AN ANALYSIS OF LONG-TERM TRENDS IN TAMPA BAY WATER QUALITY

Prepared for:

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FOREWORD

This report was prepared by Janicki Environmental, Inc. under the direction of Mr. Dick Eckenrod and Ms. Holly Greening of the Tampa Bay Estuary Program. This work was performed under Contract No. T-98-06 for the Tampa Bay Estuary Program.

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1. OVERVIEW

The Tampa Bay National Estuary Program (TBNEP) was established in 1991 to assist the community in developing a comprehensive plan to restore and protect Tampa Bay. The Comprehensive Conservation and Management Plan (CCMP) presents management actions to assist TBEP partners in realizing the goals of the TBNEP (TBNEP, 1996).

Monitoring of the health of the bay is central to the success of the restoration and protection of the bay. An effective monitoring program provides the data necessary to assess the status and trends in the health and abundance of the bay's wildlife and habitats. Monitoring program data are used to evaluate progress towards restoration and protection goals. The data are also used to evaluate the effectiveness of management strategies, to indicate when goals have been met, and to provide input to determine if management actions should continue or if more stringent management activities are warranted (TBNEP, 1996).

Analyses of data from monitoring programs enable bay managers to assess whether conditions baywide – and by bay segment, in most cases – are improving or declining. The monitoring program for Tampa Bay includes a water quality component. The water quality monitoring is designed to answer the following questions, as presented in the CCMP (TBNEP, 1996):

- Are phytoplankton biomass levels (chlorophyll *a* concentrations) above, below, or consistent with established bay segment targets?

- Are nutrient concentrations increasing, decreasing, or remaining stable?

- Is water clarity increasing, decreasing, or remaining stable?

- Is the areal extent of low dissolved oxygen concentrations (<2 mg/L) increasing, decreasing, or remaining stable?

This report examines temporal trends in water quality constituents in Tampa Bay, including those constituents addressed in the first three questions above: chlorophyll *a*, nutrient concentrations, and water clarity. Changes in the areal extent of low dissolved oxygen concentrations are the subject of another report.

1.1 Objective

The objective of this report is to provide the results of an analysis of long-term trends in water quality in Tampa Bay. This analysis provides a means of evaluating the effectiveness of management actions on bay water quality. Water quality data are collected by four organizations in Tampa Bay:

- Environmental Protection Commission of Hillsborough County (EPCHC),
- Bay Study Group, City of Tampa Department of Sanitary Sewers,
- Pinellas County Department of Environmental Management (PCDEM), and
- Manatee County Environmental Management Department (MCEMD).

The remaining sections of this report provide:

- **Descriptions** of the water quality monitoring programs listed above;
- **Methods** used for this analysis;
- **Results** of this analysis in graphical and tabular format;
- **Conclusions** from this analysis;
- **Discussion** of factors contributing to water quality trends;
- **Literature references**;
- **Appendices** providing further information concerning methods and data.

2. DESCRIPTION OF MONITORING PROGRAMS

The water quality monitoring programs of the four organizations sampling in Tampa Bay are described below. Janicki et al. (2000) provides more detailed summaries of the programs and monitoring methods.

- **Environmental Protection Commission of Hillsborough County**

The EPCHC has conducted monthly monitoring of ambient water quality in Tampa Bay since 1972, with complete records for most stations since 1974. Monitoring is currently performed at 52 fixed stations in Old Tampa Bay, Hillsborough Bay, Middle Tampa Bay, and Lower Tampa Bay. Monitoring is also performed in several bay tributaries. The monitoring site locations in the bay are shown in Figure 2-1. Water quality samples are collected at mid-depth, and are analyzed for nutrients, chlorophyll, and biochemical oxygen demand (BOD). Hydrolab measurements are taken of dissolved oxygen (DO), specific conductivity, temperature, and pH at the surface, mid-depth, and bottom. Water clarity is measured using a Secchi disc. Full descriptions of the EPCHC water quality monitoring program and data summaries are found in Boler (1998), including the methods employed for sampling and analysis.

- **Bay Study Group, City of Tampa Department of Sanitary Sewers**

The Bay Study Group, City of Tampa Department of Sanitary Sewers, performs water quality monitoring as described in the Baywide Environmental Monitoring Report 1993-1999 (TBEP, 1999). Monitoring is performed one to three times per month at 14 fixed stations. Monitoring began in 1978. Nine monitoring sites are in the Hillsborough Bay segment. Old Tampa Bay and Lower Tampa Bay contain one monitoring site each, and three monitoring sites are in Middle Tampa Bay. The monitoring site locations are shown in Figure 2-2. Surface water samples are collected and analyzed for several water quality parameters, including most notably nutrients, ^{14}C uptake, and chlorophyll *a*. Hydrolab measurements are made at multiple depths. Water clarity is measured with a Secchi disc and photosynthetically active radiation (PAR) with a LI/COR sampler.

- **Pinellas County Department of Environmental Management**

The PCDEM began monthly water quality monitoring in 1990 at fixed sites, and has monitored 202 sites in the county. Not all sites have been monitored since 1991. Monitoring sites include both freshwater and estuarine sites, with 11 fixed monitoring sites in Boca Ciega Bay, as shown in

Figure 2-3. The PCDEM also began sampling in Boca Ciega Bay in 1997 using a probabilistic sampling design for monthly water quality monitoring. In 1997, 13 sites were monitored, and in 1998, ten sites were monitored. The probabilistic monitoring site locations are shown in Figure 2-4. For both the fixed and probabilistic sampling sites, surface water samples are analyzed for nutrients and chlorophyll, and hydrolab measurements are made at the surface, mid-depth, and bottom. Water clarity is measured with a Secchi disc.

- **Manatee County Environmental Management Department**

The MCEMD began monthly water quality monitoring at fixed stations in Tampa Bay in 1988 as part of its Ambient Water Quality Program (AWP). In 1995, the MCEMD began monthly water quality monitoring based on a probabilistic sampling design as part of the Regional Ambient Monitoring Program (RAMP), and discontinued the AWP program. The AWP monitoring included four sites in Lower Tampa Bay and three sites each in the Manatee River and Terra Ceia Bay. The AWP monitoring site locations are shown in Figure 2-5. Included in the MCEMD RAMP monitoring are four sites in Terra Ceia Bay and five sites in the Manatee River as shown in Figure 2-6. Water samples collected as part of the AWP and RAMP monitoring are collected near the surface, and analyzed for nutrients and chlorophyll. The AWP monitoring measured water clarity using a Secchi disc. For the RAMP monitoring, hydrolab measurements are performed at multiple depths. The RAMP monitoring measures water clarity using a Secchi disc, and also measures photosynthetically active radiation (PAR) at 1.0 m and 1.5 m.

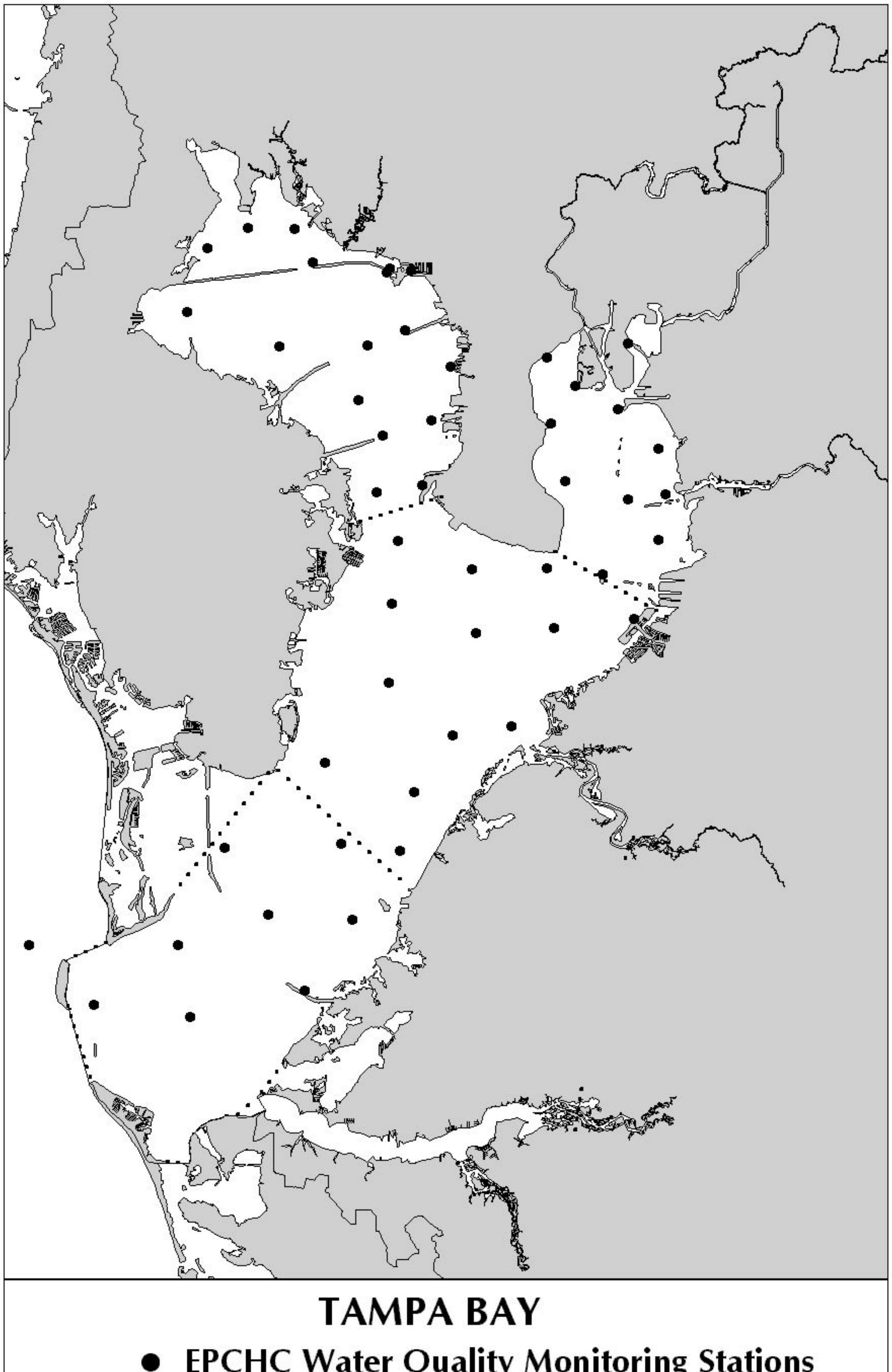

Figure 2-1. EPCHC water quality monitoring stations in Tampa Bay.

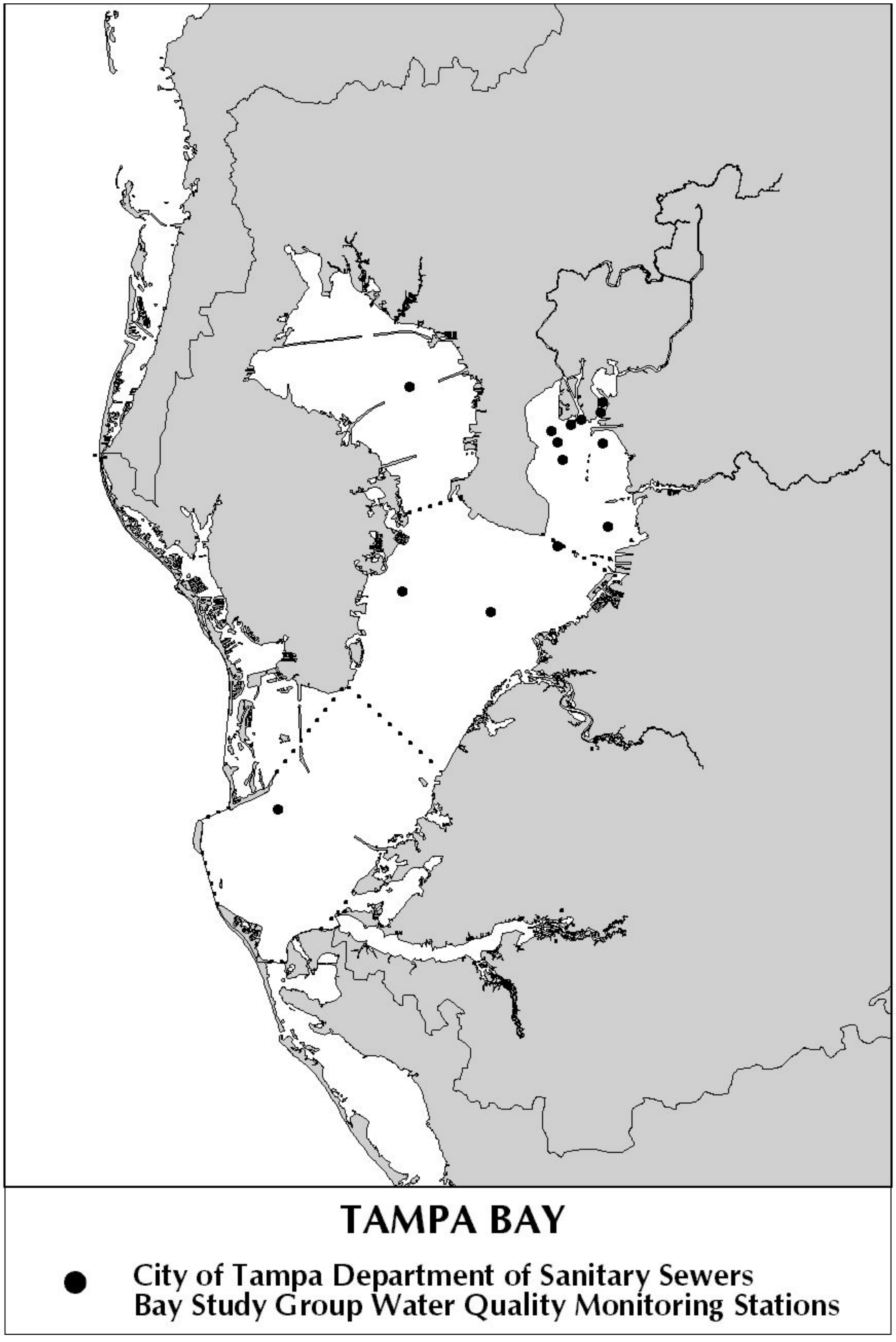

Figure 2-2. City of Tampa Bay Study Group water quality monitoring stations in Tampa Bay.

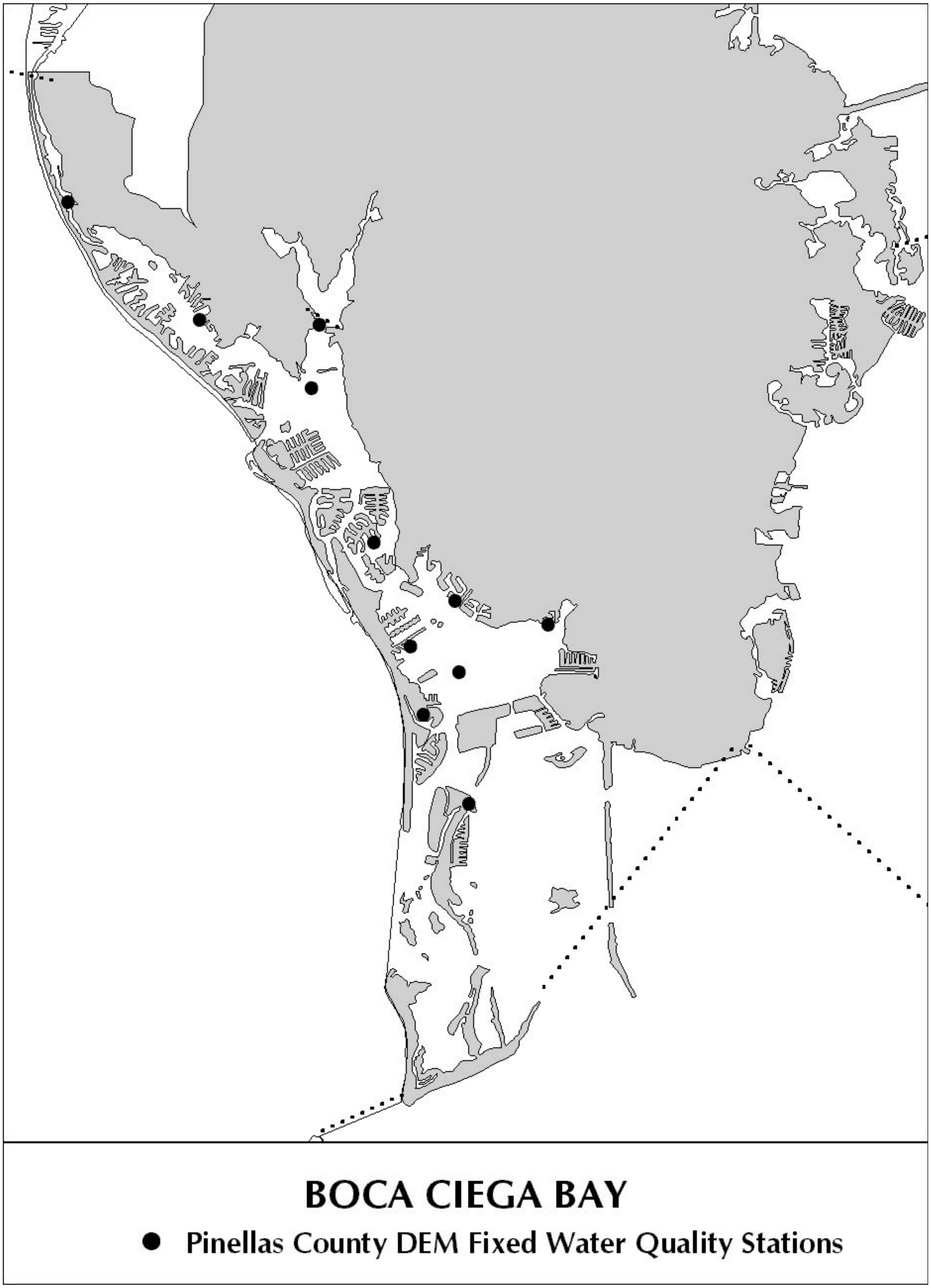

Figure 2-3. PCDEM fixed water quality monitoring stations in Boca Ciega Bay.

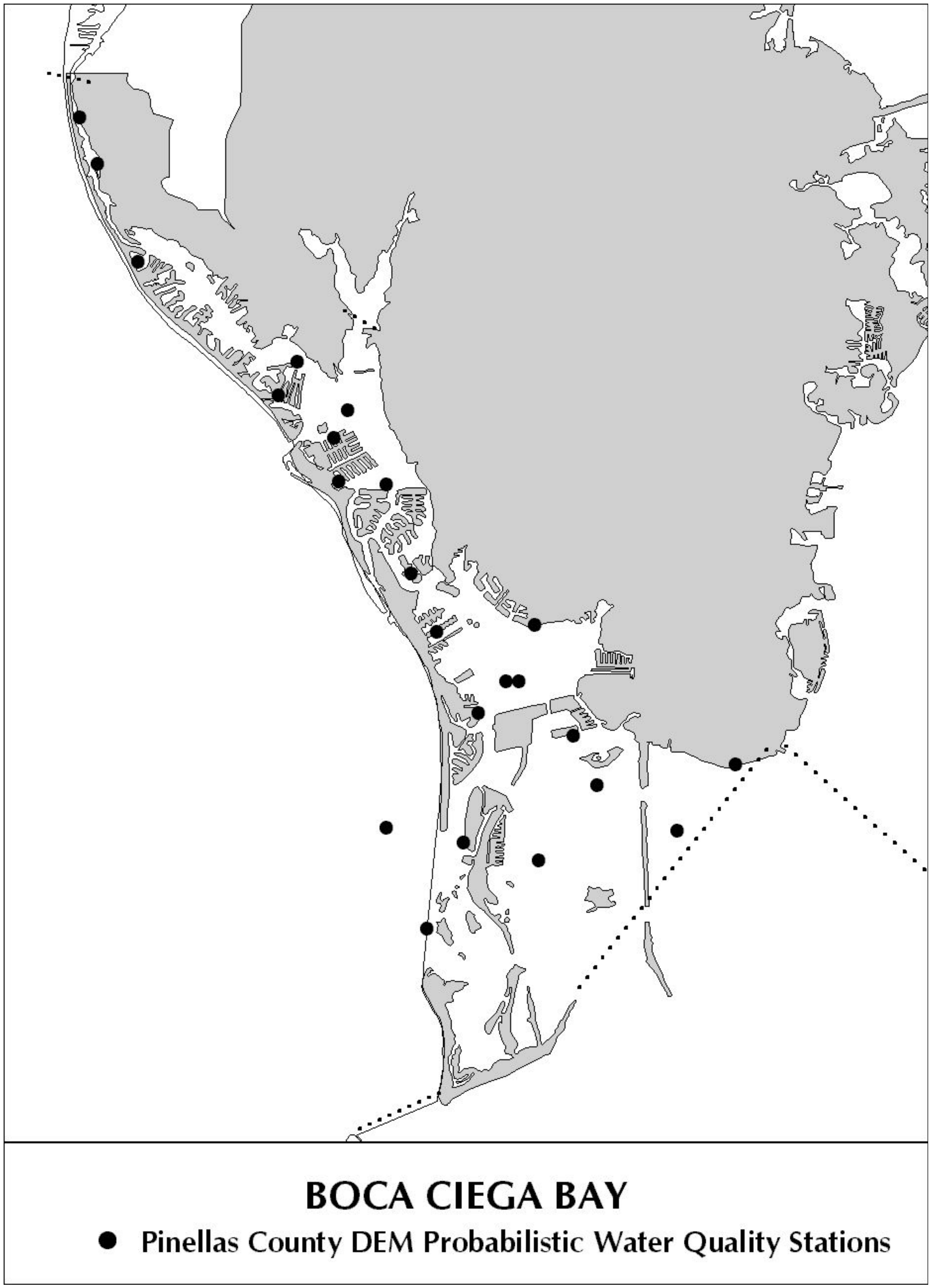

Figure 2-4. PCDEM probabilistic water quality monitoring stations in Boca Ciega Bay.

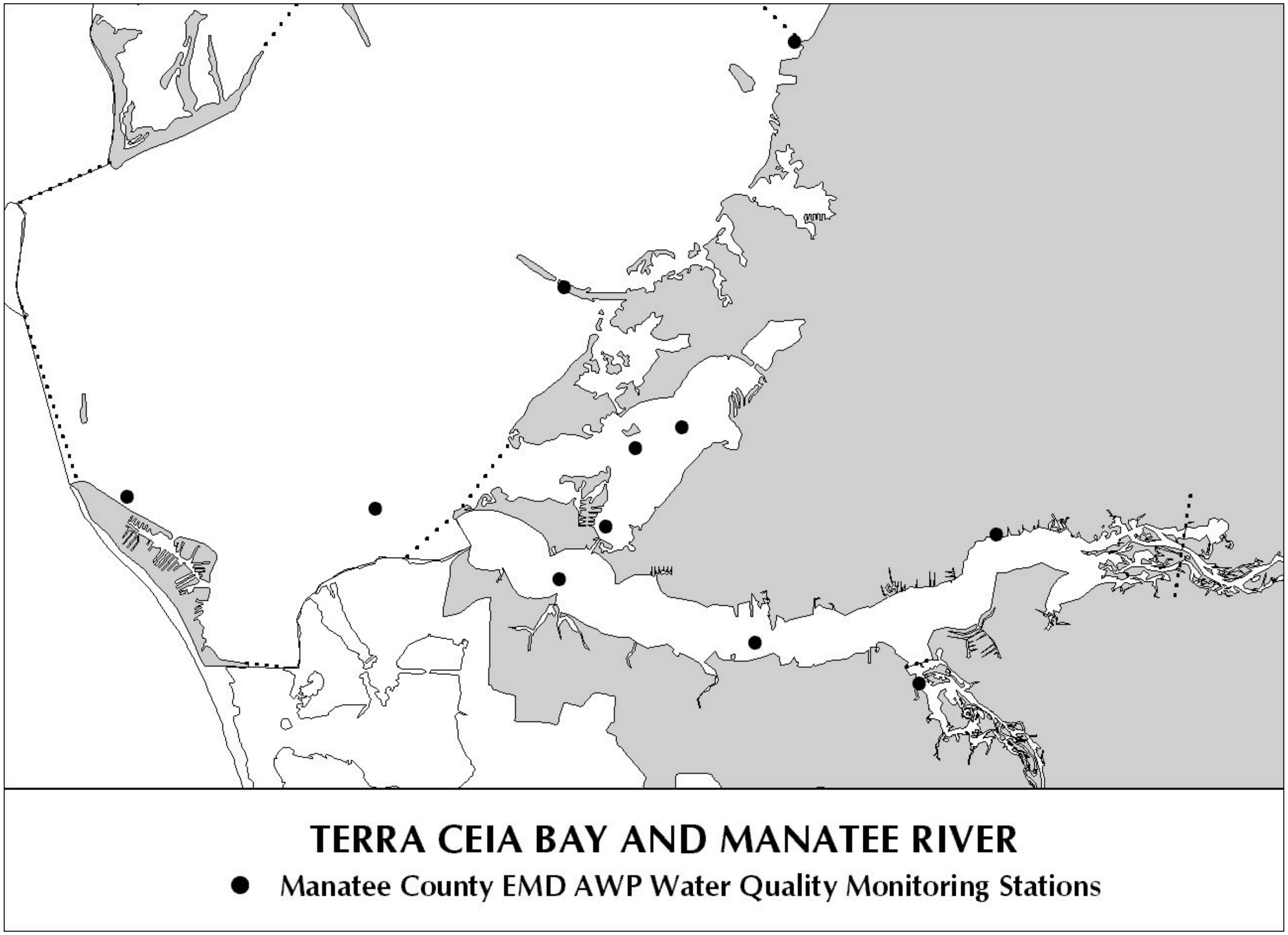

Figure 2-5. MCEMD AWP water quality monitoring stations in Terra Ceia Bay and the Manatee River.

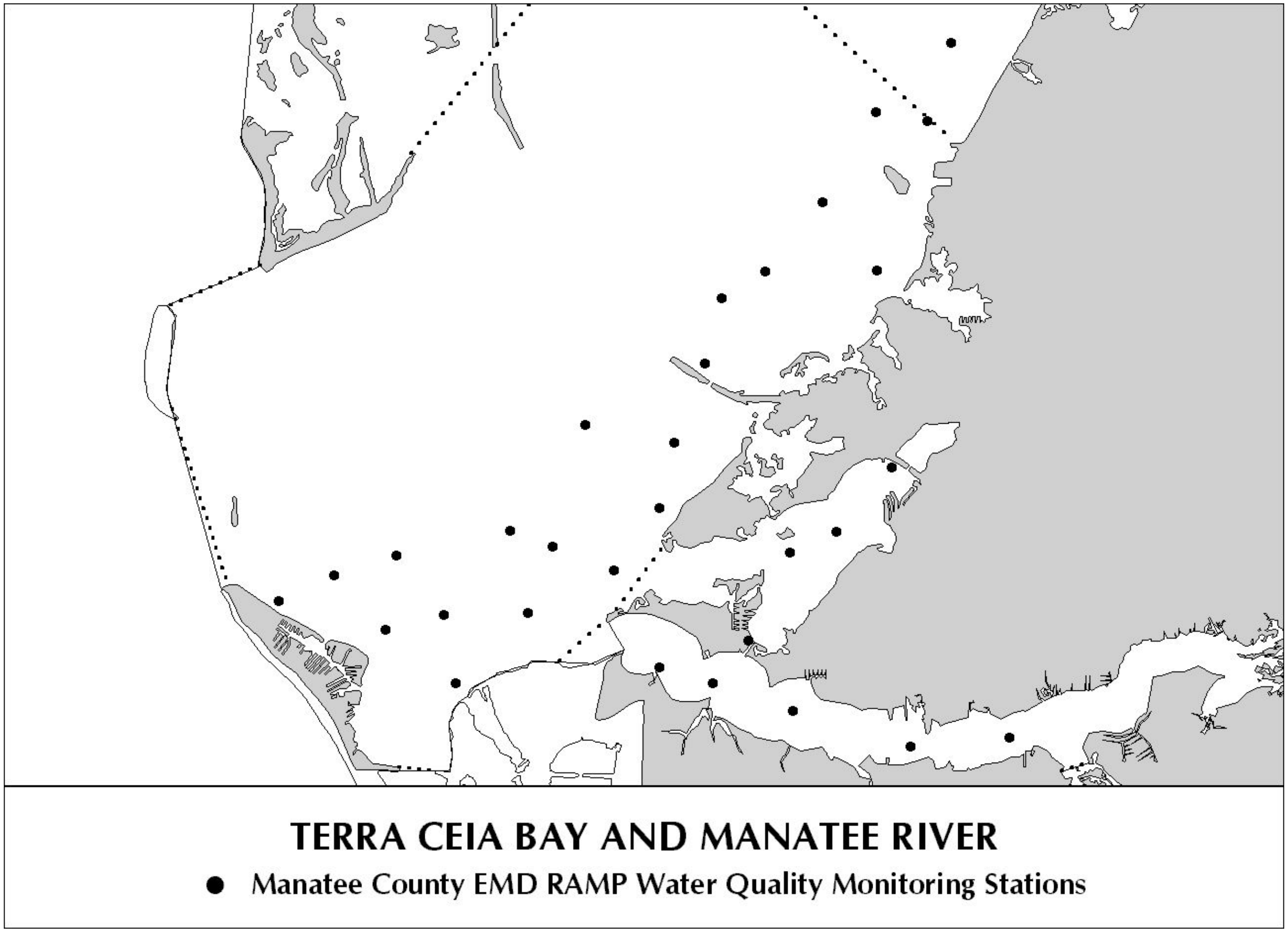

Figure 2-6. MCEMD RAMP water quality monitoring sites in Terra Ceia Bay and the Manatee River.

3. METHODS

The water quality data from monitoring programs in Tampa Bay were examined to provide information concerning long-term trends within bay segments and recent water quality differences across bay segments, particularly with respect to chlorophyll *a*, nutrients, Secchi disc depth, and bottom DO. In addition, analyses were performed to examine three other issues of concern: spatial differences in water quality within Old Tampa Bay; long-term changes in nutrient concentrations within tributaries to the bay; and long-term changes in salinity within each bay segment. The following describes the methods employed in each analysis.

3.1 Trend Analyses

Trend analyses were performed to examine long-term changes in water quality in Tampa Bay. The monitoring results from the EPC and the Bay Study Group provide adequate data for long-term trend analysis. Trend analysis of the EPC data were performed for Old Tampa Bay, Hillsborough Bay, Middle Tampa Bay, and Lower Tampa Bay using bay segment-specific average monthly water quality values. Trend analysis of data collected by the Bay Study Group were performed for three stations, COT 4, COT 12, and COT 13, using station-specific average monthly water quality values. These stations provide the longest data records available, and are indicative of water quality conditions in a latitudinal cross section of the upper bay. Station COT 4 is in middle Hillsborough Bay, Station COT 12 is in Middle Tampa Bay near Hillsborough Bay, and Station COT 13 is near the center of Middle Tampa Bay.

The PCDEM and MCEMD monitoring programs are not of sufficient duration to provide data for long-term trend analysis. The PCDEM began data collection in 1990 at a series of fixed monitoring sites whose locations fulfilled particular needs for those portions of the water bodies of concern, but the sampling design was not selected to represent ambient conditions. The PCDEM monitoring sites selected by the probabilistic sampling design in Boca Ciega Bay, initiated in 1997, does provide data representative of ambient conditions, but does not provide an adequate time series to allow meaningful trends analysis. Similarly, the MCEMD monitoring as part of RAMP in Terra Ceia Bay and the Manatee River, initiated in 1995, provides data representative of ambient conditions, but for too short a time period for trend analysis.

Two methods for estimating trends in water quality were applied using the data obtained by the EPC and the City of Tampa Bay Study Group. The first of these is the nonparametric method based on the seasonal Kendall tau test developed by Hirsch et al. (1982). This test requires no assumption regarding the distribution of the data that can affect the validity of the test (Gilbert, 1987). The second method is a parametric method for examining temporal trends developed for the Florida

Department of Environmental Protection (Coastal, 1996). More detailed descriptions of both methods are found in Appendix A.

As stated previously, trend tests were not performed using the data collected by the PCDEM and MCEMD monitoring efforts. However, plots of selected water quality constituents are provided for the PCDEM fixed stations and probabilistic monitoring design stations in Appendix D, with similar plots for the MCEMD RAMP data presented in Appendix E.

3.2 Comparison of Recent Water Quality Conditions Among Bay Segments

Water quality data from the 1996-1998 period were used to provide a comparison of recent water quality conditions across all seven bay segments. Data from the EPCHC, PCDEM, and MCEMD monitoring programs were used. The water quality parameters examined included chlorophyll *a*, total nitrogen (TN), total phosphorus (TP), and Secchi disc depth. The 1996-1998 period was chosen because 1996 was the first full year of MCEMD RAMP monitoring in Terra Ceia Bay and the Manatee River. Although the PCDEM did not begin probabilistic sampling in Boca Ciega Bay until 1997, mean annual conditions estimated from fixed station data for 1996 from the PCDEM monitoring were similar to those estimated from the probabilistic sampling in 1997 and 1998, so that the 1996-1998 data are considered representative of recent conditions.

3.3 Other Water Quality Questions of Interest

In addition, the EPCHC data were also used to address questions raised about differences in water quality in Old Tampa Bay. Seagrass along the western shore of Old Tampa Bay has not expanded into areas where recovery was expected, which may be a result of water quality conditions not represented by mean conditions in the bay segment. The EPCHC monitoring stations were grouped into those located on the eastern shore and those located on the western shore. Differences in mean annual water quality conditions at stations along each shore of Old Tampa Bay were examined.

Long-term changes in nutrient concentrations in six tributaries to the bay were also examined, using the trend tests described above and EPCHC water quality data. This analysis provides insight into changes in watershed loading to the bay.

Long-term changes in salinity were examined in each bay segment using the trend tests described above and the EPCHC water quality data. Changes in salinity were compared with changing rainfall to the watershed of each bay segment.

4. RESULTS

Following are the results of the analyses of long-term trends in water quality in Tampa Bay. The results of three sets of analyses are described, as follows:

- the long-term trends in water quality parameters reflective of the trophic status of the bay;
- a comparison of mean water quality conditions across bay segments; and
- results of analyses to address three emerging questions of interest:
  - spatial differences in water quality within Old Tampa Bay,
  - trends in nutrient concentrations in tributaries to the bay, and
  - long-term trends in salinity in the bay.

Most of the water quality parameters examined address an understanding of the trophic status of Tampa Bay. The parameters examined include:

- Nutrients – The nutrients examined included nitrogen and phosphorus (as measured by TN, NO_3-NO_2, and TP concentrations). Nutrients are essential for algal growth. Increased nutrient supply, generally from anthropogenic sources, leads to accelerated eutrophication.
- Algal biomass - Algal biomass is often expressed as chlorophyll *a* concentration. Elevated chlorophyll *a* concentrations are indicative of advanced trophic state. Algal biomass affects light attenuation, which in turn affects seagrasses. Seagrasses are an important part of the Tampa Bay Nitrogen Management Strategy, which seeks to increase seagrasses. Increased algal growth also increases the supply of organic matter, which in turn can lead to depletion of dissolved oxygen (i.e., hypoxia).
- Water clarity – Water clarity is often measured using a Secchi disc. Poor water clarity is typically due to increased algal growth, and is an additional indicator of trophic state. Water clarity in Tampa Bay is of particular importance given the seagrass restoration goal. Water clarity in Tampa Bay is primarily a function of chlorophyll *a* concentration (Janicki and Wade, 1996). Turbidity can also affect water clarity.
- Biochemical oxygen demand (BOD) - Biochemical oxygen demand is an indicator of the oxygen required to meet the respiratory requirements associated with the decomposition of organic matter in the water column. BOD is affected by allocthonous and autochthonous organic matter supplies.

- Bottom dissolved oxygen - Dissolved oxygen (DO) concentrations are important determinants of the abundance, composition, and distribution of biota, especially the benthic community. Increasing trophic status, as indicated by increasing algal biomass, leads to decreasing DO due to respiration needs for the decomposition of organic matter.

- Turbidity – Turbidity in the water column causes attenuation of downwelling light through scattering and absorption. Turbidity may be caused by the presence of suspended matter, including clay, silt, plankton, or other fine matter. High turbidity decreases light availability to seagrasses.

The water quality data utilized for the analyses described in this report and analytical results are presented in Appendices B-G. The organization of each of these appendices is described below.

Appendix B contains the EPCHC water quality data and analytical results of the trend tests. The appendix is divided by bay segment. For each of the four mainstem segments, the following is provided:

- Plots of mean annual data,

- Statistical results of the parametric trend test presented in tabular format,

- Plots of monthly data,

- Plots of within-year variation, and

- Statistical results of the nonparametric trend test presented in tabular format.

Appendix C contains the City of Tampa water quality data and analytical results, and is divided by station. For each station, information is provided as in Appendix B.

Appendix D and Appendix E, as described previously, contain plots of the Pinellas County data for Boca Ciega Bay (Appendix D) and the Manatee County data for Terra Ceia Bay and the Manatee River (Appendix E).

Appendix F contains the EPCHC nutrient data for the tributaries to the bay and analytical results of the nonparametric trend test. For each tributary, the following is provided:

- Plots of monthly data,

- Plots of within-year variation, and

- Statistical results of the nonparametric trend test presented in tabular format.

Appendix G contains the EPCHC salinity data and analytical results of the nonparametric trend test. For each mainstem bay segment, information is provided as in Appendix F.

4.1 Long-term Trend Analyses

4.1.1 Summary of the Long-term Data Record

Long-term data are available from the EPCHC for the period 1974-1998. Examination of the data from this long-term record points to three distinctive periods in this record, in which water quality in relation to trophic status varied significantly. These periods are as follows:

- The initial period, from the mid-1970s to the early 1980s, was characterized by very poor water quality conditions. Most notably, conditions were poorest in Hillsborough Bay, but poor water quality conditions were also reflected in Old Tampa Bay and Middle Tampa Bay, and to a lesser extent in Lower Tampa Bay. This period was characterized by high nutrient and chlorophyll *a* concentrations and low water clarity.

- The second period, from the early to mid-1980s, was a transition period from the highly productive conditions of the early period to less productive conditions. The most rapid changes in chlorophyll *a* and nutrient concentrations were found in Hillsborough Bay, with less rapid rates in Old Tampa Bay and Middle Tampa Bay.

- The third distinctive period in the data record, from 1985 through 1998, was characterized by maintenance of improved water quality conditions. This period was marked by relatively low chlorophyll *a* and nutrient concentrations and greater water clarity. Throughout all periods, Hillsborough Bay remained the most productive, with Old Tampa Bay and Middle Tampa Bay productivity levels intermediate between those in Hillsborough Bay and those in Lower Tampa Bay, where productivity was lowest. Appreciable year-to-year variations in water quality conditions have occurred during this period.

The improvements in water quality conditions in the bay since the early period of the data record occurred following the upgrade of the Howard F. Curren Wastewater Treatment Plant. This facility is located at Hookers Point and discharges to Hillsborough Bay. Effluent volume is typically greater than 50 million gallons per day. The facility is the largest single point source of nutrient loads to the bay. In the late 1970s, the City of Tampa upgraded the facility to AWT standards, significantly reducing TP and TN loadings from the facility to the bay. By regulation, nutrient concentrations were required to be 3 mg/L TN and 7.5 mg/L TP, representing 90% reductions from pre-AWT concentrations (Garrity et al., 1982). During the 1995-1998 period, TN and TP concentrations in the effluent were typically 2 mg/L and 3 mg/L, respectively (Pribble et al., 2000).

During the most recent period of the data record, when improved conditions existed in the bay, two important factors contributed to the observed variability in annual mean values of chlorophyll *a*, nutrients, and Secchi disc depths. Much of the variability can be attributed to year-to-year variations in rainfall. The highest total annual rainfall to the watersheds draining to the bay segments during the 1990s occurred in 1995 and 1997, as shown in Table 4-1. Higher rainfall leads to increased nutrient loadings to the bay, which in turn result in increased nutrient and chlorophyll *a* concentrations and decreased Secchi disc depths. The other contributing factor to observed variability during the final period was the accidental release of process water from Mulberry Phosphate in December 1997. During this month, when more than 15 inches of rainfall were recorded, approximately 50 million gallons of process water were released into the Alafia River, which discharges to Hillsborough Bay. Water quality monitoring in the bay in the months following the release found elevated chlorophyll and nutrient concentrations in Hillsborough Bay and Middle Tampa Bay through March 1998 (Cardinale, 1998).

4.1.2 Statistical Tests of Long-term Trends

As discussed above, long-term trends over the entire period of record were estimated. The trend tests showed that changes in water quality conditions across all four mainstem bay segments were typically statistically significant (Tables 4-2 through 4-5). Specifically, the decreasing trends in chlorophyll *a*, TP, and BOD concentrations in the four mainstem bay segments were significant. With the exception of Lower Tampa Bay, significant increases were also found in mean annual Secchi disc depth in all mainstem segments.

Interestingly, despite long-term reductions in chlorophyll *a* and BOD concentrations, bottom DO concentrations declined in all mainstem segments except Hillsborough Bay, where no trend was found. While the reductions are significant, the slopes of the trends are very small, and their significance is due primarily to the large sample size available for the analysis. Most importantly, the significance of the trends in annual mean bottom DO is due to the pronounced reduction in the maximum of the annual ranges from the early highly productive period to the later period of lower productivity. The minima of the annual ranges in bottom DO have undergone smaller changes over the period of record. While reductions have occurred, the conditions are not, on average, approaching hypoxia (<2 mg/L DO). It is uncertain how the bottom DO data, collected at mid-day, related to daily minimum DO concentrations, which may or may not show similar trends.

While the trend tests for most water quality variables were generally in agreement, more variable results were found in TN concentrations. No trends in TN concentrations in Old Tampa Bay, Middle Tampa Bay, and Lower Tampa Bay were detected. In Hillsborough Bay, the nonparametric test found no trend in TN concentrations, whereas the parametric test found a significant decline. The differences in the trend results from the two tests can be explained by the differences in the scale of temporal variability examined in the two tests. The parametric test examines the trend in mean annual conditions. In contrast, the nonparametric test examines long-term variation in mean monthly conditions. Variation in mean annual conditions is typically less than the variation in mean monthly conditions. Therefore, detection of trends in mean annual conditions by the parametric method is typically more likely.

Table 4-1. Total annual rainfall (inches) to the watersheds draining to each bay segment.

YEAR	BAY SEGMENT						
	Old Tampa Bay	Hillsborough Bay	Middle Tampa Bay	Lower Tampa Bay	Boca Ciega Bay	Terra Ceia Bay	Manatee River
1974	46.4	45.9	45.6	47.8	53.1	47.3	44.8
1975	47.8	50.4	46.8	42.9	45.4	43.3	47.2
1976	44.6	47.7	44.2	45.8	42.9	47.1	47.8
1977	39.5	46.7	45.4	42.4	38.1	44.3	50.8
1978	45.2	50.6	50.4	55.4	45.2	57.2	56.4
1979	64.5	64.2	58.3	55.6	56.9	55.9	57.6
1980	43.8	46.4	47.1	48.9	46.1	49.5	48.7
1981	42.5	44.8	49.0	49.4	47.9	50.5	52.0
1982	58.1	59.3	57.6	60.7	54.8	61.4	60.1
1983	65.6	69.0	64.9	64.2	61.7	65.7	68.4
1984	40.0	41.7	36.1	37.5	33.6	39.3	40.5
1985	47.6	49.8	48.8	51.3	48.7	50.0	46.3
1986	49.4	54.3	53.8	54.1	58.0	53.9	53.1
1987	54.7	56.6	54.5	55.1	57.2	55.8	55.8
1988	58.0	58.3	62.7	65.0	66.1	64.4	61.9
1989	43.2	45.4	48.8	52.2	43.5	53.0	52.5
1990	38.5	41.0	38.7	41.0	38.1	42.1	41.3
1991	48.3	49.8	48.2	46.6	48.4	47.3	49.6
1992	45.2	52.2	55.4	59.8	46.1	61.5	62.6
1993	41.8	44.7	48.3	50.0	41.5	50.5	52.3
1994	47.8	57.8	56.2	56.4	44.5	57.2	59.8
1995	57.2	56.0	62.5	64.1	63.1	64.3	63.7
1996	49.6	49.7	45.3	47.0	44.0	47.7	47.0
1997	67.7	65.0	71.3	73.3	71.7	74.1	73.5
1998	55.4	58.2	58.3	56.4	54.8	57.2	59.6

Reductions were observed in NO_3-NO_2 concentrations in all four mainstem segments. Both tests found significant declines in Old Tampa Bay and Hillsborough Bay, whereas in Middle Tampa Bay and Lower Tampa Bay, only the nonparametric test detected significant declines.

To examine the relative rates of change in water quality conditions across the mainstem bay segments, the slopes of the changes in mean annual chlorophyll *a*, TP, and bottom DO concentrations, and Secchi disc depths were estimated (Figure 4-1). The greatest rates of change in TP and chlorophyll *a* concentrations were found in Hillsborough Bay. Intermediate rates of change were observed in Old Tampa Bay and Middle Tampa Bay, and Lower Tampa Bay reflected the least rapid rates of change in each of these variables. Interestingly, the rates of increase in Secchi disc depths in Old Tampa Bay, Hillsborough Bay, and Middle Tampa Bay were very similar. Slight declines in bottom DO concentrations were found in all four bay segments, with the greatest rate of decline in Lower Tampa Bay. As discussed previously, much of this decline in bottom DO concentrations is due to the elevated maximum values observed early in the monitoring period.

Table 4-2. Long-term trend test results for Old Tampa Bay. Data source: EPCHC.

Water Quality Constituent	Nonparametric	Parametric
Chlorophyll	-	-
Total Nitrogen	0	0
Total Phosphorus	-	-
Secchi Disc Depth	+	+
Bottom Dissolved Oxygen	-	-
Turbidity	0	0
BOD	0	-
Nitrate-Nitrite Nitrogen	-	-

Table 4-3. Long-term trend test results for Hillsborough Bay. Data source: EPCHC.

