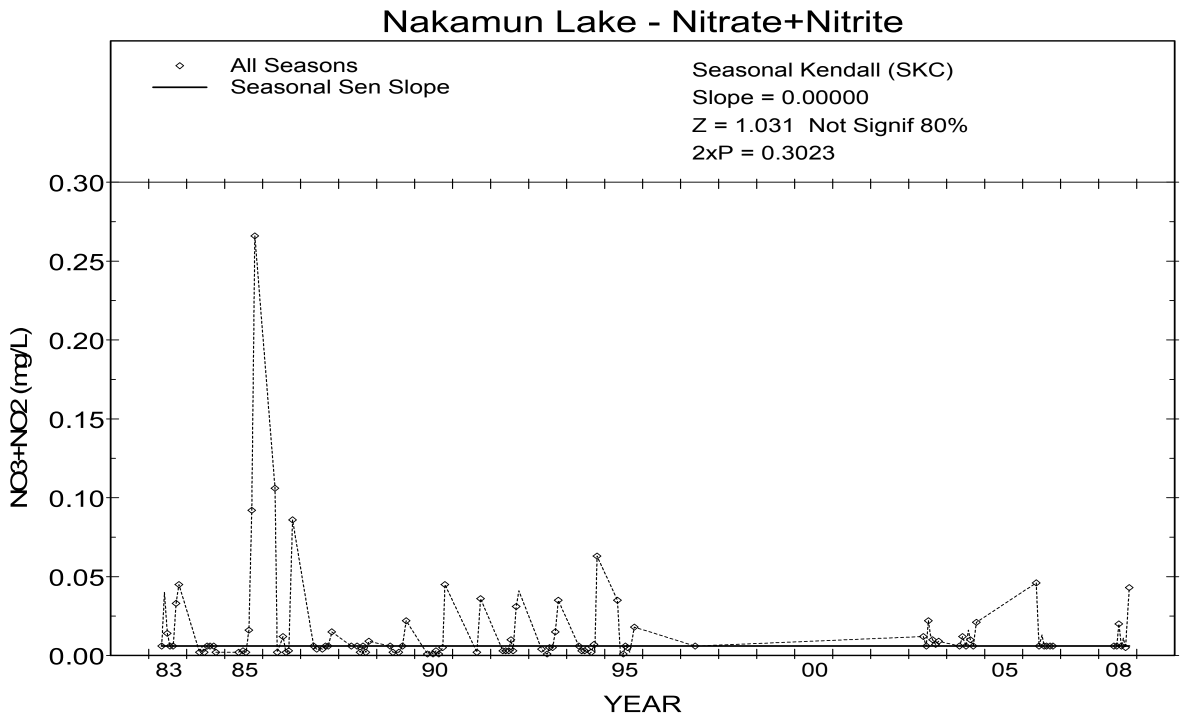


Figure 76b **Nakamun Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record



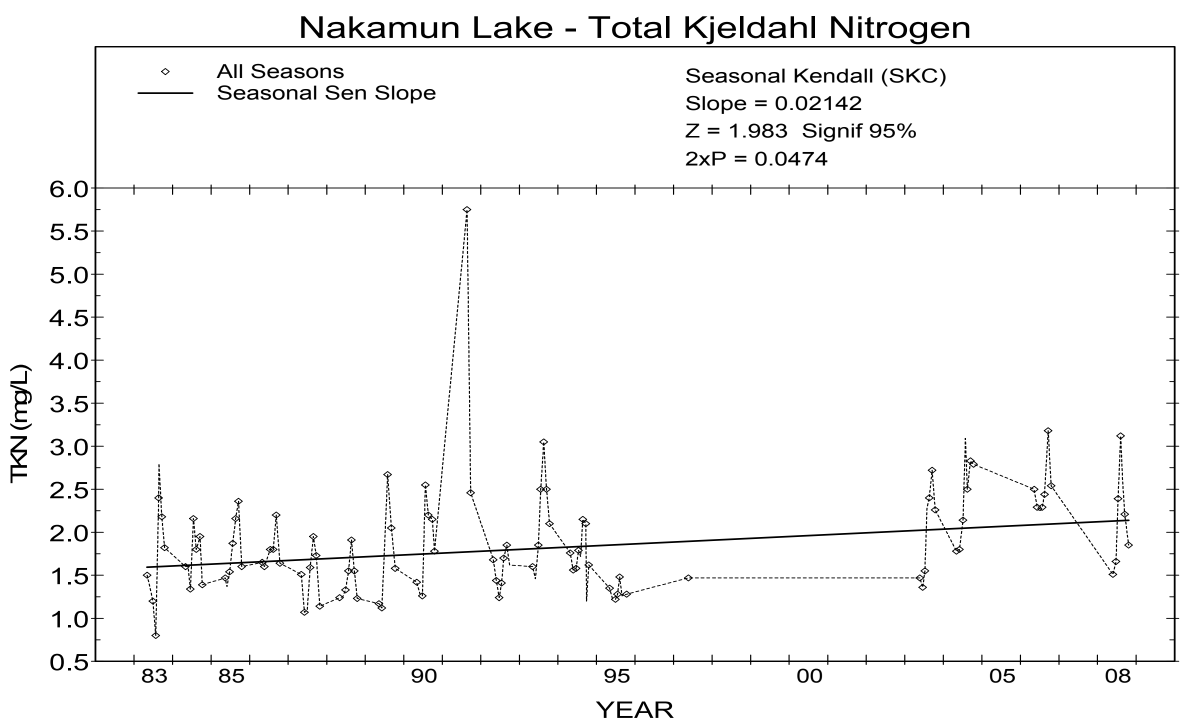
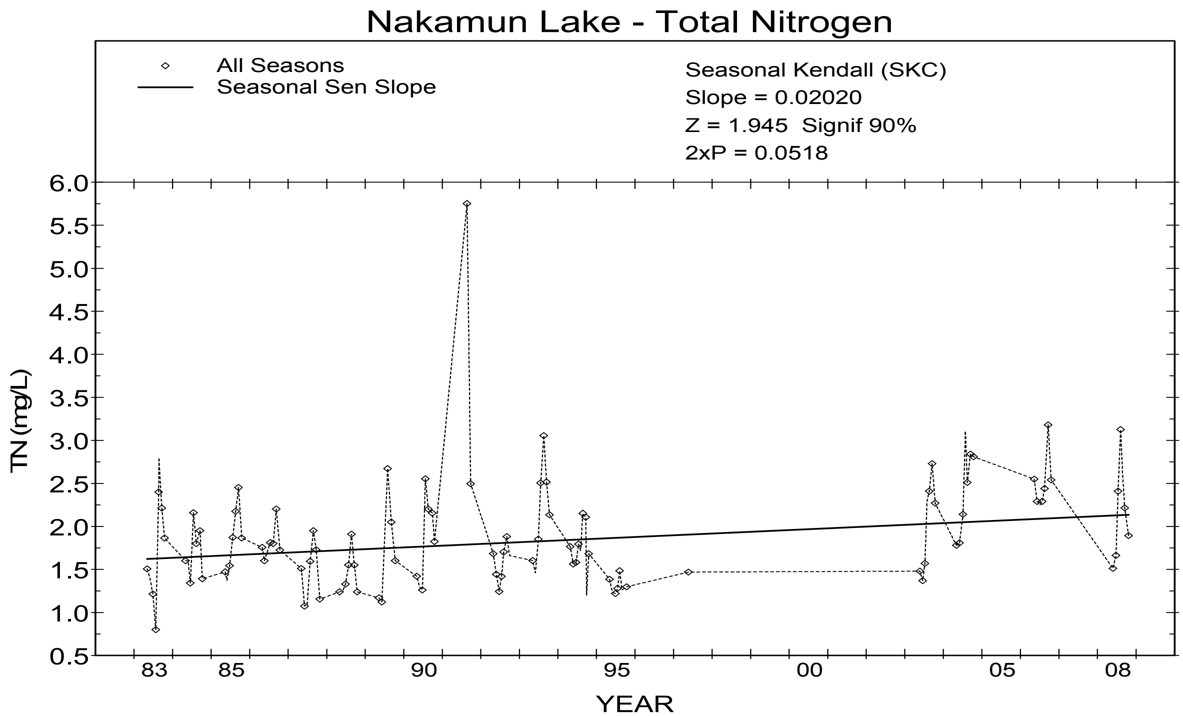


Figure 76b **Nakamun Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)



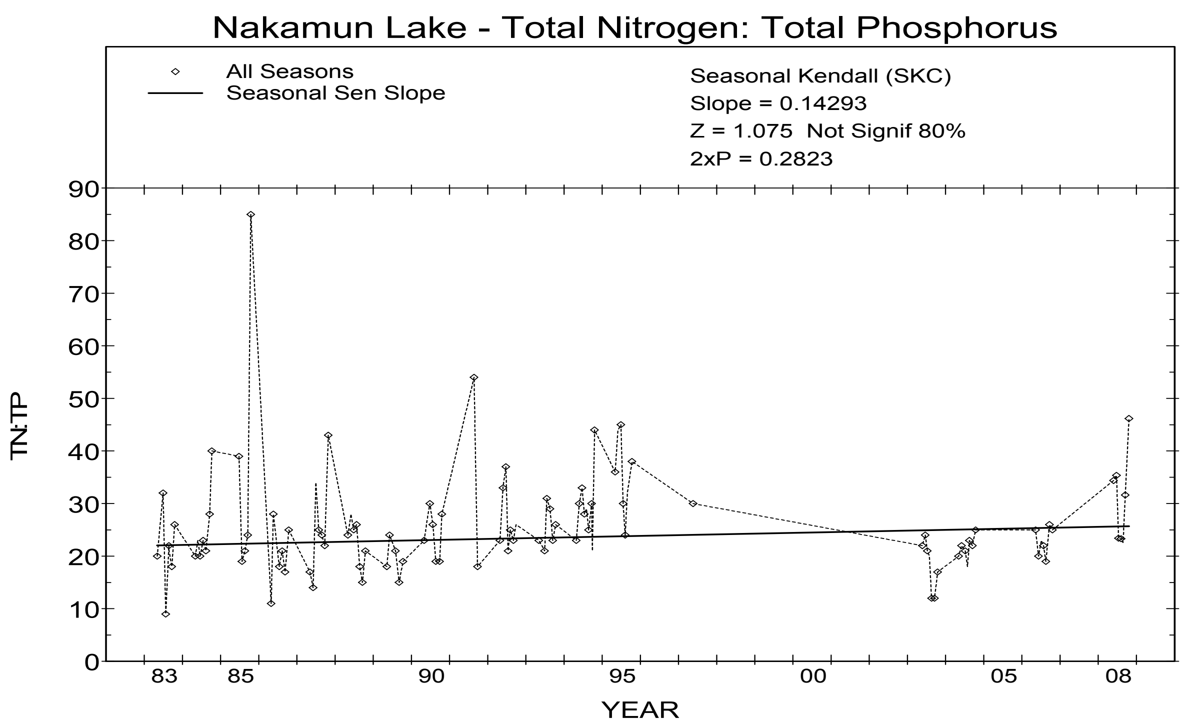
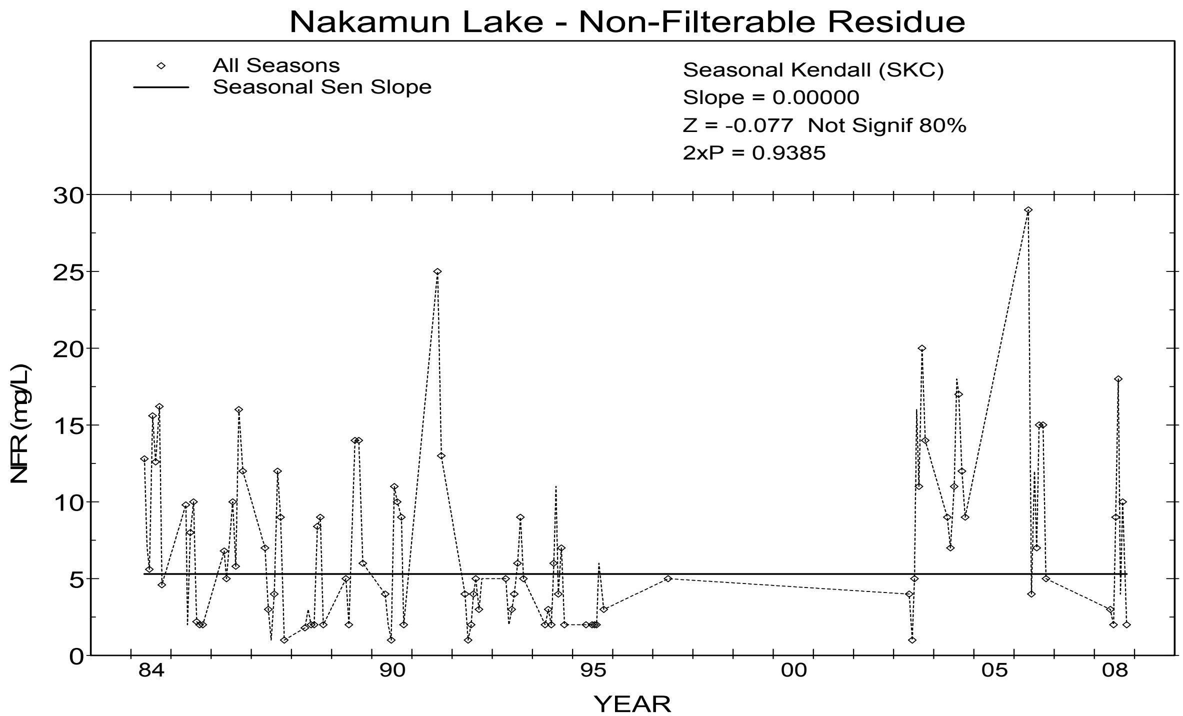


Figure 76b **Nakamun Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)



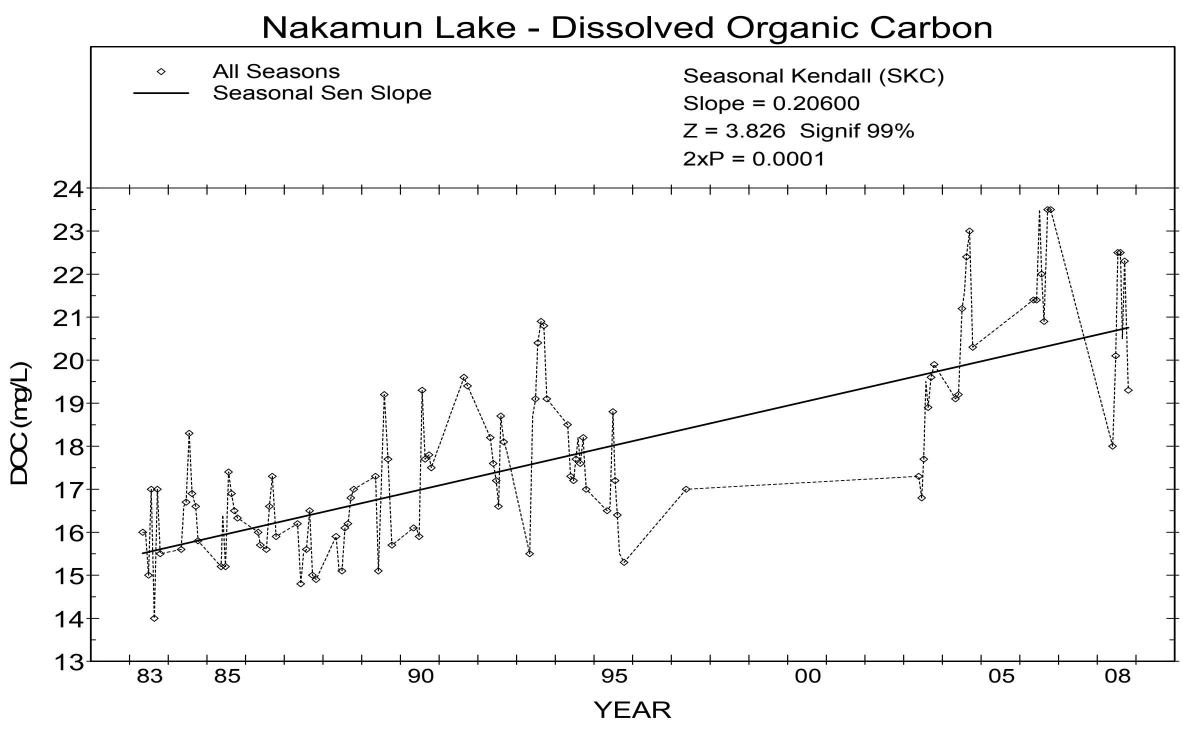


Figure 76b **Nakamun Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)

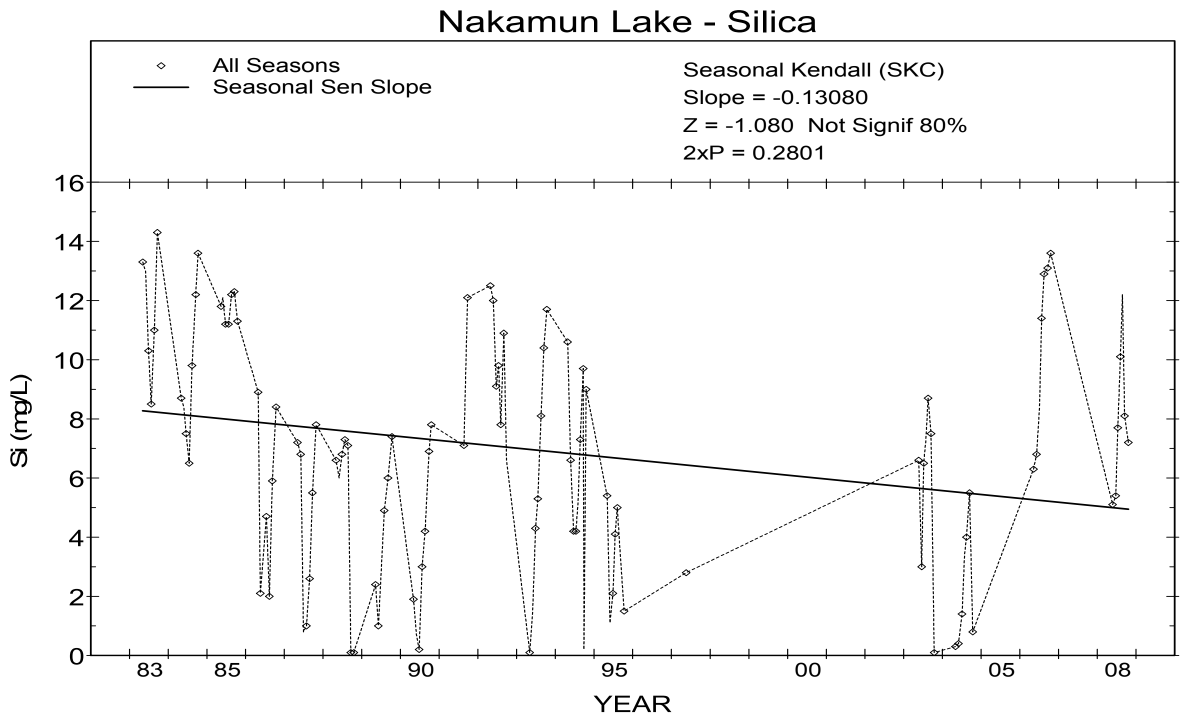
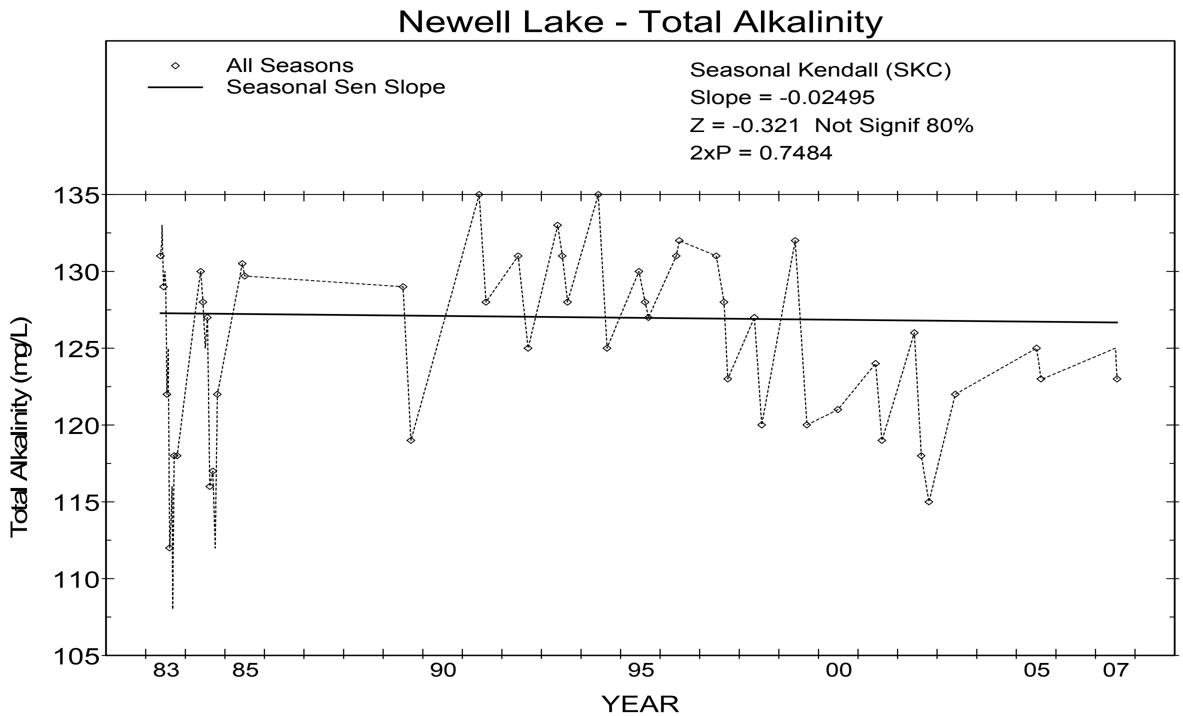


Figure 76b **Nakamun Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (concluded)



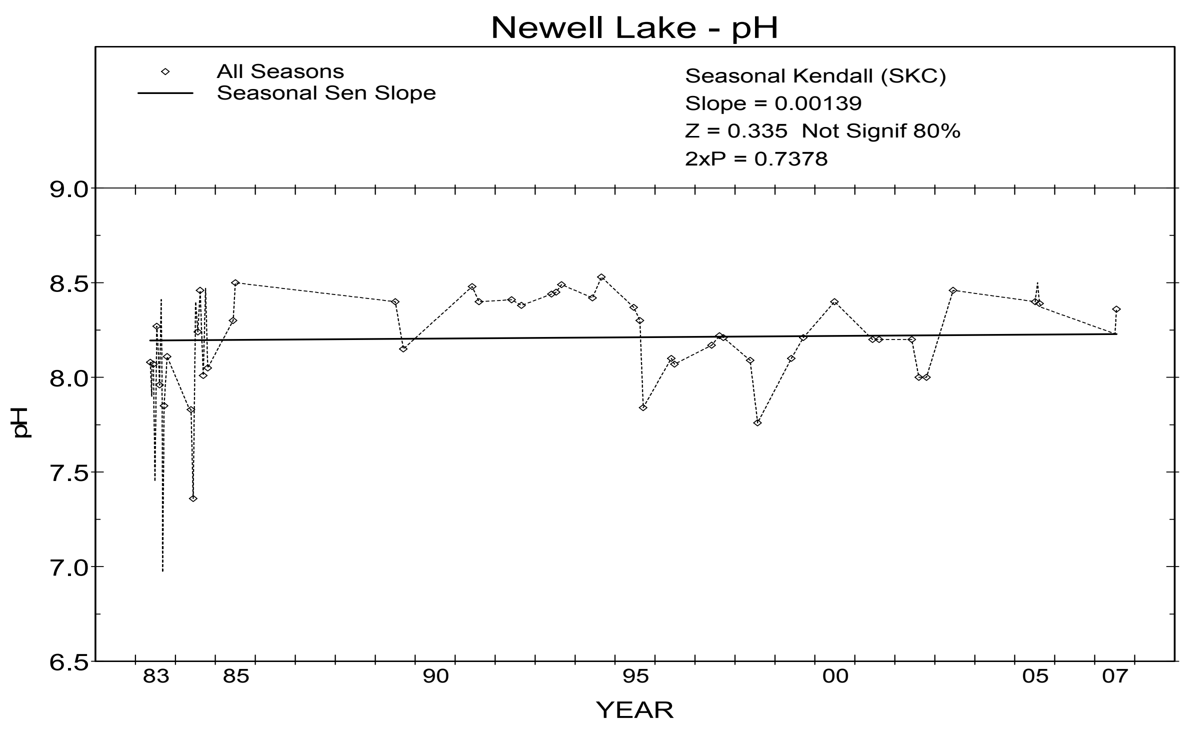
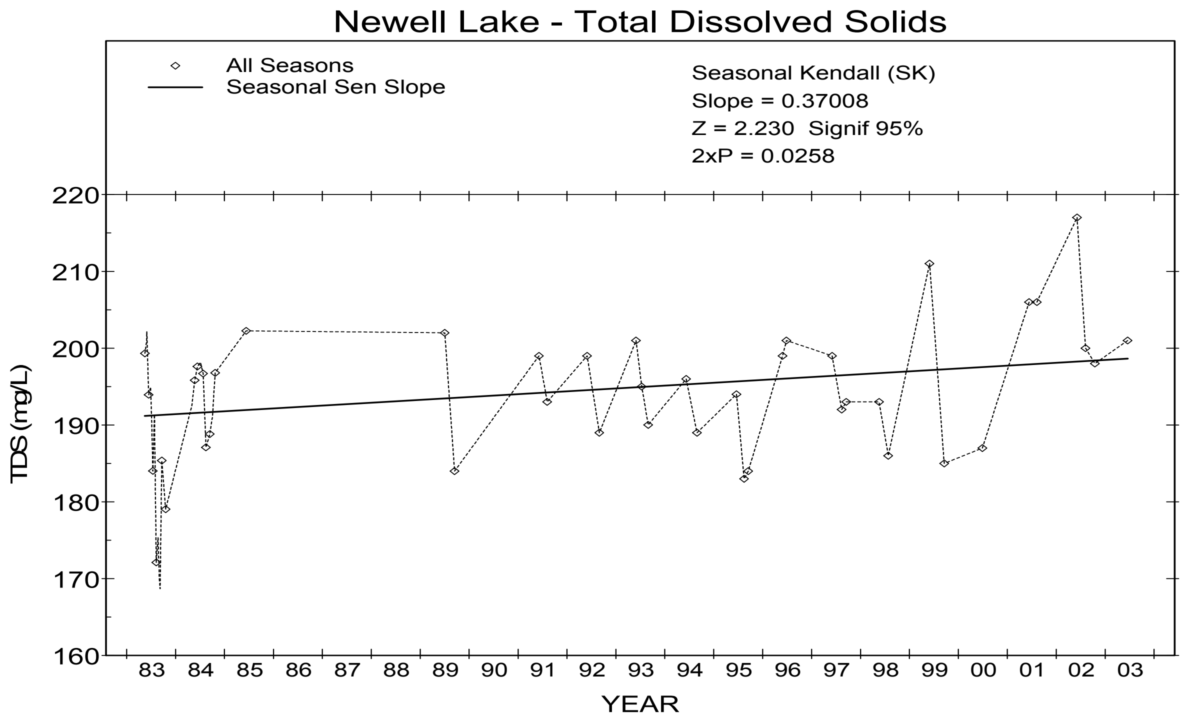


Figure 77 **Newell Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



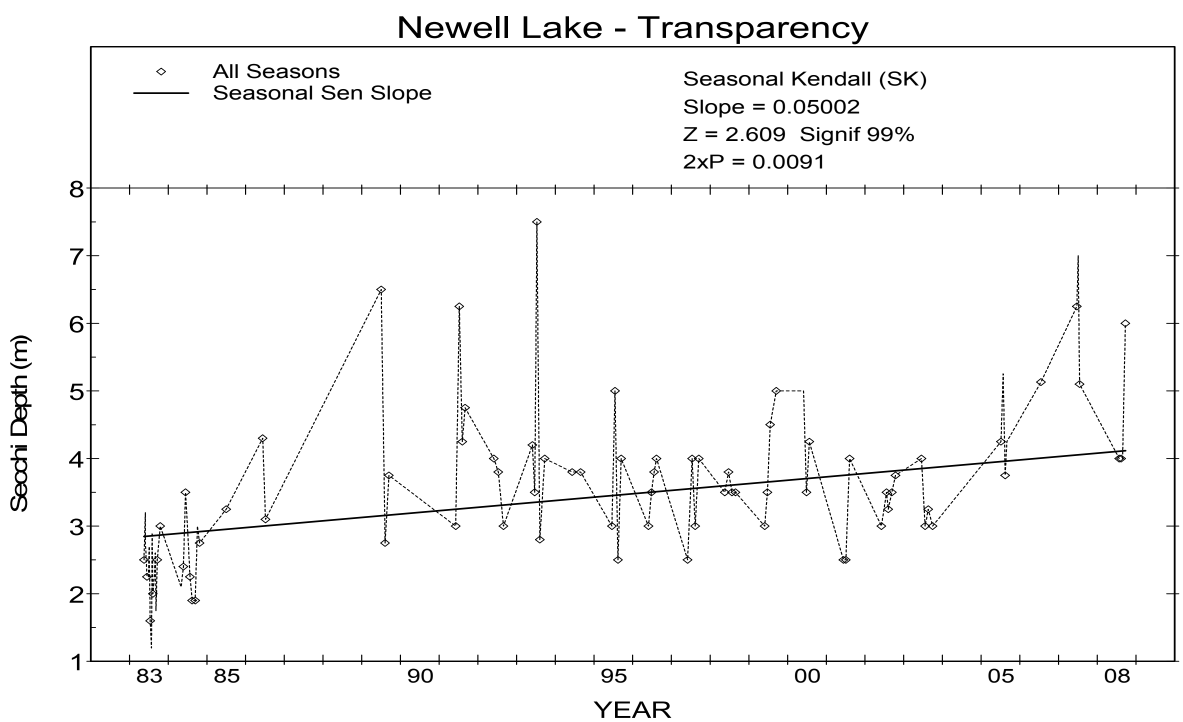
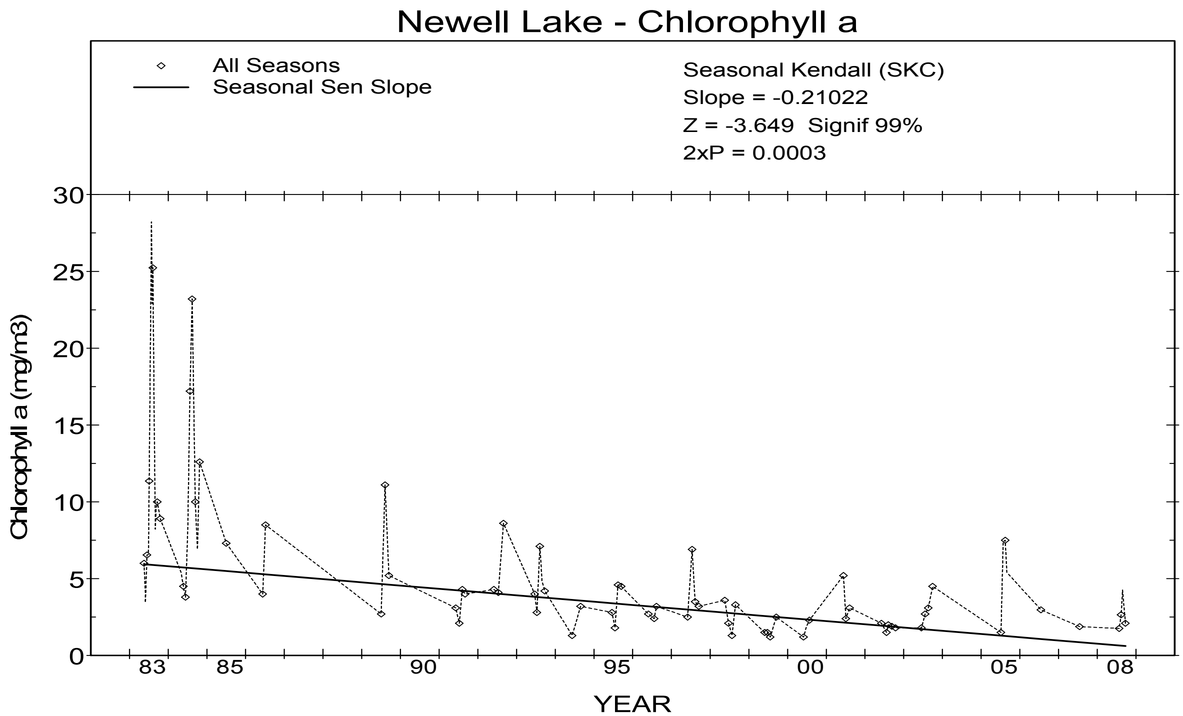


Figure 77 **Newell Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



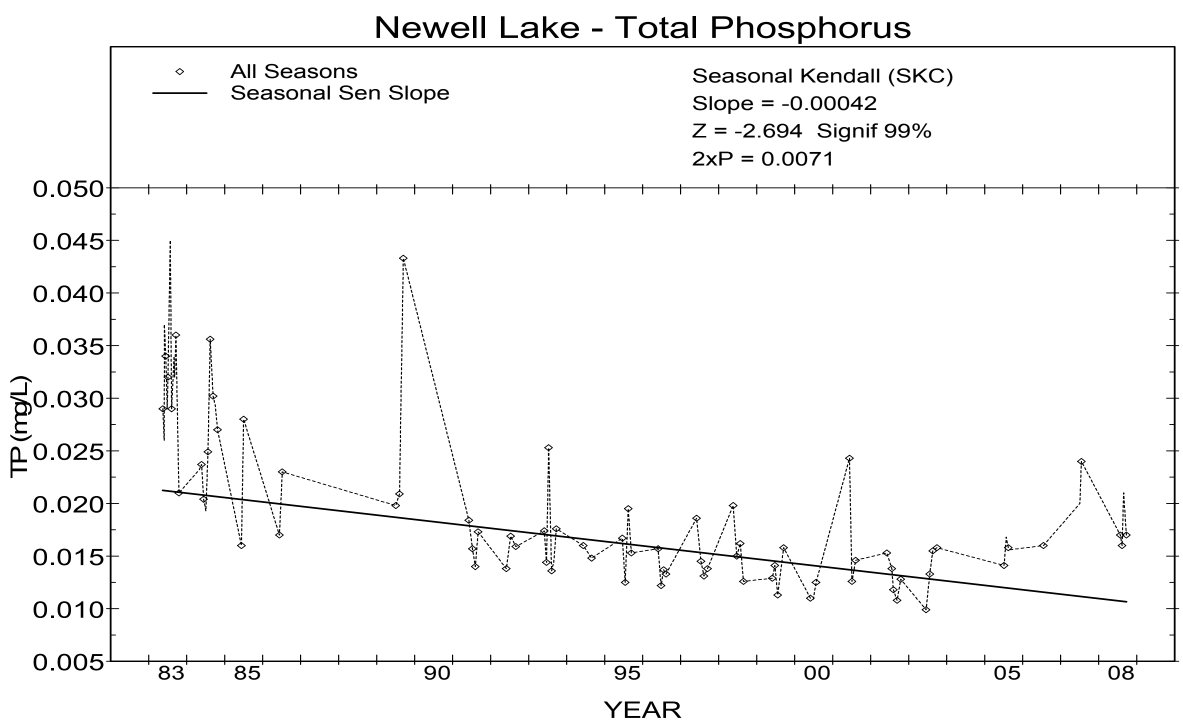
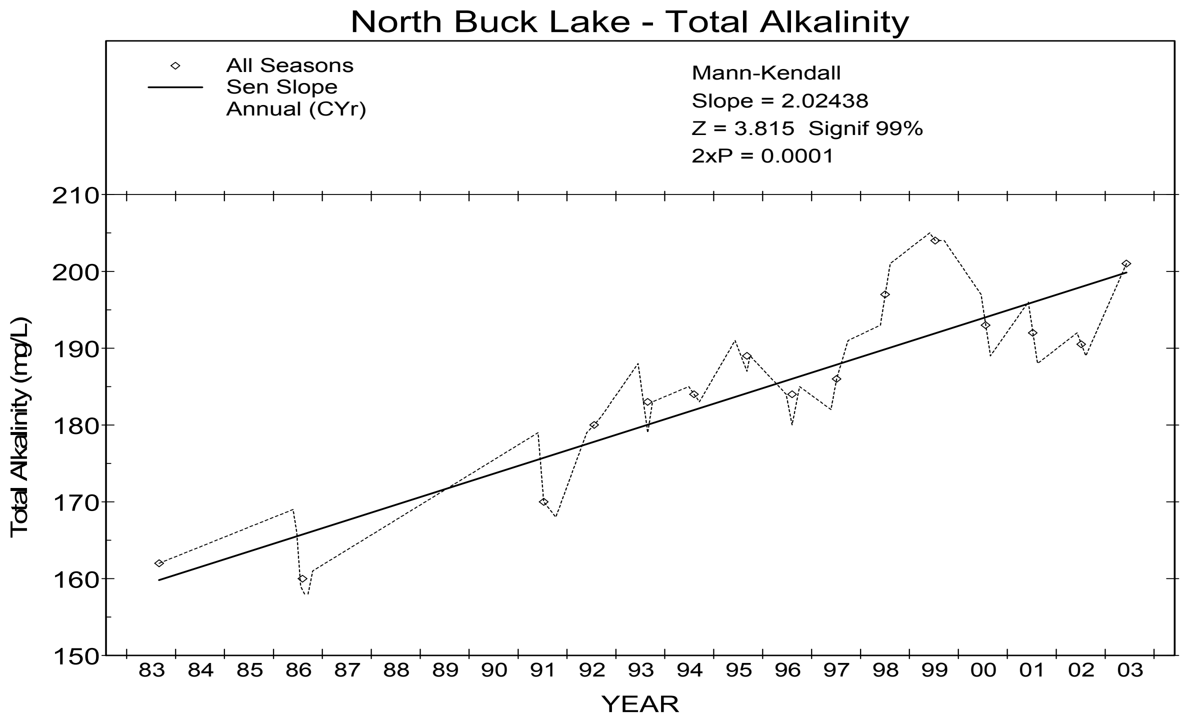


Figure 77 **Newell Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



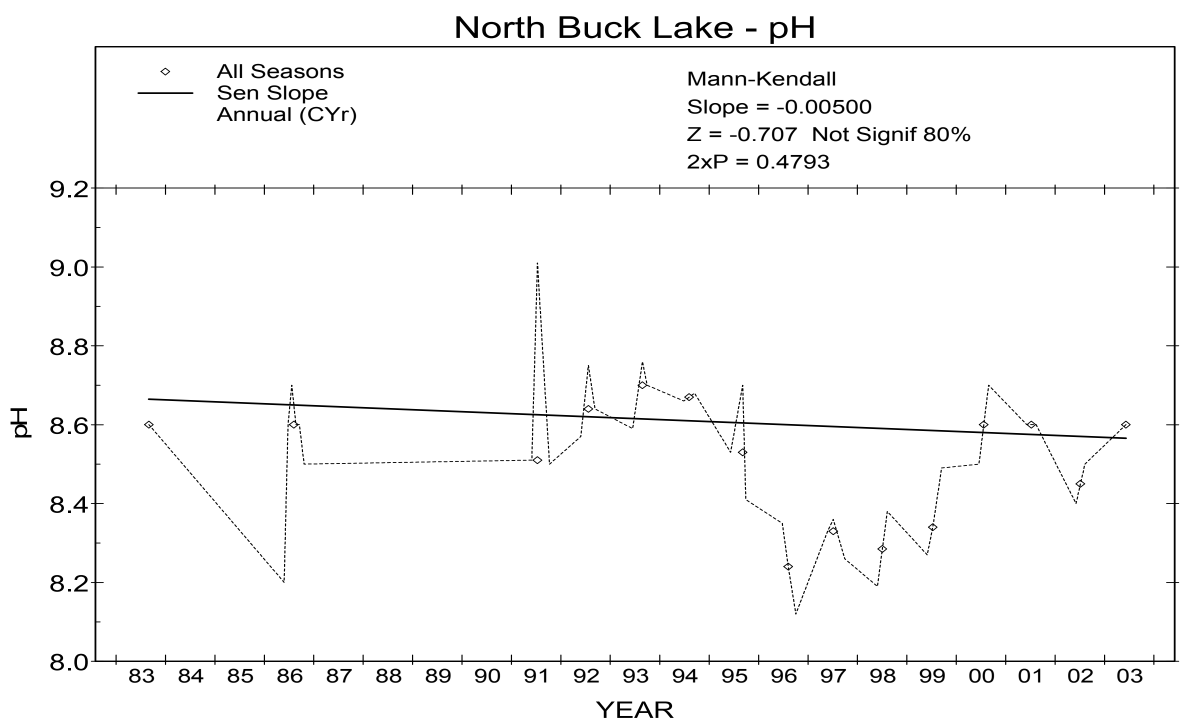
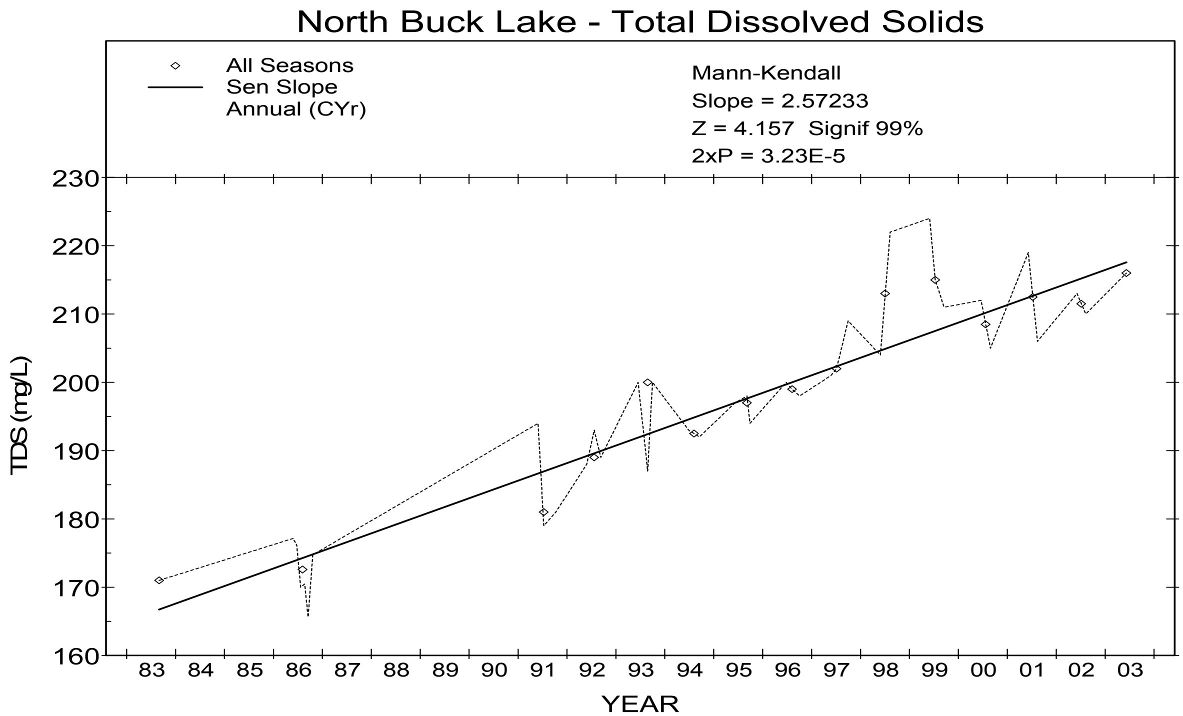


Figure 78 **North Buck Lake –** Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



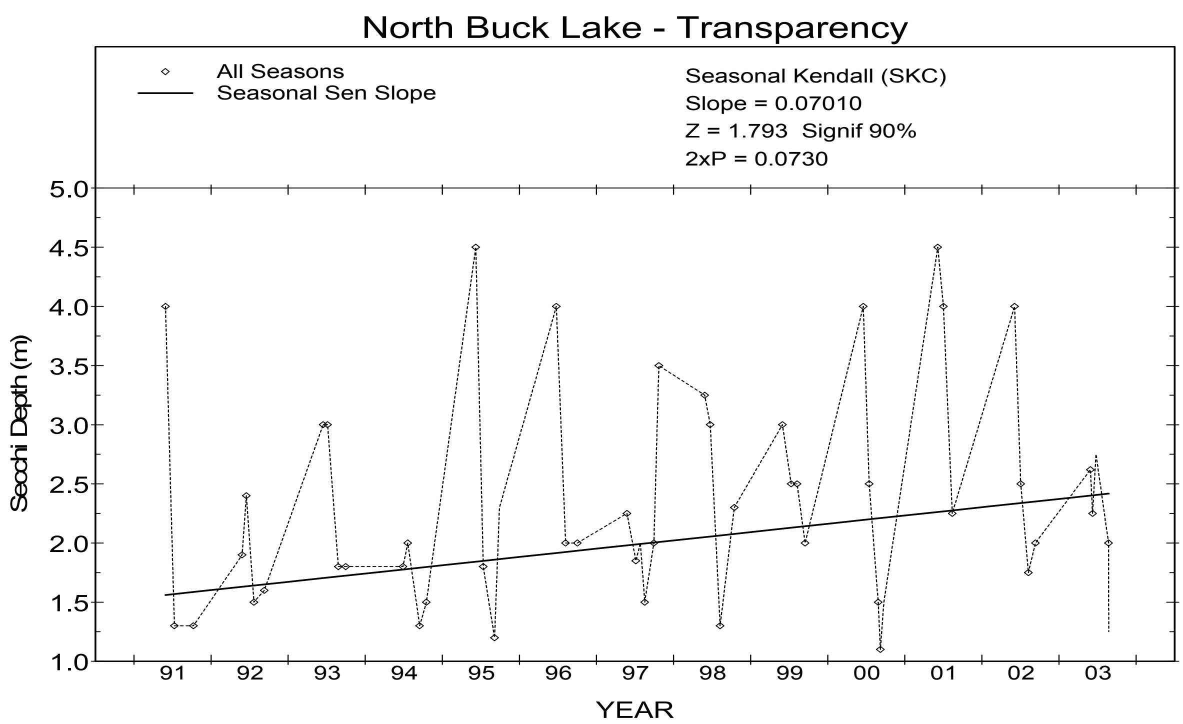
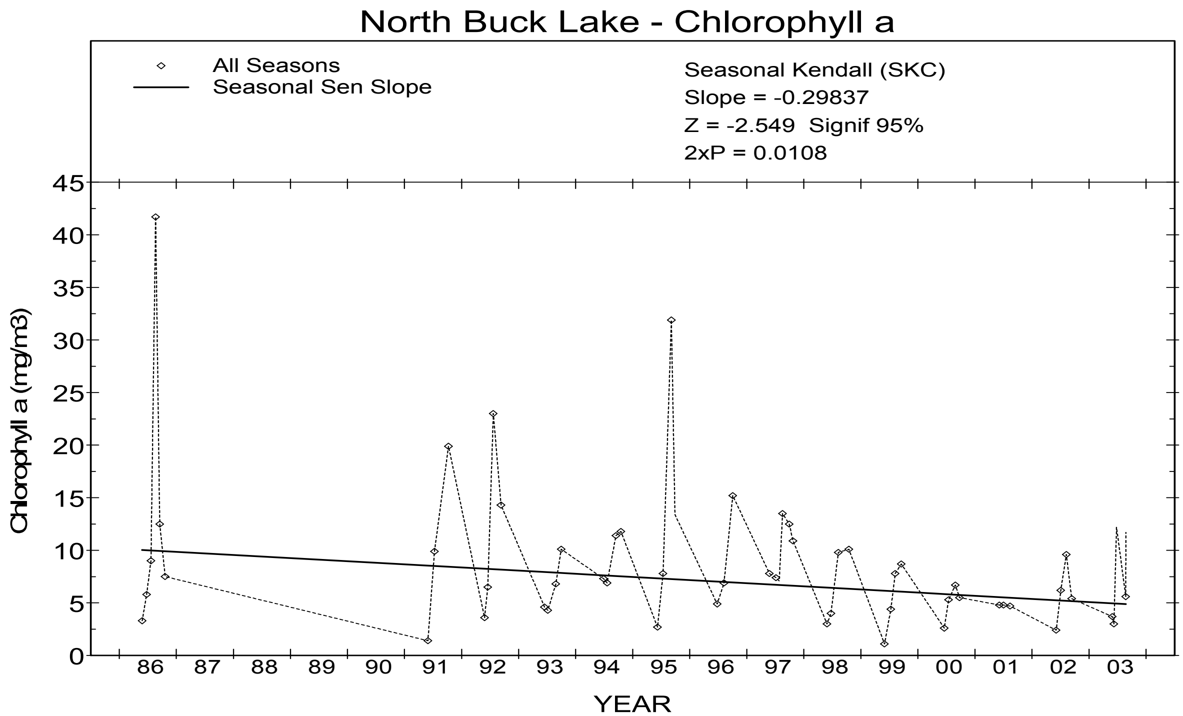


Figure 78 **North Buck Lake –** Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



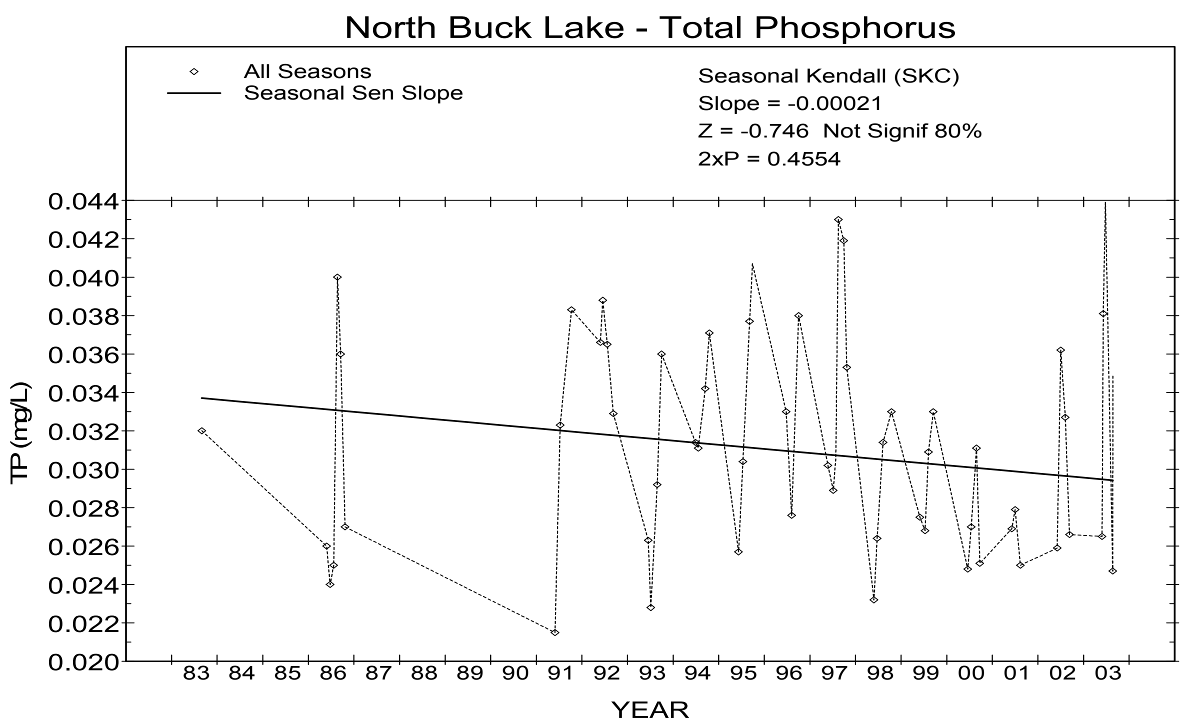
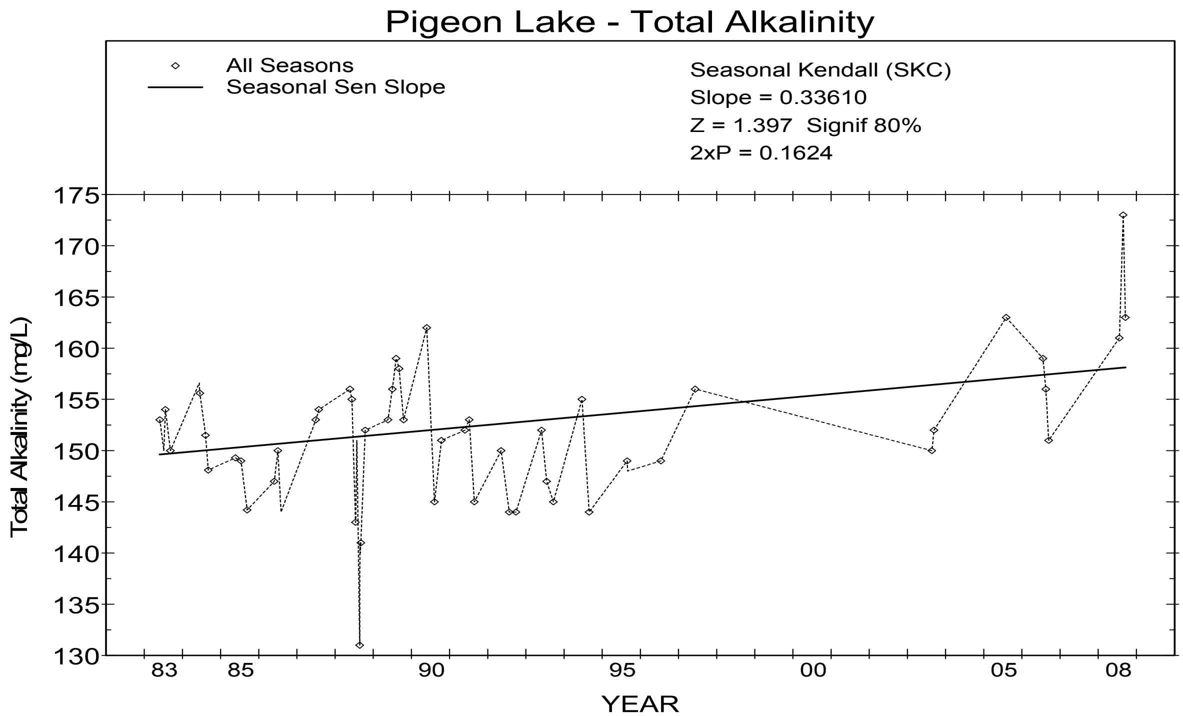


Figure 78 **North Buck Lake –** Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



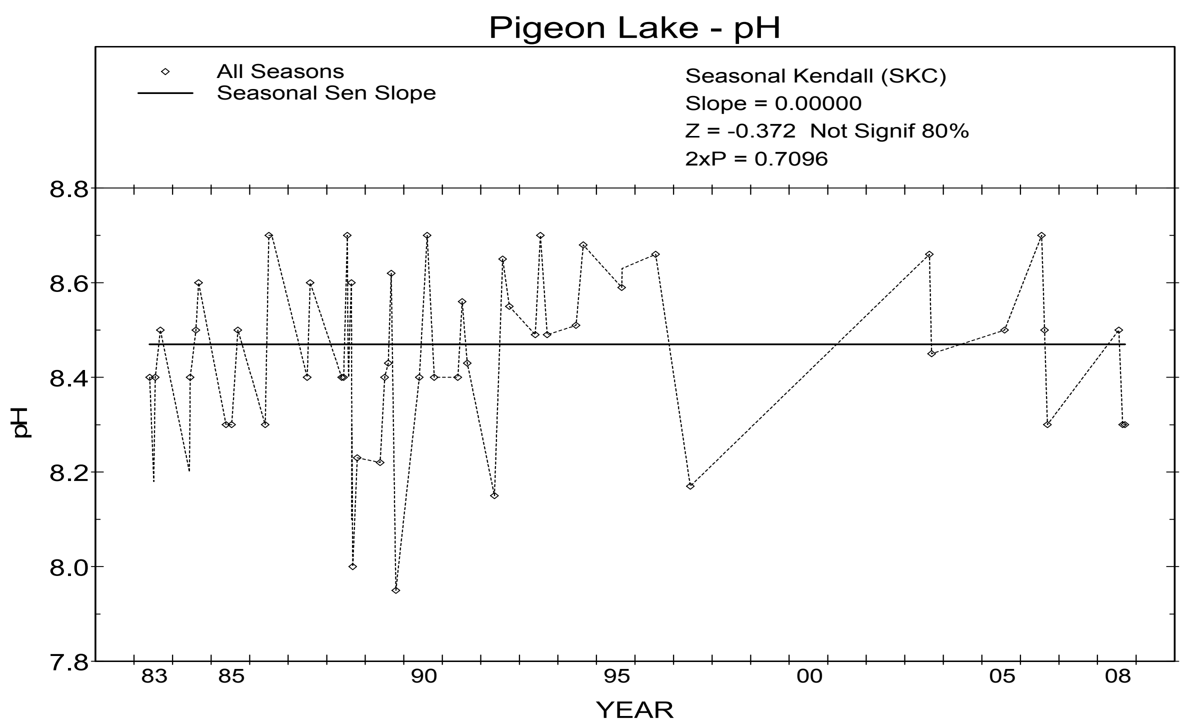
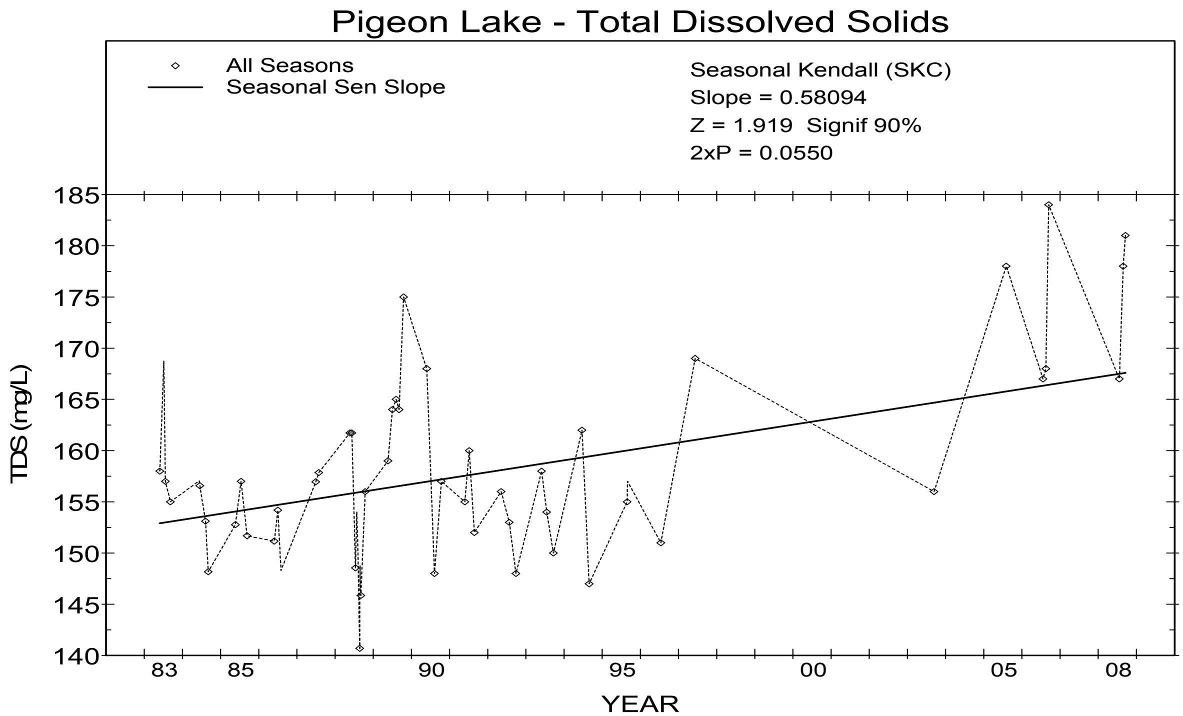