Water Quality Constituent	Nonparametric	Parametric
Chlorophyll	-	-
Total Nitrogen	0	-
Total Phosphorus	-	-
Secchi Disc Depth	+	+
Bottom Dissolved Oxygen	0	0
Turbidity	0	0
BOD	-	-
Nitrate-Nitrite Nitrogen	-	-

Table 4-4. Long-term trend test results for Middle Tampa Bay. Data source: EPCHC.		
Water Quality Constituent	**Nonparametric**	**Parametric**
Chlorophyll	-	-
Total Nitrogen	0	0
Total Phosphorus	-	-
Secchi Disc Depth	0	+
Bottom Dissolved Oxygen	-	-
Turbidity	0	0
BOD	-	-
Nitrate-Nitrite Nitrogen	-	0

Table 4-5. Long-term trend test results for Lower Tampa Bay. Data source: EPCHC.		
Water Quality Constituent	**Nonparametric**	**Parametric**
Chlorophyll	-	-
Total Nitrogen	0	0
Total Phosphorus	-	-
Secchi Disc Depth	0	0
Bottom Dissolved Oxygen	-	-
Turbidity	0	0
BOD	-	-
Nitrate-Nitrite Nitrogen	-	0

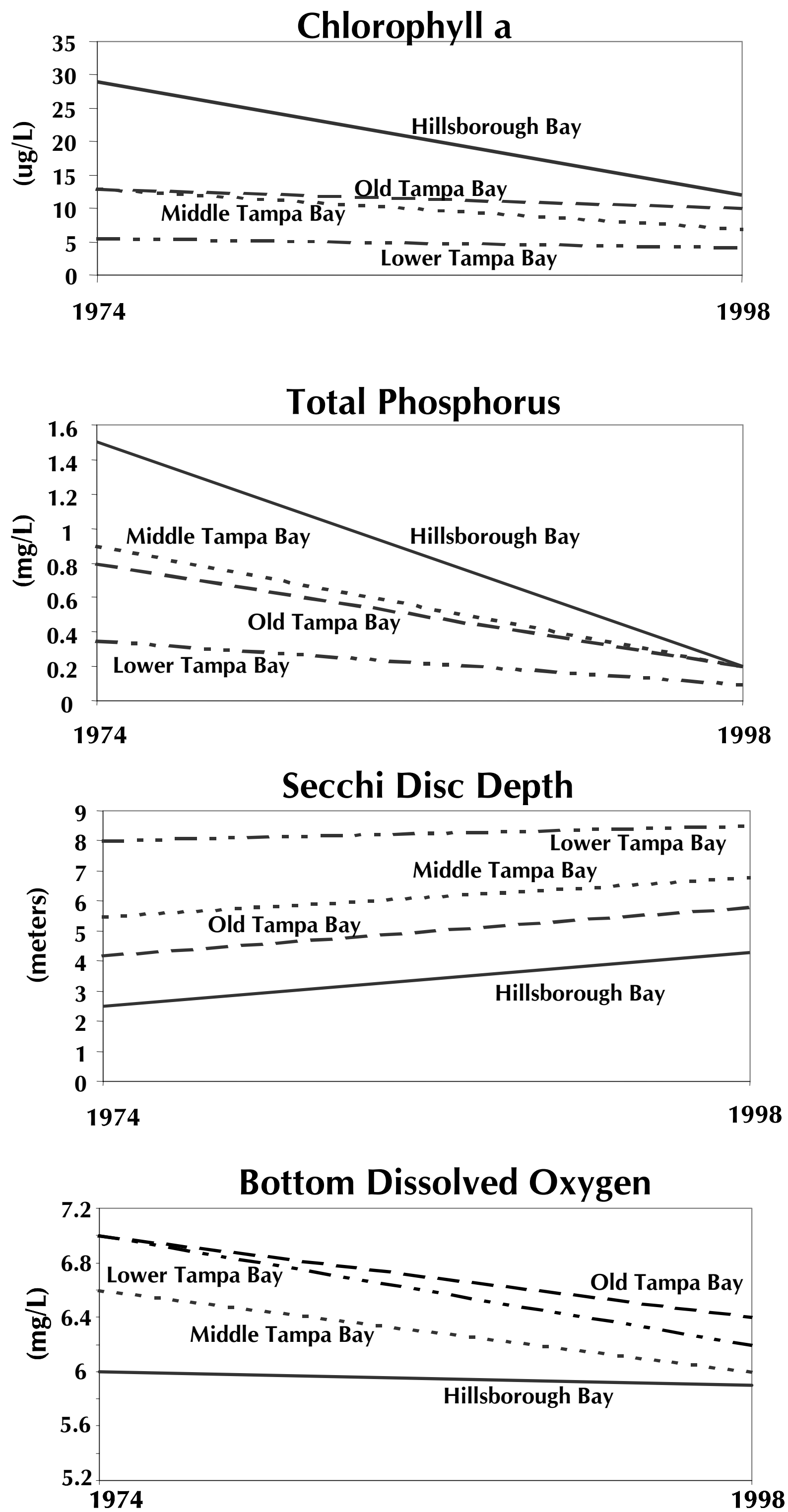

Figure 4-1. Comparison of slopes from parametric trend test for chlorophyll *a*, TP, Secchi disc depth, and bottom dissolved oxygen.

4.1.3 Effects of Rainfall on Long-term Trends

The interaction between rainfall and water quality conditions in the bay is complex. During periods of high rainfall, nutrient loads to the bay are generally greater due to greater runoff volume. Associated with high rainfalls are large hydrologic loads as well. As hydrologic loads increase, dilution in the bay increases, and residence times are reduced. Dilution results in lower salinity, which may in turn result in changes in the phytoplankton community composition. Conversely, during periods of low rainfall and correspondingly small hydrologic loads, residence times increase and salinity increases. These conditions may also result in changes in the phytoplankton community composition.

Water quality conditions in Tampa Bay have been shown to be related to nutrient loads to the bay (Janicki and Wade, 1996). Nutrient loads are a function of rainfall to the watershed and the bay. The effects of the variability in rainfall with respect to the trends in water quality were examined to evaluate if changes in rainfall contributed to the observed trends.

The monthly rainfall to the surface of each bay segment was estimated for the 1974-1998 period to examine the temporal variability in rainfall. These data were evaluated for any trends in rainfall using the nonparametric test. Significant positive trends in rainfall were found in Hillsborough Bay and Middle Tampa Bay, although the slopes were very small. These trends are attributable to higher than normal rainfall during 1995, 1997, and 1998. Despite the positive trends in rainfall, negative trends in chlorophyll *a* and TP, and positive trends in Secchi disc depth, were found in both Hillsborough Bay and Middle Tampa Bay. Monthly water quality conditions (TN, TP, chlorophyll *a*, and Secchi disc depth) in Hillsborough Bay, where observed trends in water quality were most dramatic, were then plotted as functions of monthly rainfall to the segment. No relationships were found between any of the water quality variables examined and rainfall. Improvements or declines in water quality conditions were not related to changes in rainfall.

To further examine the influence of rainfall on water quality in Tampa Bay, the annual TN loadings from all sources to each bay segment for the 1985-1998 period were plotted as a function of the annual hydrologic loadings, as shown in Figures 4-2 through 4-8. The annual hydrologic loadings are functions not only of rainfall, but also of hydrologic loadings from all other sources in the watershed. In the figures, the data points representing the recently developed 1995-1998 loadings (Pribble et al., 2001) are labeled for comparison with those from the 1985-1994 period (Zarbock et al., 1994; 1996). For all bay segments, the relationships between hydrologic loads and TN loadings are approximately linear, suggesting that the TN loadings per unit hydrologic loadings have not changed during the 1985-1998 period.

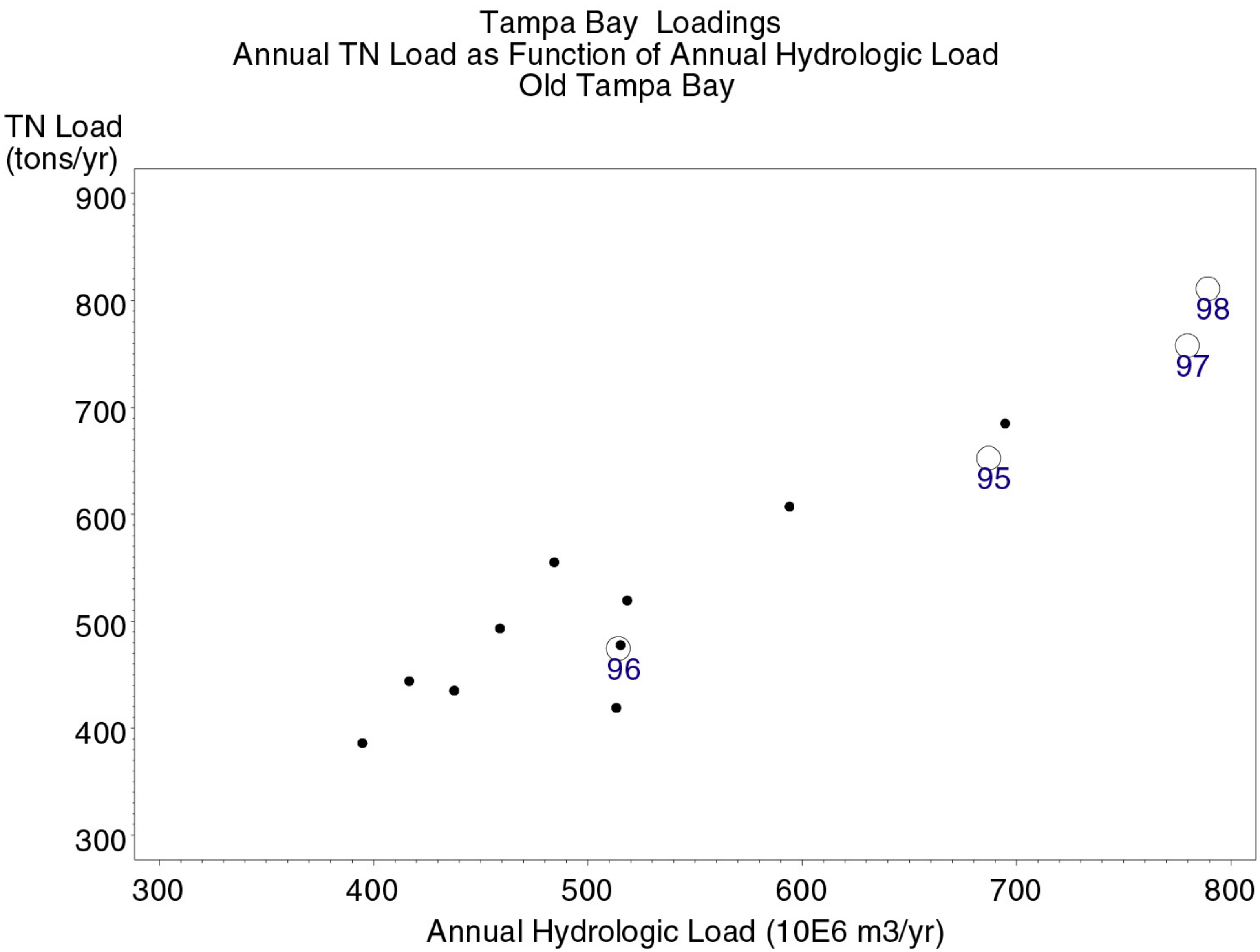

Figure 4-2. Relationship between TN and hydrologic loadings, Old Tampa Bay, 1985-1998 (from Pribble et al., 2001).

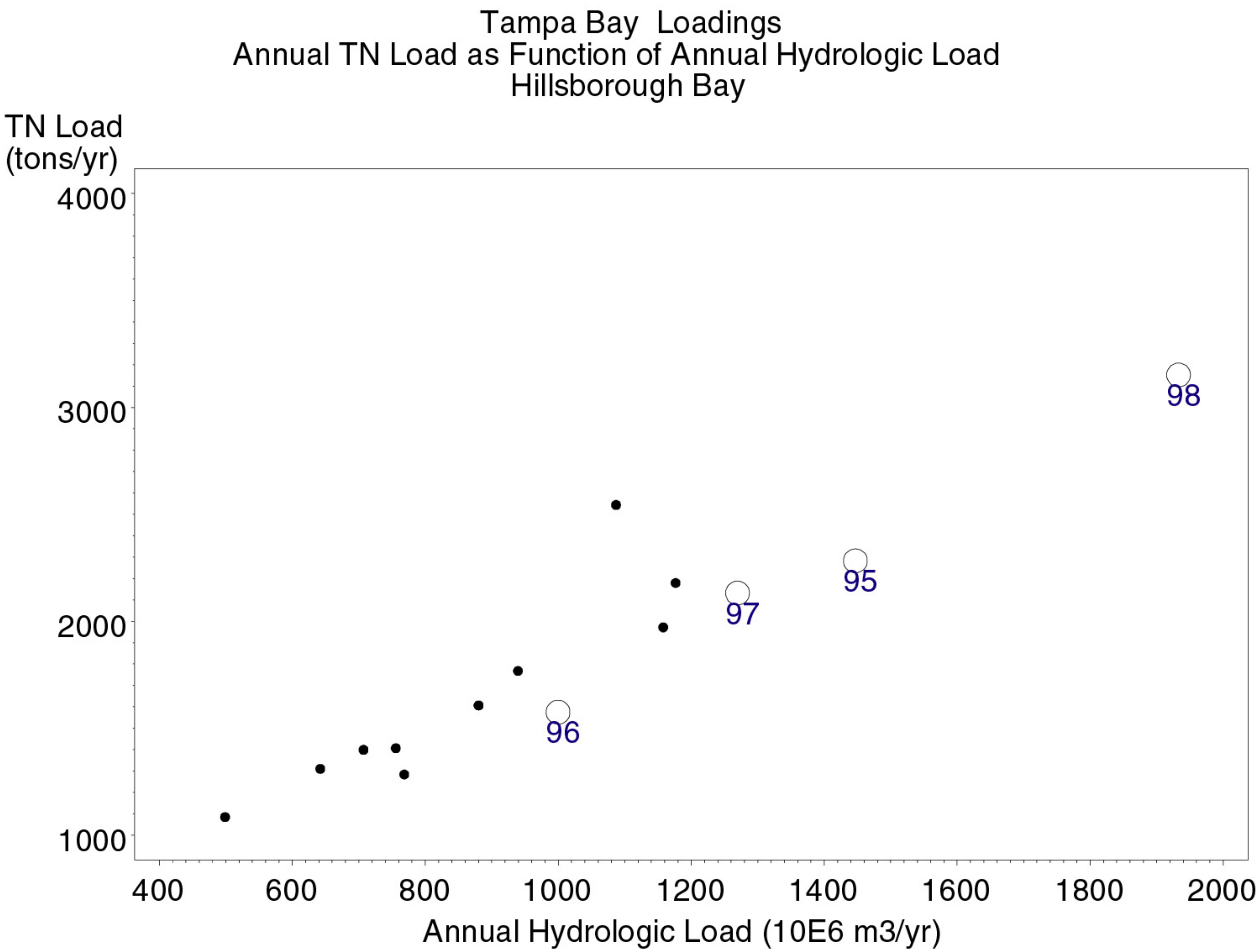

Figure 4-3. Relationship between TN and hydrologic loadings, Hillsborough Bay, 1985-1998 (from Pribble et al., 2001).

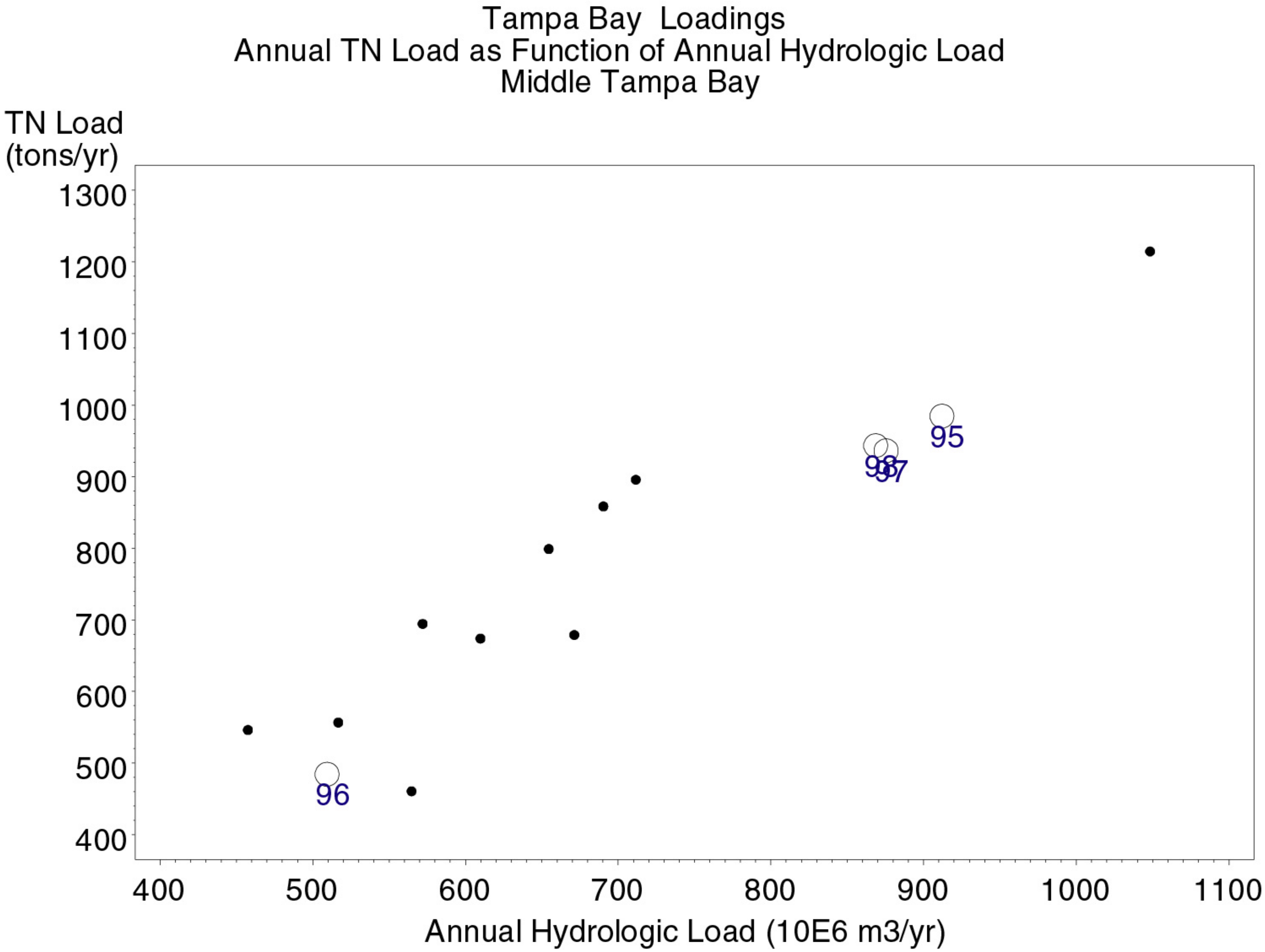

Figure 4-4. Relationship between TN and hydrologic loadings, Middle Tampa Bay, 1985-1998 (from Pribble et al., 2001).

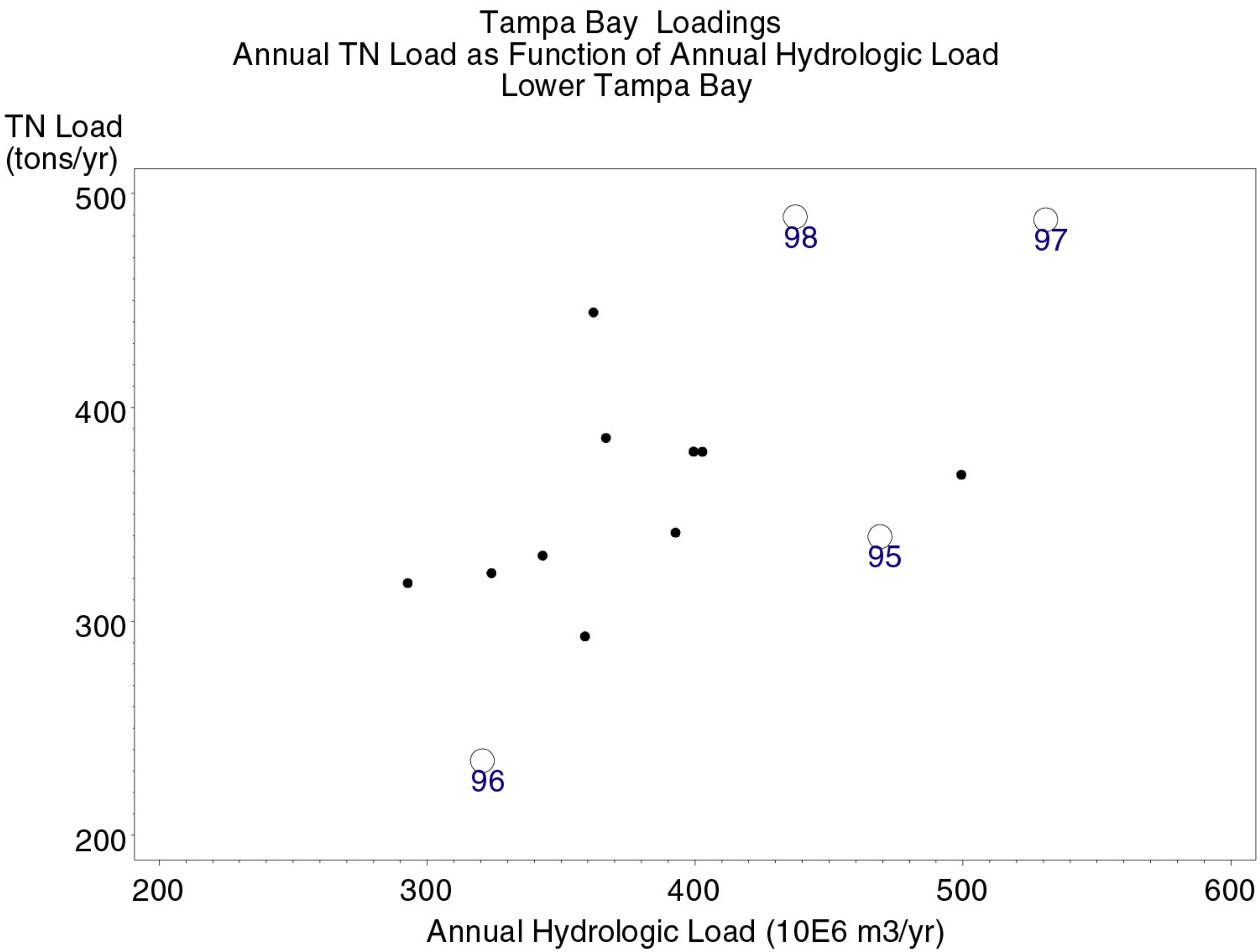

Figure 4-5. Relationship between TN and hydrologic loadings, Lower Tampa Bay, 1985-1998 (from Pribble et al., 2001).

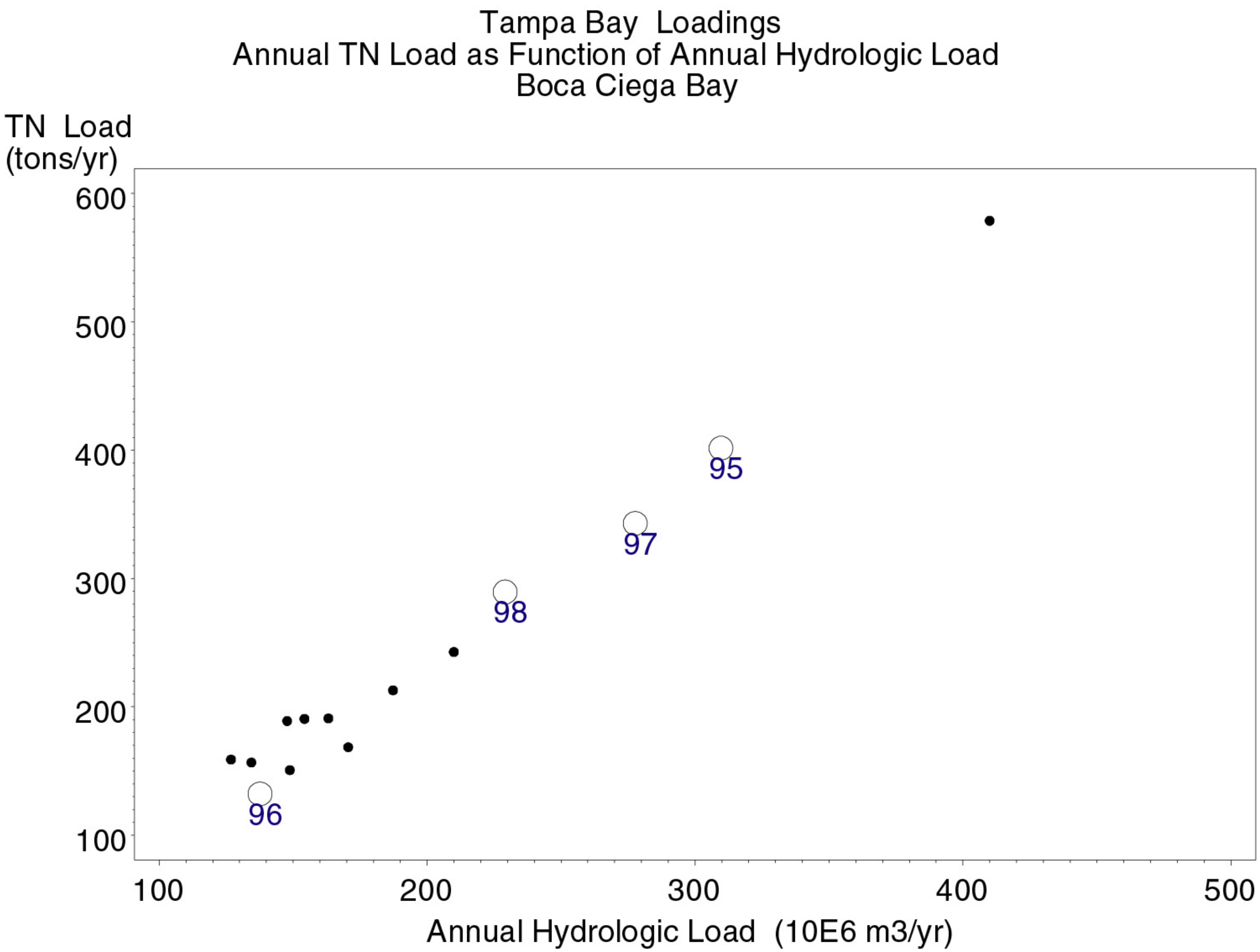

Figure 4-6. Relationship between TN and hydrologic loadings, Boca Ciega Bay, 1985-1998 (from Pribble et al., 2001).

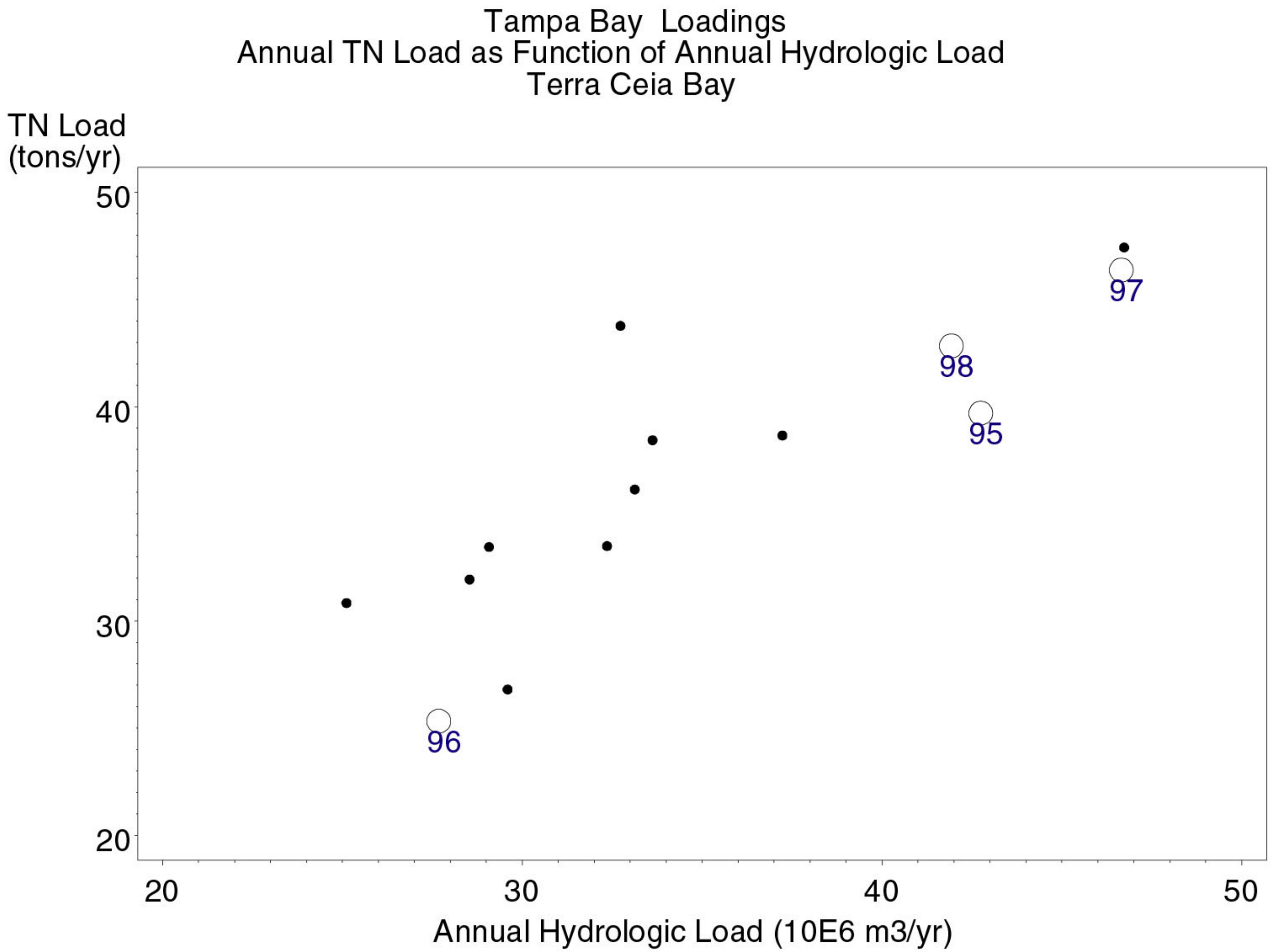

Figure 4-7. Relationship between TN and hydrologic loadings, Terra Ceia Bay, 1985-1998 (from Pribble et al., 2001).

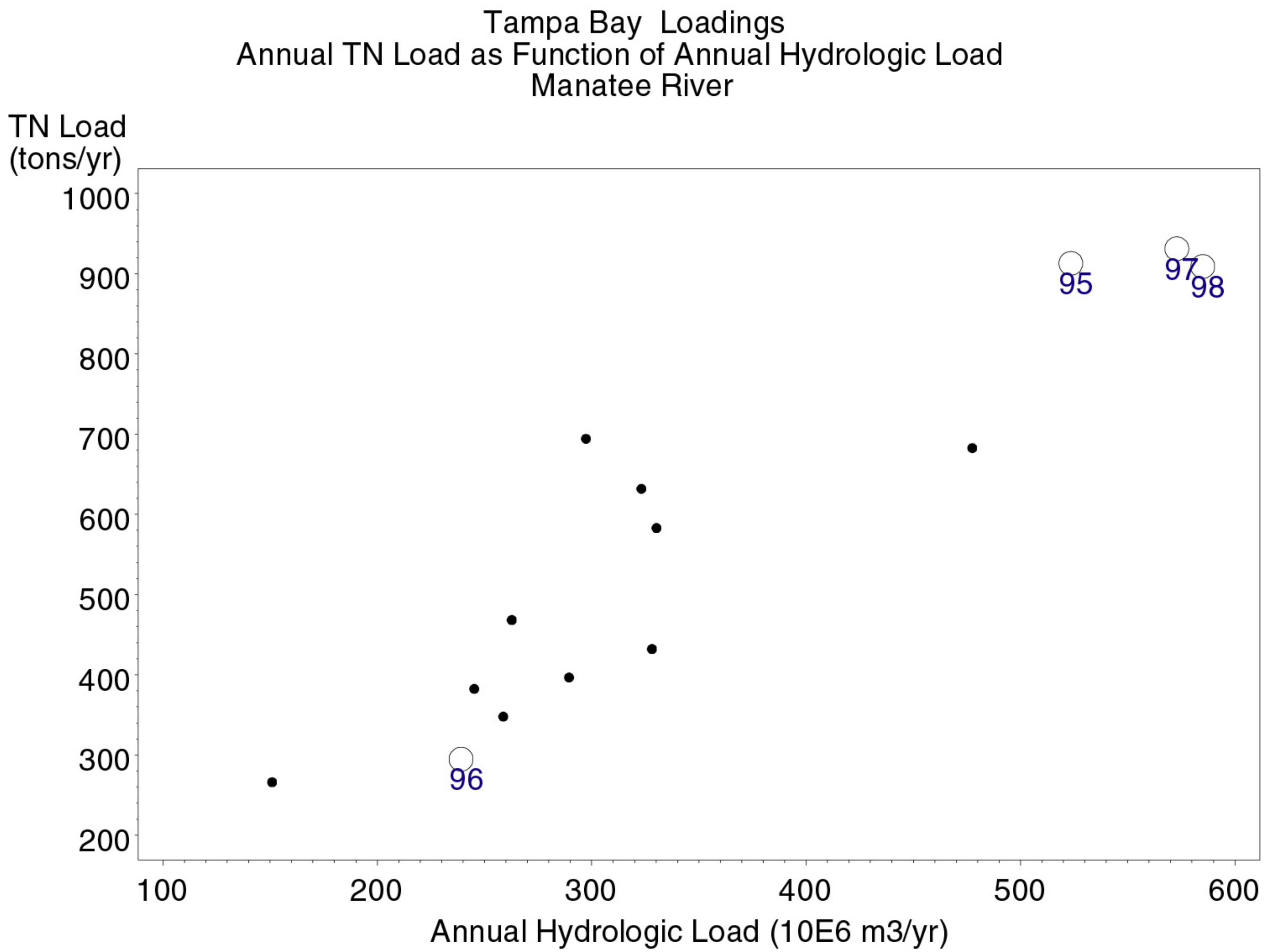

Figure 4-8. Relationship between TN and hydrologic loadings, Manatee River, 1985-1998 (from Pribble et al., 2001).

4.2 Comparison of Recent Water Quality Conditions Among Bay Segments

As discussed above, prior to the 1990s the primary source for water quality data was the EPCHC ambient monitoring program, which is limited to the four mainstem bay segments. With the initiation of sampling by Pinellas County in Boca Ciega Bay and Manatee County in Terra Ceia Bay and the Manatee River, data exist that allow more comprehensive comparisons of water quality conditions among all seven bay segments.

Mean annual chlorophyll *a*, TN, and TP concentrations and Secchi disc depths were estimated for each bay segment for the period 1996-1998. The estimates are presented graphically in Figure 4-9. This figure allows comparison of all of the parameters of concern among all bay segments. For each bay segment, the array of data points is as follows:

Upper Left	Upper Right
Chlorophyll *a*	TN
Lower Left	Lower Right
TP	Secchi disc depth

The size of the points vary according to their relative values, thus larger points typically represent higher concentrations and smaller points typically represent lower concentrations. The estimated mean annual values presented in Figure 4-9 are given in Table 4-6.

As observed during the entire period of record from the EPCHC data, the poorest water quality conditions among the four mainstem segments were found in Hillsborough Bay (highest chlorophyll *a*, TN, and TP concentrations and lowest Secchi disc depths). During 1996-1998, Lower Tampa Bay reflected the best water quality, and conditions in Old Tampa Bay and Middle Tampa Bay were intermediate.

Comparison of the water quality in Boca Ciega Bay, Terra Ceia Bay, and the Manatee River to that in the mainstem segments provides some interesting findings. This is especially true with respect to chlorophyll *a* and nutrient concentrations. Terra Ceia Bay and the Manatee River were most similar in water quality to Old Tampa Bay and Middle Tampa Bay. However, in Boca Ciega Bay, the water quality, as reflected in chlorophyll *a* and nutrient concentrations, was generally better than that observed in these segments. Surprisingly, however, the mean annual Secchi disc depth in Boca Ciega Bay was not as indicative of good water quality conditions as were the other parameters.

Table 4-6. Mean annual water quality conditions for the period 1996-1998 for each bay segment.

BAY SEGMENT	WATER QUALITY VARIABLE			
	Chlorophyll a (:g/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Secchi Disc Depth (m)
Old Tampa Bay	8.8	0.75	0.21	1.6
Hillsborough Bay	14.1	0.81	0.36	1.2
Middle Tampa Bay	8.0	0.72	0.23	1.8
Lower Tampa Bay	4.2	0.50	0.12	2.7
Boca Ciega Bay	6.6	0.51	0.08	1.2
Terra Ceia Bay	8.3	0.78	0.29	1.3
Manatee River	8.1	0.76	0.26	1.1

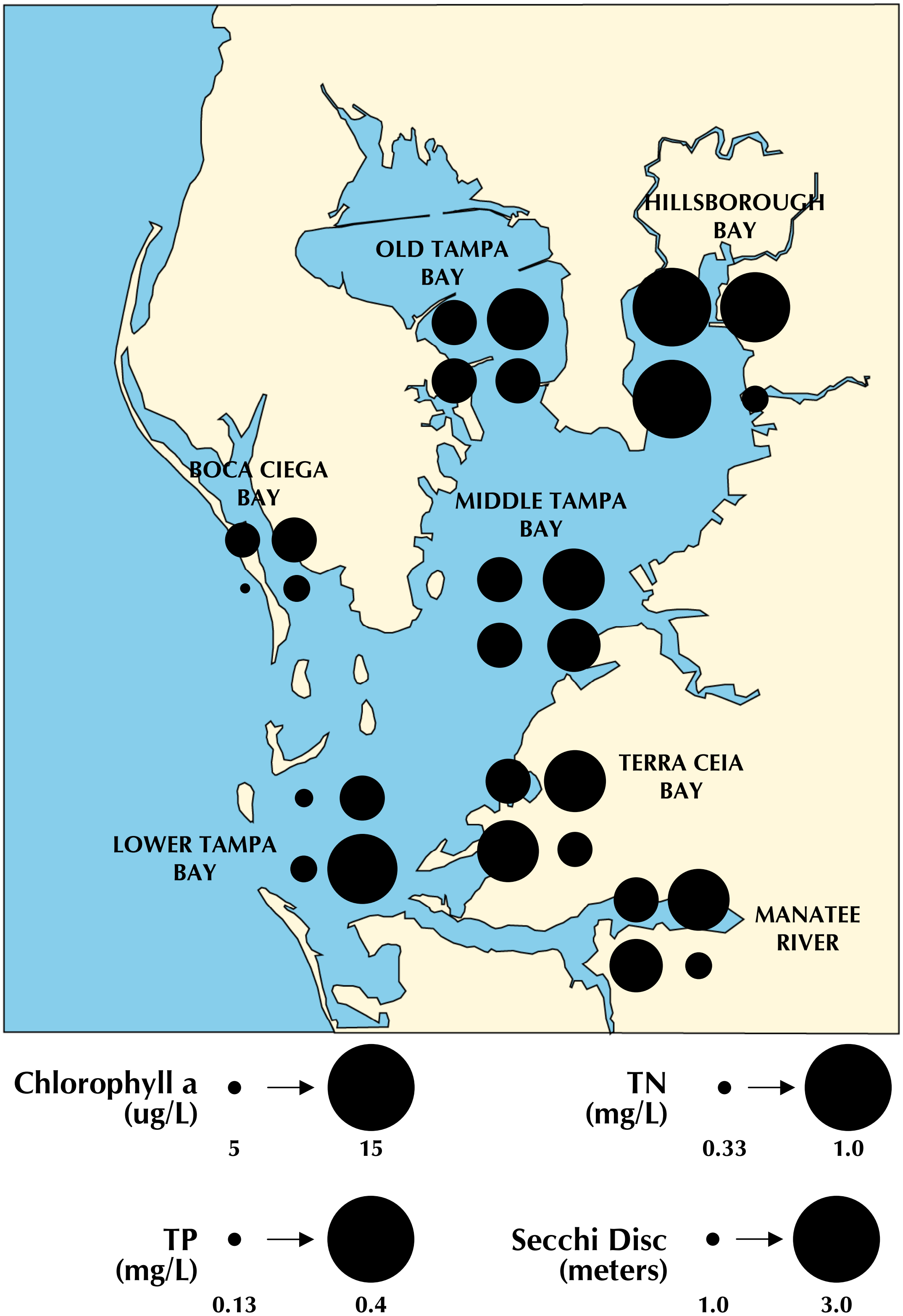

Figure 4-9. Relative values of chlorophyll a and nutrient concentrations and Secchi disc depths in seven segments of Tampa Bay.

4.3 Other Water Quality Questions of Interest

Three questions of interest have emerged recently. These involve:

- spatial differences in water quality within Old Tampa Bay,
- long-term changes in nutrient concentrations within bay tributaries, and
- long-term changes in salinity within each bay segment.

Data analyses were performed to address these questions.

4.3.1 Spatial Differences in Water Quality within Old Tampa Bay

Recent seagrass monitoring has detected appreciable reductions in seagrass in Old Tampa Bay between 1996 and 1999. The losses were primarily found along the western shoreline of this segment. A question has arisen as to whether these losses may be due to water quality degradation along the western shore of Old Tampa Bay.

To address this question, EPCHC water quality data from a series of sampling sites located along the western and eastern shores of Old Tampa Bay were analyzed (Figure 4-10). Mean chlorophyll *a* concentrations and Secchi disc depths were estimated for these sites for the 1990-1998 period (Figure 4-11).

Each of the stations along the western shore had higher chlorophyll *a* concentrations than any station along the eastern shore. Secchi disc depths were also generally shallower by approximately one foot at the western shore stations. The worst water quality conditions were generally found along the western shore between the Howard Frankland Bridge and the Courtney Campbell Causeway.

To examine the statistical significance of the observed differences, analyses of variance were performed (Sokal and Rohlf, 1995). The primary null hypothesis tested was that no differences in the mean chlorophyll *a* concentration or Secchi disc depth during 1990-1998 existed. The significance of within-year variation in both of these variables could influence inferences regarding the between-shore differences. Therefore, month was included as a main effect and the shore*month interaction term was also included in the model. The test of significance of the interactions term is critical since the error mean square of this term should be used in the F-test for the shore main effect when the interaction is significant.

Significant between-shore and among-month differences were detected for both chlorophyll *a* concentrations and Secchi disc depths (Table 4-7). Similar results were obtained for both untransformed and log-transformed (to address any non-homogeneity of variances) data. None of the interaction terms were significant. Therefore, it can be concluded that the east-west shore differences in chlorophyll *a* concentrations and Secchi disc depths were significant and these differences were consistent across all months.

Table 4-7. Results of the analyses of variance of water quality conditions along the western and eastern shores of Old Tampa Bay.

Month		**Chlorophyll a (μg/L)**		**Secchi Disc Depth (feet)**	
		East	**West**	**East**	**West**
1		4.1	5.9	7.6	5.9
2		4.8	6.3	6.6	5.2
3		4.7	5.5	5.8	5.2
4		5.1	6.4	5.9	5.1
5		6.1	7.8	5.7	4.9
6		8.0	9.6	5.6	4.5
7		9.0	10.2	5.9	4.9
8		10.2	14.7	5.7	4.5
9		12.1	17.4	5.0	4.1
10		14.1	17.0	5.3	4.2
11		11.3	13.2	4.7	4.3
12		6.1	9.0	6.9	4.7
Shore	F	60.13		103.51	
	p>F	<0.0001		<0.0001	
Month	F	54.27		11.32	
	p>F	<0.0001		<0.0001	
Shore*Month	F	1.78		1.37	
	p>F	0.0527		0.1830	

4.3.2 Trends in Tributary Nutrient Concentrations

Recent concerns about increases in nonpoint source loadings (Pribble et al., 2000) have led to questions regarding trends in nutrient concentrations in tributaries to the bay. To address these questions, trends in nutrient concentrations in six tributaries to the bay were estimated using the nonparametric trend test. The following tributaries (Figure 4-12) were examined:

- Double Branch Creek,
- Rocky Creek,
- Hillsborough River - at Rowlett Park Drive,
- Palm River - at US 41,
- Little Manatee River - at US 301, and
- Alafia River - at Bell Shoals Road.

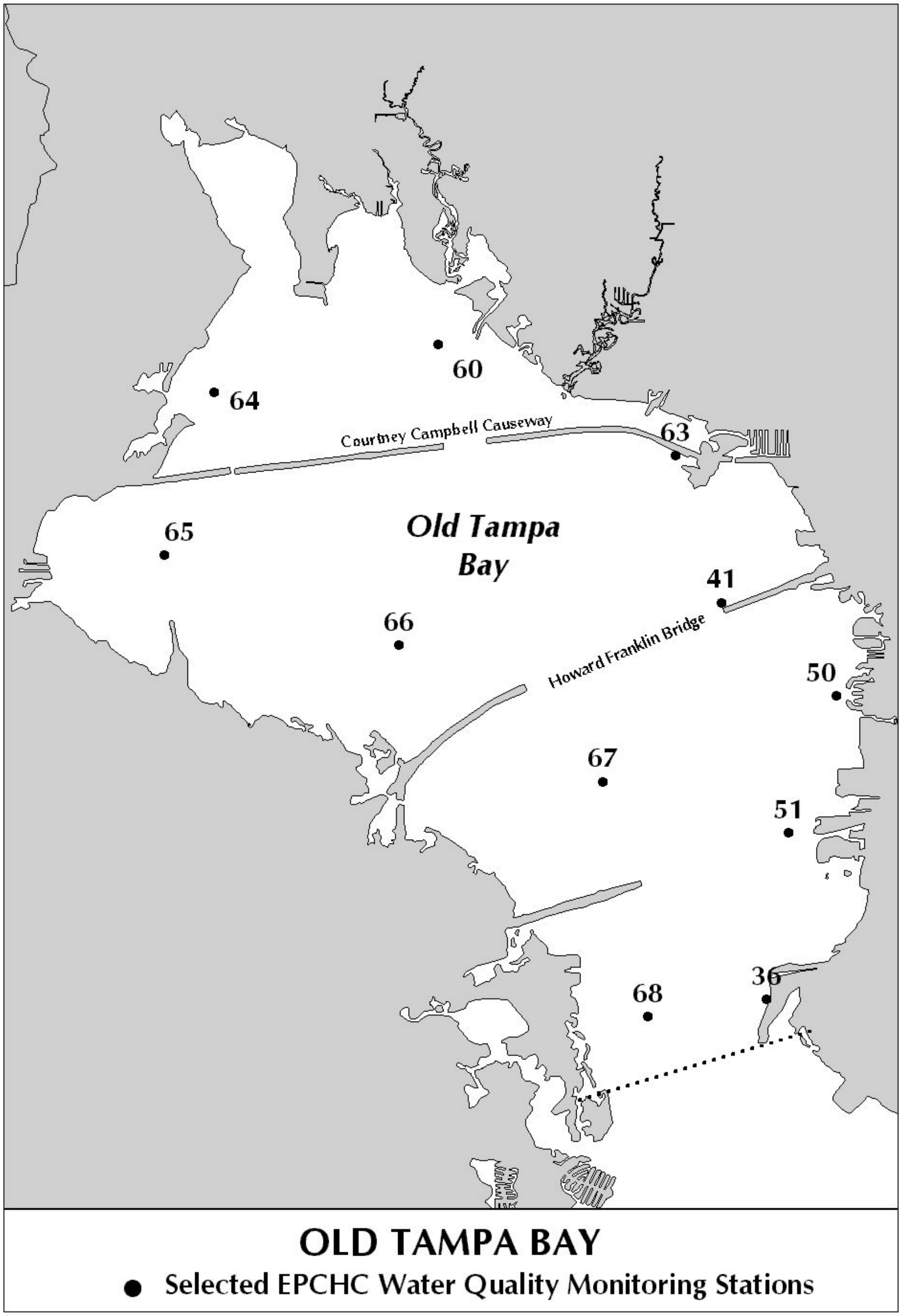

Figure 4-10. Locations of EPCHC water quality monitoring stations used for comparison of eastern and western shore conditions in Old Tampa Bay.

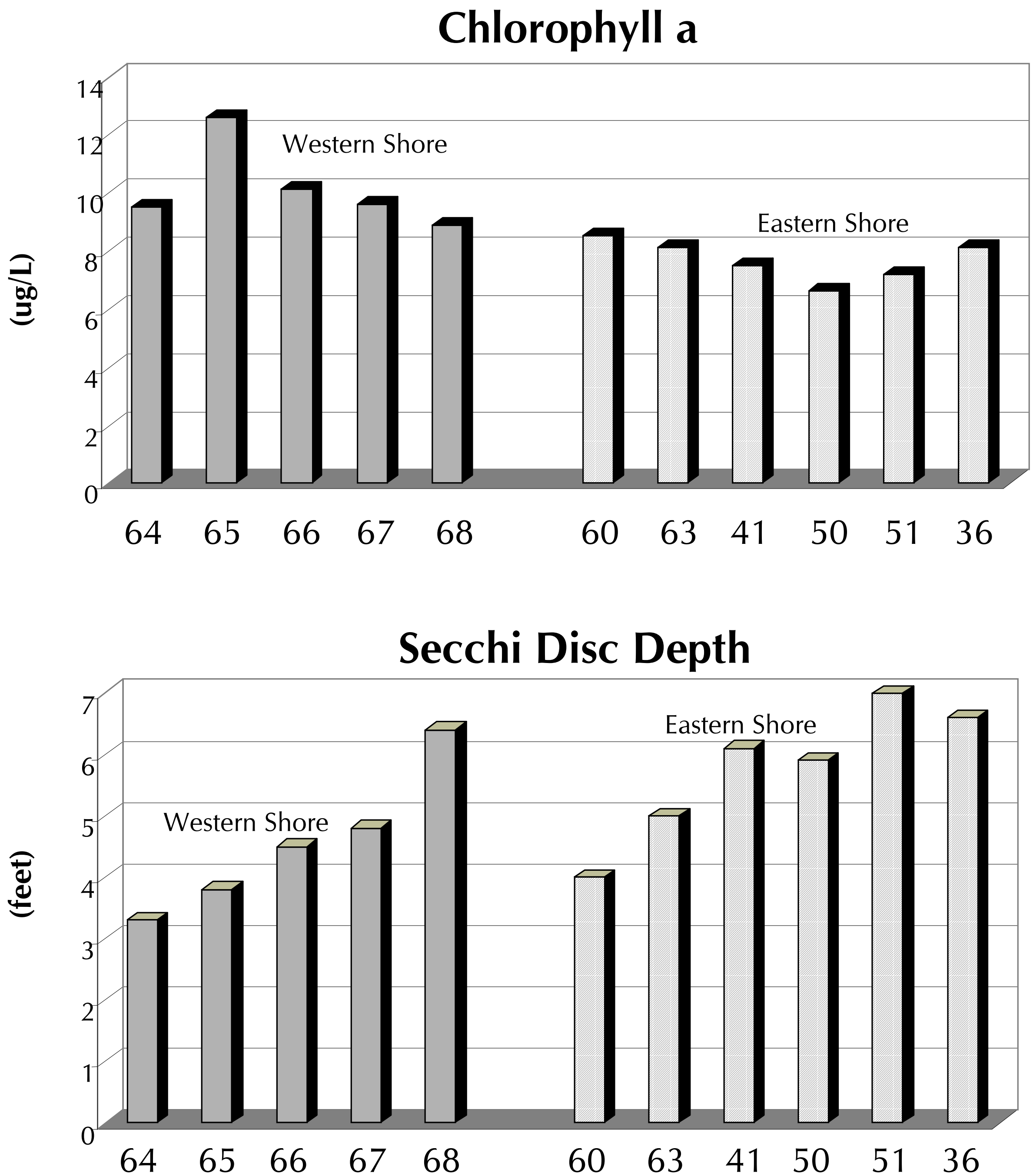

Figure 4-11. Mean 1990-1998 chlorophyll *a* concentrations and Secchi disc depths from EPCHC monitoring sites along the western and eastern shores of Old Tampa Bay.

In Rocky Creek and the Hillsborough, Palm, and Alafia rivers, both TN and TP concentrations have declined significantly during the 1974-1998 period. In Double Branch Creek, a similar trend was observed in TP concentrations, but no trend was detected in TN concentrations. No significant trends in either TN or TP were observed in the Little Manatee River (Table 4-8).

Table 4-8. Long-term nonparametric trend test results for tributaries to the bay.

BAY SEGMENT	TN Concentrations	TP Concentrations
Double Branch Creek	0	-
Rocky Creek	-	-
Hillsborough River	-	-
Palm River	-	-
Little Manatee River	0	0
Alafia River	-	-

4.3.3 Long-term Salinity Trends

The need for new potable water supplies to alleviate groundwater pumping and meet future water needs has led local governments to look toward surface water withdrawal and seawater desalination as new water supplies. The most immediate effects of new surface water supply projects will be changes in salinity. Questions about long-term trends in the salinity of Tampa Bay have arisen.

Long-term trends in surface and bottom salinity were examined in each mainstem bay segment using the nonparametric method. The trend test results for surface and bottom salinity are shown in Table 4-9. No significant trends were found for surface or bottom salinity in Hillsborough Bay, Old Tampa Bay, and Middle Tampa Bay. In Lower Tampa Bay, a significant but small reduction was found in surface and bottom salinity. Generally, it can be concluded that the long-term salinity trends in the mainstem of Tampa Bay have not been significant.

Table 4-9. Long-term nonparametric trend test results for surface and bottom salinity in the mainstem segments of the bay.

BAY SEGMENT	SALINITY	
	Surface	Bottom
Old Tampa Bay	0	0
Hillsborough Bay	0	0
Middle Tampa Bay	0	0
Lower Tampa Bay	-	-

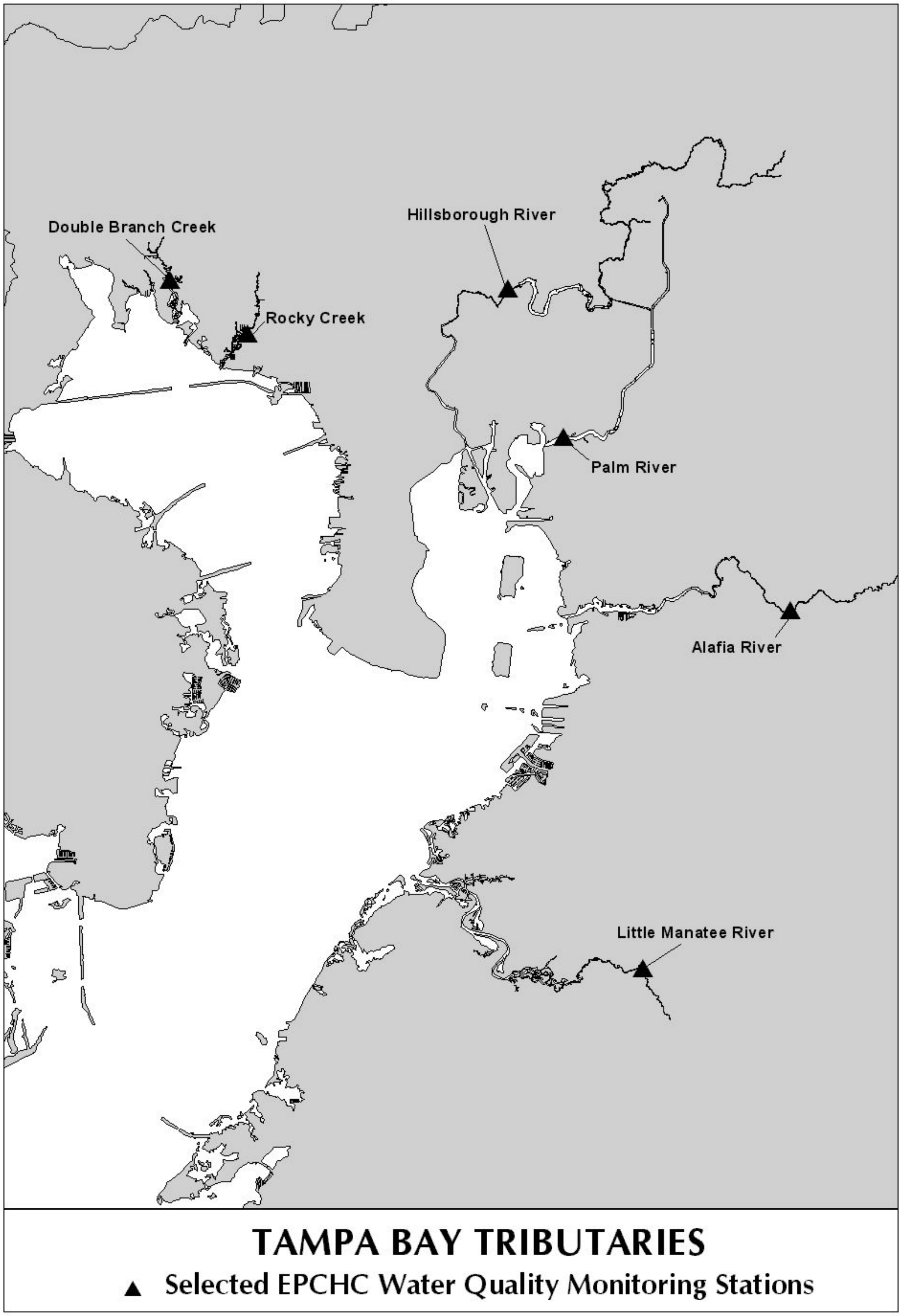

Figure 4-12. Locations of EPCHC water quality monitoring stations in tributaries.

5. DISCUSSION AND CONCLUSIONS

Water quality in Tampa Bay has been monitored since 1974 by the EPCHC, and since 1978 by the City of Tampa Bay Study Group, in Old Tampa Bay, Hillsborough Bay, Middle Tampa Bay, and Lower Tampa Bay. The PCDEM and MCEMD have monitored water quality for shorter periods in Boca Ciega Bay, Terra Ceia Bay, and the Manatee River. The data from these programs were examined to assess long-term trends in each bay segment and recent water quality differences across bay segments. Specifically, temporal and spatial trends in chlorophyll *a*, nutrients, and bottom dissolved oxygen concentrations, and Secchi disc depths were examined. In addition, analyses were performed to address several emerging questions of interest.

Significant temporal trends in water quality have been observed in Tampa Bay. The 1974-1998 period of record is characterized by three distinctive periods of differing water quality conditions in the mainstem segments of the bay. From the mid-1970s to the early 1980s, highly eutrophic conditions were observed. These conditions were reflected most notably in Hillsborough Bay, at intermediate levels in Old Tampa Bay and Middle Tampa Bay, and least prevalent in Lower Tampa Bay. From the early to the mid-1980s, rapid improvements in water quality were observed. These changes occurred most rapidly in Hillsborough Bay, and less rapidly in Old Tampa Bay and Middle Tampa Bay.

Initially, it is important to understand the reasons for the poor water quality in Tampa Bay. Poor water quality from early in the period of record was due to uncontrolled nutrient loadings to the bay. With an ever-increasing human population and development in the watershed, the need for controlling nutrient loadings became evident.

Several factors resulting from management actions to address these loadings have potentially contributed to the observed changes in water quality in Tampa Bay. The most influential factor was the upgrade of the City of Tampa's Howard F. Curren wastewater treatment facility to AWT standards that occurred in the late 1970s. The improvements to AWT standards have led to improvements in water quality throughout Tampa Bay, but most noticeably in Hillsborough Bay. All wastewater treatment facilities discharging directly to the bay are by regulation AWT facilities.

Stormwater regulations have also likely contributed to the improvements in bay water quality since 1974. SWFWMD regulations address stormwater runoff from newly developed land parcels. These regulations specifically address total suspended solids loadings, but also address TN loadings. The FDEP implements the NPDES permitting of stormwater runoff from existing urban areas. The observed long-term decline in TN and TP concentrations in tributaries to the bay may reflect the influence of these regulatory actions in the Tampa Bay watershed.

The third factor potentially contributing to observed improvements in water quality are recent changes at some of the fertilizer handling facilities in the bay area. In some cases, significant advances have recently been made in reducing nutrient inputs from facilities (Pribble et al., 2001).

Another factor contributing to water quality conditions in the bay is the atmospheric deposition of nutrients directly to the bay. The NADP monitors nitrogen concentrations in precipitation at the Verna Wellfield site in Sarasota County, and performs trend analysis of inorganic nitrogen deposition. Annual wet deposition of inorganic nitrogen at the Verna Wellfield increased during the period of 1983-1999 (NADP, 2000). Clearly, changes in atmospheric deposition to the bay has not contributed to the observed water quality improvements.

In addition to the significant temporal trends observed in Tampa Bay, spatial differences in water quality conditions have also been observed. Hillsborough Bay has consistently had the poorest water quality, as reflected by the highest chlorophyll *a* and nutrient concentrations and lowest Secchi disc depths of any of the mainstem bay segments. The relatively poor water quality in Hillsborough Bay is not unexpected (Johansson, 1991; Squires et al., 1992). Hillsborough Bay is characterized by being shallow, and therefore has a relatively small volume. Hillsborough Bay also receives approximately half of the TN load to Tampa Bay (Pribble et al., 2001). Given these conditions, it is not surprising that Hillsborough Bay reflects the poorest water quality in Tampa Bay.

Lower Tampa Bay consistently reflects the best water quality in Tampa Bay. This segment is relatively deep and has a relatively large surface area, resulting in the largest volume of any mainstem bay segment. It also has the smallest watershed of any of the mainstem segments (Pribble, 1999), and nutrient loads from its watershed are correspondingly small. Much of the nutrient load to Lower Tampa Bay is delivered by exchanges with Middle Tampa Bay via circulation. Given the position of this segment in the bay, tidal exchange with the Gulf of Mexico also contributes to the dilution of nutrients in the segment.

The other mainstem bay segments reflect water column conditions more or less intermediate to those in Hillsborough Bay and Lower Tampa Bay. Much of the spatial deviation that exists is driven by the differences in water quality between Hillsborough Bay and Lower Tampa Bay.

Recent results from the Tampa Bay seagrass monitoring program have pointed to appreciable losses of seagrass in Old Tampa Bay between 1996 and 1999 (Tomasko, 2000). These losses have been most apparent along the western shoreline of Old Tampa Bay.

Questions have arisen about the potential role of water quality deterioration along the western shoreline as compared to water quality conditions on the eastern shore. The water quality along the western shore of Old Tampa Bay, most notably between the Howard Frankland Bridge and the Courtney Campbell Causeway, is clearly poorer than that observed recently along the eastern shore. These results do not necessarily imply some sort of cause – effect relationship. However, more intensive water quality sampling, especially in the western shallow regions between the Howard Frankland Bridge and the Courtney Campbell Causeway, may prove useful in assessing the seagrass loss in that area.

The following conclusions can be drawn from this report:

- Long-term improvements in the trophic status of the bay have been observed. The long-term record of water quality in Tampa Bay points to three distinctive periods with different water quality conditions in the bay. Relatively poor conditions existed from the mid-1970s to the early 1980s, a transitional period to improved conditions followed until the mid-1980s, and a period of relatively good water quality conditions has persisted since.

- Throughout the period of record, Hillsborough Bay has reflected the poorest water quality conditions of the mainstem bay segments. The best water quality conditions are typically observed in Lower Tampa Bay. Comparison with the other five bay segments shows intermediate water quality conditions between those in Hillsborough Bay and Lower Tampa Bay.

- Significant long-term declines in nutrient concentrations have also occurred in tributaries to the bay.

- Recent water quality along the western shore of Old Tampa Bay is poorer than that observed along the eastern shore of the segment, especially in the area between the Howard Frankland Bridge and the Courtney Campbell Causeway.

- No meaningful trends in salinity have occurred in the four mainstem segments of the bay during the 1974-1998 period.

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APPENDIX A

DETAILS OF PARAMETRIC AND NONPARAMETRIC METHODS FOR TREND DETECTION

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NONPARAMETRIC TEST FOR TRENDS IN MEAN ANNUAL WATER QUALITY

One of the methods employed to assess temporal trends in Tampa Bay water quality is based on the seasonal Kendall tau test developed by Hirsch, Slack, and Smith (1982). They proposed a modification of the nonparametric Mann-Kendall test for trend when seasonality in the data is present. This test may be used even when there are missing, tied, or non-detection values are present in the data. There also is no assumption regarding the distribution of the data that can affect the validity of the test (Gilbert, 1987).

The seasonal Kendall test is a generalization of the Mann-Kendall test where the Mann-Kendall test statistic *S* and its variance *VAR(S)* is calculated separately for each season (month) according to the following steps.

1.) Order the data according to the date of their collection: $x_1, x_2, \ldots, x_n$.

2.) Determine the sign of all n(n-1)/2 possible differences $x_j - x_k$, where $j>k$, representing the season (month).

3.) Compute the Mann-Kendall statistic *S*, which is the sum of the number of positive differences less the sum of the number of negative differences, for each season (month) *i*.

$$S_i = \sum_{k=1}^{n_i-1} \sum_{j=k+1}^{n_i} \operatorname{sgn}(x_j - x_k)$$

If S_i is large and positive, then the data collected later in time tend to be larger than those taken earlier. If S_i is large and negative, then the data collected later in time tend to be smaller than those collected earlier.

4.) The variance of the S statistic for each season (month) is calculated as:

$$VAR(S_i) = \frac{1}{18}\left[n_i\,(n_i-1)\,(2n_i+5) - \sum_{p=1}^{g_i}(t_{ip}-1)\,(2t_{ip}+5)\right]$$

where: g_i = *number of groups of tied data in season i*,
and t_{ip} *is the number of tied data in the* p^{th} *group for season i.*

5.) After S_I and $Var(S_I)$ are computed, sum across all K seasons (months) as follows:

$$S' = \sum^{K} S_i$$

and

$$VAR(S') = \sum^{K} VAR(S_i)$$

6.) Compute the Z statistic using *S'* and *VAR(S')* as follows:

$$z = \frac{S'-1}{[VAR(S')]^{1/2}} \quad if\ S' > 0$$

$$= 0 \quad if\ S' = 0$$

$$= \frac{S'+1}{[VAR(S')]^{1/2}} \quad if\ S' < 0$$

Z is positive when the trend is increasing, negative when the trend is decreasing. The Z statistic has a standard normal distribution.

PARAMETRIC TEST FOR TRENDS IN MEAN ANNUAL WATER QUALITY

One of the methods employed to assess temporal trends in Tampa Bay water quality is based on a procedure developed by Coastal Environmental (Coastal, 1996) for the Florida Department of Environmental Protection (DEP). That project, headed by the St. Johns River Water Management District, examined methods by which long-term water quality data collected by DEP could be examined for temporal trends.

The following outlines the steps taken to estimate the slope of the line that best defines the trend in annual mean water quality conditions.

1.) Estimate the mean for the response variable and the variance of the estimated mean for each season (*s*) and year (*t*). The subscript, *i*, denotes the sample number within season and year; n_{st} is the number of samples within season and year.

Mean: $$\bar{y}_{st} = \frac{1}{n_{st}} \sum_{i=1}^{n_{st}} y_{ist}$$

Variance: $$\operatorname{var}(\bar{y}_{st}) = \frac{1}{n_{st}} \sum_{i=1}^{n_{st}} \frac{(y_{ist} - \bar{y}_{st})^2}{n_{st} - 1}$$

2.) Estimate the annual mean and the variance of the estimated annual mean for each year. The number of seasons is denoted by *r*; the duration of season *s* is *w* months.

Annual Mean: $$\bar{y}_t = \frac{\sum_{s=1}^{r} w_s \times \bar{y}_{st}}{\sum_{s=1}^{r} w_s}$$

Annual Variance: $$\operatorname{var}(\bar{y}_t) = \frac{\sum_{s=1}^{r} w_s^2 \times \operatorname{var}(\bar{y}_{st})}{\left[\sum_{s=1}^{r} w_s\right]^2}$$

3.) If there are no missing estimated means or variances for all M years within the study period then the dataset is deemed complete and proceed to the next step.

4.) Estimate the slope, ß, and the variance for the estimated slope.

Slope: $$\beta = \sum_{t=1}^{M} c_t \times \bar{y}_t$$

Variance of Slope: $$\mathrm{var}(\beta) = \sum_{t=1}^{M} c_t^2 \times \mathrm{var}(\bar{y}_t)$$

Where: $$c_t^2 = \frac{t-\bar{t}}{\sum_{t=1}^{M}(t-\bar{t})^2} \quad \text{and} \quad \bar{t} = \frac{1}{M}\sum_{t=1}^{M} t$$

5.) Calculate the 95% confidence limits for the estimated slope.

Lower Limit: $$\beta - \left[1.96 \times \sqrt{\mathrm{var}(\beta)}\right]$$

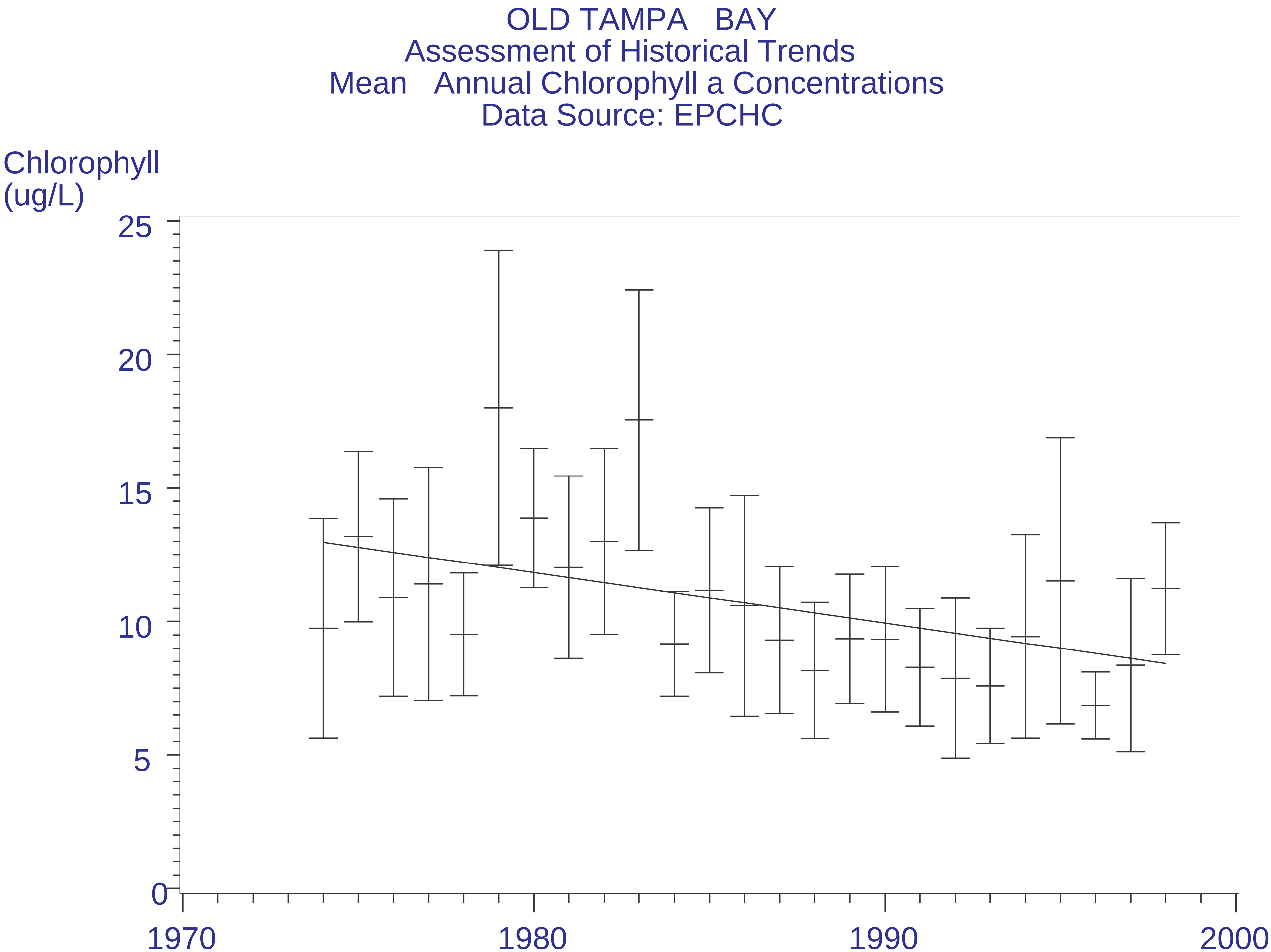
Upper Limit: $$\beta + \left[1.96 \times \sqrt{\mathrm{var}(\beta)}\right]$$

APPENDIX B

TREND RESULTS AND WATER QUALITY DATA PLOTS, EPCHC

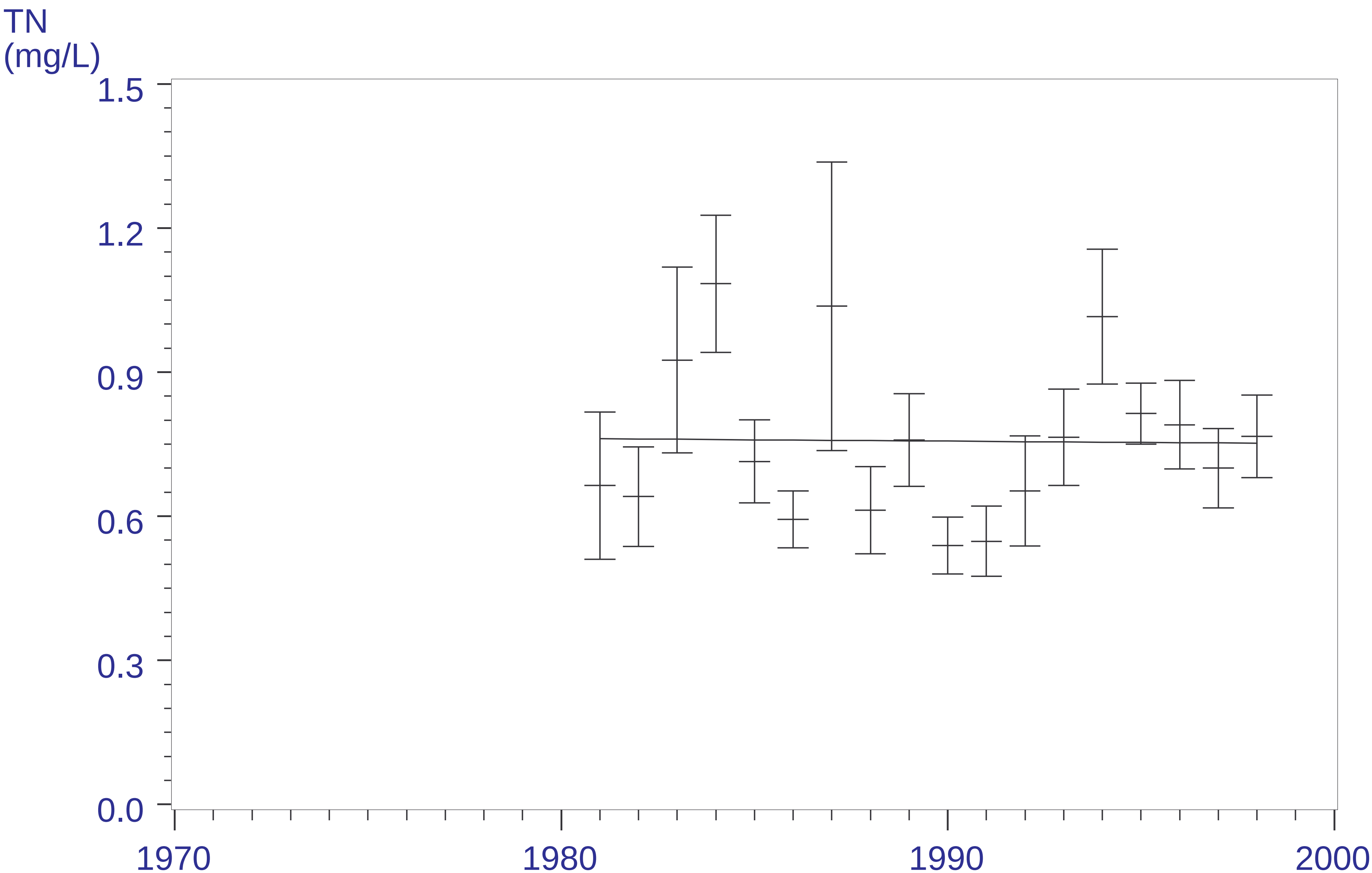
OLD TAMPA BAY

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Old Tampa Bay Chlorophyll a (ug/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	279
Mean Annual Slope Estimate	-0.189
Lower 95% Confidence Limit	-0.285
Upper 95% Confidence Limit	-0.094
p Value Slope Statistic	0.0001
Percent Change per Year	-0.018


OLD TAMPA BAY
Assessment of Historical Trends
Mean Annual Chlorophyll a Concentrations
Data Source: EPCHC
Chlorophyll
(ug/L)
25
20
15
10
5
0
1970
1980
1990
2000

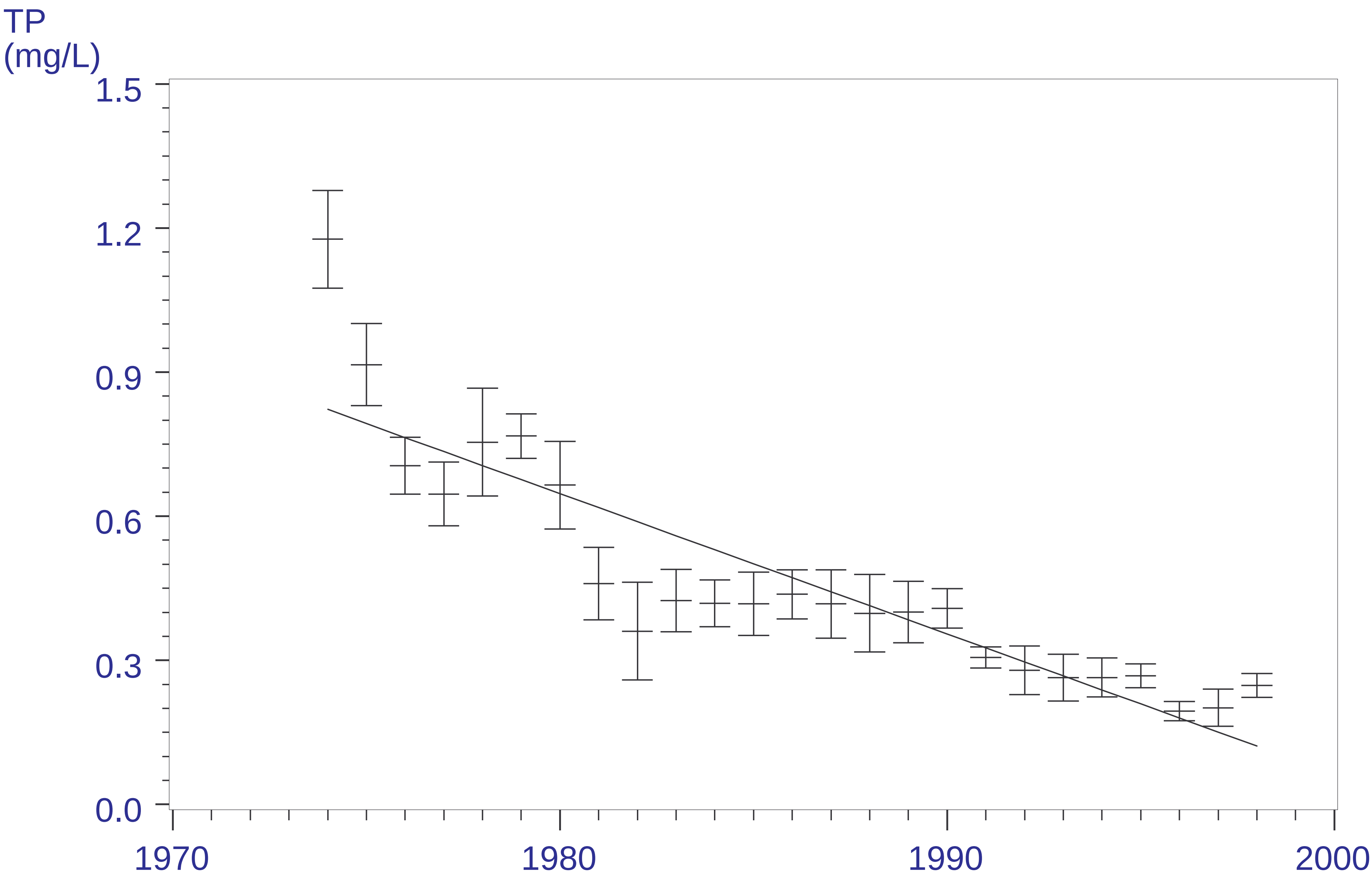
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Old Tampa Bay Total Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	18
Number of Samples	202
Mean Annual Slope Estimate	-0.001
Lower 95% Confidence Limit	-0.006
Upper 95% Confidence Limit	-0.005
p Value Slope Statistic	0.8477
Percent Change per Year	-0.001

OLD TAMPA BAY
Assessment of Historical Trends
Mean Annual Total Nitrogen Concentrations
Data Source: EPCHC



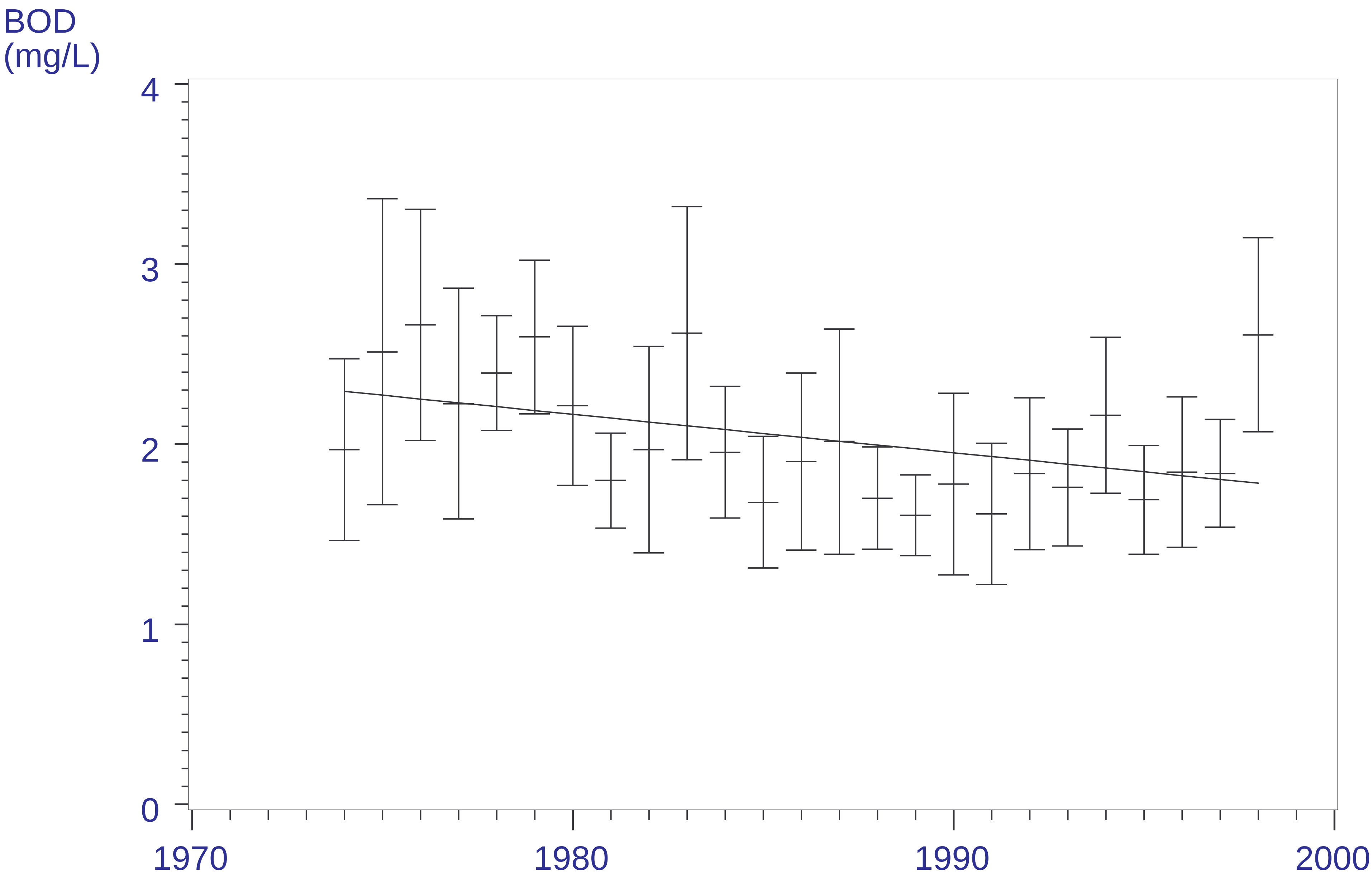
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Old Tampa Bay Total Phosphorus (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	279
Mean Annual Slope Estimate	-0.029
Lower 95% Confidence Limit	-0.031
Upper 95% Confidence Limit	-0.027
p Value Slope Statistic	0.0000
Percent Change per Year	-0.062

OLD TAMPA BAY
Assessment of Historical Trends
Mean Annual Total Phosphorus Concentrations
Data Source: EPCHC



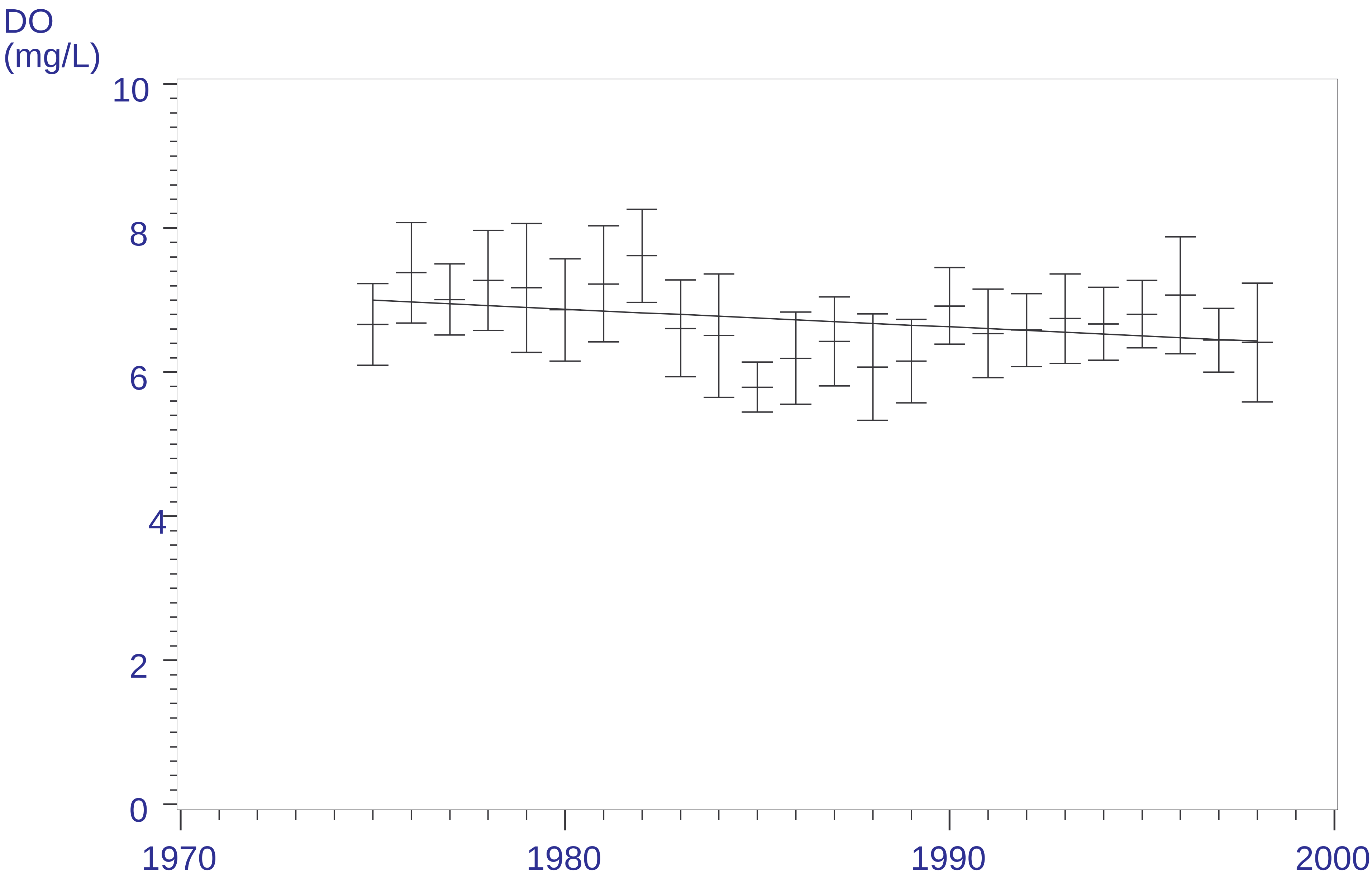
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Old Tampa Bay BOD (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	278
Mean Annual Slope Estimate	-0.021
Lower 95% Confidence Limit	-0.035
Upper 95% Confidence Limit	-0.007
p Value Slope Statistic	0.0028
Percent Change per Year	-0.010

OLD TAMPA BAY
Assessment of Historical Trends
Mean Annual Biochemical Oxygen Demand Concentrations
Data Source: EPCHC

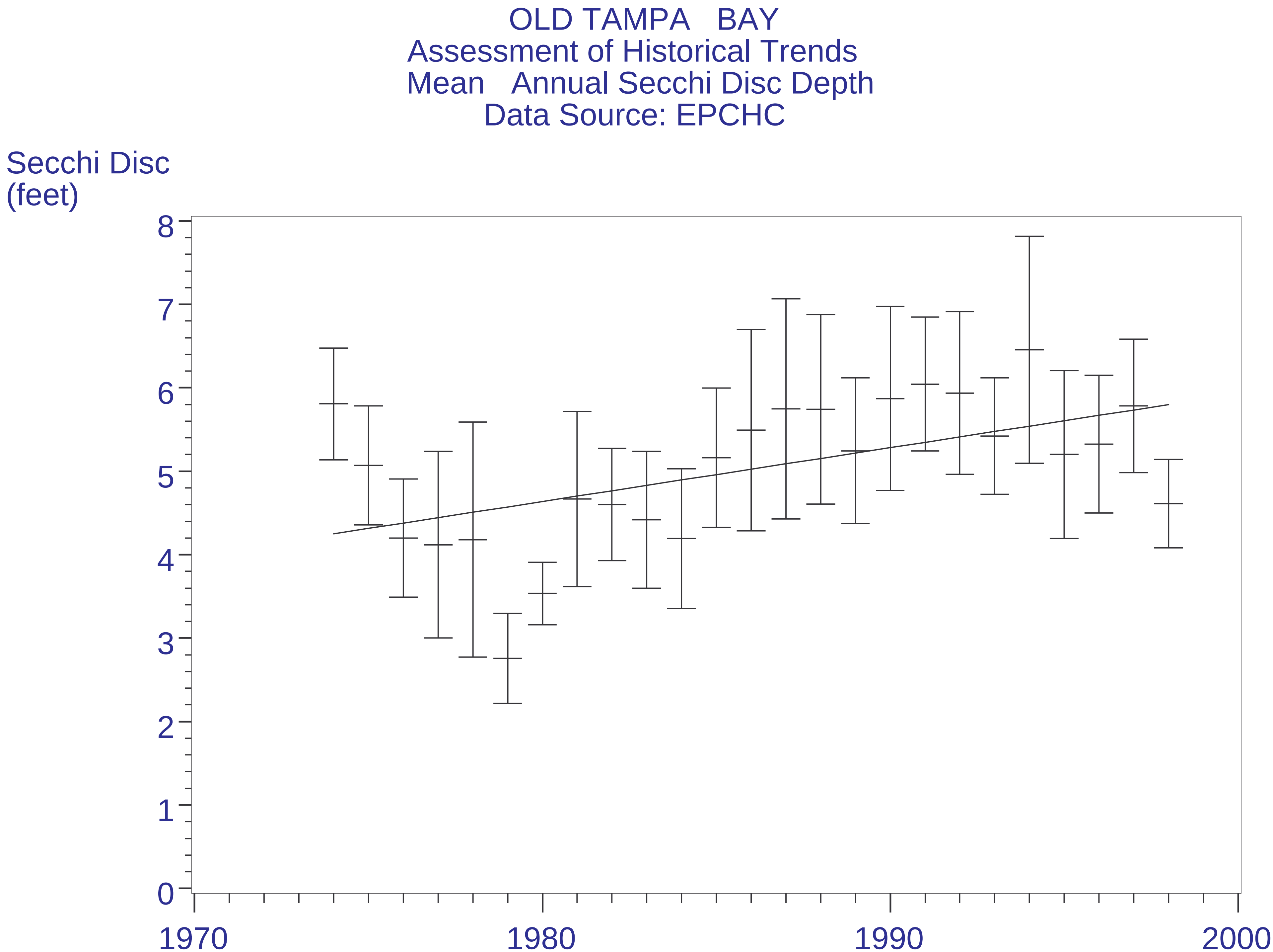


TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Old Tampa Bay Bottom Dissolved Oxygen (mg/L) Data Source: EPCHC	
# of Years of Sampling	24
Number of Samples	258
Mean Annual Slope Estimate	-0.025
Lower 95% Confidence Limit	-0.044
Upper 95% Confidence Limit	-0.006
p Value Slope Statistic	0.0110
Percent Change per Year	-0.004