Figure 79 **Pigeon Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



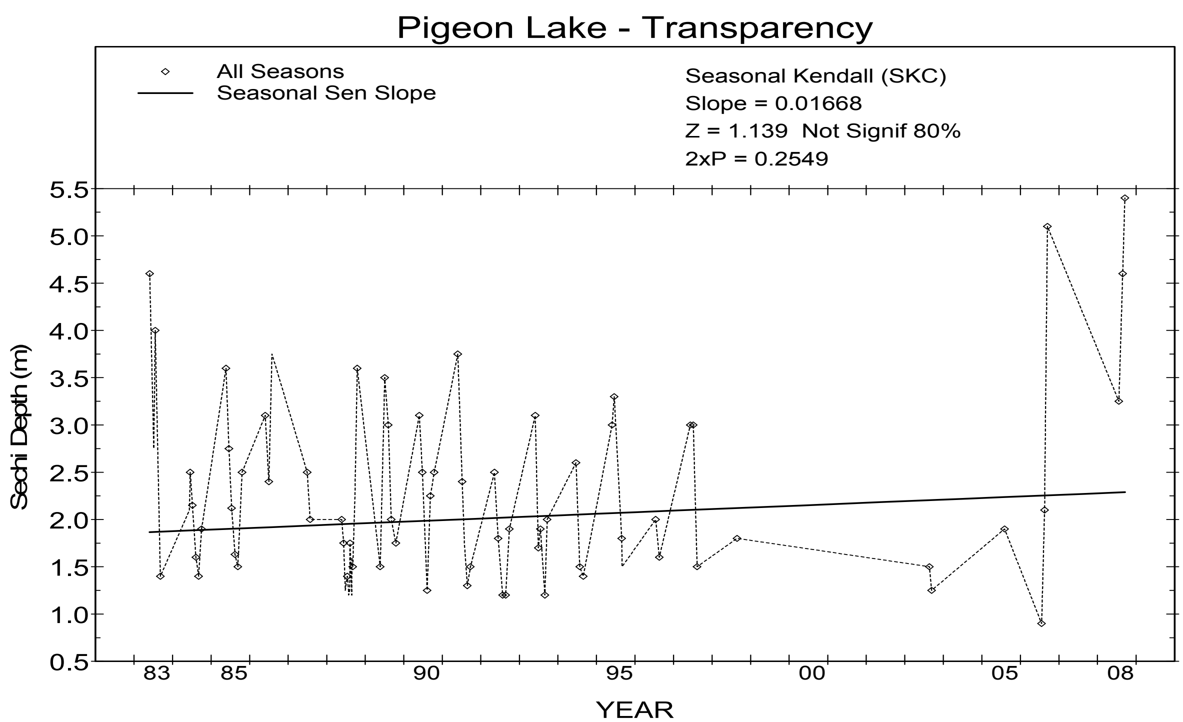
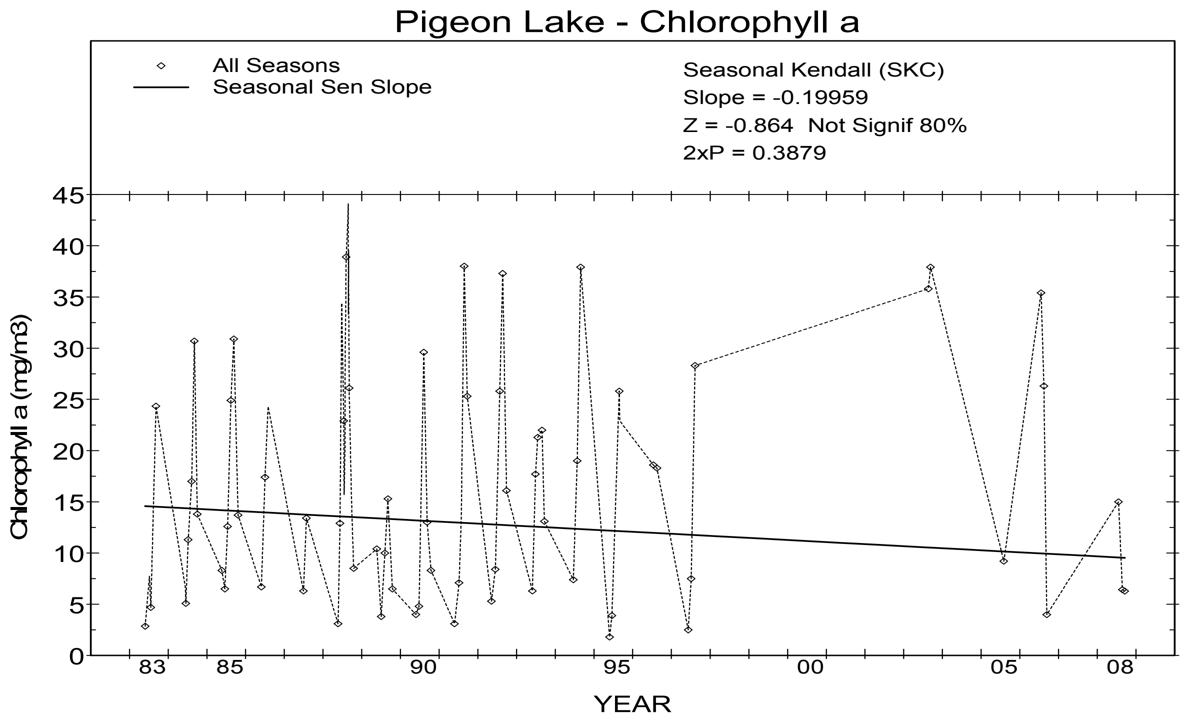


Figure 79 **Pigeon Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



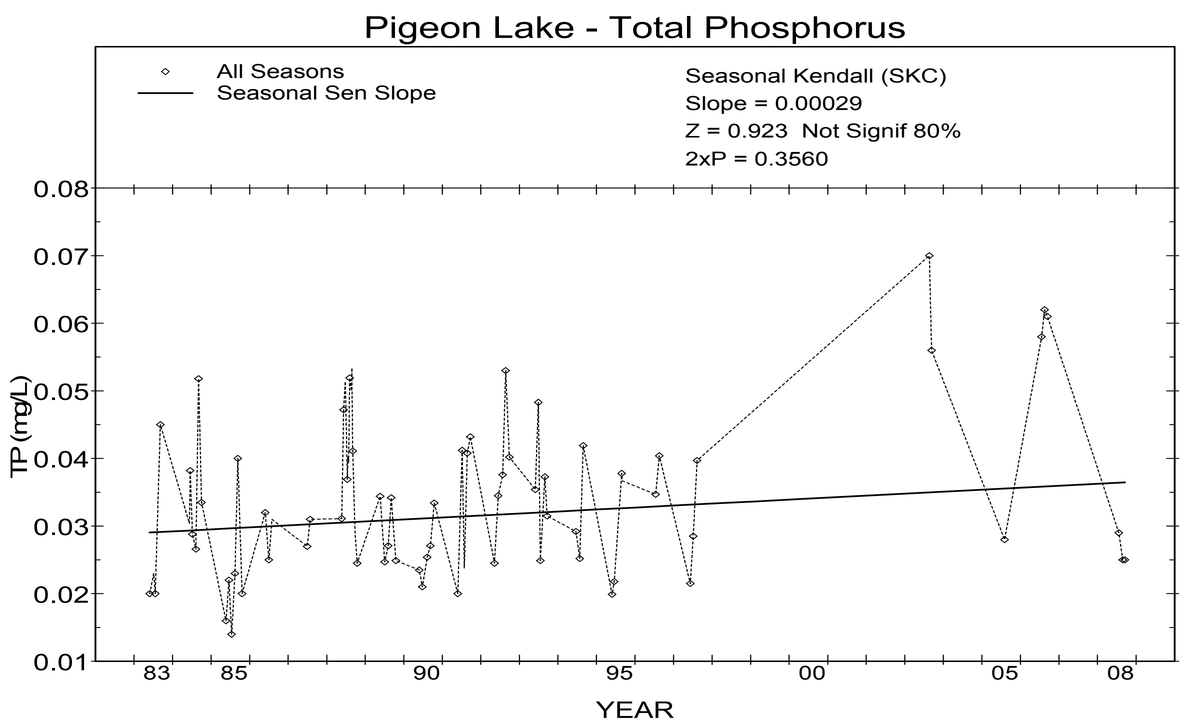
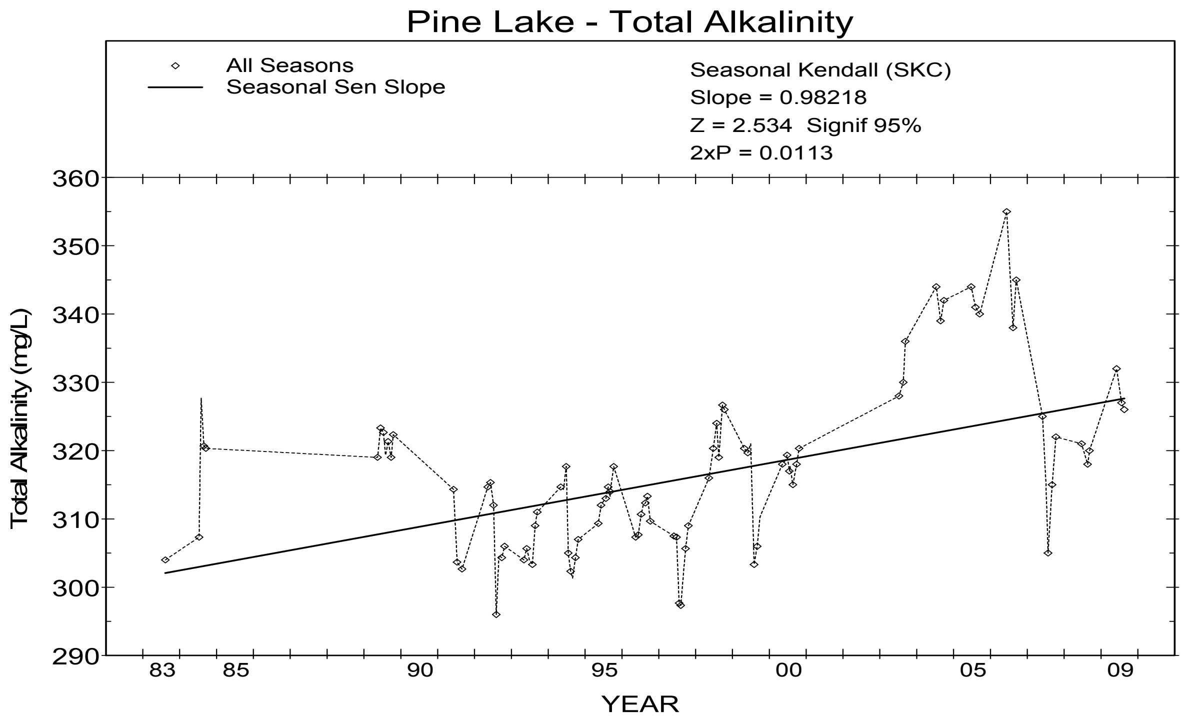


Figure 79 **Pigeon Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



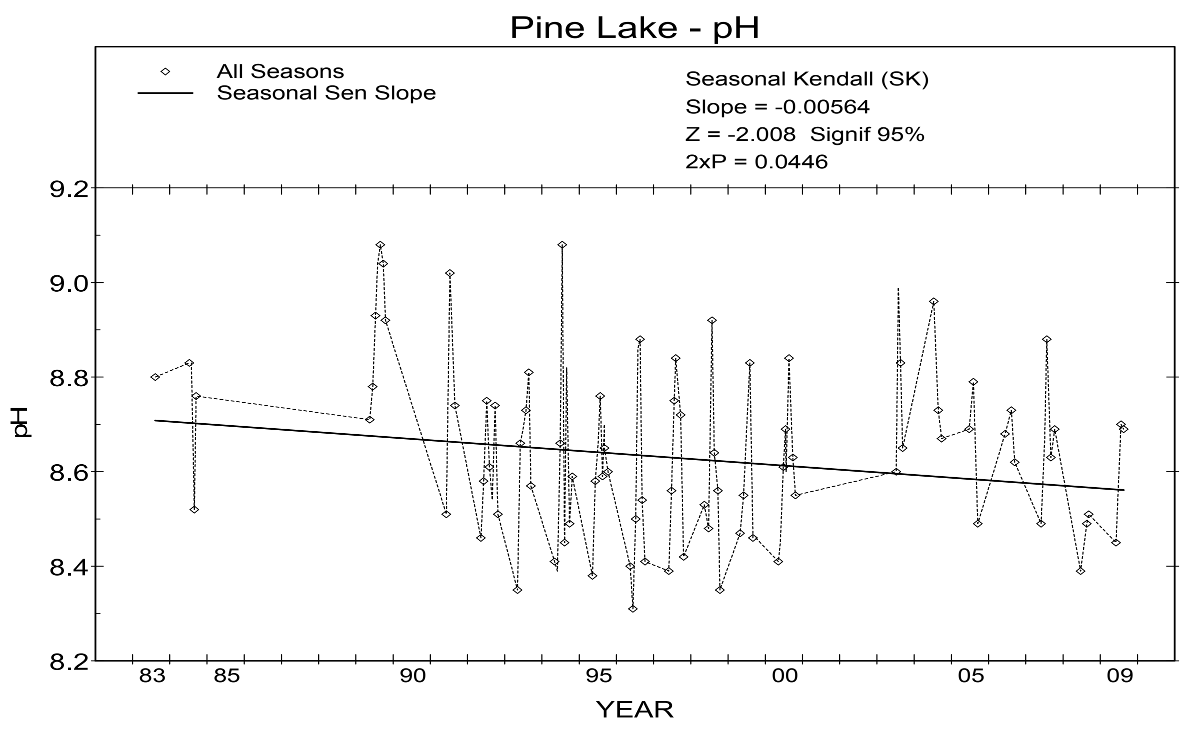
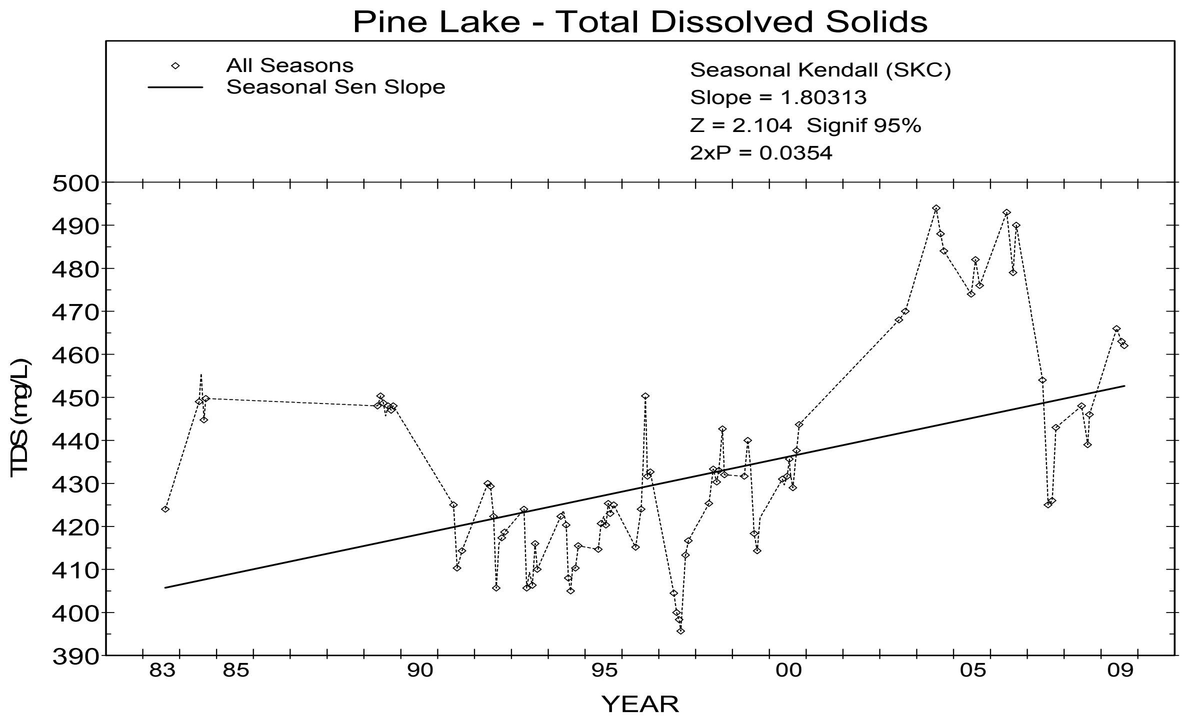


Figure 80a **Pine Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



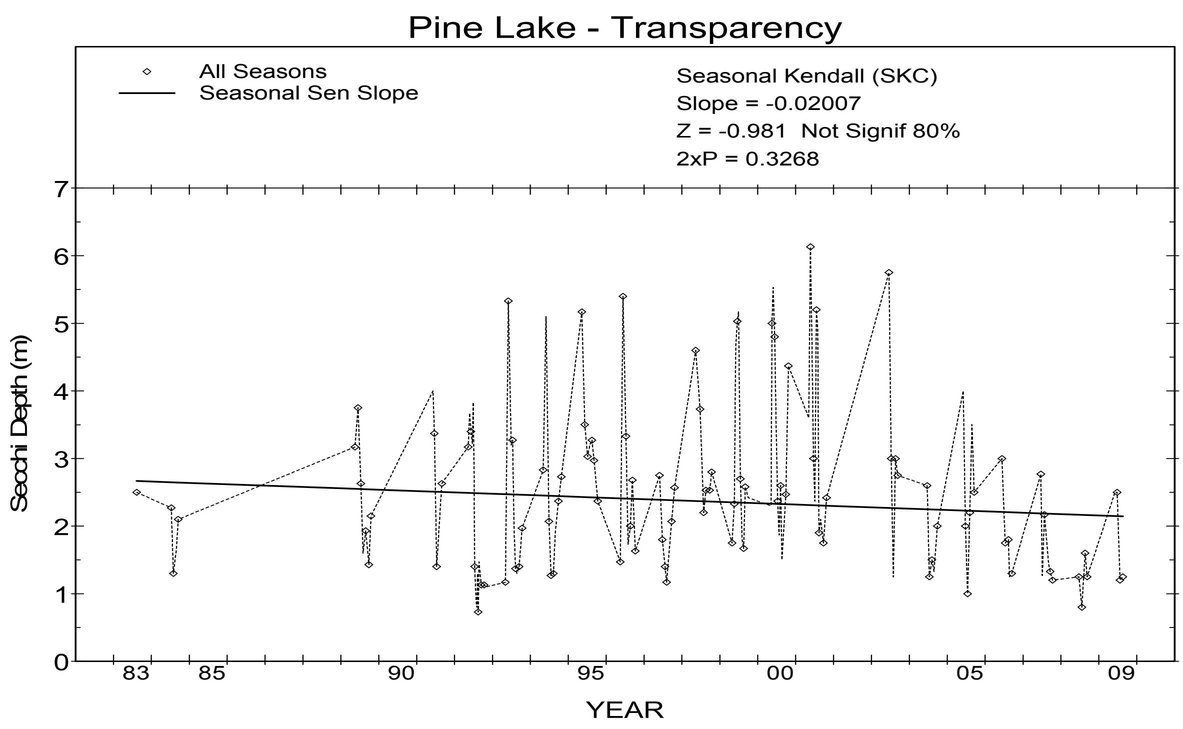
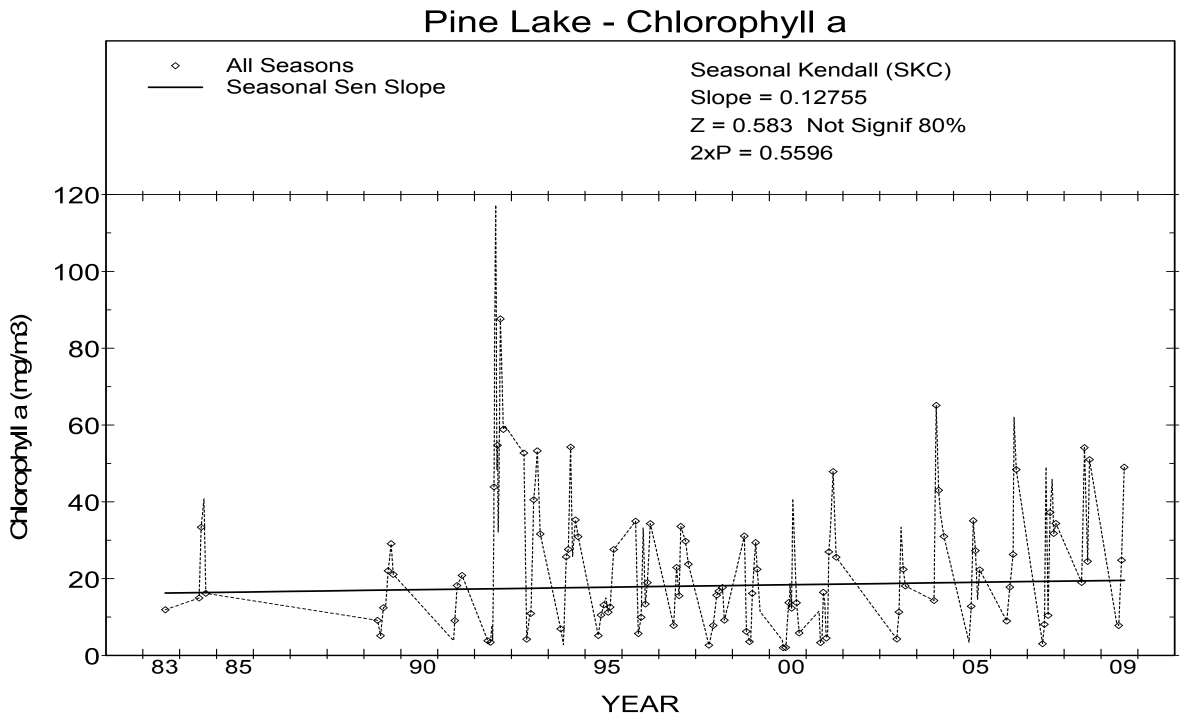


Figure 80a **Pine Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



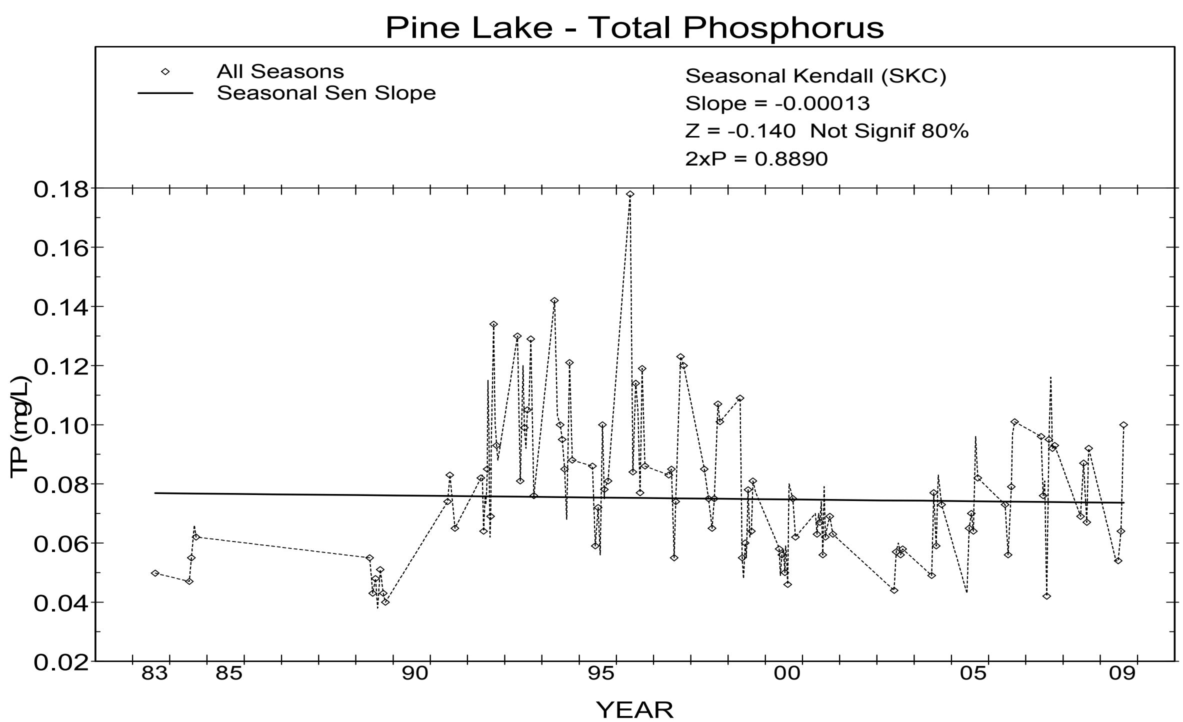
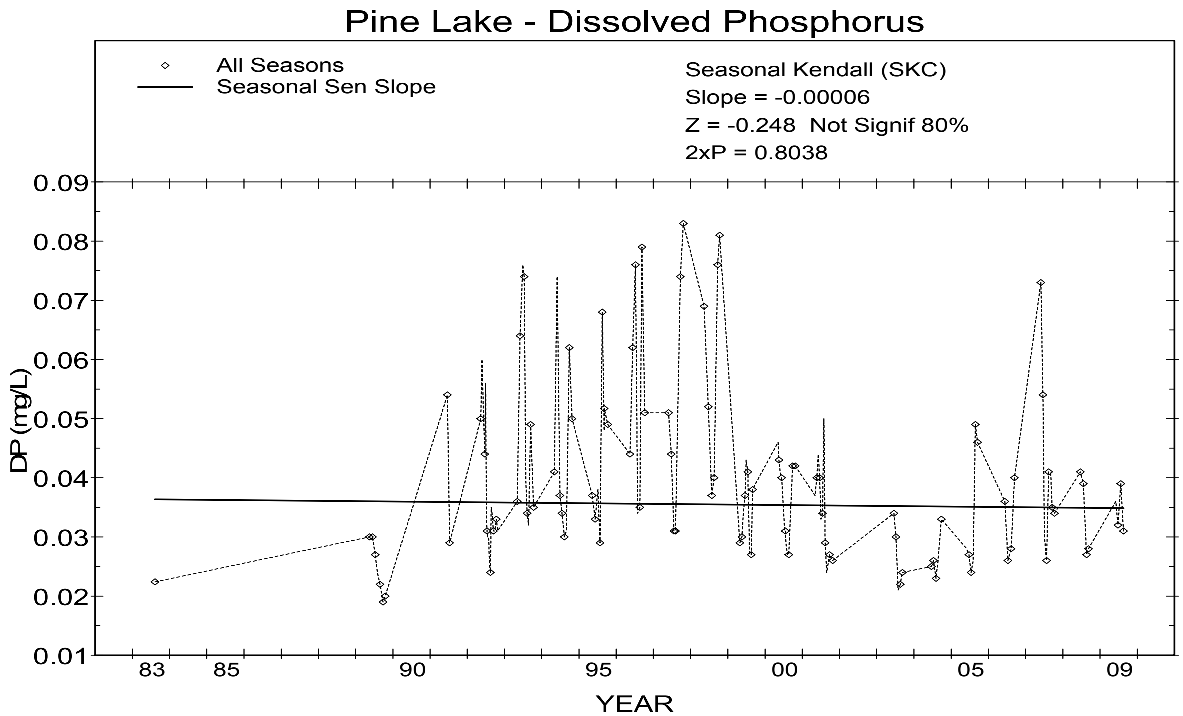


Figure 80a **Pine Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



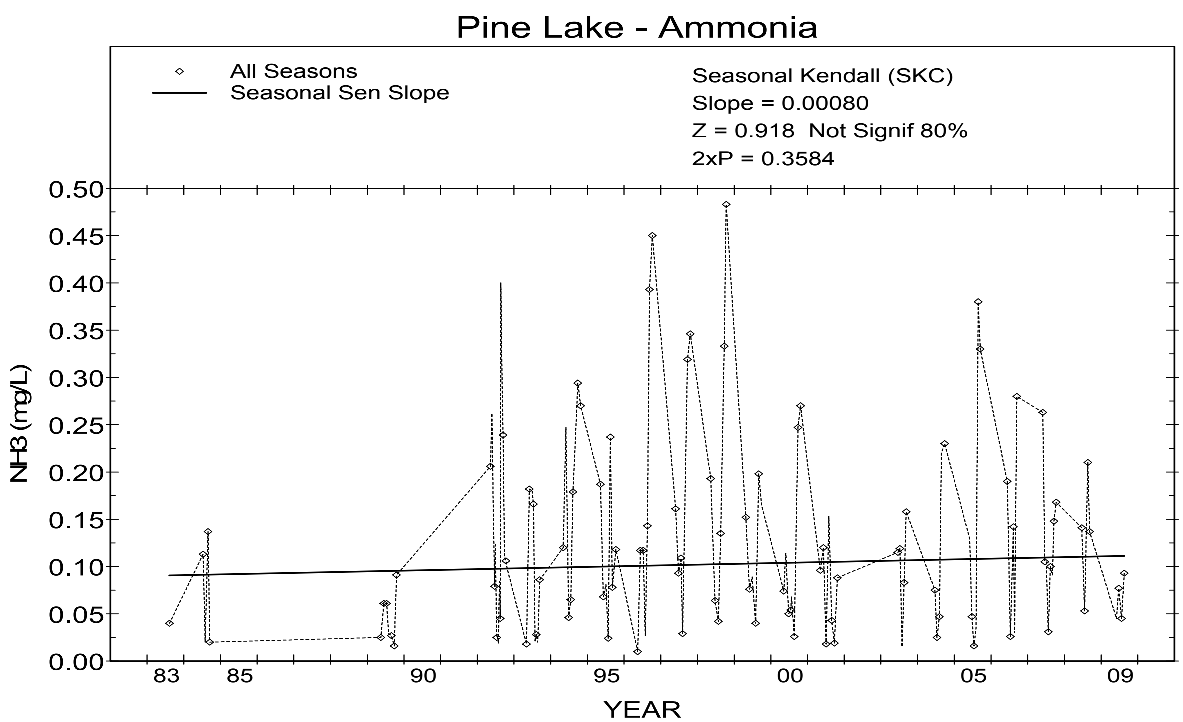
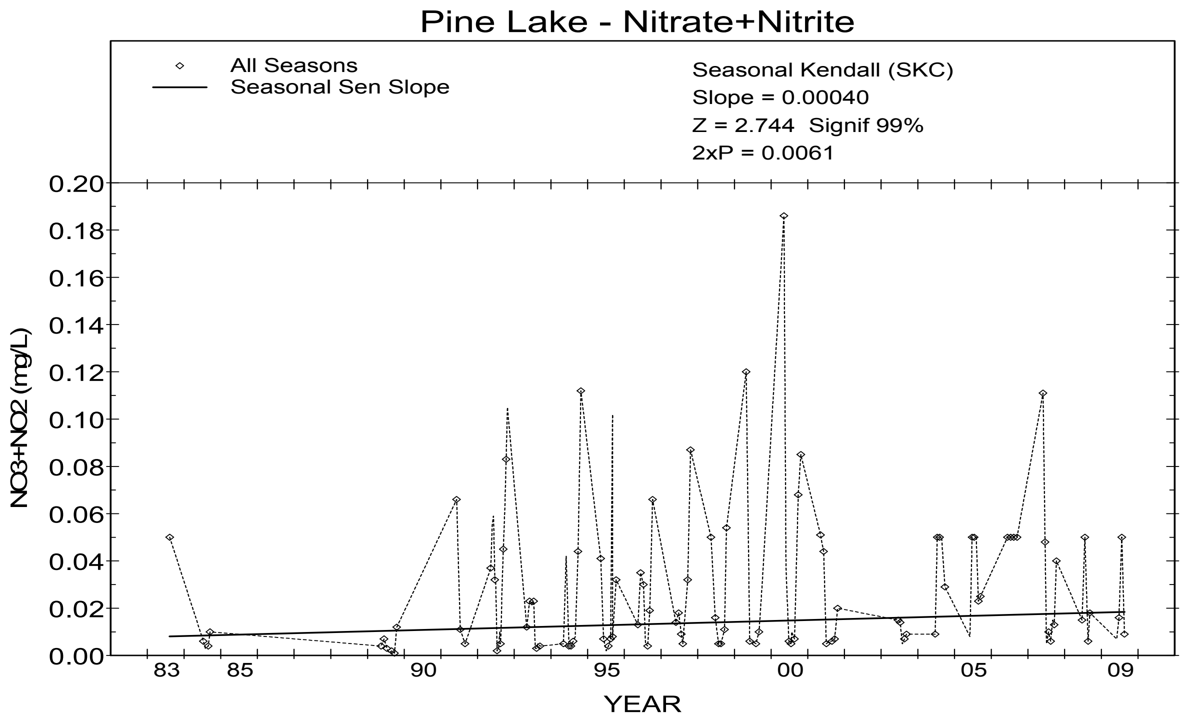


Figure 80b **Pine Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record



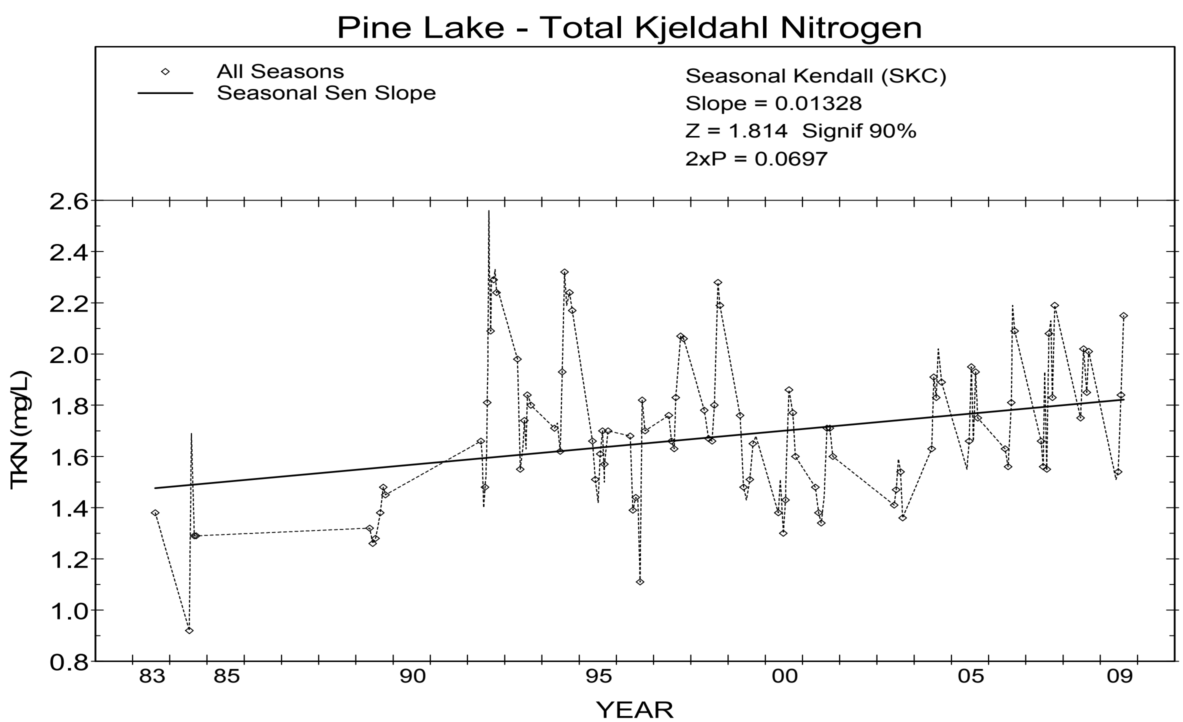
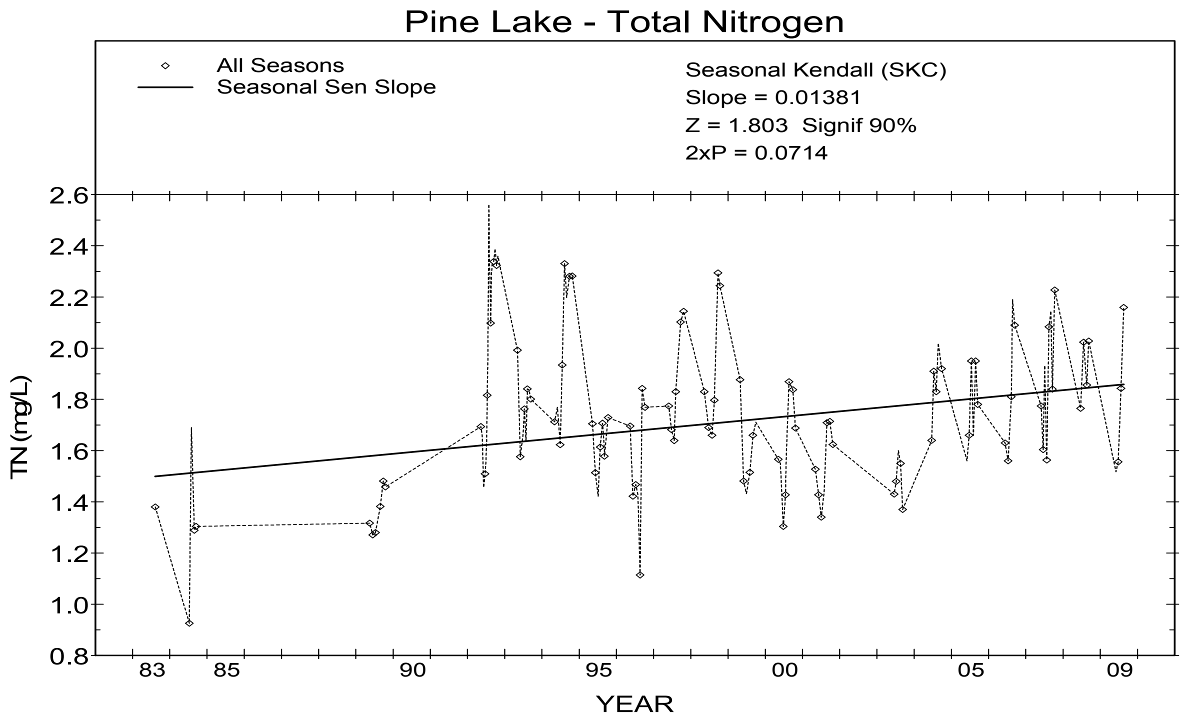


Figure 80b **Pine Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)



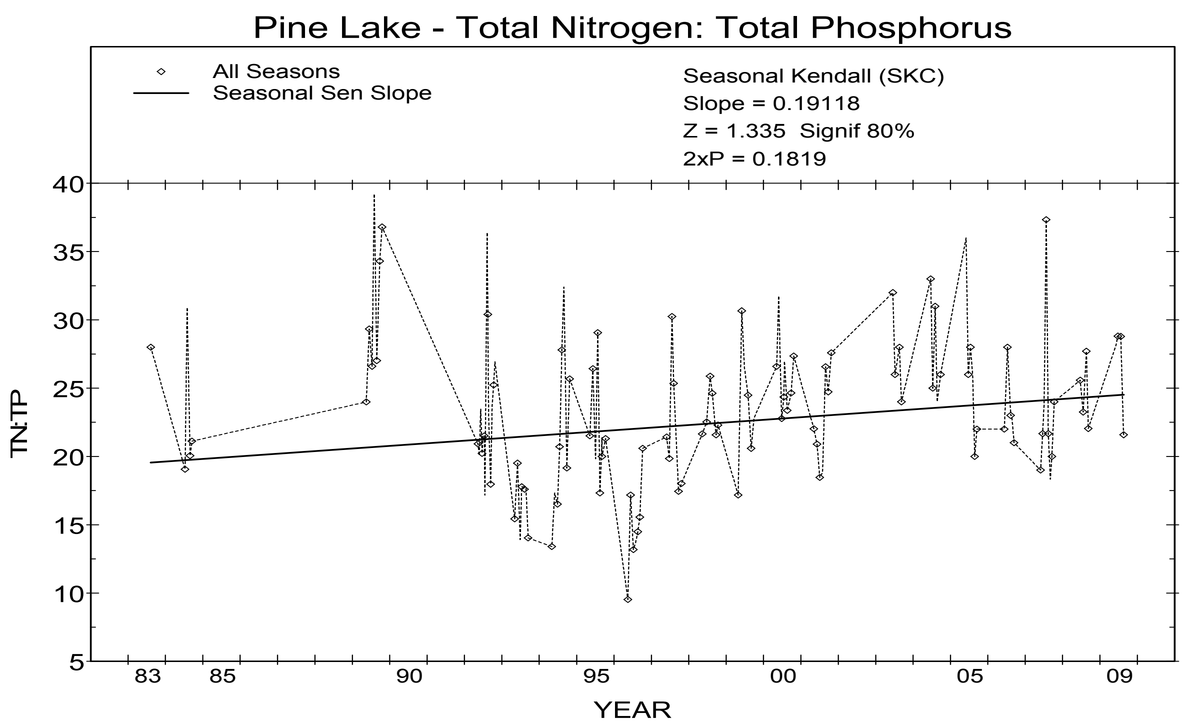
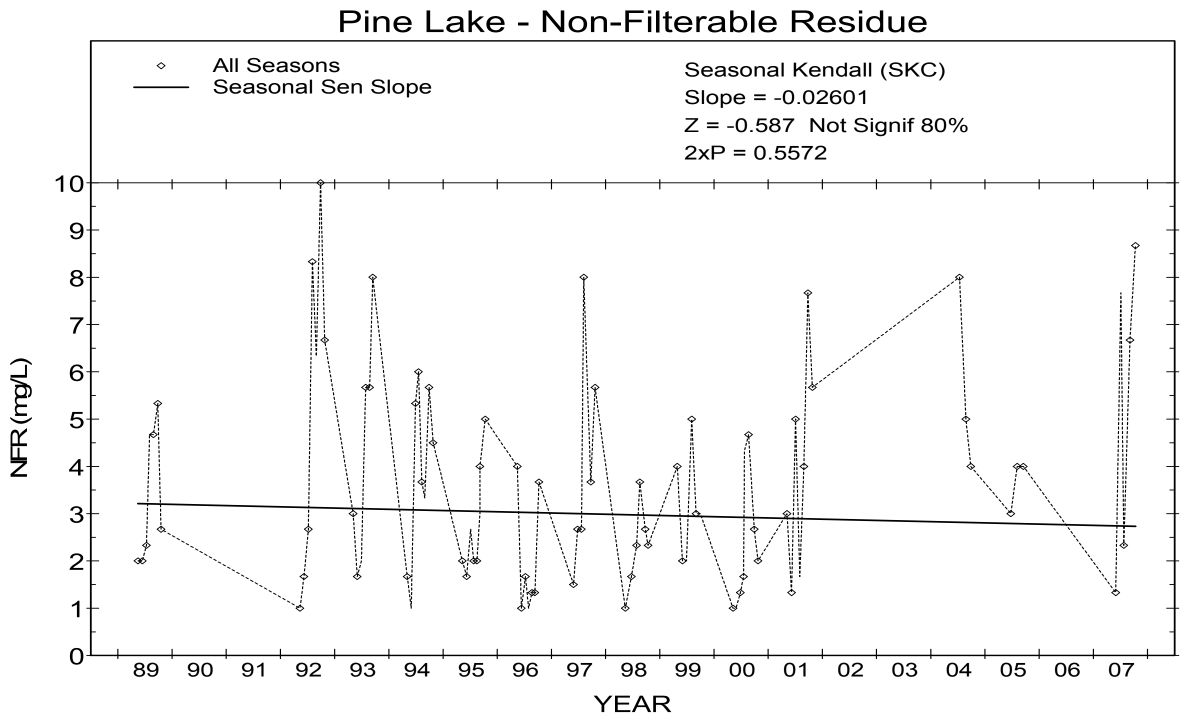


Figure 80b **Pine Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)



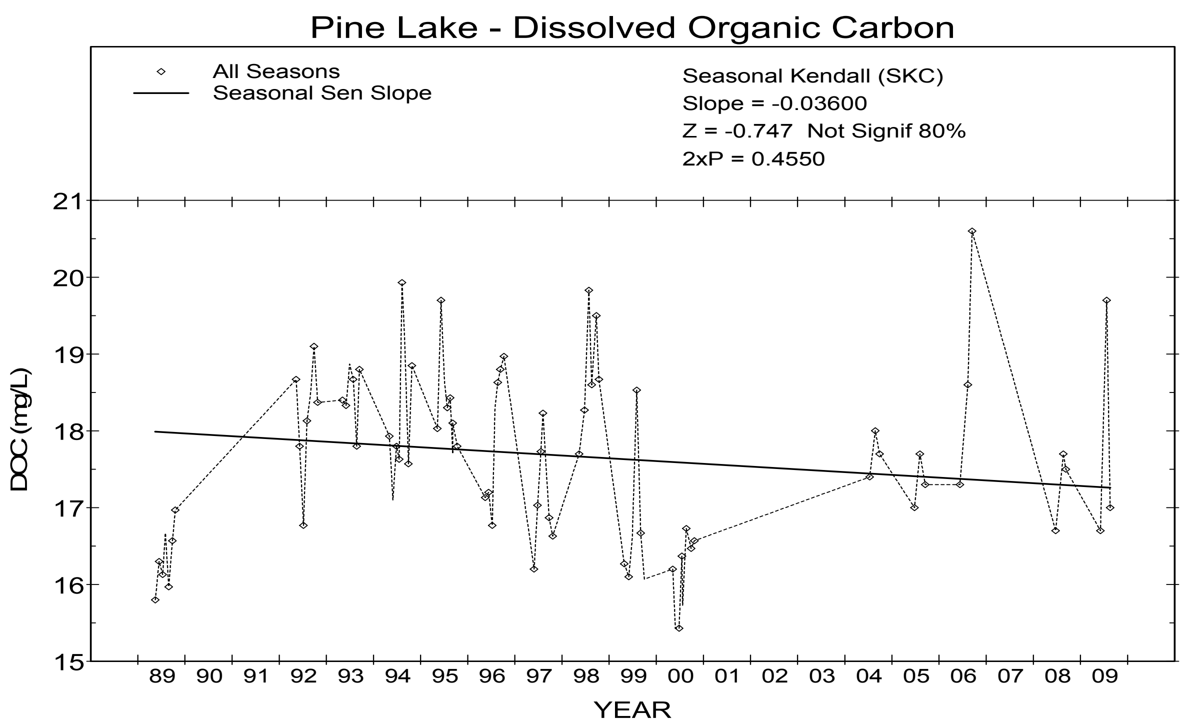


Figure 80b **Pine Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)

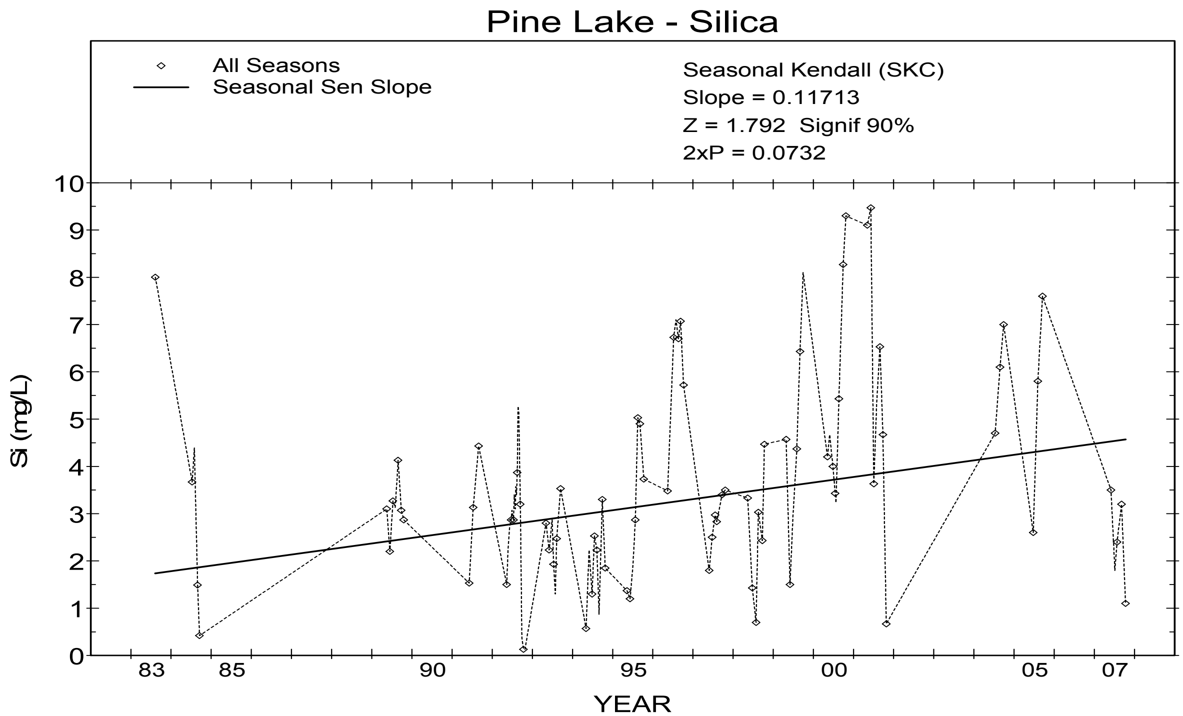
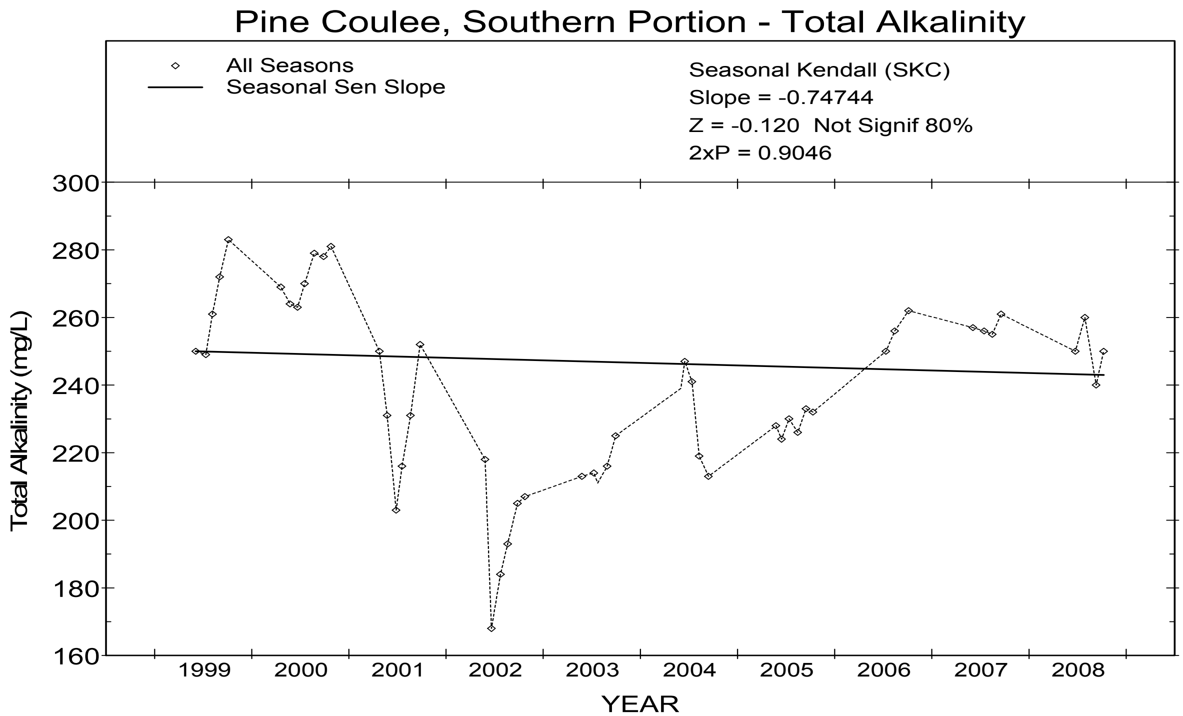


Figure 80b **Pine Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, nitrate+nitrite-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (concluded)



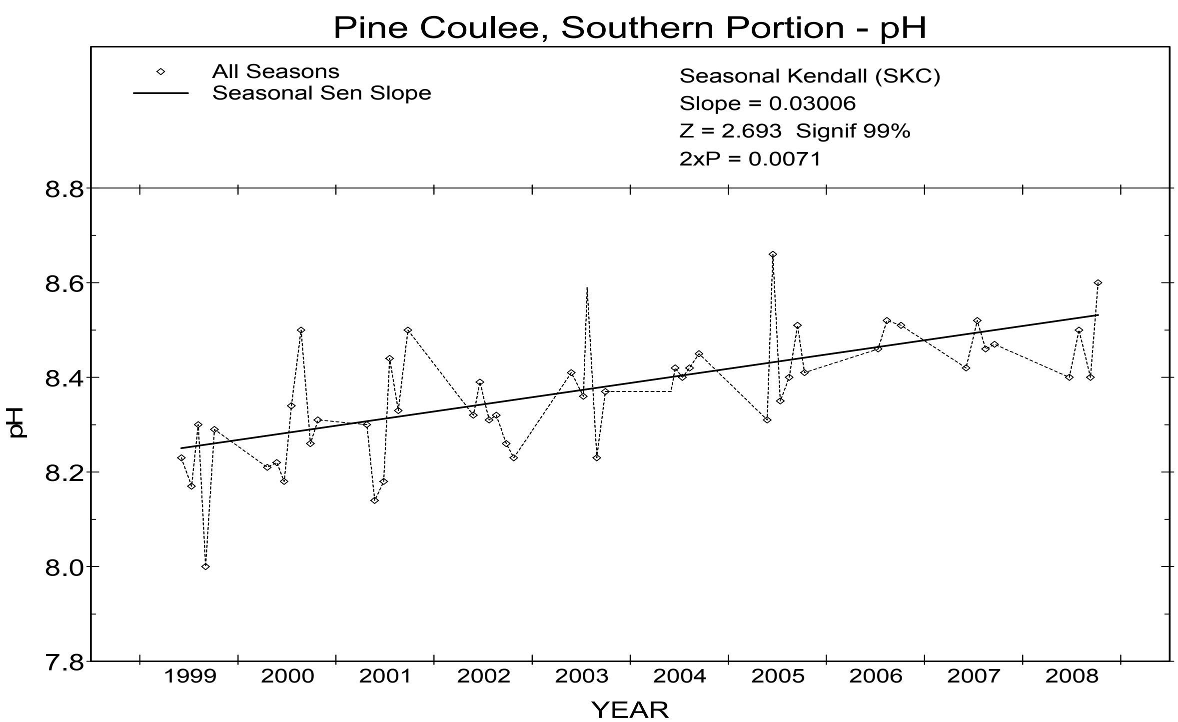
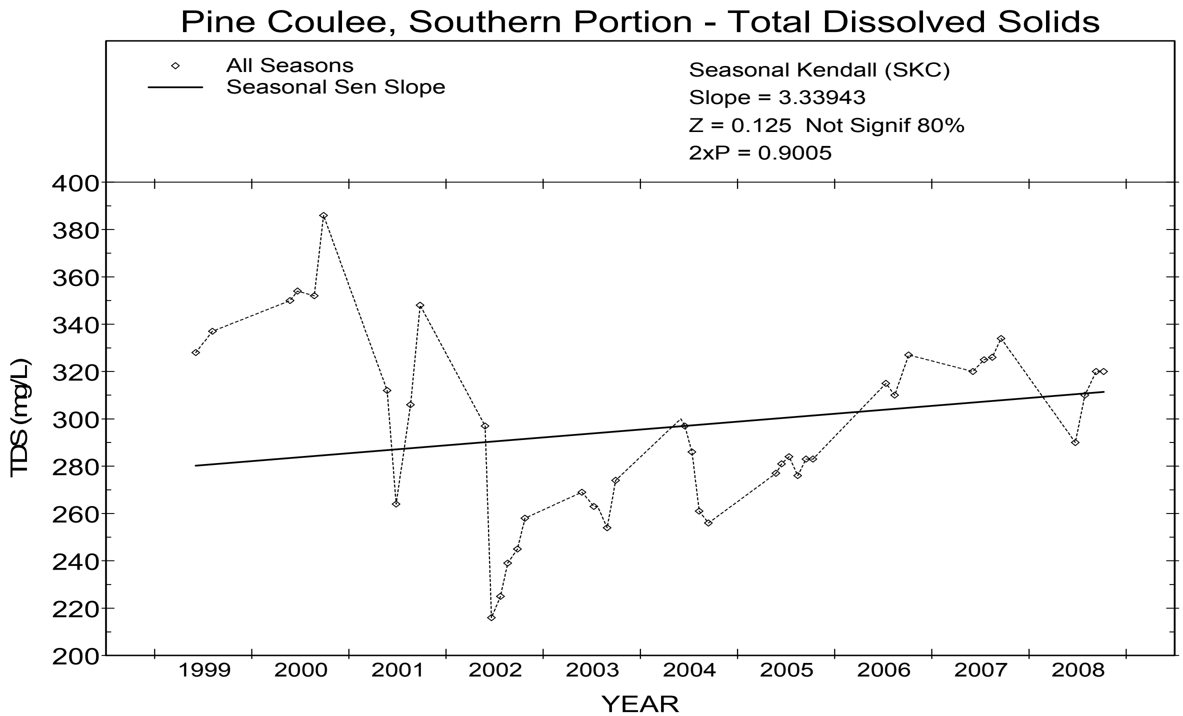


Figure 81 **Pine Coulee, Southern Portion** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



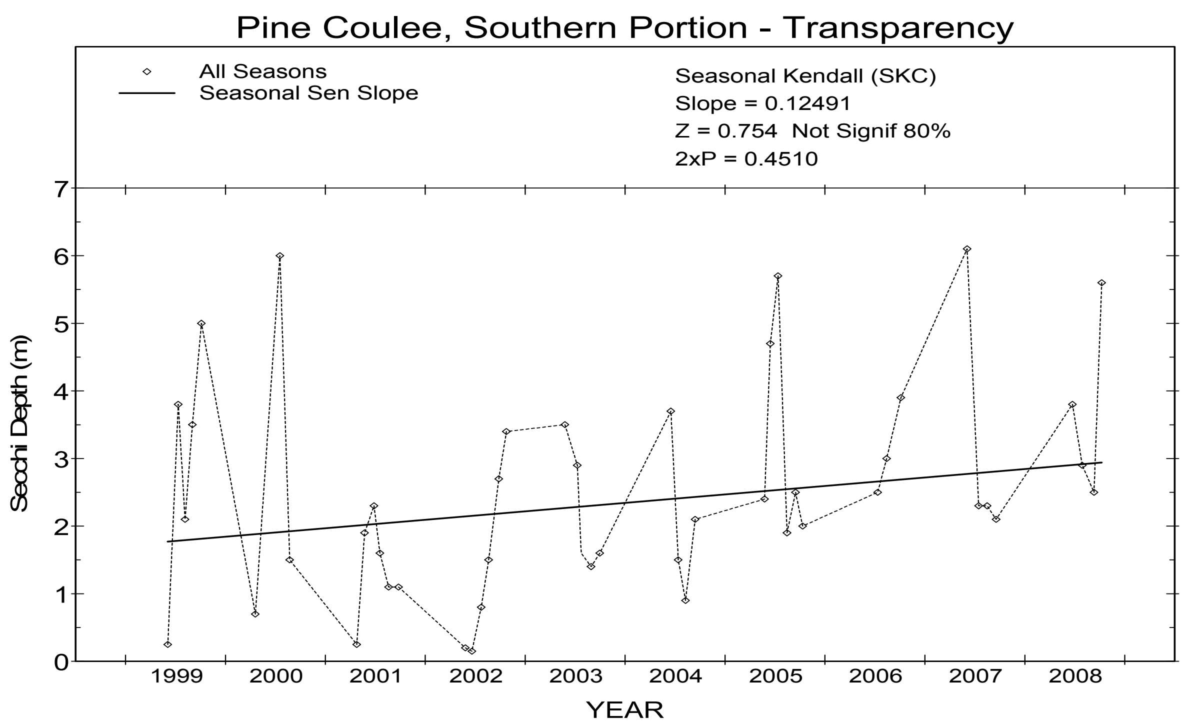
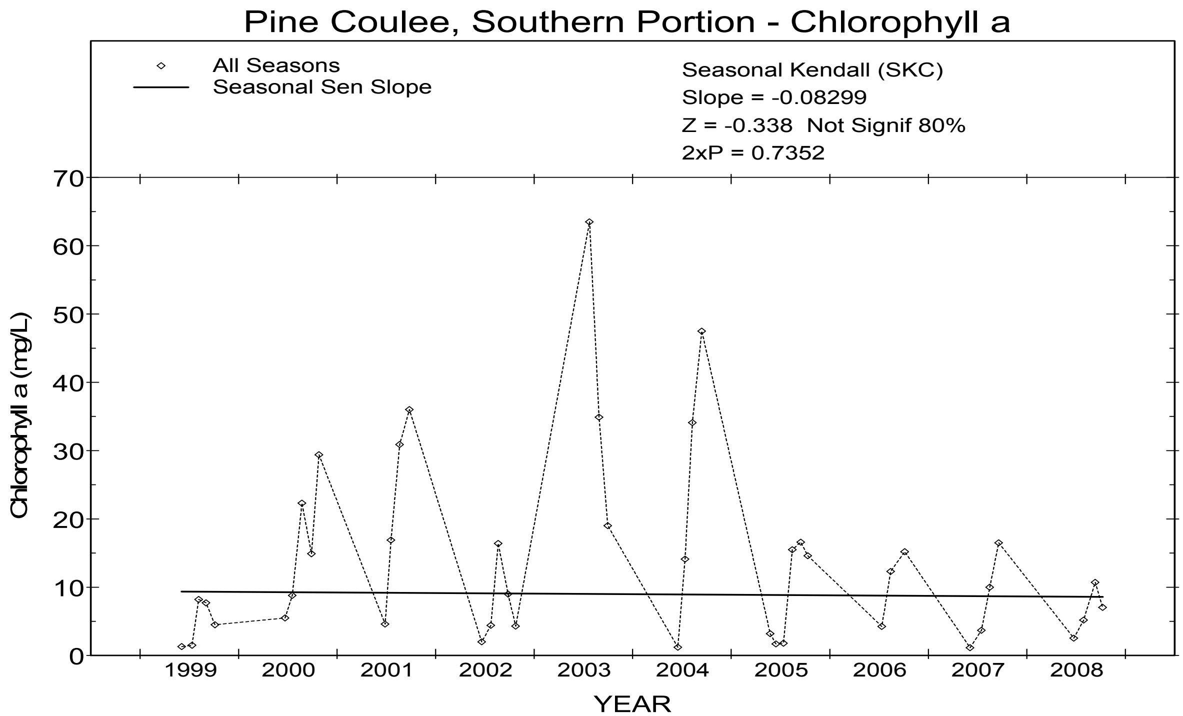