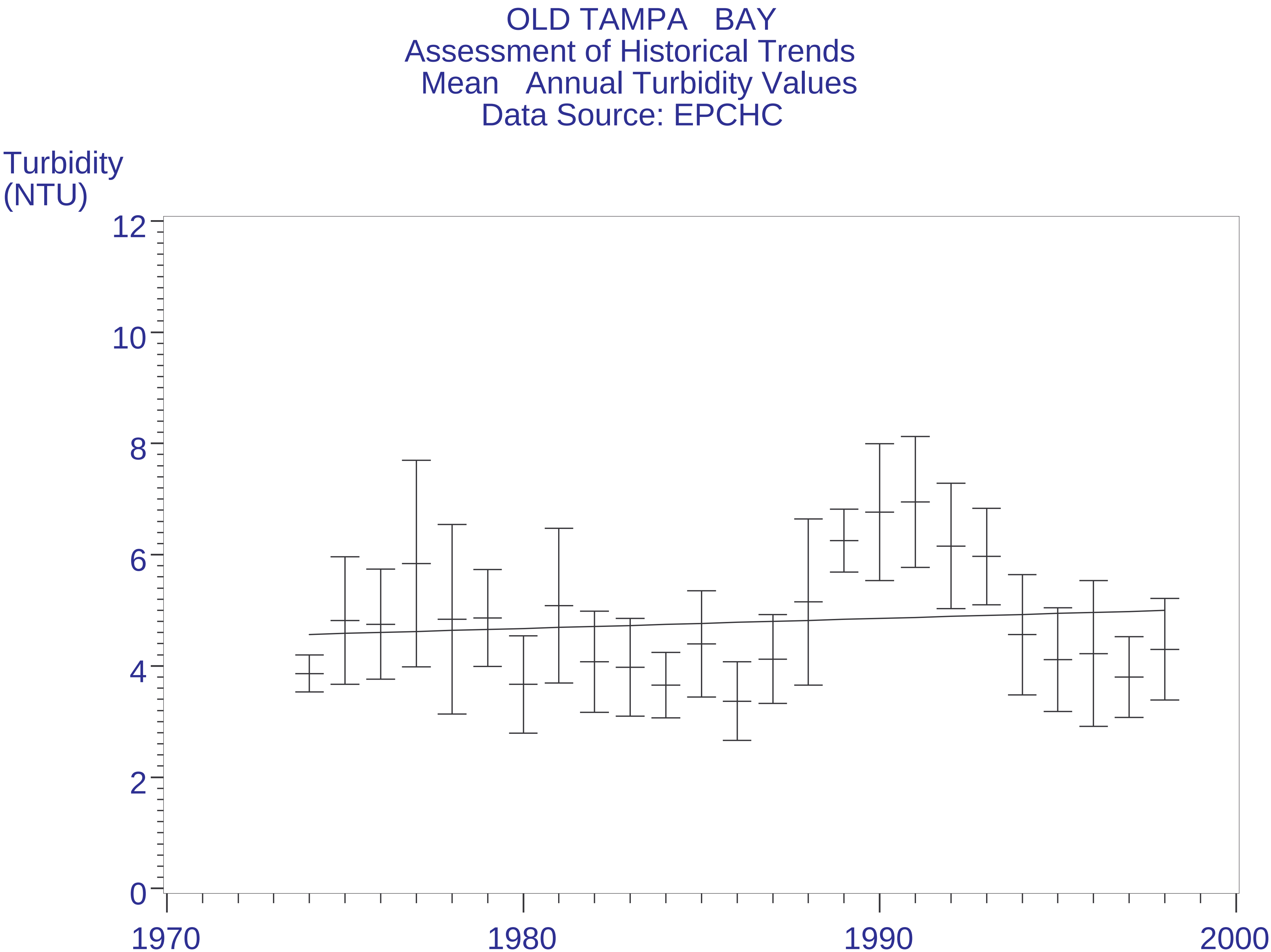
OLD TAMPA BAY
Assessment of Historical Trends
Mean Annual Bottom Dissolved Oxygen Concentrations
Data Source: EPCHC



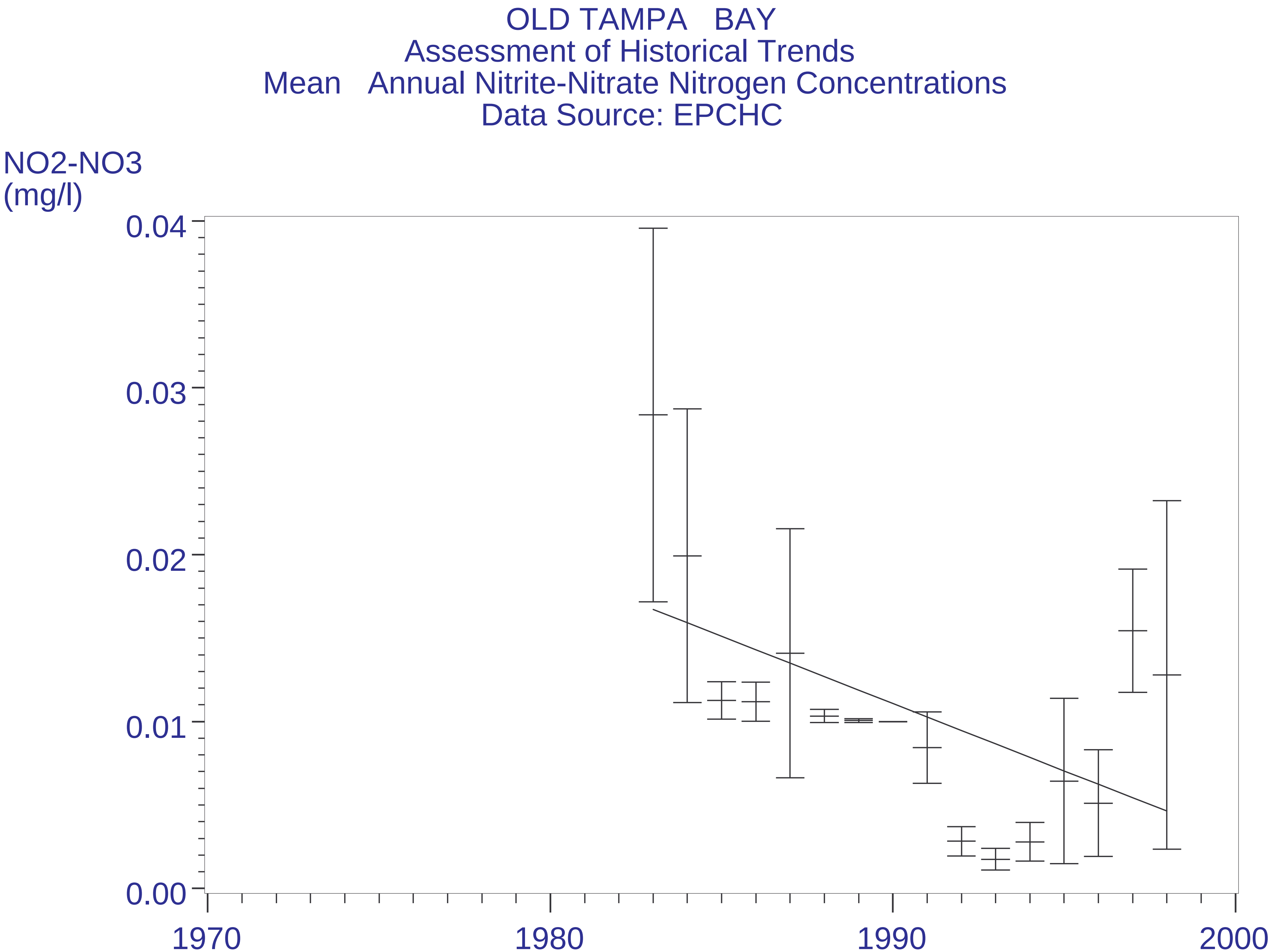
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Old Tampa Bay Secchi Disc Depth (feet) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	279
Mean Annual Slope Estimate	0.065
Lower 95% Confidence Limit	0.041
Upper 95% Confidence Limit	0.088
p Value Slope Statistic	0.0000
Percent Change per Year	0.013


OLD TAMPA BAY
Assessment of Historical Trends
Mean Annual Secchi Disc Depth
Data Source: EPCHC
Secchi Disc
(feet)
8
7
6
5
4
3
2
1
0
1970
1980
1990
2000

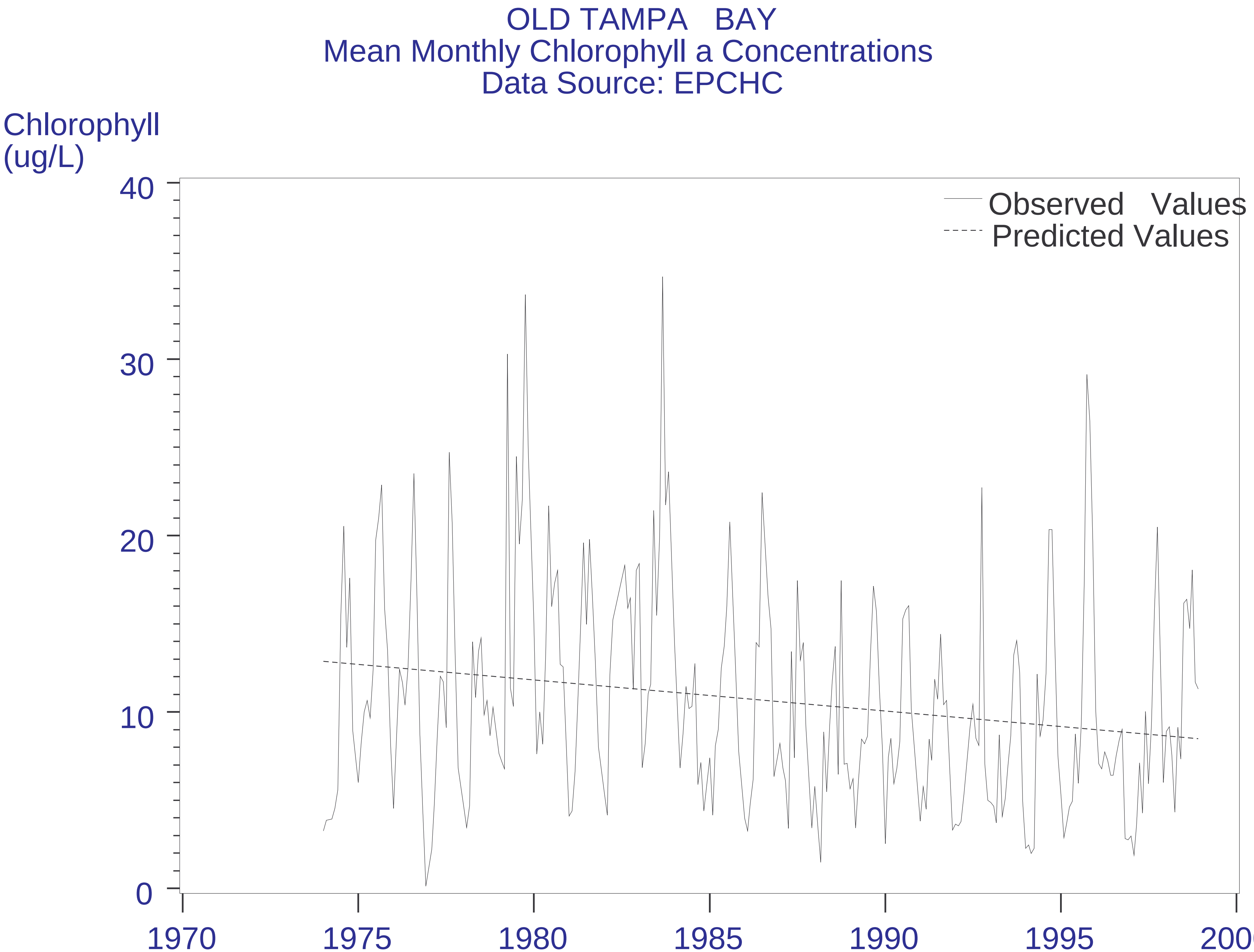
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Old Tampa Bay Turbidity (NTU) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	279
Mean Annual Slope Estimate	0.018
Lower 95% Confidence Limit	-0.012
Upper 95% Confidence Limit	0.047
p Value Slope Statistic	0.2328
Percent Change per Year	0.004


OLD TAMPA BAY
Assessment of Historical Trends
Mean Annual Turbidity Values
Data Source: EPCHC
Turbidity
(NTU)
12
10
8
6
4
2
0
1970
1980
1990
2000

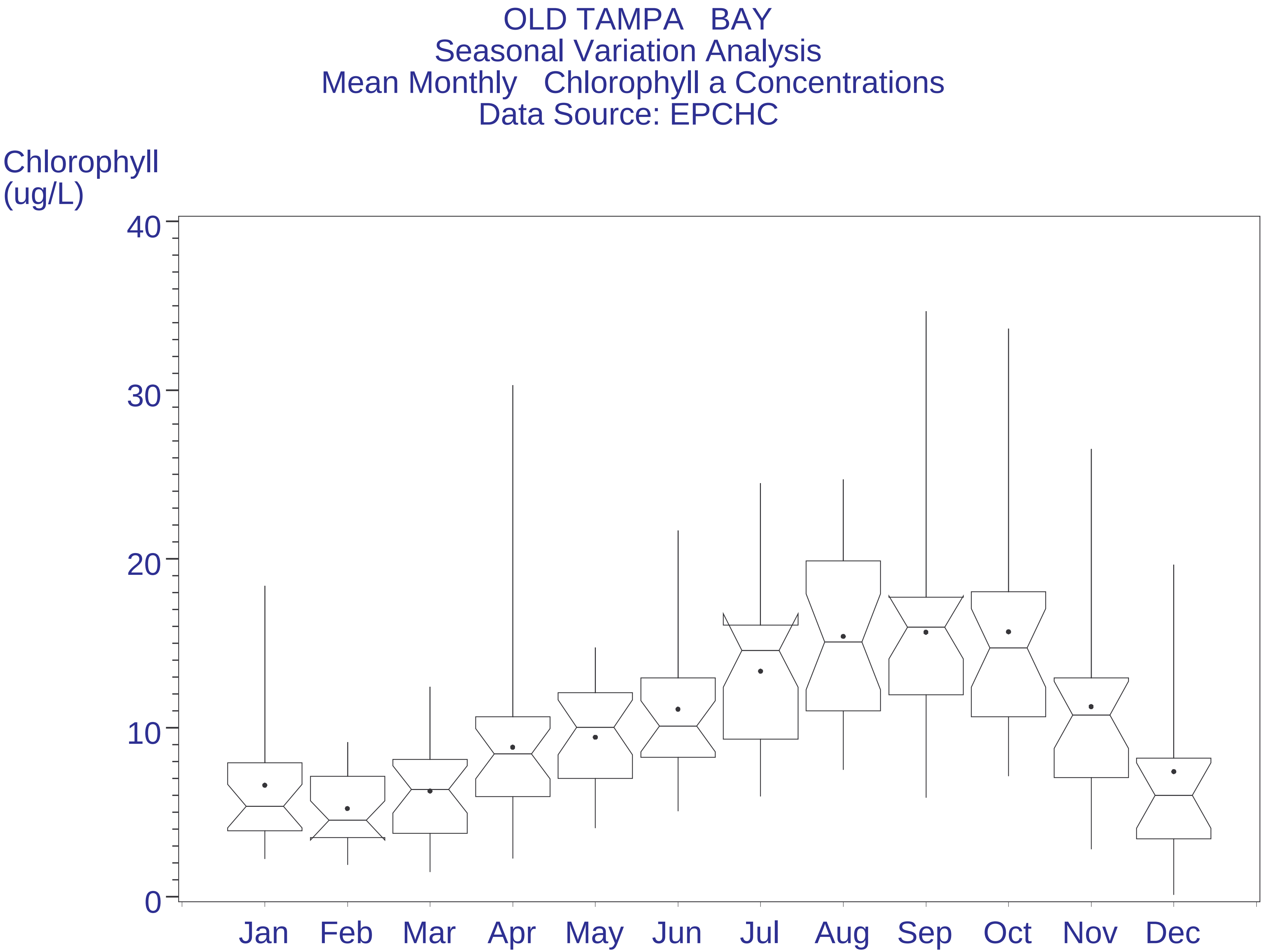
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Old Tampa Bay Nitrate-Nitrite Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	16
Number of Samples	180
Mean Annual Slope Estimate	-0.001
Lower 95% Confidence Limit	-0.001
Upper 95% Confidence Limit	0.000
p Value Slope Statistic	0.0001
Percent Change per Year	-0.075


OLD TAMPA BAY
Assessment of Historical Trends
Mean Annual Nitrite-Nitrate Nitrogen Concentrations
Data Source: EPCHC
NO2-NO3
(mg/l)
0.04
0.03
0.02
0.01
0.00
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Old Tampa Bay Chlorophyll a (ug/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	279
Tau Statistic	-0.226
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.004
p Value Slope Statistic	-0.1801

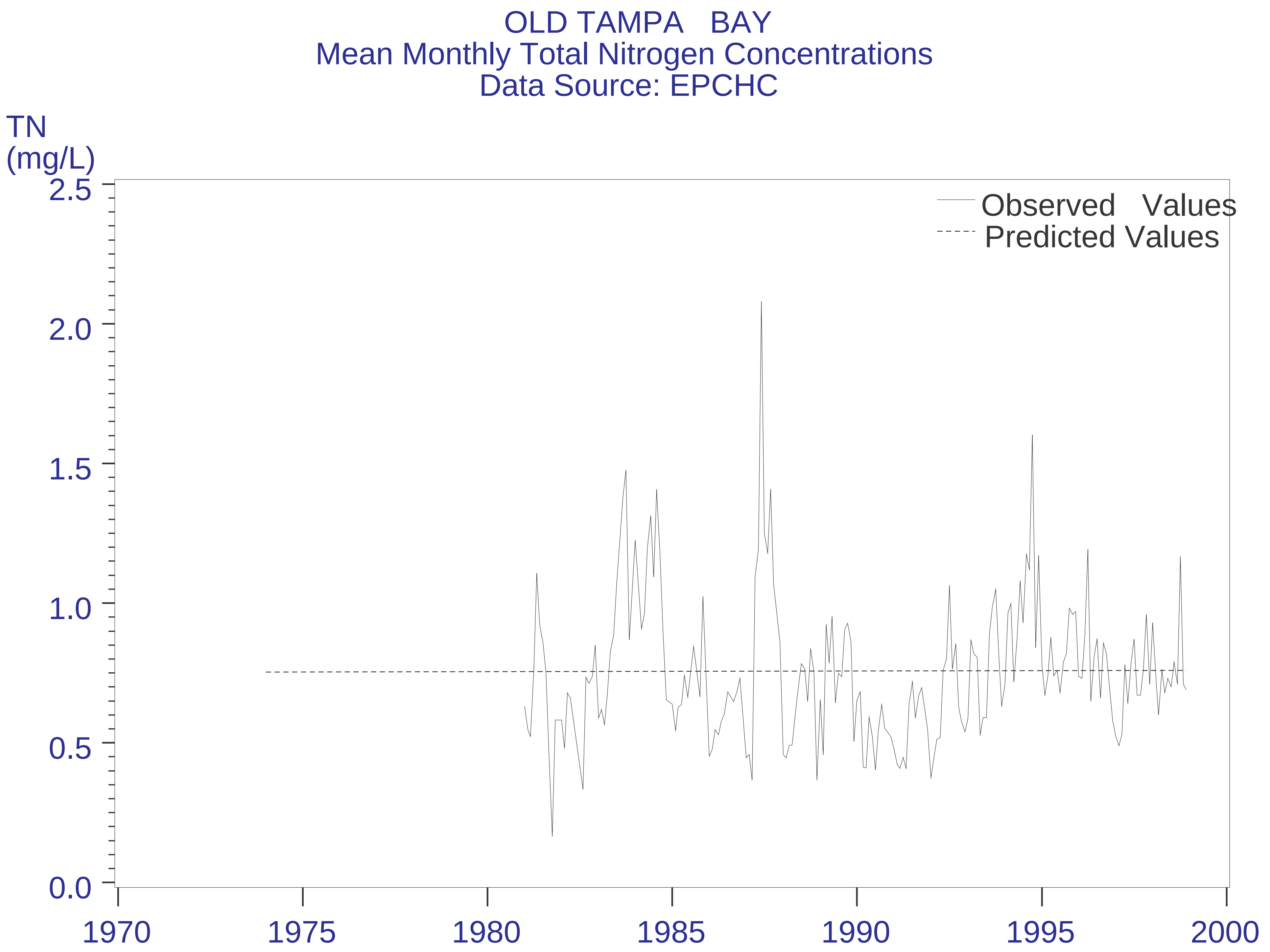


OLD TAMPA BAY
Mean Monthly Chlorophyll a Concentrations
Data Source: EPCHC
Chlorophyll
(ug/L)
40
30
20
10
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

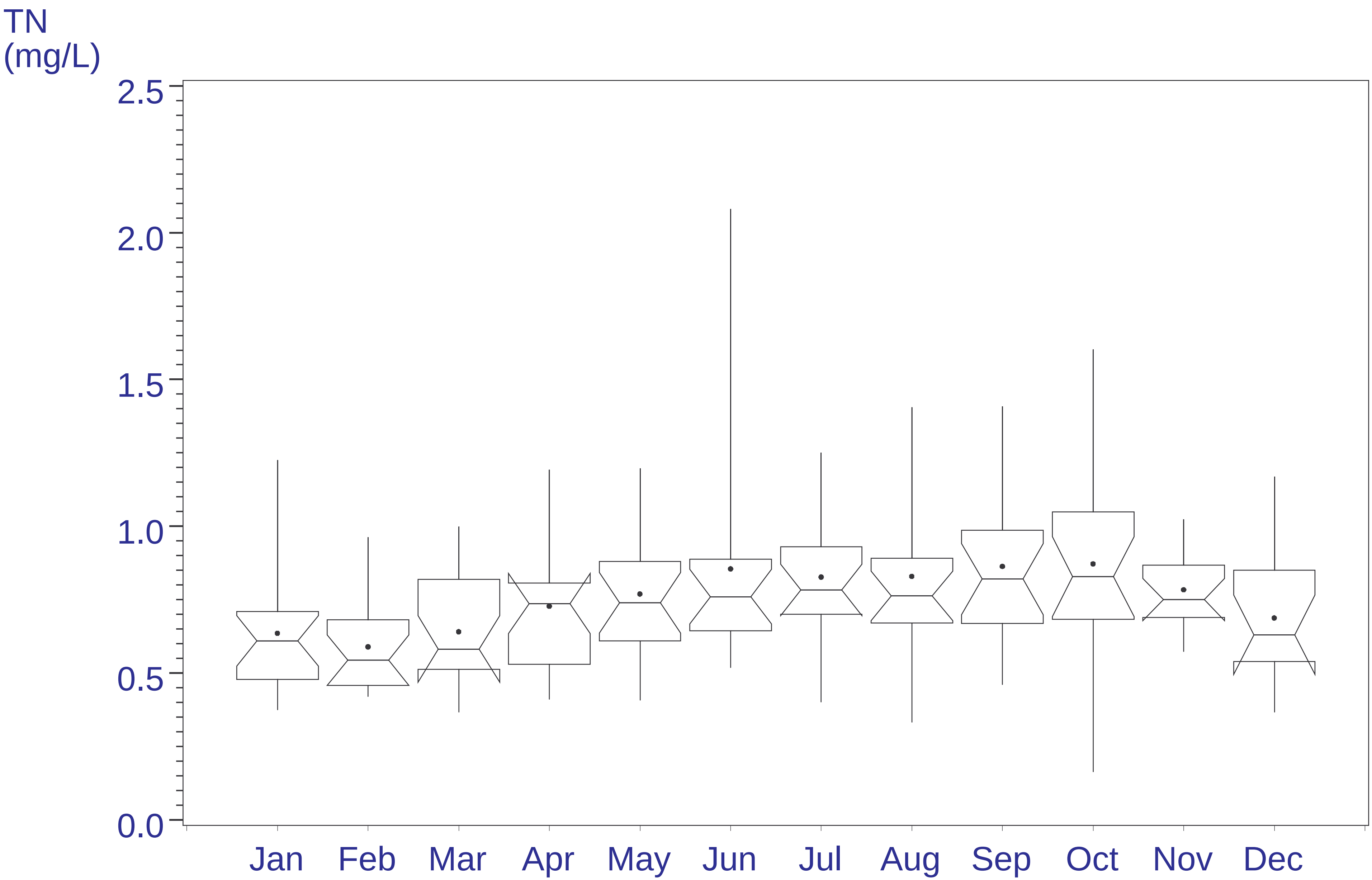


OLD TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Chlorophyll a Concentrations
Data Source: EPCHC
Chlorophyll
(ug/L)
0
10
20
30
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

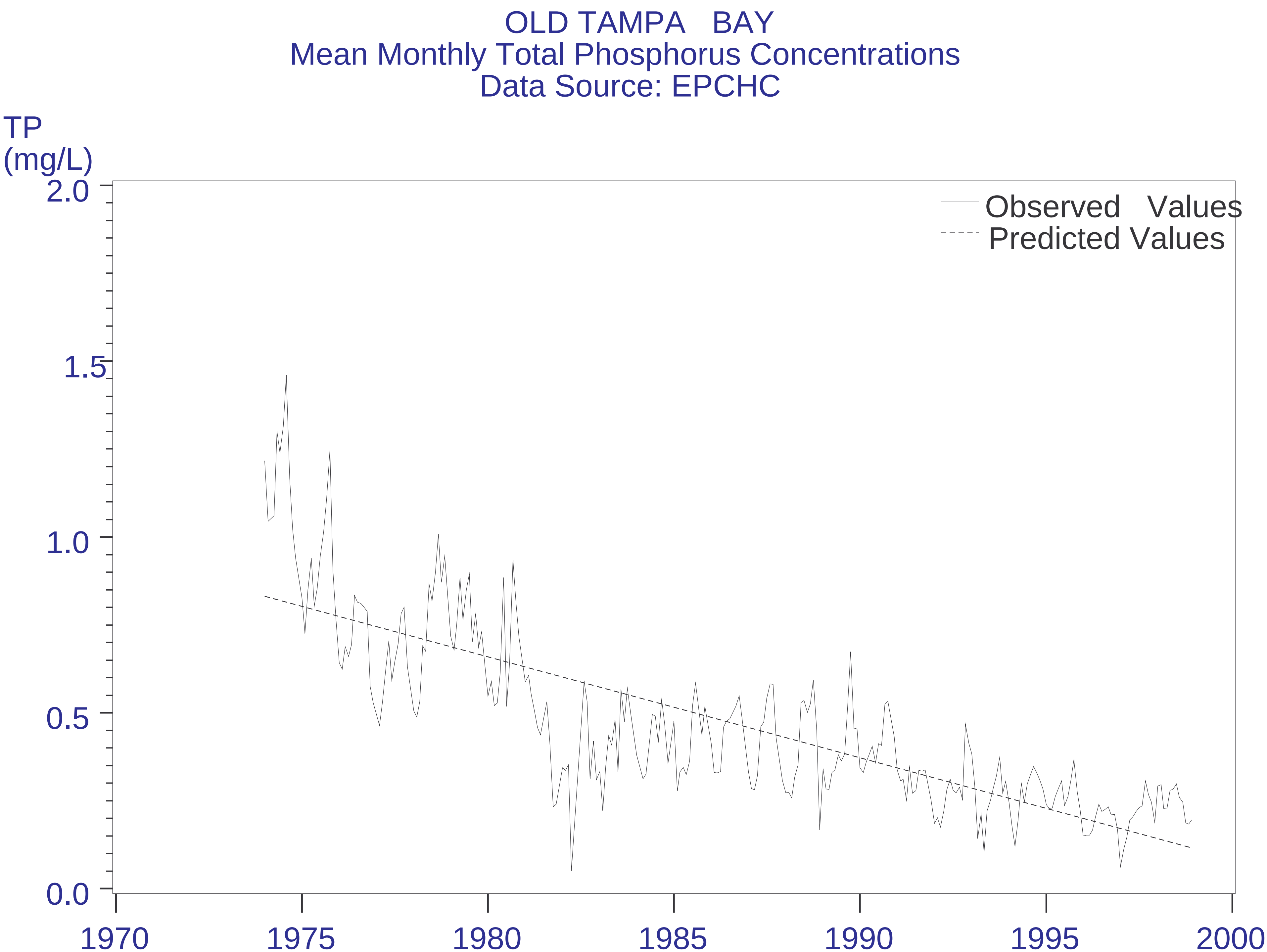
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Old Tampa Bay Total Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	18
Number of Samples	202
Tau Statistic	0.035
P-value without Serial Correlation	0.503
P-value with Serial Correlation	0.753
p Value Slope Statistic	0.0027


OLD TAMPA BAY
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

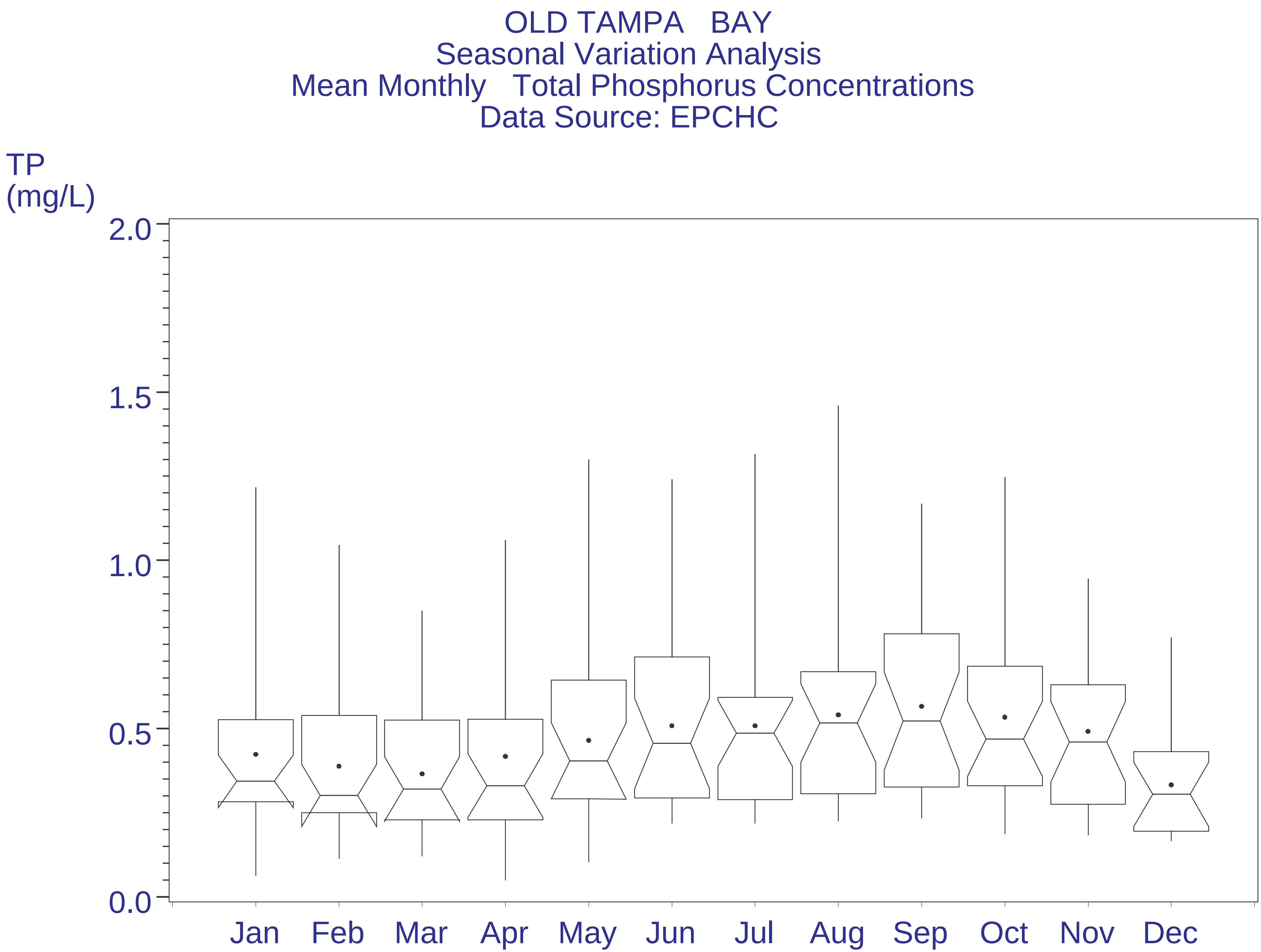
OLD TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC



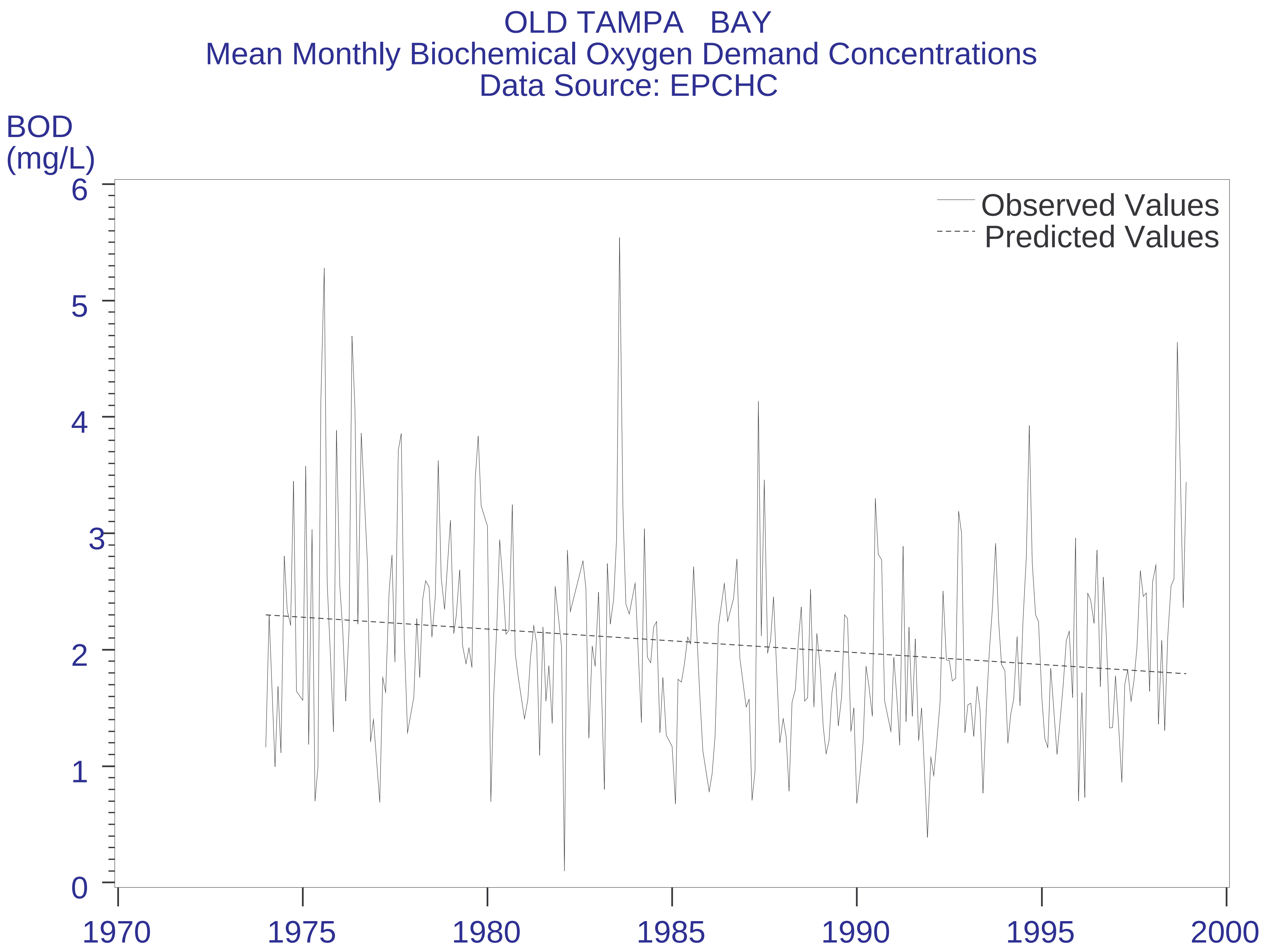
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Old Tampa Bay Total Phosphorus (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	279
Tau Statistic	-0.719
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.000
p Value Slope Statistic	-0.0258

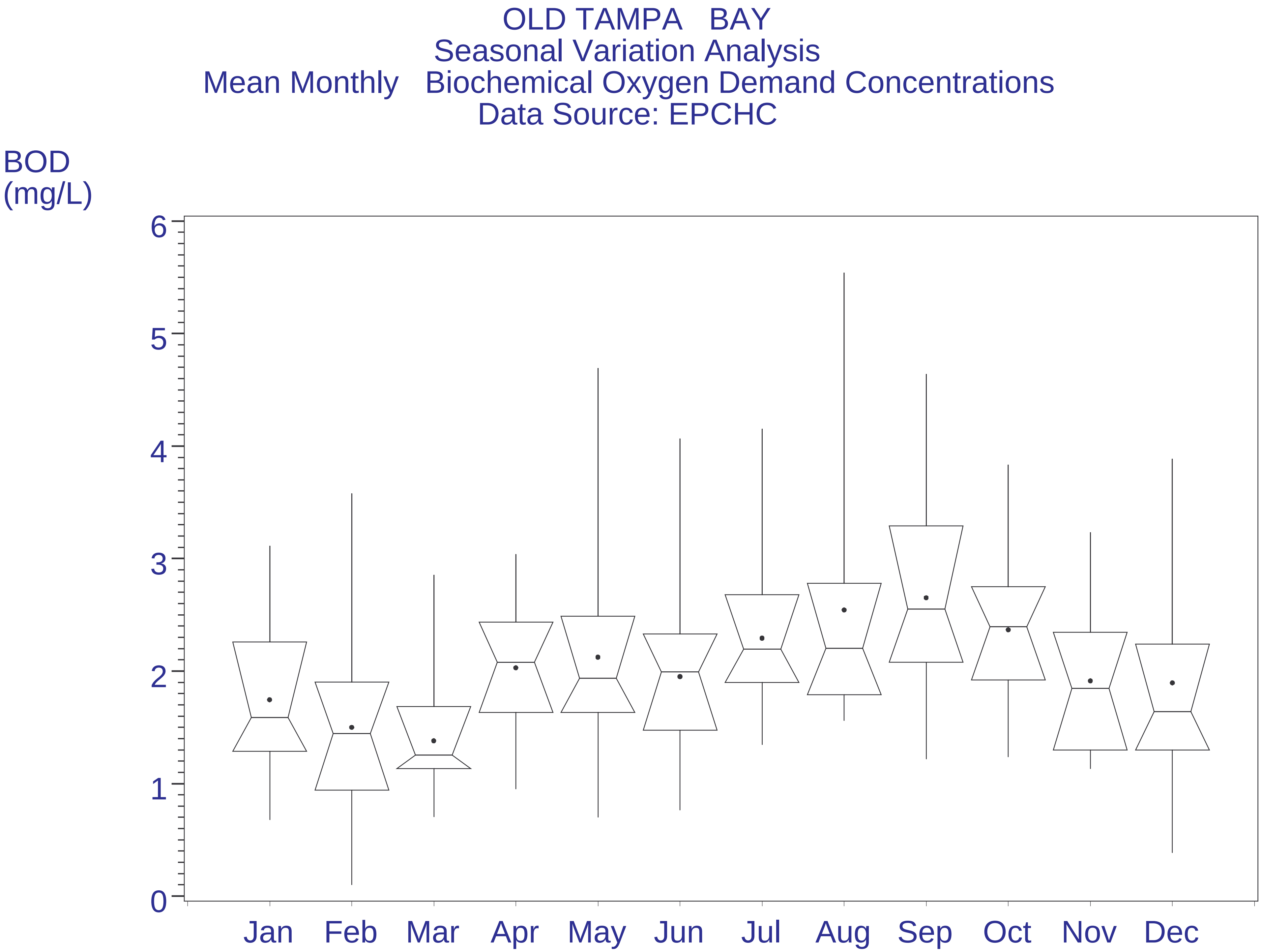


OLD TAMPA BAY
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

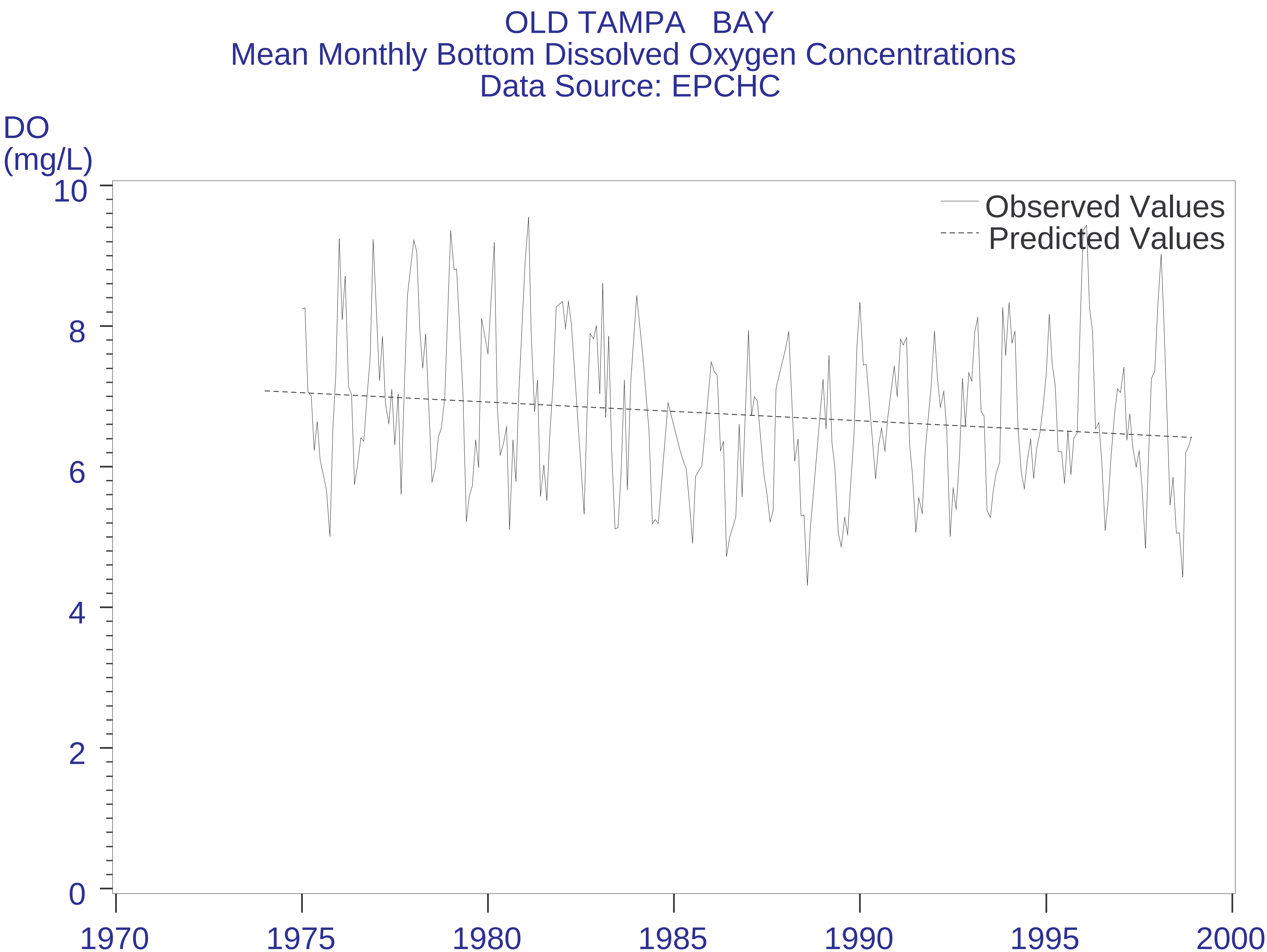

OLD TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

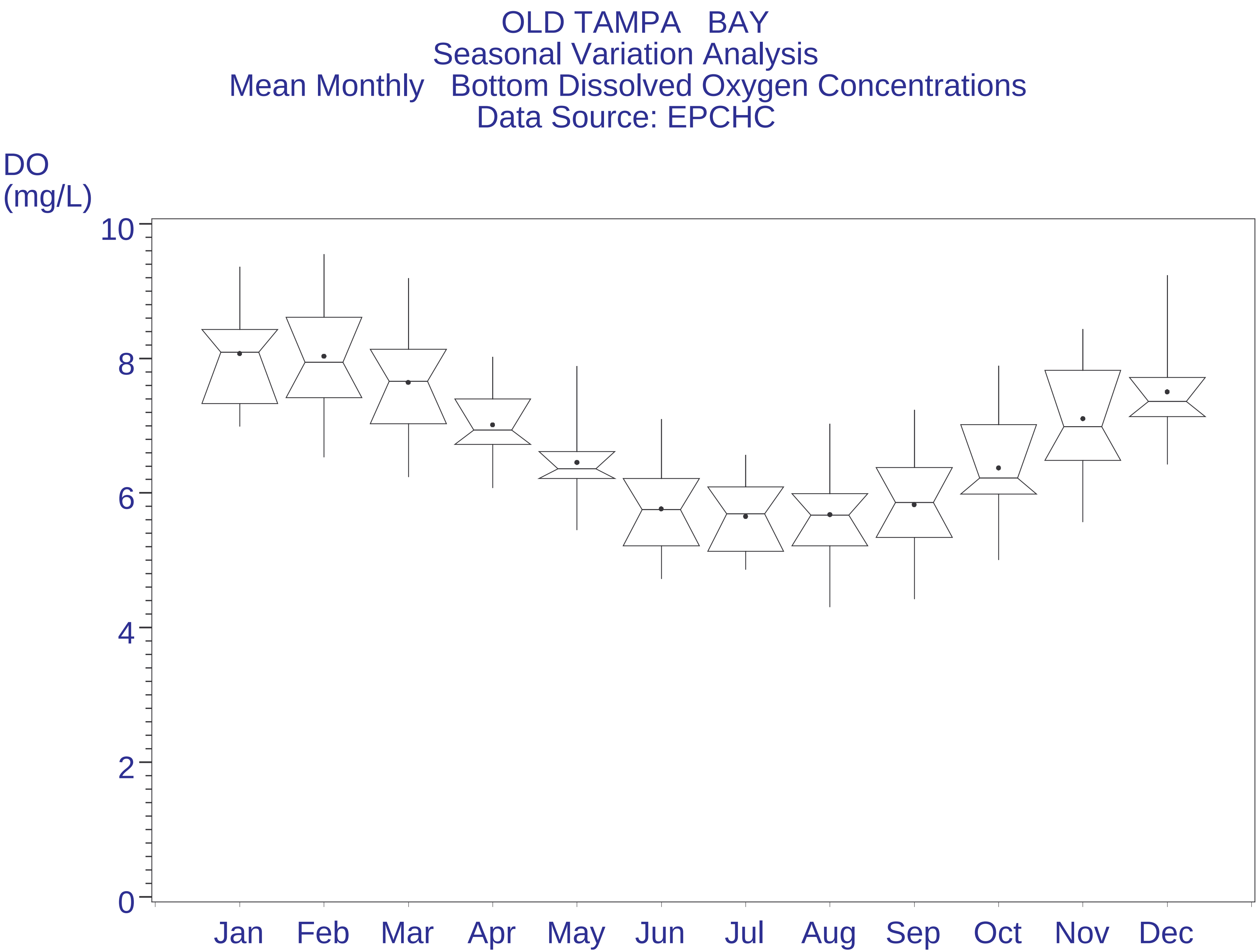
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Old Tampa Bay BOD (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	278
Tau Statistic	-0.120
P-value without Serial Correlation	0.005
P-value with Serial Correlation	0.064
p Value Slope Statistic	-0.0186


OLD TAMPA BAY
Mean Monthly Biochemical Oxygen Demand Concentrations
Data Source: EPCHC
BOD
(mg/L)
6
5
4
3
2
1
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

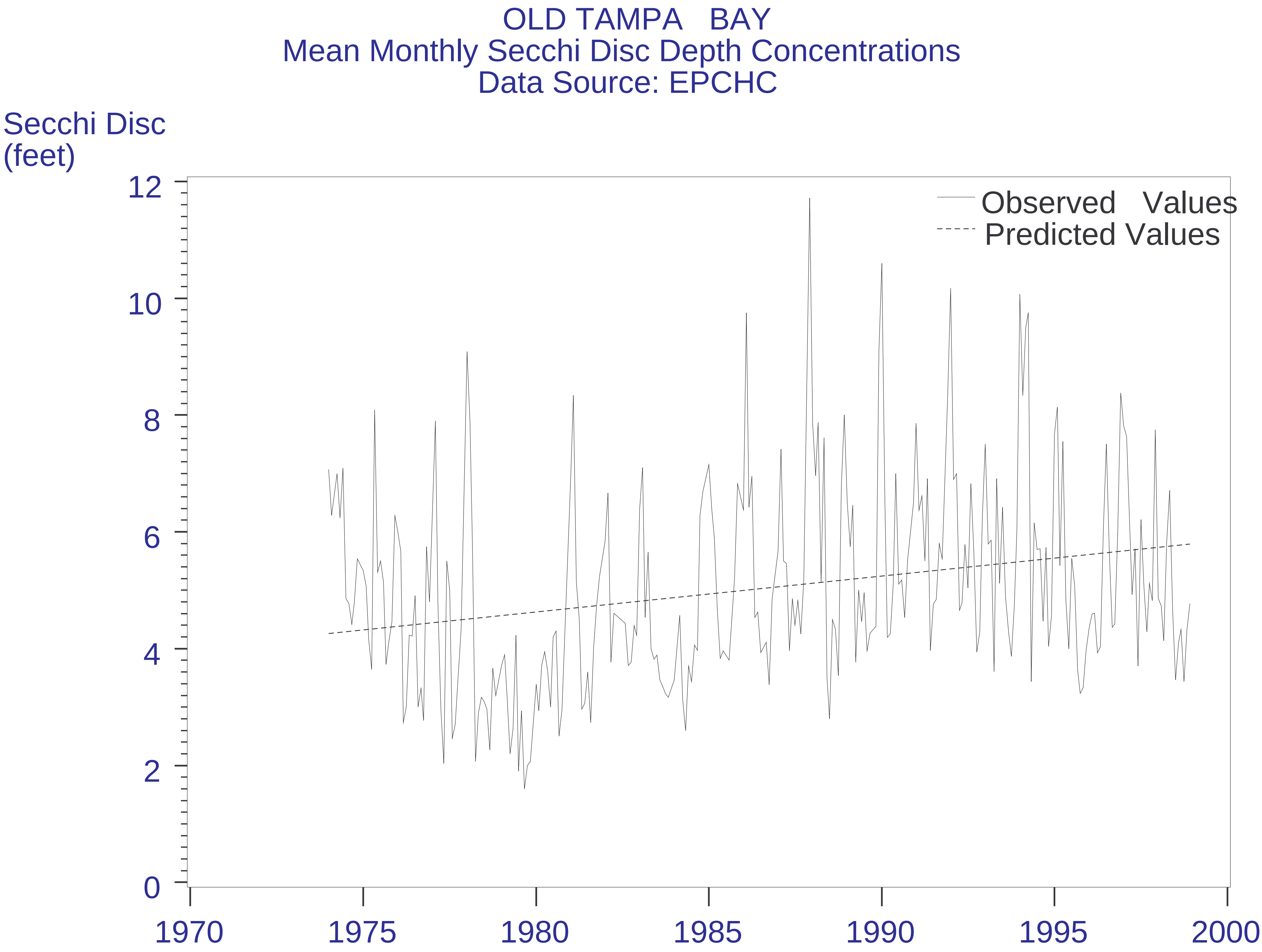

OLD TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Biochemical Oxygen Demand Concentrations
Data Source: EPCHC
BOD
(mg/L)
0
1
2
3
4
5
6
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

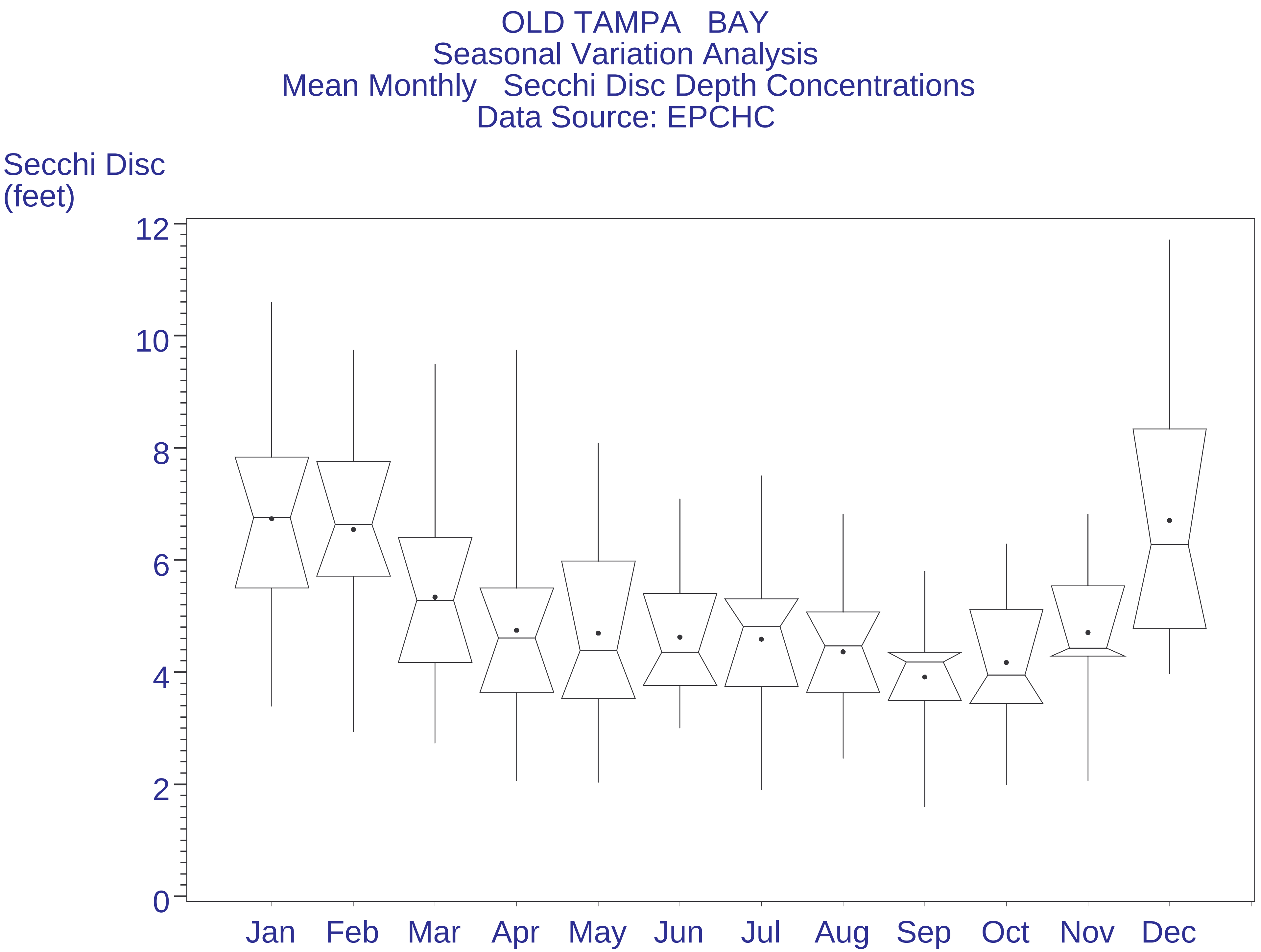
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Old Tampa Bay Bottom Dissolved Oxygen (mg/L) Data Source: EPCHC	
# of Years of Sampling	24
Number of Samples	258
Tau Statistic	-0.176
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.038
p Value Slope Statistic	-0.0234


OLD TAMPA BAY
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: EPCHC
DO
(mg/L)
10
8
6
4
2
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

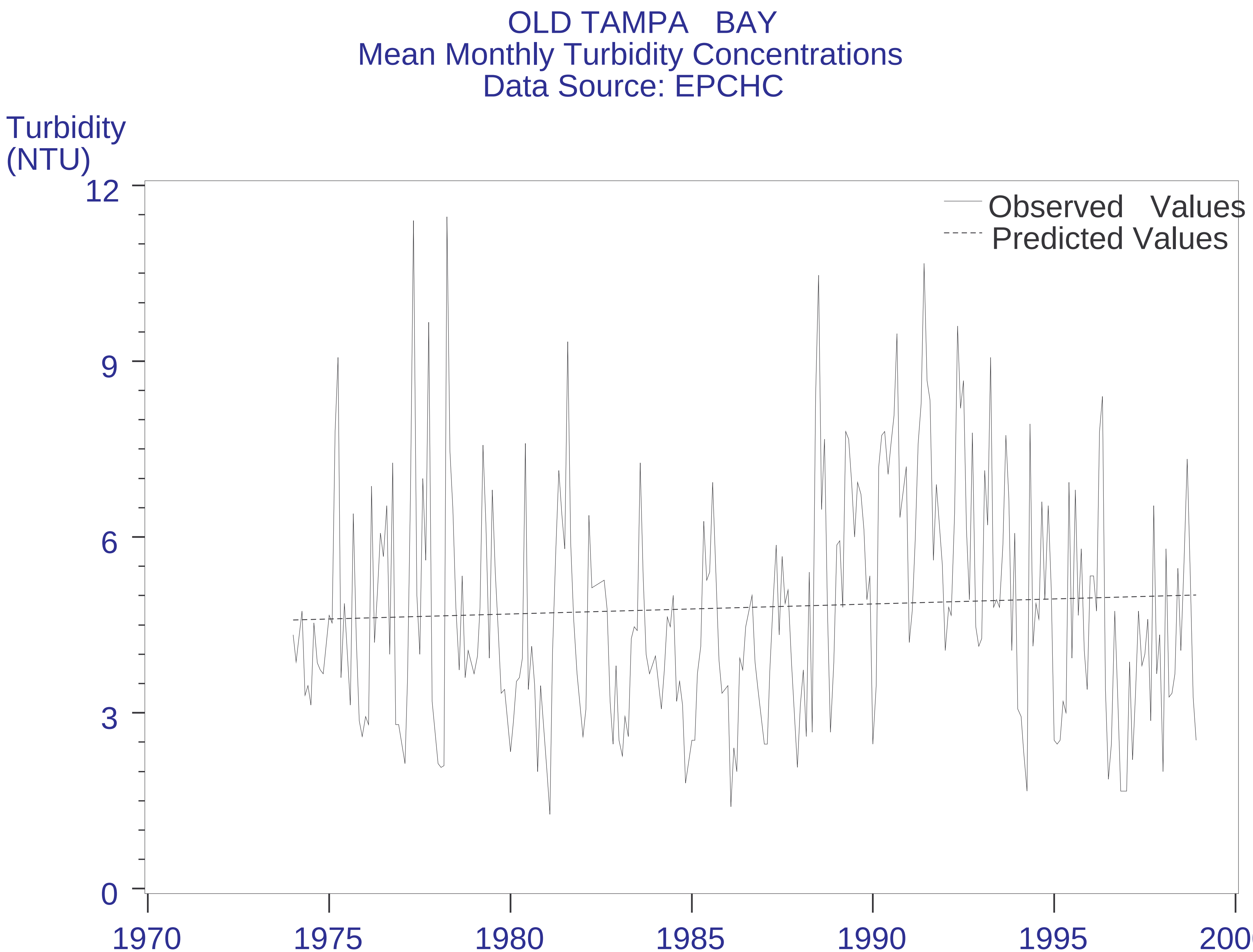

OLD TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: EPCHC
DO
(mg/L)
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM **Temporal Trend Analysis Results** **Nonparametric Tests** **Old Tampa Bay** **Secchi Disc Depth (feet)** **Data Source: EPCHC**	
# of Years of Sampling	25
Number of Samples	279
Tau Statistic	0.237
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.005
p Value Slope Statistic	0.0634

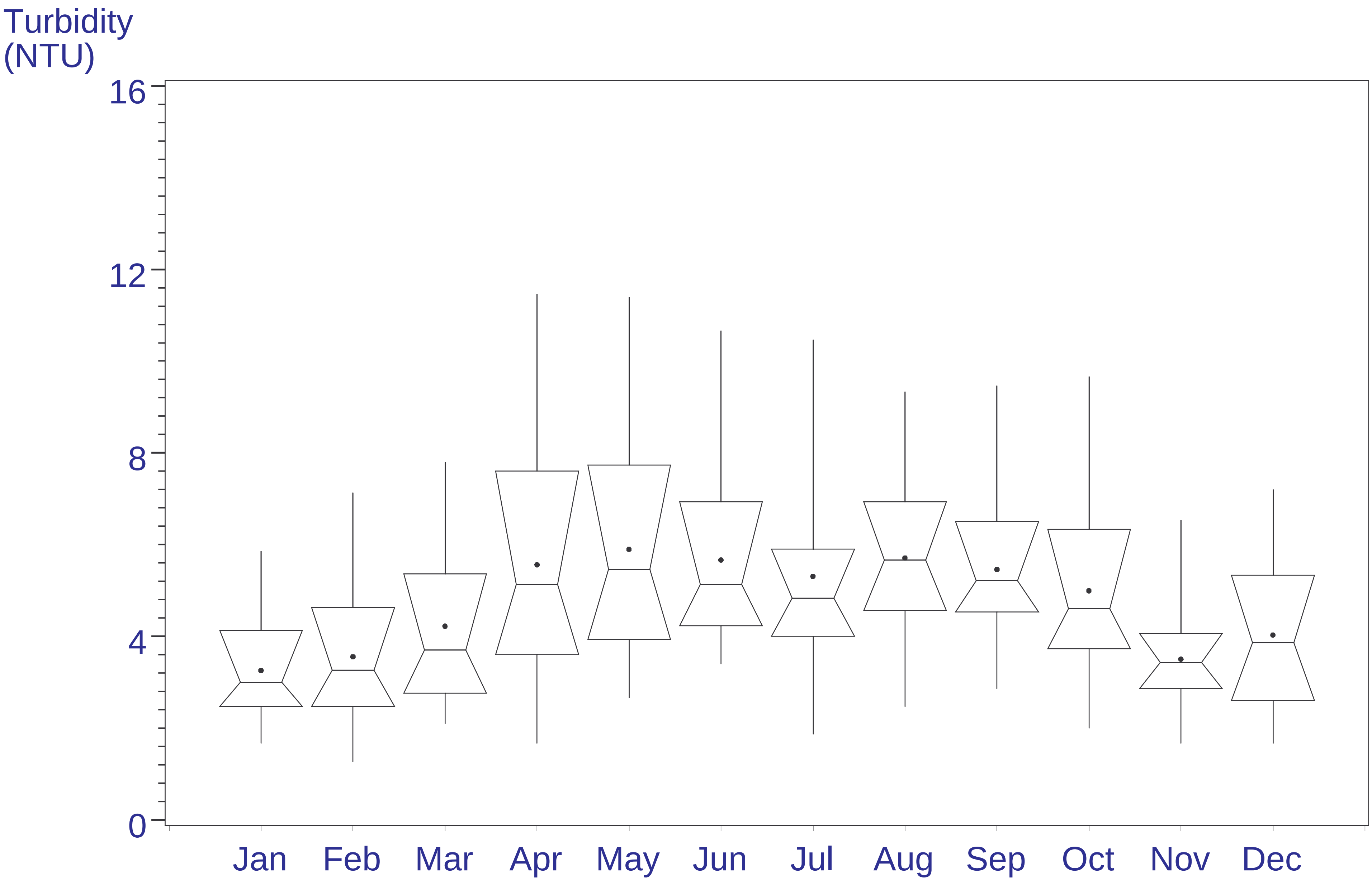

OLD TAMPA BAY
Mean Monthly Secchi Disc Depth Concentrations
Data Source: EPCHC
Secchi Disc
(feet)
12
10
8
6
4
2
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


OLD TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Secchi Disc Depth Concentrations
Data Source: EPCHC
Secchi Disc
(feet)
0
2
4
6
8
10
12
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

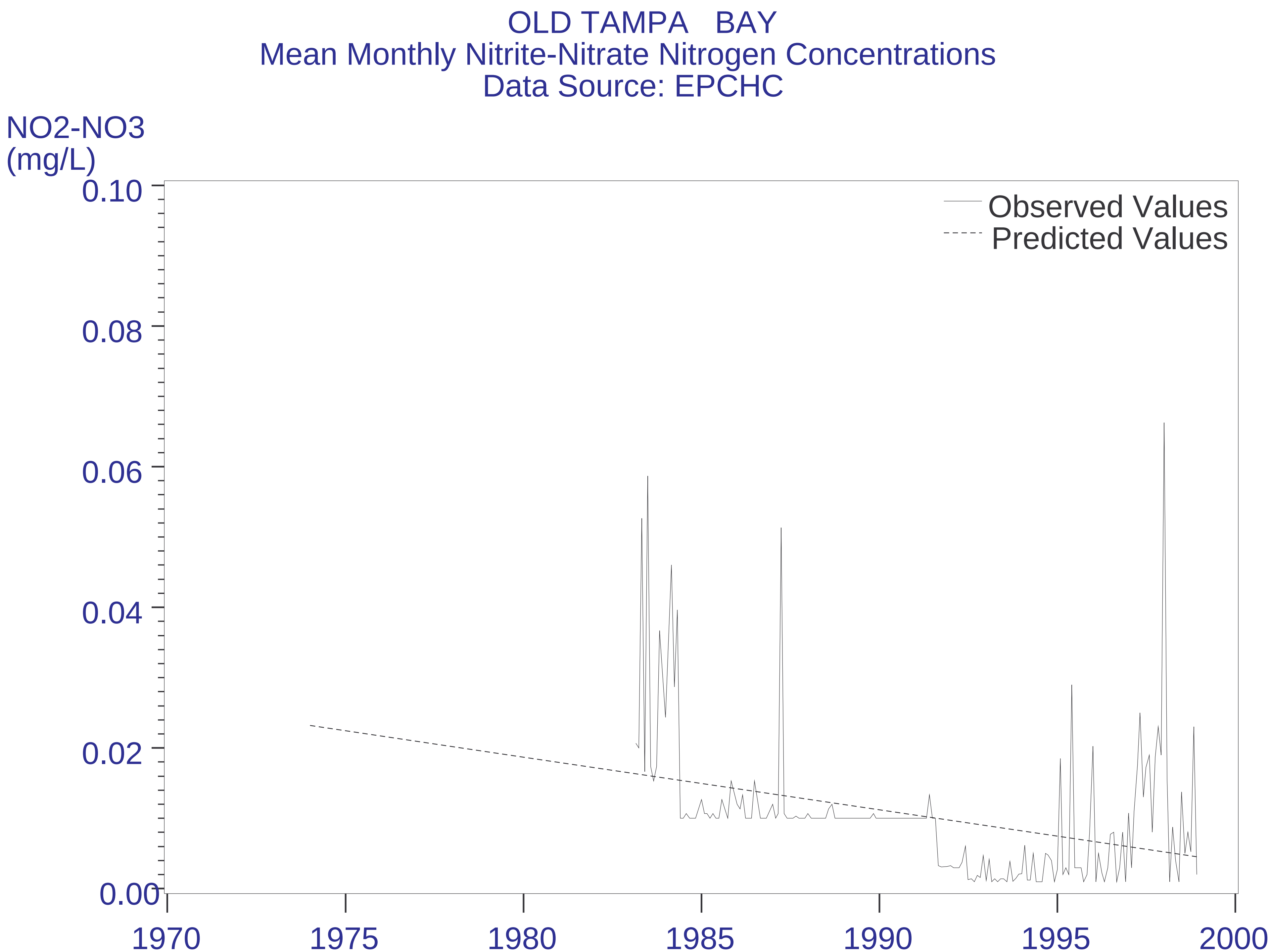
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Old Tampa Bay Turbidity (NTU) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	279
Tau Statistic	0.072
P-value without Serial Correlation	0.098
P-value with Serial Correlation	0.371
p Value Slope Statistic	0.0274

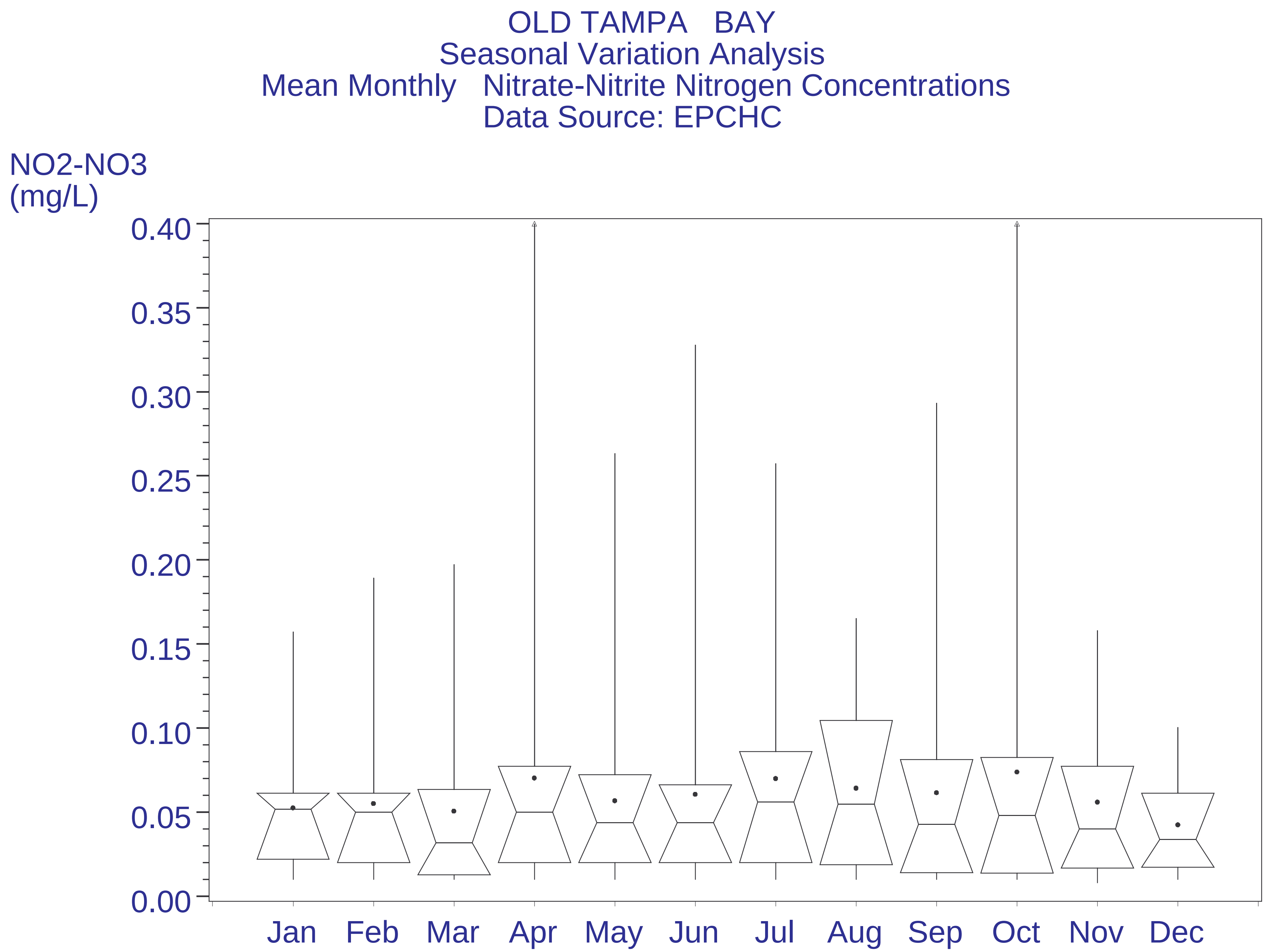

OLD TAMPA BAY
Mean Monthly Turbidity Concentrations
Data Source: EPCHC
Turbidity
(NTU)
12
9
6
3
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

OLD TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Turbidity Concentrations
Data Source: EPCHC



TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Old Tampa Bay Nitrate-Nitrite Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	16
Number of Samples	180
Tau Statistic	-0.382
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.008
p Value Slope Statistic	-0.0007

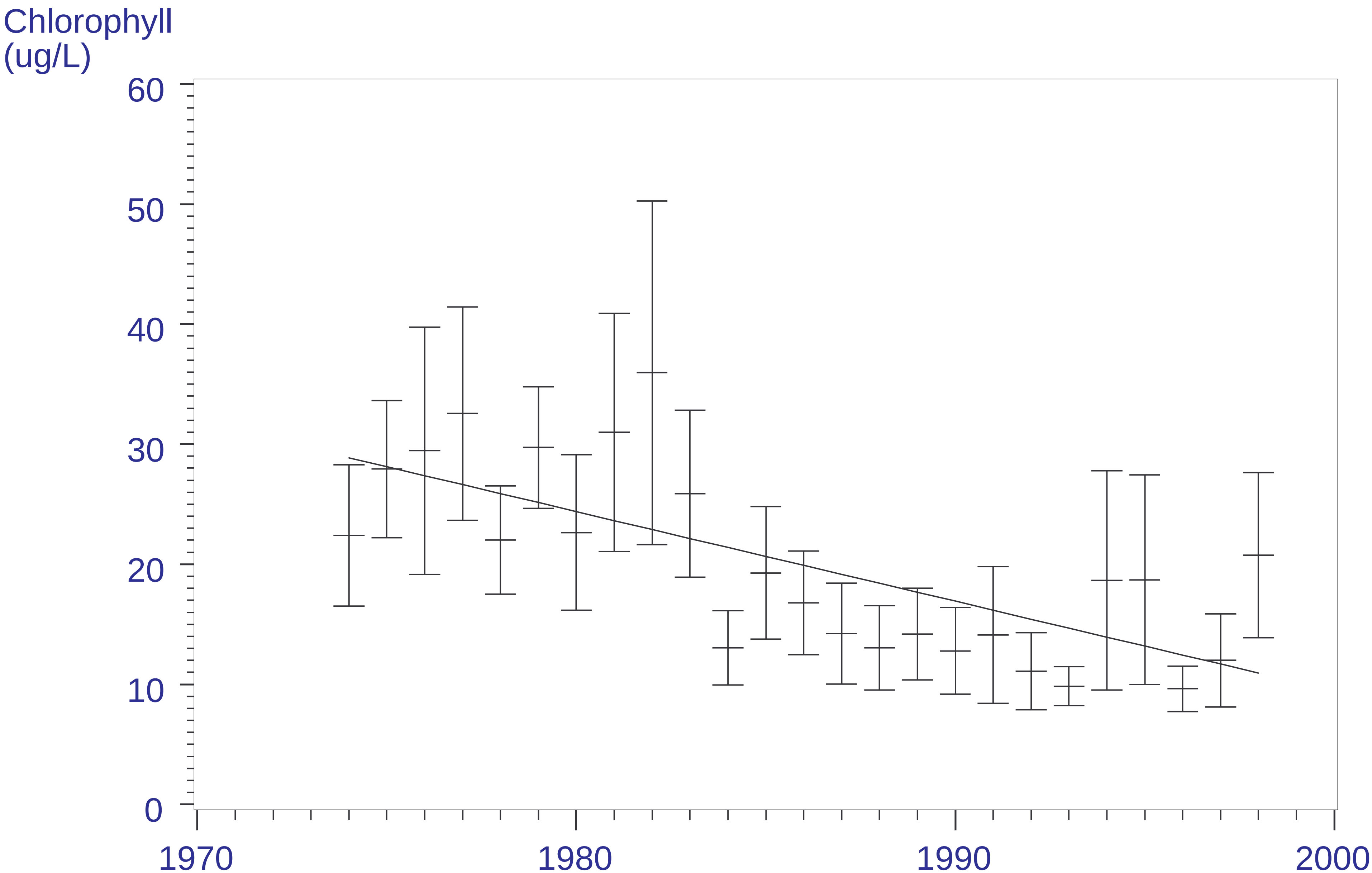

OLD TAMPA BAY
Mean Monthly Nitrite-Nitrate Nitrogen Concentrations
Data Source: EPCHC
NO2-NO3
(mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


OLD TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Nitrate-Nitrite Nitrogen Concentrations
Data Source: EPCHC
NO2-NO3
(mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

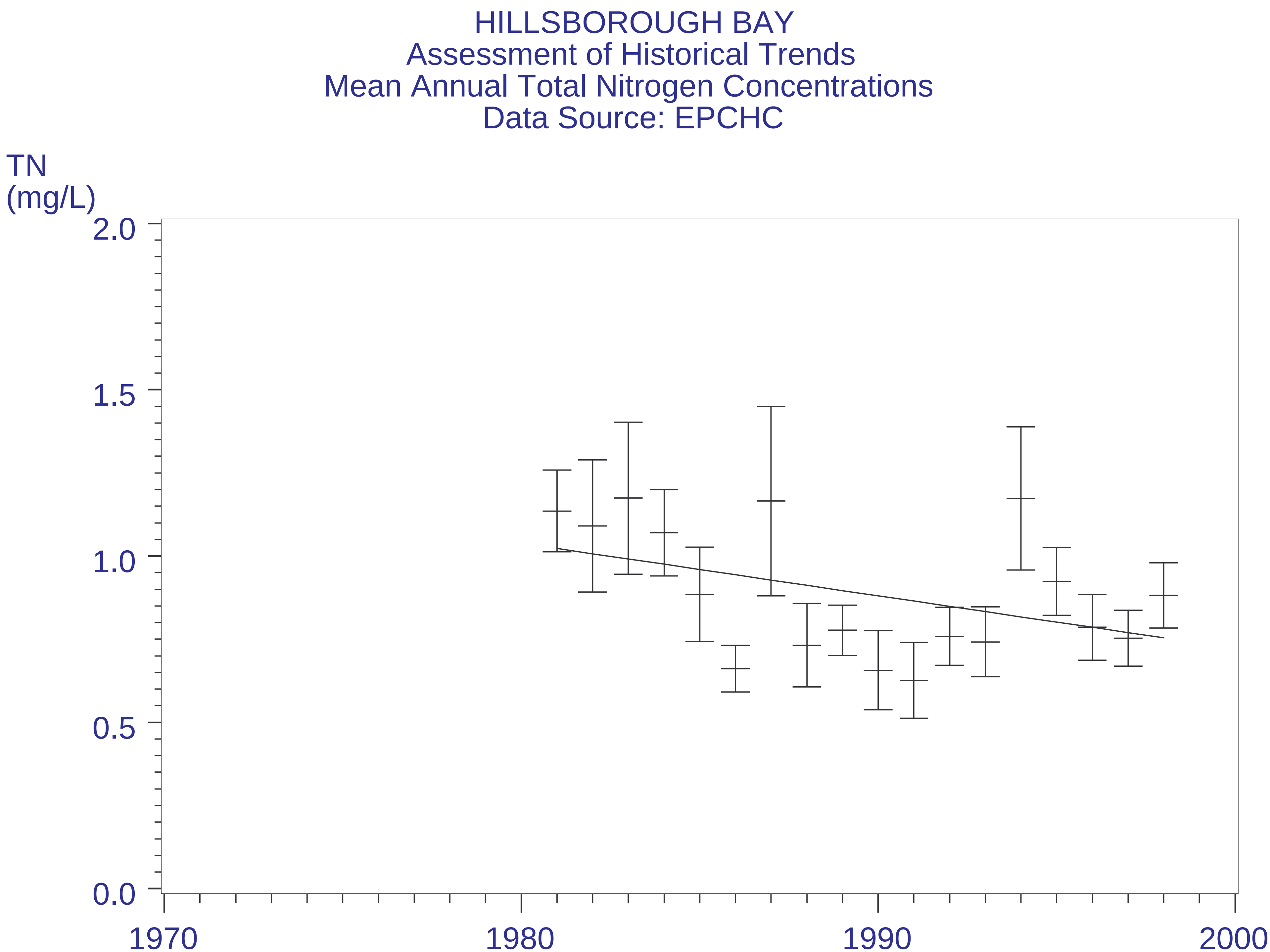
HILLSBOROUGH BAY

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay Chlorophyll a (ug/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	285
Mean Annual Slope Estimate	-0.747
Lower 95% Confidence Limit	-0.929
Upper 95% Confidence Limit	-0.564
p Value Slope Statistic	0.0000
Percent Change per Year	-0.038

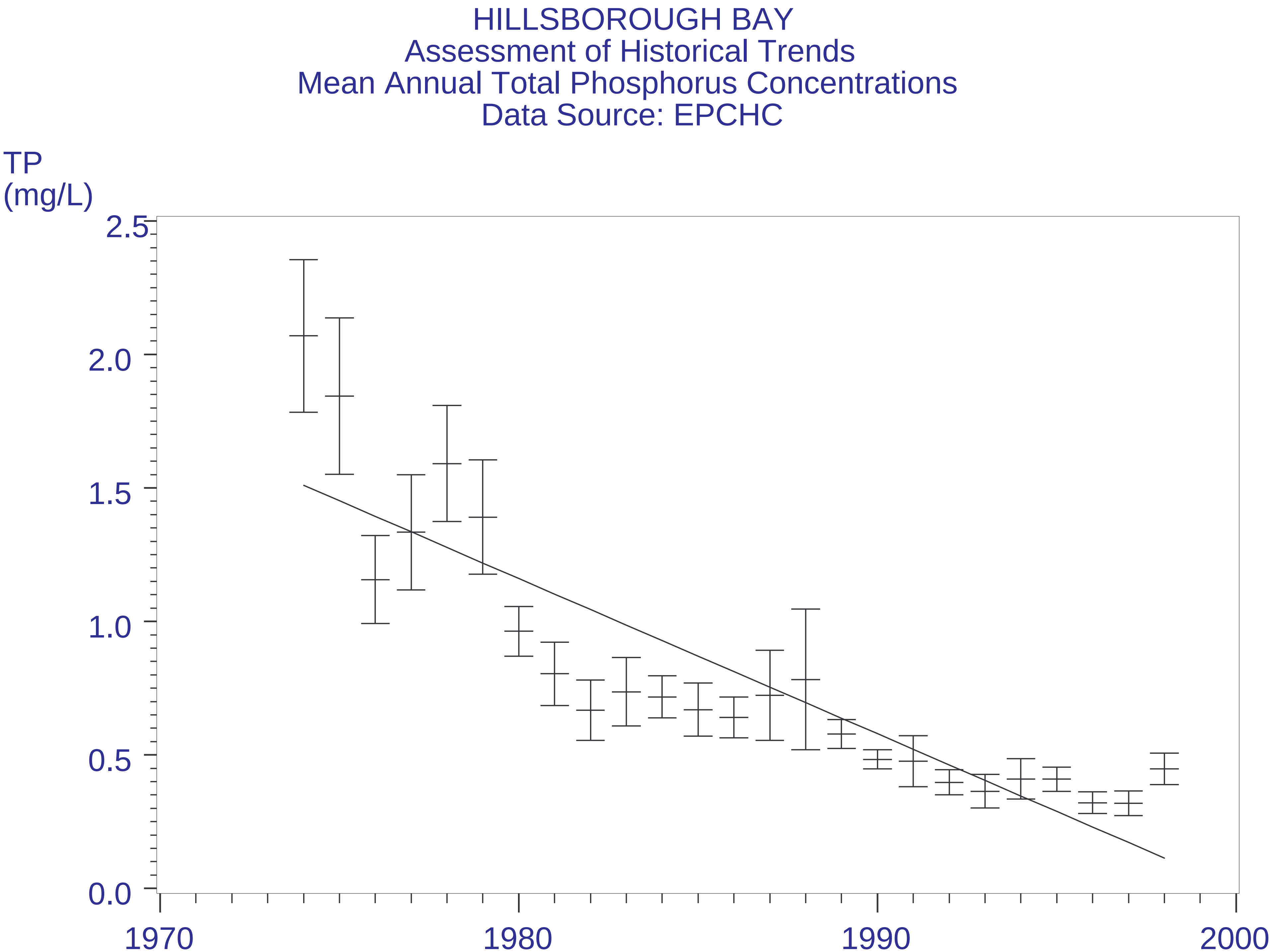
HILLSBOROUGH BAY
Assessment of Historical Trends
Mean Annual Chlorophyll a Concentrations
Data Source: EPCHC



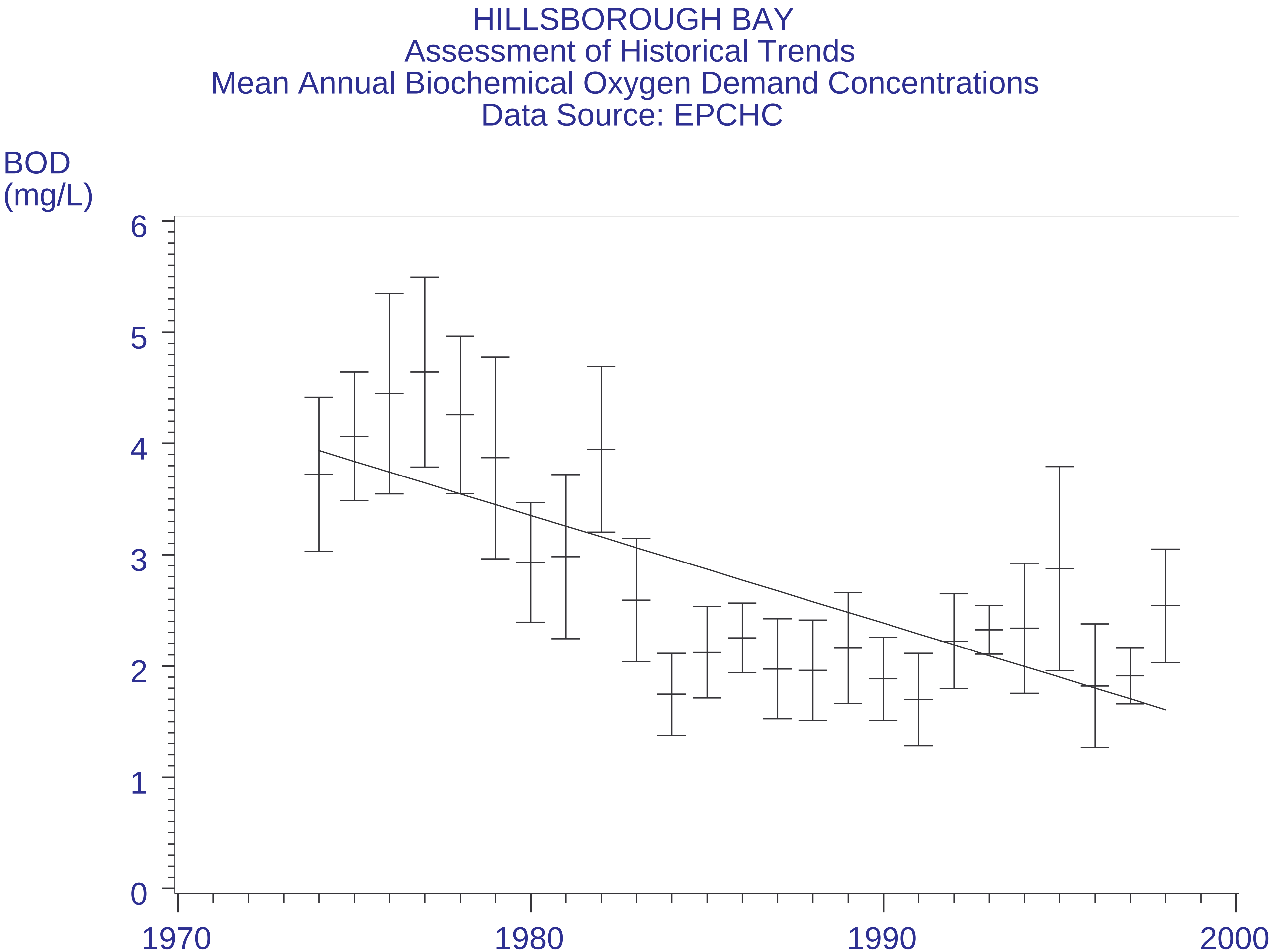
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay Total Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	18
Number of Samples	210
Mean Annual Slope Estimate	-0.016
Lower 95% Confidence Limit	-0.022
Upper 95% Confidence Limit	-0.009
p Value Slope Statistic	0.0000
Percent Change per Year	-0.018


HILLSBOROUGH BAY
Assessment of Historical Trends
Mean Annual Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
2.0
1.5
1.0
0.5
0.0
1970
1980
1990
2000

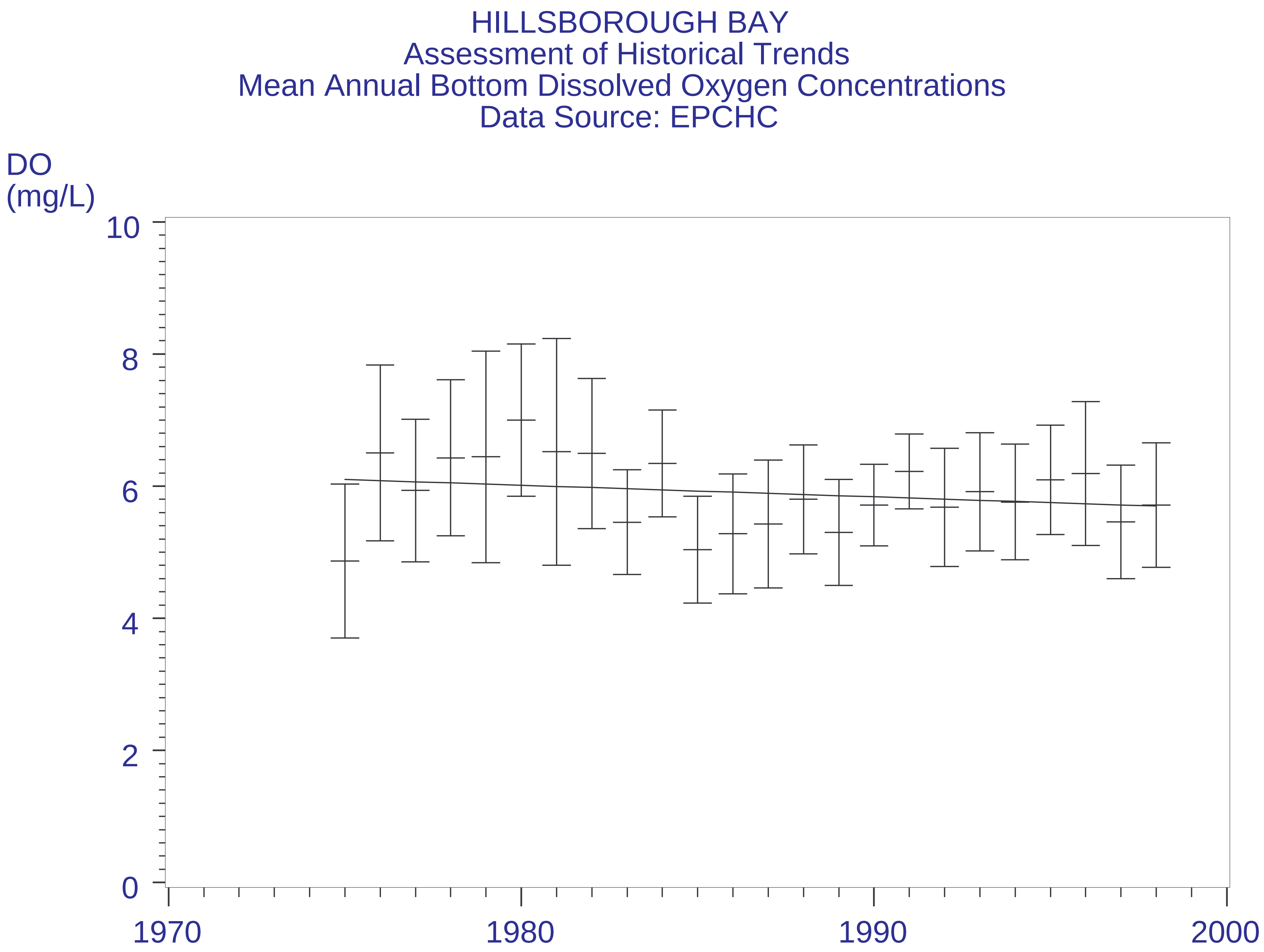
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay Total Phosphorus (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	284
Mean Annual Slope Estimate	-0.058
Lower 95% Confidence Limit	-0.063
Upper 95% Confidence Limit	-0.054
p Value Slope Statistic	0.0000
Percent Change per Year	-0.072