Figure 81 **Pine Coulee, Southern Portion** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



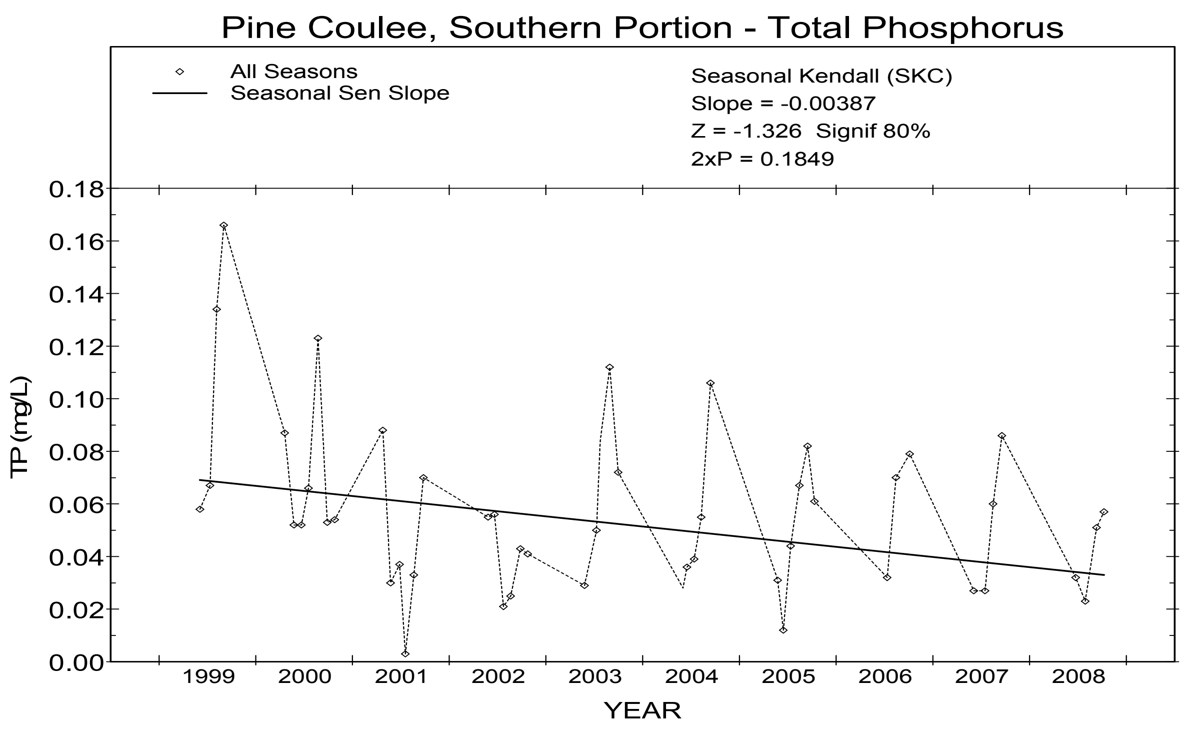
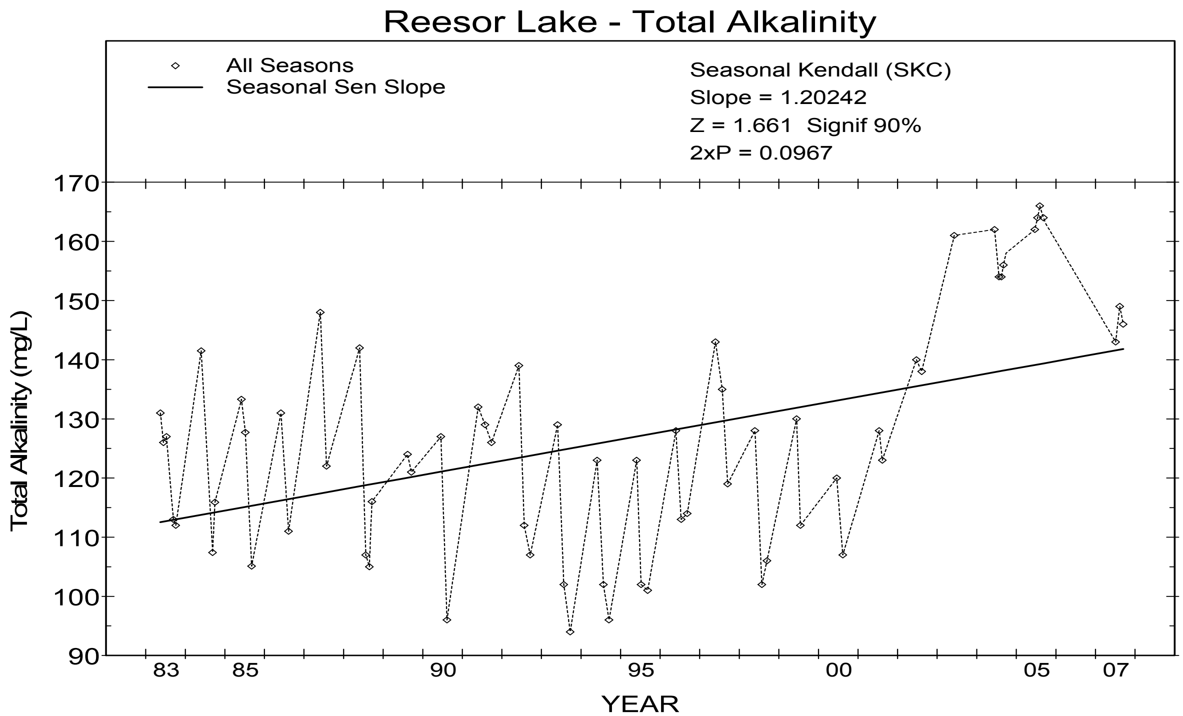


Figure 81 **Pine Coulee, Southern Portion –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



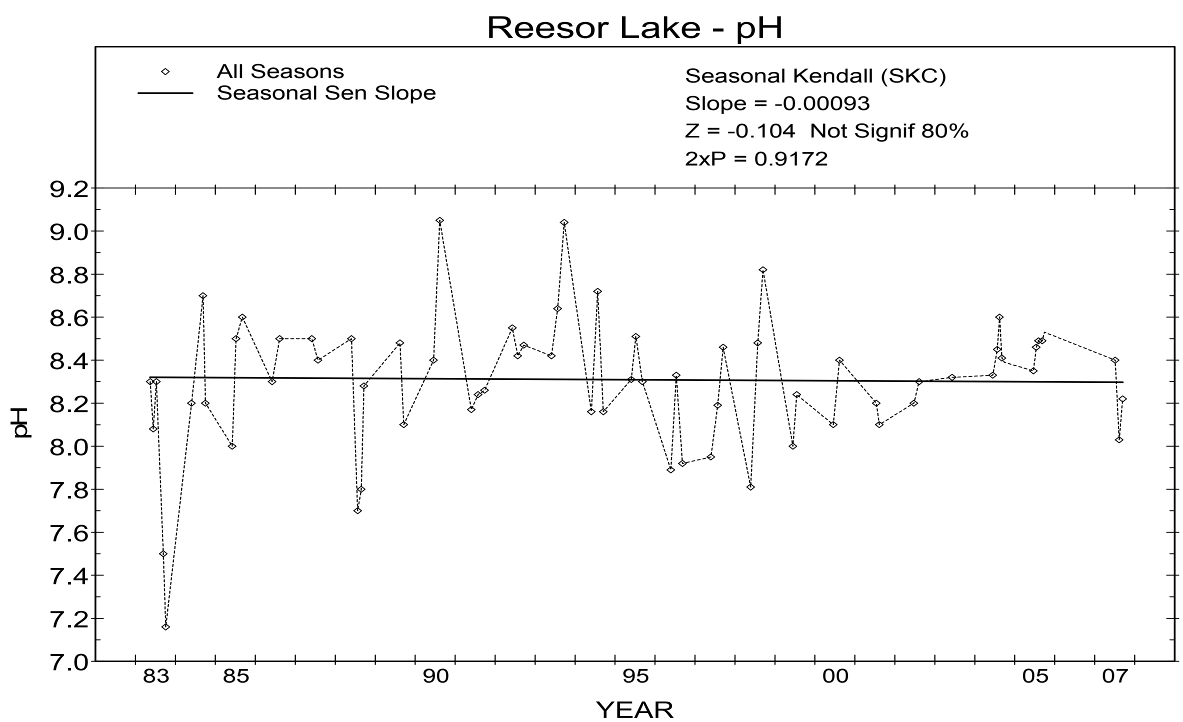
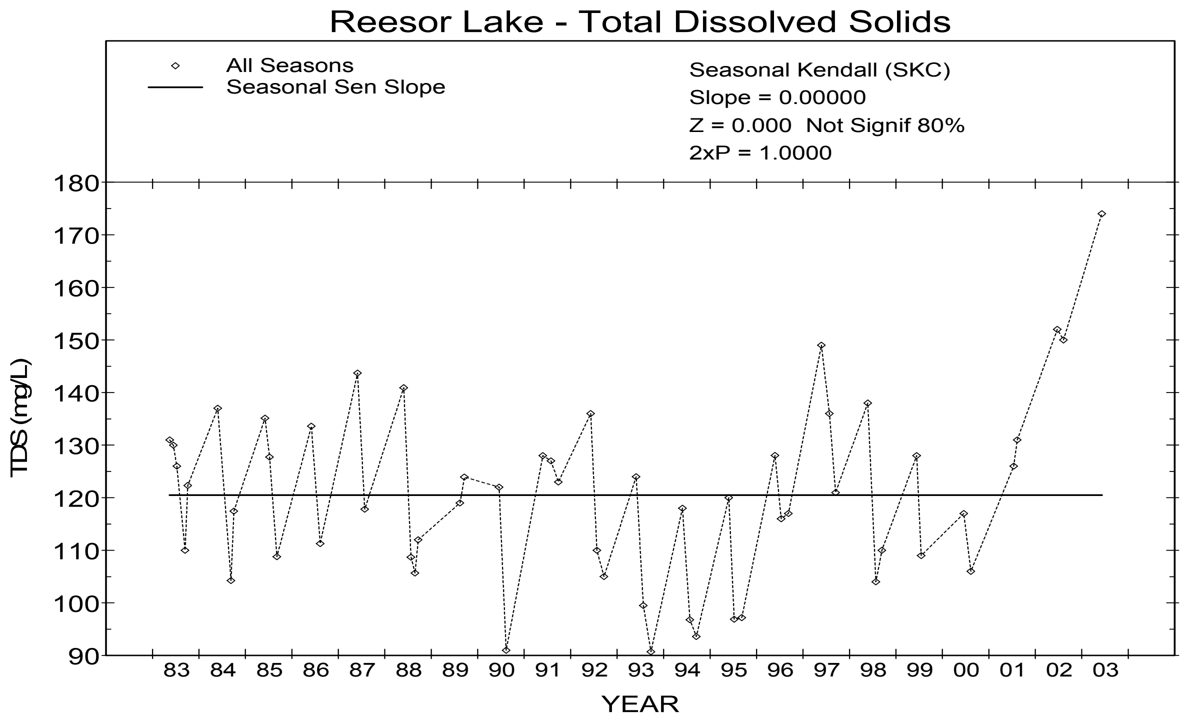


Figure 82 **Reesor Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



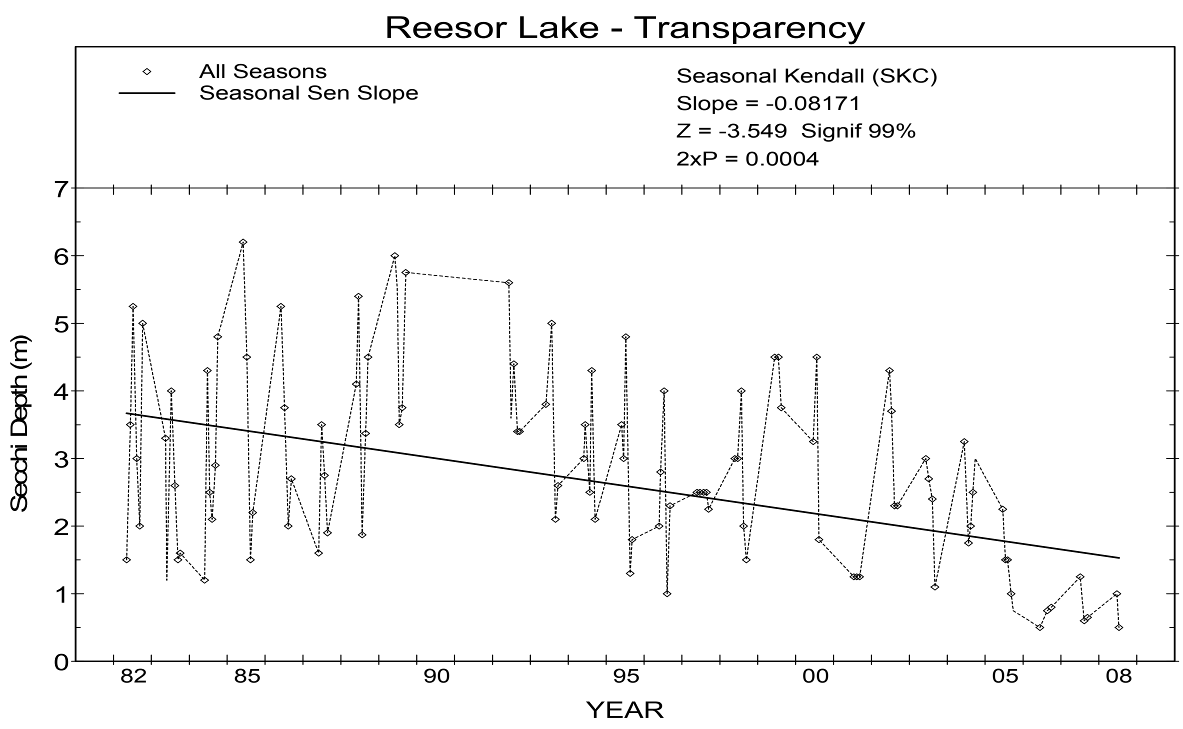
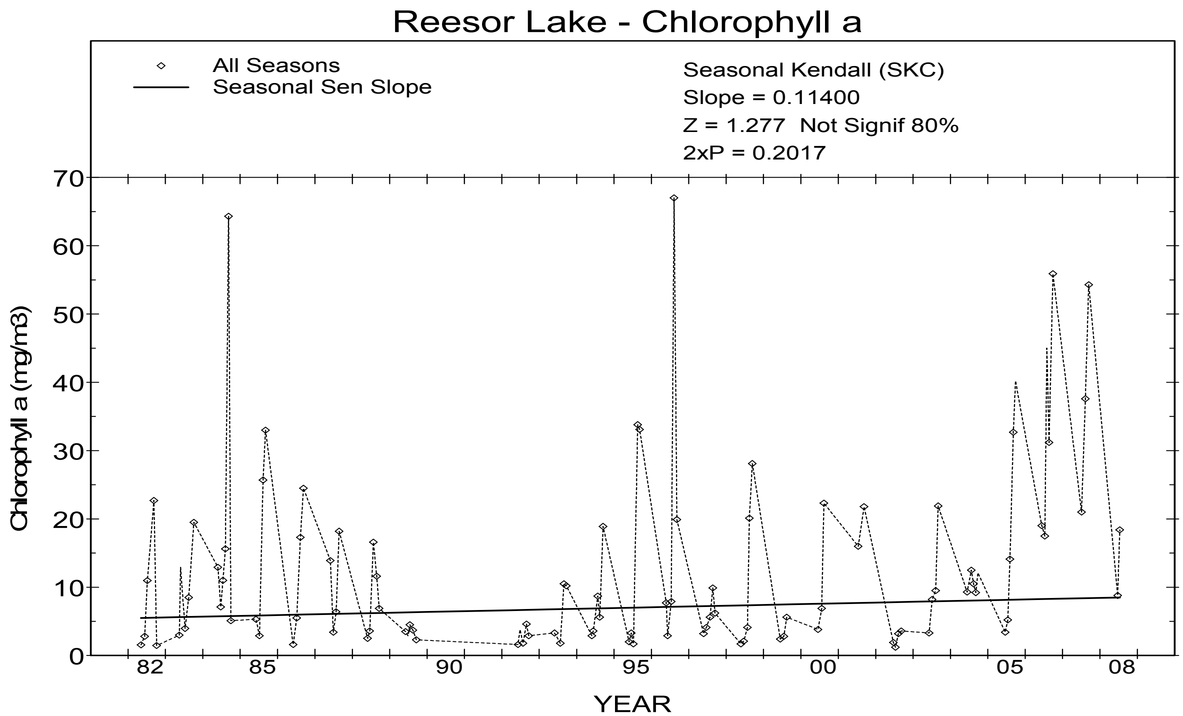


Figure 82 **Reesor Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record. (continued)



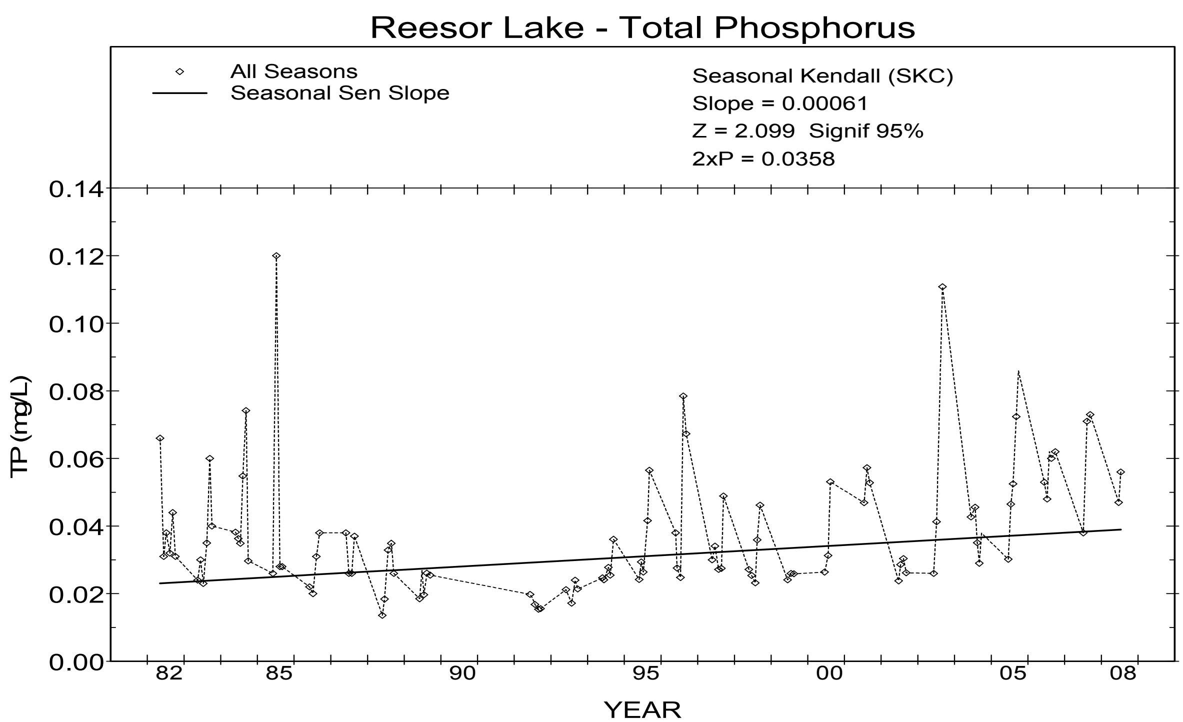
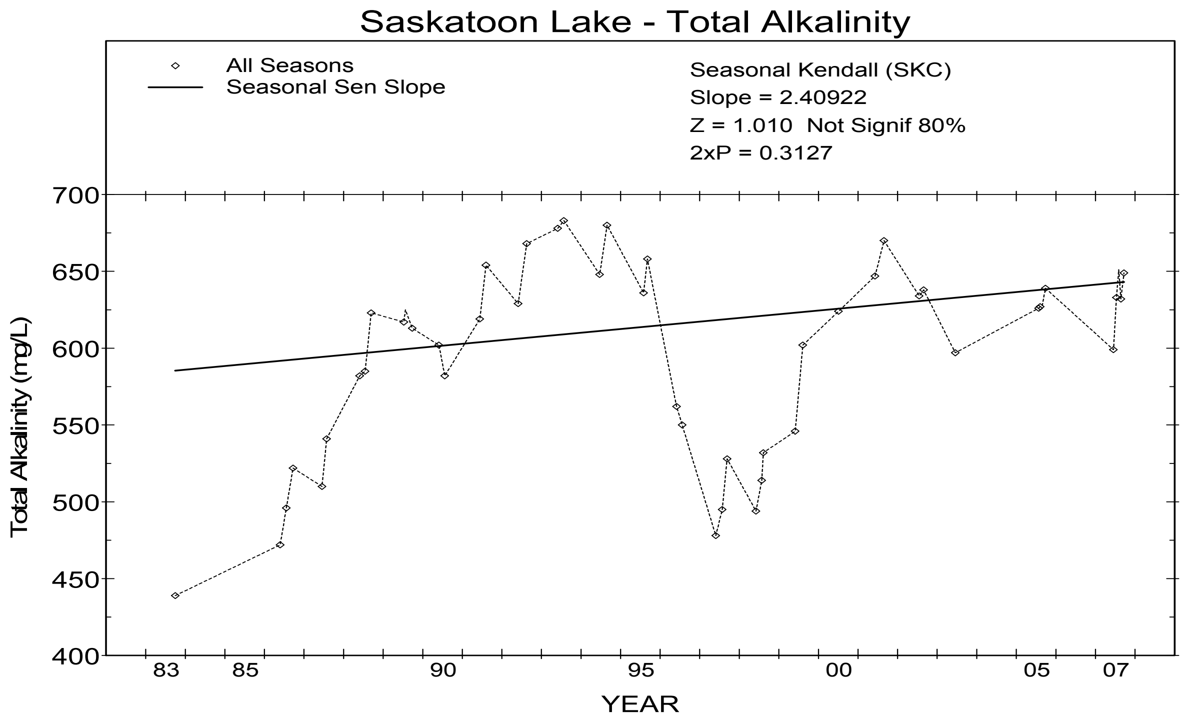


Figure 82 **Reesor Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



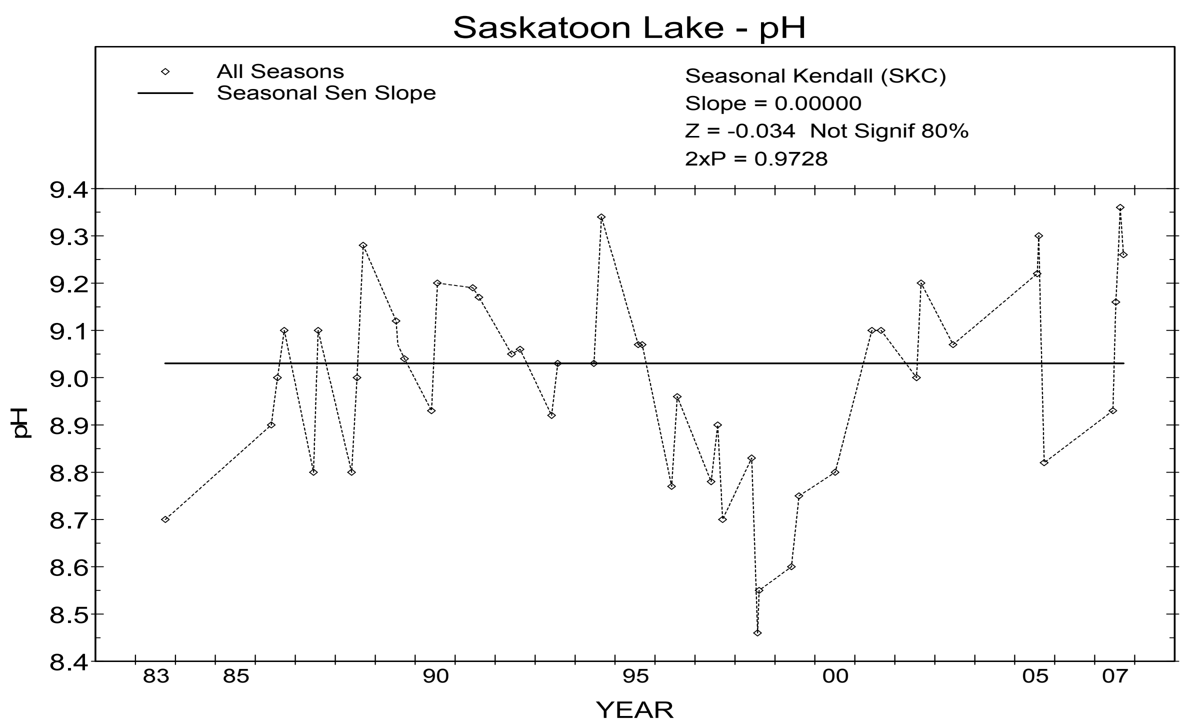
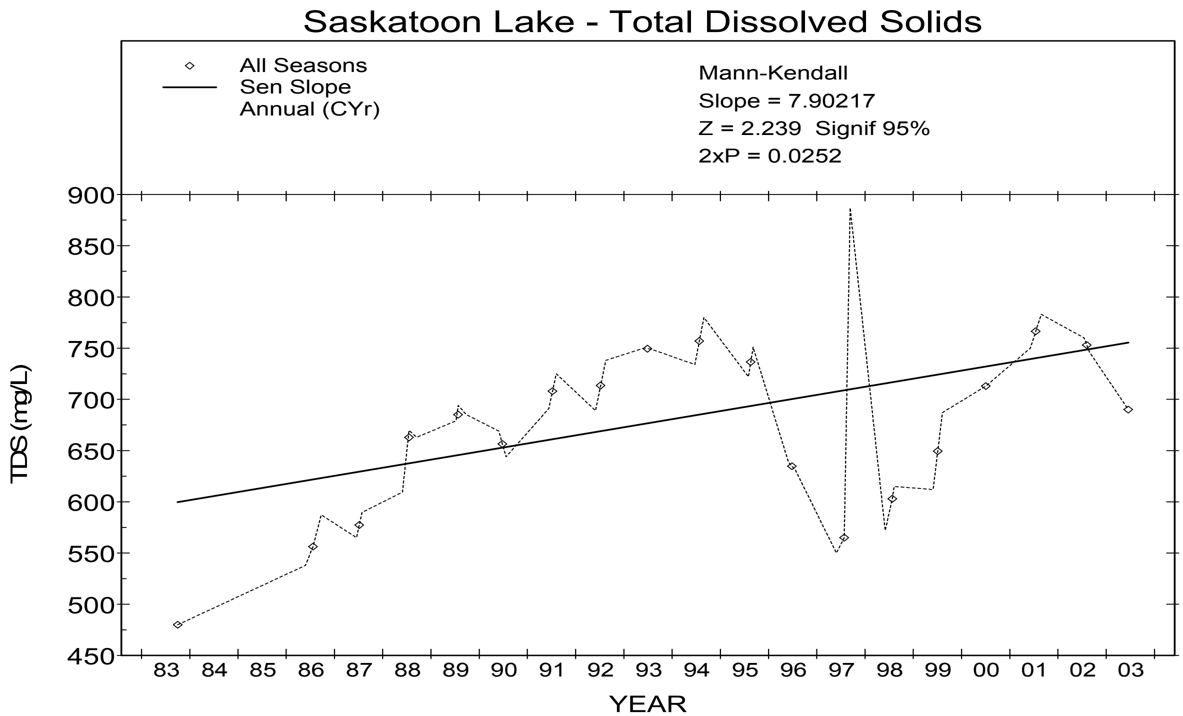


Figure 83 **Saskatoon Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



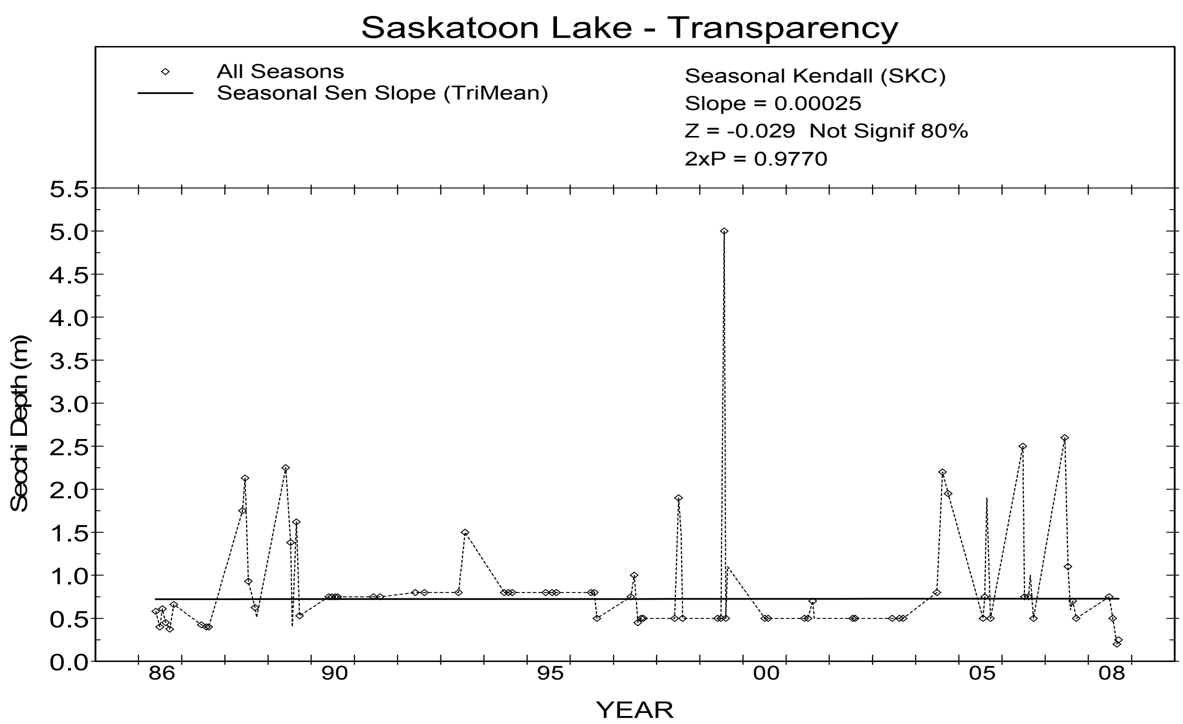
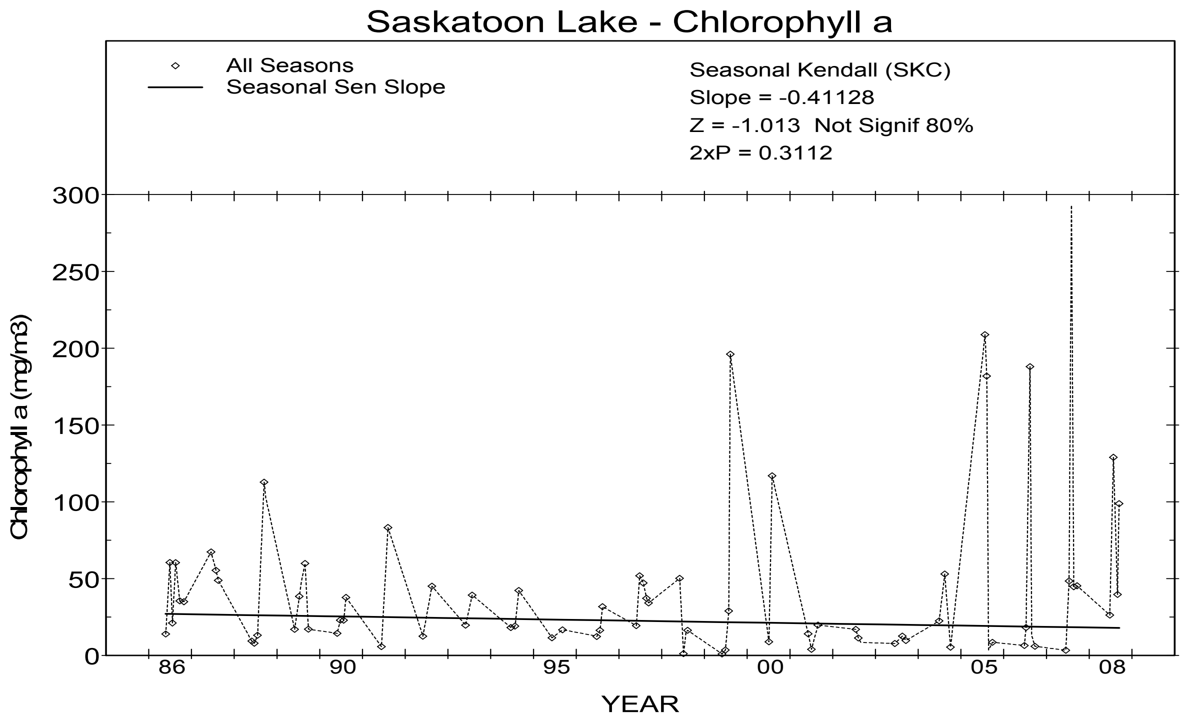


Figure 83 **Saskatoon Lake –** Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



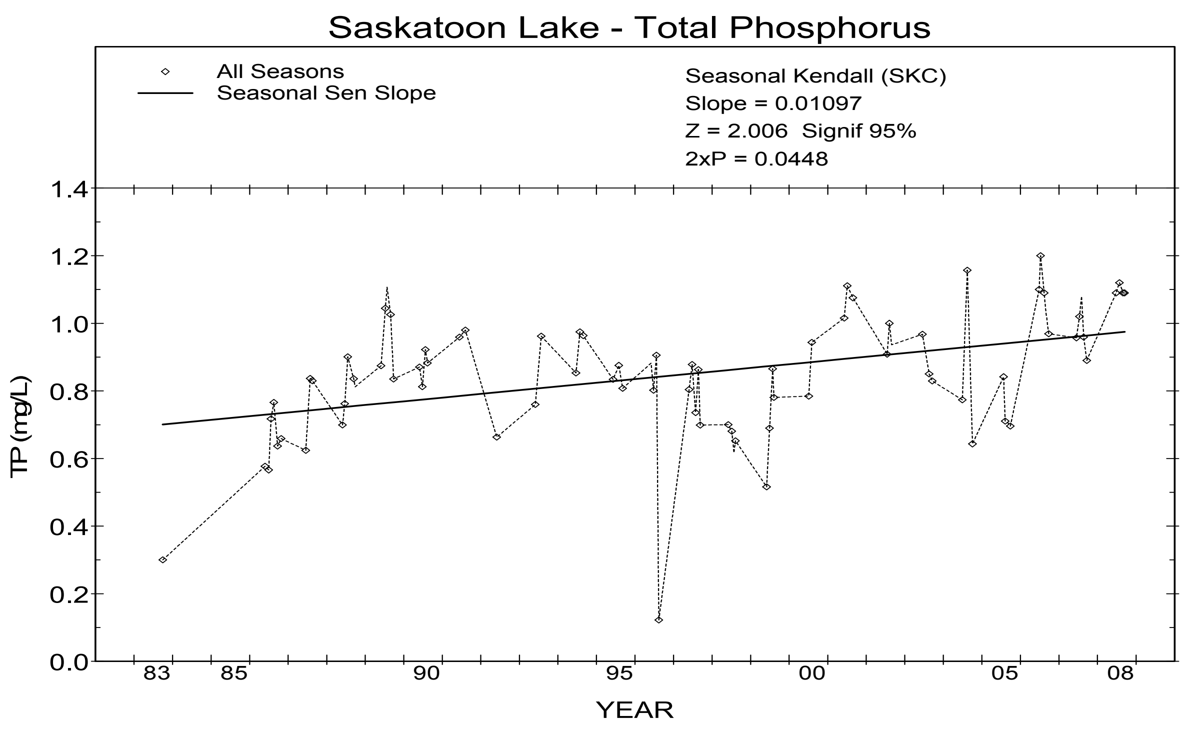
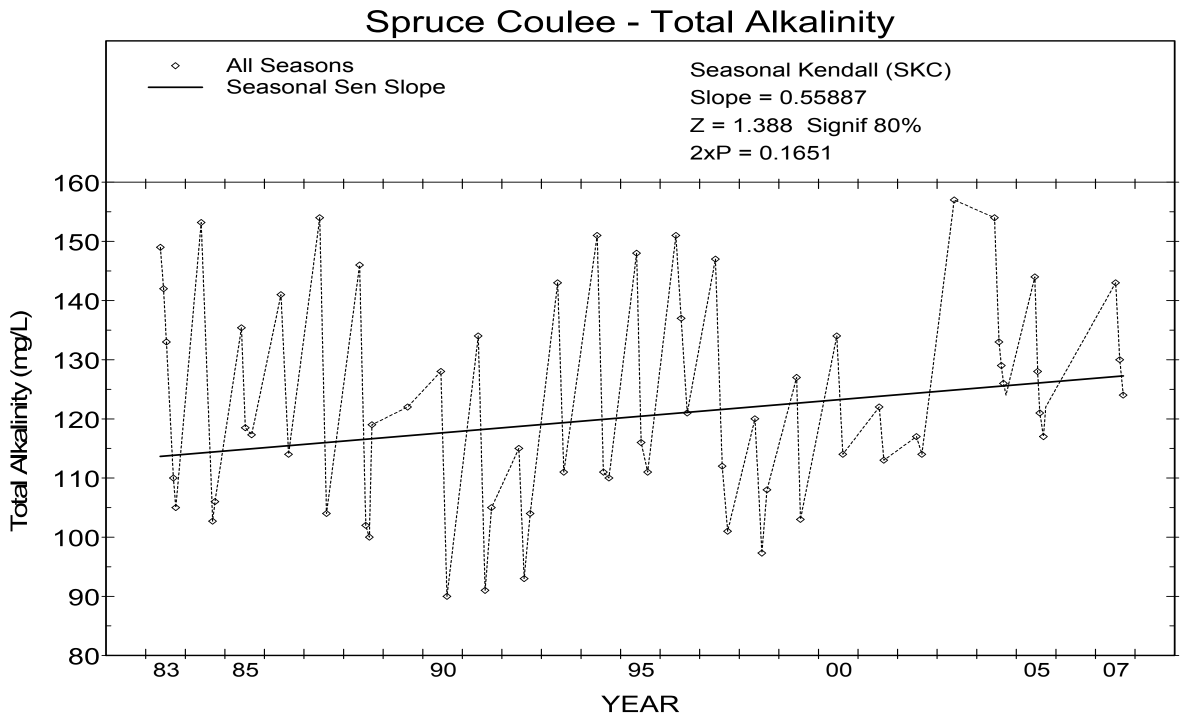


Figure 83 **Saskatoon Lake –** Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



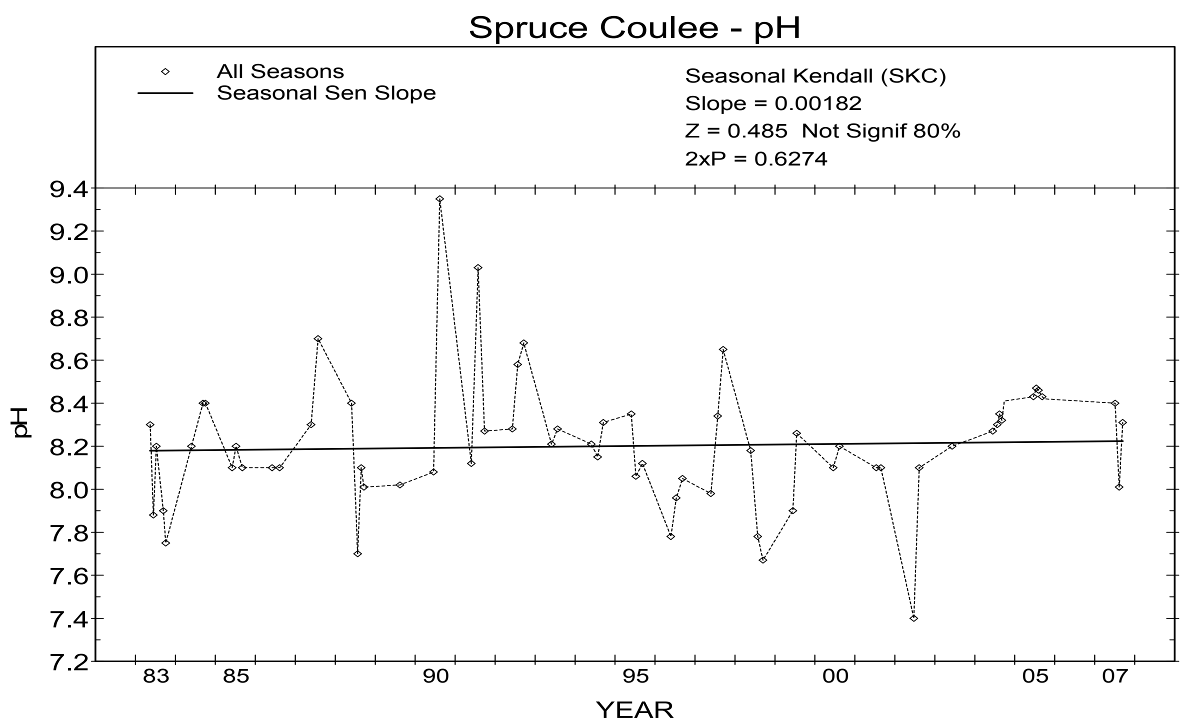
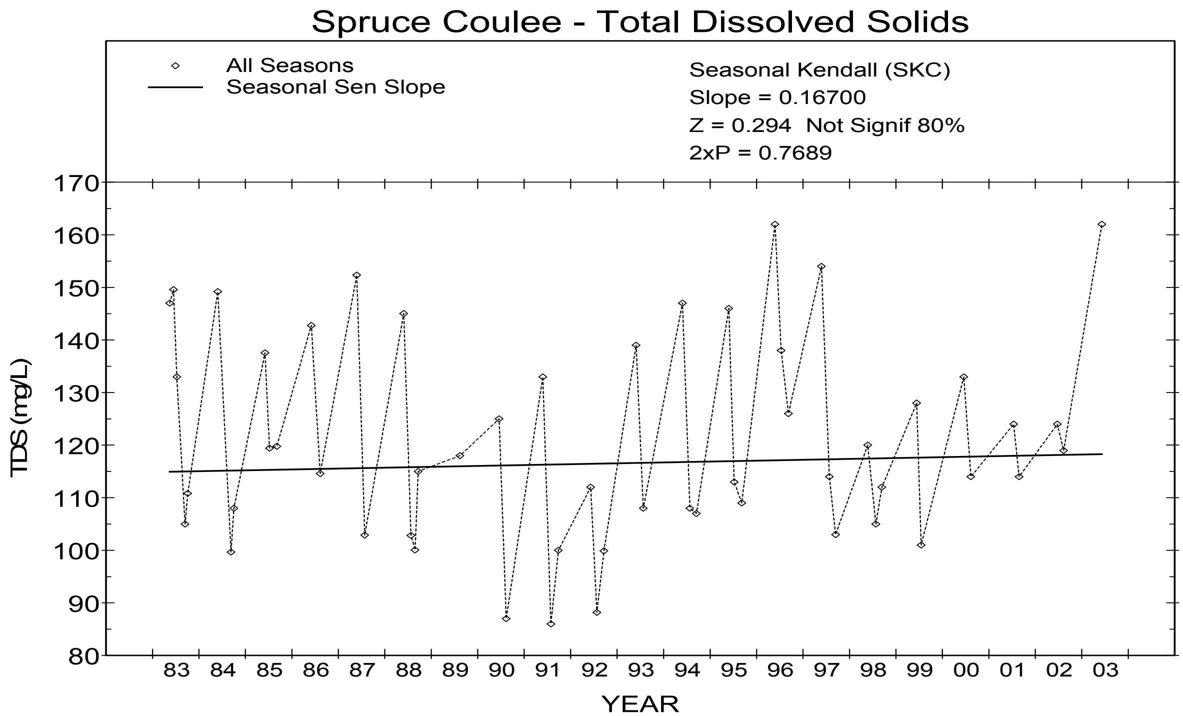


Figure 84 **Spruce Coulee –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



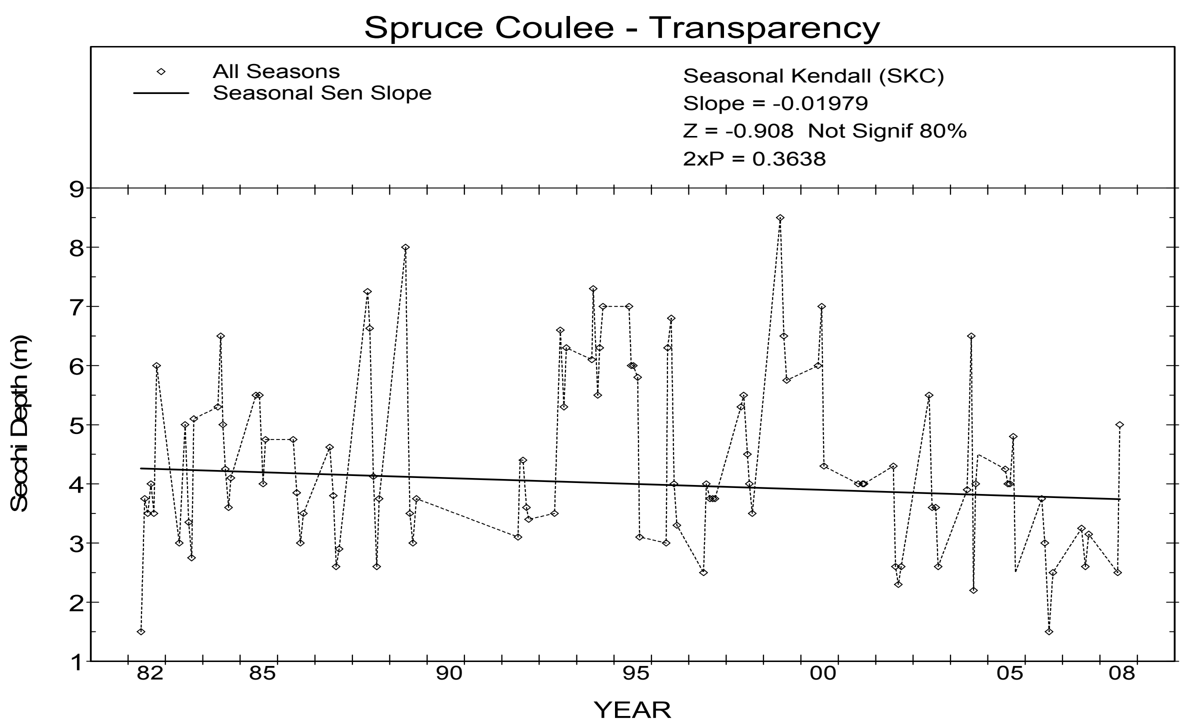
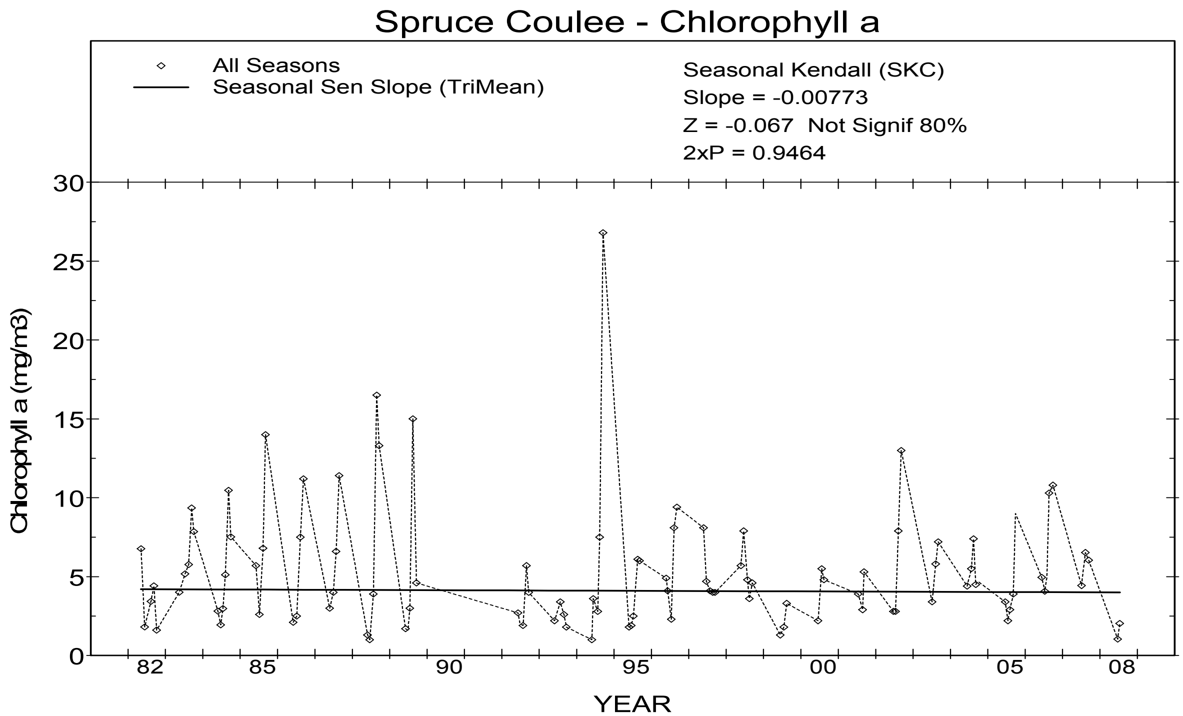


Figure 84 **Spruce Coulee** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



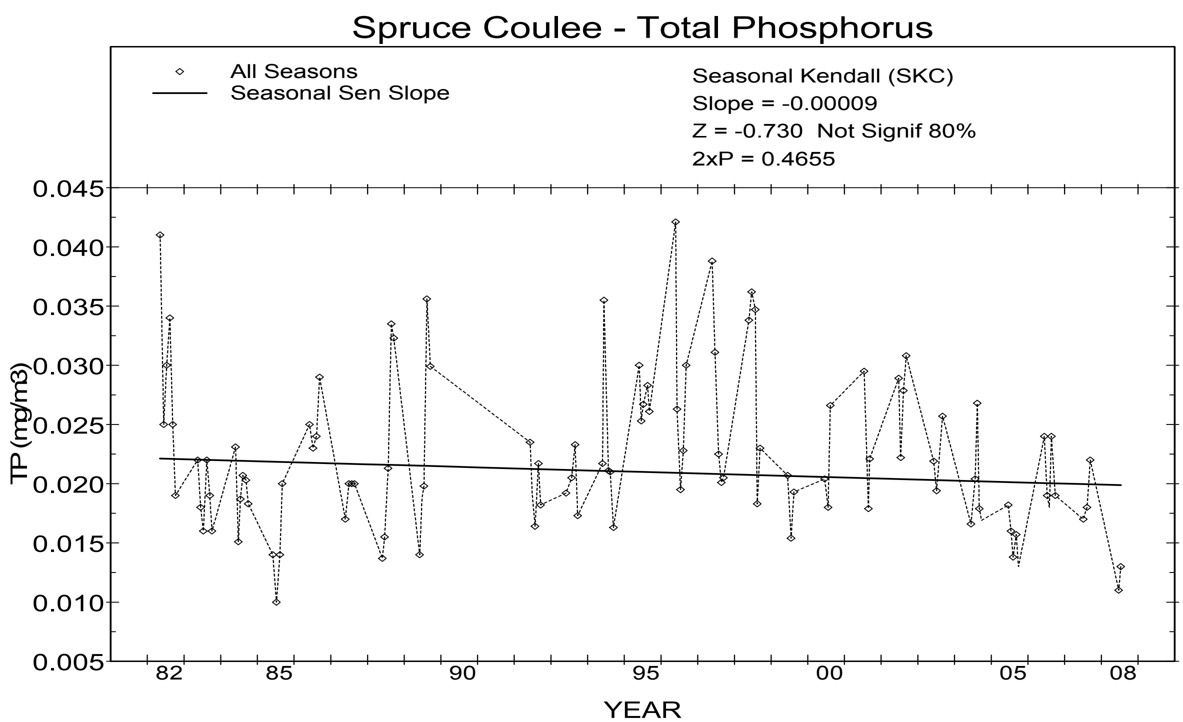
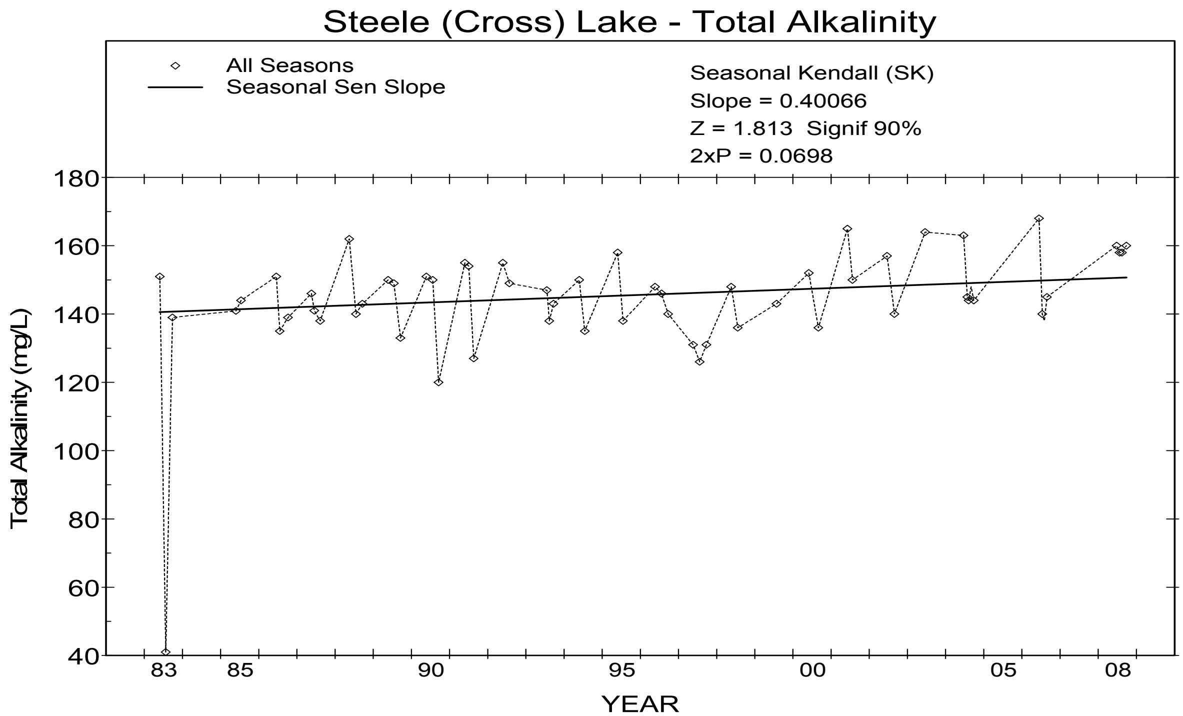


Figure 84 **Spruce Coulee –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



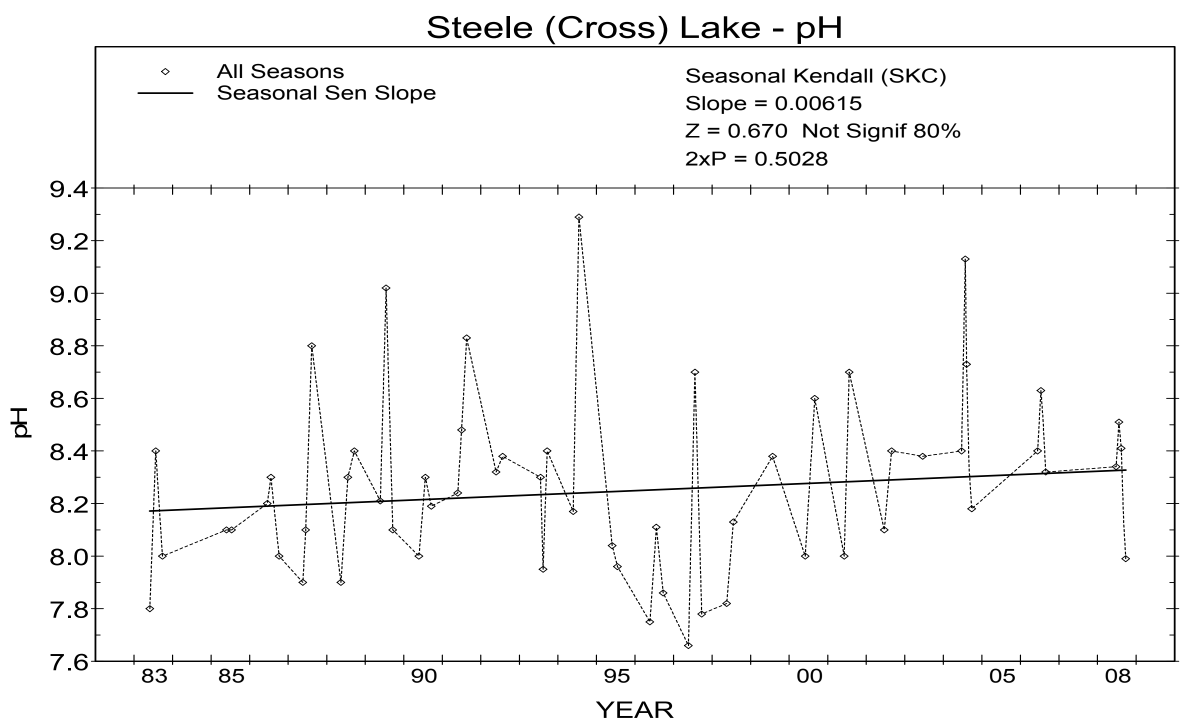
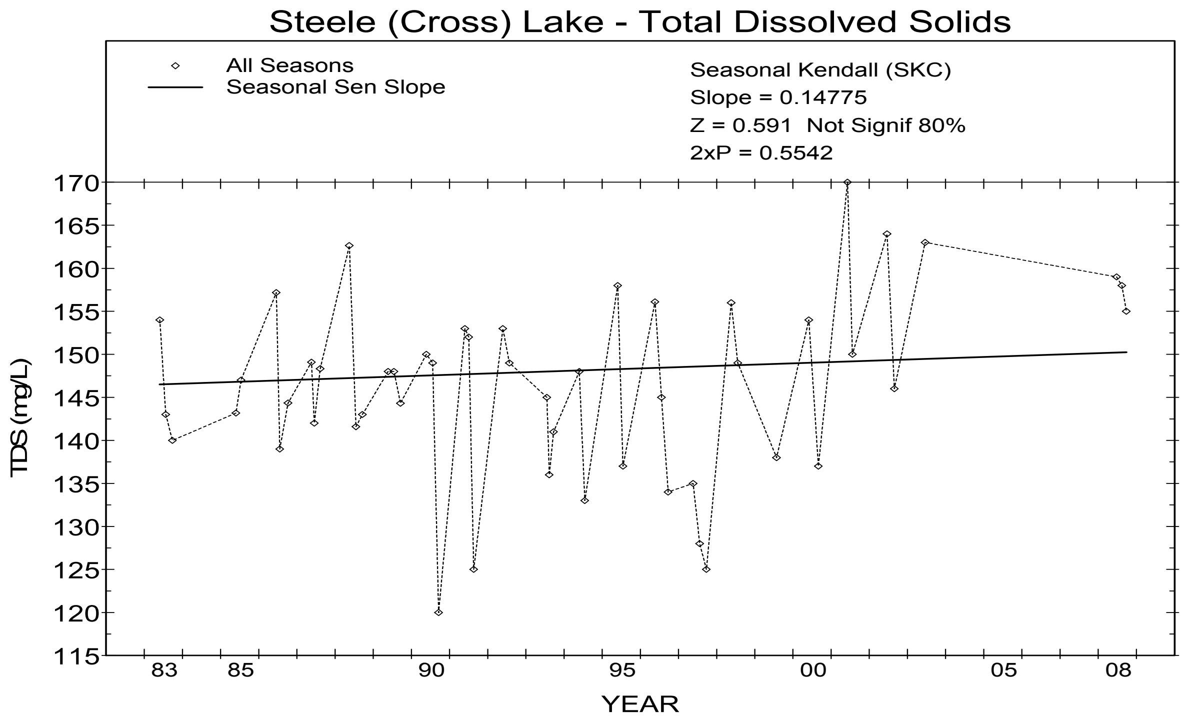