HILLSBOROUGH BAY
Assessment of Historical Trends
Mean Annual Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
1970
1980
1990
2000

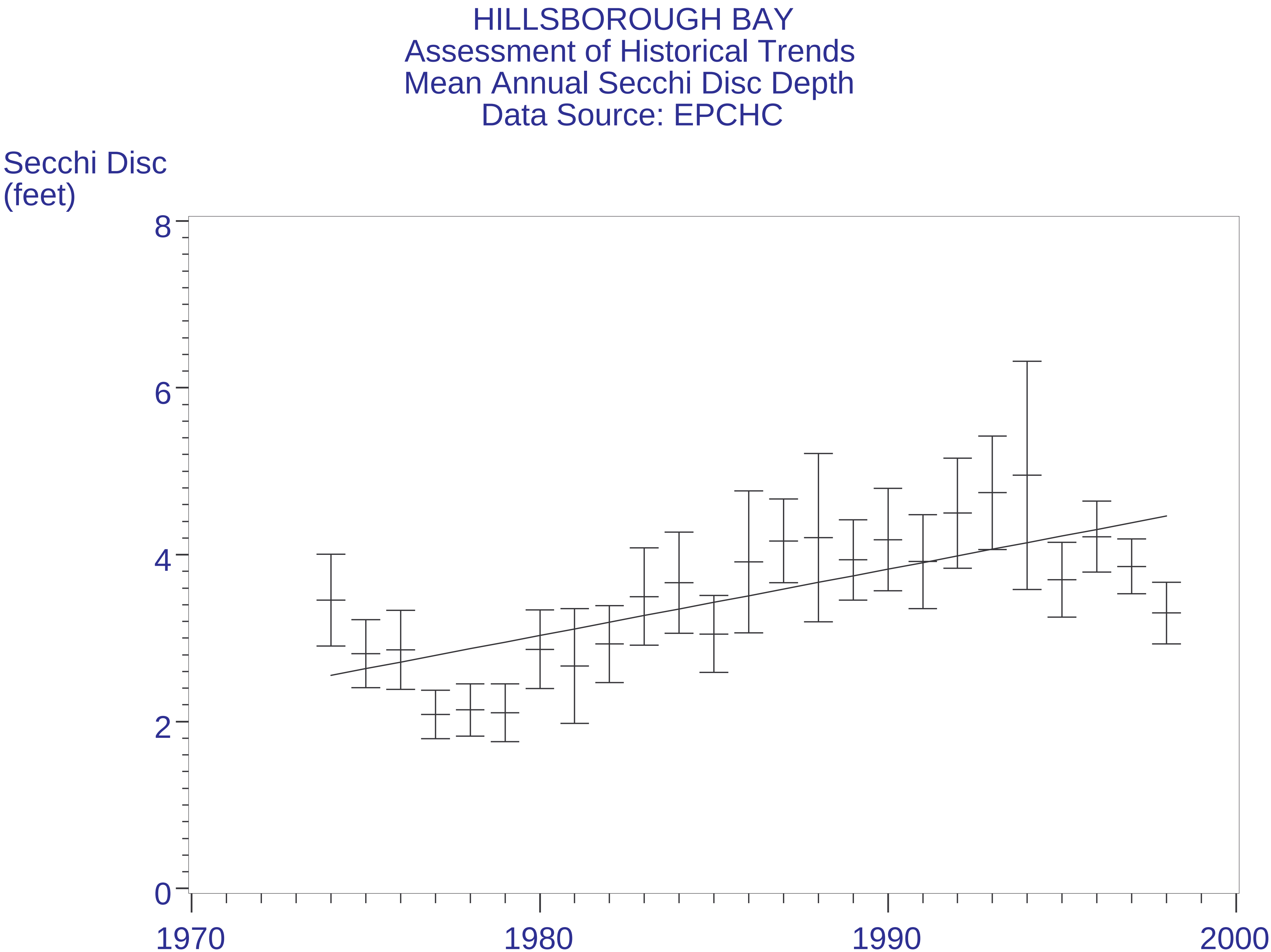
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay BOD (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	285
Mean Annual Slope Estimate	-0.097
Lower 95% Confidence Limit	-0.115
Upper 95% Confidence Limit	-0.079
p Value Slope Statistic	0.0000
Percent Change per Year	-0.035


HILLSBOROUGH BAY
Assessment of Historical Trends
Mean Annual Biochemical Oxygen Demand Concentrations
Data Source: EPCHC
BOD
(mg/L)
6
5
4
3
2
1
0
1970
1980
1990
2000

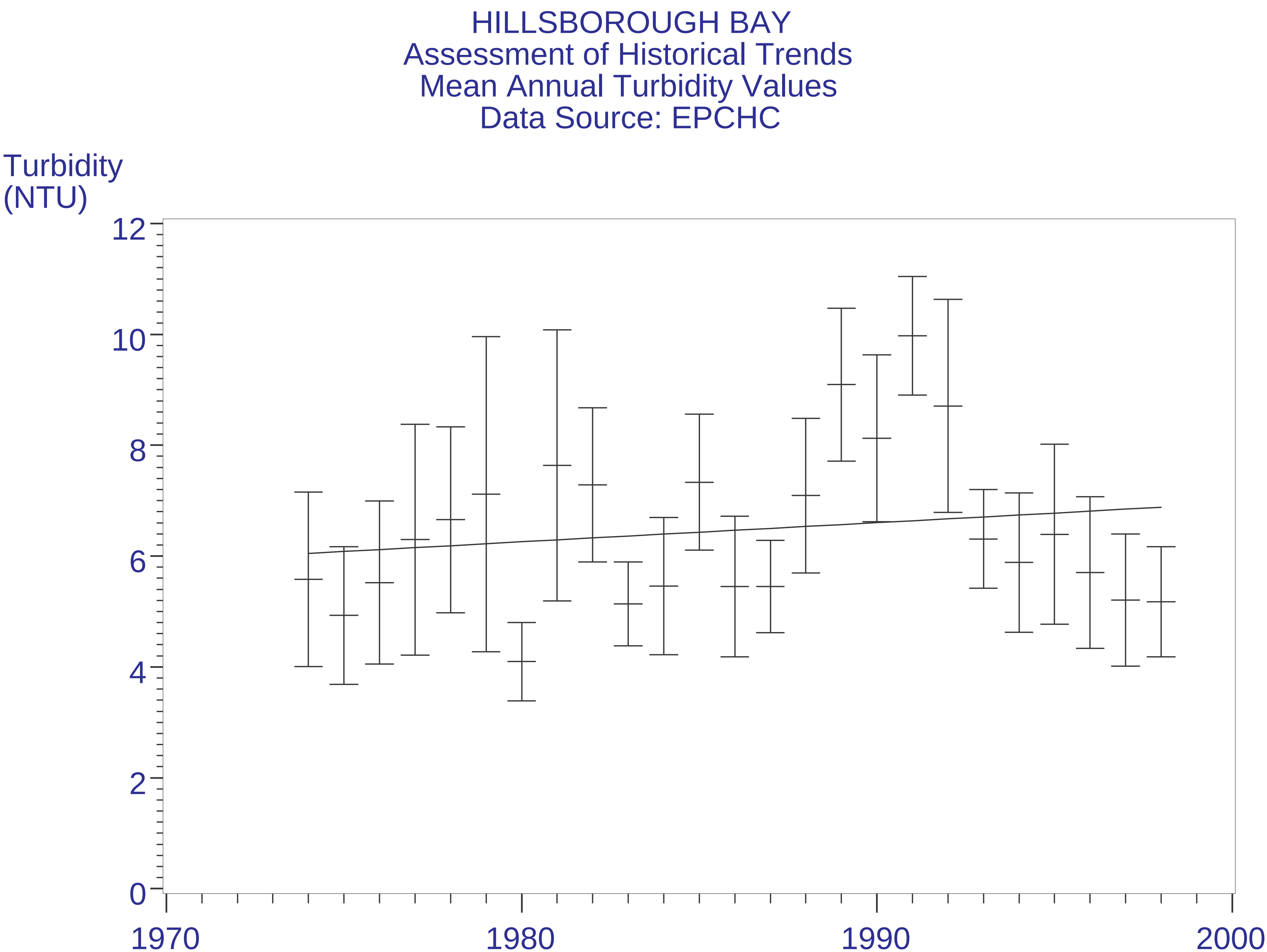
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay Bottom Dissolved Oxygen (mg/L) Data Source: EPCHC	
# of Years of Sampling	24
Number of Samples	263
Mean Annual Slope Estimate	-0.018
Lower 95% Confidence Limit	-0.049
Upper 95% Confidence Limit	0.014
p Value Slope Statistic	0.2786
Percent Change per Year	-0.003


HILLSBOROUGH BAY
Assessment of Historical Trends
Mean Annual Bottom Dissolved Oxygen Concentrations
Data Source: EPCHC
DO
(mg/L)
10
8
6
4
2
0
1970
1980
1990
2000

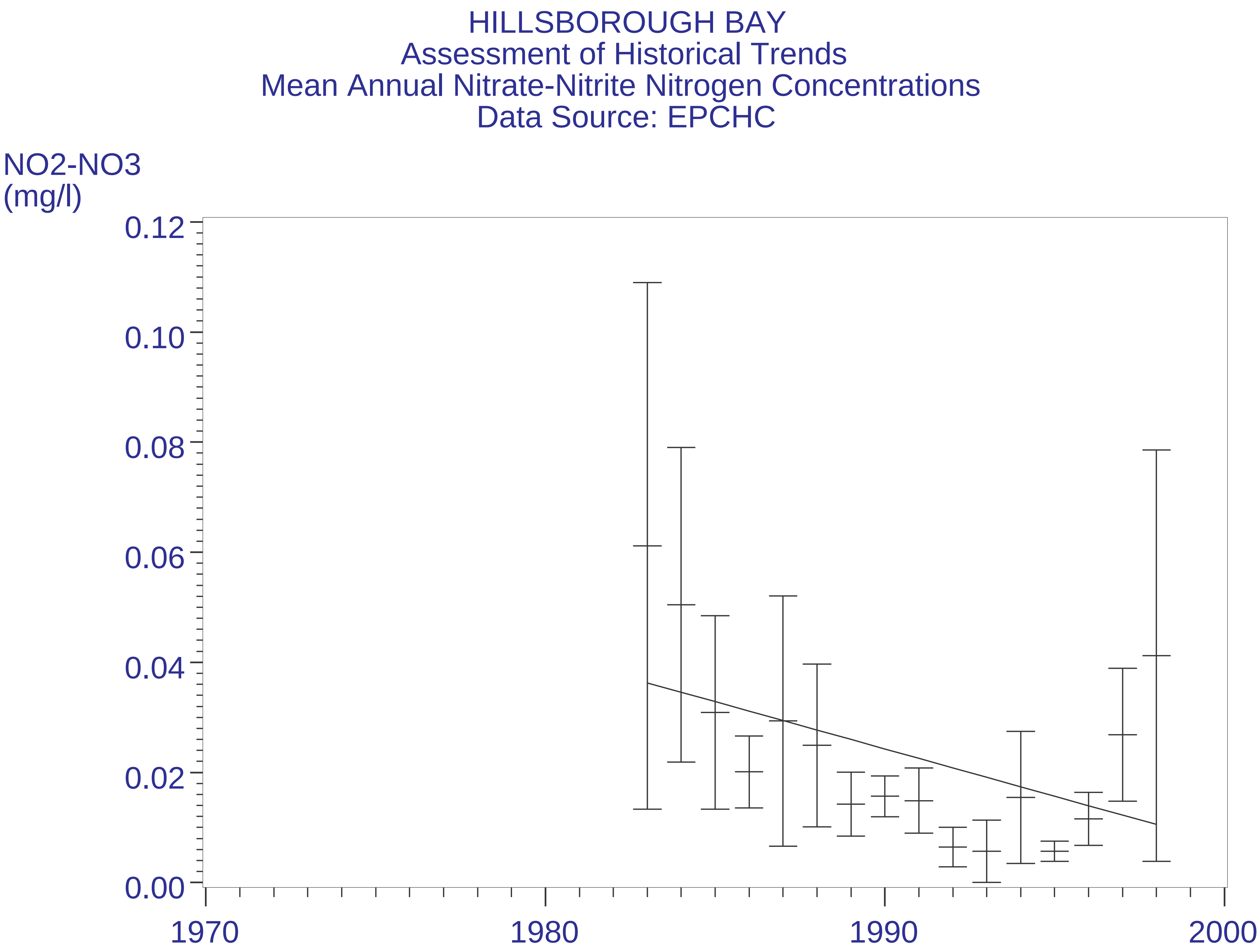
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay Secchi Disc Depth (feet) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	284
Mean Annual Slope Estimate	0.079
Lower 95% Confidence Limit	0.065
Upper 95% Confidence Limit	0.094
p Value Slope Statistic	0.0000
Percent Change per Year	0.023


HILLSBOROUGH BAY
Assessment of Historical Trends
Mean Annual Secchi Disc Depth
Data Source: EPCHC
Secchi Disc
(feet)
8
6
4
2
0
1970
1980
1990
2000

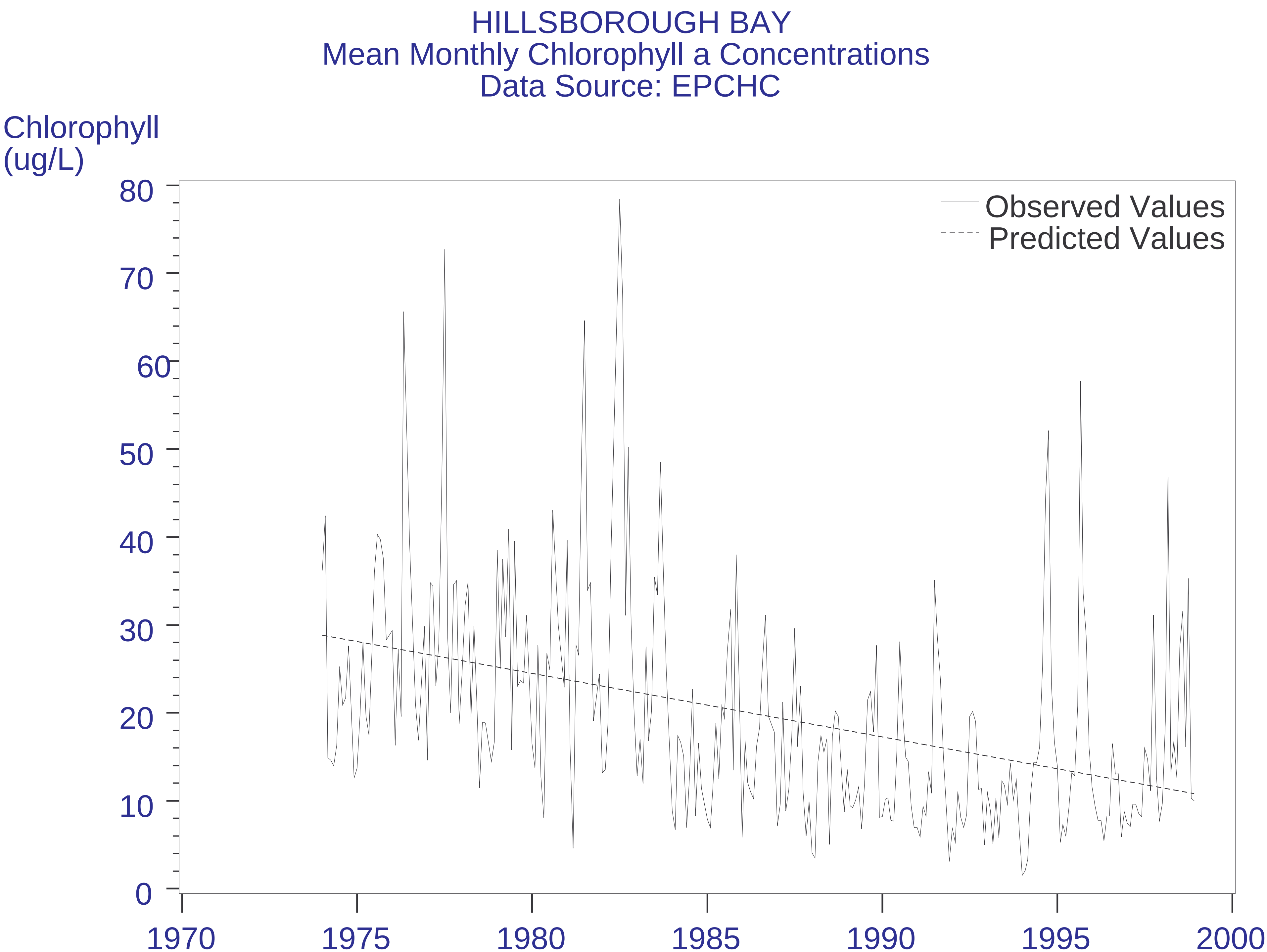
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay Turbidity (NTU) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	284
Mean Annual Slope Estimate	0.035
Lower 95% Confidence Limit	-0.007
Upper 95% Confidence Limit	0.076
p Value Slope Statistic	0.0991
Percent Change per Year	0.005


HILLSBOROUGH BAY
Assessment of Historical Trends
Mean Annual Turbidity Values
Data Source: EPCHC
Turbidity
(NTU)
12
10
8
6
4
2
0
1970
1980
1990
2000

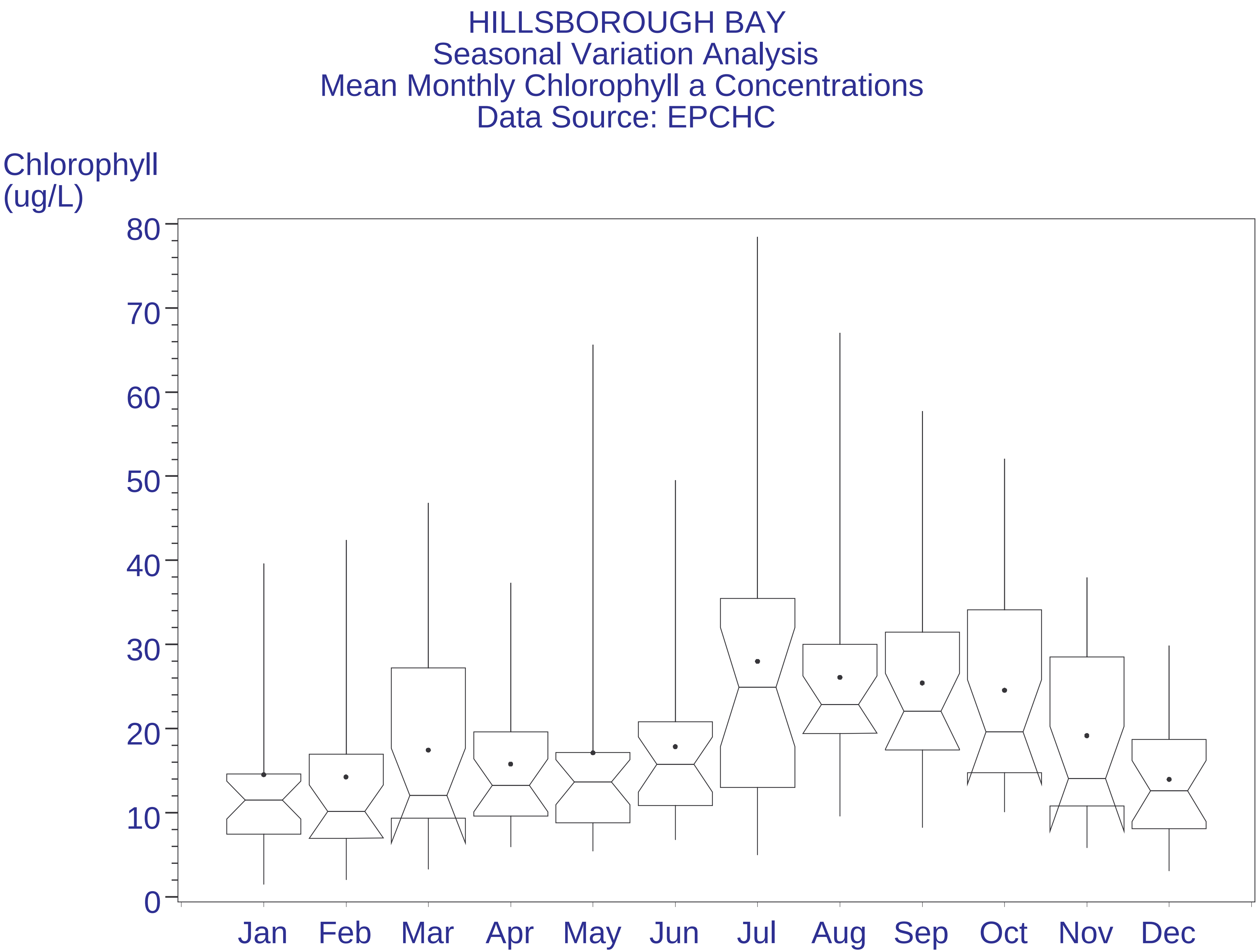
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay Nitrate-Nitrite Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	16
Number of Samples	187
Mean Annual Slope Estimate	-0.002
Lower 95% Confidence Limit	-0.003
Upper 95% Confidence Limit	0.000
p Value Slope Statistic	0.0244
Percent Change per Year	-0.073


HILLSBOROUGH BAY
Assessment of Historical Trends
Mean Annual Nitrate-Nitrite Nitrogen Concentrations
Data Source: EPCHC
NO2-NO3
(mg/l)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1970
1980
1990
2000

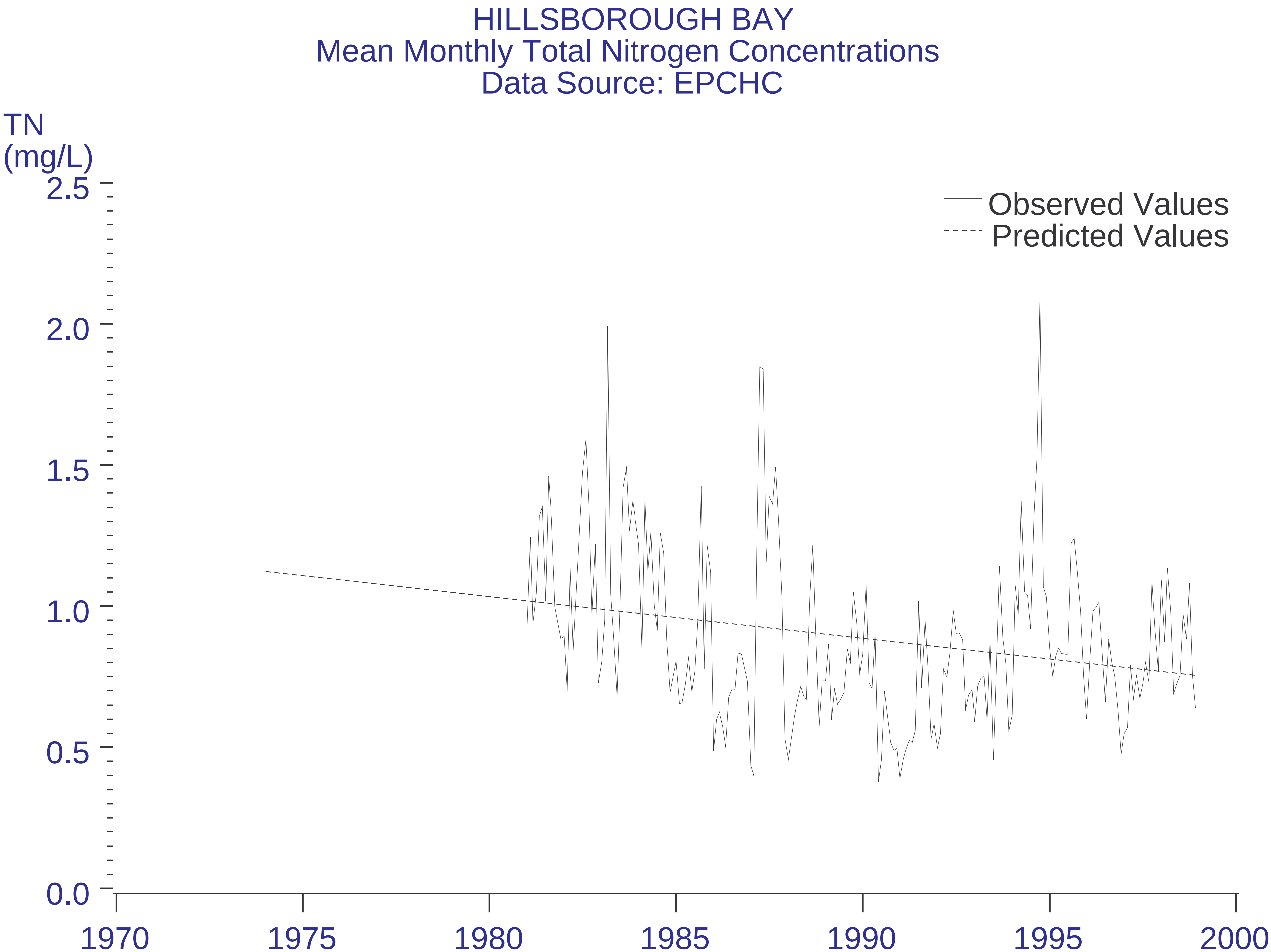
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay Chlorophyll a (ug/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	285
Tau Statistic	-0.398
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.000
p Value Slope Statistic	-0.6575

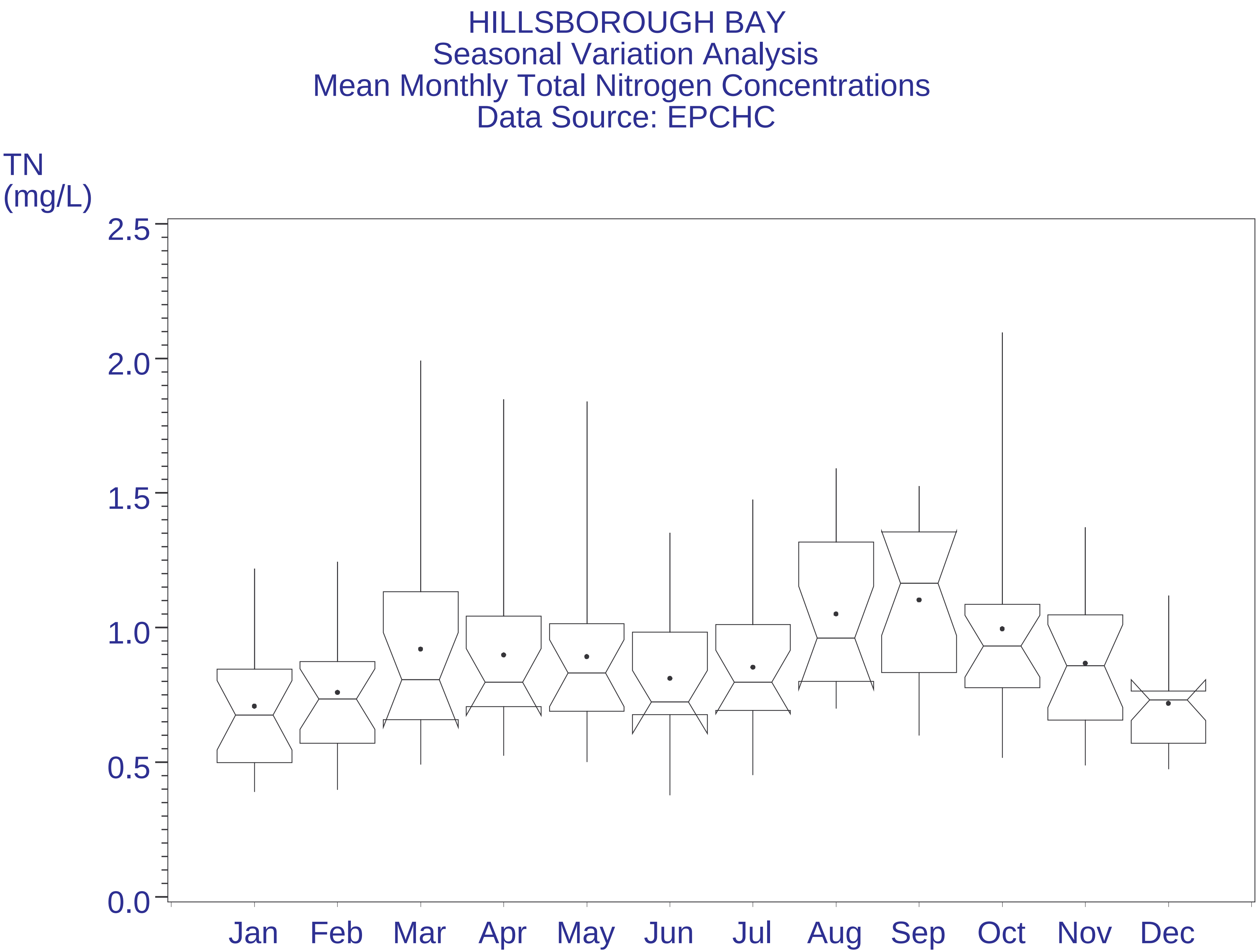


HILLSBOROUGH BAY
Mean Monthly Chlorophyll a Concentrations
Data Source: EPCHC
Chlorophyll
(ug/L)
80
70
60
50
40
30
20
10
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


HILLSBOROUGH BAY
Seasonal Variation Analysis
Mean Monthly Chlorophyll a Concentrations
Data Source: EPCHC
Chlorophyll
(ug/L)
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

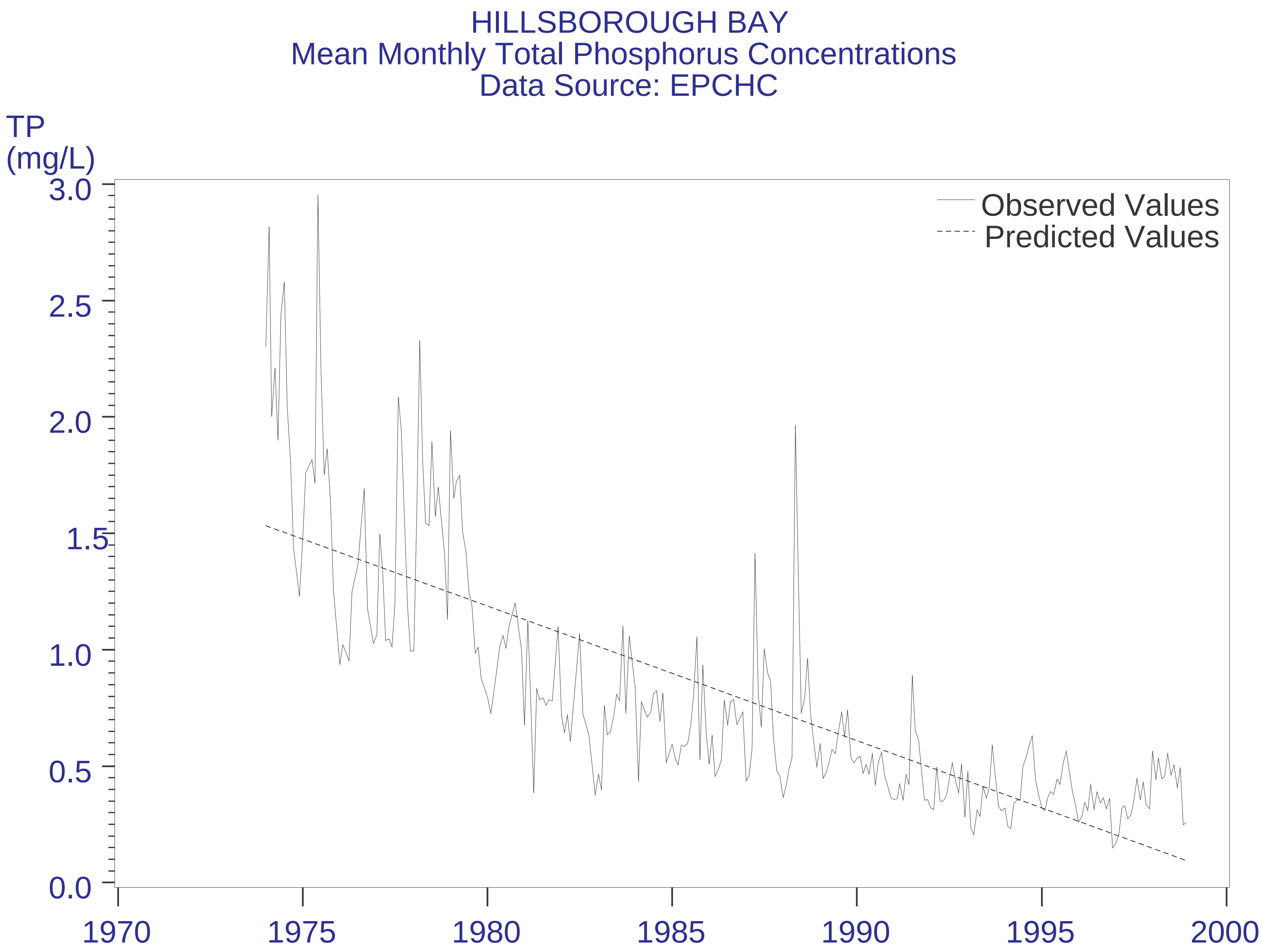
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay Total Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	18
Number of Samples	210
Tau Statistic	-0.159
P-value without Serial Correlation	0.002
P-value with Serial Correlation	0.177
p Value Slope Statistic	-0.0135

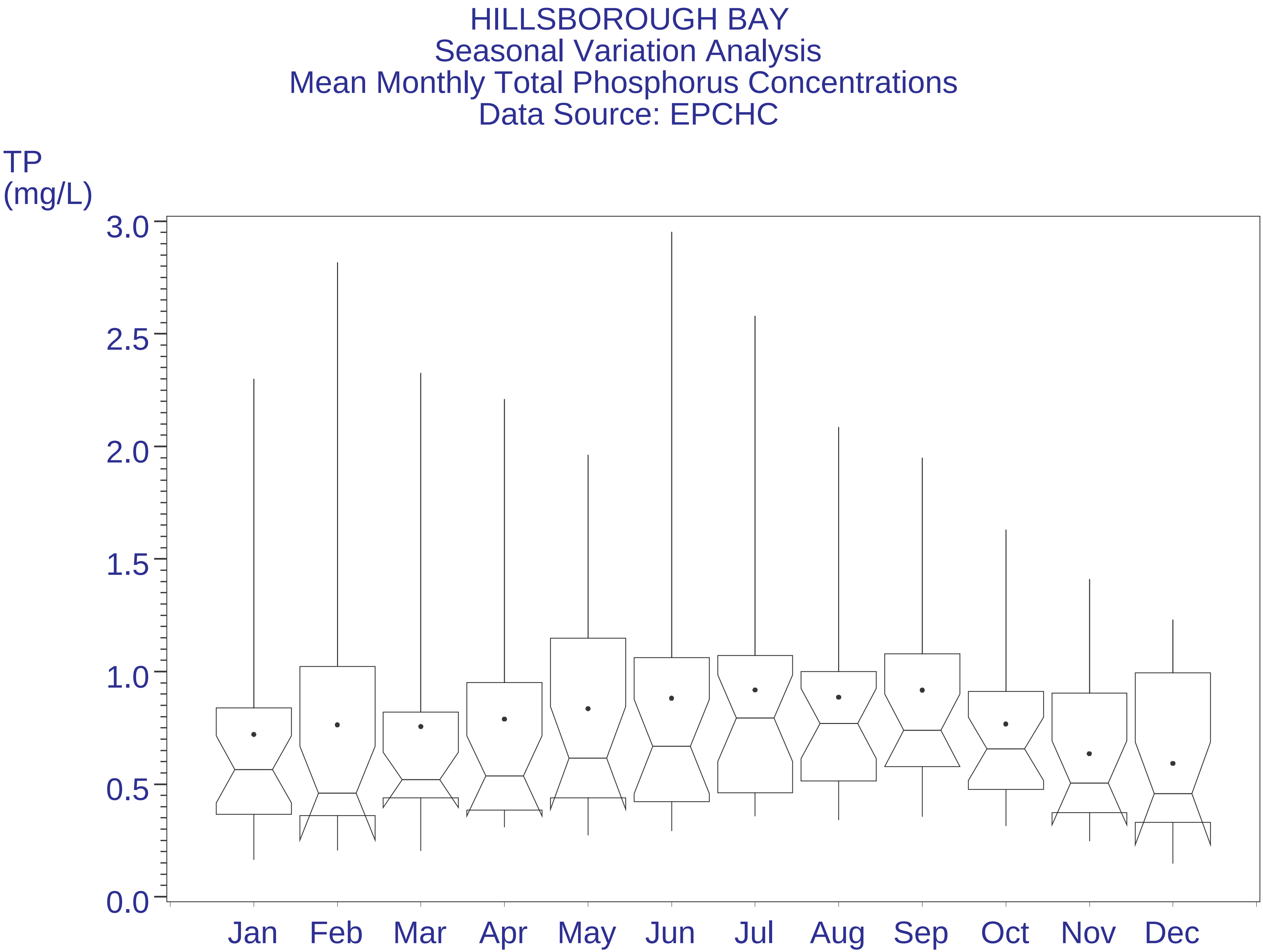

HILLSBOROUGH BAY
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values



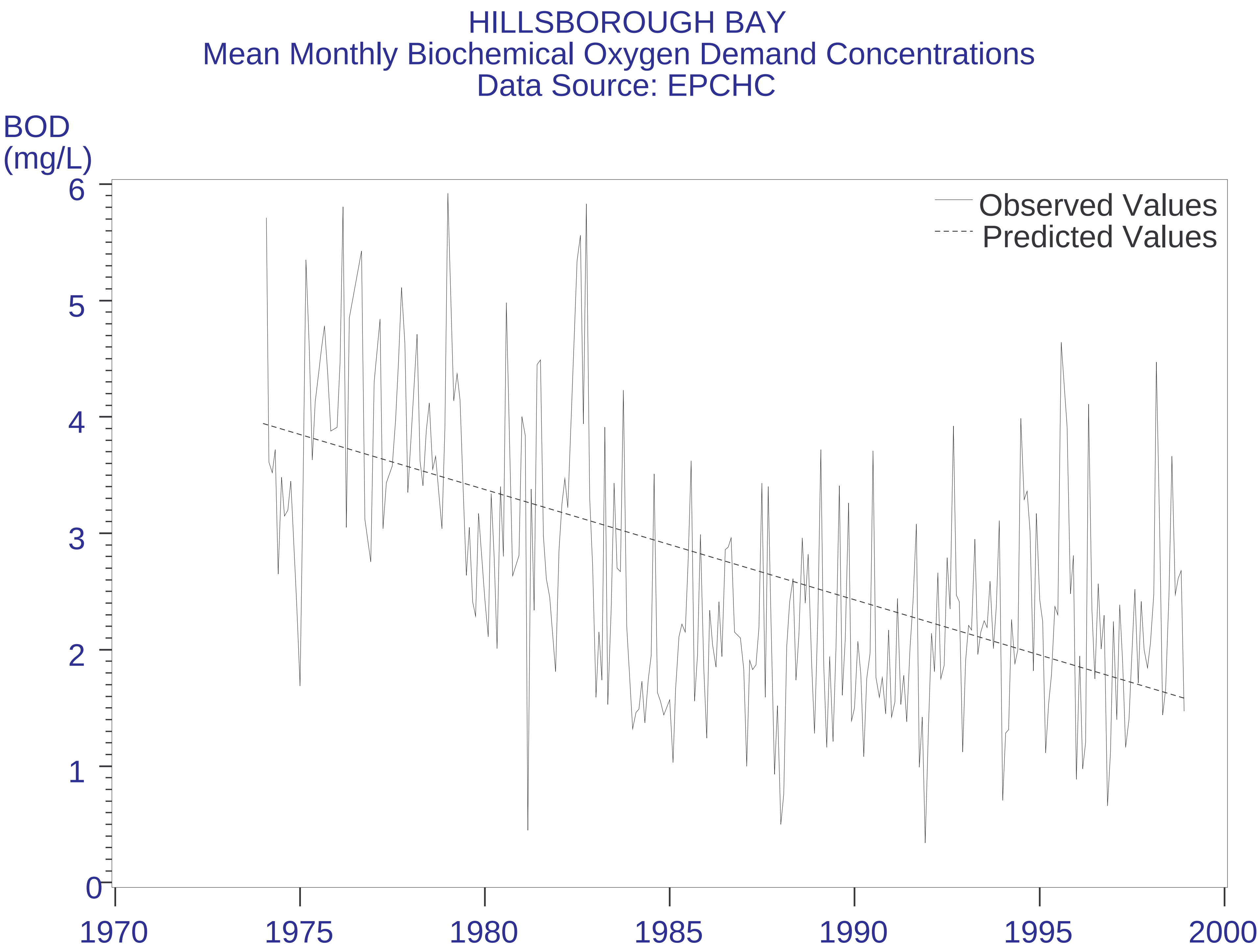
HILLSBOROUGH BAY
Seasonal Variation Analysis
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

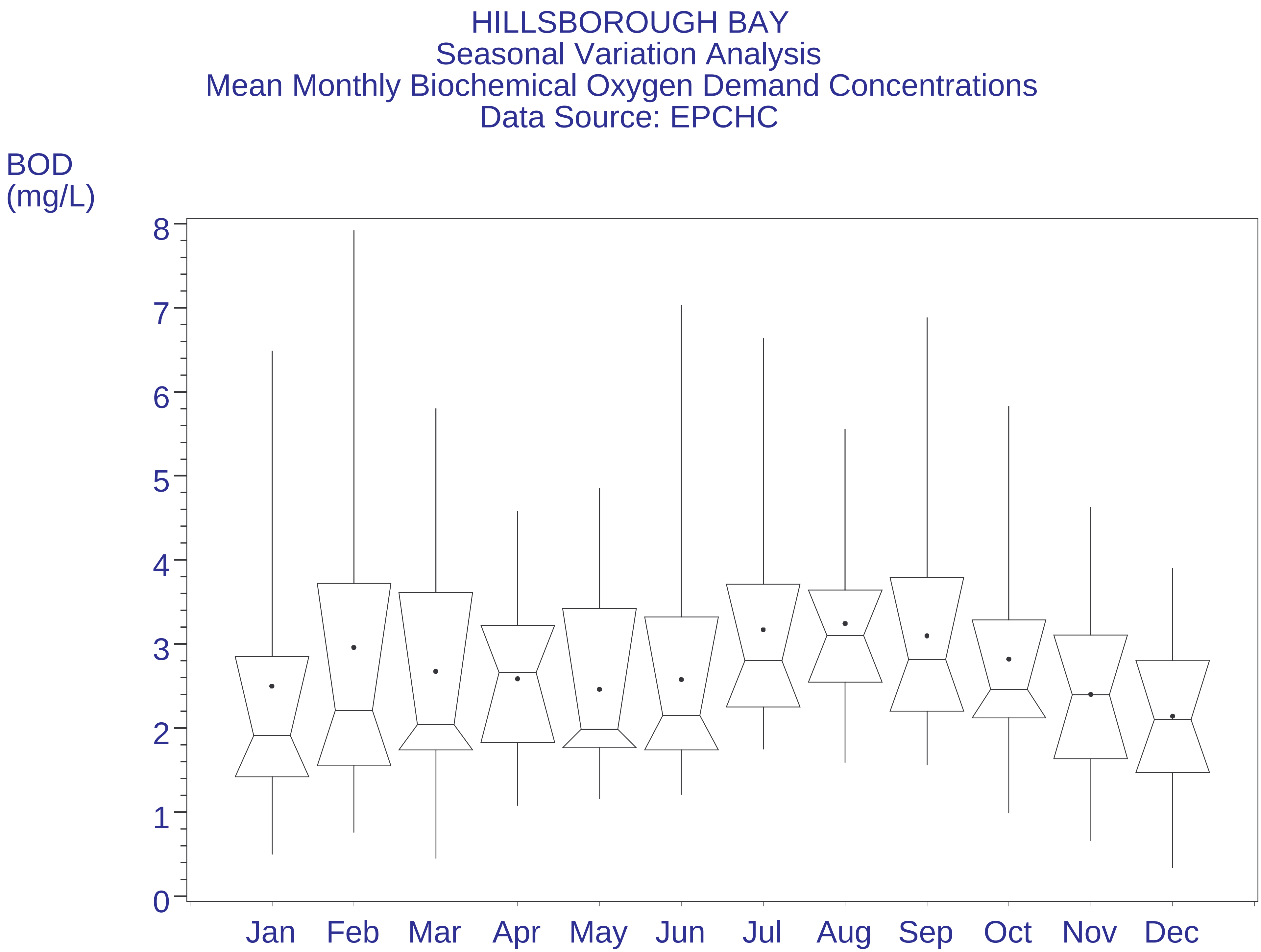
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay Total Phosphorus (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	284
Tau Statistic	-0.730
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.000
p Value Slope Statistic	-0.0438


HILLSBOROUGH BAY
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

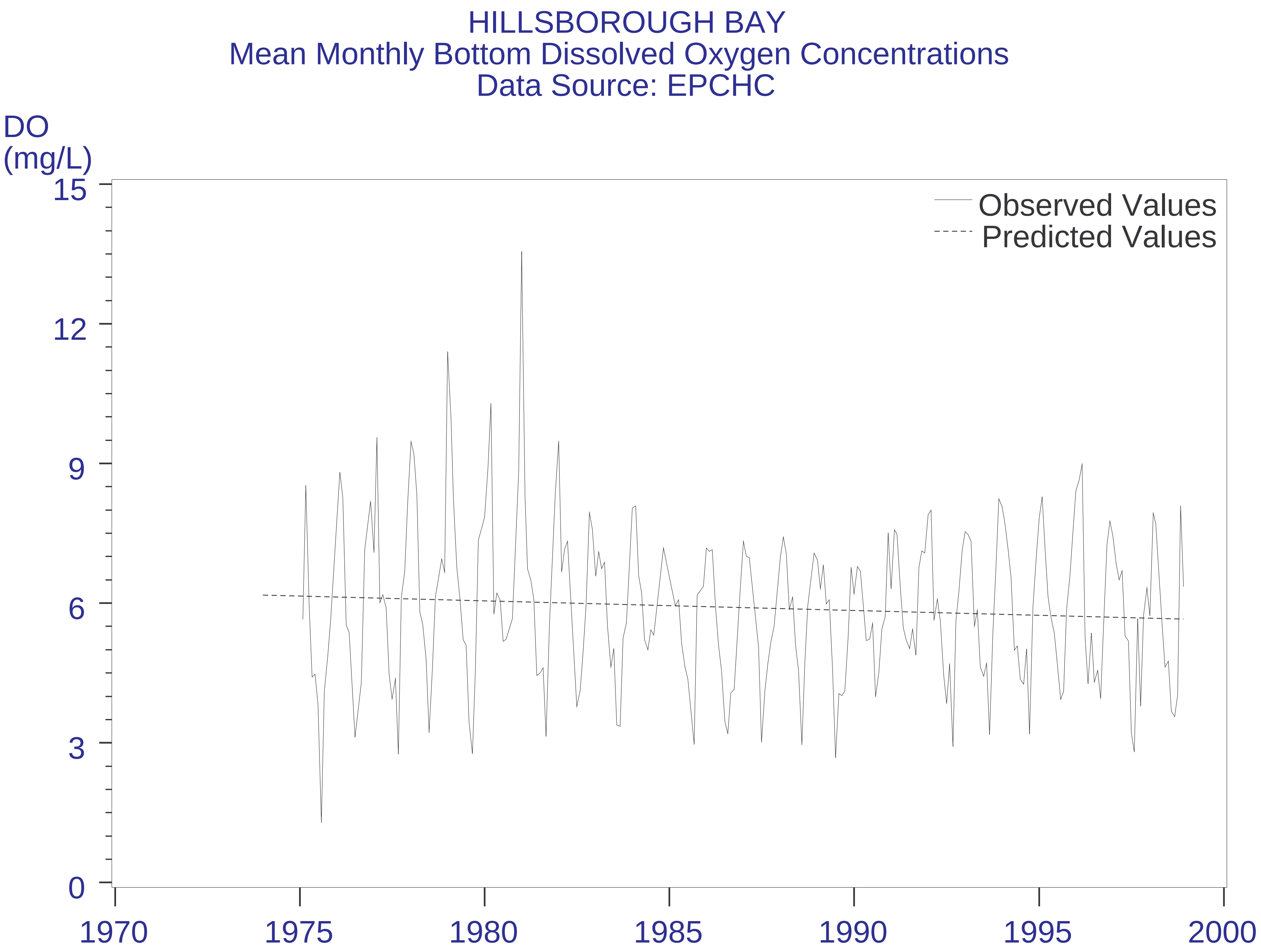

HILLSBOROUGH BAY
Seasonal Variation Analysis
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay BOD (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	285
Tau Statistic	-0.364
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.000
p Value Slope Statistic	-0.0831

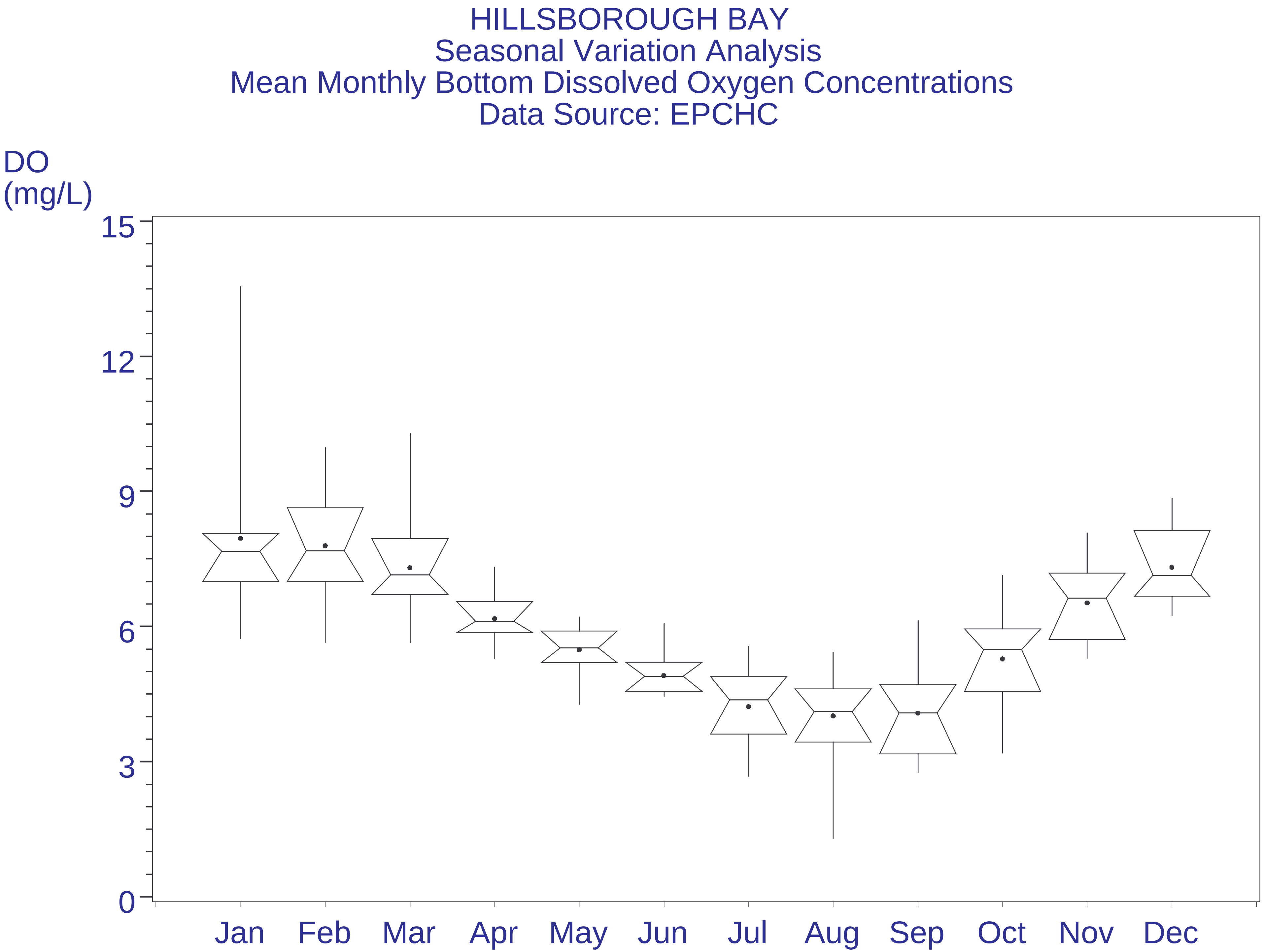

HILLSBOROUGH BAY
Mean Monthly Biochemical Oxygen Demand Concentrations
Data Source: EPCHC
BOD
(mg/L)
6
5
4
3
2
1
0
Observed Values
Predicted Values
1970
1975
1980
1985
1990
1995
2000


HILLSBOROUGH BAY
Seasonal Variation Analysis
Mean Monthly Biochemical Oxygen Demand Concentrations
Data Source: EPCHC
BOD
(mg/L)
0
1
2
3
4
5
6
7
8
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

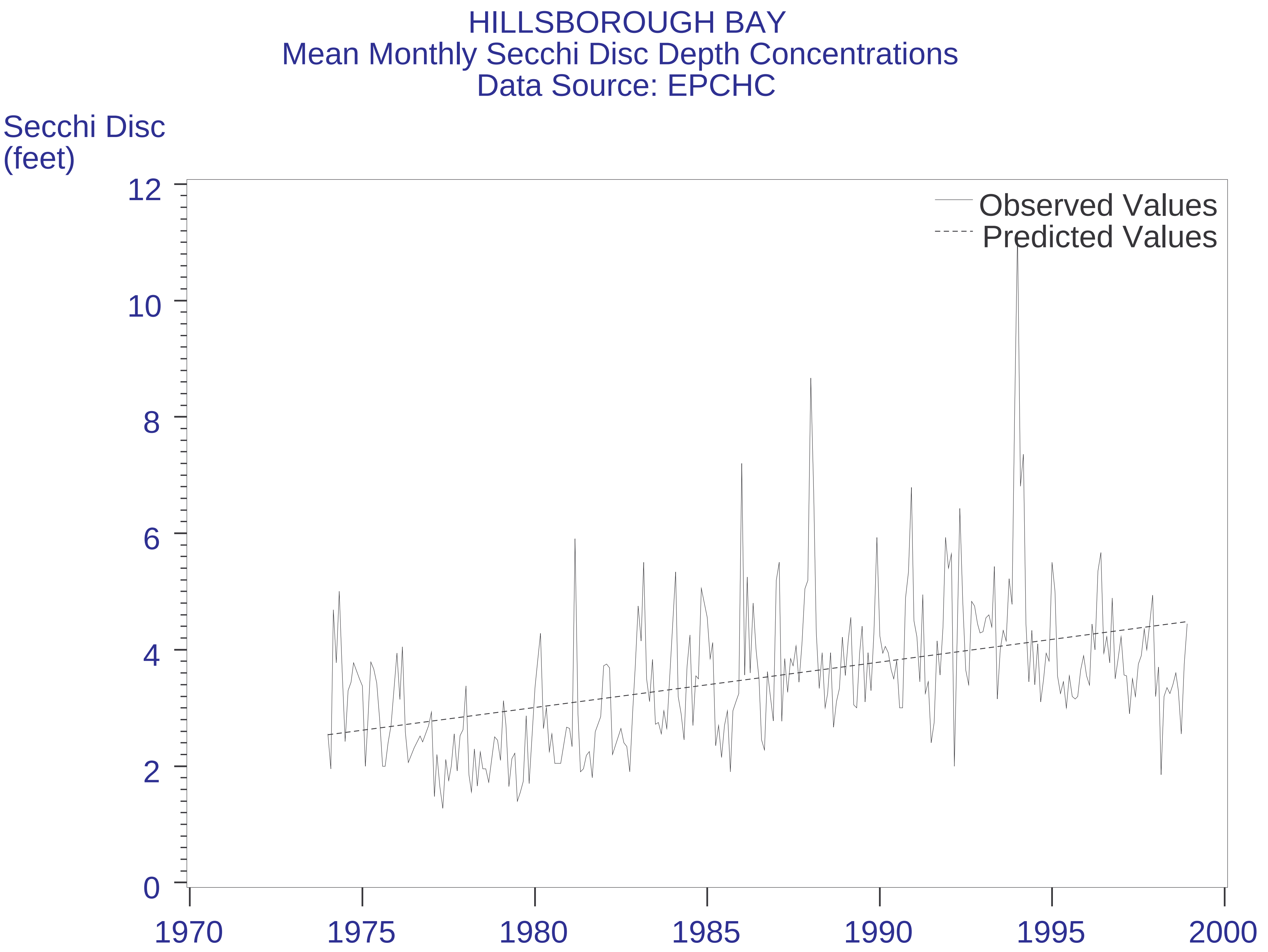
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay Bottom Dissolved Oxygen (mg/L) Data Source: EPCHC	
# of Years of Sampling	24
Number of Samples	263
Tau Statistic	-0.038
P-value without Serial Correlation	0.403
P-value with Serial Correlation	0.579
p Value Slope Statistic	-0.0064



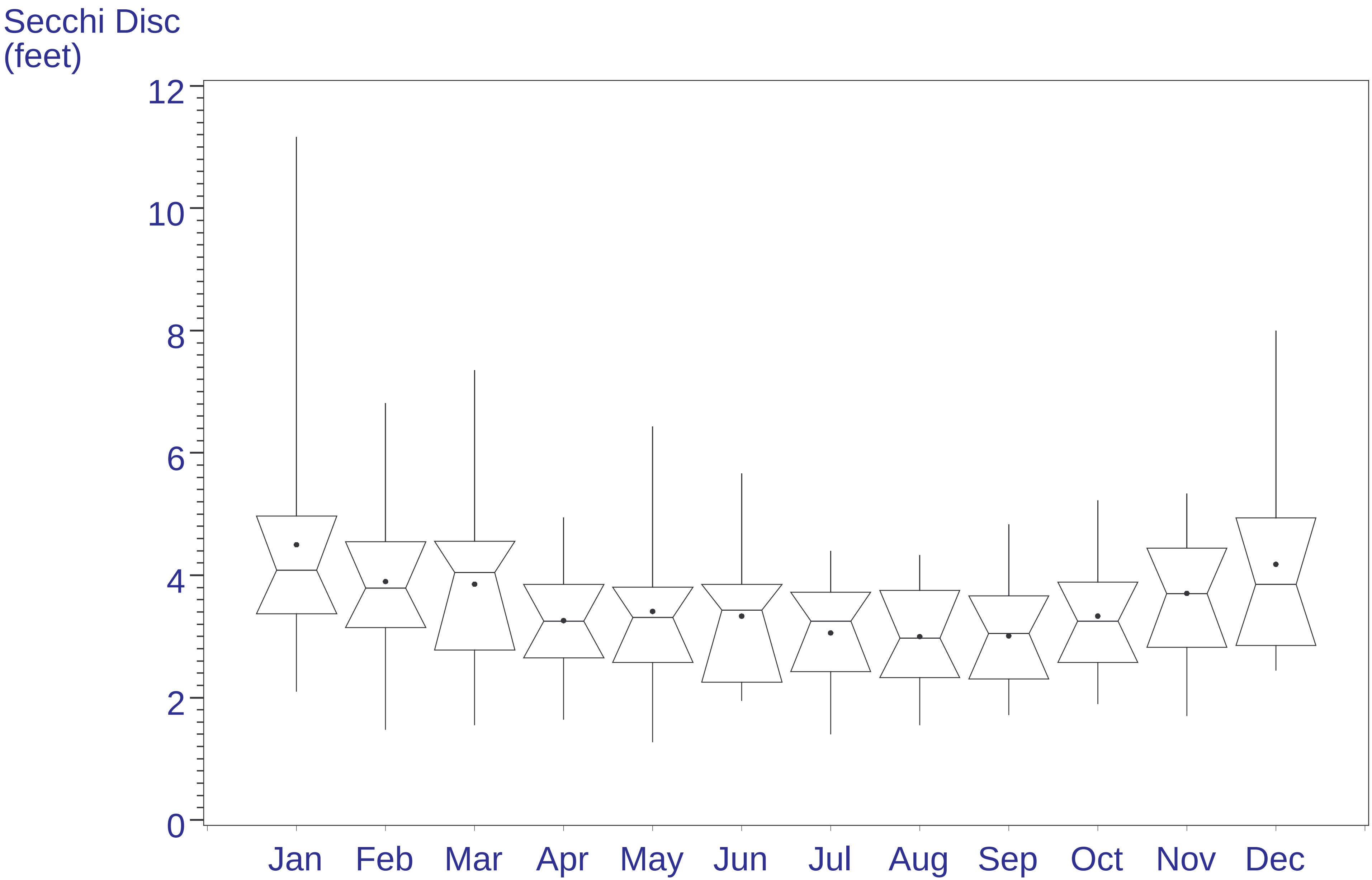
HILLSBOROUGH BAY
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: EPCHC
DO
(mg/L)
15
12
9
6
3
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


HILLSBOROUGH BAY
Seasonal Variation Analysis
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: EPCHC
DO
(mg/L)
15
12
9
6
3
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

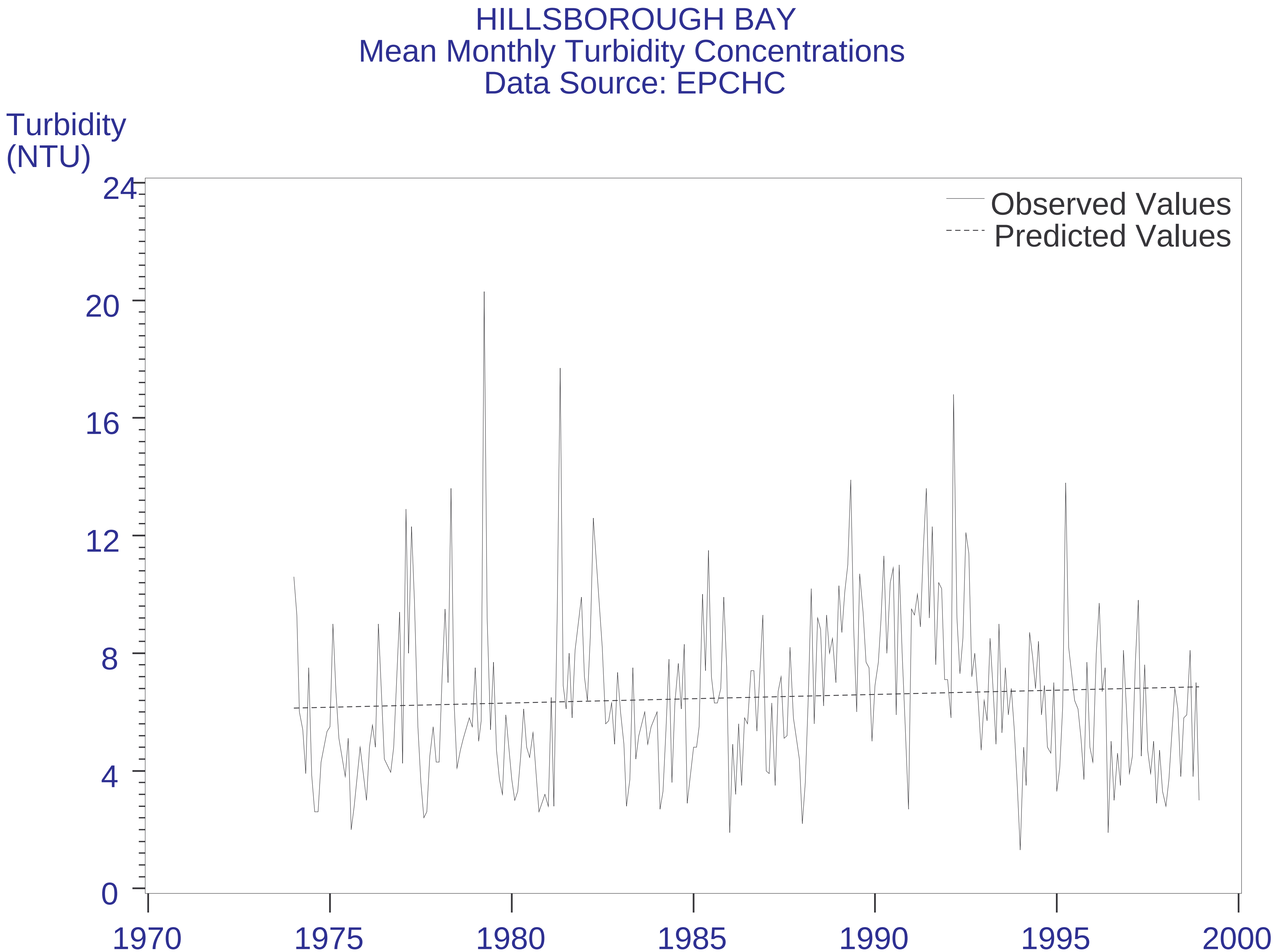
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay Secchi Disc Depth (feet) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	284
Tau Statistic	0.385
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.000
p Value Slope Statistic	0.0759


HILLSBOROUGH BAY
Mean Monthly Secchi Disc Depth Concentrations
Data Source: EPCHC
Secchi Disc
(feet)
12
10
8
6
4
2
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

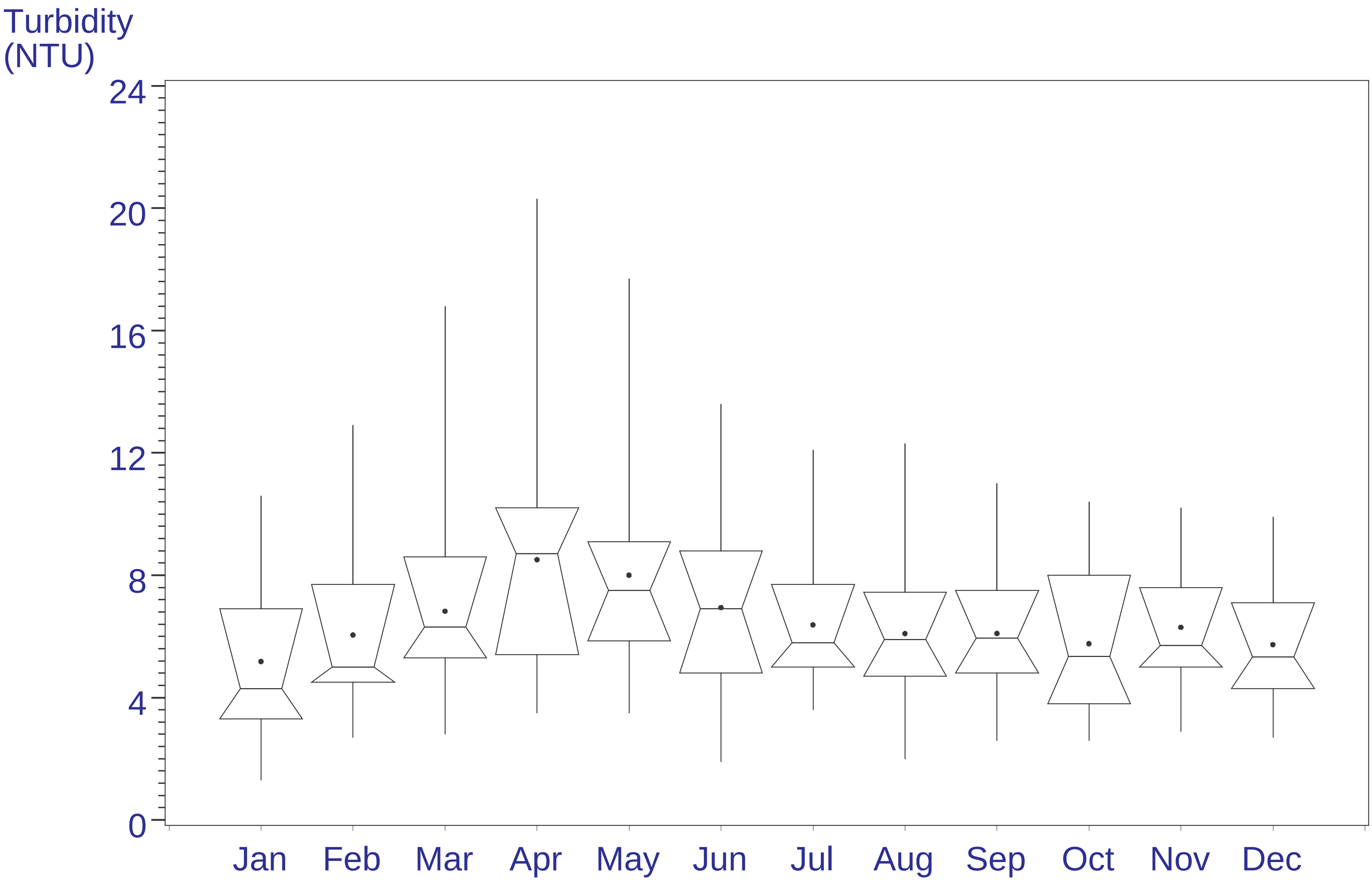
HILLSBOROUGH BAY
Seasonal Variation Analysis
Mean Monthly Secchi Disc Depth Concentrations
Data Source: EPCHC



TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay Turbidity (NTU) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	284
Tau Statistic	0.071
P-value without Serial Correlation	0.097
P-value with Serial Correlation	0.374
p Value Slope Statistic	0.0400

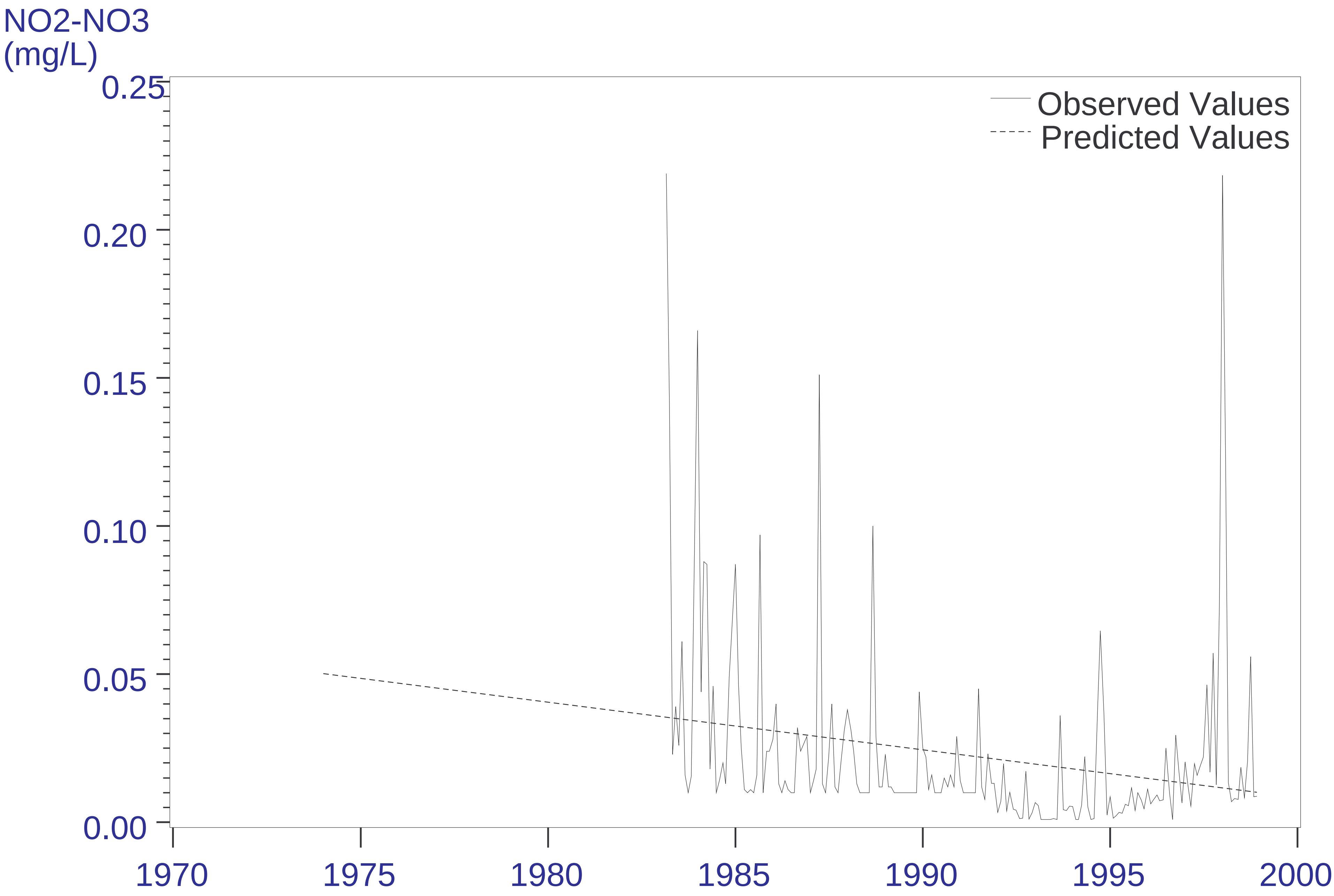

HILLSBOROUGH BAY
Mean Monthly Turbidity Concentrations
Data Source: EPCHC
Turbidity
(NTU)
24
20
16
12
8
4
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

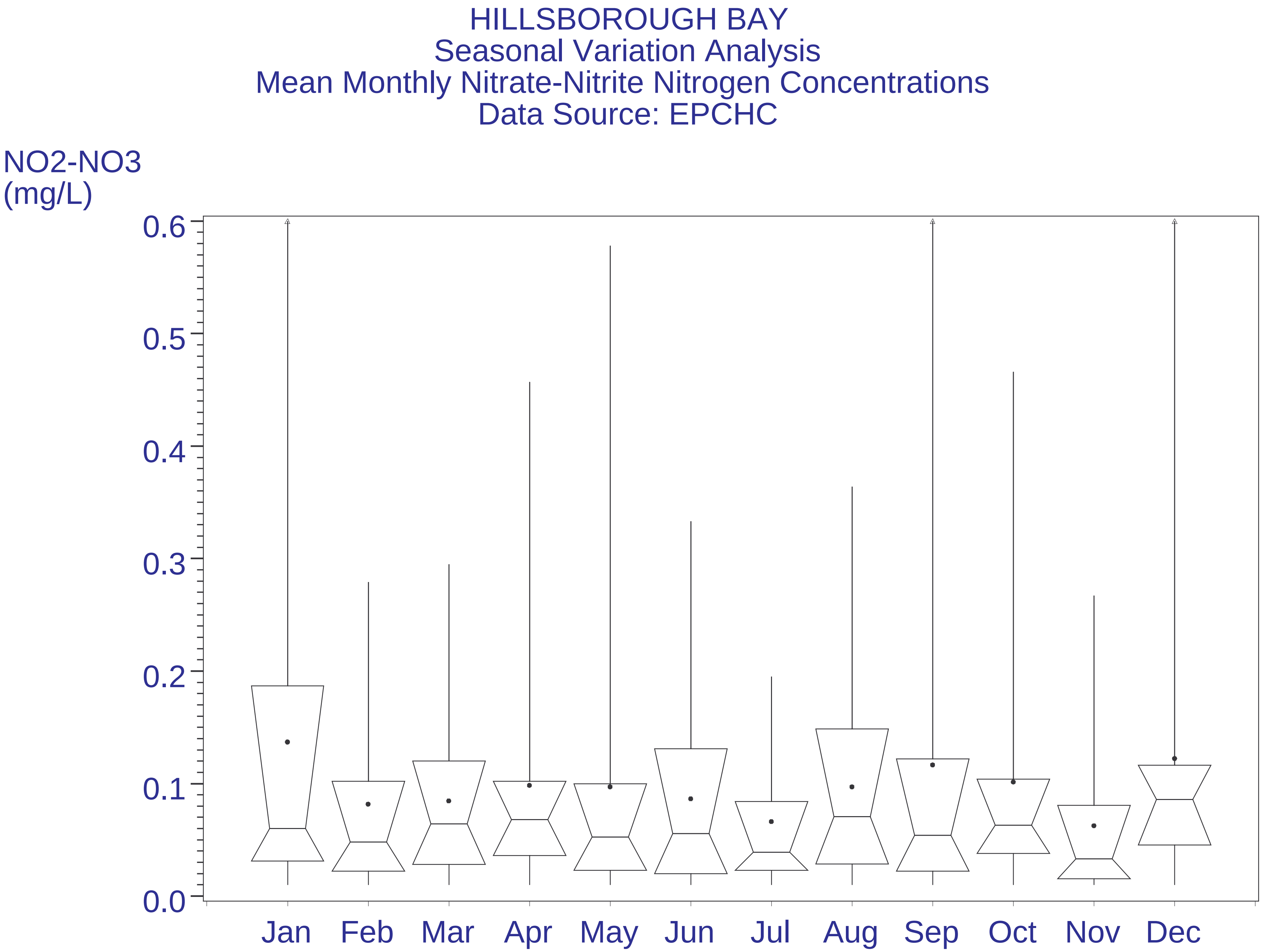
HILLSBOROUGH BAY
Seasonal Variation Analysis
Mean Monthly Turbidity Concentrations
Data Source: EPCHC



TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay Nitrate-Nitrite Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	16
Number of Samples	187
Tau Statistic	-0.288
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.015
p Value Slope Statistic	-0.0009

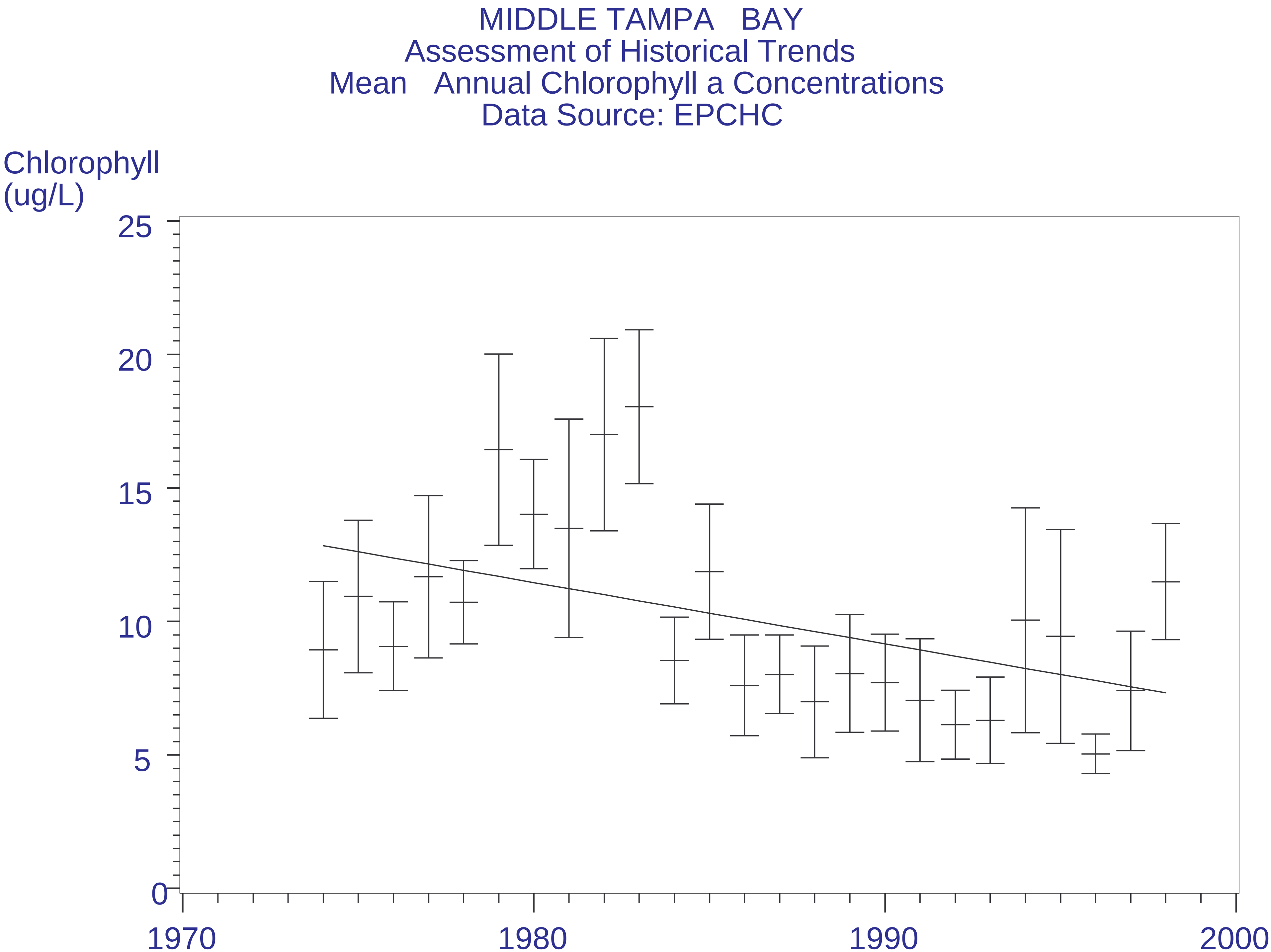
HILLSBOROUGH BAY
Mean Monthly Nitrite-Nitrate Nitrogen Concentrations
Data Source: EPCHC



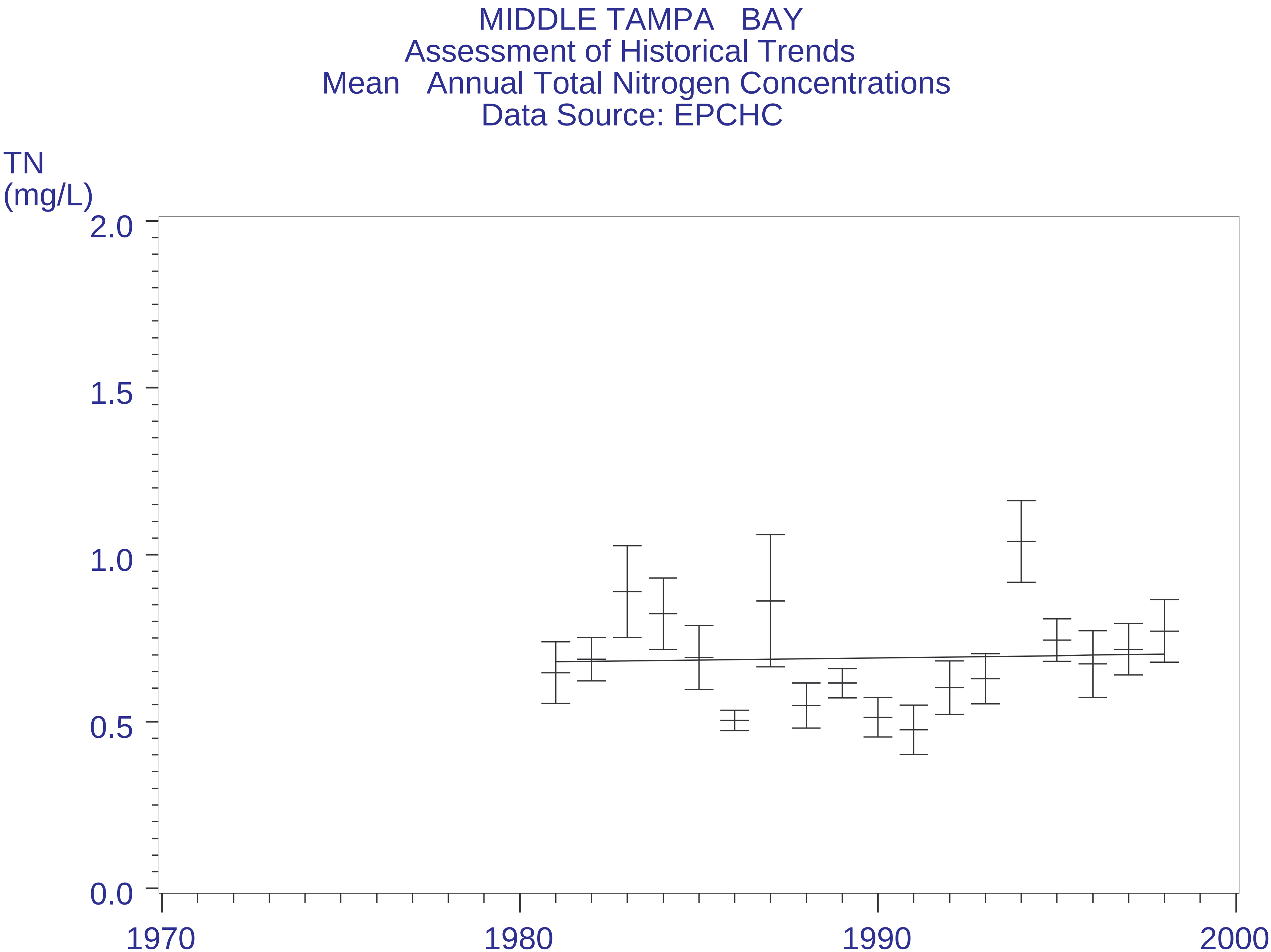

HILLSBOROUGH BAY
Seasonal Variation Analysis
Mean Monthly Nitrate-Nitrite Nitrogen Concentrations
Data Source: EPCHC
NO2-NO3
(mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

MIDDLE TAMPA BAY

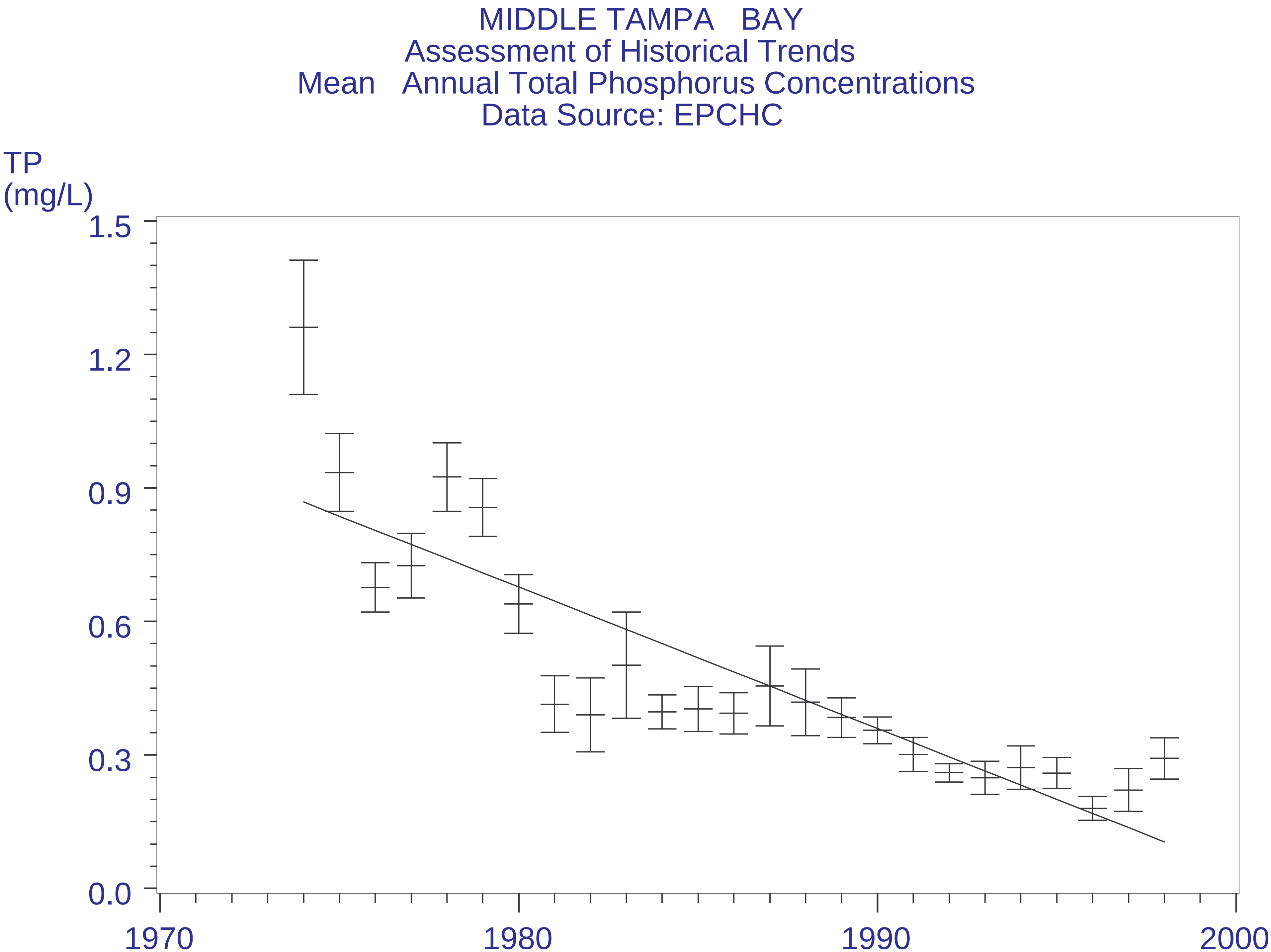
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay Chlorophyll a (ug/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	297
Mean Annual Slope Estimate	-0.230
Lower 95% Confidence Limit	-0.300
Upper 95% Confidence Limit	-0.159
p Value Slope Statistic	0.0000
Percent Change per Year	-0.023


MIDDLE TAMPA BAY
Assessment of Historical Trends
Mean Annual Chlorophyll a Concentrations
Data Source: EPCHC
Chlorophyll
(ug/L)
25
20
15
10
5
0
1970
1980
1990
2000

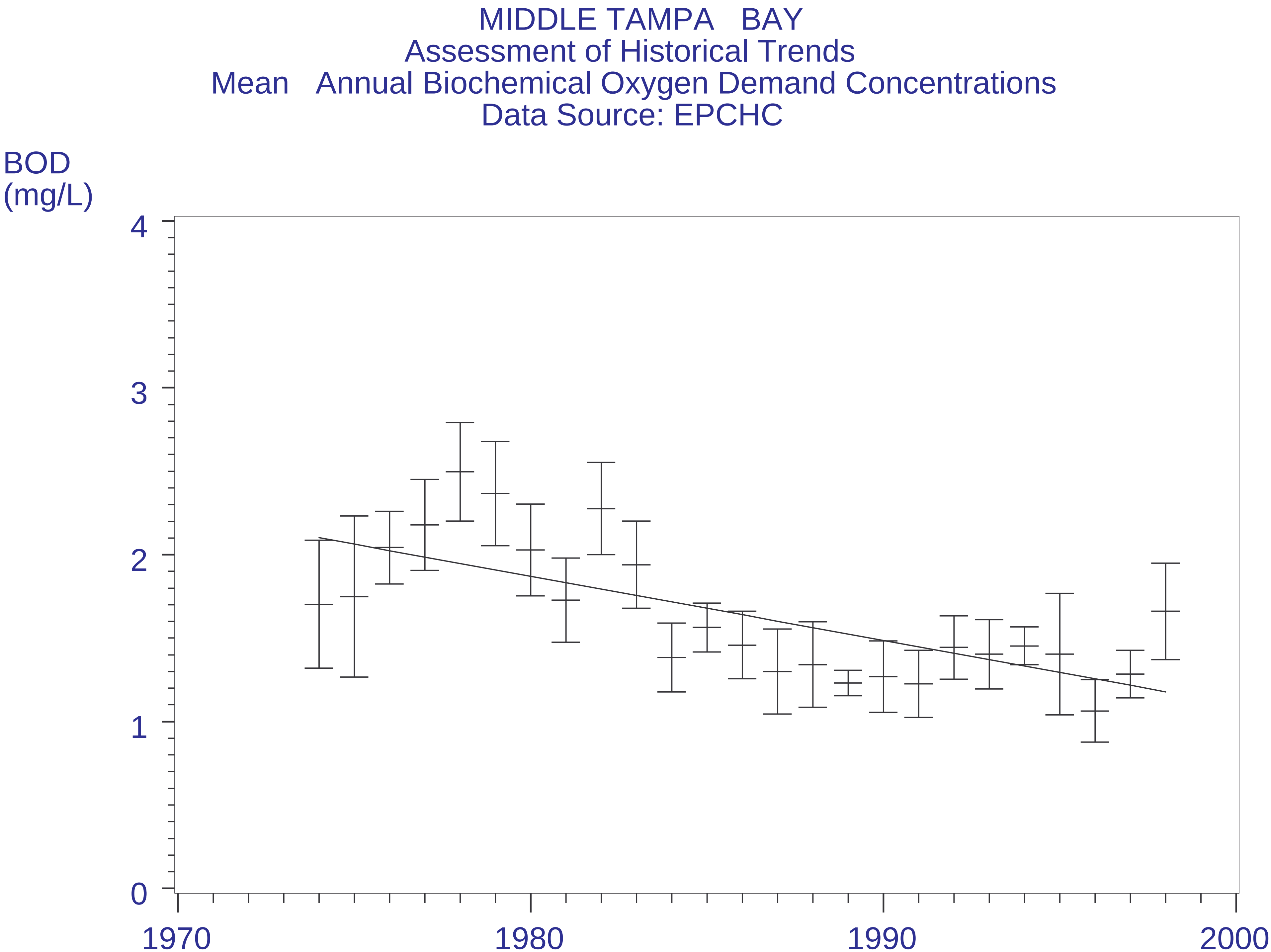
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay Total Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	18
Number of Samples	214
Mean Annual Slope Estimate	0.001
Lower 95% Confidence Limit	-0.003
Upper 95% Confidence Limit	0.006
p Value Slope Statistic	0.5474
Percent Change per Year	0.002