Figure 85 **Steele (Cross) Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



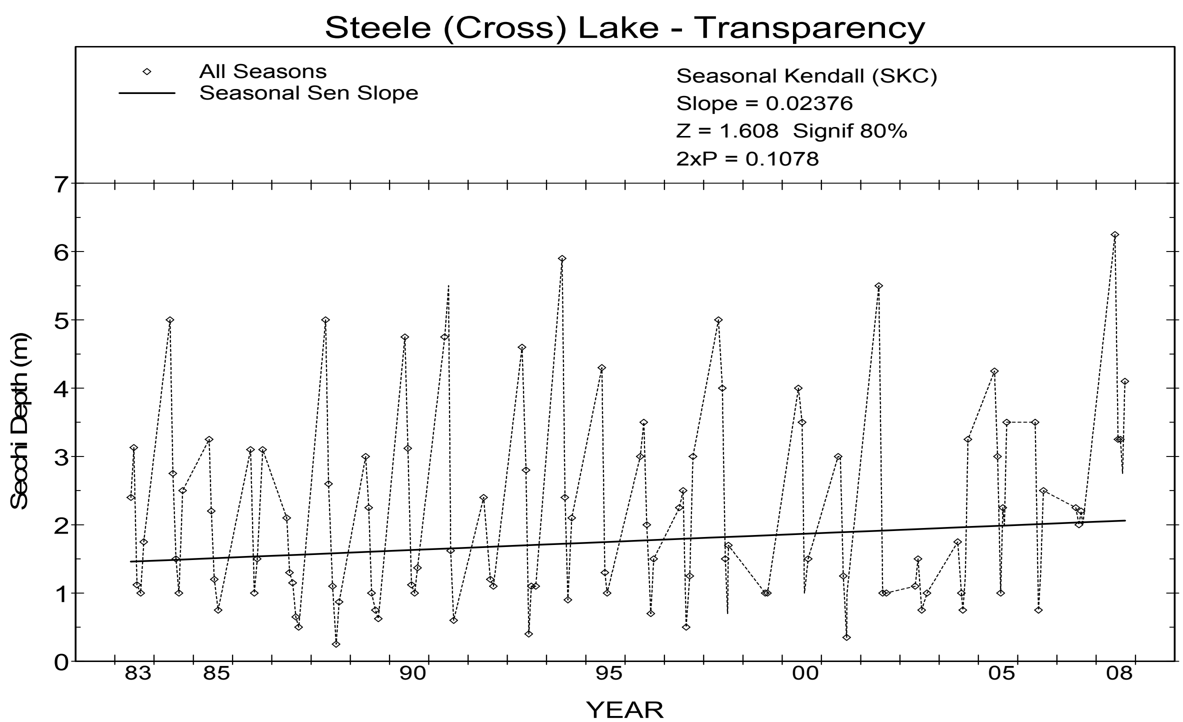
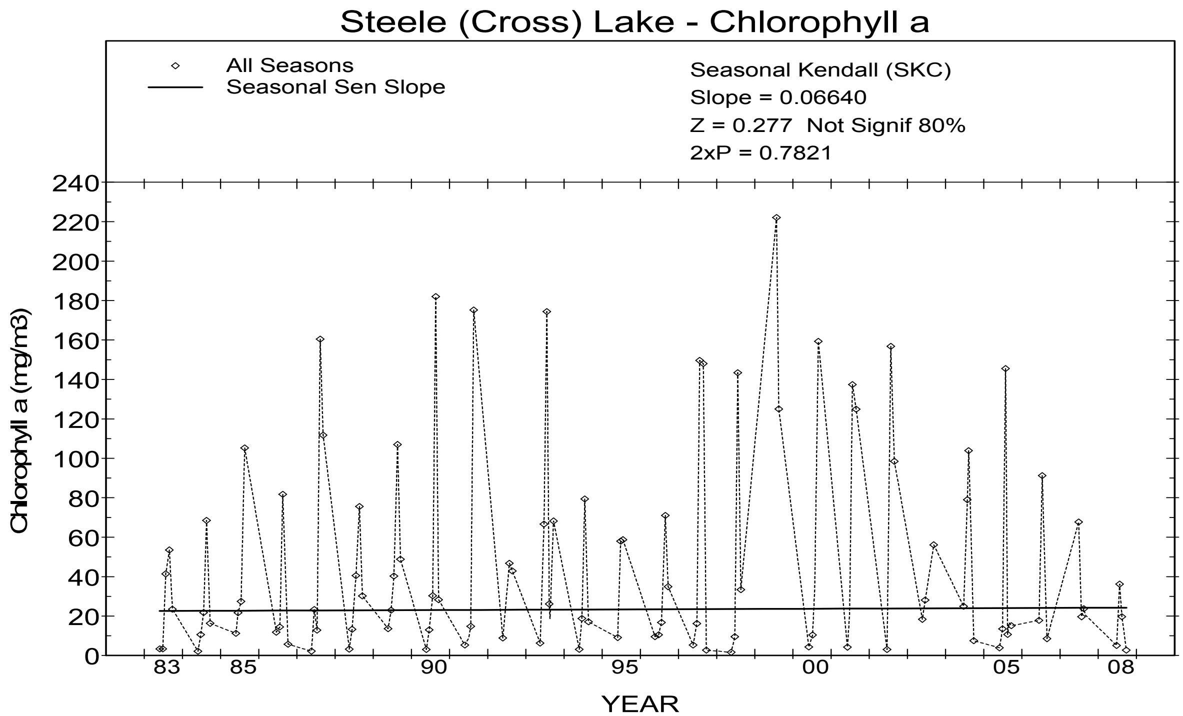


Figure 85 **Steele (Cross) Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



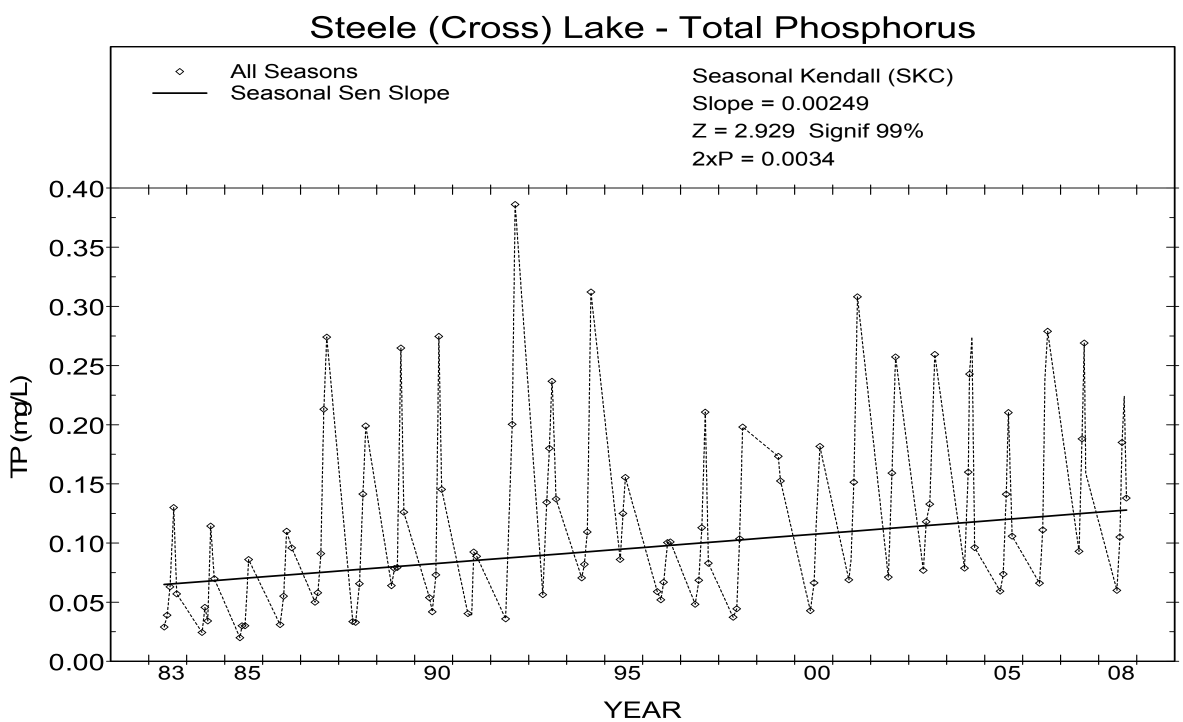
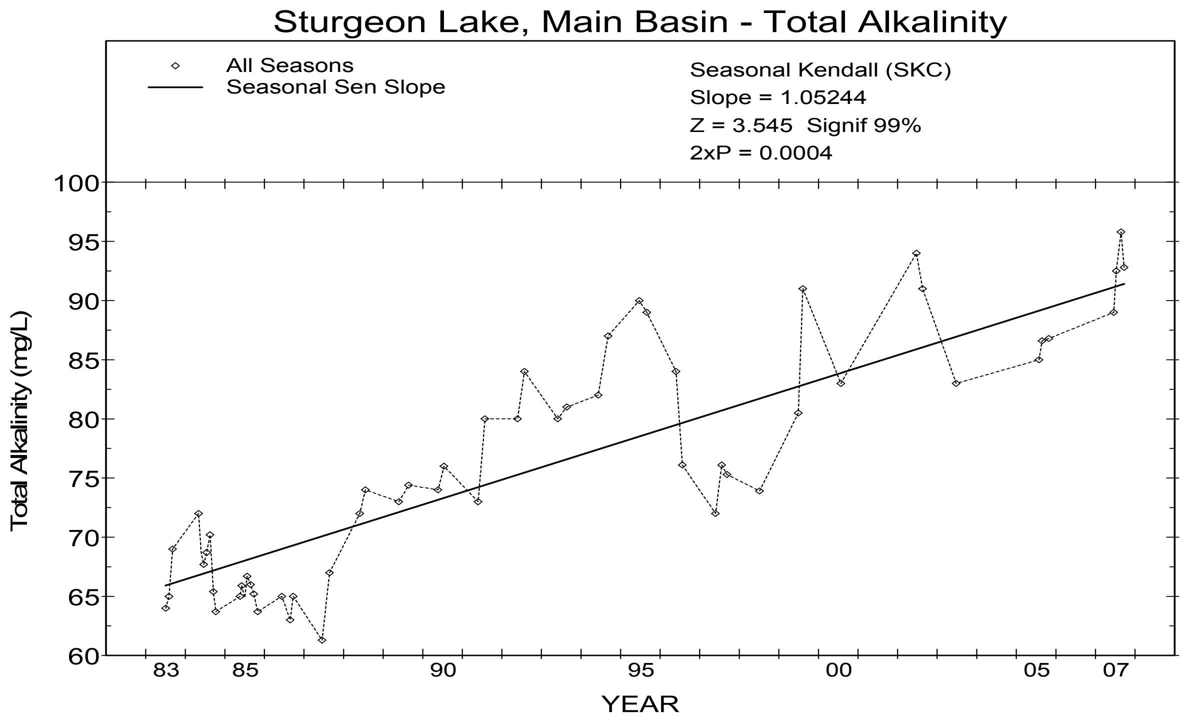


Figure 85 **Steele (Cross) Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



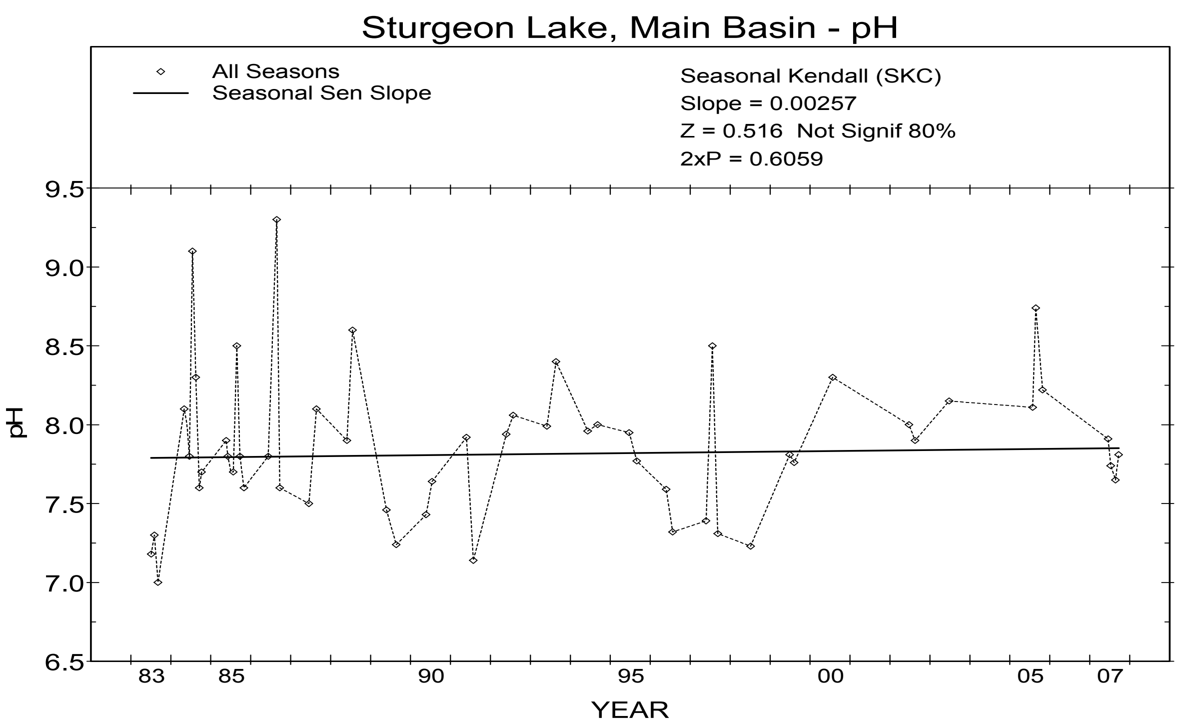
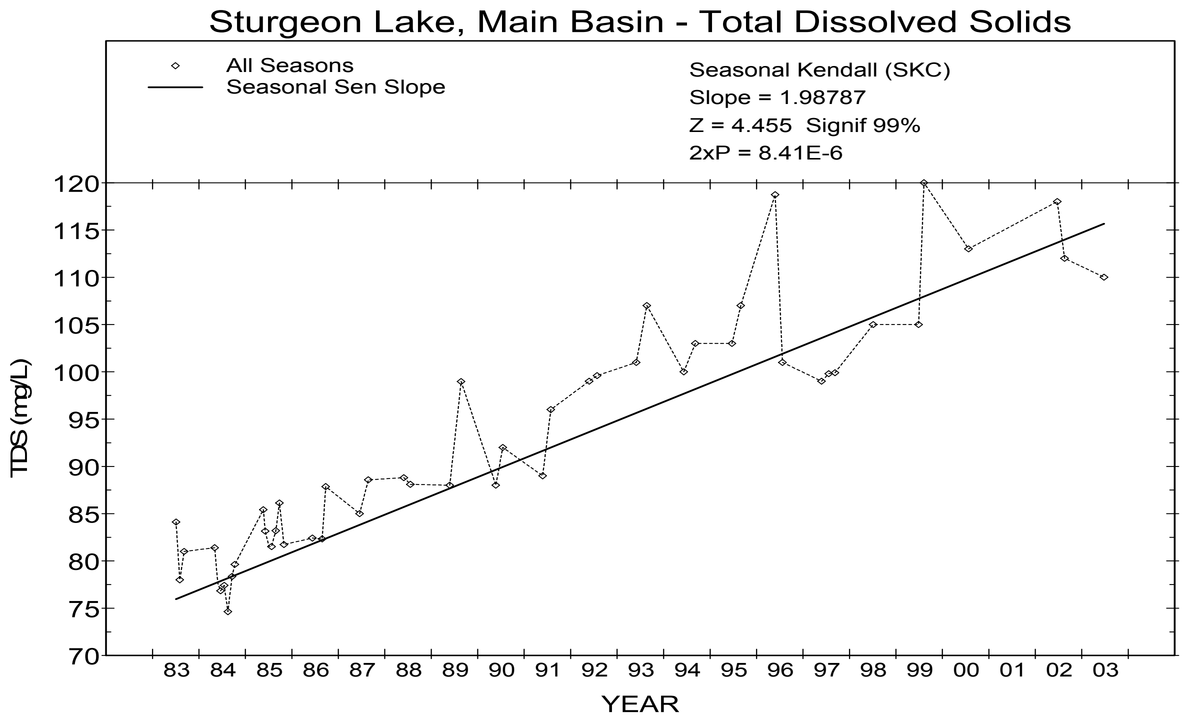


Figure 86 **Sturgeon Lake, Main Basin** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



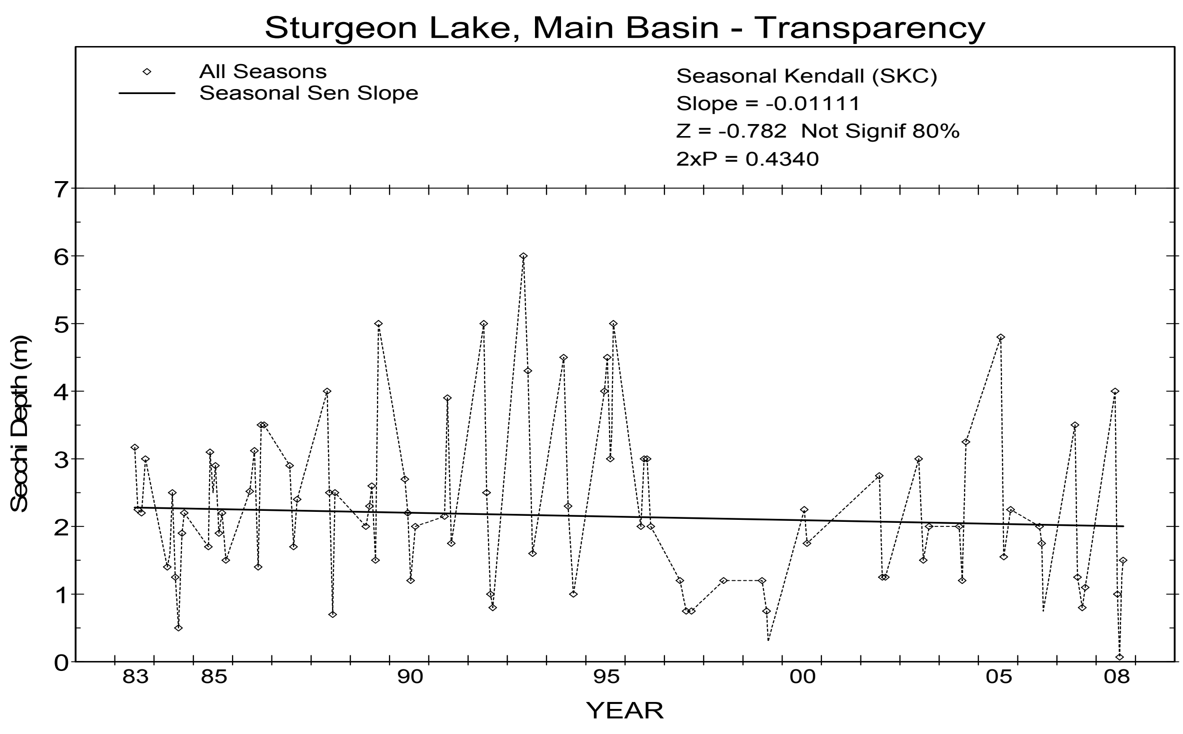
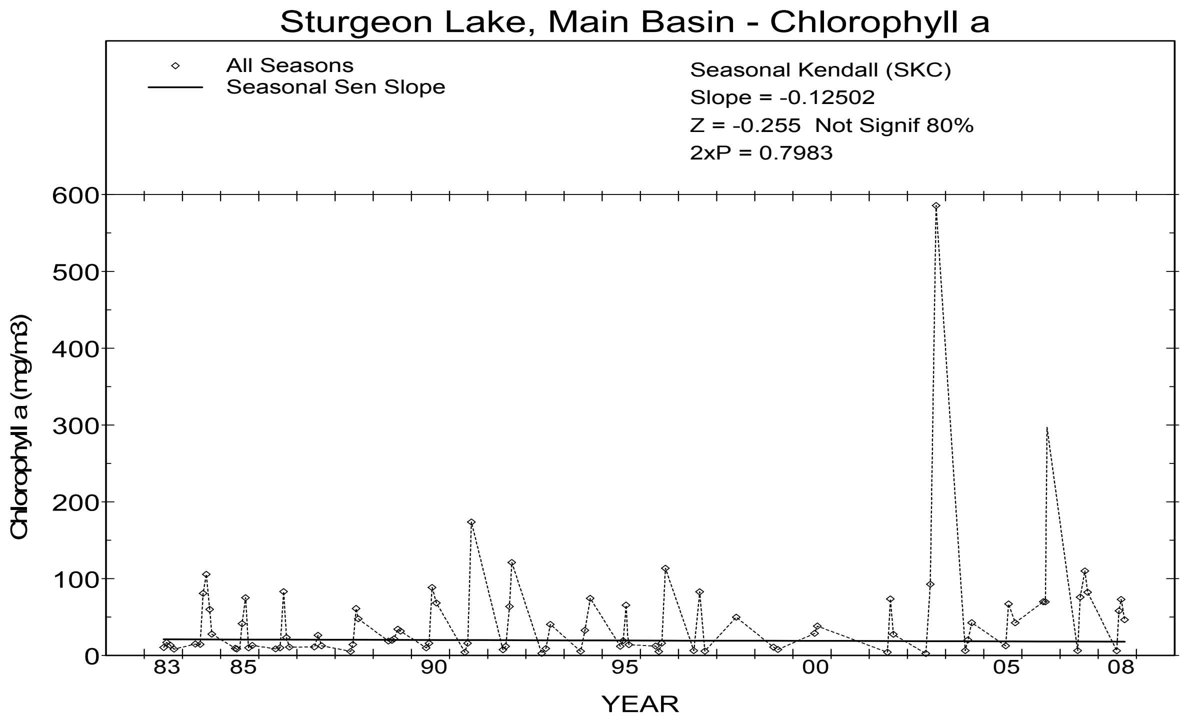


Figure 86 **Sturgeon Lake, Main Basin** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



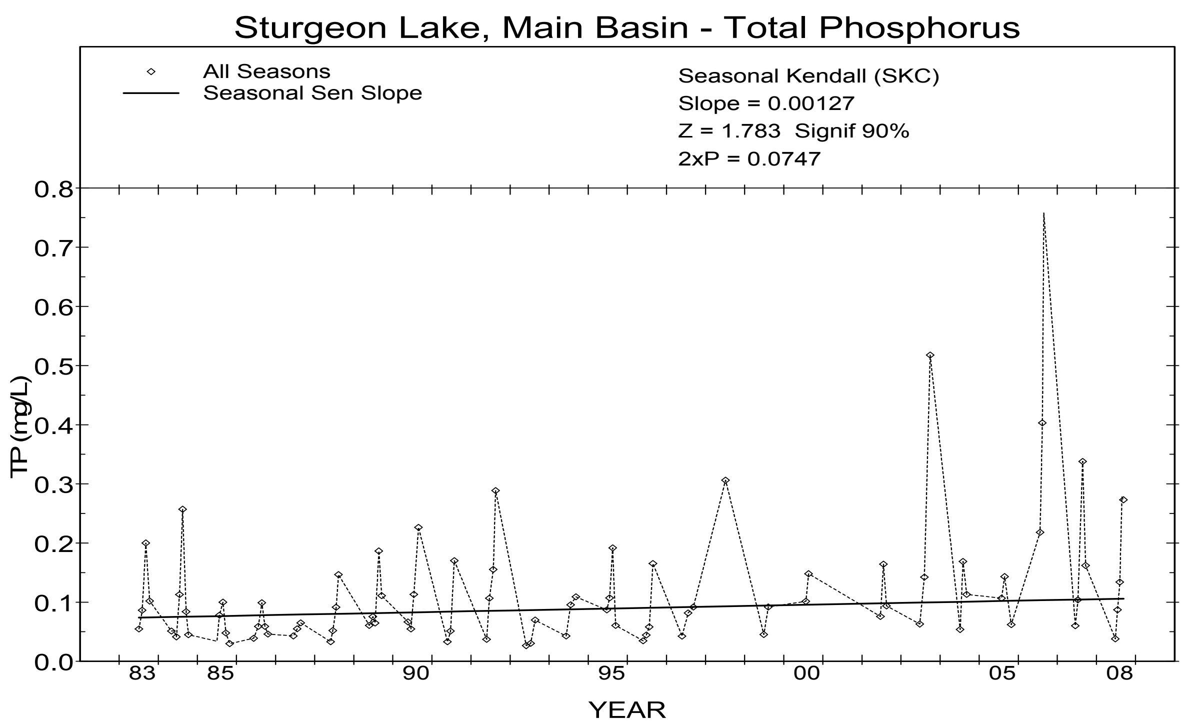
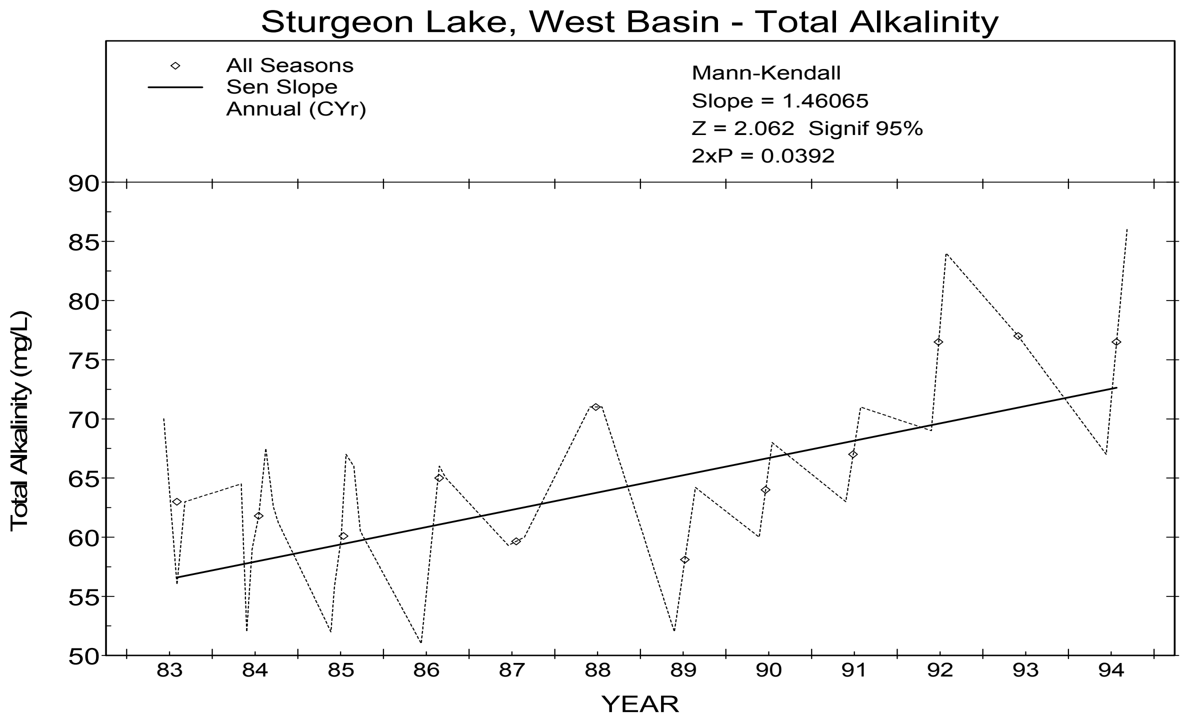


Figure 86 **Sturgeon Lake, Main Basin** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



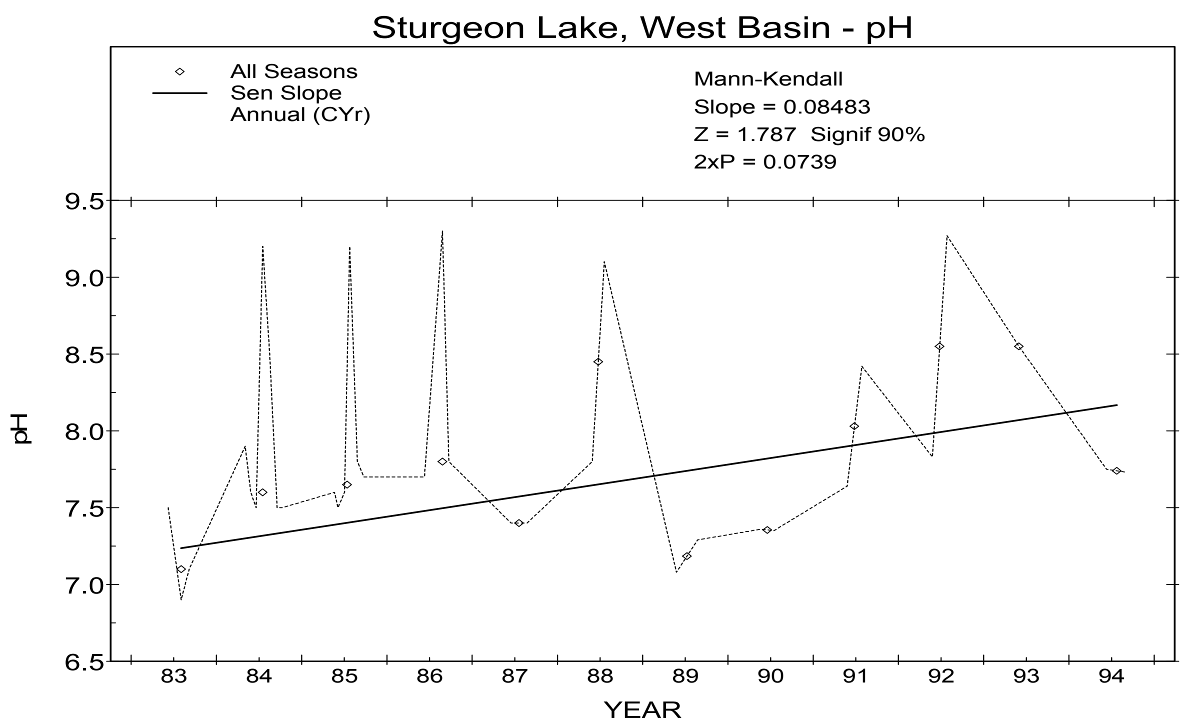
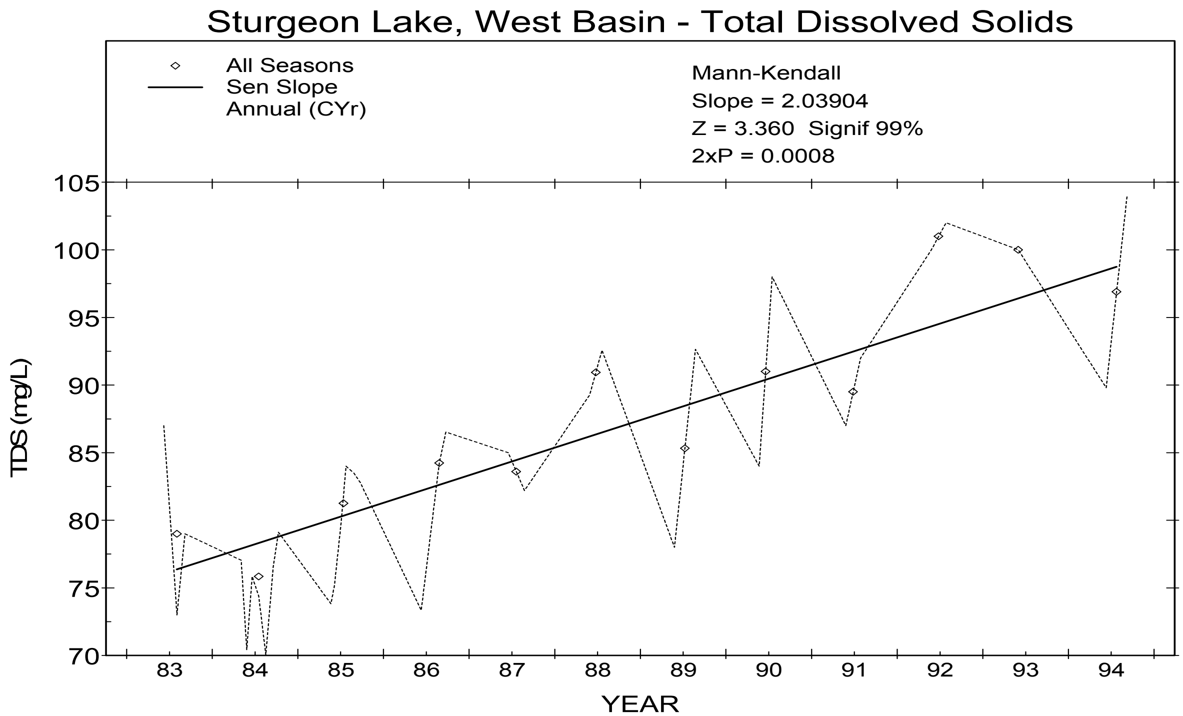


Figure 87 **Sturgeon Lake, West Basin** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



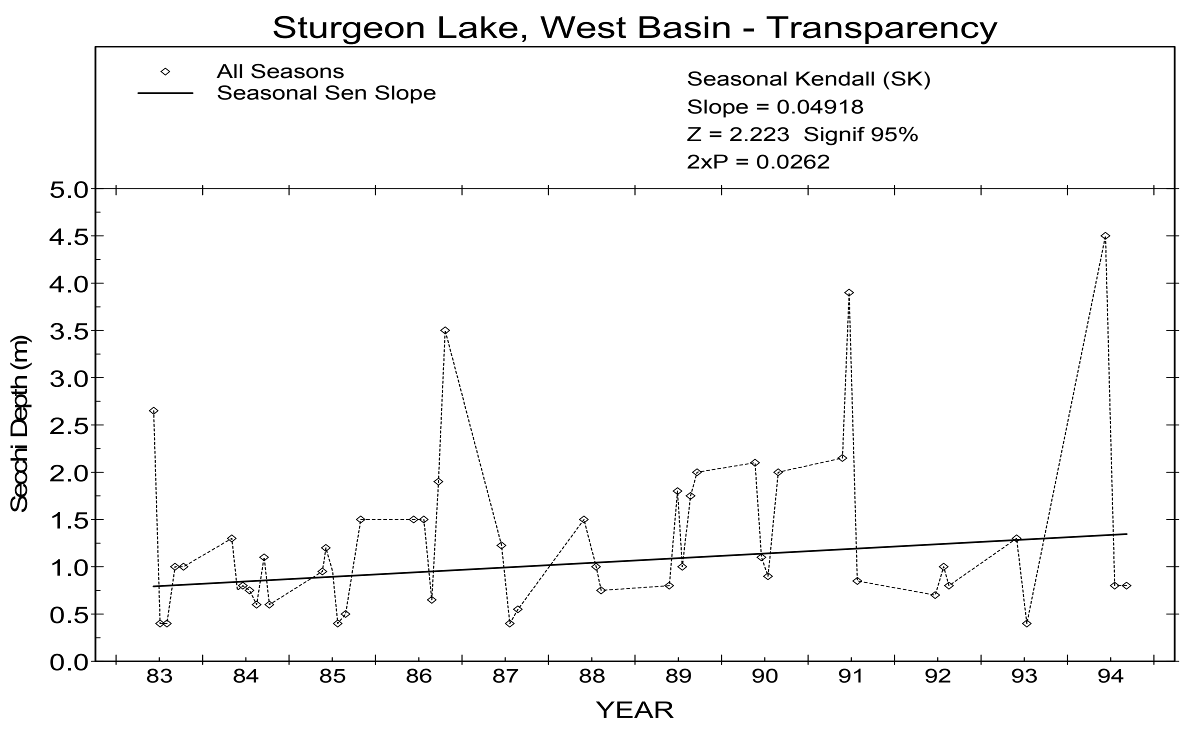
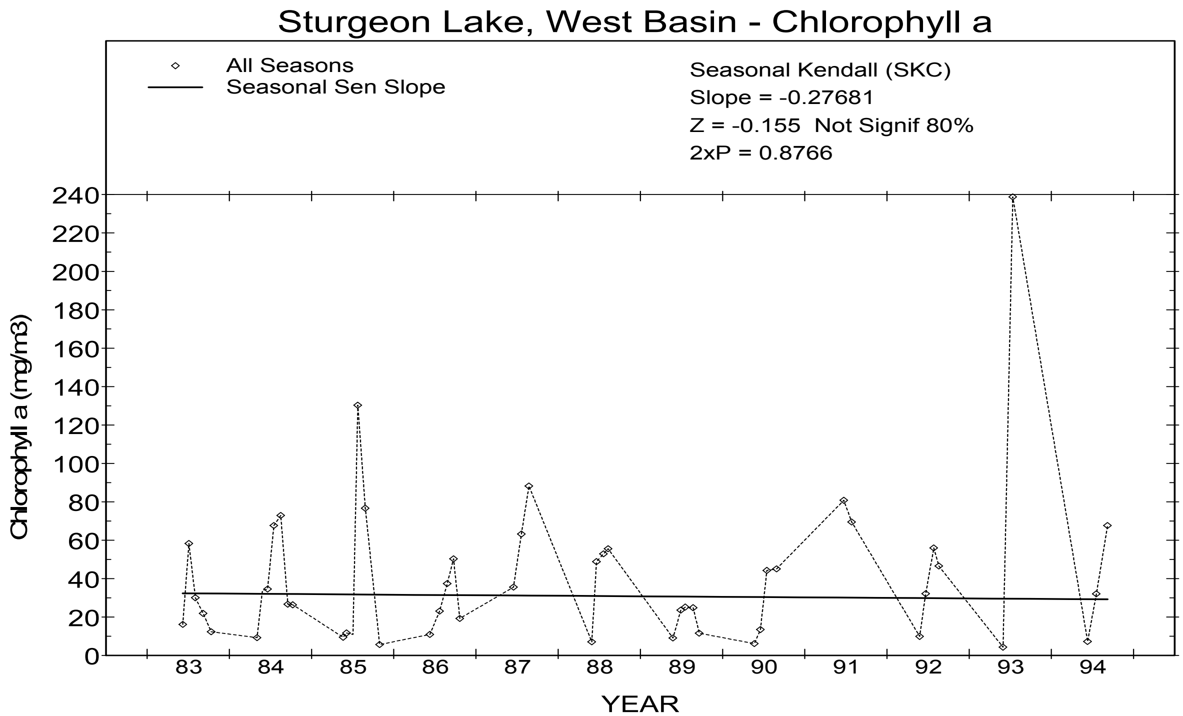


Figure 87 **Sturgeon Lake, West Basin** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



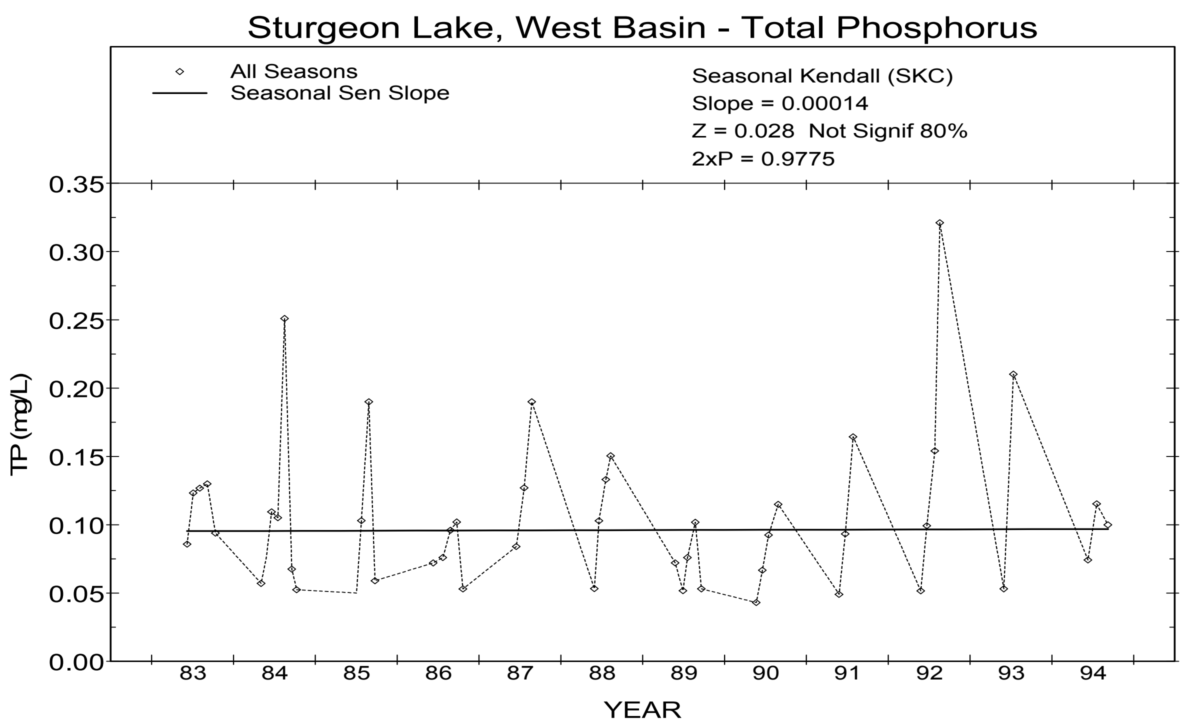
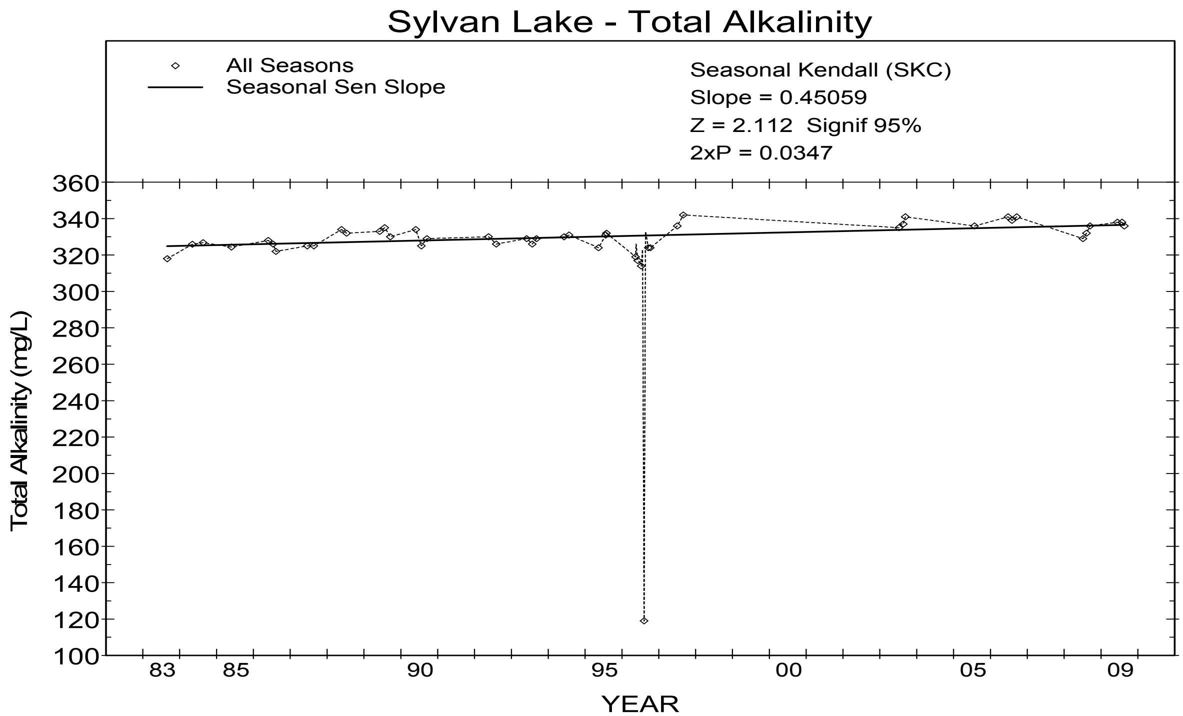


Figure 87 **Sturgeon Lake, West Basin** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



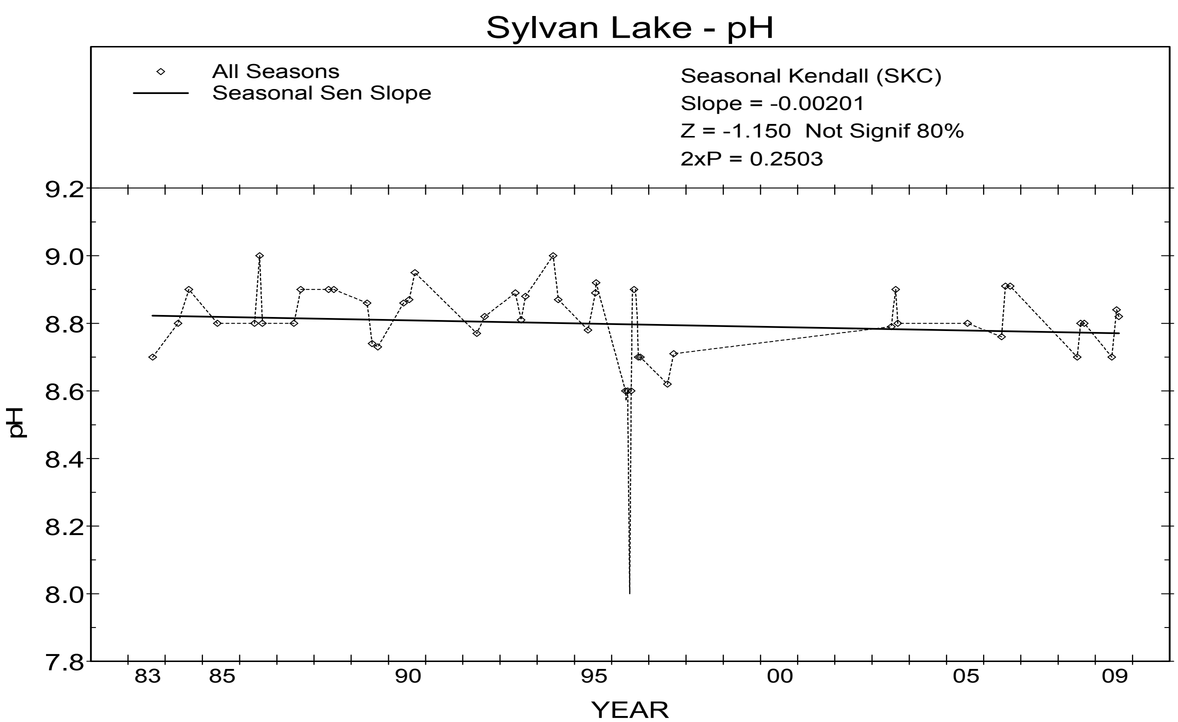
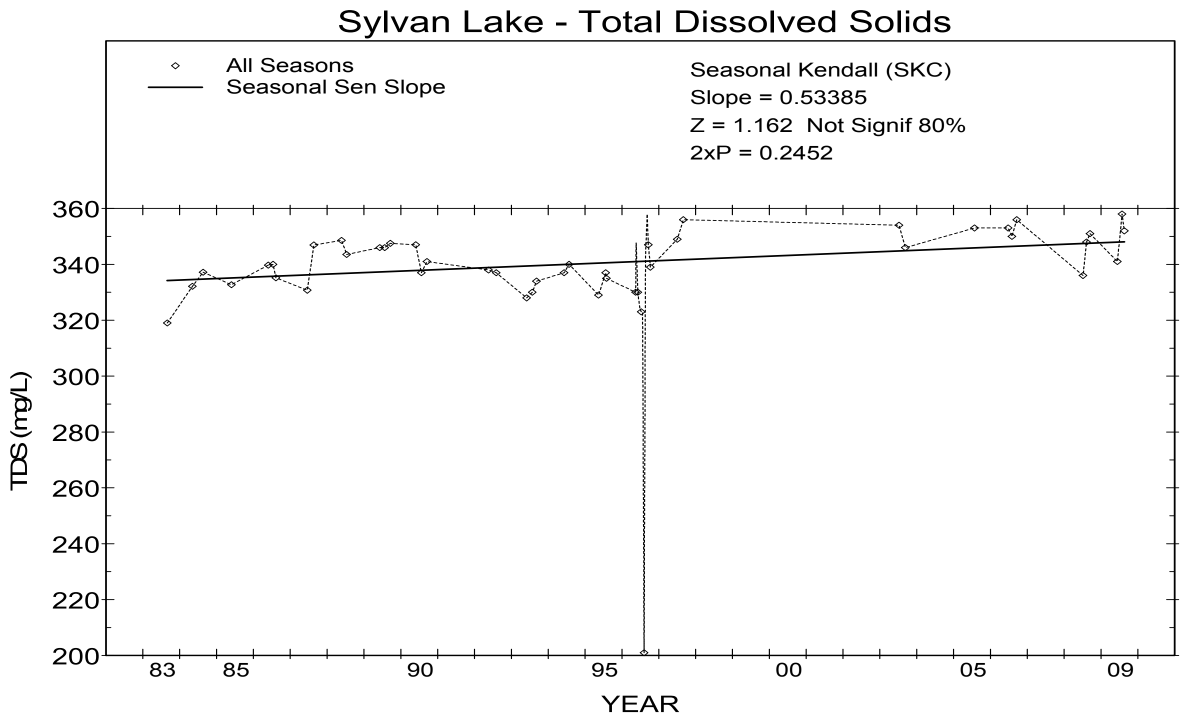


Figure 88 **Sylvan Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



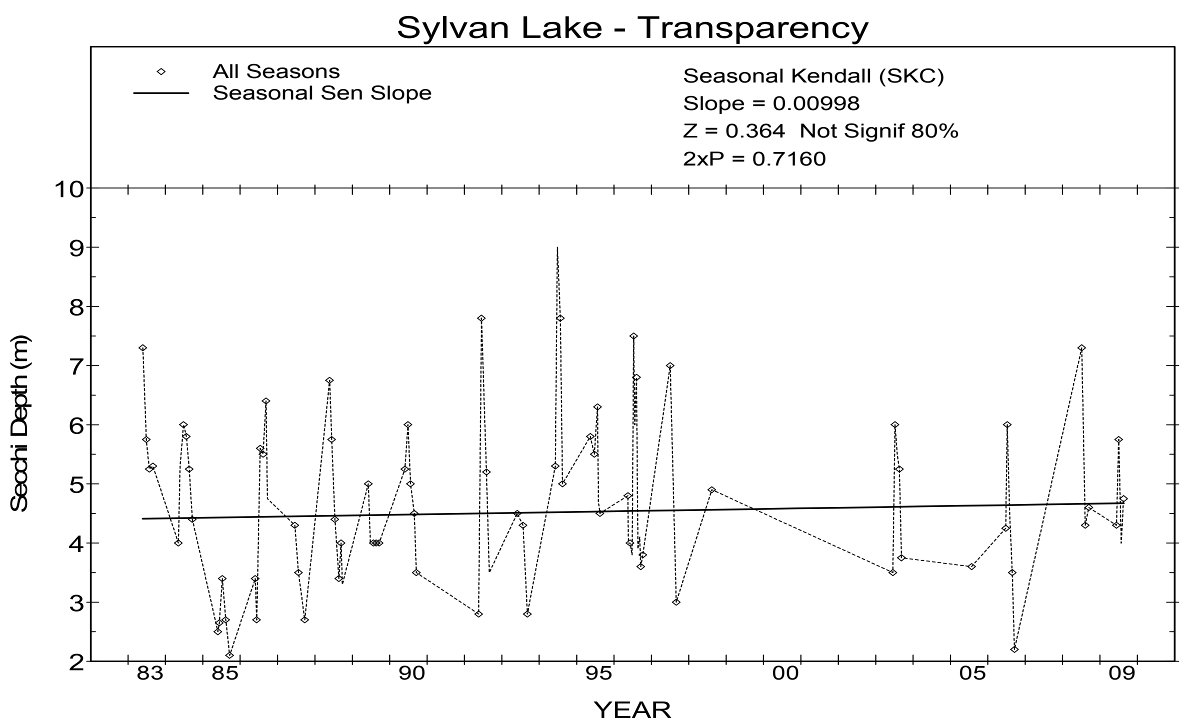
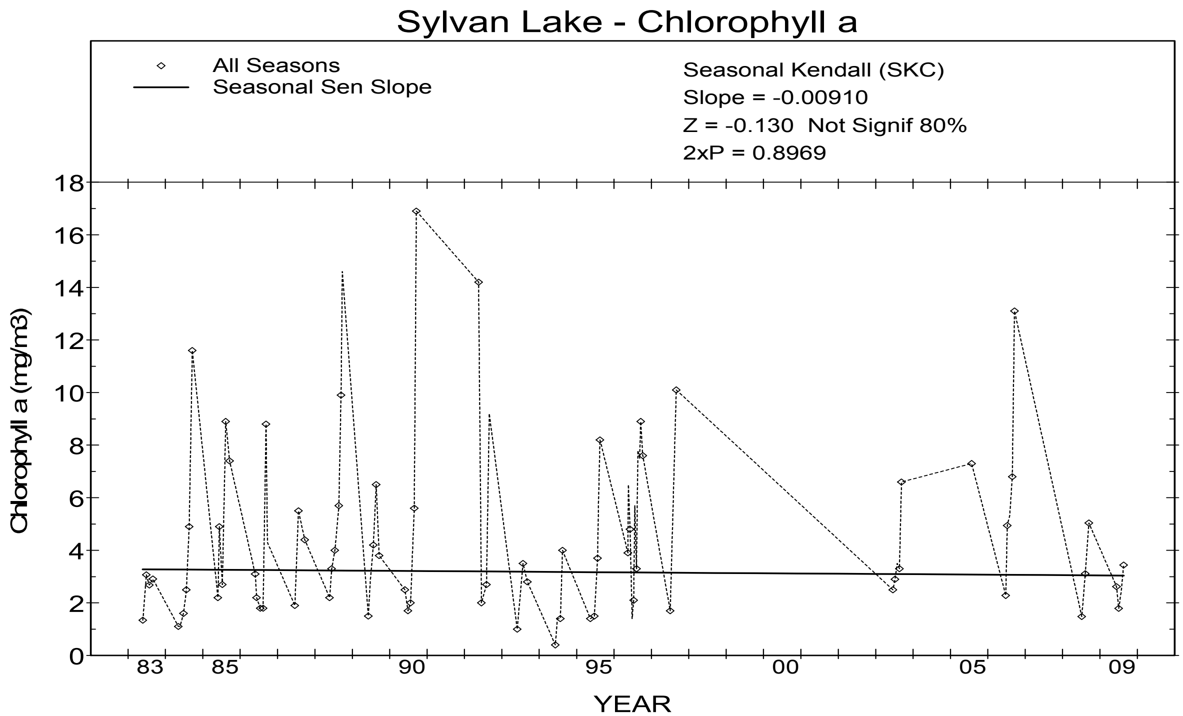


Figure 88 **Sylvan Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



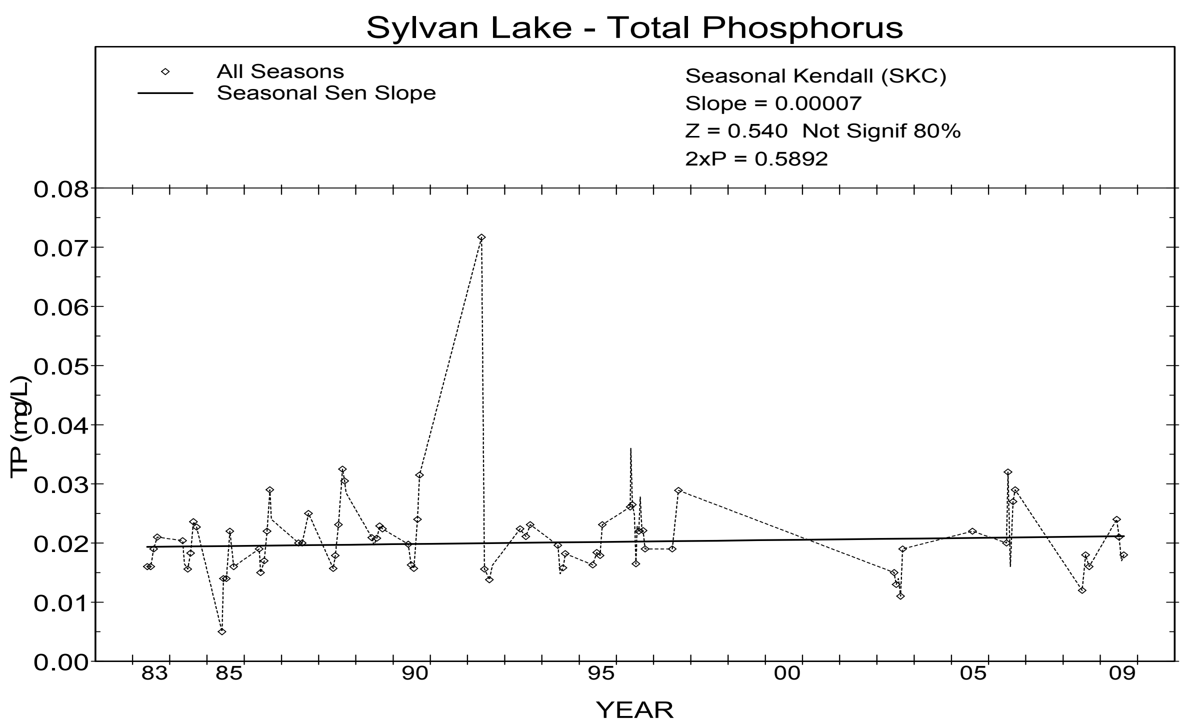
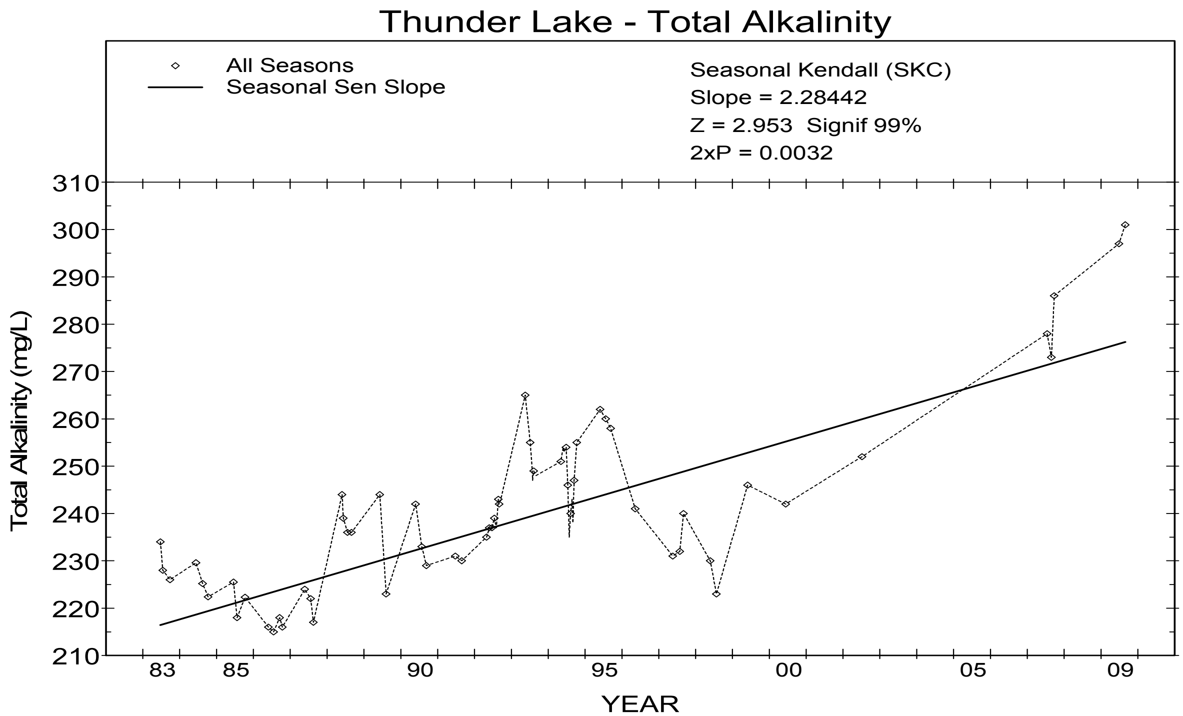


Figure 88 **Sylvan Lake –** Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



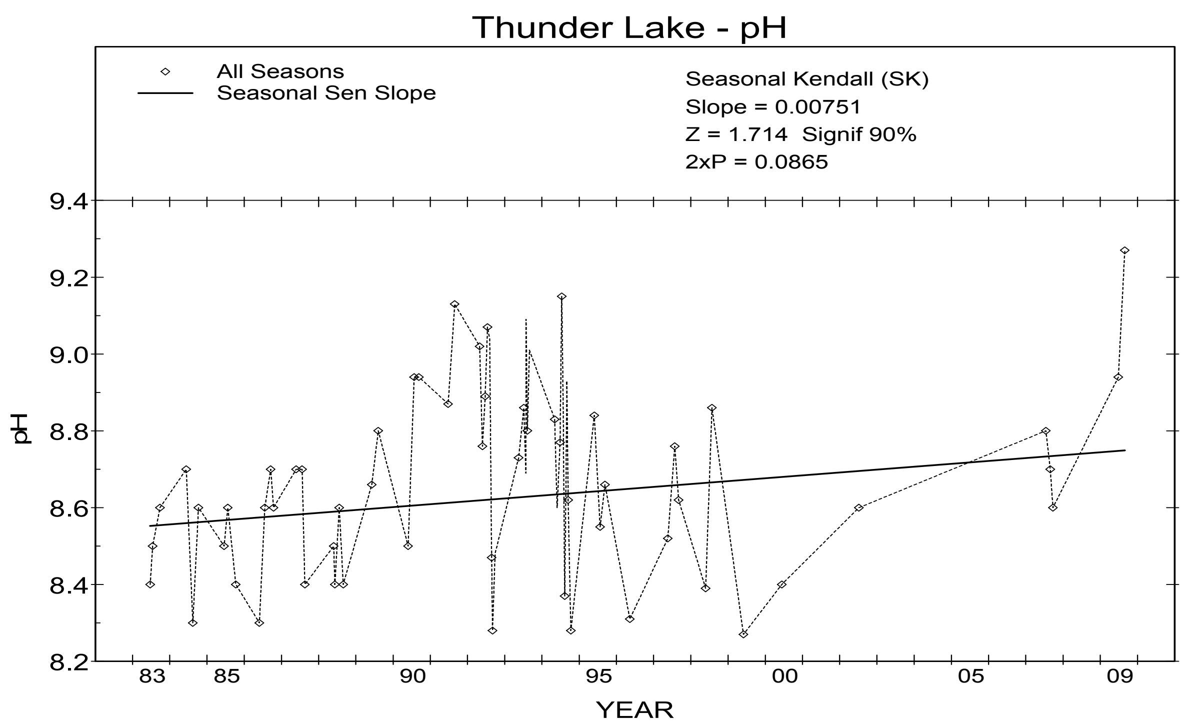
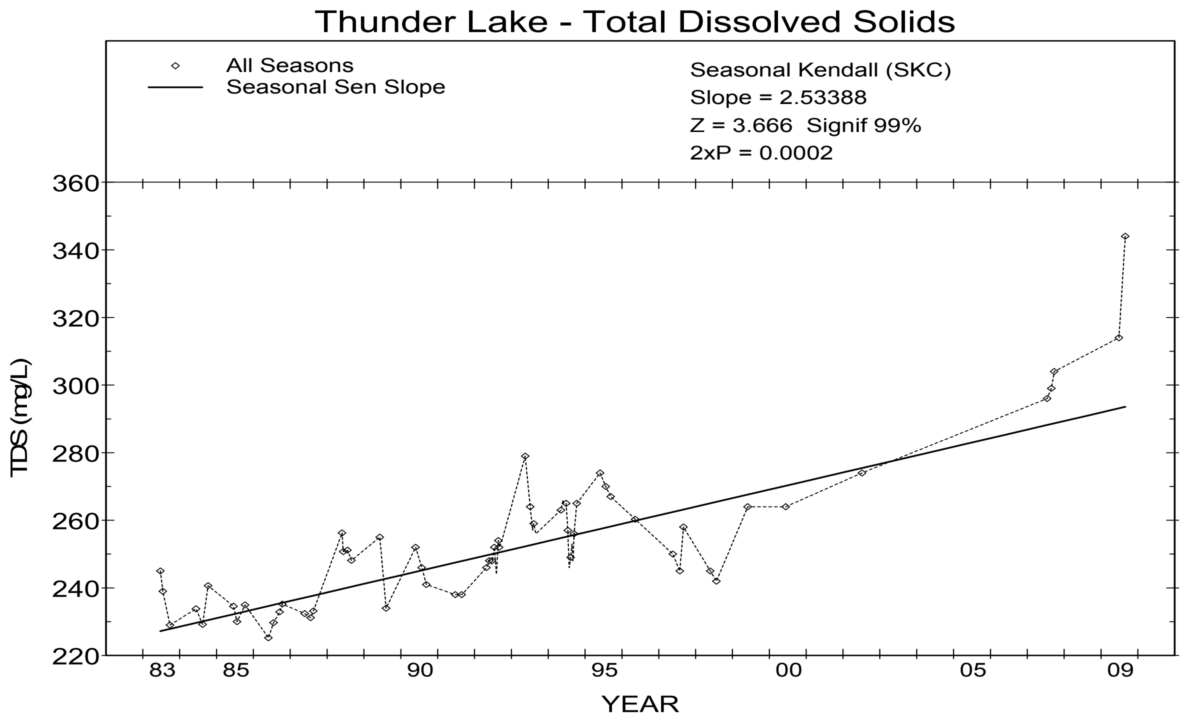


Figure 89 **Thunder Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



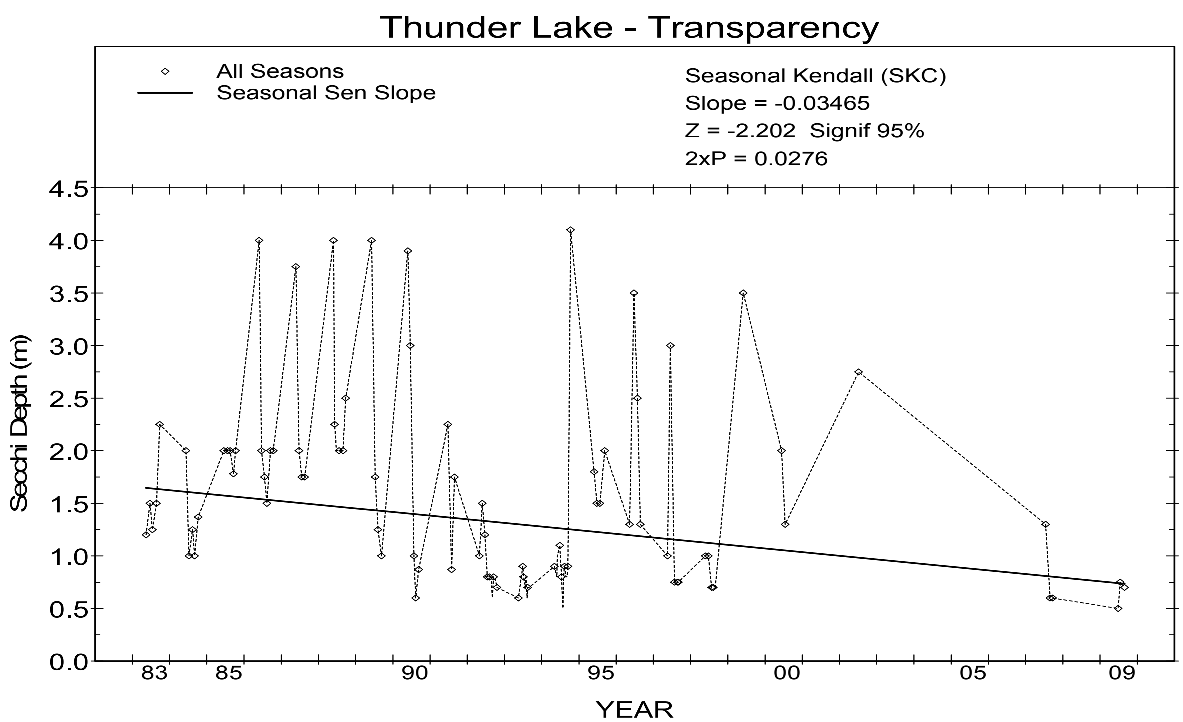
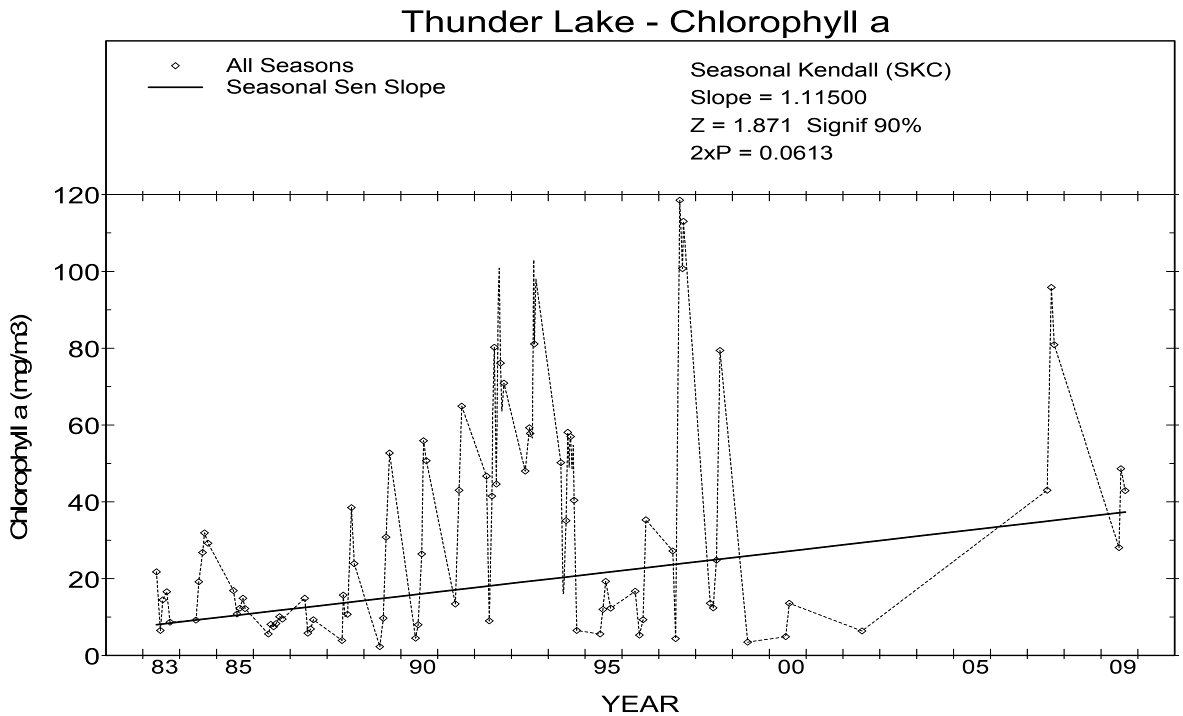


Figure 89 **Thunder Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



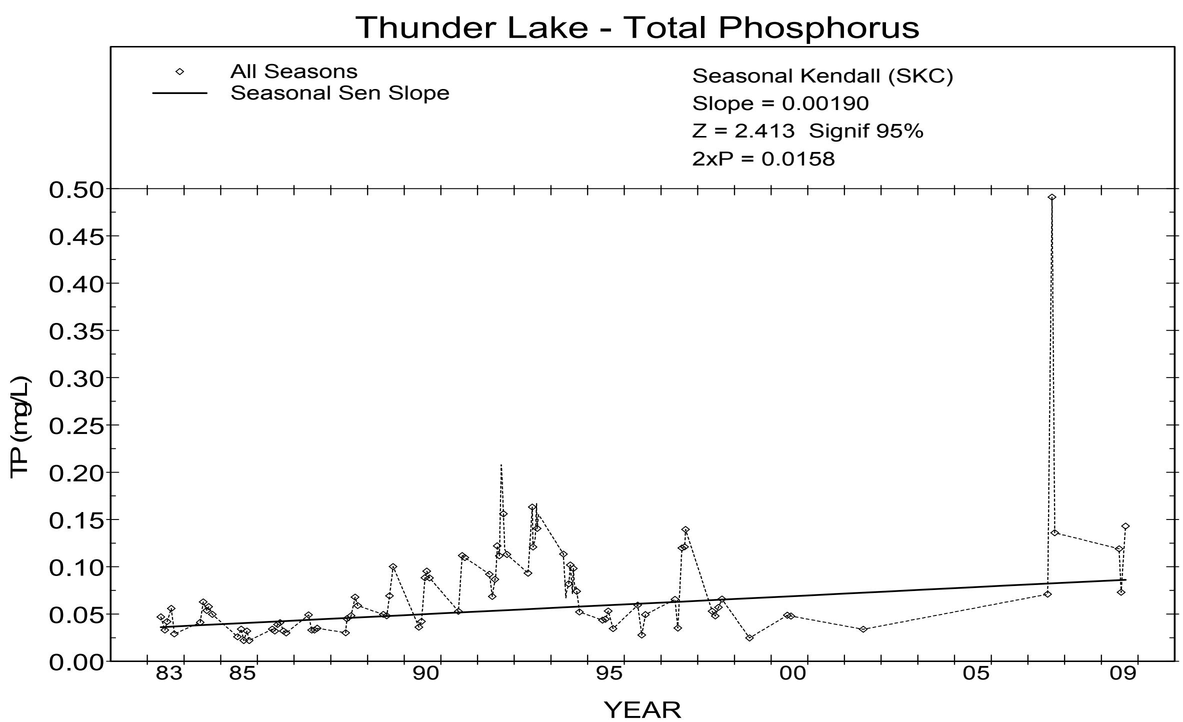
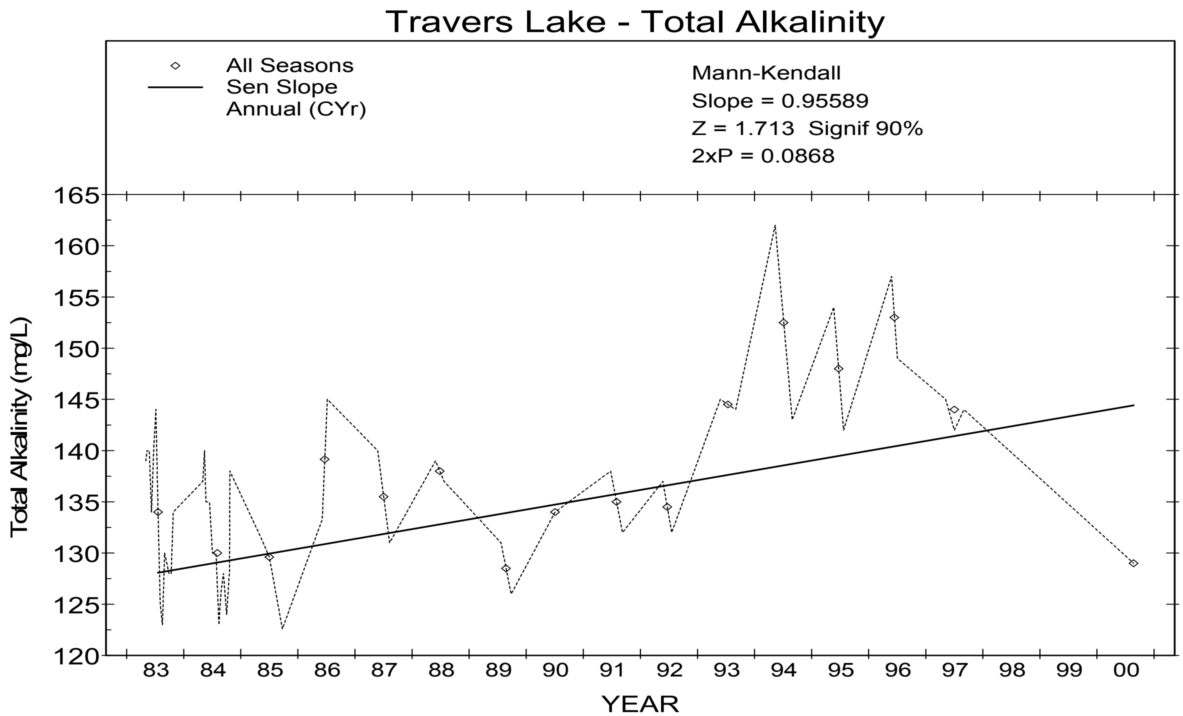


Figure 89 **Thunder Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



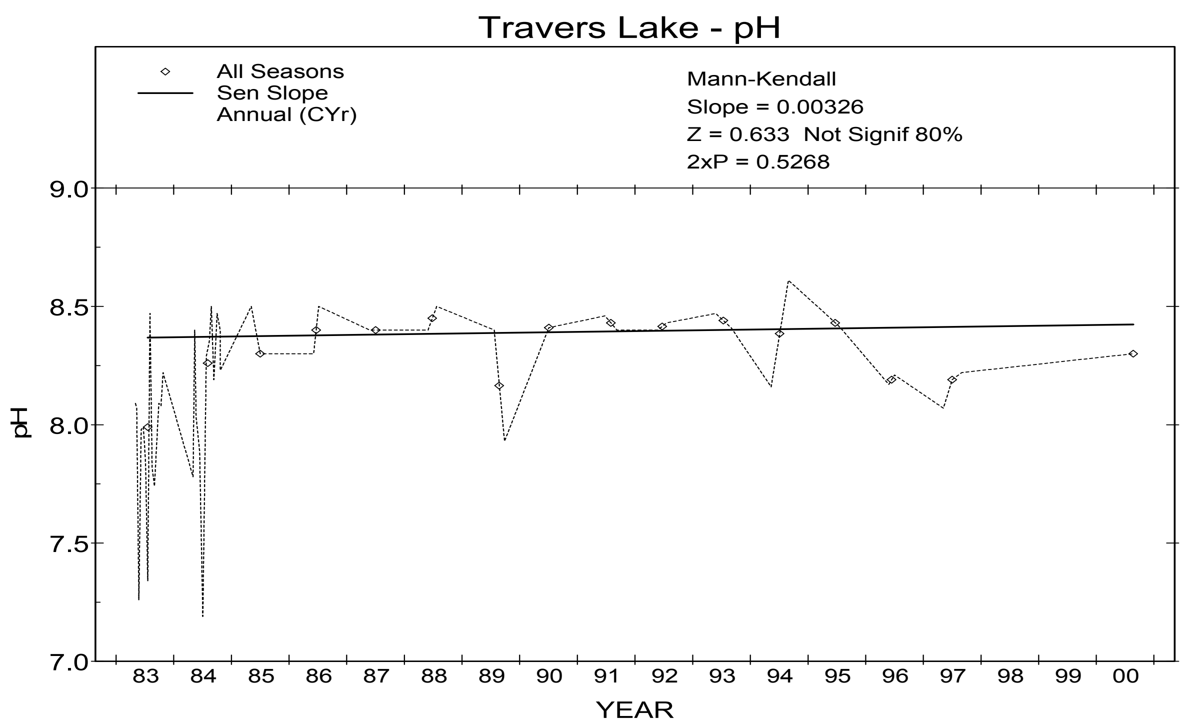
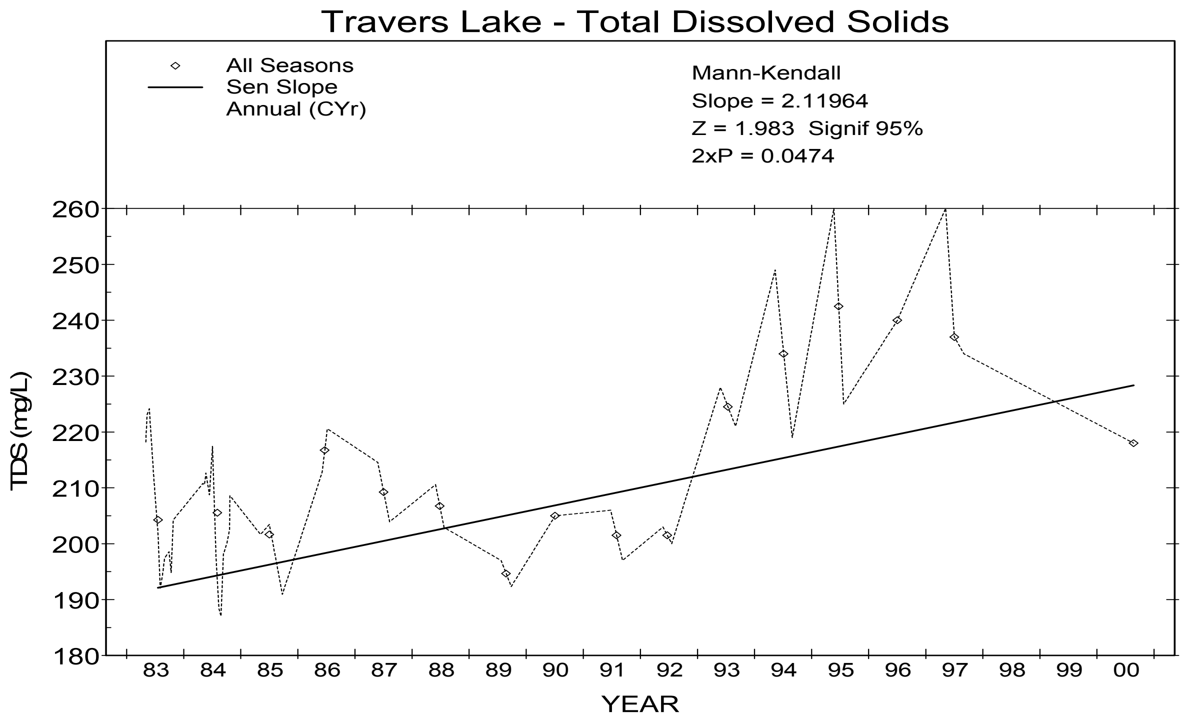


Figure 90 **Travers Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



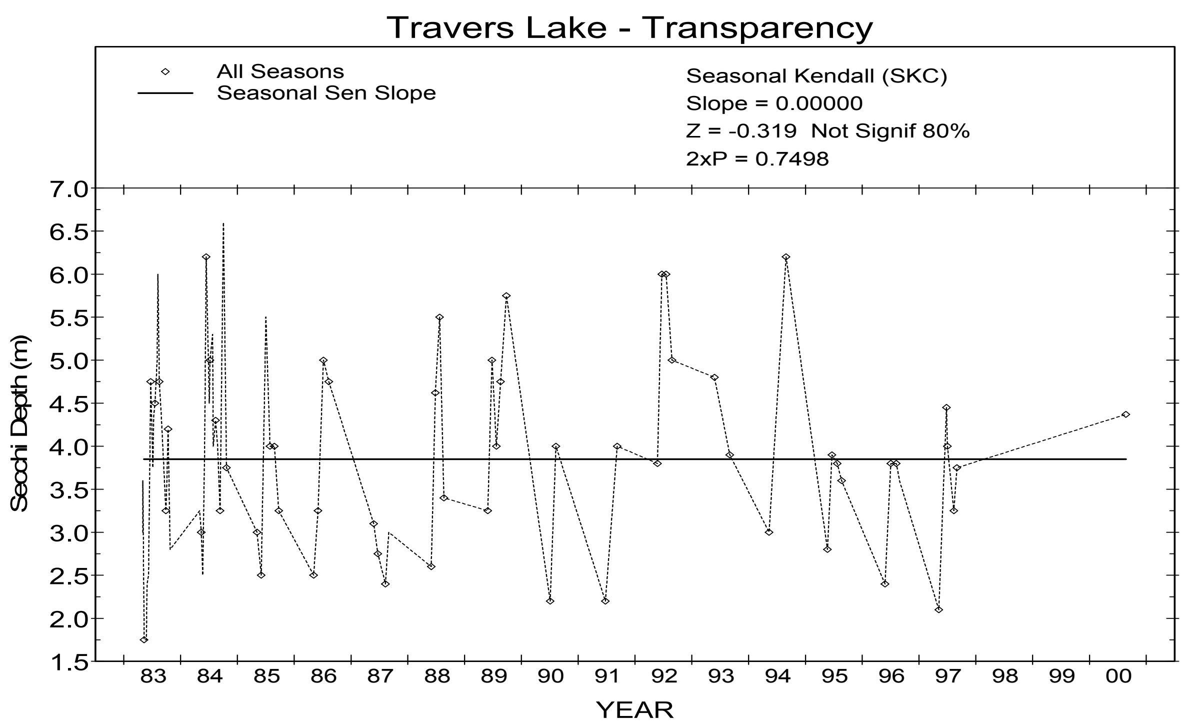
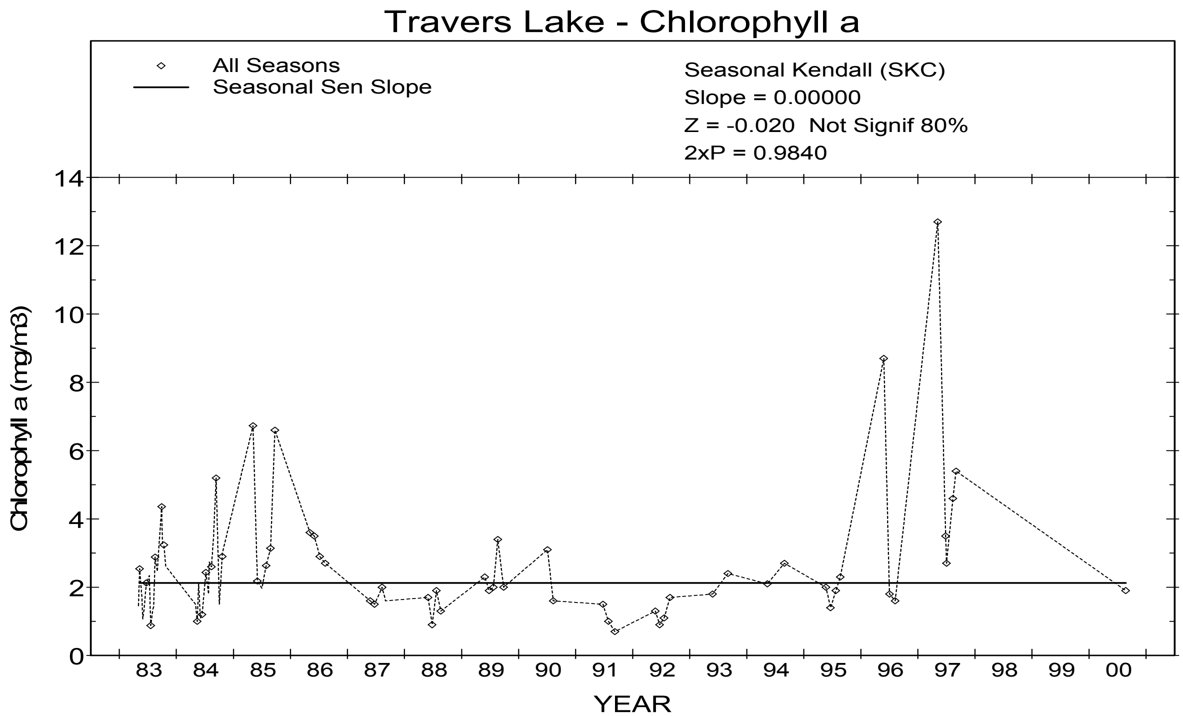


Figure 90 **Travers Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



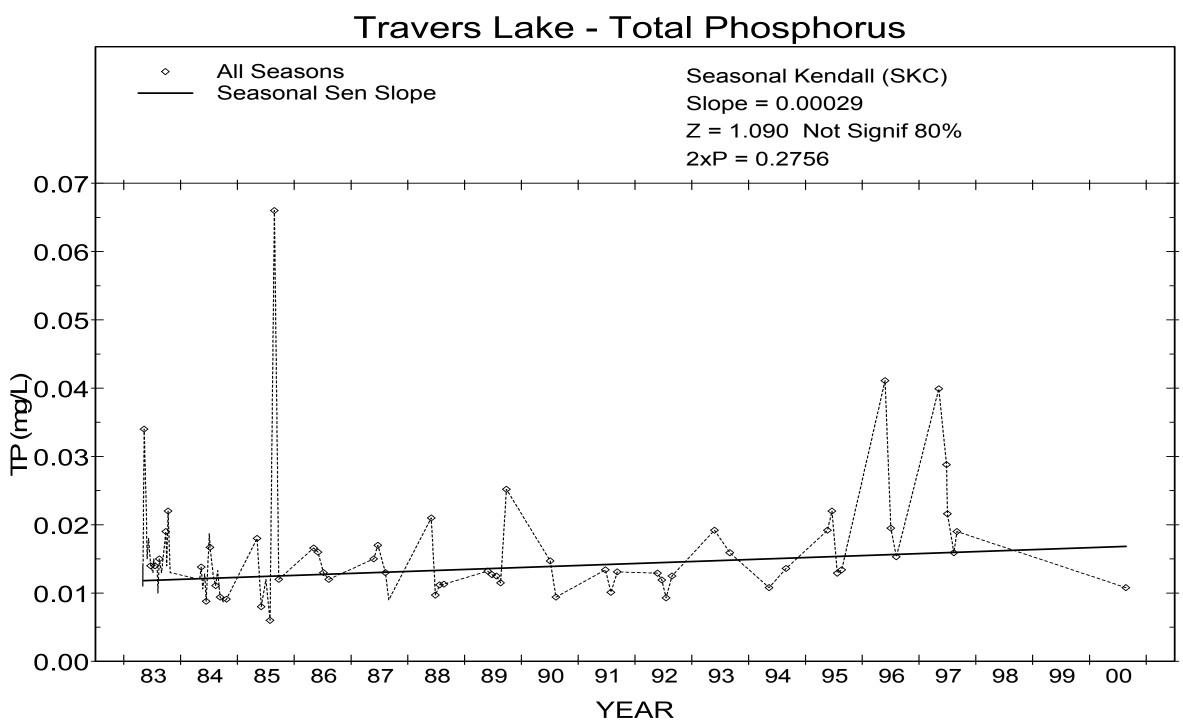


Figure 90 **Travers Lake** – Seasonal Kendall or Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)

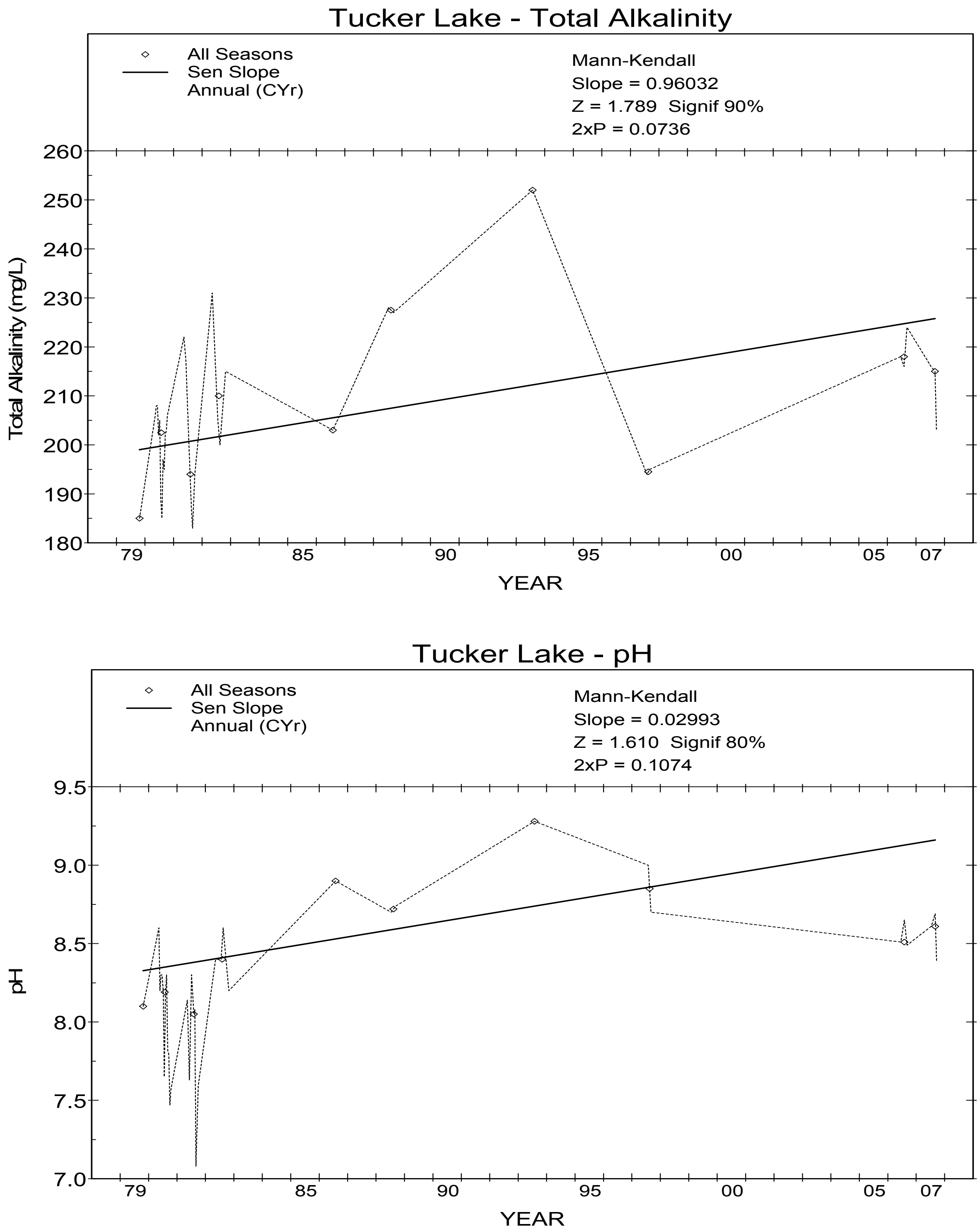
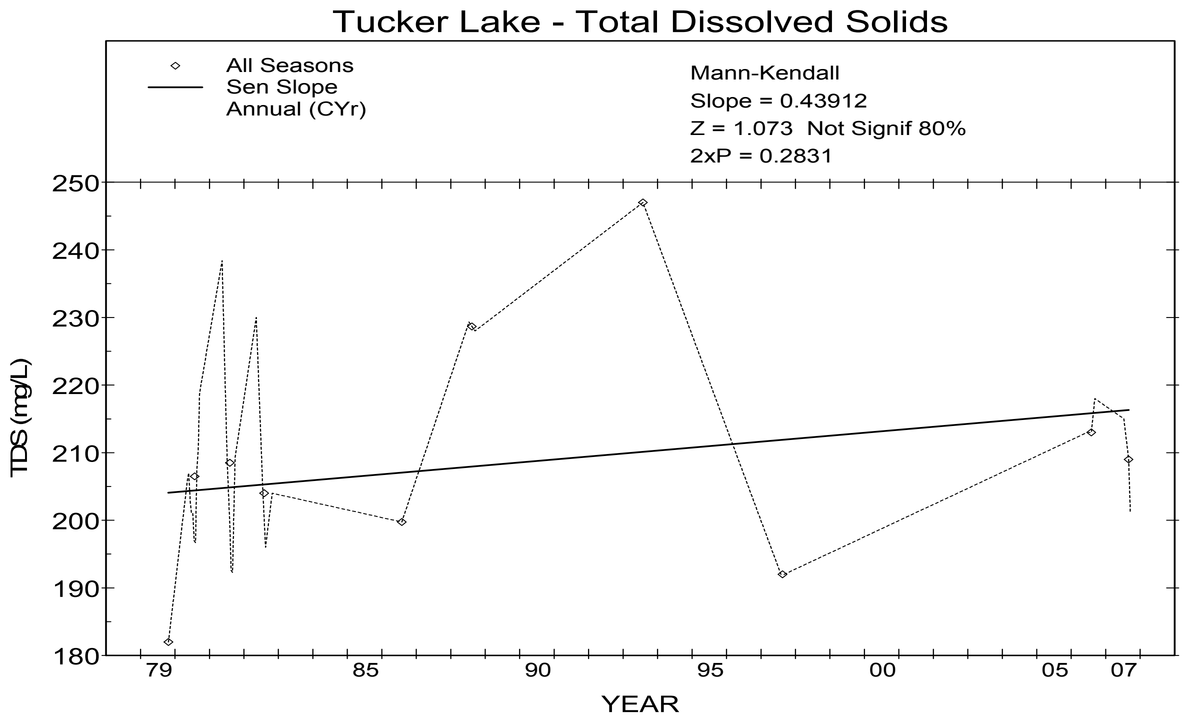


Figure 91 **Tucker Lake** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



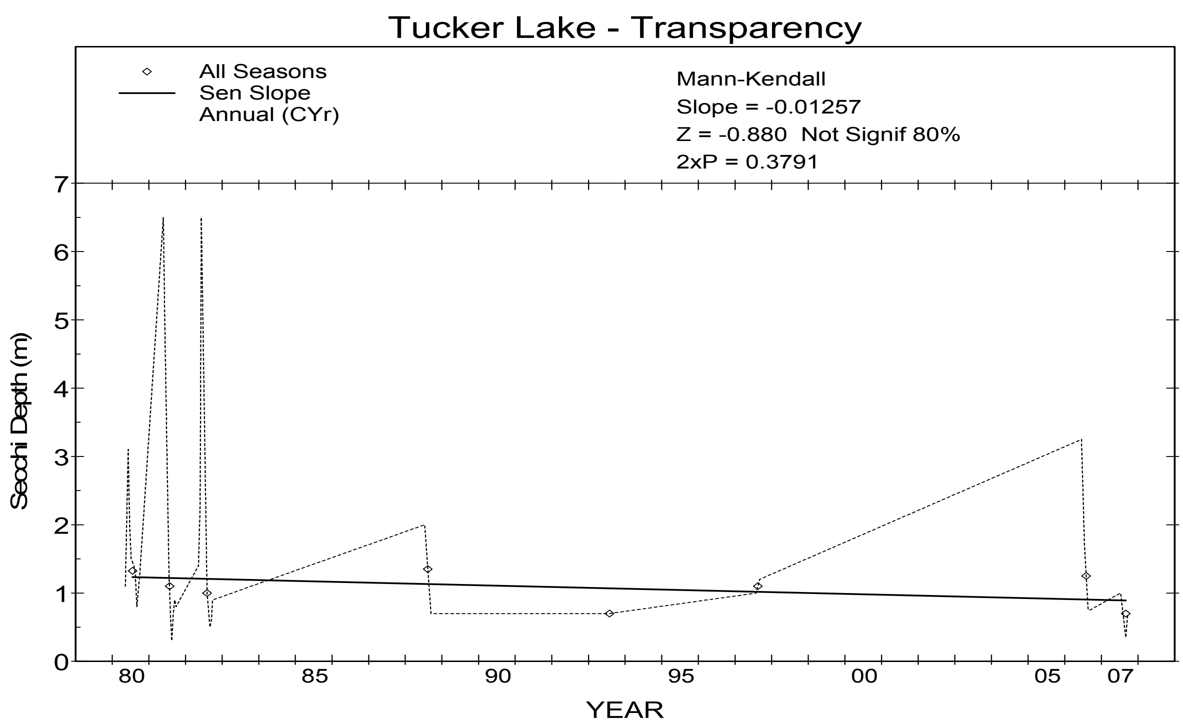
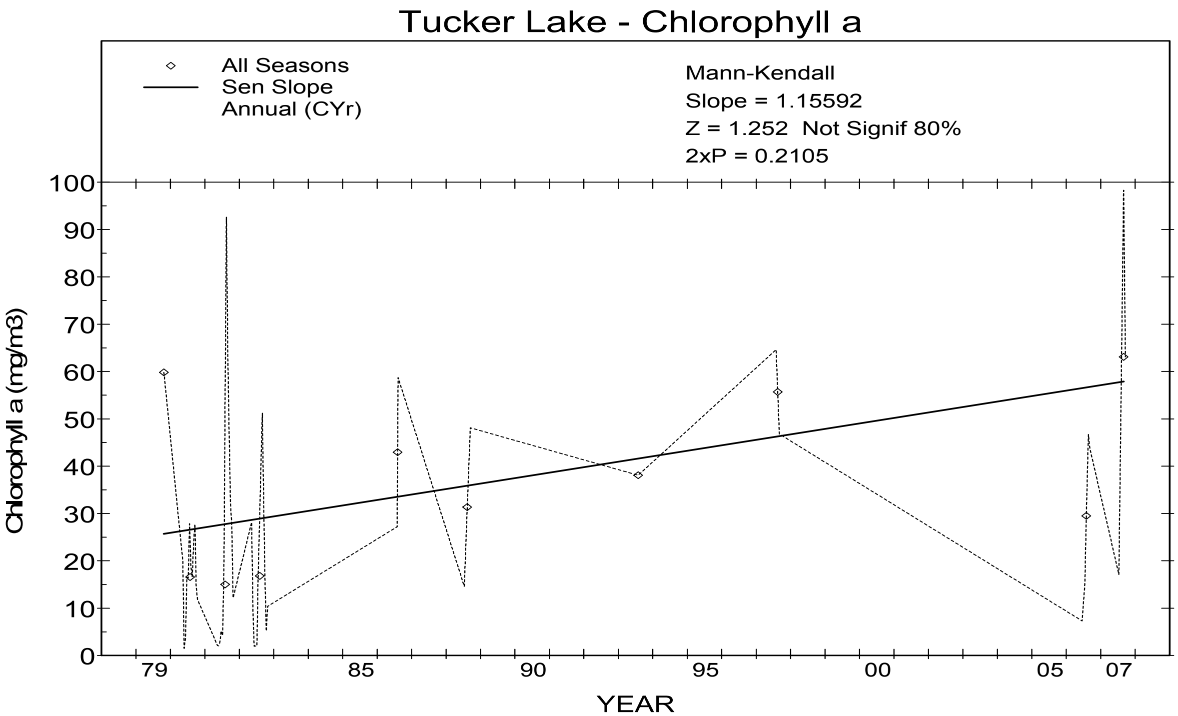


Figure 91 **Tucker Lake** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



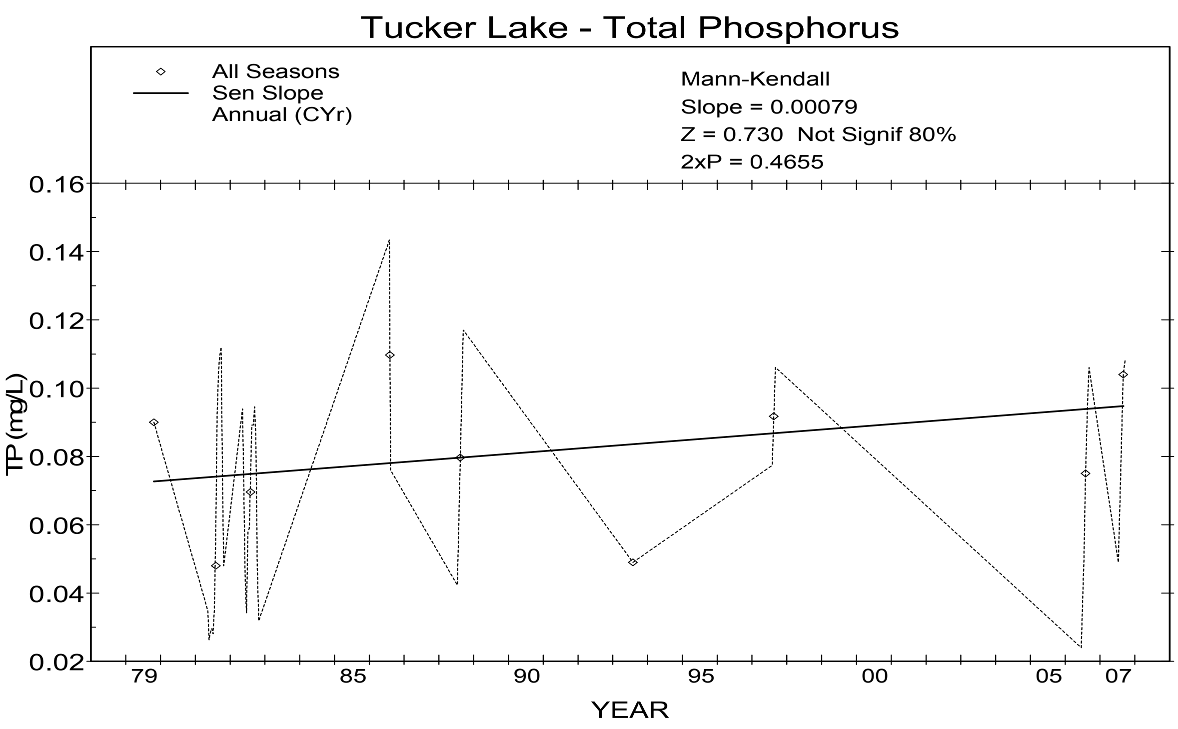
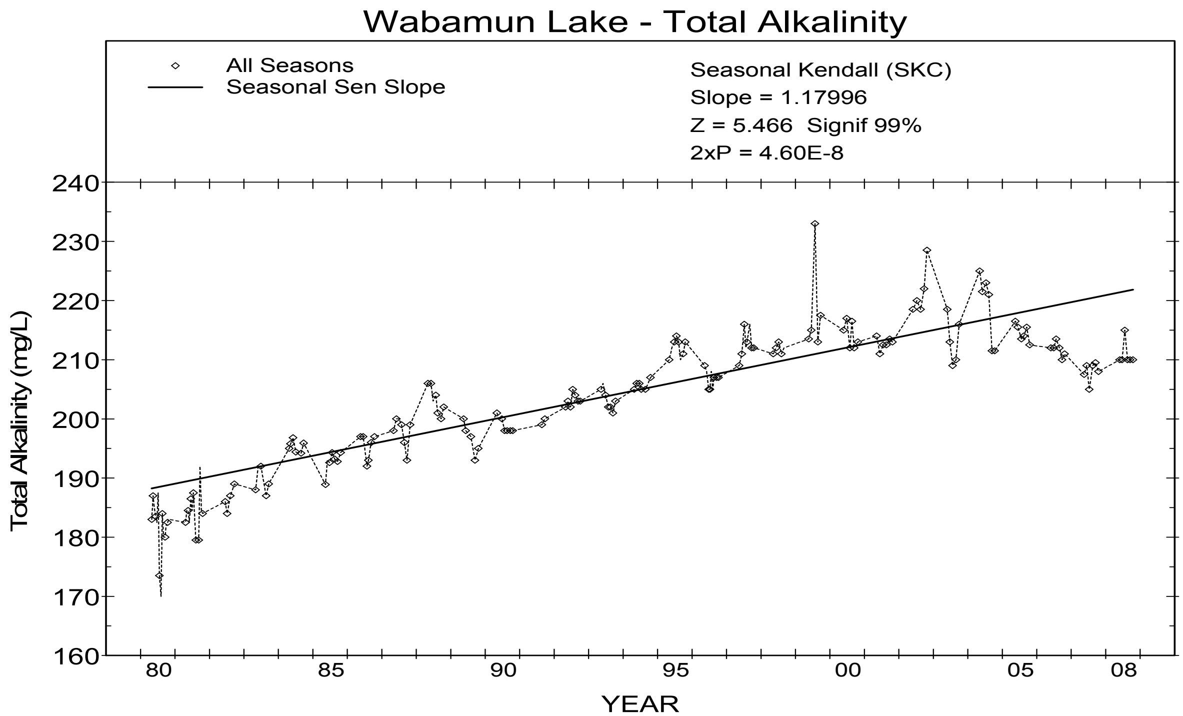


Figure 91 **Tucker Lake** – Mann-Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



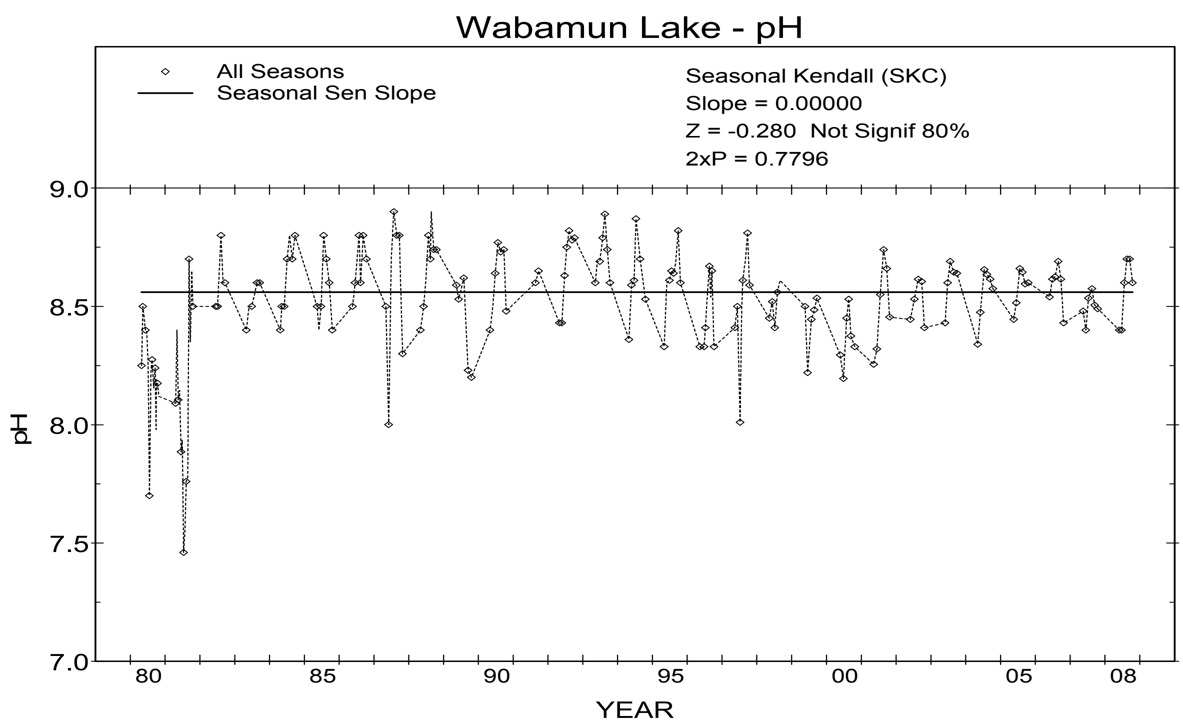
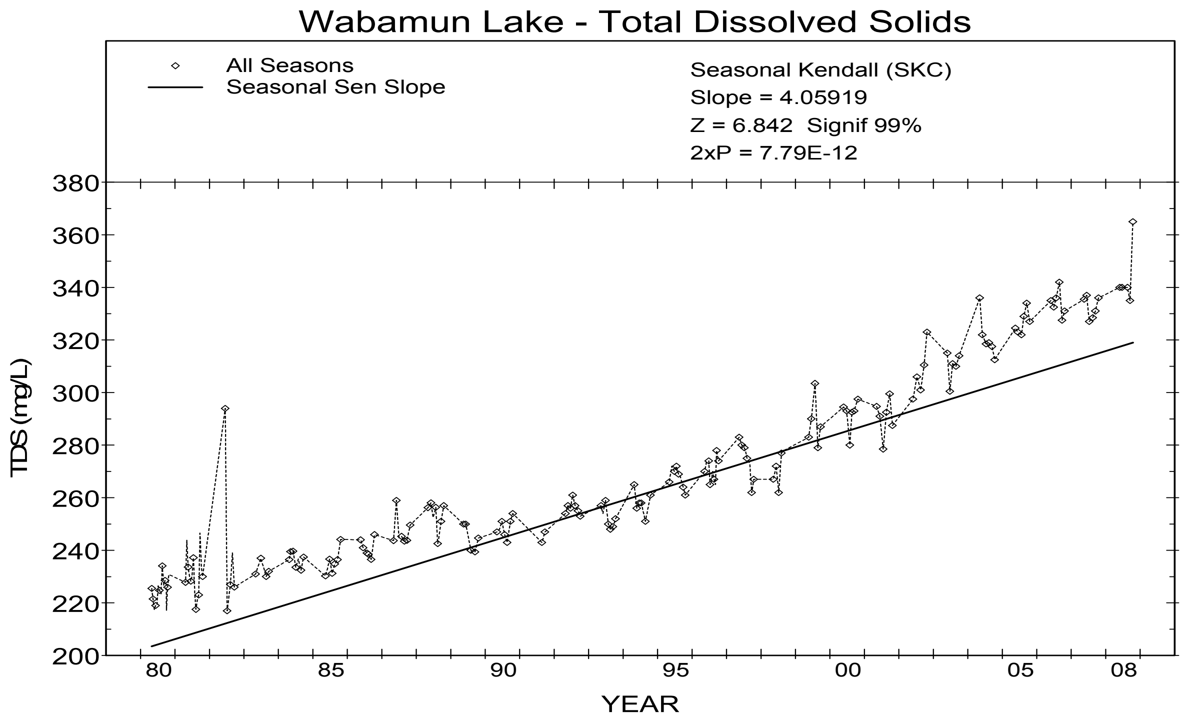


Figure 92a **Wabamun Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



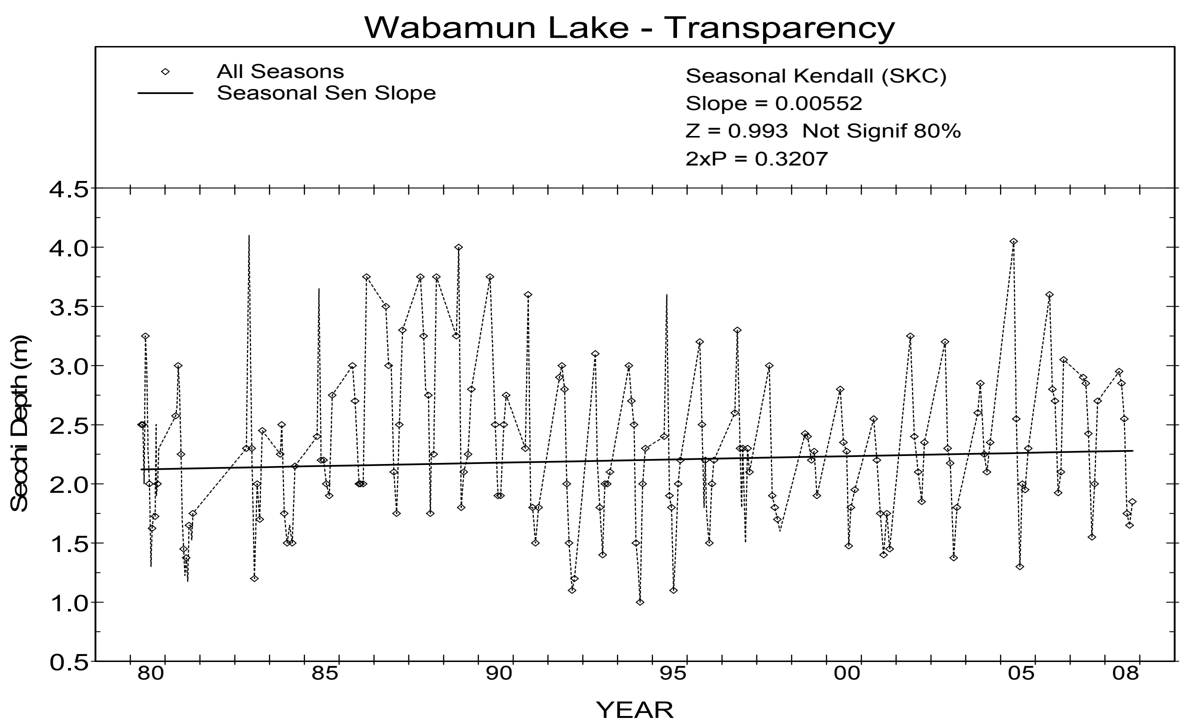
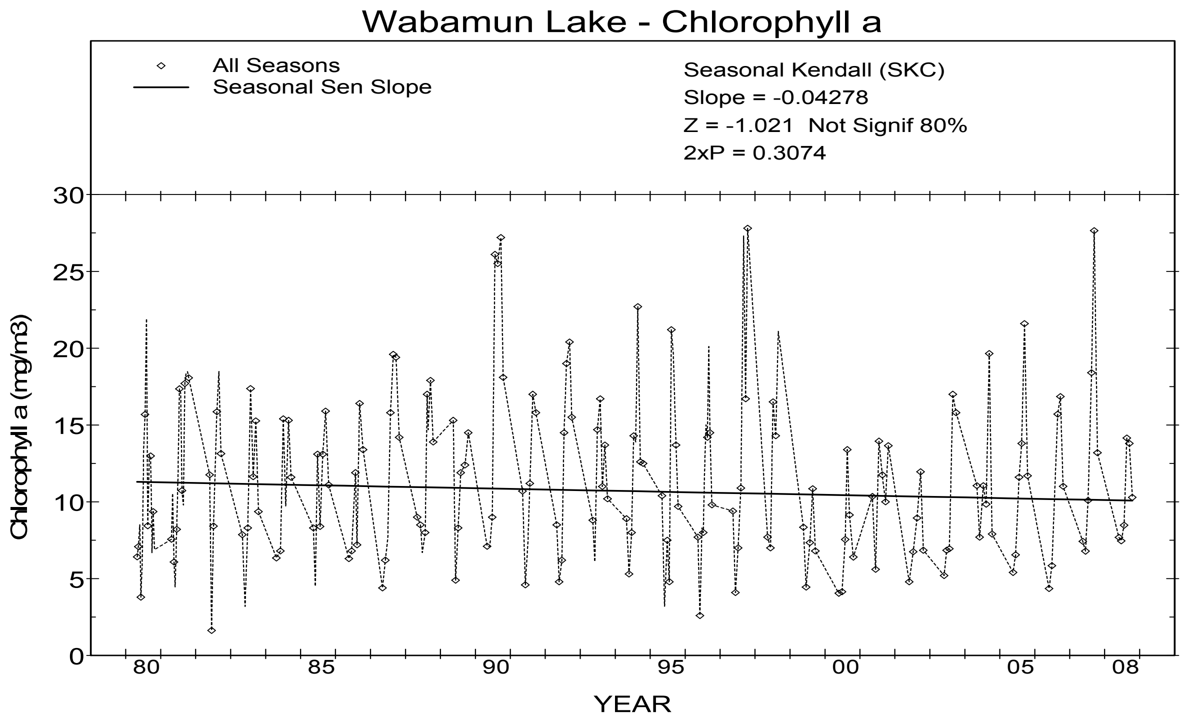


Figure 92a **Wabamun Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



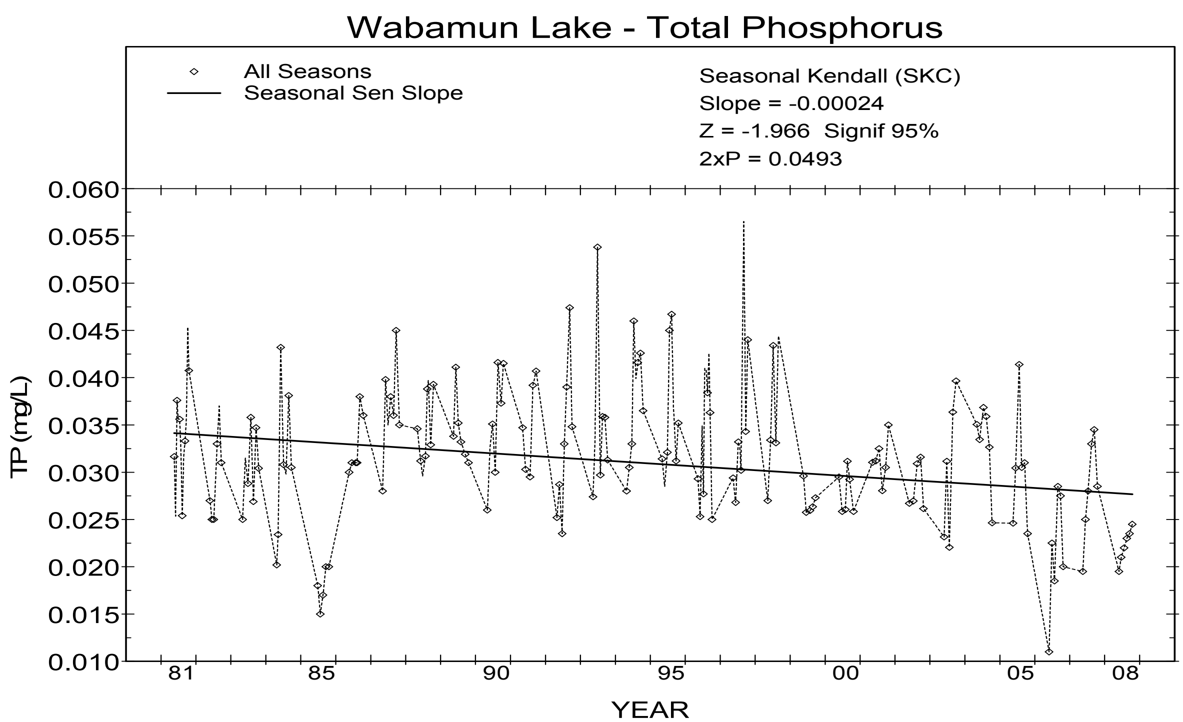
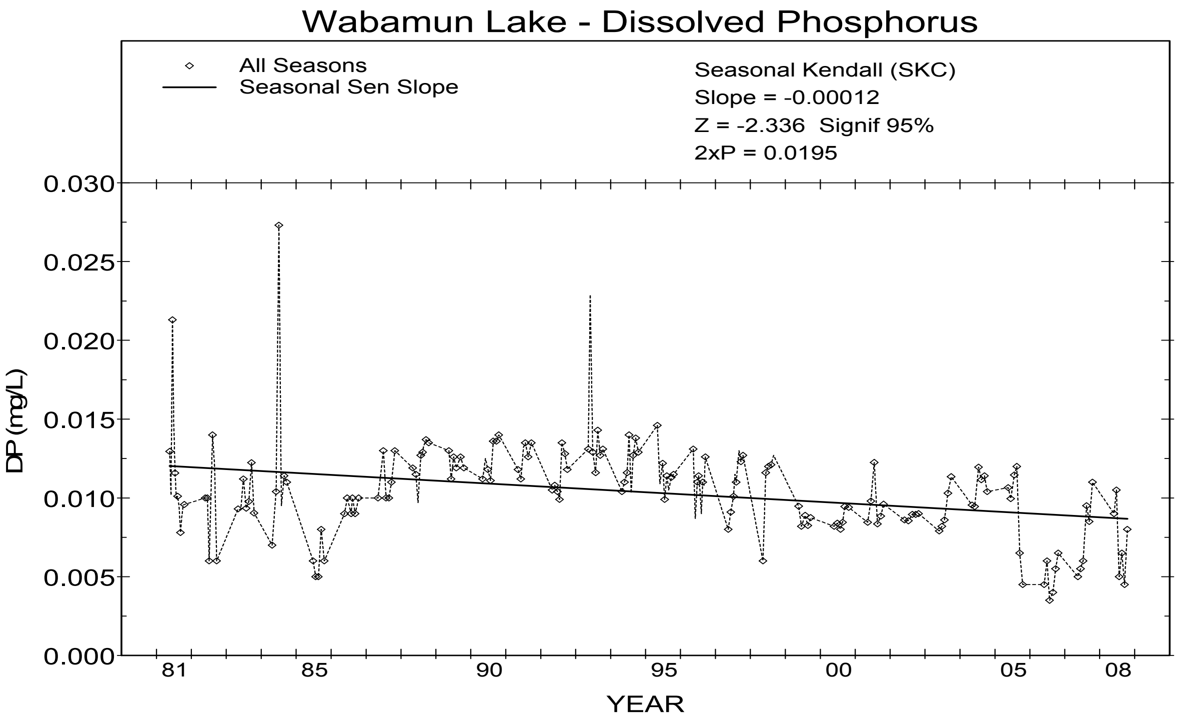


Figure 92a **Wabamun Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)



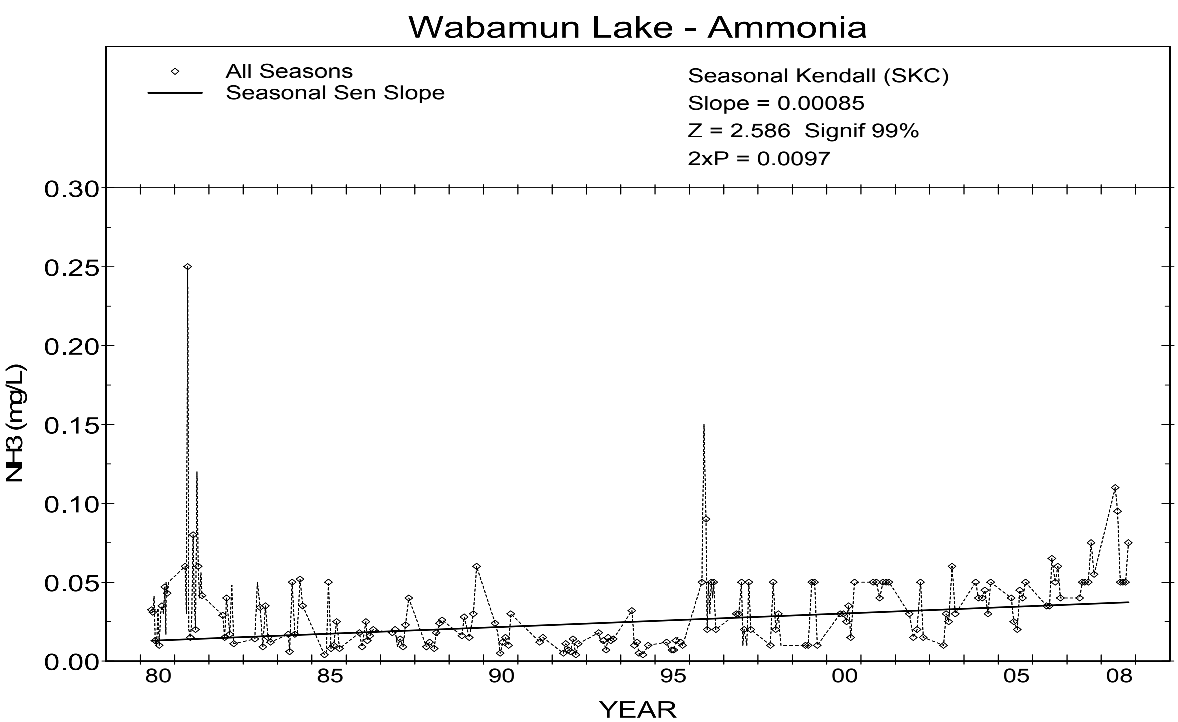
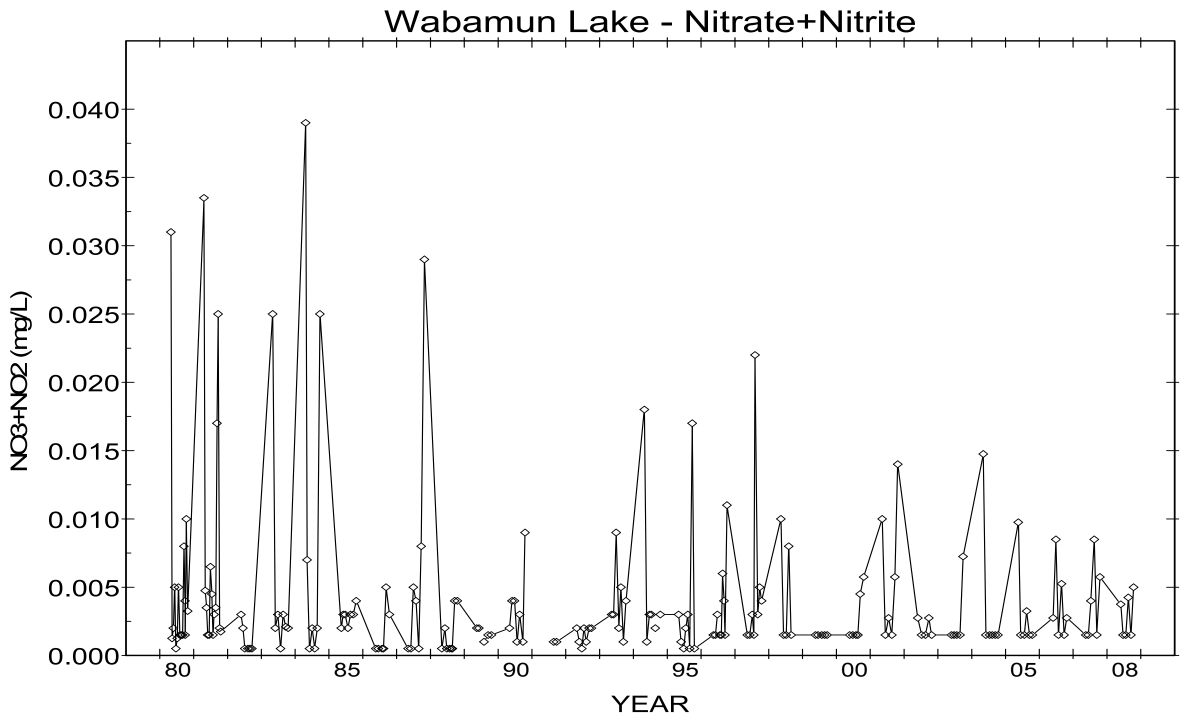


Figure 92b **Wabamun Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record



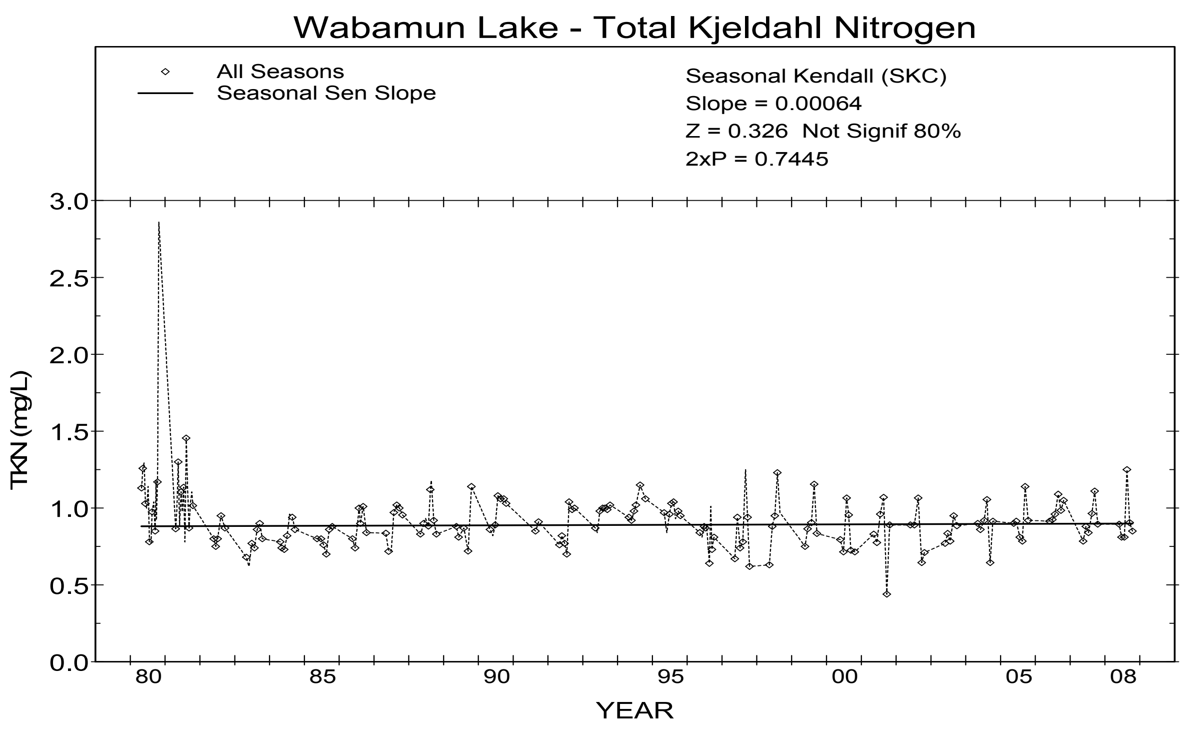
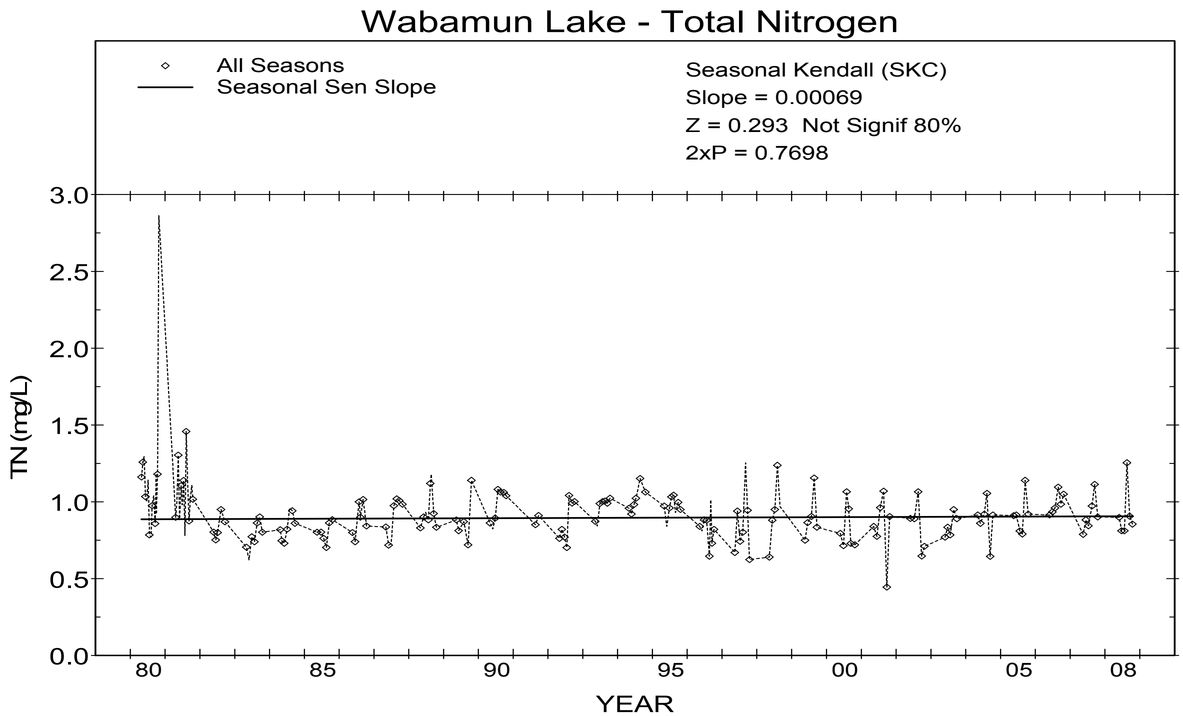


Figure 92b **Wabamun Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record. Trends were not evaluated for nitrate+nitrite-N due to excessive censored data (46% of the samples) (continued)



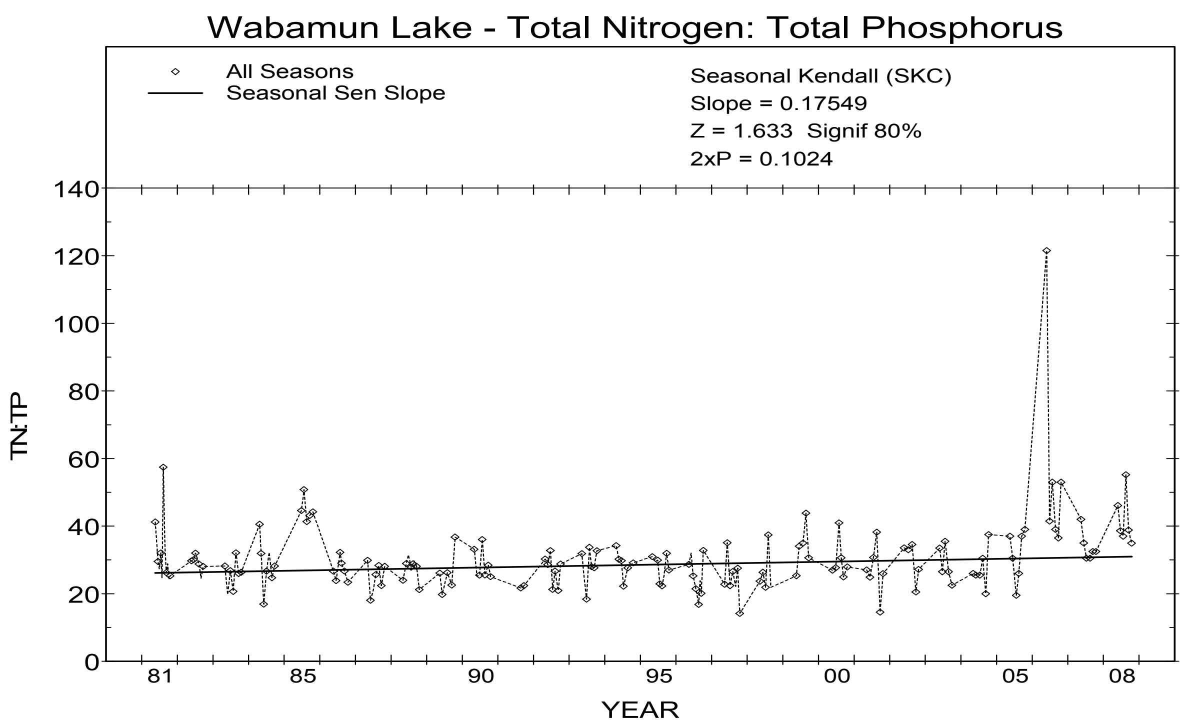
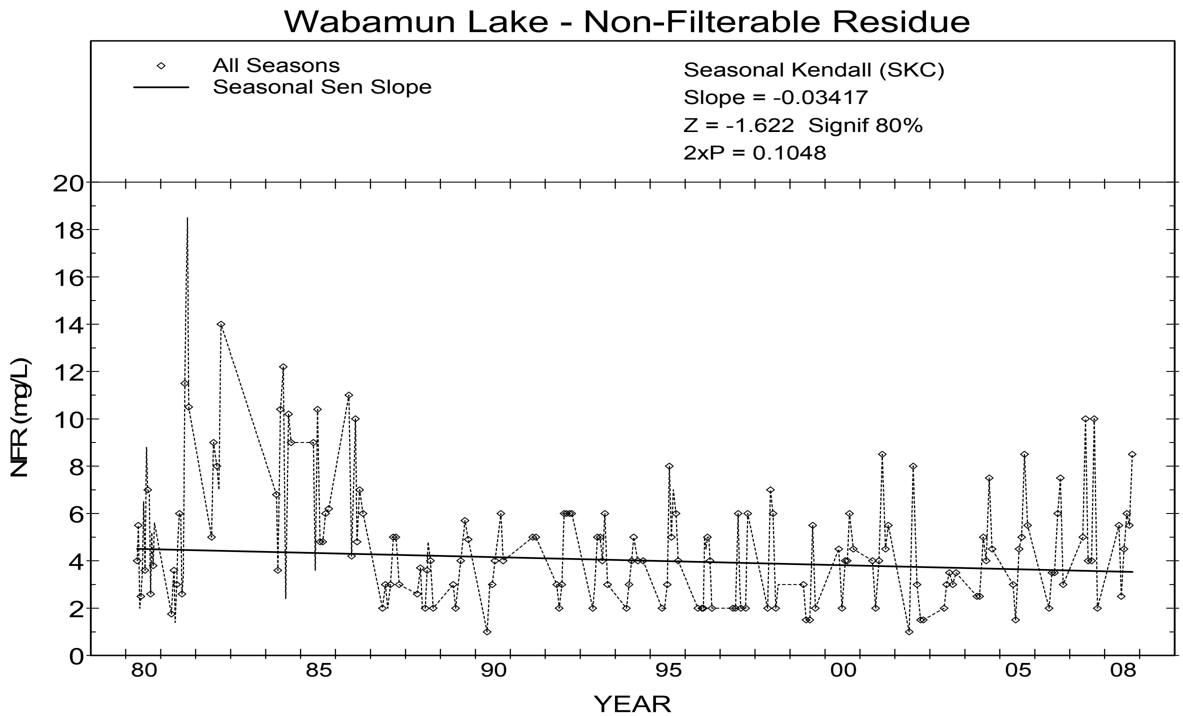


Figure 92b **Wabamun Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)



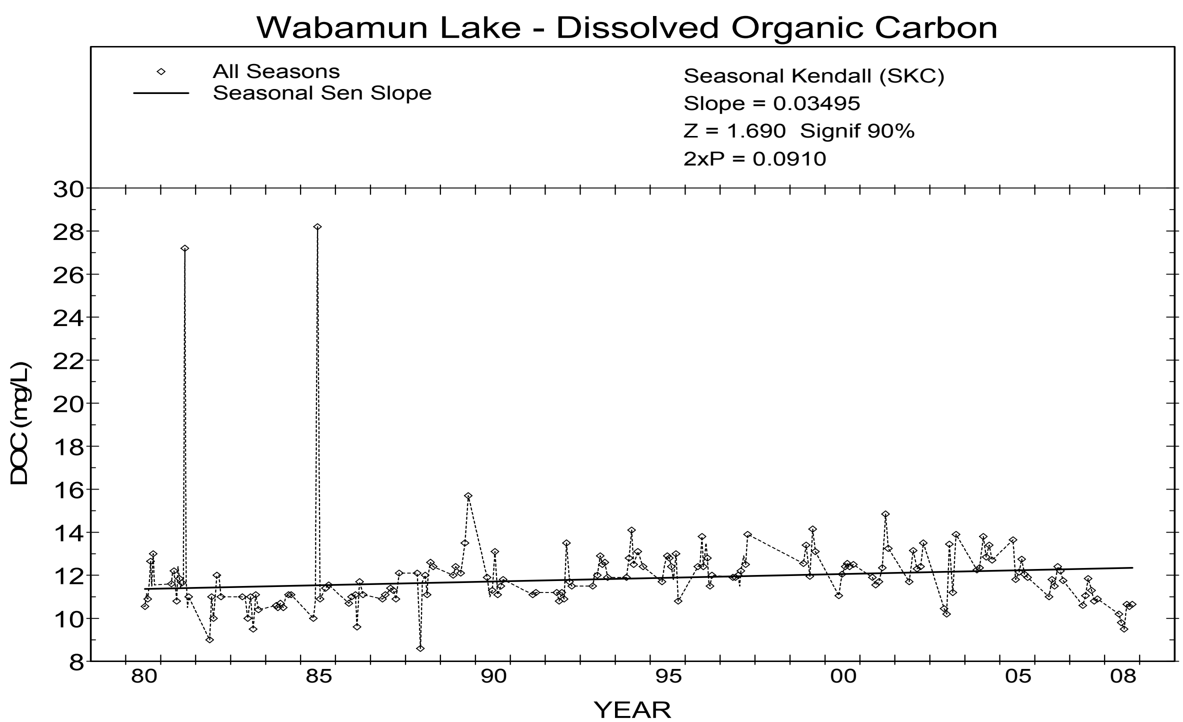


Figure 92b **Wabamun Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (continued)

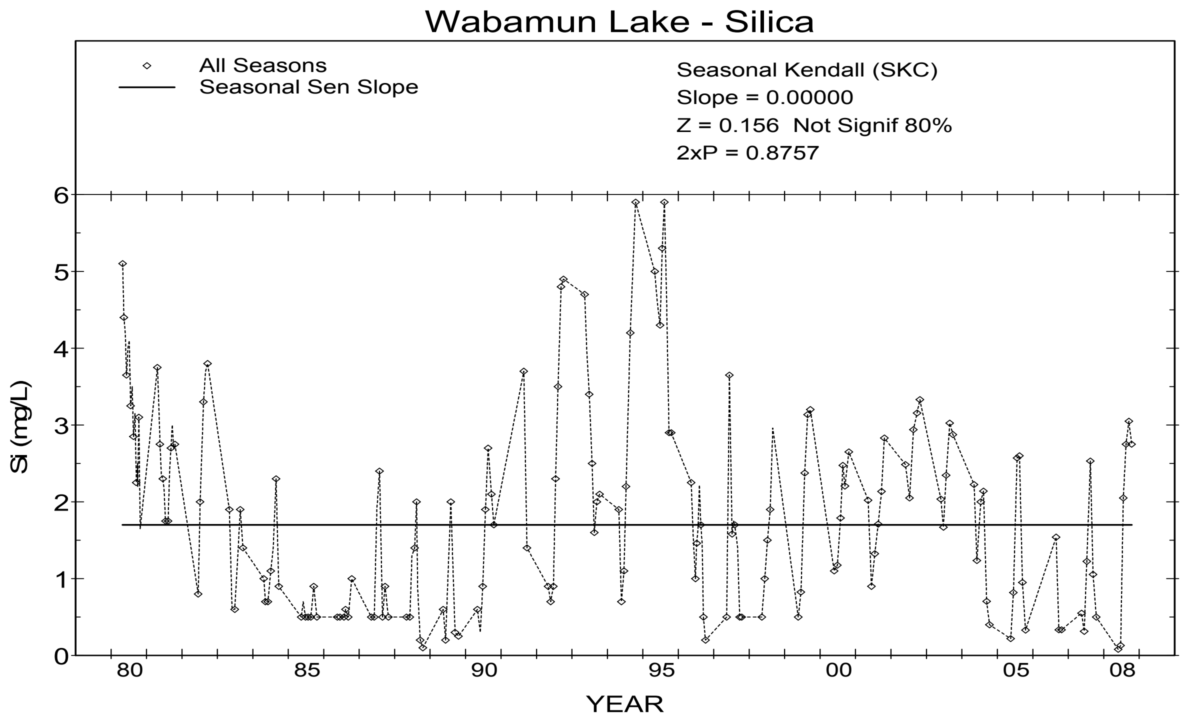


Figure 92b **Wabamun Lake** – Seasonal Kendall test for dissolved phosphorus, ammonia-N, total Kjeldahl nitrogen, total nitrogen, total nitrogen: total phosphorus, non-filterable residue, dissolved organic carbon and silica levels over the sample record (concluded)

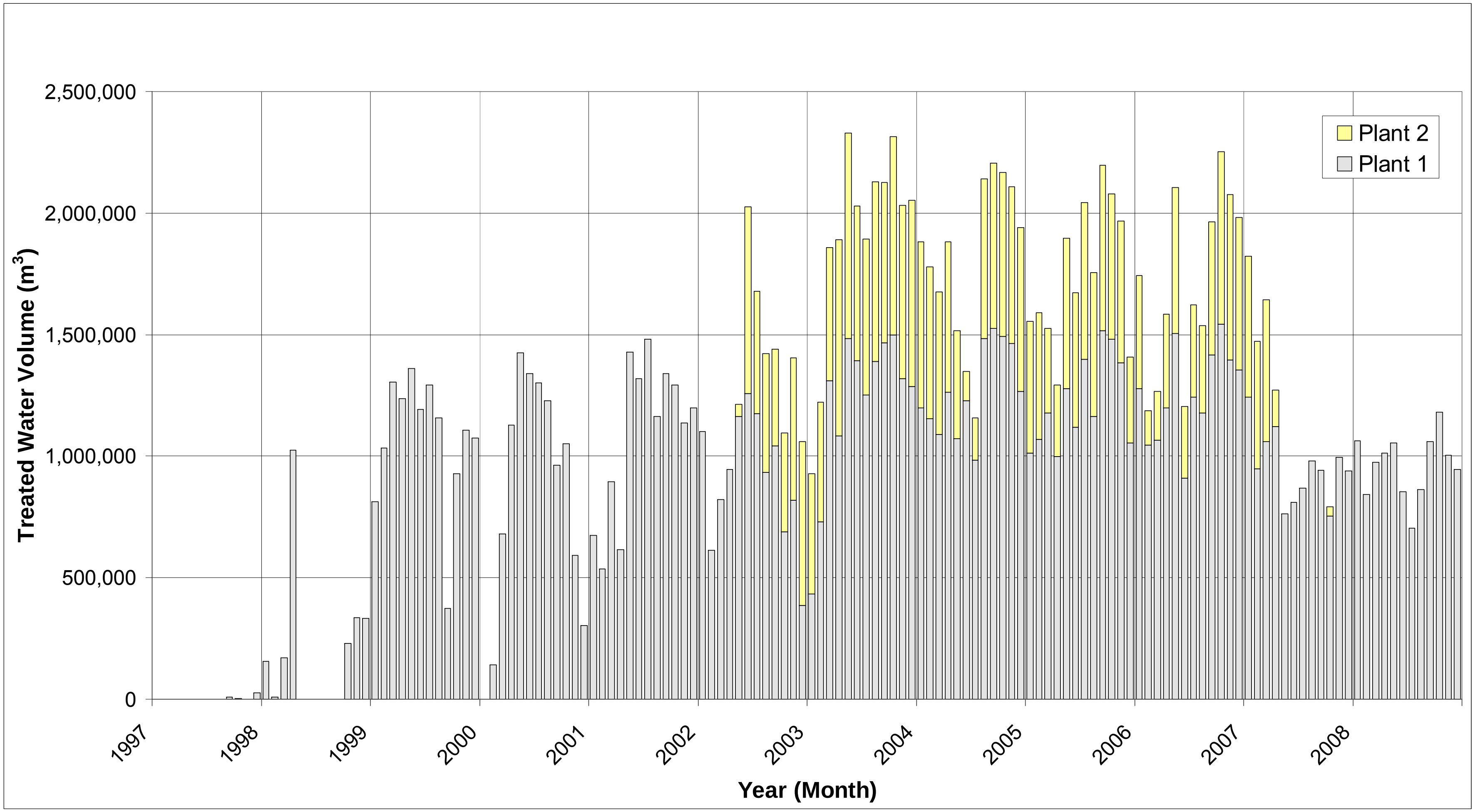
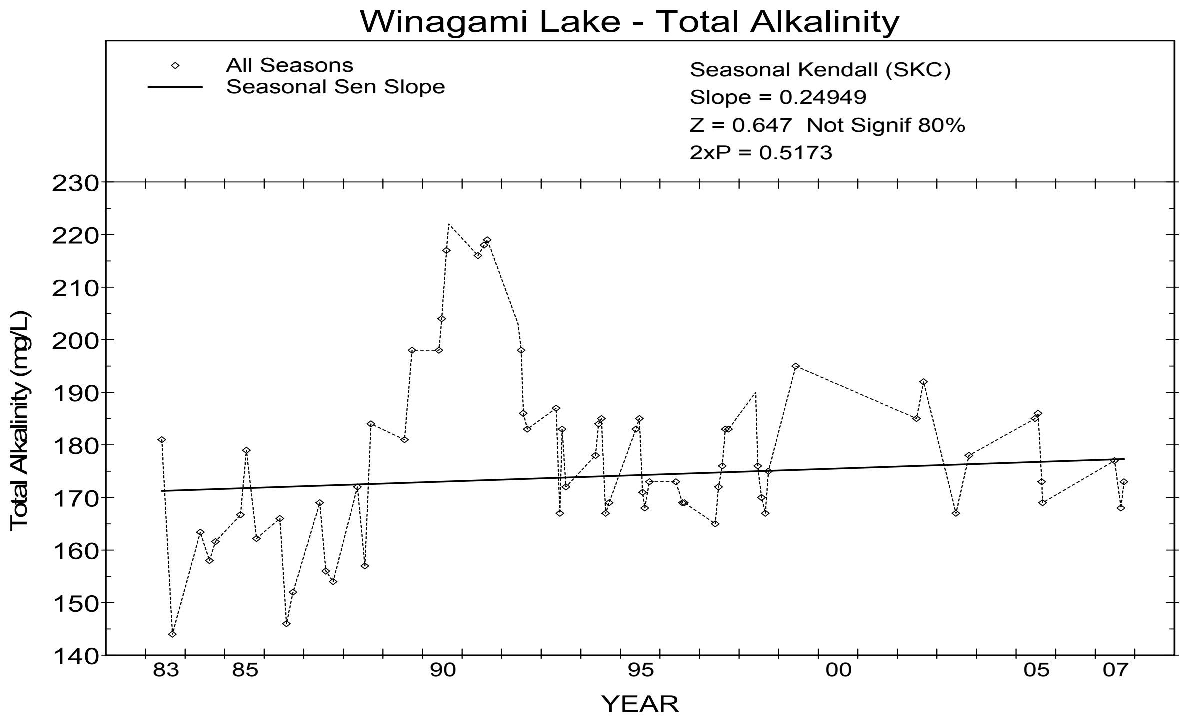


Figure 92c **Wabamun Lake -** Monthly volumes of treated water pumped to the lake, 1997 to 2008



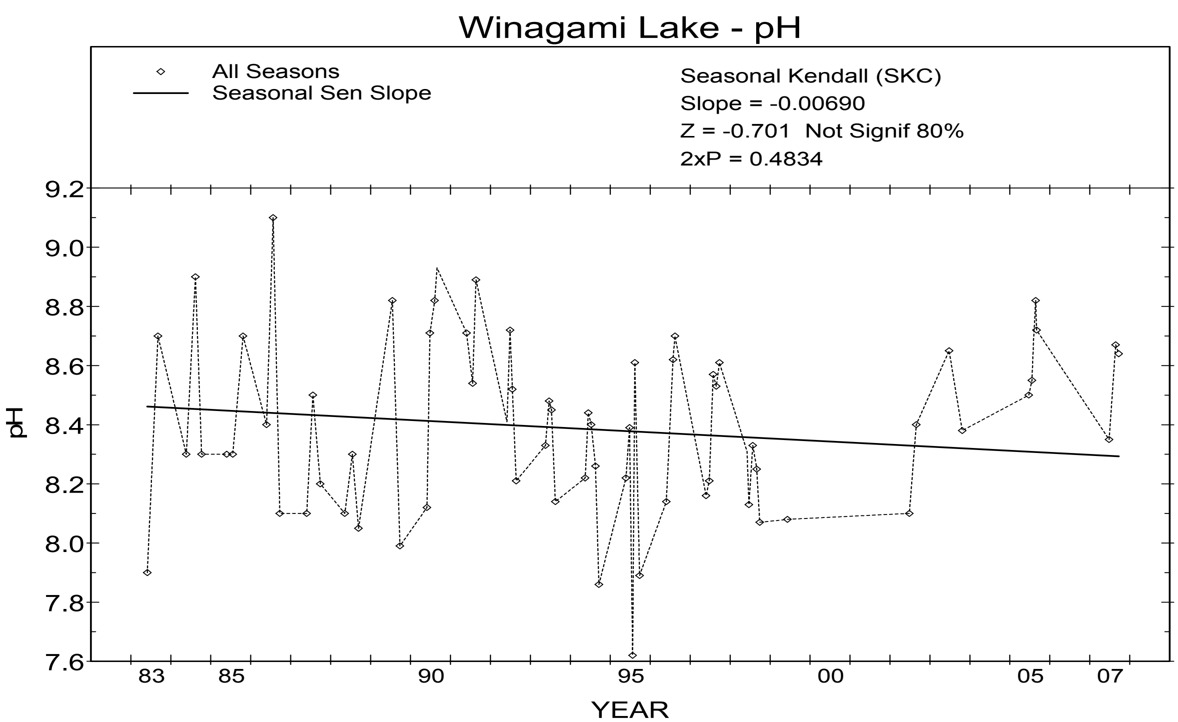
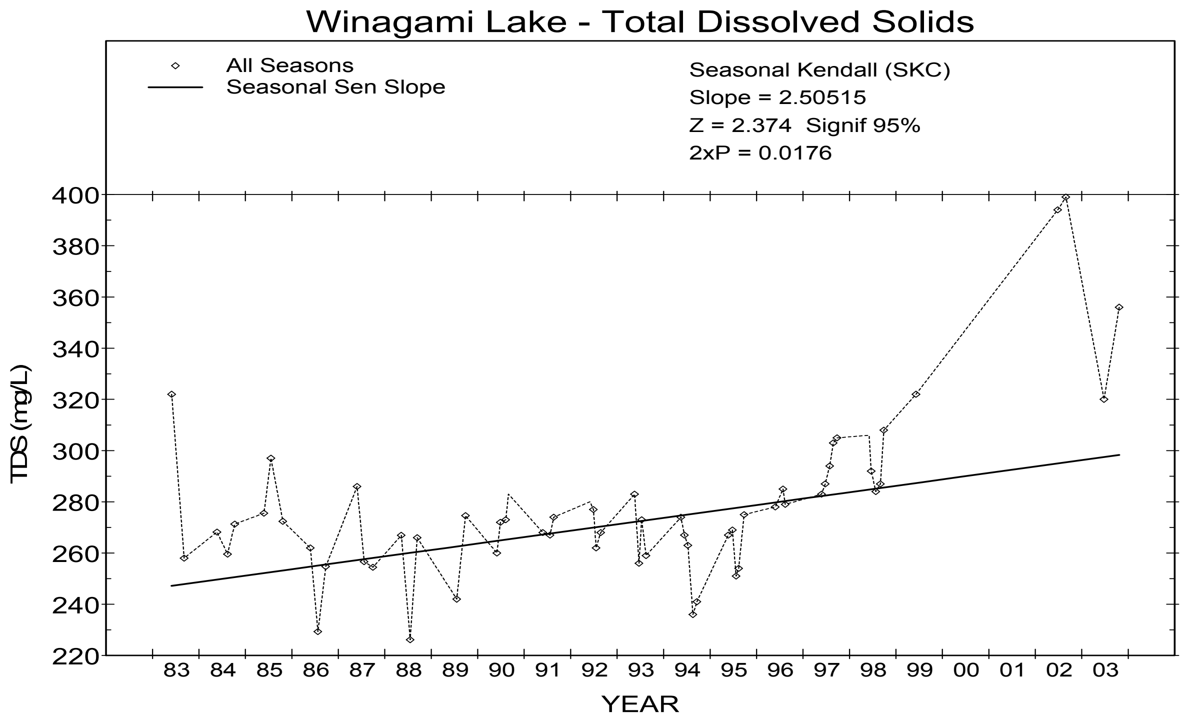


Figure 93 **Winagami Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record



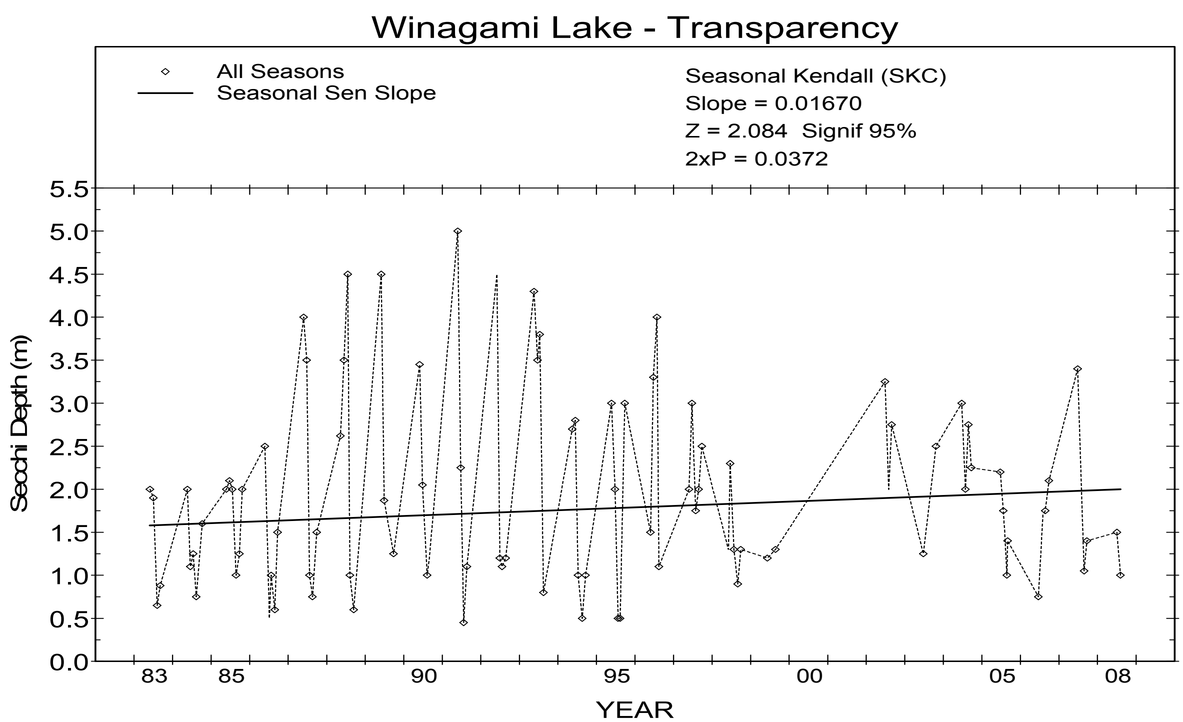
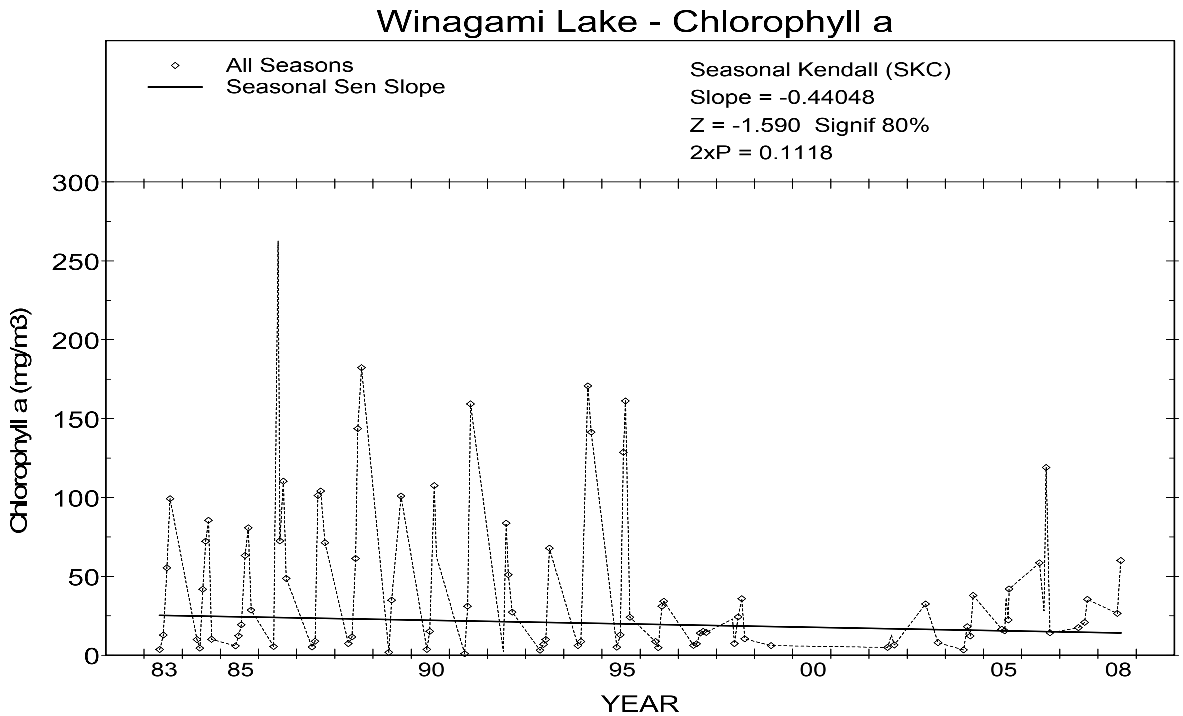


Figure 93 **Winagami Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (continued)



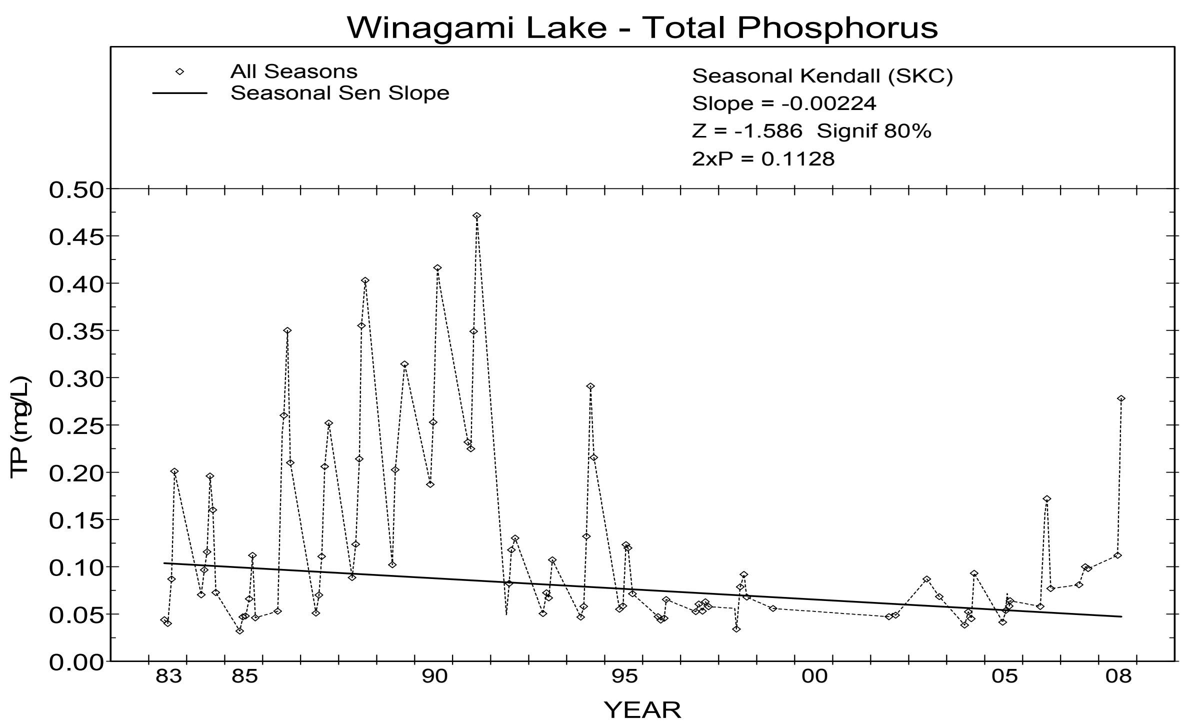


Figure 93 **Winagami Lake** – Seasonal Kendall test for total alkalinity, pH, total dissolved solids (TDS), transparency, chlorophyll-*a* and total phosphorus (TP) levels over the sample record (concluded)

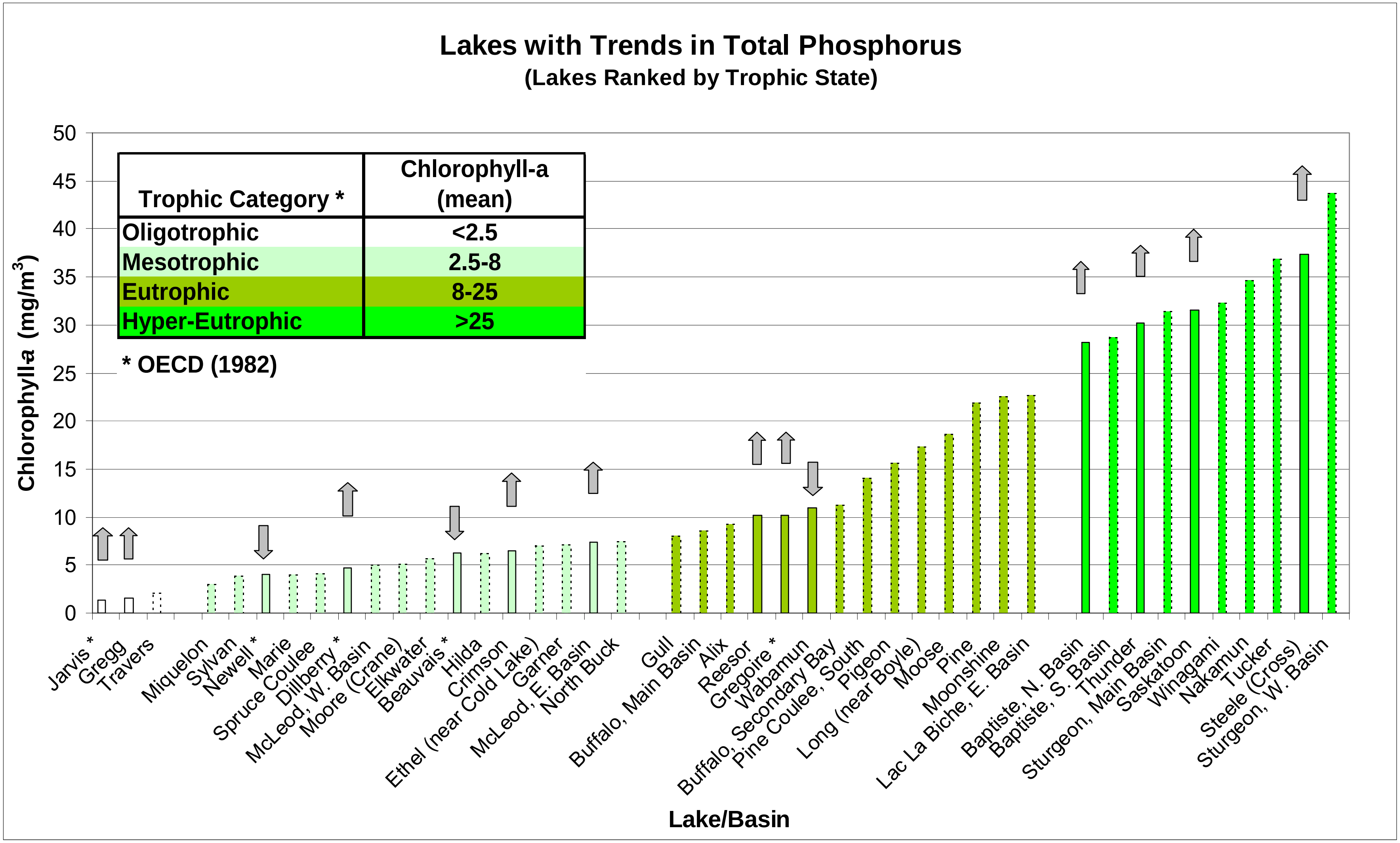


Figure 94a Fourteen lakes with trends for total phosphorus (TP) in the composite samples, 1979 to 2009 (based on Figure 6). Arrows show increasing or decreasing trends. Five lakes marked by an asterix have the same trend direction for TP and chlorophyll-*a*.

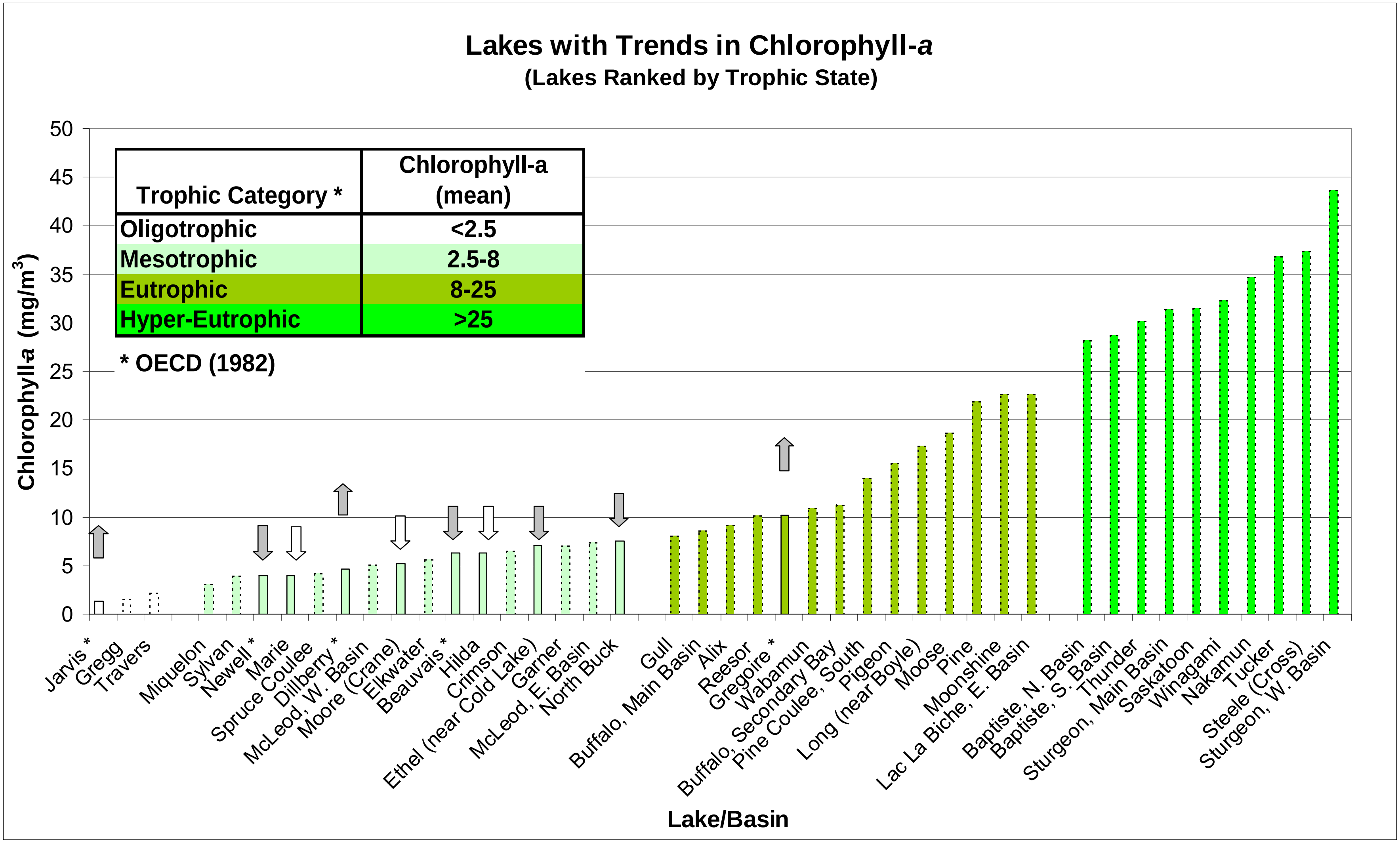
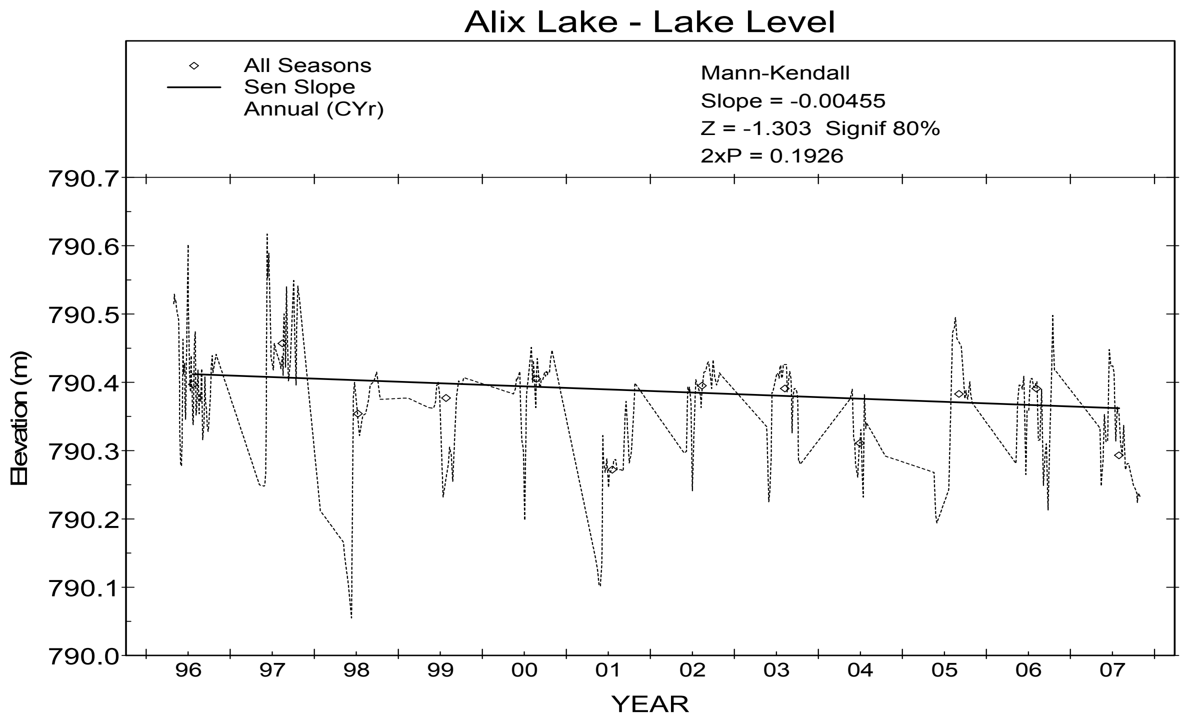


Figure 94b Ten lakes with trends for chlorophyll-*a* in the composite samples, 1979 to 2009 (based on Figure 6). Arrows show increasing or decreasing trends; arrows of three lakes with more limited data are not shaded (Section 3.3.3). Five lakes marked by an asterix have the same trend direction for chlorophyll-*a* and total phosphorus.

E. TRENDS IN LAKE LEVEL

This section includes the time series graphs and trend results (Mann-Kendall test) in the annual (median) lake level for the 37 lakes with data that coincided with the water quality sampling record. Lakes are listed in alphabetical order. Each graph shows the data analysed (open circles), trend line, Sen slope, test statistic (Z) and two-tailed probability value (2XP). The hatched line represents all lake level records. See Section 2.3 for more detail.



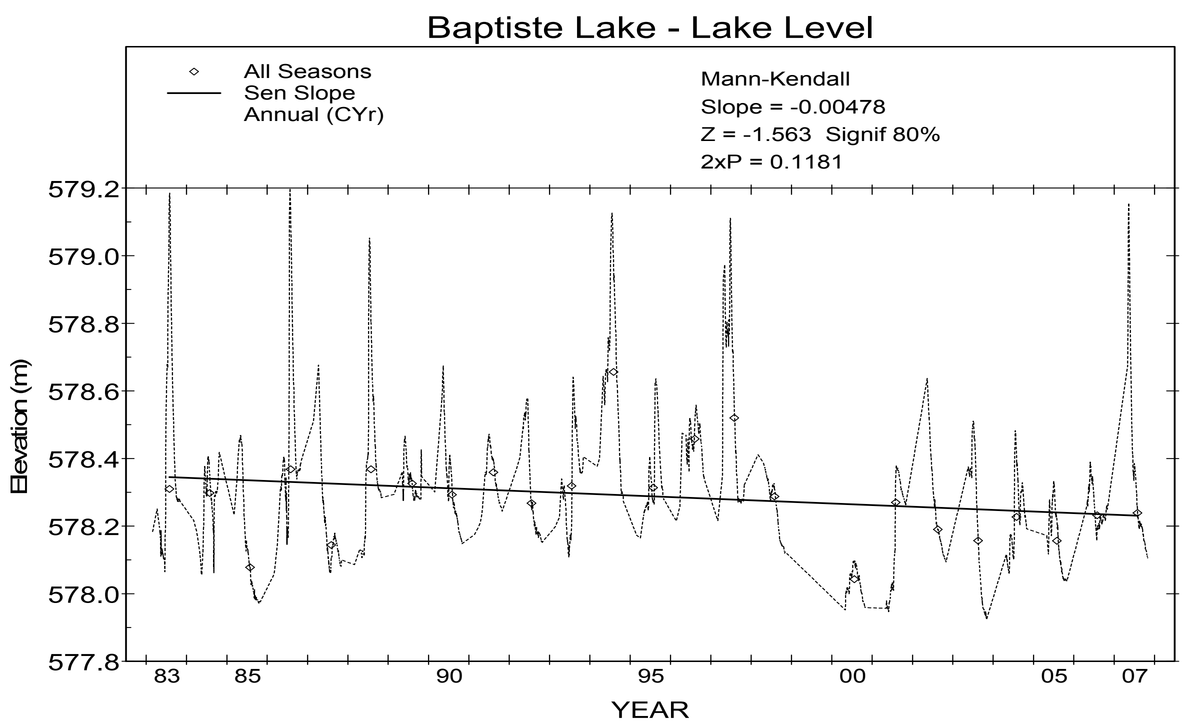
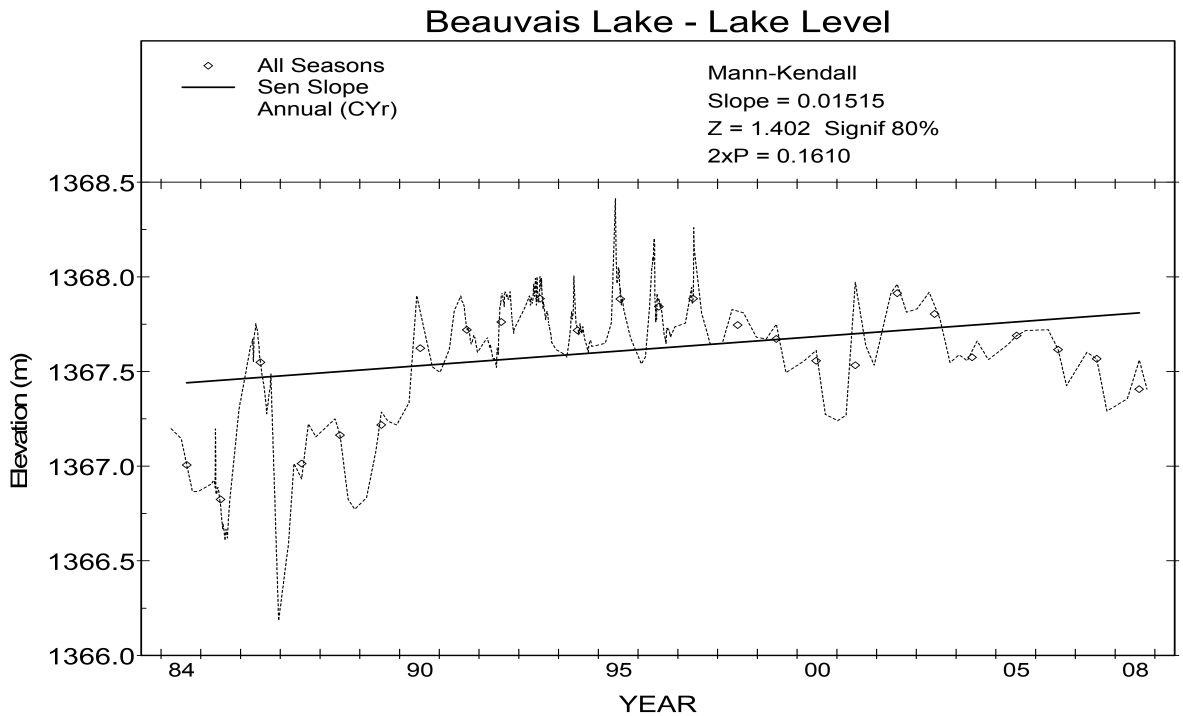


Figure 95 Trends in annual lake level for 37 lakes



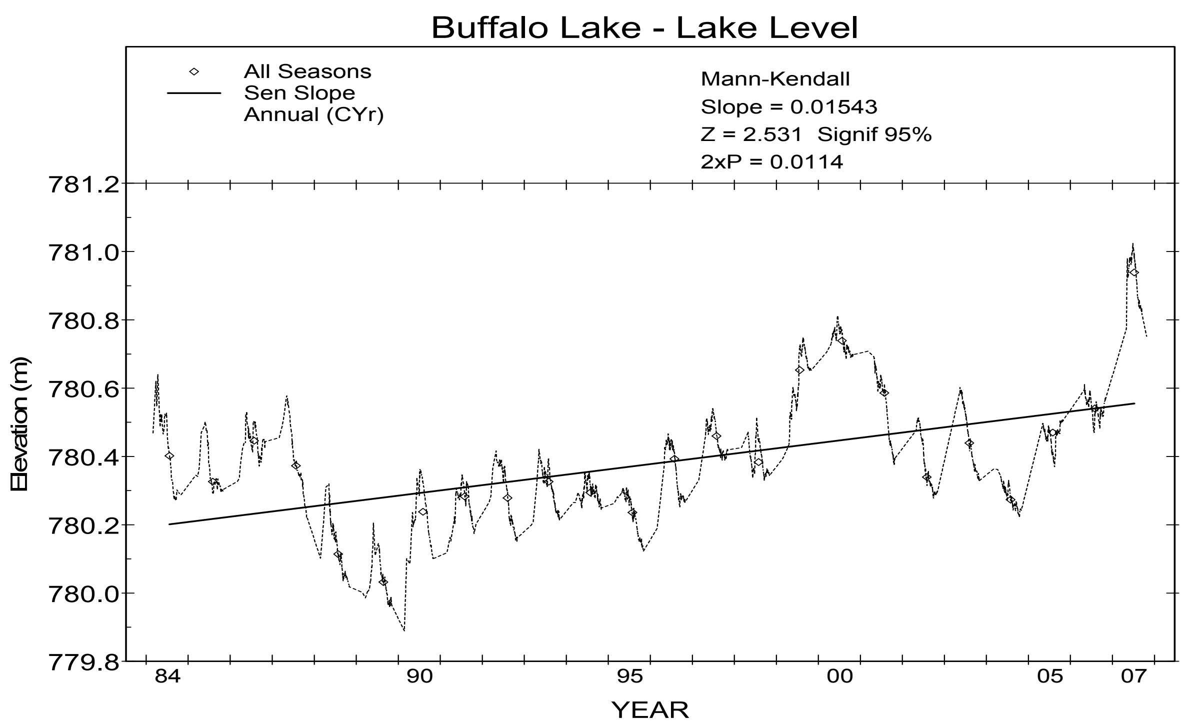
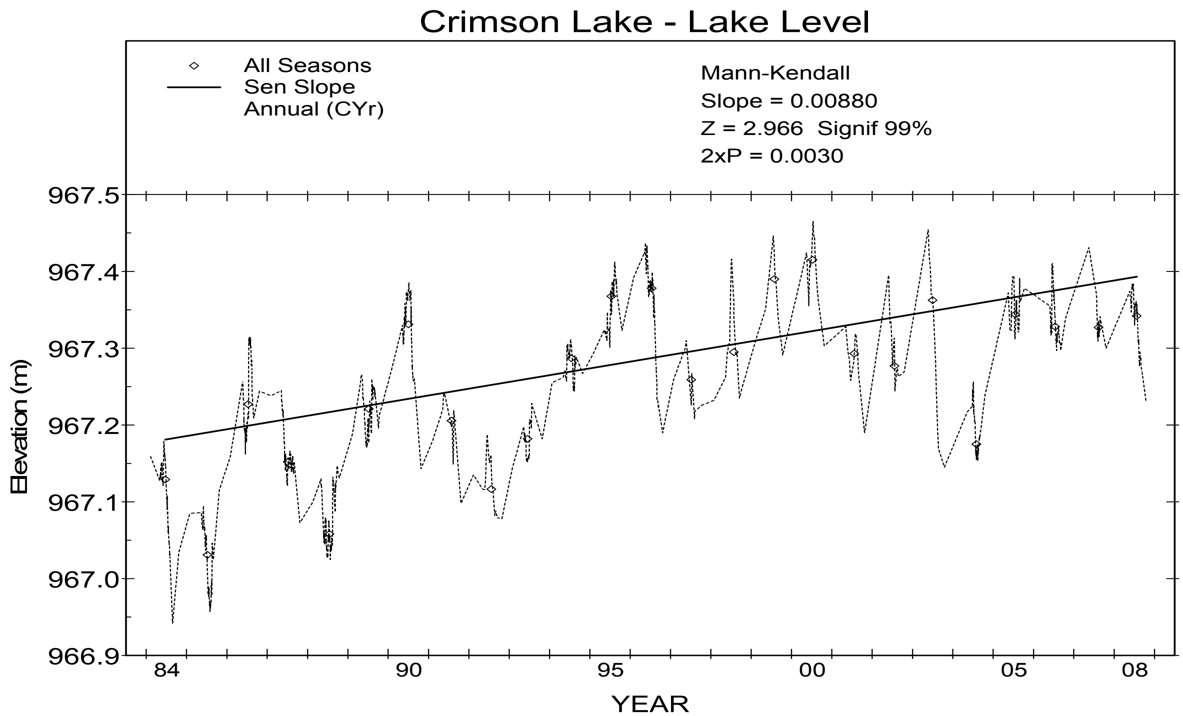


Figure 95 Trends in annual lake level for 37 lakes (continued)



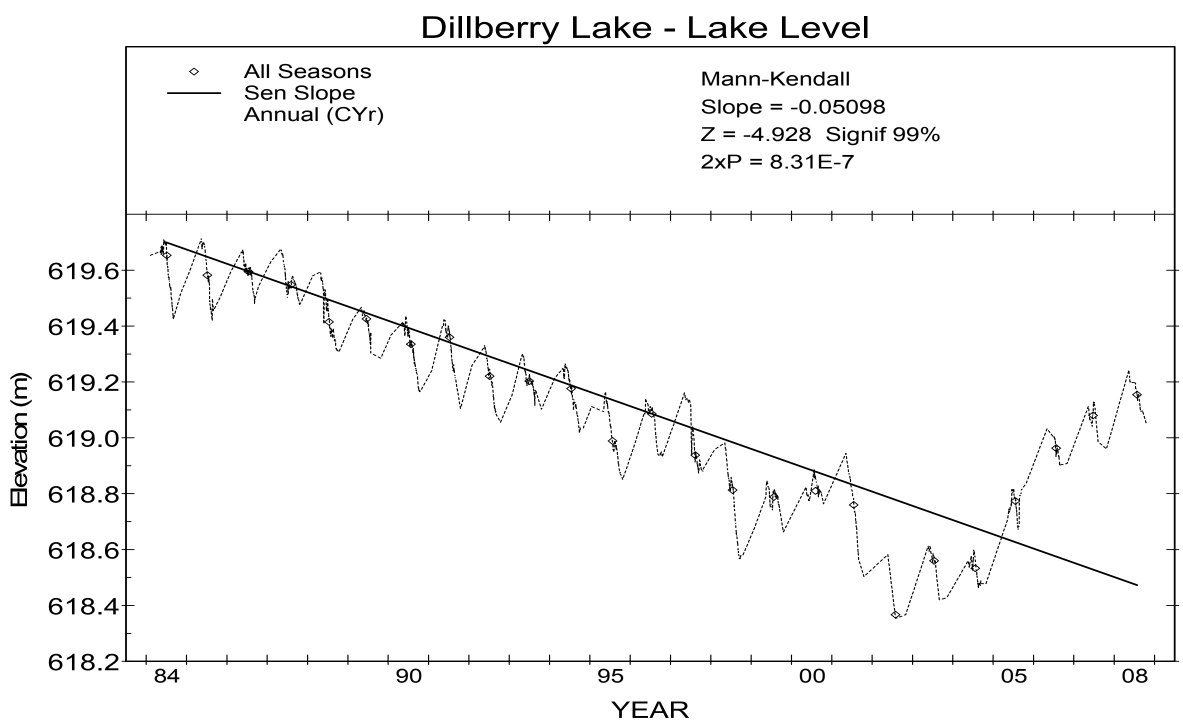
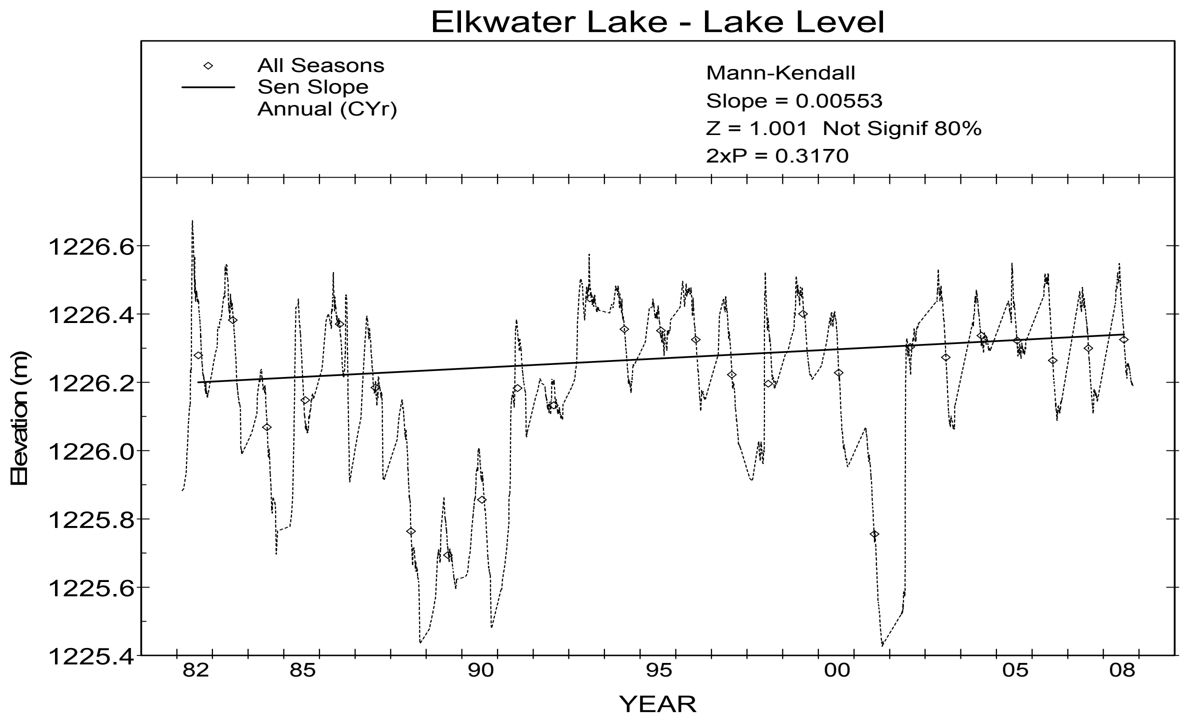


Figure 95 Trends in annual lake level for 37 lakes (continued)



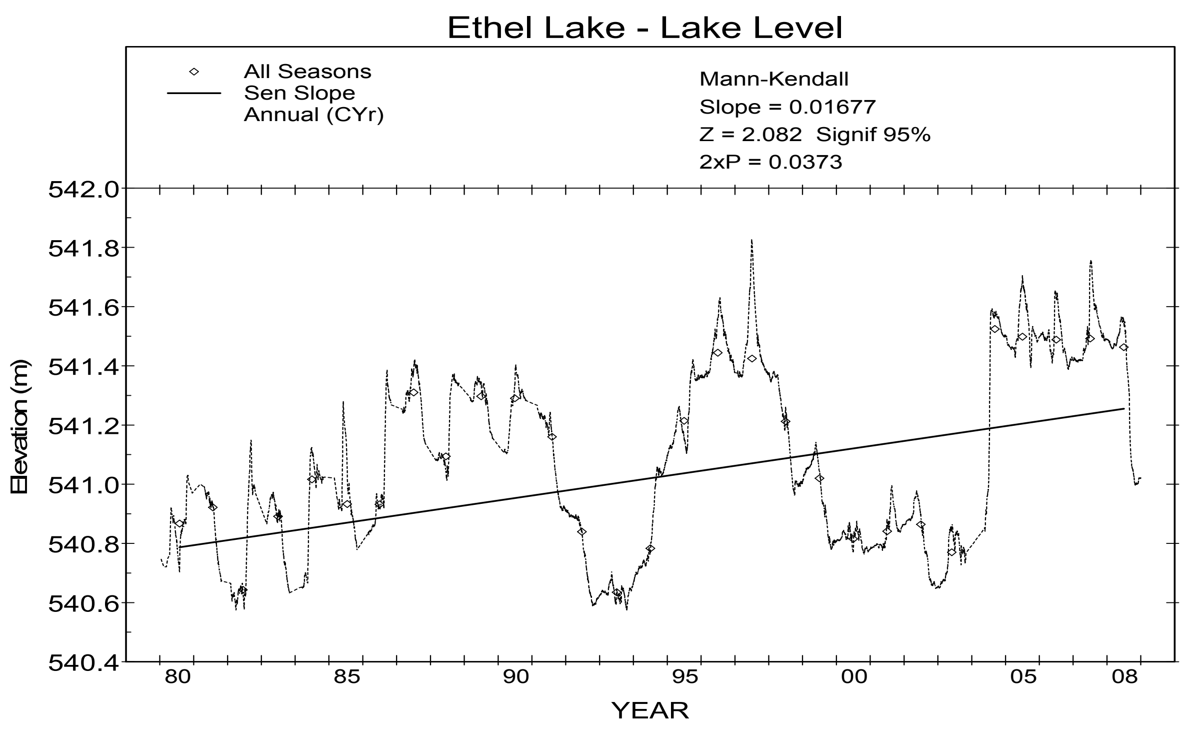
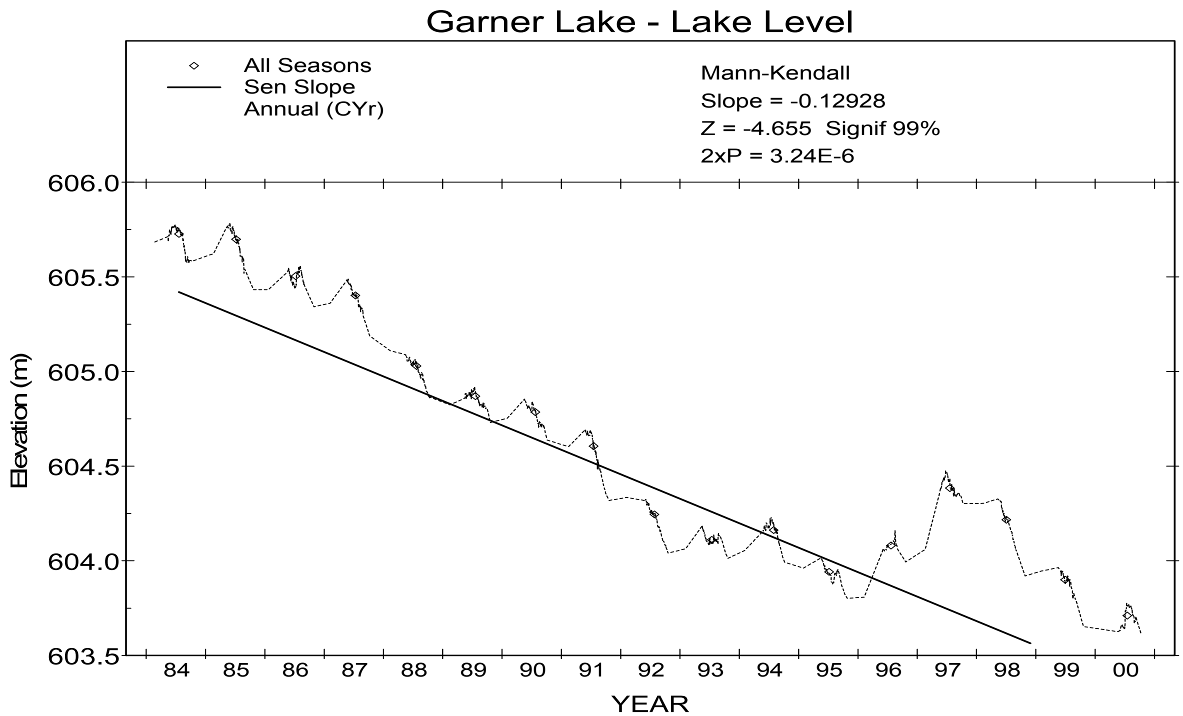


Figure 95 Trends in annual lake level test for 37 lakes (continued)



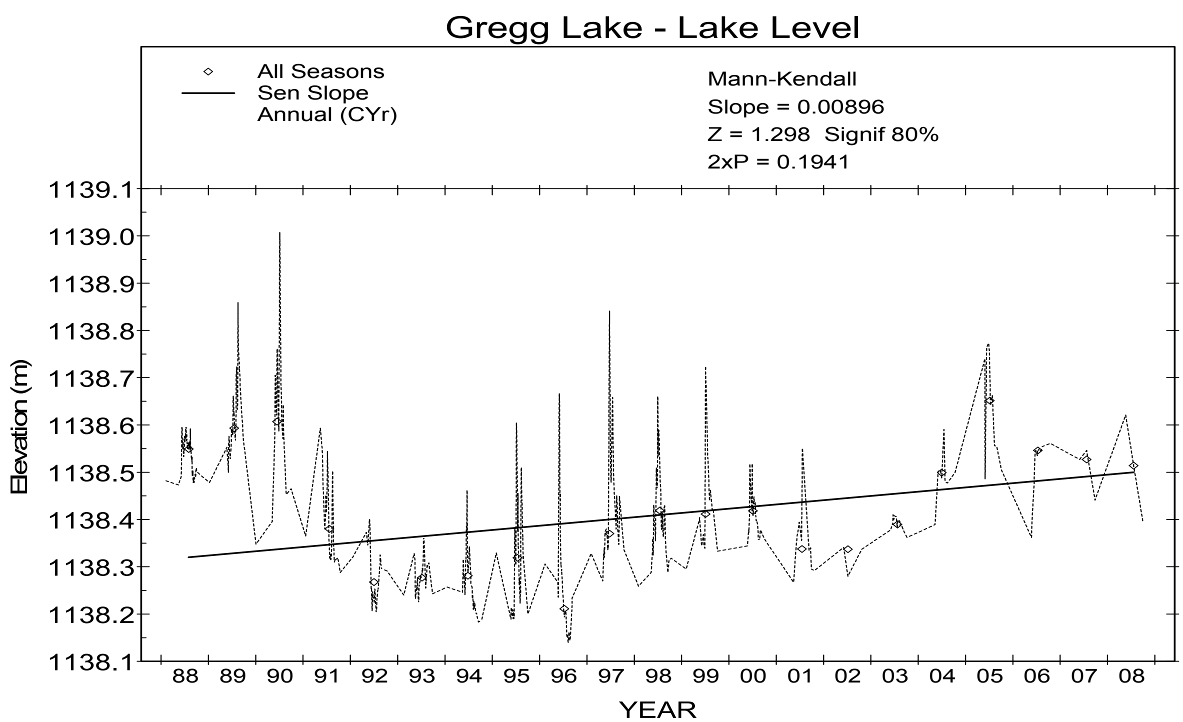
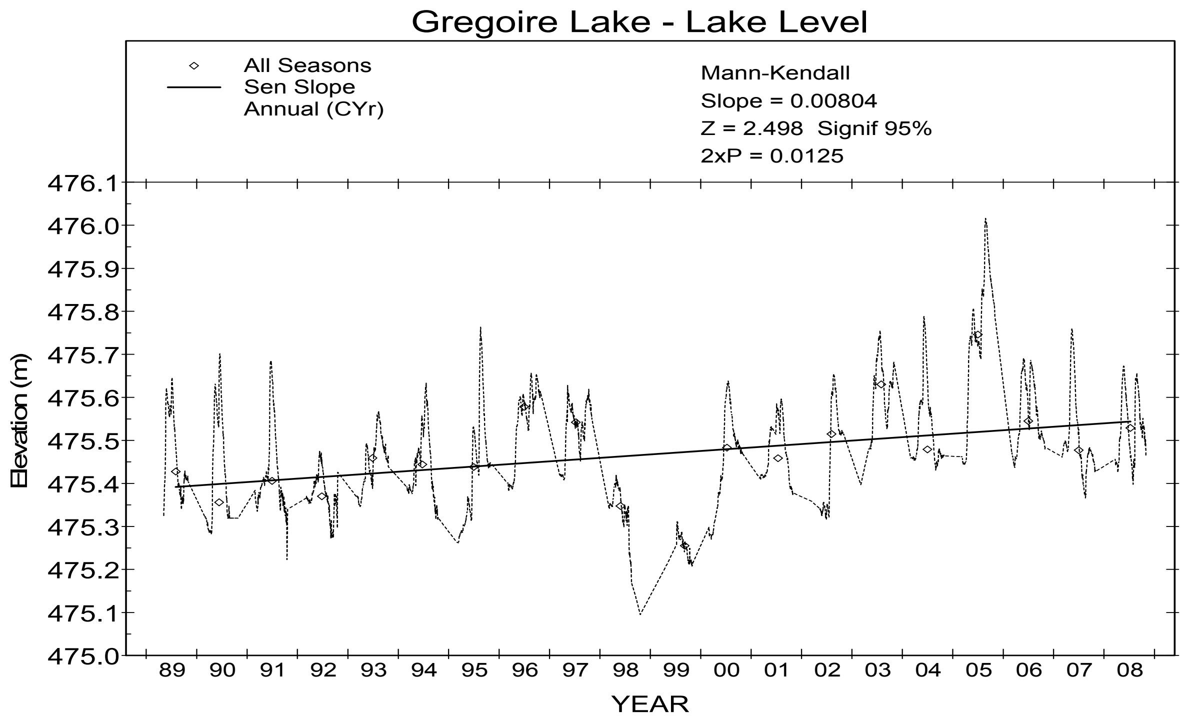


Figure 95 Trends in annual lake level for 37 lakes (continued)



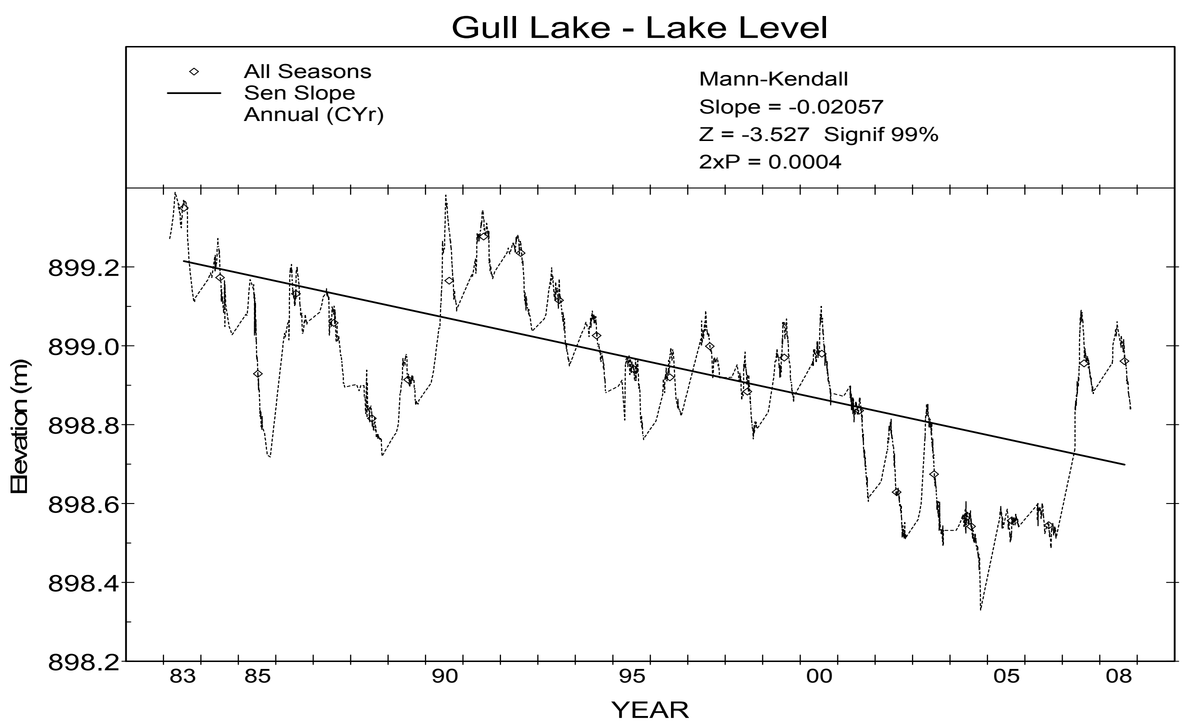
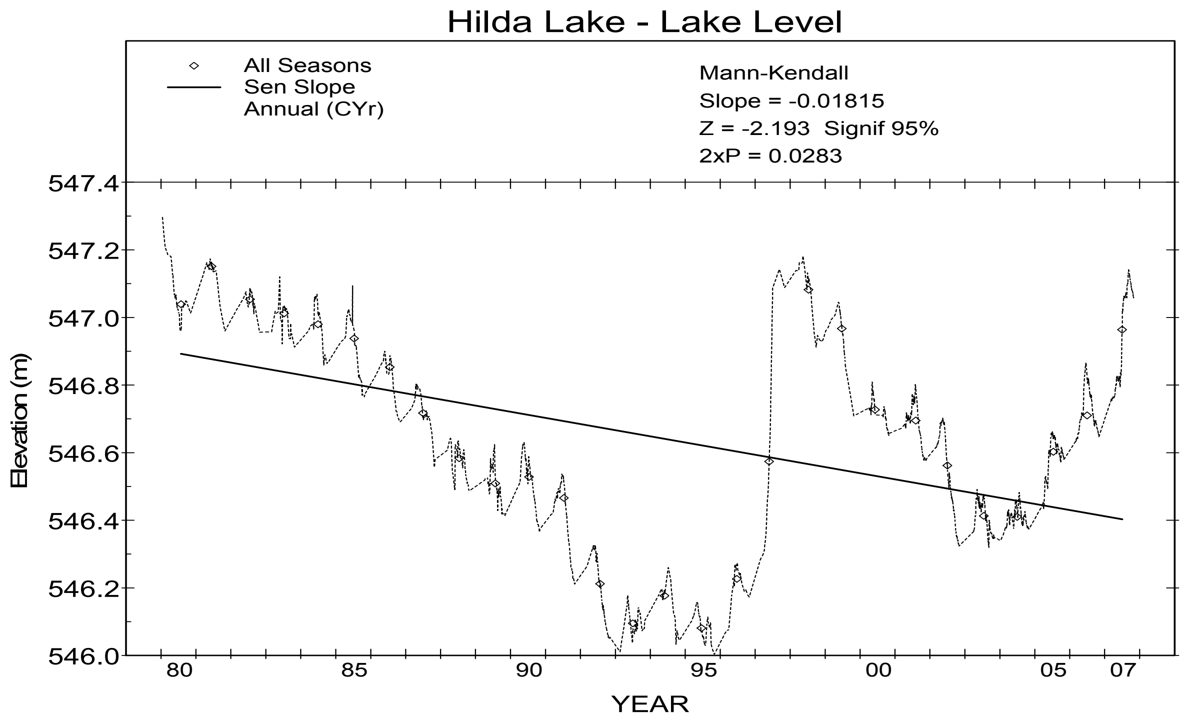


Figure 95 Trends in annual lake level for 37 lakes (continued)



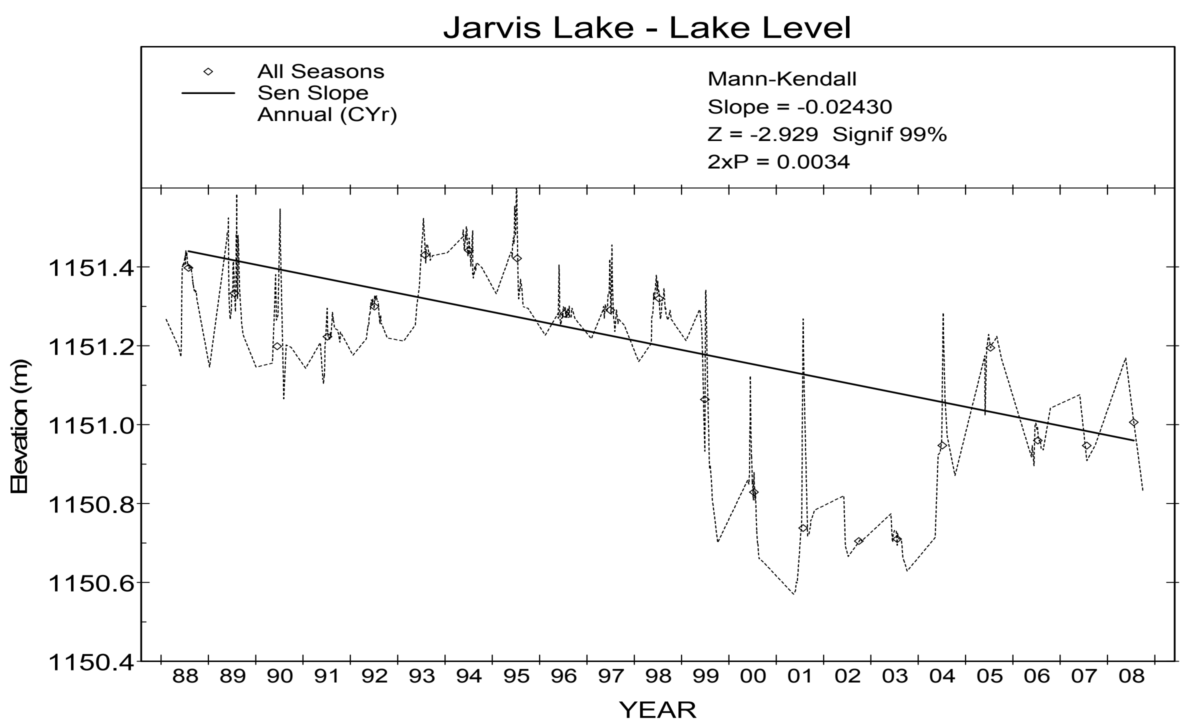
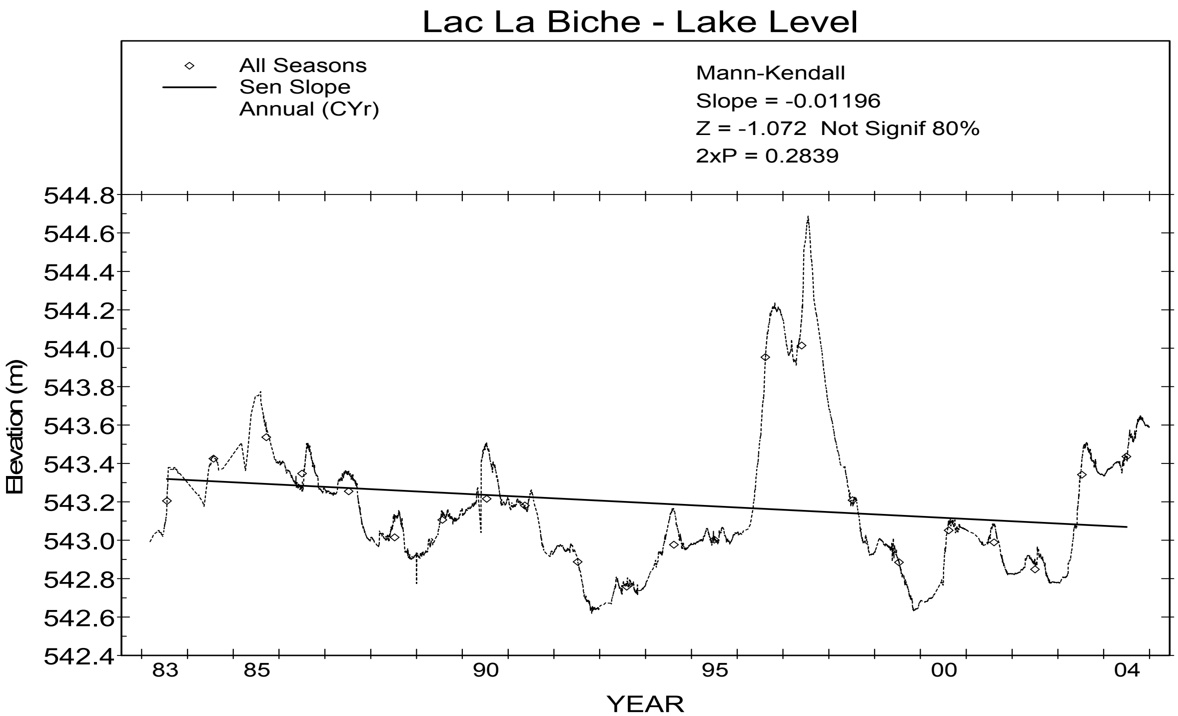


Figure 95 Trends in annual lake level for 37 lakes (continued)



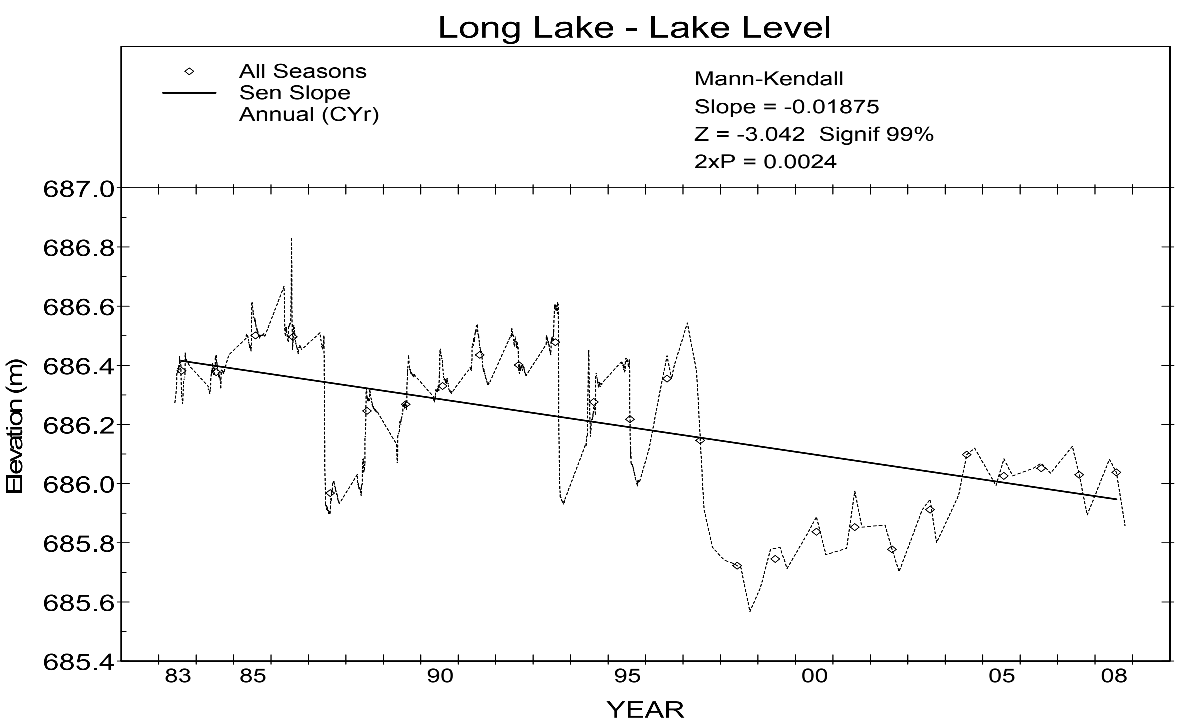
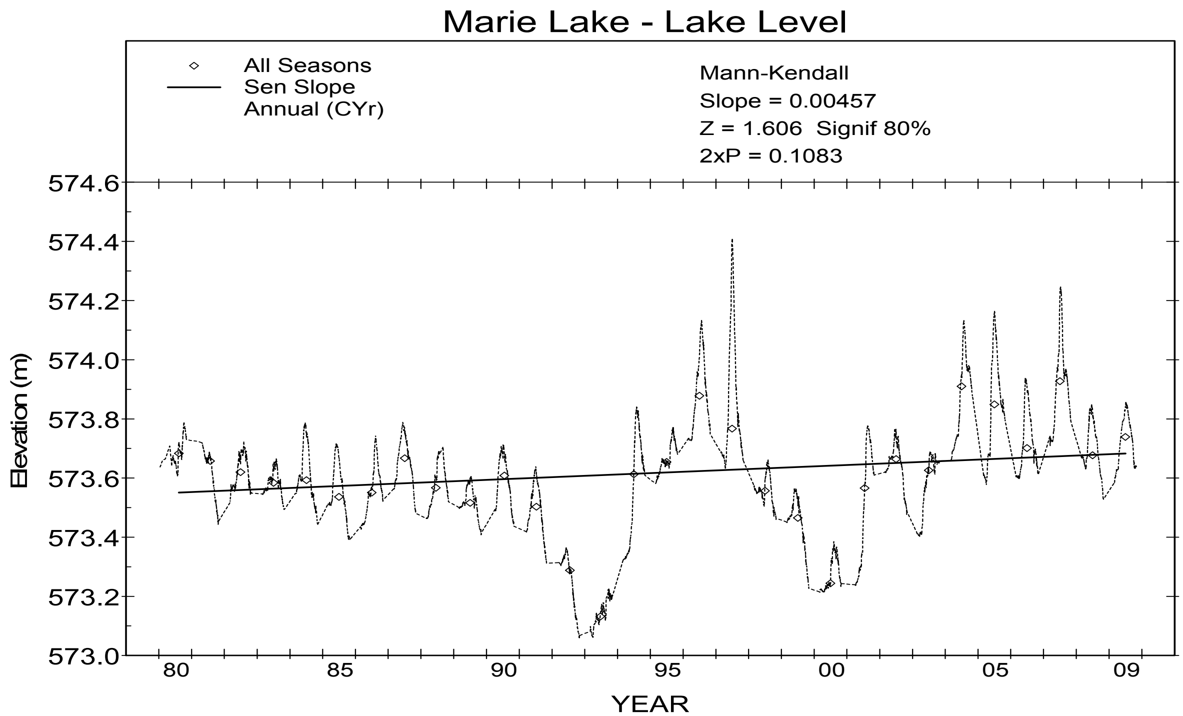


Figure 95 Trends in annual lake level for 37 lakes (continued)



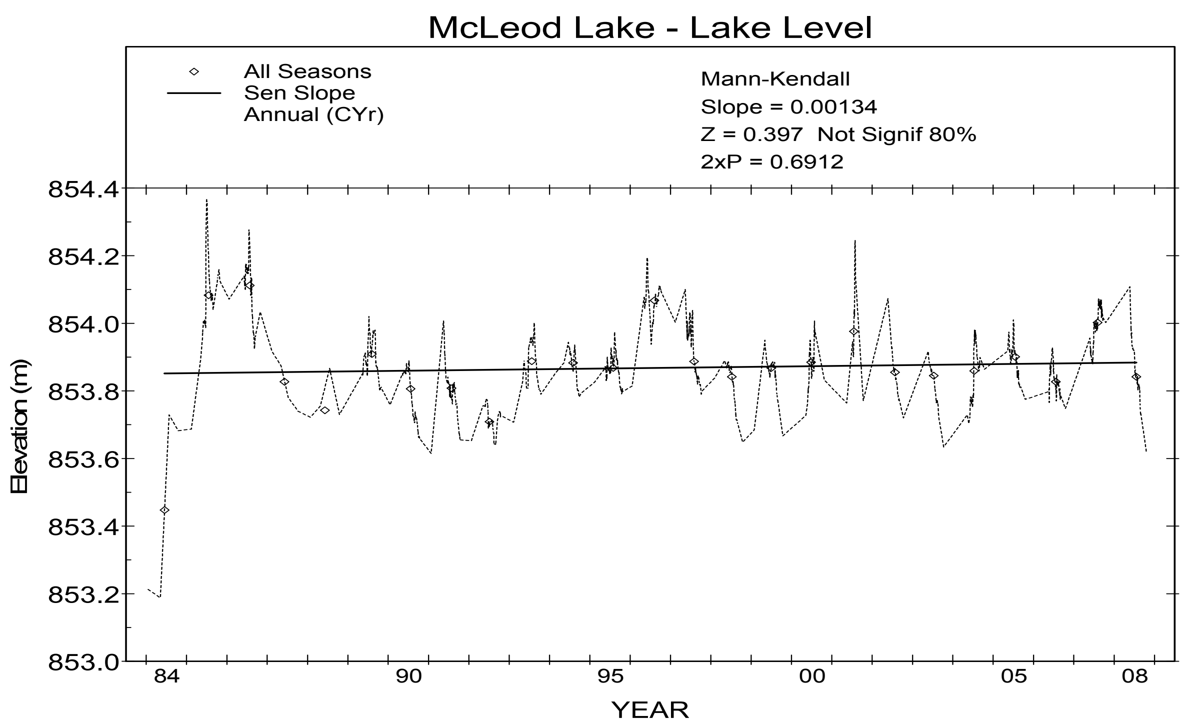
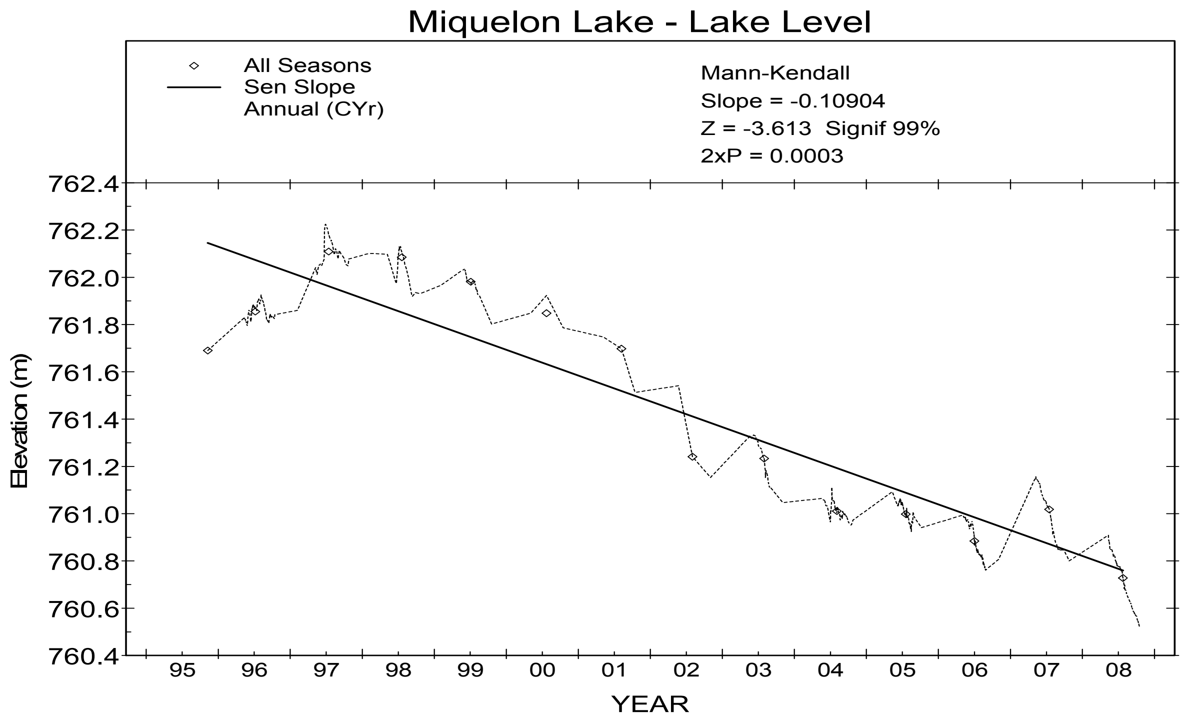


Figure 95 Trends in annual lake level 37 lakes (continued)



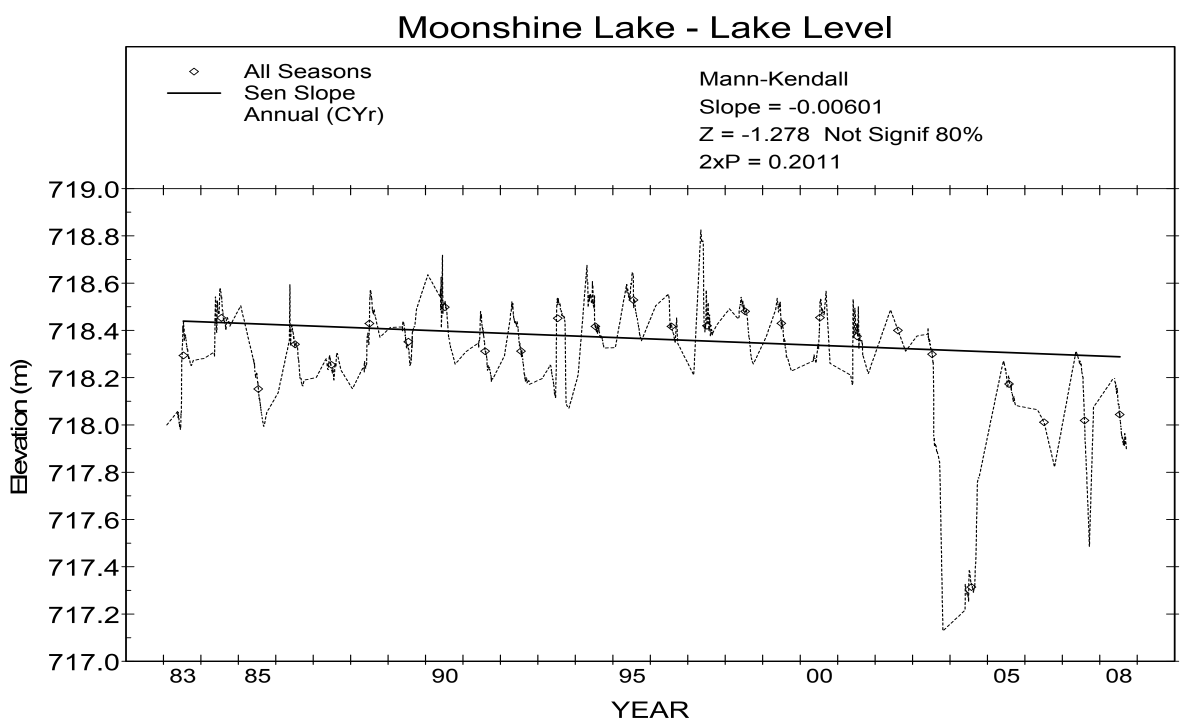
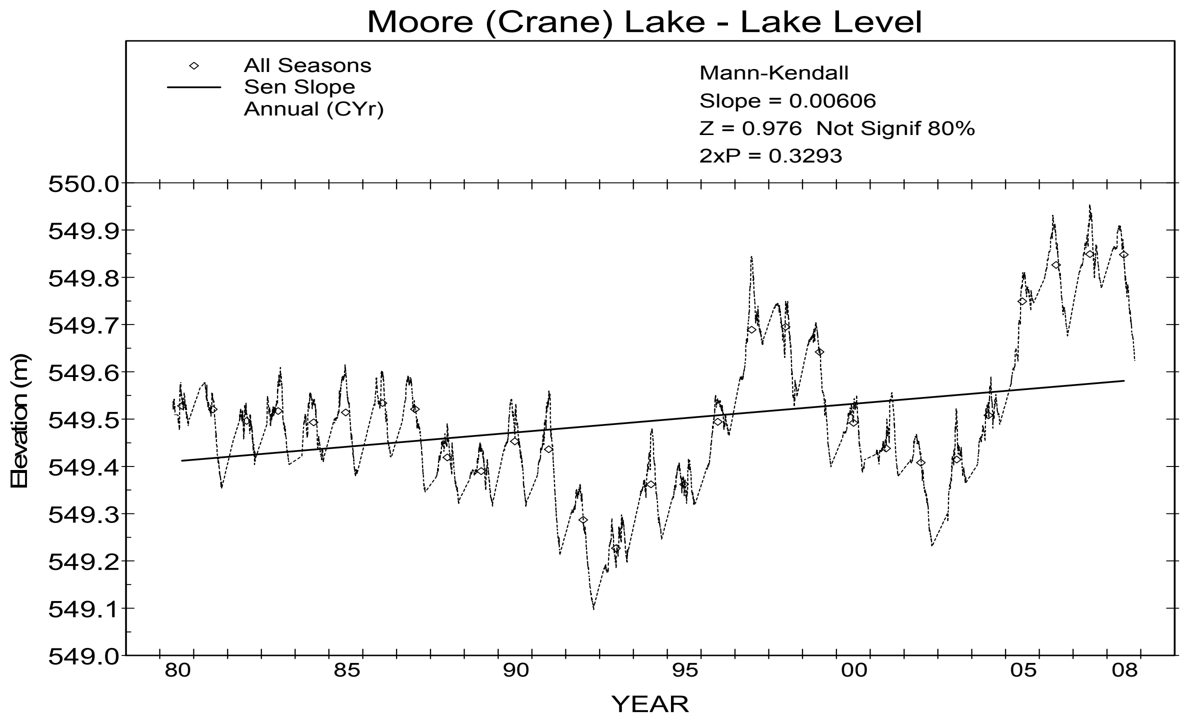


Figure 95 Trends in annual lake level for 37 lakes (continued)



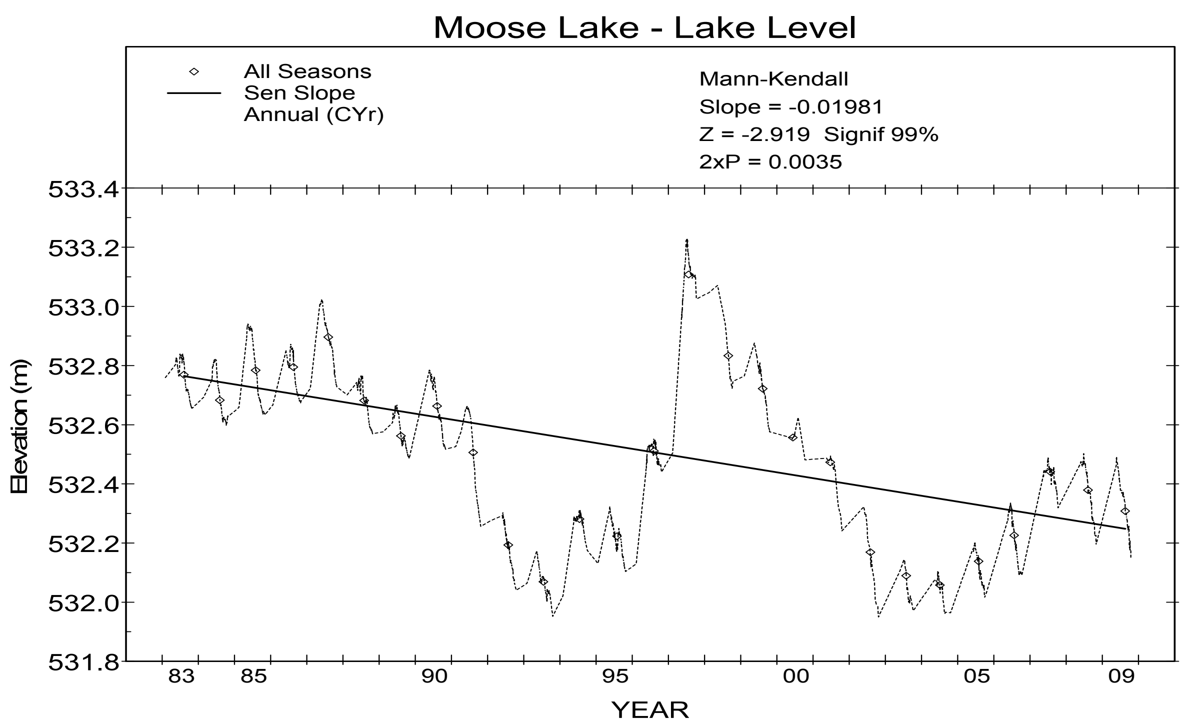
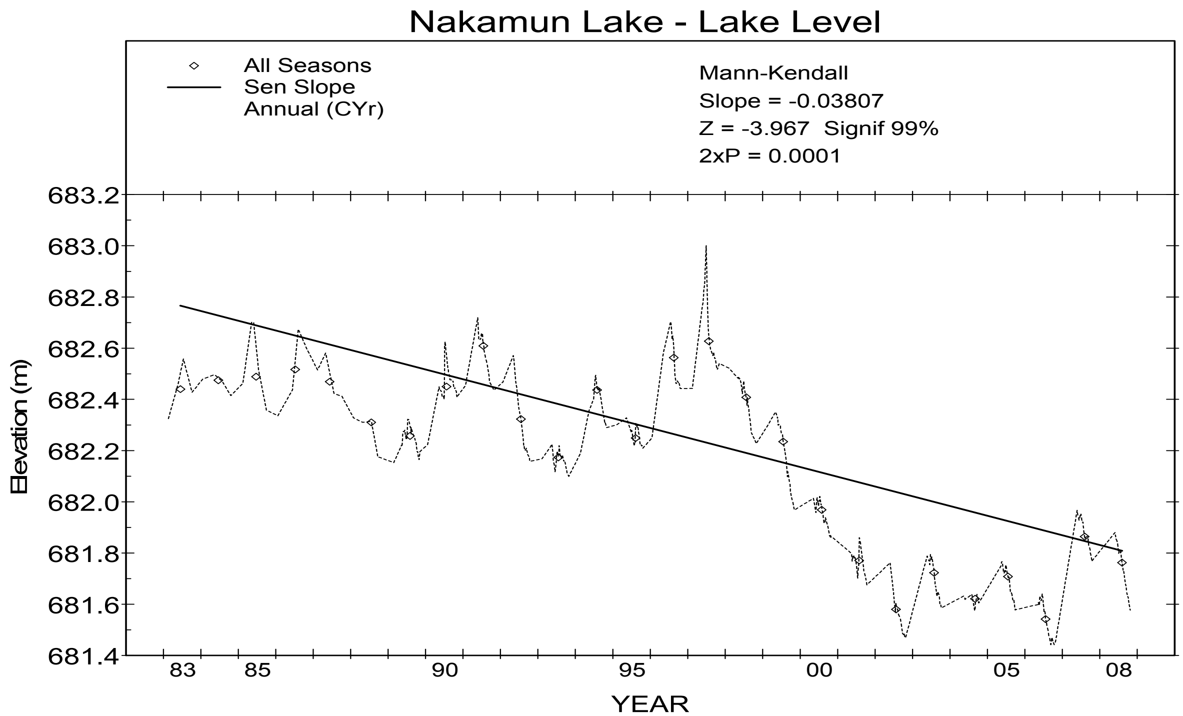


Figure 95 Trends in annual lake level for 37 lakes (continued)



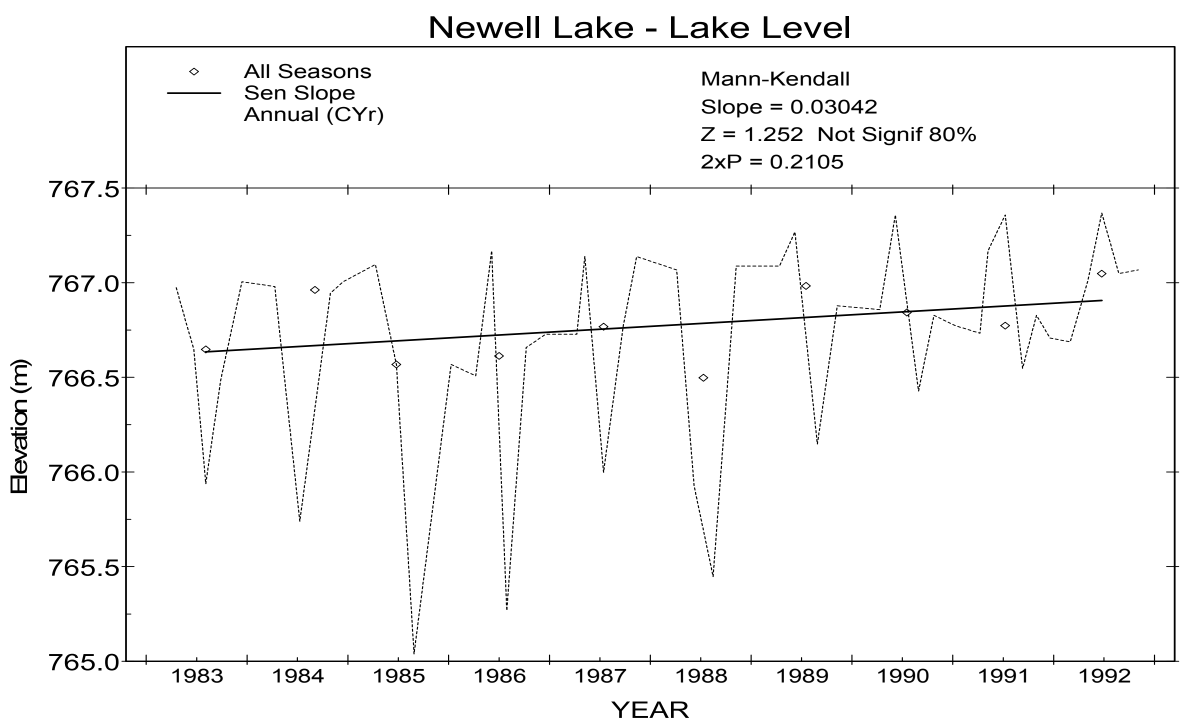
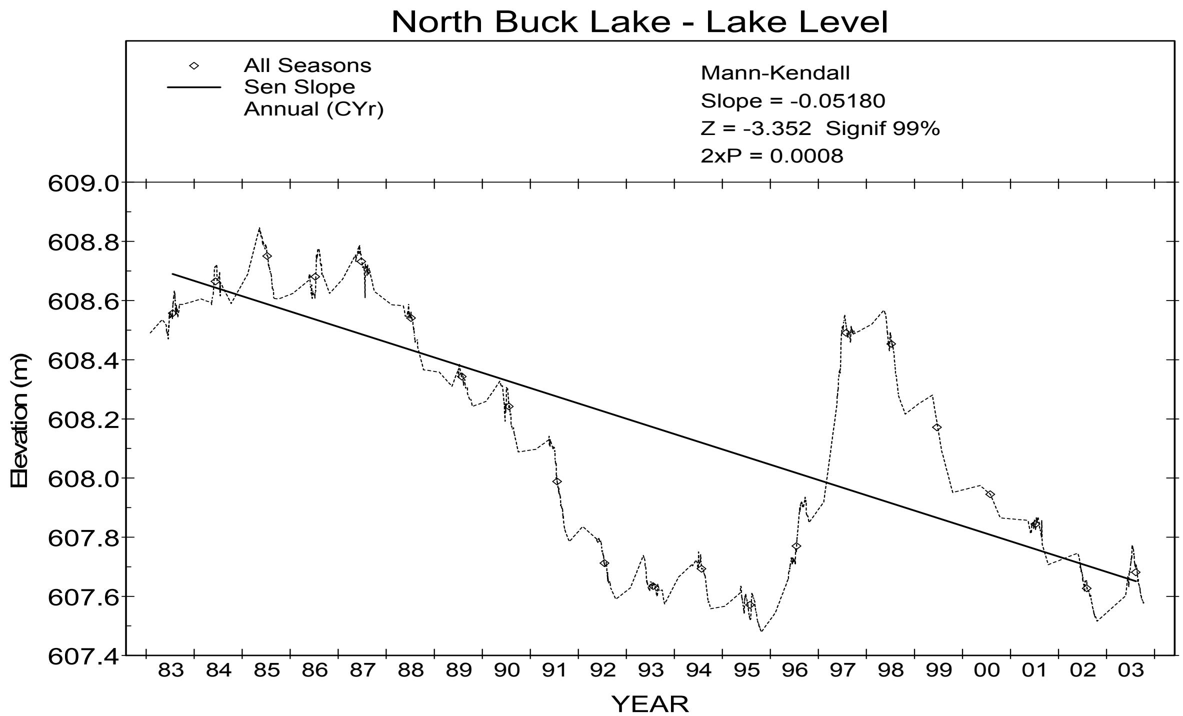


Figure 95 Trends in annual lake level for 37 lakes (continued)



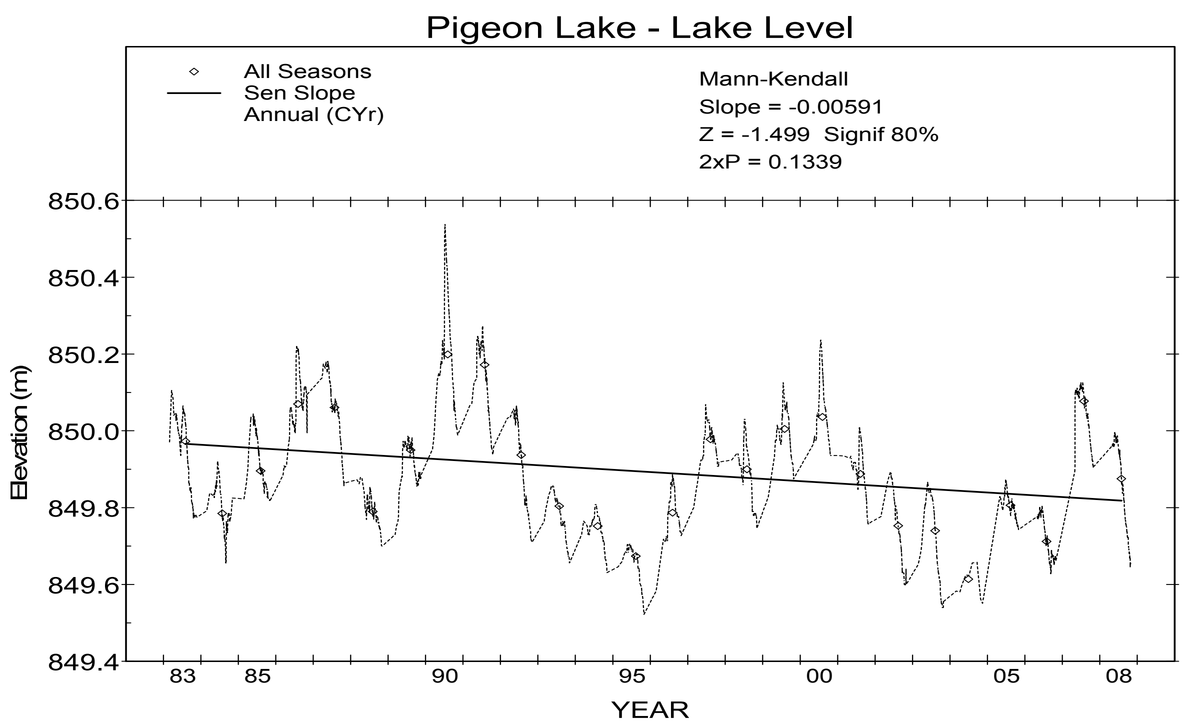
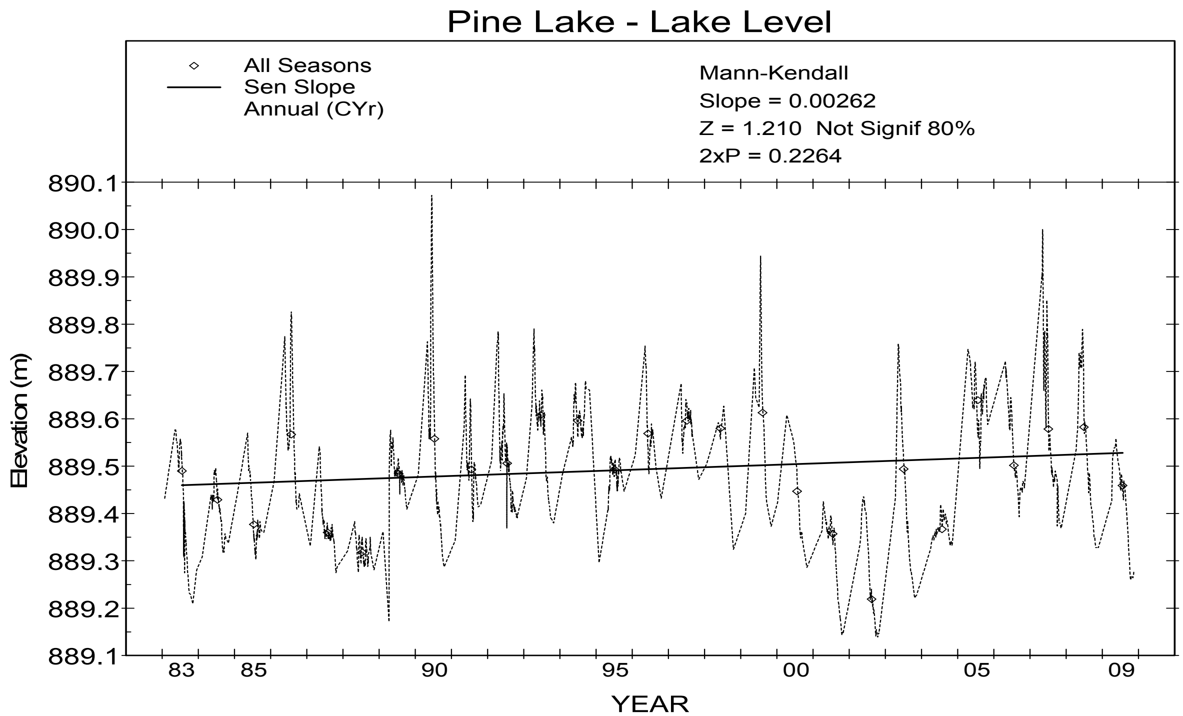


Figure 95 Trends in annual lake level for 37 lakes (continued)



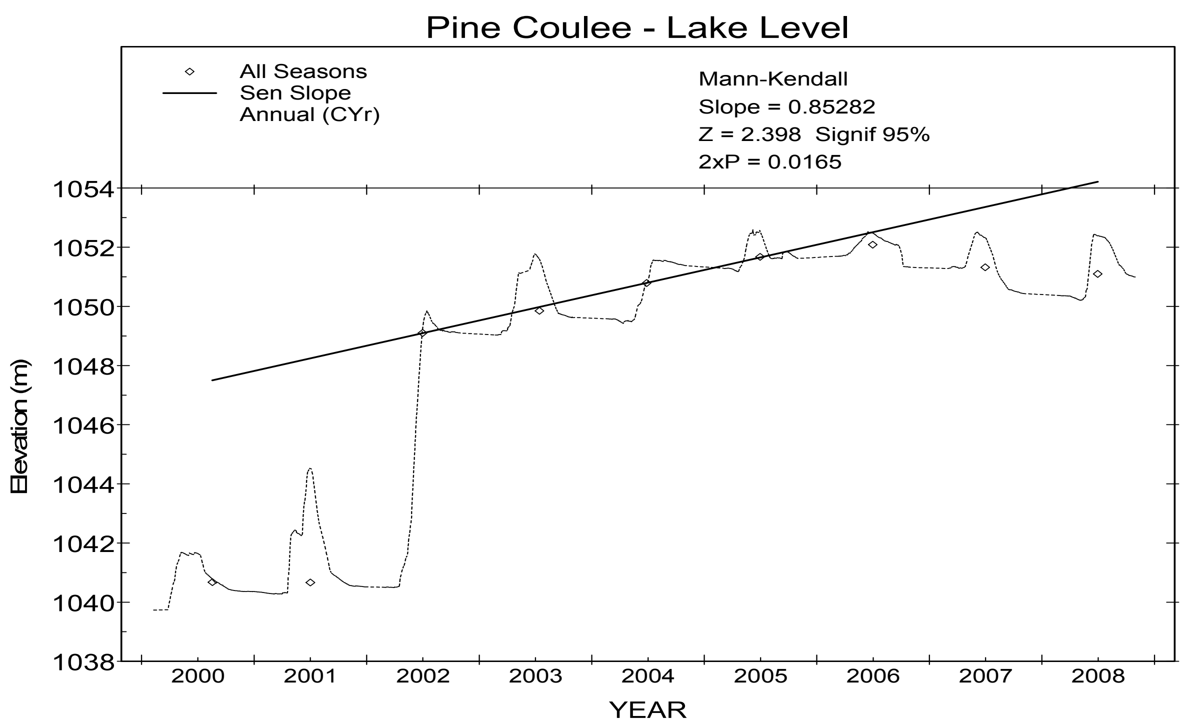
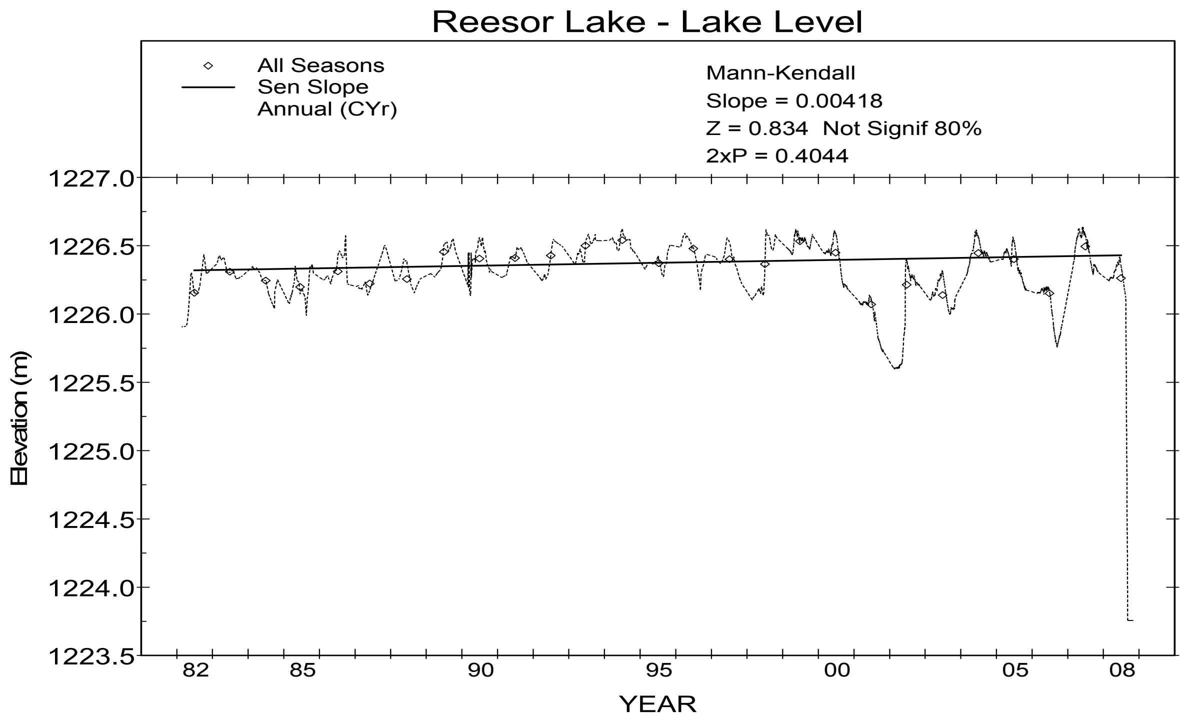


Figure 95 Trends in annual lake level for 37 lakes (continued)



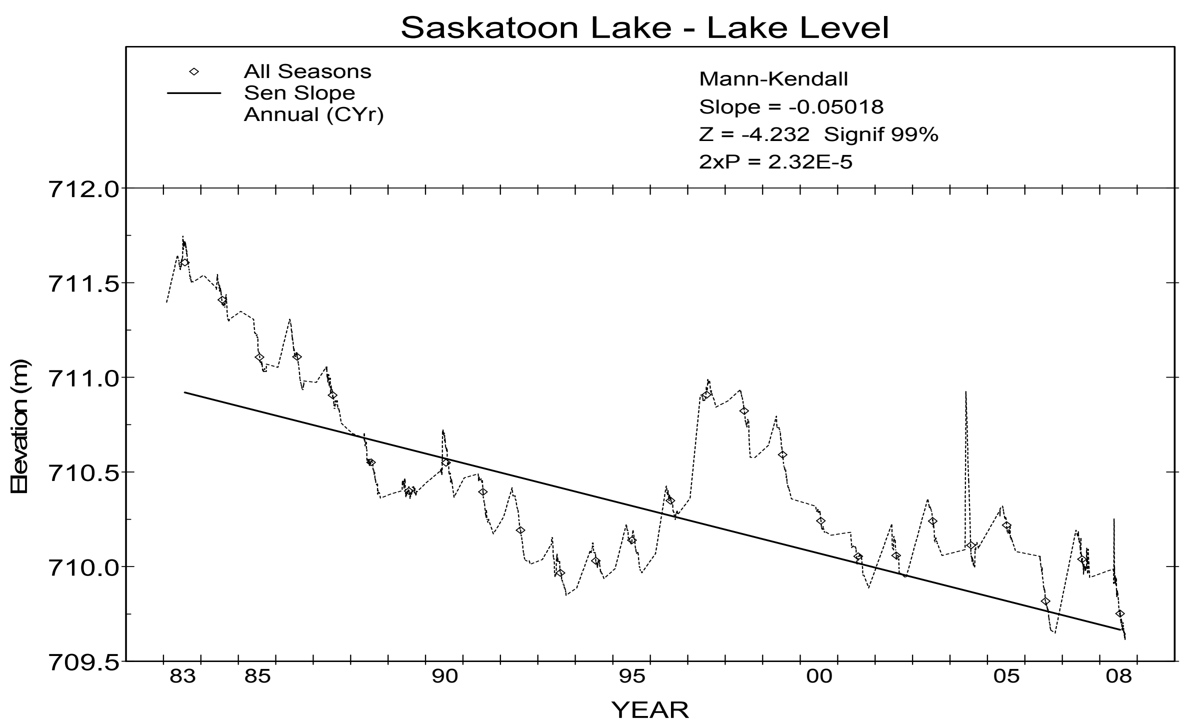
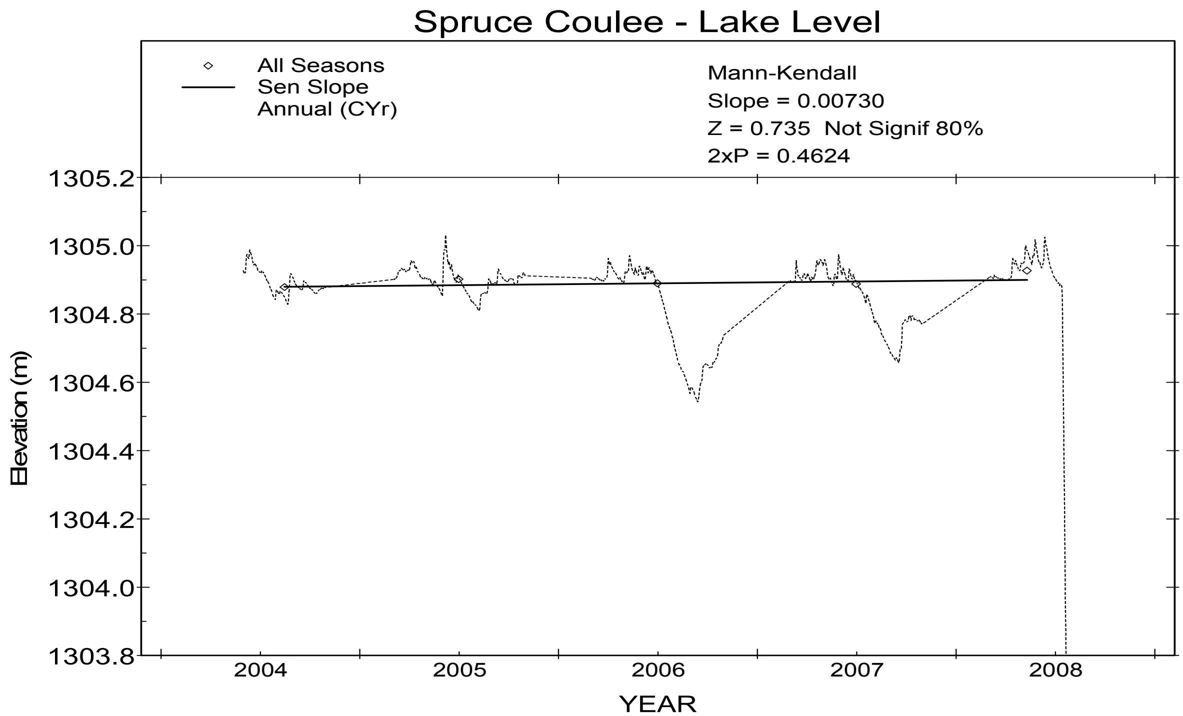


Figure 95 Trends in annual lake level for 37 lakes (continued)



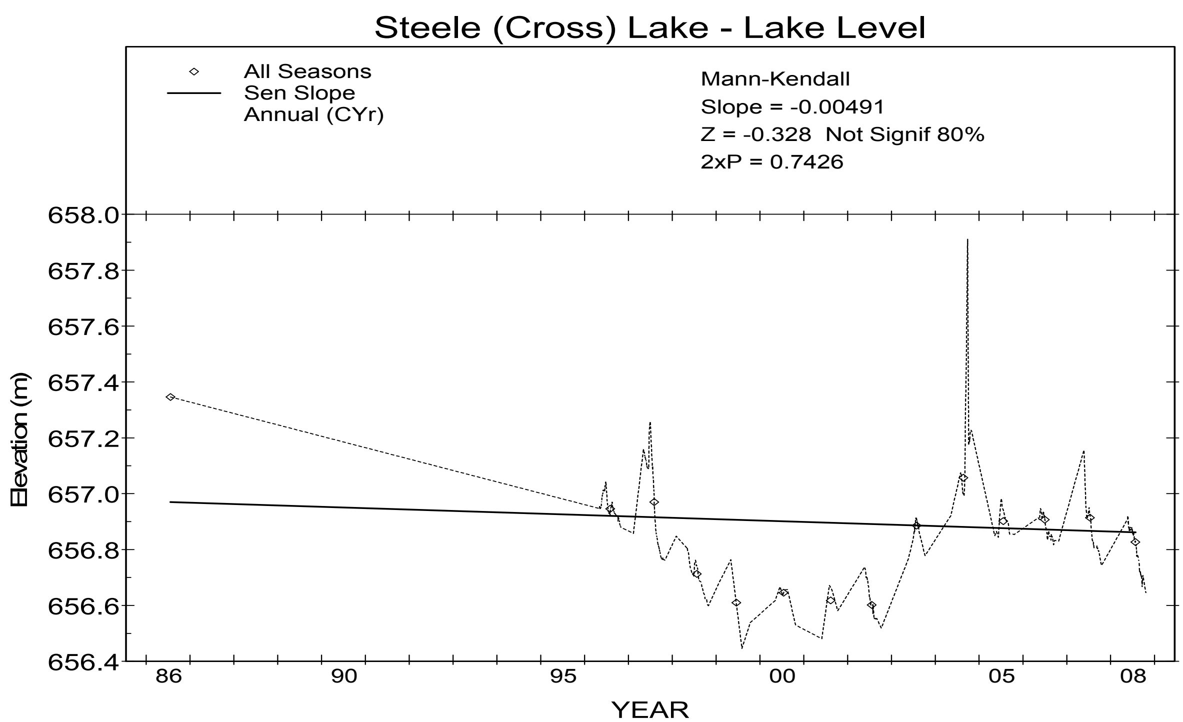
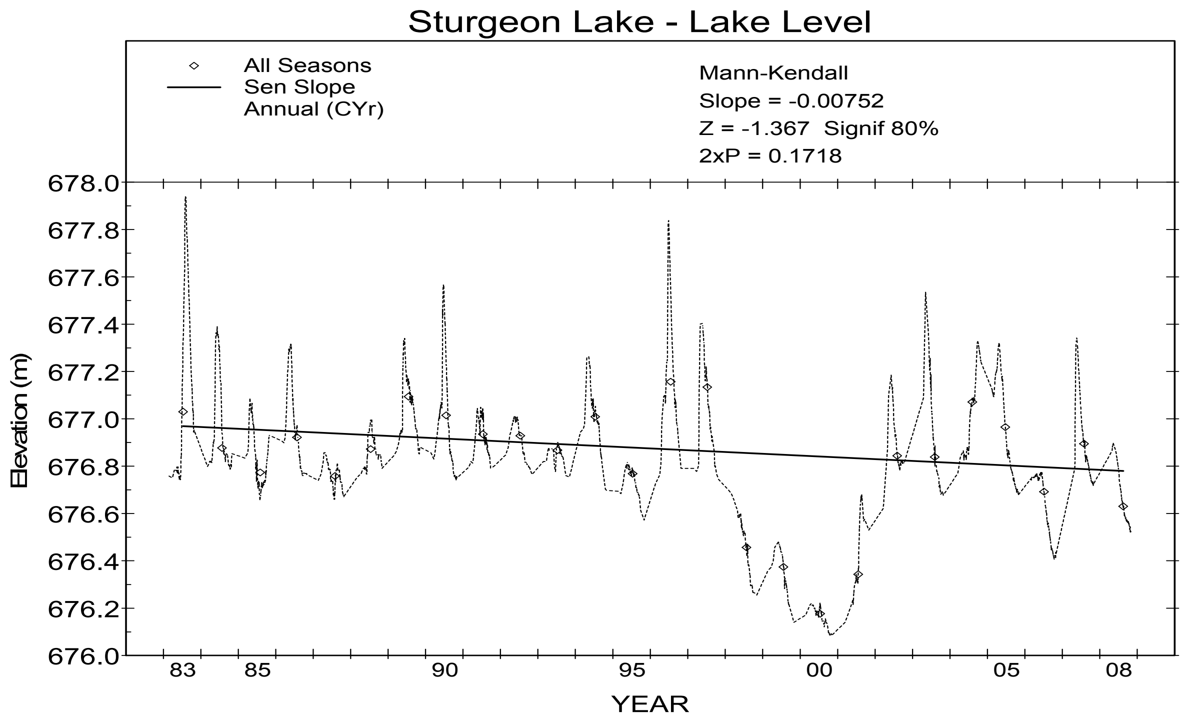


Figure 95 Trends in annual lake level for 37 lakes (continued)



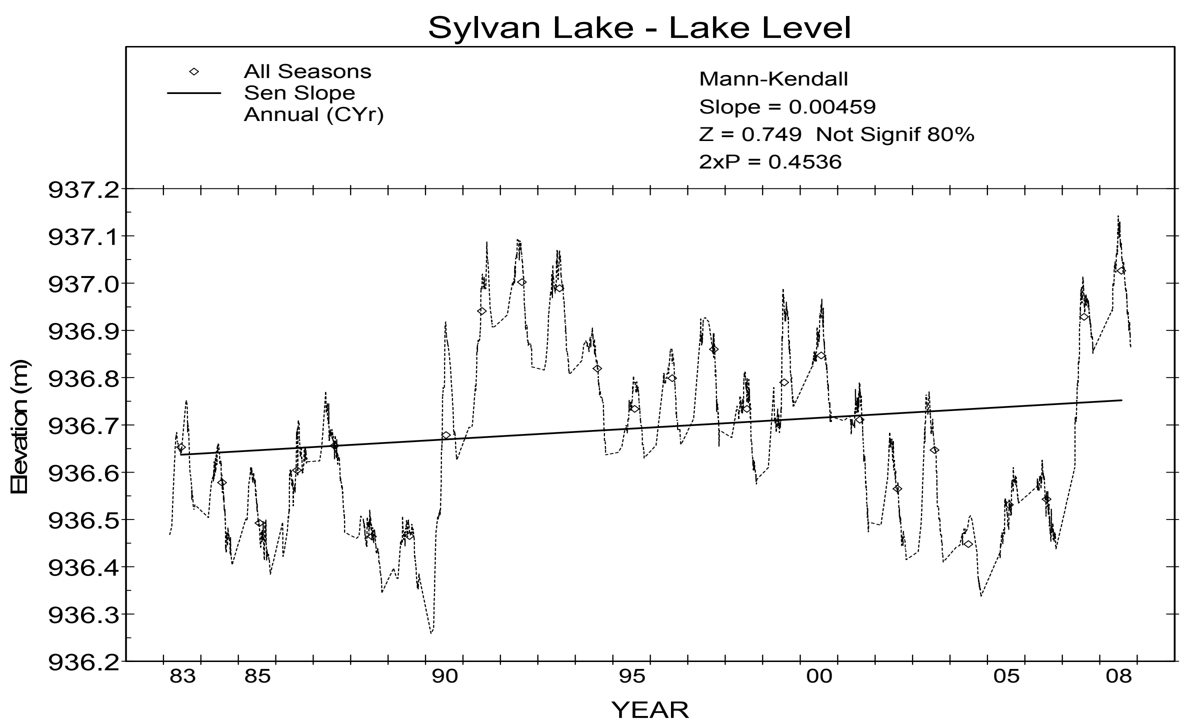
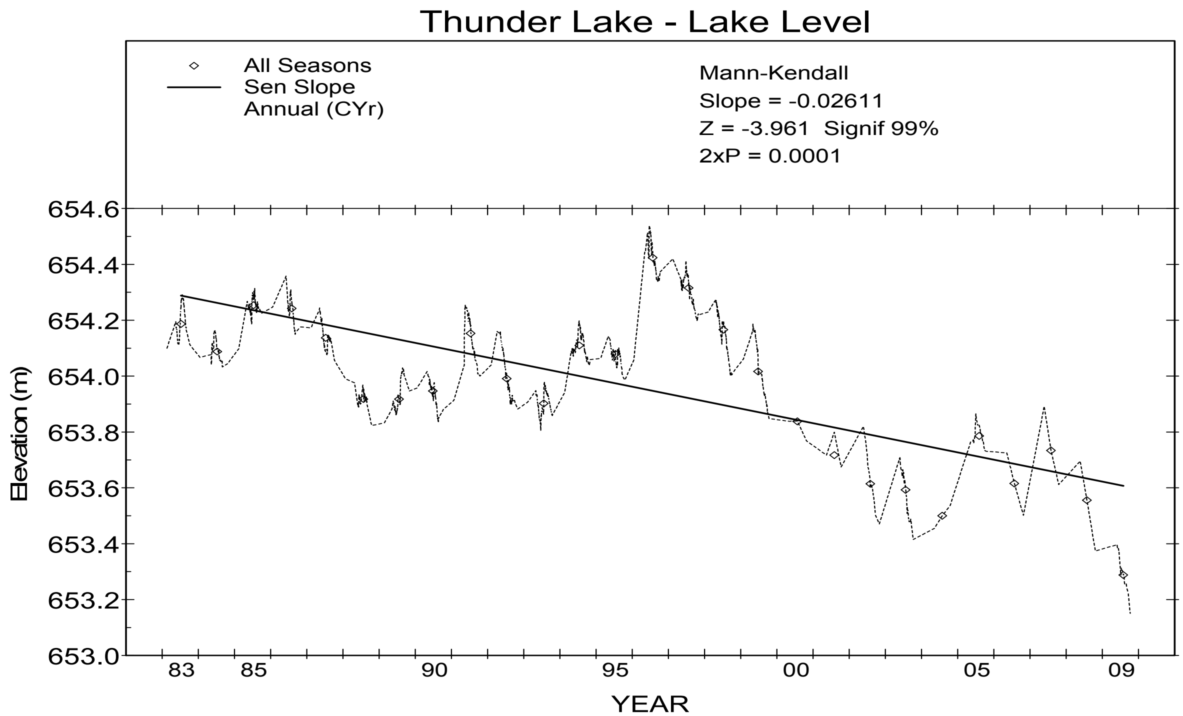


Figure 95 Trends in annual lake level for 37 lakes (continued)



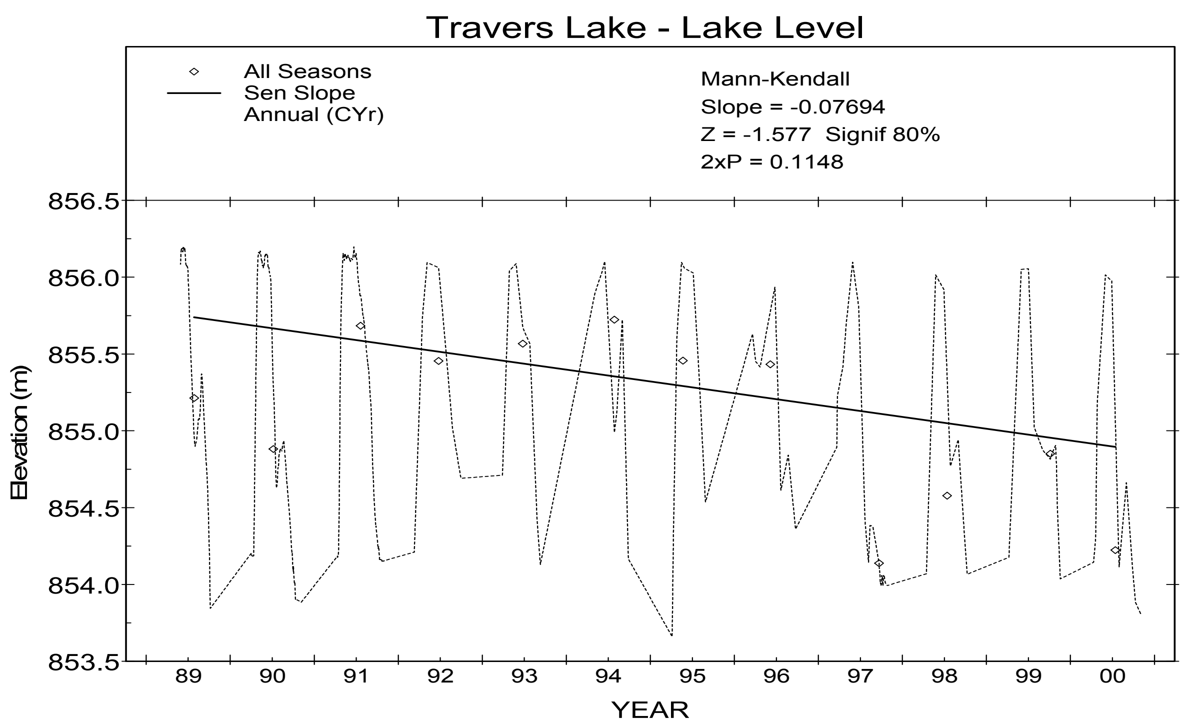
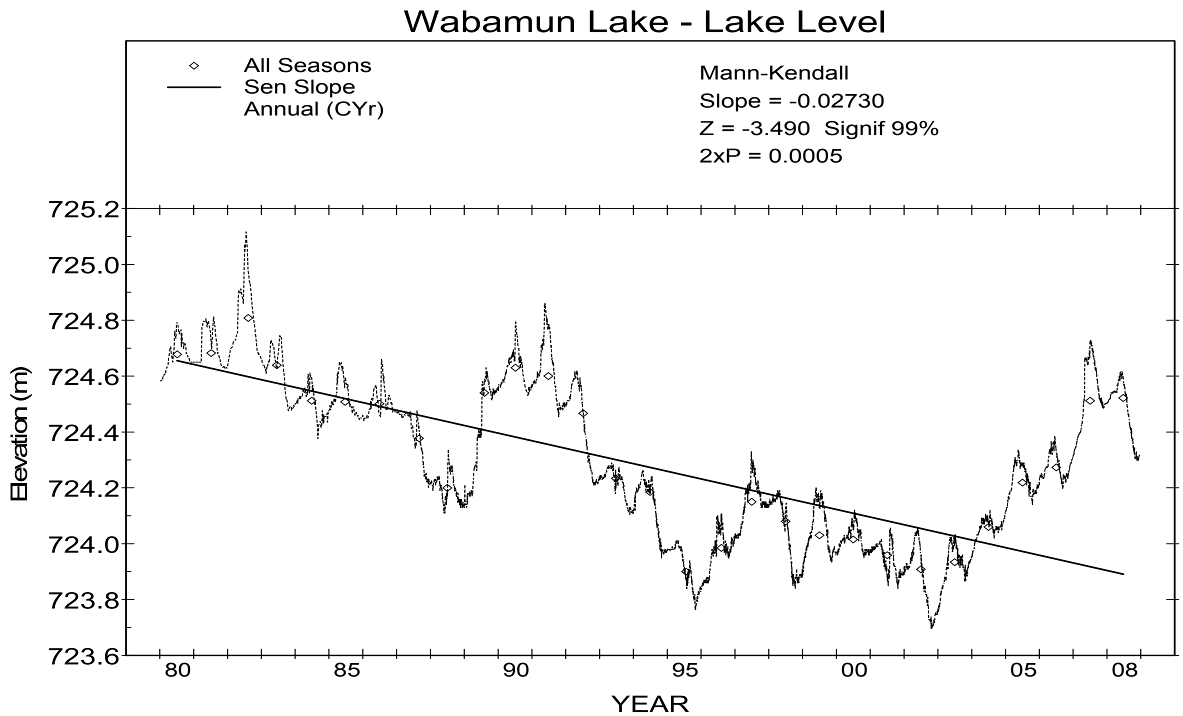


Figure 95 Trends in annual lake level for 37 lakes (continued)



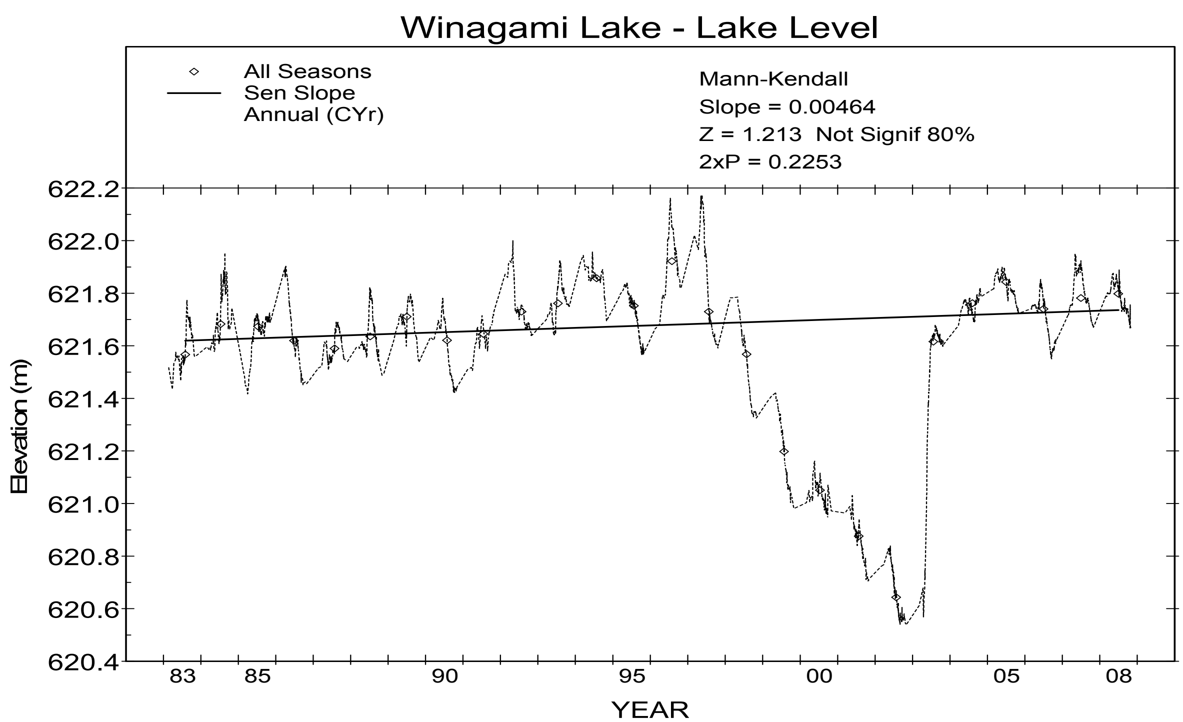


Figure 95 Trends in annual lake level for 37 lakes (concluded)

APPENDIX A Total number of composite samples and percentage of censored data for water quality variables analysed in the study lakes (1979 to 2009)

Lake or Basin: [A]	Alix		Bapiste Lake, North Basin		Bapiste Lake, South Basin		Beauvais		Buffalo, Secondary Bay		Buffalo, Main Basin		Crimson		Dillberry		Elkwater	
Maximum No. Years of Composite Samples:	10		18		18		21		15		17		23		19		27	
Water Quality Variable [A]	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL
pH (Lab)	47		106		104		47		65		72		43		41		65	
Total Alkalinity ($CaCO_3$)	47		106		104		47		65		72		43		41		65	
Phenolphthalein Alkalinity ($CaCO_3$)	47		40		39		14		44		44		18		22		31	
Samples <MDL [B, C, D]	21	45	5	13	7	18	10	71	0	0	0	0	3	17	2	9	4	13
Specific Conductance (Lab)	42		105		104		47		58		66		43		40		65	
Total Dissolved Solids (TDS)	38		104		102		44		63		72		33		31		54	
Filterable Residue (FR)	14		3		3		1		9		6		0		0		3	
Total Hardness ($CaCO_3$)	42		104		102		44		62		72		33		31		53	
Calcium (Ca Diss.& Extr.)	47		104		102		44		65		72		33		31		54	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg Diss. & Extr.)	47		104		102		43		65		72		34		31		54	
Sodium Dissolved (Na)	47		104		102		44		65		72		36		34		58	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potassium Dissolved (K)	47		104		102		44		65		72		36		34		58	
Bicarbonate (HCO_3)	47		106		104		47		65		72		43		40		63	
Carbonate (CO_3)	47		68		81		30		65		68		43		40		60	
Samples <MDL [B, C, D]	22	47	7	10	12	15	14	47	0	0	0	0	11	26	2	5	7	12
Sulphate Dissolved (SO_4)	47		104		102		44		65		72		36		34		58	
Samples <MDL [B, C, D]	0	0	0	0	1	1	9	20	0	0	0	0	25	69	8	24	0	0
Chloride Dissolved (Cl)	47		104		102		44		65		72		36		34		58	
Samples <MDL [B, C, D]	0	0	0	0	2	2	20	45	0	0	0	0	5	14	4	12	0	0
Fluoride Dissolved (F)	10		100		98		38		31		41		32		28		52	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0
Silica (Si)	34		102		100		39		58		68		33		28		52	
Samples <MDL [B, C, D]	3	9	19	19	21	21	2	5	1	2	4	6	0	0	0	0	0	0
Total Organic Carbon (TOC)	42		2		2		0		40		40		0		0		2	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inorganic Carbon	6		1		1		0		6		6		0		0		0	
Dissolved Inorganic Carbon (DIC)	6		61		59		1		12		12		1		0		1	
Dissolved Organic Carbon (DOC)	12		104		102		4		11		11		5		6		6	
Iron (Fe Diss. & Extr)	0		102		99		34		21		31		21		22		38	
Samples <MDL [B, C, D]	0	0	42	41	50	51	12	35	0	0	0	0	5	24	17	77	13	34
Non-Filterable Residue (NFR)	43		97		95		1		46		43		1		0		3	
Samples <MDL [B, C, D]	24	56	5	5	2	2	0	0	6	13	13	30	0	0	0	0	0	0
Phosphorus Total (TP)	47		111		111		88		68		81		73		69		119	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	0	0
Chlorophyll-a mg/m^3	47		113		113		87		68		84		72		69		117	
Transparency (Secchi Depth)	46		112		113		90		58		84		73		71		121	
Samples <MDL [B, C, D]	4	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus Total Diss. (TDP)	45		106		105		6		49		46		11		5		9	
Samples <MDL [B, C, D]	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Kjeldahl Nitrogen (TKN)	47		108		106		8		51		48		11		14		17	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia-N (NH_3-N)	47		103		101		6		50		47		6		5		6	
Samples <MDL [B, C, D]	19	40	0	0	0	0	0	0	3	6	2	4	0	0	0	0	1	17
Nitrate+Nitrite-N (NO_3+NO_2 -N)	46		107		105		42		65		72		37		36		56	
Samples <MDL [B, C, D]	29	63	19	18	26	25	35	83	26	40	38	53	25	68	24	67	42	75
Nitrate-N (NO_3 -N)	22		0		0		2		23		23		0		0		2	
Samples <MDL [B, C, D]	19	86	0	0	0	0	2	100	12	52	12	52	0	0	0	0	2	100
Nitrite-N (NO_2 -N)	22		101		98		35		44		54		26		21		41	
Samples <MDL [B, C, D]	21	95	42	42	43	44	30	86	29	66	33	61	19	73	18	86	30	73
Total Nitrogen (TN) [G]	46		107		105		7		51		48		16		13		22	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TN:TP Ratio	46		105		103		7		51		48		11		13		16	

Footnotes:

[A] For each lake, the number of samples for each water quality variable over the sample record is shown in bold font

[B] If censored data occurred, the number and percentage of those samples (No. and % <MDL) is shown

[C] Variables with 20 to 29% and 30 to 100% of values <MDL are highlighted with yellow and pink shading, respectively

[D] Ranges of censored values for Pine and Wabamun lakes are based on multiple composite samples taken in select years

[E] For Pine Lake, the composite samples were taken over the entire lake (1983, 1995, 2003 to 2006 and 2008 to 2009), or in three portions of the lake (north, middle and south) (1984 to 2001 and 2007)

[F] For Wabamun Lake, the composite samples were taken in the east and west basins (1980 to 1982 and 1999 to 2008), or over the entire lake (1983 to 1998)

[G] TN was based on the sum of TKN (i.e., organic nitrogen and ammonia-N) and nitrate+nitrite-N samples; half the MDL was used when NO_3+NO_2-N values were <MDL.

Lake or Basin: [A]	Ethel (near Cold Lake)		Garner		Gregg		Gregoire		Gull		Hilda		Jarvis		Lac La Biche, E. Basin		Lac La Biche, W. Basin	
Maximum No. Years of Composite Samples:	22		14		20		20		18		12		20		10		4	
Water Quality Variable [A]	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL
pH (Lab)	135		30		41		48		50		39		42		28		16	
Total Alkalinity ($CaCO_3$)	135		30		41		48		50		39		42		28		16	
Phenolphthalein Alkalinity ($CaCO_3$)	67		6		22		26		15		34		23		14		5	
Samples <MDL [B, C, D]	33	49	0	0	12	55	26	100	0	0	7	21	16	70	8	57	3	60
Specific Conductance (Lab)	135		30		41		48		50		39		42		28		16	
Total Dissolved Solids (TDS)	135		30		30		36		50		39		31		28		16	
Filterable Residue (FR)	15		0		0		1		3		11		0		1		2	
Total Hardness ($CaCO_3$)	113		30		30		36		50		23		31		28		16	
Calcium (Ca Diss.& Extr.)	133		30		30		36		50		37		31		28		16	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg Diss. & Extr.)	135		30		30		36		50		38		31		28		16	
Sodium Dissolved (Na)	135		30		33		39		50		39		34		28		16	
Samples <MDL [B, C, D]	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0
Potassium Dissolved (K)	135		30		33		39		50		39		34		28		16	
Bicarbonate (HCO_3)	107		30		41		48		50		16		42		28		16	
Carbonate (CO_3)	85		30		31		18		50		16		28		20		11	
Samples <MDL [B, C, D]	24	28	0	0	13	42	17	94	0	0	0	0	14	50	6	30	3	27
Sulphate Dissolved (SO_4)	135		30		33		39		50		39		34		28		16	
Samples <MDL [B, C, D]	96	71	0	0	17	52	1	3	0	0	0	0	19	56	5	18	2	13
Chloride Dissolved (Cl)	135		30		33		39		50		39		34		28		16	
Samples <MDL [B, C, D]	3	2	0	0	2	6	4	10	0	0	0	0	0	0	0	0	0	0
Fluoride Dissolved (F)	119		30		25		30		45		20		26		27		14	
Samples <MDL [B, C, D]	1	1	0	0	1	4	1	3	0	0	0	0	1	4	0	0	0	0
Silica (Si)	135		30		25		31		48		33		26		28		16	
Samples <MDL [B, C, D]	8	6	1	3	0	0	0	0	1	2	4	12	0	0	0	0	1	6
Total Organic Carbon (TOC)	28		0		0		0		3		25		0		1		2	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inorganic Carbon	28		0		0		0		3		25		0		0		0	
Dissolved Inorganic Carbon (DIC)	73		0		1		0		1		4		1		0		1	
Dissolved Organic Carbon (DOC)	146		0		7		7		9		37		7		15		16	
Iron (Fe Diss. & Extr)	129		24		18		18		32		36		18		20		15	
Samples <MDL [B, C, D]	75	58	20	83	6	33	1	6	14	44	17	47	9	50	9	45	10	67
Non-Filterable Residue (NFR)	118		0		1		1		10		25		1		15		16	
Samples <MDL [B, C, D]	26	22	0	0	0	0	0	0	0	0	3	12	0	0	0	0	1	6
Phosphorus Total (TP)	139		61		58		88		67		39		60		38		17	
Samples <MDL [B, C, D]	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorophyll-a mg/m^3	154		60		61		87		68		51		64		37		17	
Transparency (Secchi Depth)	144		61		63		91		67		44		63		39		17	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus Total Diss. (TDP)	141		1		6		5		22		39		6		16		16	
Samples <MDL [B, C, D]	2	1	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0
Total Kjeldahl Nitrogen (TKN)	152		1		15		17		22		47		15		17		17	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia-N (NH_3-N)	152		1		6		7		19		49		6		17		17	
Samples <MDL [B, C, D]	4	3	0	0	0	0	0	0	1	5	1	2	0	0	0	0	0	0
Nitrate+Nitrite-N (NO_3+NO_2 -N)	153		26		36		41		48		47		36		24		17	
Samples <MDL [B, C, D]	71	46	18	69	22	61	32	78	41	85	26	55	29	81	15	63	6	35
Nitrate-N (NO_3 -N)	19		0		2		2		6		19		2		0		0	
Samples <MDL [B, C, D]	11	58	0	0	1	50	2	100	6	100	9	47	2	100	0	0	0	0
Nitrite-N (NO_2 -N)	148		25		18		19		36		38		18		22		15	
Samples <MDL [B, C, D]	113	76	11	44	14	78	9	47	32	89	30	79	15	83	11	50	7	47
Total Nitrogen (TN) [G]	153		1		15		17		22		48		15		17		17	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TN:TP Ratio	133		1		15		17		22		34		15		16		17	

Footnotes:

[A] For each lake, the number of samples for each water quality variable over the sample record is shown in bold font

[B] If censored data occurred, the number and percentage of those samples (No. and % <MDL) is shown

[C] Variables with 20 to 29% and 30 to 100% of values <MDL are highlighted with yellow and pink shading, respectively

[D] Ranges of censored values for Pine and Wabamun lakes are based on multiple composite samples taken in select years

[E] For Pine Lake, the composite samples were taken over the entire lake (1983, 1995, 2003 to 2006 and 2008 to 2009), or in three portions of the lake (north, middle and south) (1984 to 2001 and 2007)

[F] For Wabamun Lake, the composite samples were taken in the east and west basins (1980 to 1982 and 1999 to 2008), or over the entire lake (1983 to 1998)

[G] TN was based on the sum of TKN (i.e., organic nitrogen and ammonia-N) and nitrate+nitrite-N samples; half the MDL was used when NO_3+NO_2-N values were <MDL.

Lake or Basin: [A]	Long (near Boyle)		Marie		McLeod, East Basin		McLeod, West Basin		Miquelon		Moonshine		Moore (Crane)		Moose		Nakamun	
Maximum No. Years of Composite Samples:	26		11		24		12		15		24		12		20		18	
Water Quality Variable [A]	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL
pH (Lab)	71		41		55		28		29		49		40		53		114	
Total Alkalinity ($CaCO_3$)	71		41		55		28		29		49		40		53		114	
Phenolphthalein Alkalinity ($CaCO_3$)	36		37		23		2		22		24		35		23		41	
Samples <MDL [B, C, D]	10	28	22	59	15	65	2	100	0	0	15	63	4	11	2	9	1	2
Specific Conductance (Lab)	71		38		55		28		29		49		40		50		113	
Total Dissolved Solids (TDS)	59		41		48		28		17		39		40		53		114	
Filterable Residue (FR)	0		12		2		2		0		1		9		1		0	
Total Hardness ($CaCO_3$)	59		25		48		28		17		39		25		51		114	
Calcium (Ca Diss.& Extr.)	59		38		48		28		17		39		37		53		114	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0
Magnesium (Mg Diss. & Extr.)	59		41		49		28		17		40		40		53		113	
Sodium Dissolved (Na)	62		41		51		28		20		42		40		53		114	
Samples <MDL [B, C, D]	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potassium Dissolved (K)	62		41		51		28		20		42		40		53		114	
Bicarbonate (HCO_3)	71		19		55		28		29		49		19		51		114	
Carbonate (CO_3)	59		17		37		14		29		23		19		51		87	
Samples <MDL [B, C, D]	17	29	2	12	20	54	4	29	0	0	11	48	0	0	2	4	7	8
Sulphate Dissolved (SO_4)	62		41		51		28		20		42		40		53		114	
Samples <MDL [B, C, D]	0	0	19	46	17	33	14	50	0	0	0	0	0	0	0	0	25	22
Chloride Dissolved (Cl)	62		41		51		28		20		42		40		53		114	
Samples <MDL [B, C, D]	7	11	9	22	0	0	0	0	0	0	12	29	0	0	0	0	1	1
Fluoride Dissolved (F)	52		17		43		26		12		37		17		43		114	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silica (Si)	53		30		45		28		12		38		29		44		114	
Samples <MDL [B, C, D]	0	0	4	13	1	2	1	4	1	8	2	5	0	0	0	0	3	3
Total Organic Carbon (TOC)	0		25		0		0		0		0		26		0		0	
Samples <MDL [B, C, D]	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inorganic Carbon	0		25		0		0		0		0		25		0		0	
Dissolved Inorganic Carbon (DIC)	1		3		1		0		0		0		3		2		65	
Dissolved Organic Carbon (DOC)	9		37		4		0		6		3		40		12		114	
Iron (Fe Diss. & Extr)	39		35		30		26		10		28		35		46		112	
Samples <MDL [B, C, D]	20	51	13	37	11	37	9	35	0	0	4	14	15	43	32	70	63	56
Non-Filterable Residue (NFR)	4		23		1		0		0		0		21		5		107	
Samples <MDL [B, C, D]	0	0	7	30	0	0	0	0	0	0	0	0	2	10	0	0	5	5
Phosphorus Total (TP)	123		40		102		48		45		94		41		89		119	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorophyll-a mg/m^3	127		48		107		50		45		95		52		88		120	
Transparency (Secchi Depth)	127		46		107		52		48		96		51		91		120	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus Total Diss. (TDP)	12		40		10		0		5		10		41		23		118	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0
Total Kjeldahl Nitrogen (TKN)	21		52		9		0		15		11		53		24		115	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia-N (NH_3-N)	11		52		6		0		5		6		53		23		115	
Samples <MDL [B, C, D]	0	0	2	4	0	0	0	0	0	0	0	0	2	4	0	0	1	1
Nitrate+Nitrite-N (NO_3+NO_2 -N)	65		51		45		26		25		41		51		56		115	
Samples <MDL [B, C, D]	37	57	34	67	36	80	22	85	10	40	22	54	34	67	42	75	27	23
Nitrate-N (NO_3 -N)	4		20		3		0		2		1		20		0		0	
Samples <MDL [B, C, D]	3	75	12	60	2	67	0	0	0	0	0	0	14	70	0	0	0	0
Nitrite-N (NO_2 -N)	45		34		39		28		10		35		32		43		113	
Samples <MDL [B, C, D]	26	58	22	65	27	69	16	57	4	40	14	40	27	84	30	70	47	42
Total Nitrogen (TN) [G]	21		52		13		0		15		15		53		24		115	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TN:TP Ratio	21		39		8		0		15		11		38		24		113	

Footnotes:

[A] For each lake, the number of samples for each water quality variable over the sample record is shown in bold font

[B] If censored data occurred, the number and percentage of those samples (No. and % <MDL) is shown

[C] Variables with 20 to 29% and 30 to 100% of values <MDL are highlighted with yellow and pink shading, respectively

[D] Ranges of censored values for Pine and Wabamun lakes are based on multiple composite samples taken in select years

[E] For Pine Lake, the composite samples were taken over the entire lake (1983, 1995, 2003 to 2006 and 2008 to 2009), or in three portions of the lake (north, middle and south) (1984 to 2001 and 2007)

[F] For Wabamun Lake, the composite samples were taken in the east and west basins (1980 to 1982 and 1999 to 2008), or over the entire lake (1983 to 1998)

[G] TN was based on the sum of TKN (i.e., organic nitrogen and ammonia-N) and nitrate+nitrite-N samples; half the MDL was used when NO_3+NO_2-N values were <MDL.

Lake or Basin: [A]	Newell		North Buck		Pigeon		Pine [E]		Pine Coulee, South		Reesor		Saskatoon		Spruce Coulee		Steele (Cross)	
Maximum No. Years of Composite Samples:	22		15		20		21		10		25		24		25		26	
Water Quality Variable [A]	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL	No.	% <MDL
pH (Lab)	61		39		60		96		51		69		49		67		62	
Total Alkalinity ($CaCO_3$)	61		39		60		96		51		69		49		67		62	
Phenolphthalein Alkalinity ($CaCO_3$)	39		12		12		57		51		34		22		33		29	
Samples <MDL [B, C, D]	27	69	5	42	5	42	0-3	0-3	13	25	12	35	0	0	17	52	15	52
Specific Conductance (Lab)	61		39		58		85		51		69		48		67		62	
Total Dissolved Solids (TDS)	54		39		59		93		43		56		40		54		51	
Filterable Residue (FR)	21		0		1		14		0		3		1		2		1	
Total Hardness ($CaCO_3$)	43		39		59		94		51		54		40		52		51	
Calcium (Ca Diss.& Extr.)	55		39		58		101		51		58		40		54		51	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg Diss. & Extr.)	55		39		59		88		51		58		41		55		51	
Sodium Dissolved (Na)	57		39		59		94		51		60		43		58		54	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	2	3	0	0	2	3	1	2
Potassium Dissolved (K)	57		39		59		94		51		60		43		58		54	
Bicarbonate (HCO_3)	49		39		60		96		51		67		49		65		62	
Carbonate (CO_3)	37		38		48		95		51		50		49		38		38	
Samples <MDL [B, C, D]	17	46	10	26	17	35	0-1	0-1	13	25	20	40	0	0	19	50	17	45
Sulphate Dissolved (SO_4)	57		39		59		94		51		60		43		58		54	
Samples <MDL [B, C, D]	0	0	0	0	28	47	0	0	0	0	35	58	0	0	31	53	37	69
Chloride Dissolved (Cl)	57		39		59		94		51		60		43		58		54	
Samples <MDL [B, C, D]	1	2	7	18	20	34	0	0	0	0	37	62	0	0	34	59	28	52
Fluoride Dissolved (F)	53		36		57		75		51		53		36		52		45	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silica (Si)	53		36		58		102		0		54		38		52		47	
Samples <MDL [B, C, D]	2	4	2	6	1	2	0	0	0	0	0	0	4	11	0	0	3	6
Total Organic Carbon (TOC)	20		0		0		11		0		2		0		2		0	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inorganic Carbon	0		0		0		5		0		0		0		0		0	
Dissolved Inorganic Carbon (DIC)	1		7		1		53		0		1		0		1		0	
Dissolved Organic Carbon (DOC)	12		7		2		82		51		5		3		5		6	
Iron (Fe Diss. & Extr)	40		22		49		43		26		38		24		37		34	
Samples <MDL [B, C, D]	20	50	20	91	33	67	4-13	24-50	1	4	5	13	0	0	7	19	2	6
Non-Filterable Residue (NFR)	21		7		1		85		51		3		0		3		0	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0-14	0-18	7	14	0	0	0	0	0	0	0	0
Phosphorus Total (TP)	91		59		82		146		50		110		84		111		113	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorophyll-a mg/m^3	87		58		82		147		43		108		83		108		112	
Transparency (Secchi Depth)	91		53		84		143		46		109		86		109		115	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus Total Diss. (TDP)	7		7		11		141		50		6		9		6		5	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0
Total Kjeldahl Nitrogen (TKN)	27		8		12		129		51		17		11		17		14	
Samples <MDL [B, C, D]	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia-N (NH_3-N)	23		8		8		129		51		6		7		6		5	
Samples <MDL [B, C, D]	10	43	0	0	1	13	0	0	10	20	1	17	0	0	1	17	0	0
Nitrate+Nitrite-N (NO_3+NO_2 -N)	53		31		57		132		51		59		39		58		52	
Samples <MDL [B, C, D]	26	49	22	71	42	74	12-17	12-45	11	22	43	73	20	51	45	78	24	46
Nitrate-N (NO_3 -N)	2		3		6		0		51		2		2		2		1	
Samples <MDL [B, C, D]	2	100	3	100	3	50	0	0	13	25	2	100	1	50	1	50	1	100
Nitrite-N (NO_2 -N)	43		25		54		71		51		44		30		43		32	
Samples <MDL [B, C, D]	34	79	20	80	47	87	4-9	7-43	37	73	34	77	10	33	36	84	14	44
Total Nitrogen (TN) [G]	31		8		12		129		51		19		14		19		14	
Samples <MDL [B, C, D]	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TN:TP Ratio	26		8		12		129		50		17		11		17		14	

Footnotes:

[A] For each lake, the number of samples for each water quality variable over the sample record is shown in bold font

[B] If censored data occurred, the number and percentage of those samples (No. and % <MDL) is shown

[C] Variables with 20 to 29% and 30 to 100% of values <MDL are highlighted with yellow and pink shading, respectively

[D] Ranges of censored values for Pine and Wabamun lakes are based on multiple composite samples taken in select years

[E] For Pine Lake, the composite samples were taken over the entire lake (1983, 1995, 2003 to 2006 and 2008 to 2009), or in three portions of the lake (north, middle and south) (1984 to 2001 and 2007)

[F] For Wabamun Lake, the composite samples were taken in the east and west basins (1980 to 1982 and 1999 to 2008), or over the entire lake (1983 to 1998)

[G] TN was based on the sum of TKN (i.e., organic nitrogen and ammonia-N) and nitrate+nitrite-N samples; half the MDL was used when NO_3+NO_2-N values were <MDL.

Lake or Basin: [A]	Sturgeon, Main Basin		Sturgeon, West Basin		Sylvan		Thunder		Travers		Tucker		Wabamun [F]		Winagami	
Maximum No. Years of Composite Samples:	**25**		**12**		**20**		**21**		**16**		**10**		**29**		**24**	
Water Quality Variable [A]	**No.**	**% <MDL**	**No.**	**% <MDL**	**No.**	**% <MDL**	**No.**	**% <MDL**	**No.**	**% <MDL**	**No.**	**% <MDL**	**No.**	**% <MDL**	**No.**	**% <MDL**
pH (Lab)	**57**		**34**		**54**		**69**		**53**		**36**		**193**		**70**	
Total Alkalinity ($CaCO_3$)	**57**		**34**		**54**		**69**		**53**		**36**		**193**		**70**	
Phenolphthalein Alkalinity ($CaCO_3$)	**28**		**12**		**17**		**14**		**31**		**29**		**123**		**30**	
Samples <MDL [B, C, D]	18	64	3	25	0	0	2	14	30	97	14	48	5-24	13-29	8	27
Specific Conductance (Lab)	**57**		**34**		**50**		**69**		**53**		**36**		**193**		**70**	
Total Dissolved Solids (TDS)	**50**		**34**		**52**		**69**		**52**		**36**		**191**		**62**	
Filterable Residue (FR)	**2**		**1**		**1**		**0**		**23**		**11**		**64**		**1**	
Total Hardness ($CaCO_3$)	**50**		**34**		**51**		**69**		**40**		**18**		**172**		**62**	
Calcium (Ca Diss.& Extr.)	**50**		**34**		**42**		**69**		**53**		**33**		**188**		**62**	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium (Mg Diss. & Extr.)	**51**		**34**		**42**		**69**		**53**		**36**		**191**		**63**	
Sodium Dissolved (Na)	**53**		**34**		**52**		**69**		**53**		**36**		**192**		**65**	
Samples <MDL [B, C, D]	1	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0
Potassium Dissolved (K)	**53**		**34**		**41**		**69**		**53**		**36**		**193**		**65**	
Bicarbonate (HCO_3)	**57**		**34**		**52**		**69**		**40**		**12**		**162**		**70**	
Carbonate (CO_3)	**19**		**10**		**53**		**66**		**27**		**12**		**160**		**50**	
Samples <MDL [B, C, D]	14	74	3	30	1	2	6	9	17	63	0	0	3-10	5-10	11	22
Sulphate Dissolved (SO_4)	**53**		**34**		**52**		**69**		**53**		**36**		**193**		**65**	
Samples <MDL [B, C, D]	0	0	0	0	0	0	28	41	0	0	15	42	0	0	0	0
Chloride Dissolved (Cl)	**53**		**34**		**52**		**69**		**53**		**36**		**193**		**65**	
Samples <MDL [B, C, D]	11	21	4	12	8	15	7	10	0	0	3	8	0-1	0-1	1	2
Fluoride Dissolved (F)	**46**		**32**		**43**		**66**		**52**		**19**		**158**		**60**	
Samples <MDL [B, C, D]	4	9	2	6	0	0	0	0	0	0	0	0	0	0	0	0
Silica (Si)	**48**		**34**		**44**		**66**		**52**		**30**		**190**		**61**	
Samples <MDL [B, C, D]	9	19	4	12	2	5	7	11	1	2	0	0	1-19	1-18	6	10
Total Organic Carbon (TOC)	**0**		**0**		**10**		**0**		**22**		**24**		**42**		**0**	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inorganic Carbon	**0**		**0**		**0**		**0**		**0**		**24**		**26**		**0**	
Dissolved Inorganic Carbon (DIC)	**15**		**13**		**1**		**20**		**0**		**23**		**68**		**0**	
Dissolved Organic Carbon (DOC)	**18**		**13**		**17**		**22**		**9**		**51**		**183**		**3**	
Iron (Fe Diss. & Extr)	38		33		32		59		46		32		113		45	
Samples <MDL [B, C, D]	3	8	0	0	21	66	34	58	23	50	6	19	0-60	0-76	8	18
Non-Filterable Residue (NFR)	**15**		**13**		**11**		**20**		**22**		**19**		**186**		**0**	
Samples <MDL [B, C, D]	0	0	0	0	1	9	0	0	0	0	2	11	6-12	7-12	0	0
Phosphorus Total (TP)	**91**		**49**		**87**		**100**		**81**		**50**		**184**		**98**	
Samples <MDL [B, C, D]	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0
Chlorophyll-a mg/m^3	**93**		**50**		**87**		**101**		**82**		**53**		**201**		**96**	
Transparency (Secchi Depth)	**94**		**49**		**88**		**102**		**81**		**40**		**197**		**98**	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Phosphorus Total Diss. (TDP)	**22**		**11**		**28**		**27**		**0**		**43**		**181**		**5**	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Kjeldahl Nitrogen (TKN)	**22**		**13**		**29**		**26**		**21**		**58**		**193**		**10**	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia-N (NH_3-N)	**19**		**13**		**26**		**26**		**22**		**57**		**195**		**4**	
Samples <MDL [B, C, D]	0	0	1	8	2	8	0	0	12	55	0	0	10-22	9-25	0	0
Nitrate+Nitrite-N (NO_3+NO_2 -N)	**48**		**32**		**54**		**64**		**48**		**59**		**194**		**56**	
Samples <MDL [B, C, D]	26	54	17	53	43	80	36	56	26	54	22	37	33-60	31-66	25	45
Nitrate-N (NO_3 -N)	**2**		**0**		**4**		**4**		**1**		**19**		**75**		**1**	
Samples <MDL [B, C, D]	1	50	0	0	3	75	2	50	1	100	8	42	0-51	0-70	1	100
Nitrite-N (NO_2 -N)	**42**		**32**		**33**		**59**		**47**		**49**		**168**		**51**	
Samples <MDL [B, C, D]	22	52	14	44	29	88	32	54	35	74	29	59	60-78	74-87	17	33
Total Nitrogen (TN) [G]	**27**		**13**		**29**		**26**		**21**		**57**		**192**		**11**	
Samples <MDL [B, C, D]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TN:TP Ratio	**20**		**11**		**29**		**26**		**21**		**45**		**174**		**10**	

Footnotes:

[A] For each lake, the number of samples for each water quality variable over the sample record is shown in bold font

[B] If censored data occurred, the number and percentage of those samples (No. and % <MDL) is shown

[C] Variables with 20 to 29% and 30 to 100% of values <MDL are highlighted with yellow and pink shading, respectively

[D] Ranges of censored values for Pine and Wabamun lakes are based on multiple composite samples taken in select years

[E] For Pine Lake, the composite samples were taken over the entire lake (1983, 1995, 2003 to 2006 and 2008 to 2009), or in three portions of the lake (north, middle and south) (1984 to 2001 and 2007)

[F] For Wabamun Lake, the composite samples were taken in the east and west basins (1980 to 1982 and 1999 to 2008), or over the entire lake (1983 to 1998)

[G] TN was based on the sum of TKN (i.e., organic nitrogen and ammonia-N) and nitrate+nitrite-N samples; half the MDL was used when NO_3+NO_2-N values were <MDL.