MIDDLE TAMPA BAY
Assessment of Historical Trends
Mean Annual Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
2.0
1.5
1.0
0.5
0.0
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay Total Phosphorus (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	297
Mean Annual Slope Estimate	-0.032
Lower 95% Confidence Limit	-0.034
Upper 95% Confidence Limit	-0.030
p Value Slope Statistic	0.0000
Percent Change per Year	-0.065

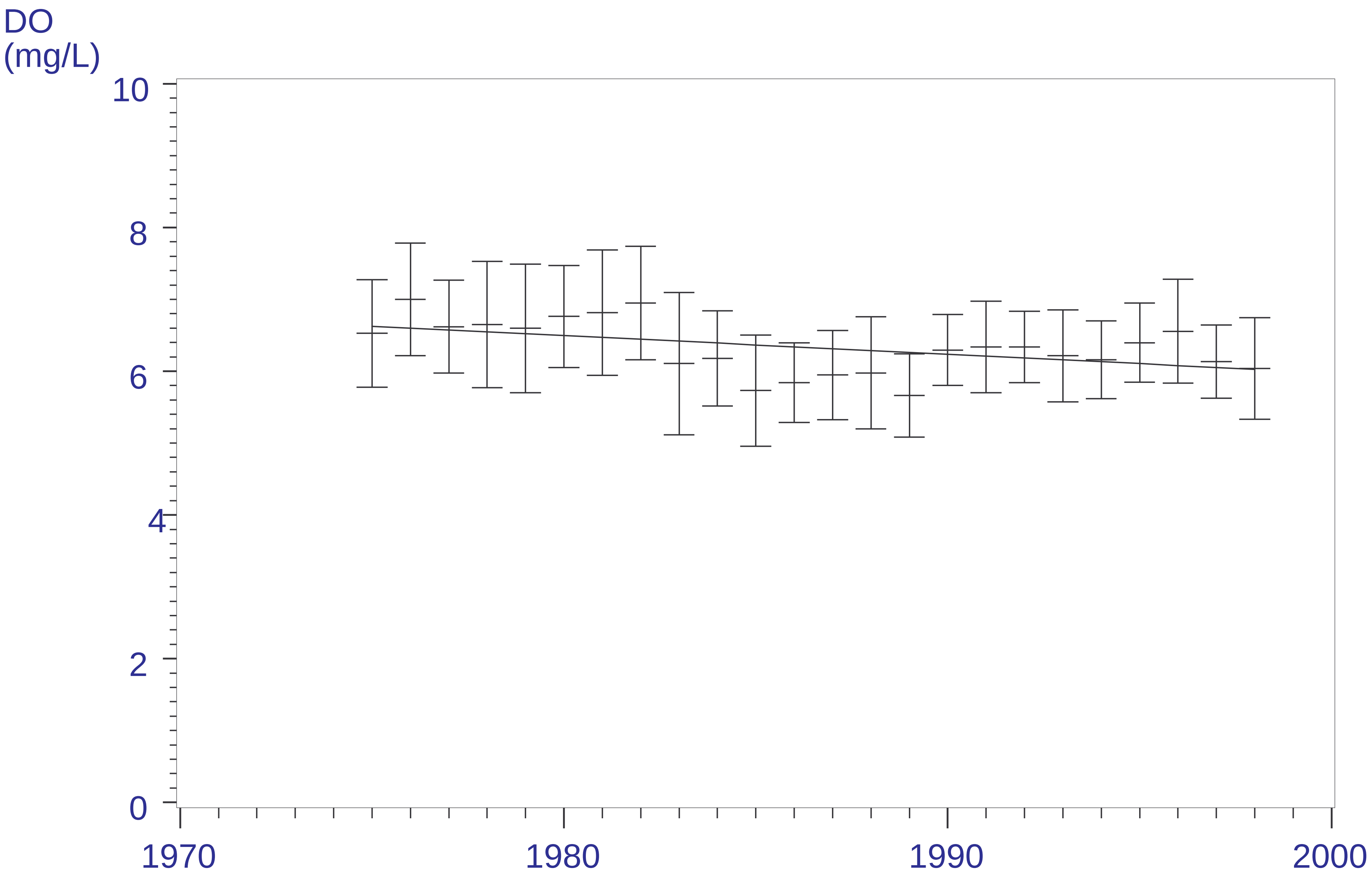

MIDDLE TAMPA BAY
Assessment of Historical Trends
Mean Annual Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
1.5
1.2
0.9
0.6
0.3
0.0
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay BOD (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	297
Mean Annual Slope Estimate	-0.038
Lower 95% Confidence Limit	-0.046
Upper 95% Confidence Limit	-0.030
p Value Slope Statistic	0.0000
Percent Change per Year	-0.023


MIDDLE TAMPA BAY
Assessment of Historical Trends
Mean Annual Biochemical Oxygen Demand Concentrations
Data Source: EPCHC
BOD
(mg/L)
4
3
2
1
0
1970
1980
1990
2000

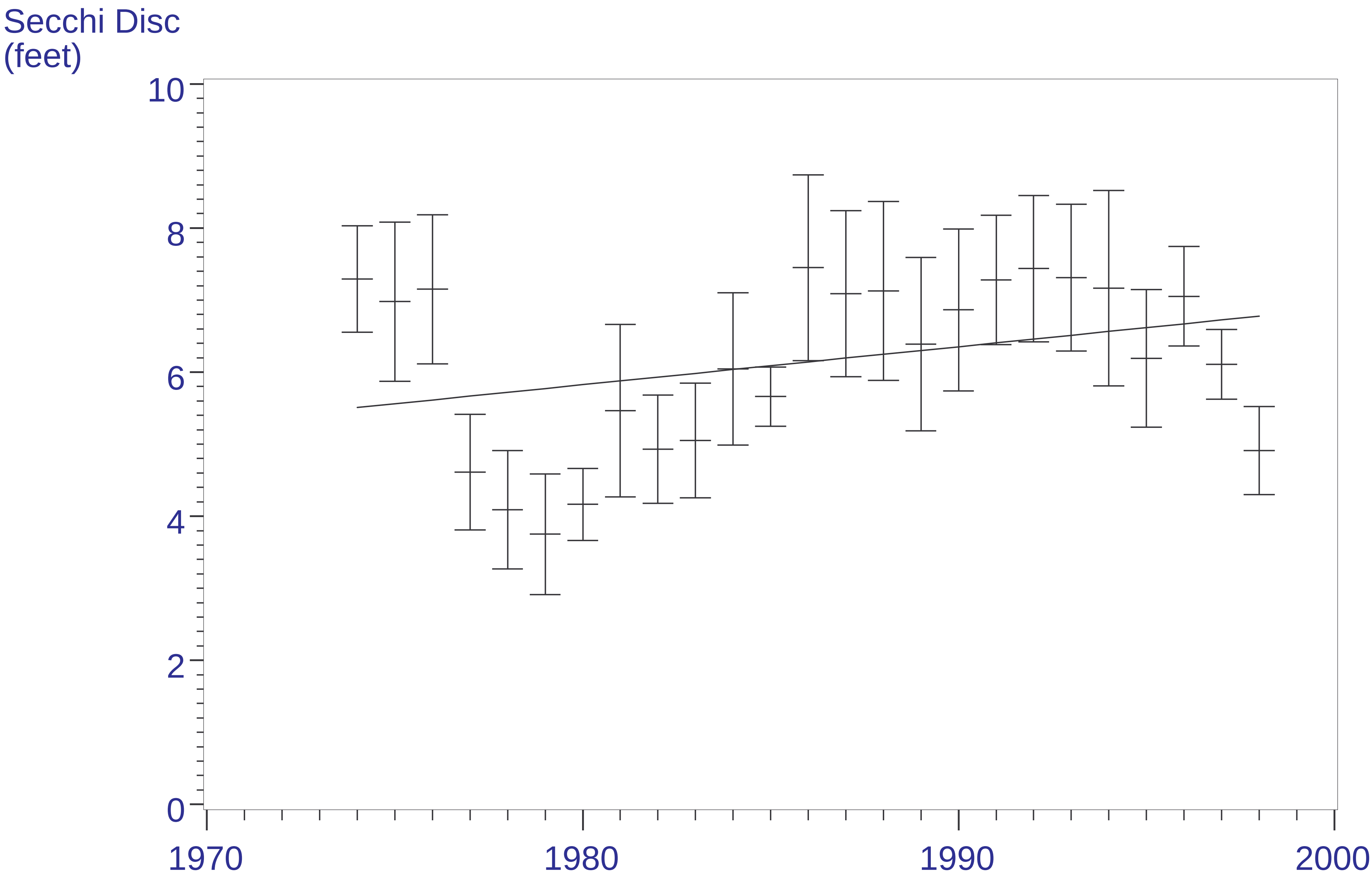
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay Bottom Dissolved Oxygen (mg/L) Data Source: EPCHC	
# of Years of Sampling	24
Number of Samples	280
Mean Annual Slope Estimate	-0.026
Lower 95% Confidence Limit	-0.046
Upper 95% Confidence Limit	-0.006
p Value Slope Statistic	0.0125
Percent Change per Year	-0.004

MIDDLE TAMPA BAY
Assessment of Historical Trends
Mean Annual Bottom Dissolved Oxyen Concentrations
Data Source: EPCHC

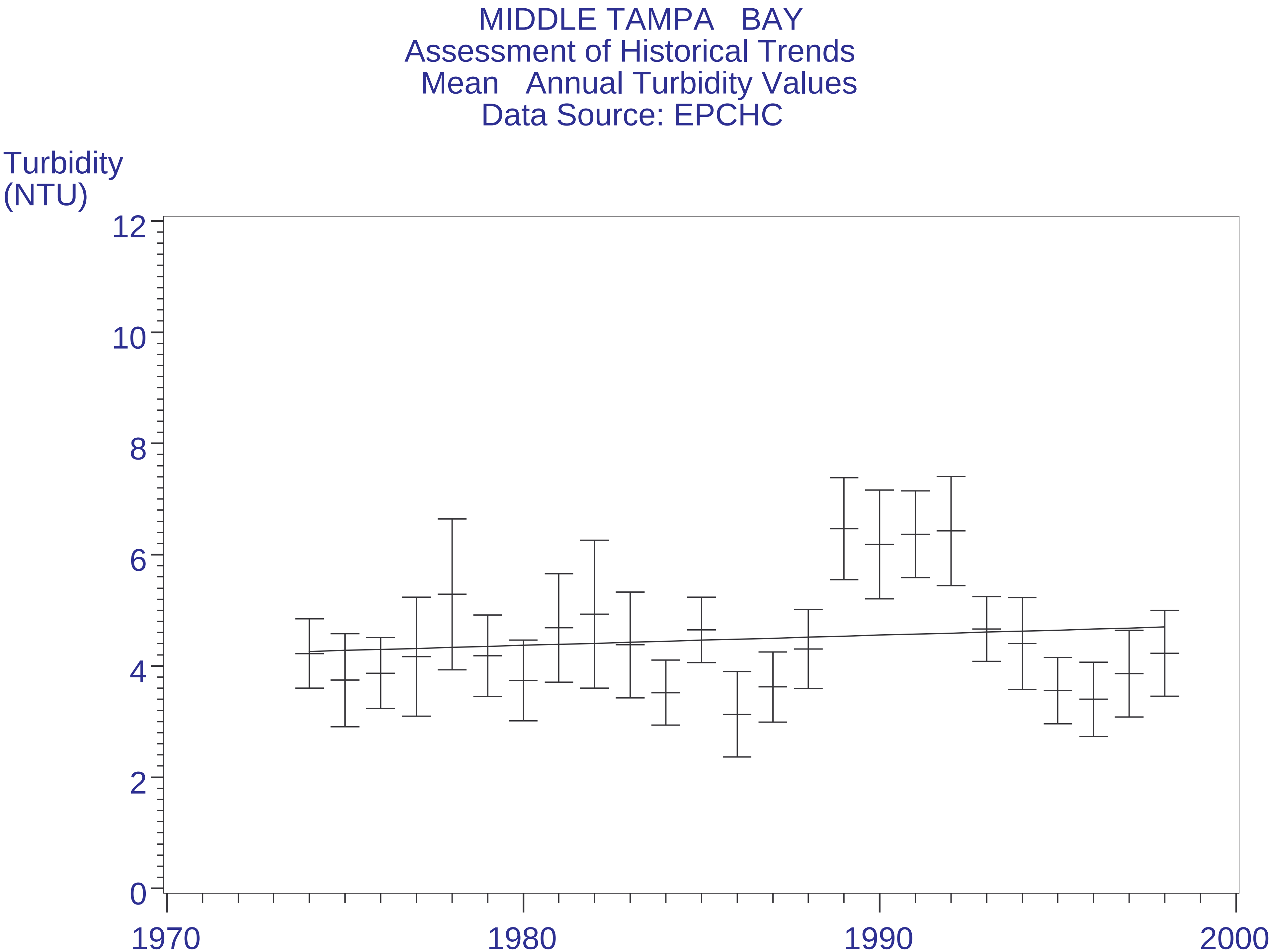


TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay Secchi Disc Depth (feet) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	297
Mean Annual Slope Estimate	0.053
Lower 95% Confidence Limit	0.029
Upper 95% Confidence Limit	0.077
p Value Slope Statistic	0.0000
Percent Change per Year	0.009

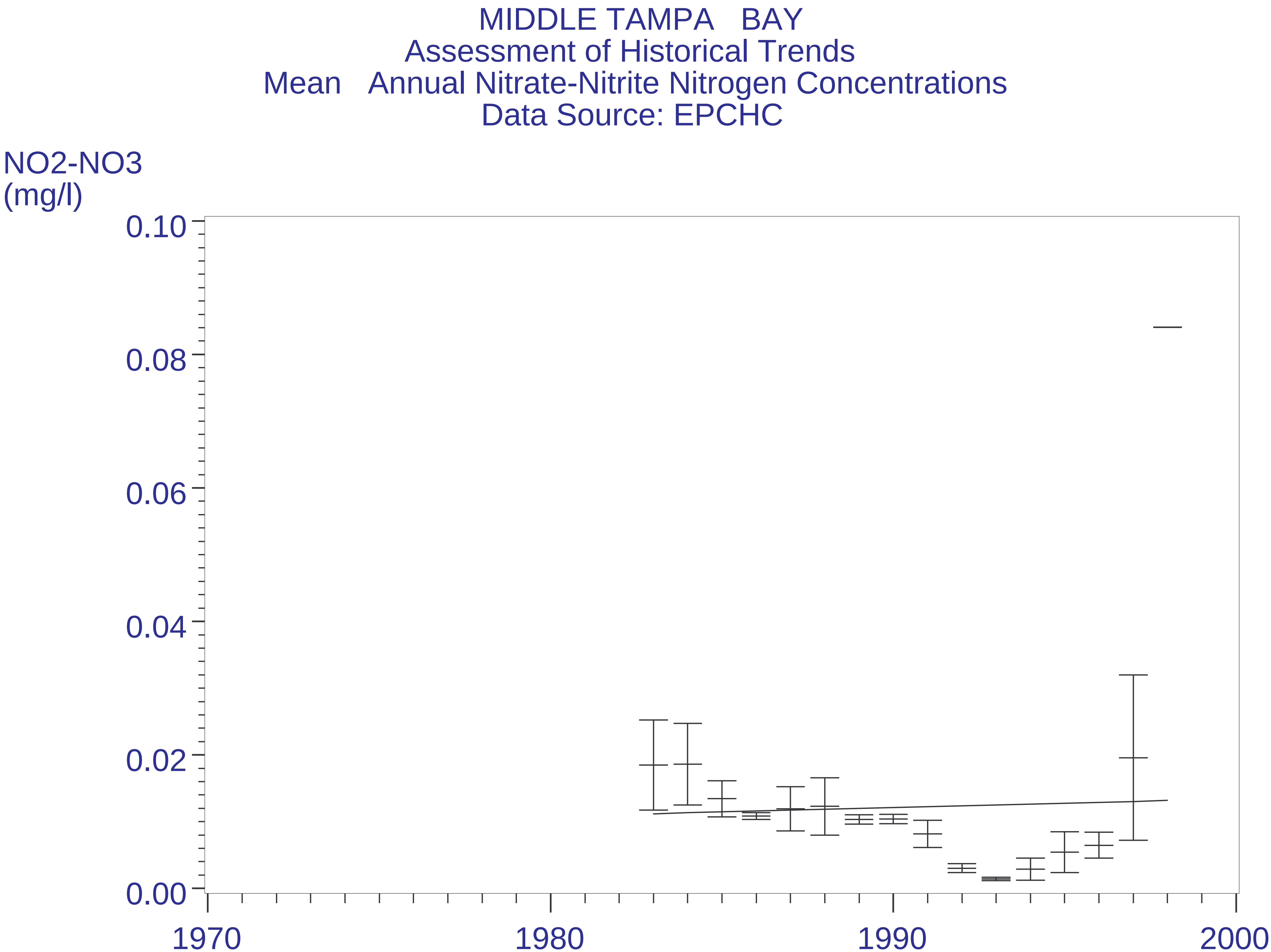
MIDDLE TAMPA BAY
Assessment of Historical Trends
Mean Annual Secchi Disc Depth
Data Source: EPCHC



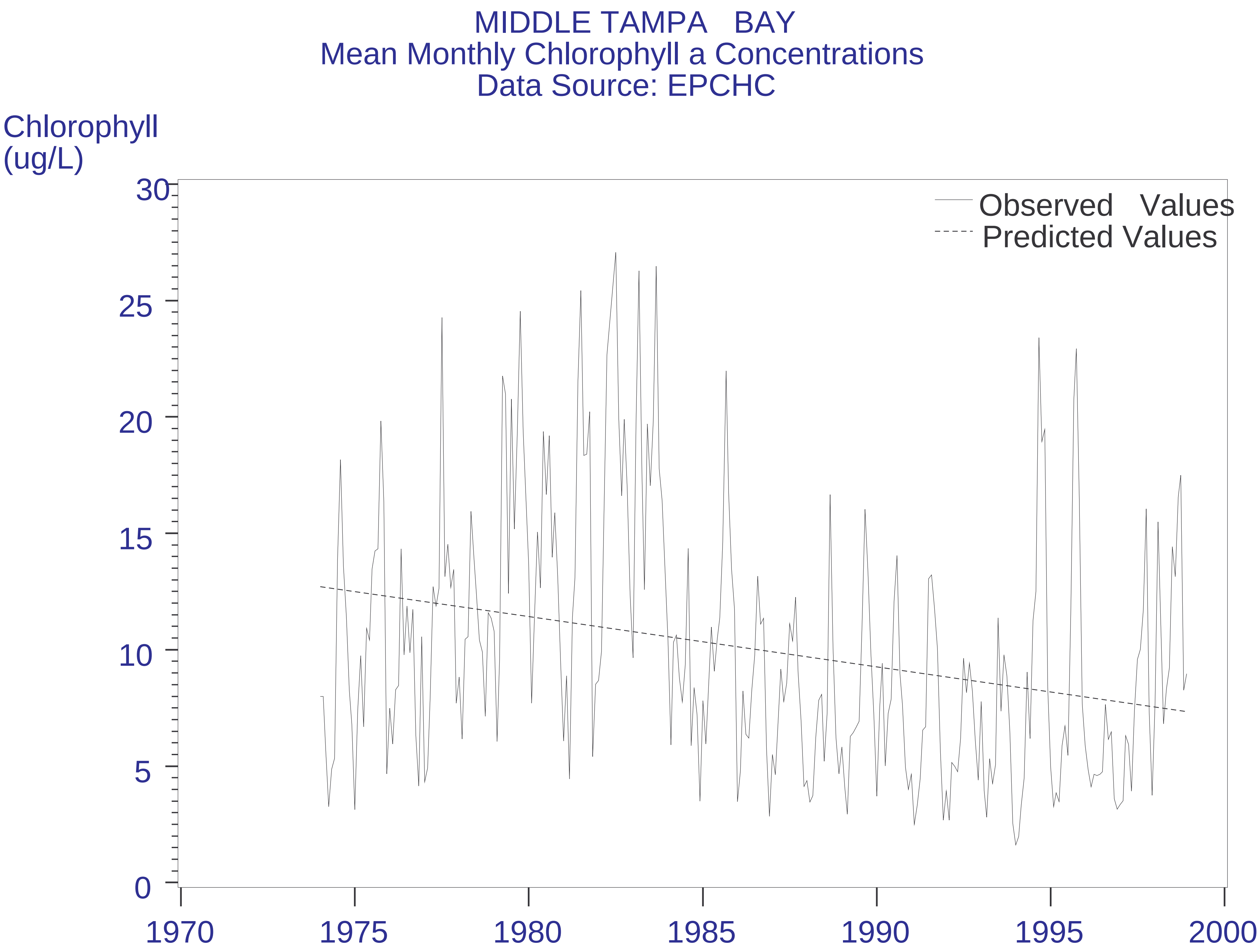
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay Turbidity (NTU) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	297
Mean Annual Slope Estimate	0.018
Lower 95% Confidence Limit	-0.004
Upper 95% Confidence Limit	0.040
p Value Slope Statistic	0.1059
Percent Change per Year	0.004

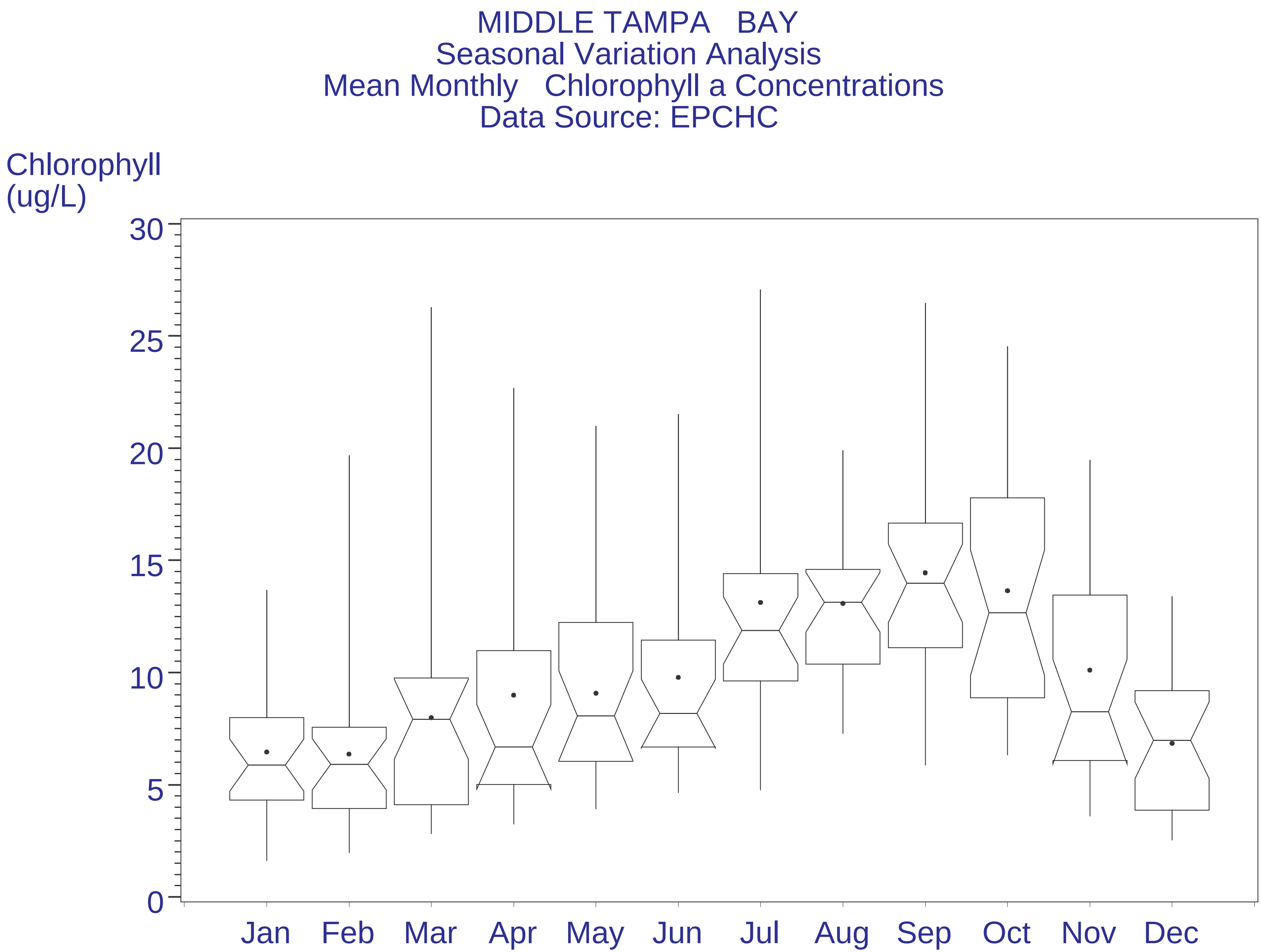

MIDDLE TAMPA BAY
Assessment of Historical Trends
Mean Annual Turbidity Values
Data Source: EPCHC
Turbidity
(NTU)
12
10
8
6
4
2
0
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay Nitrate-Nitrite Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	16
Number of Samples	190
Mean Annual Slope Estimate	0.000
Lower 95% Confidence Limit	-0.001
Upper 95% Confidence Limit	0.001
p Value Slope Statistic	0.7898
Percent Change per Year	0.011


MIDDLE TAMPA BAY
Assessment of Historical Trends
Mean Annual Nitrate-Nitrite Nitrogen Concentrations
Data Source: EPCHC
NO2-NO3
(mg/l)
0.10
0.08
0.06
0.04
0.02
0.00
1970
1980
1990
2000

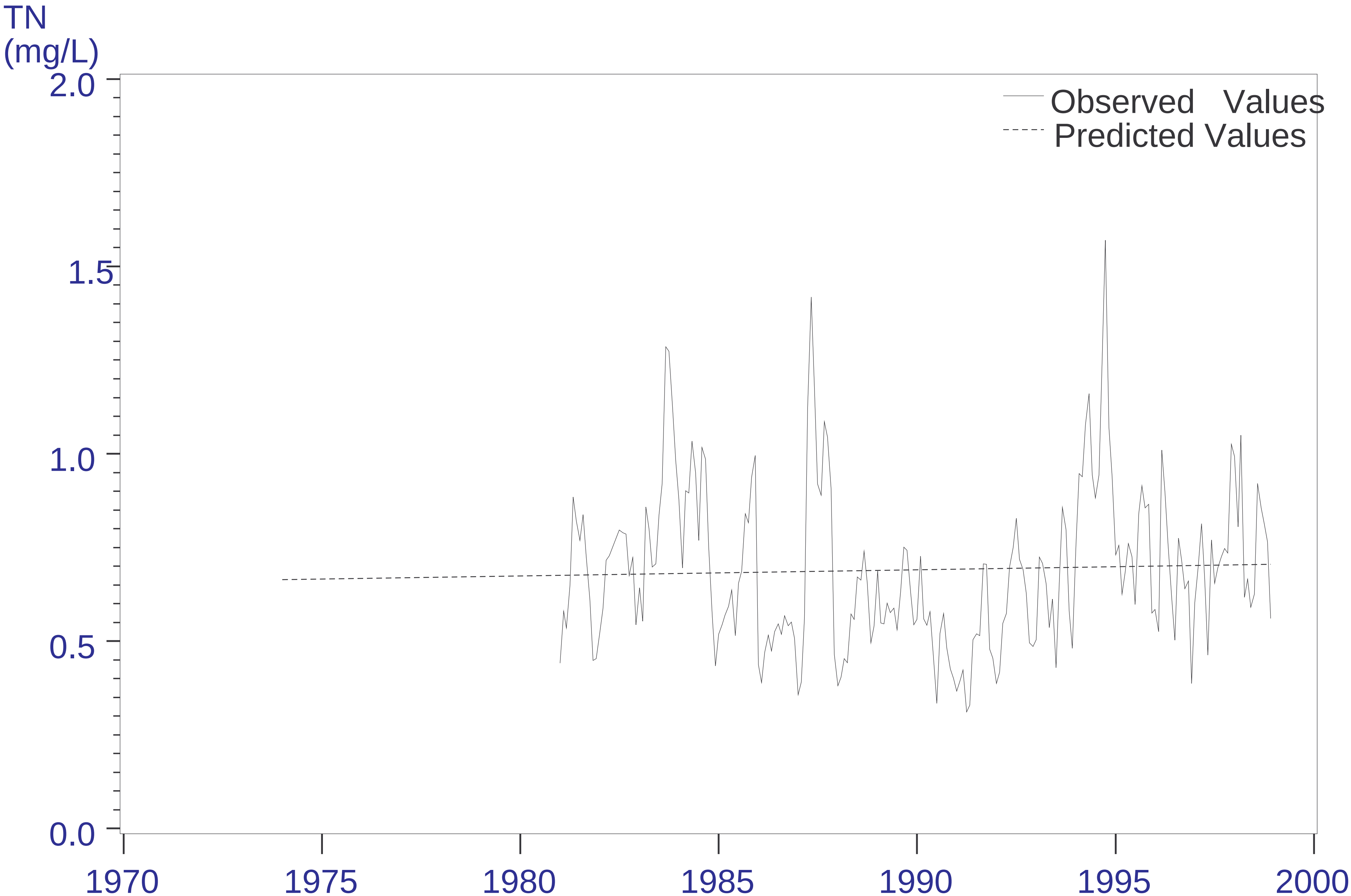
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay Chlorophyll a (ug/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	297
Tau Statistic	-0.288
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.005
p Value Slope Statistic	-0.2236

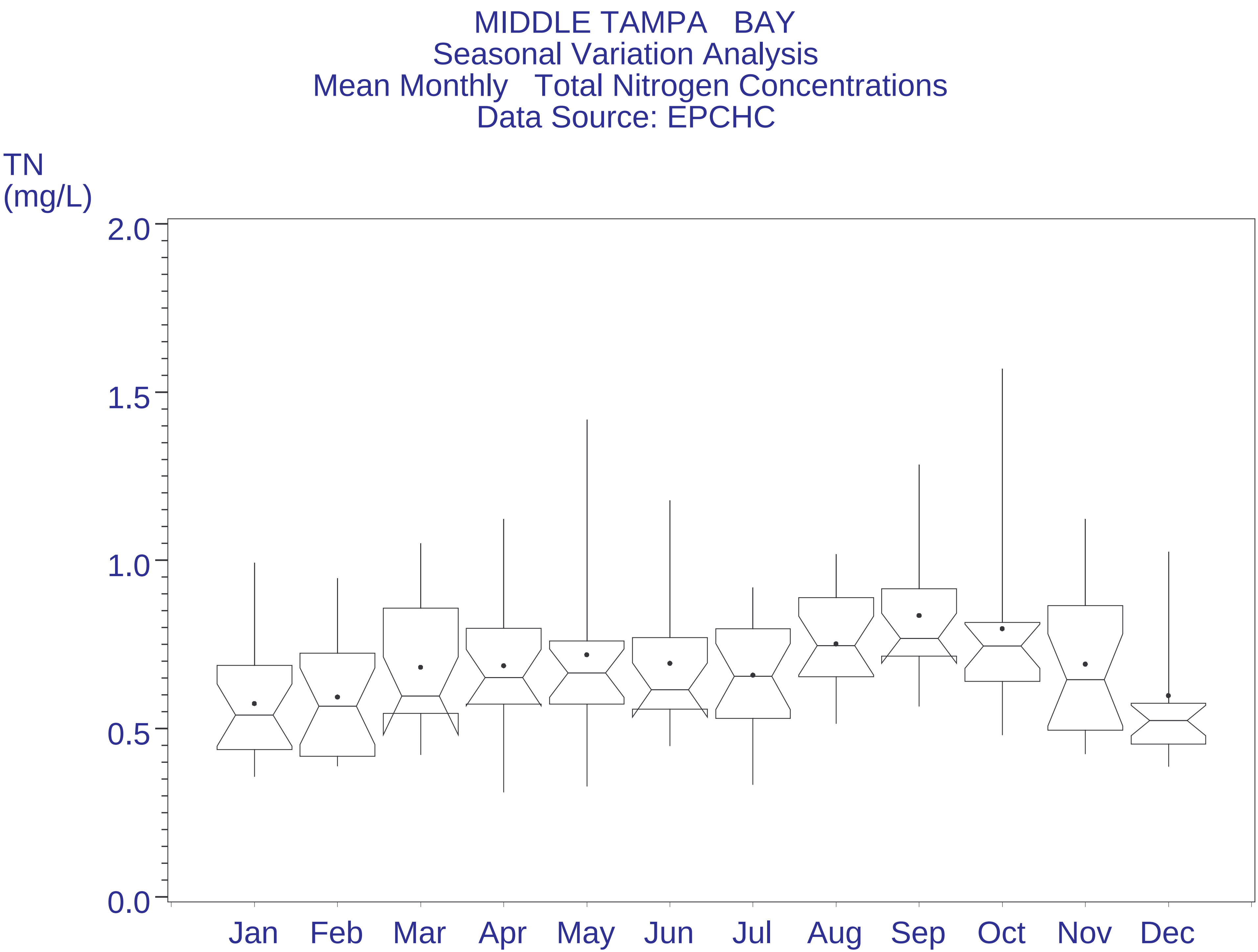

MIDDLE TAMPA BAY
Mean Monthly Chlorophyll a Concentrations
Data Source: EPCHC
Chlorophyll (ug/L)
0
5
10
15
20
25
30
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


MIDDLE TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Chlorophyll a Concentrations
Data Source: EPCHC
Chlorophyll
(ug/L)
30
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay Total Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	18
Number of Samples	214
Tau Statistic	0.052
P-value without Serial Correlation	0.308
P-value with Serial Correlation	0.681
p Value Slope Statistic	0.0025

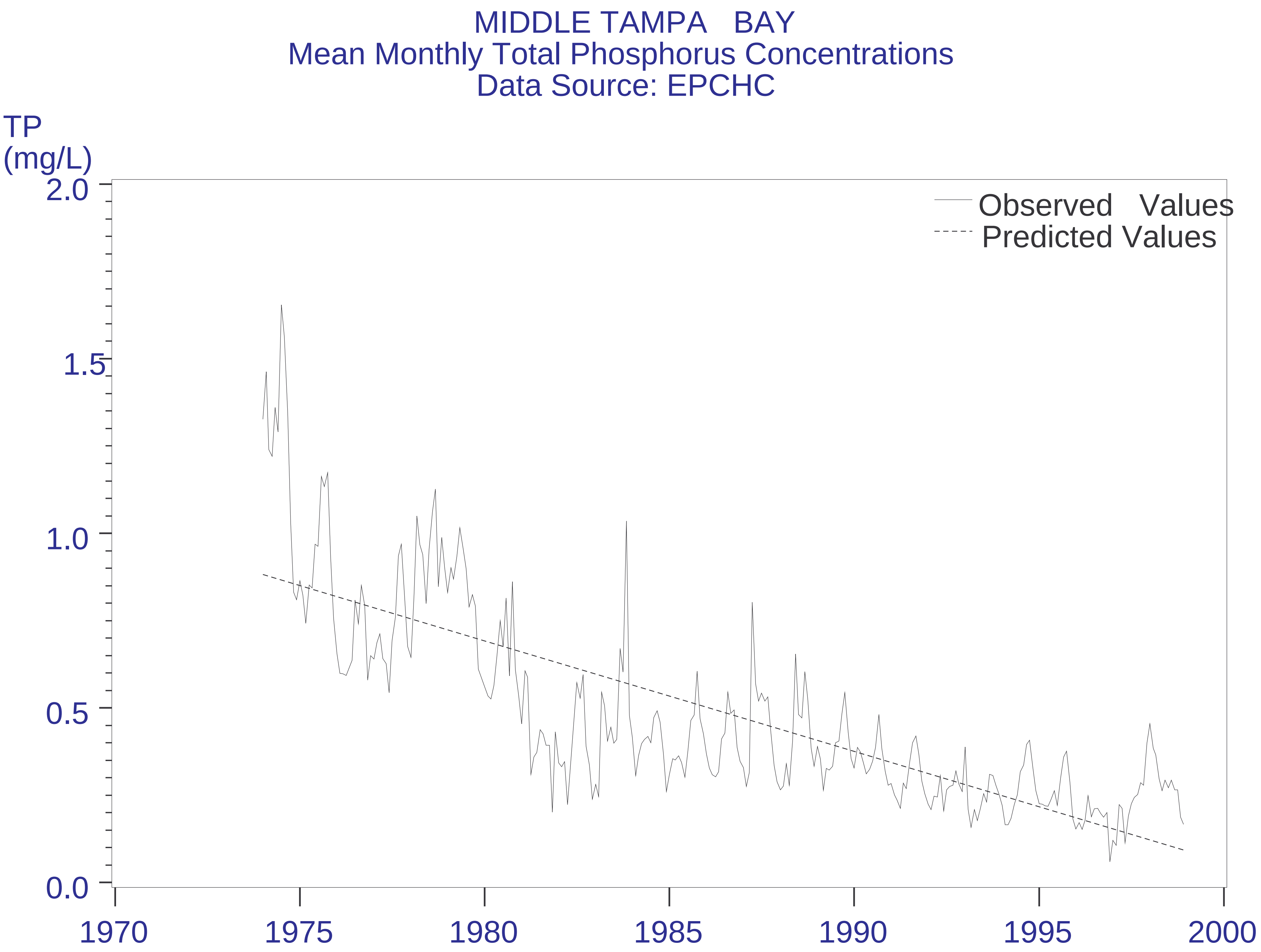
MIDDLE TAMPA BAY
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC

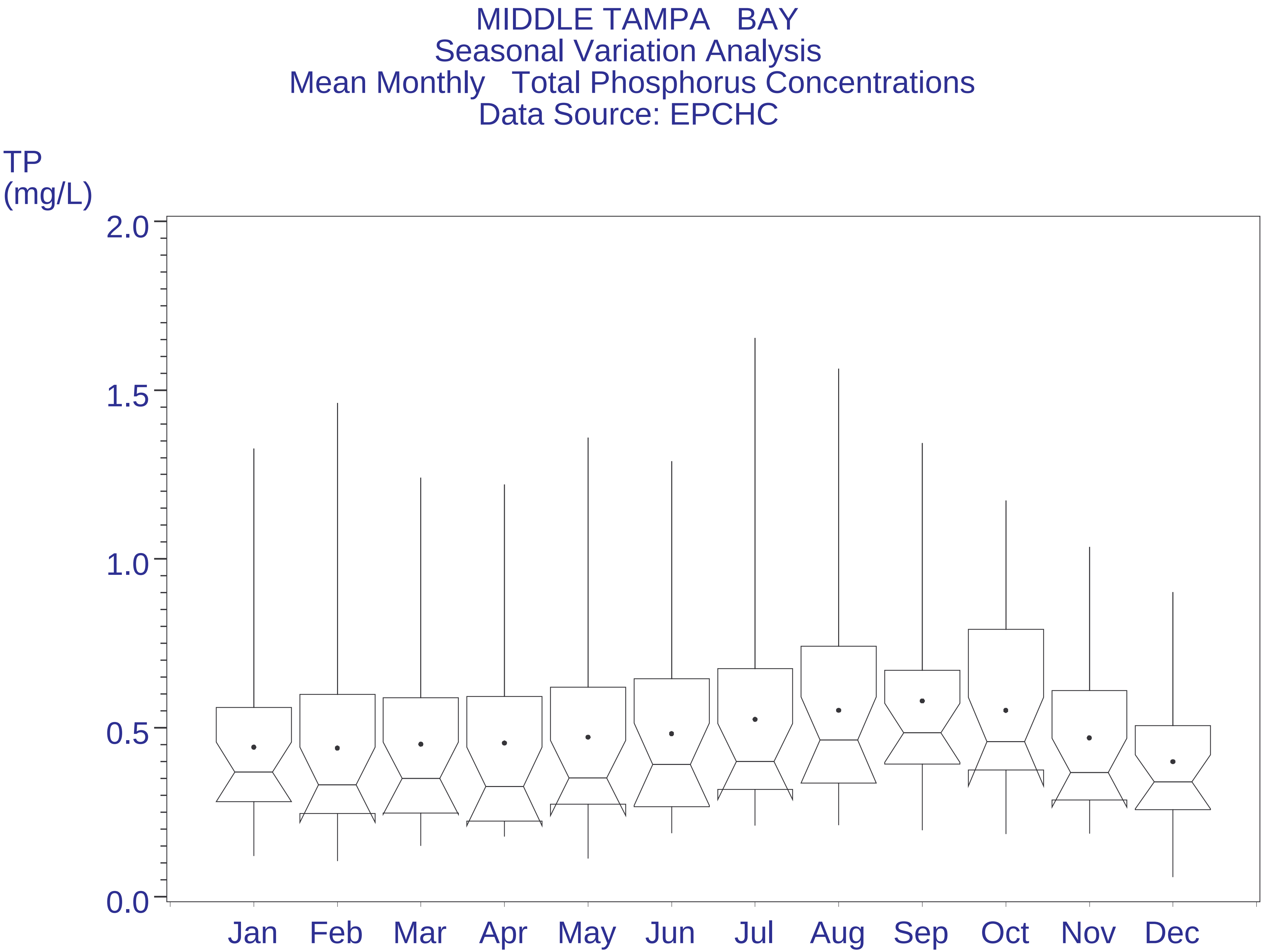




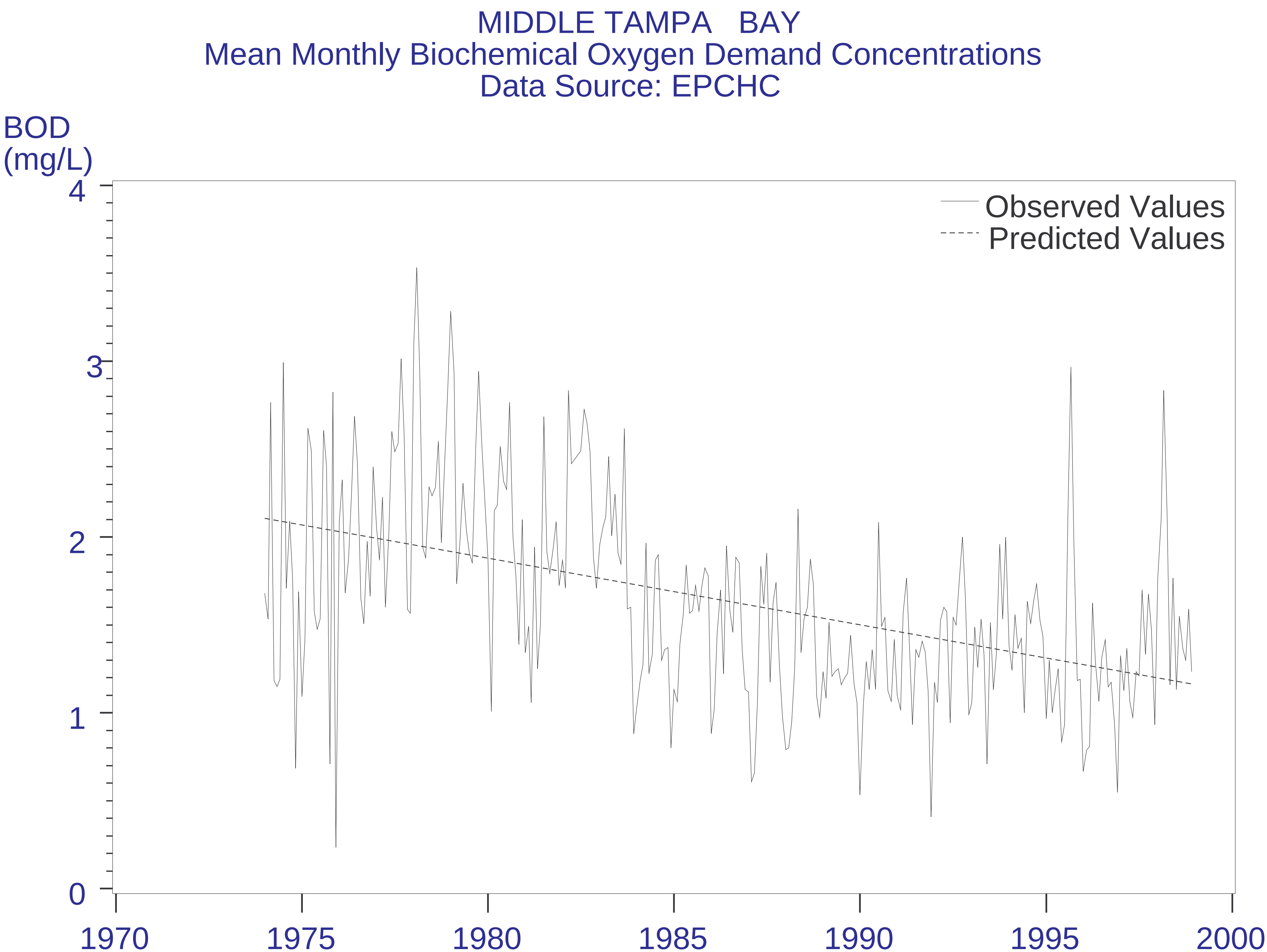
MIDDLE TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

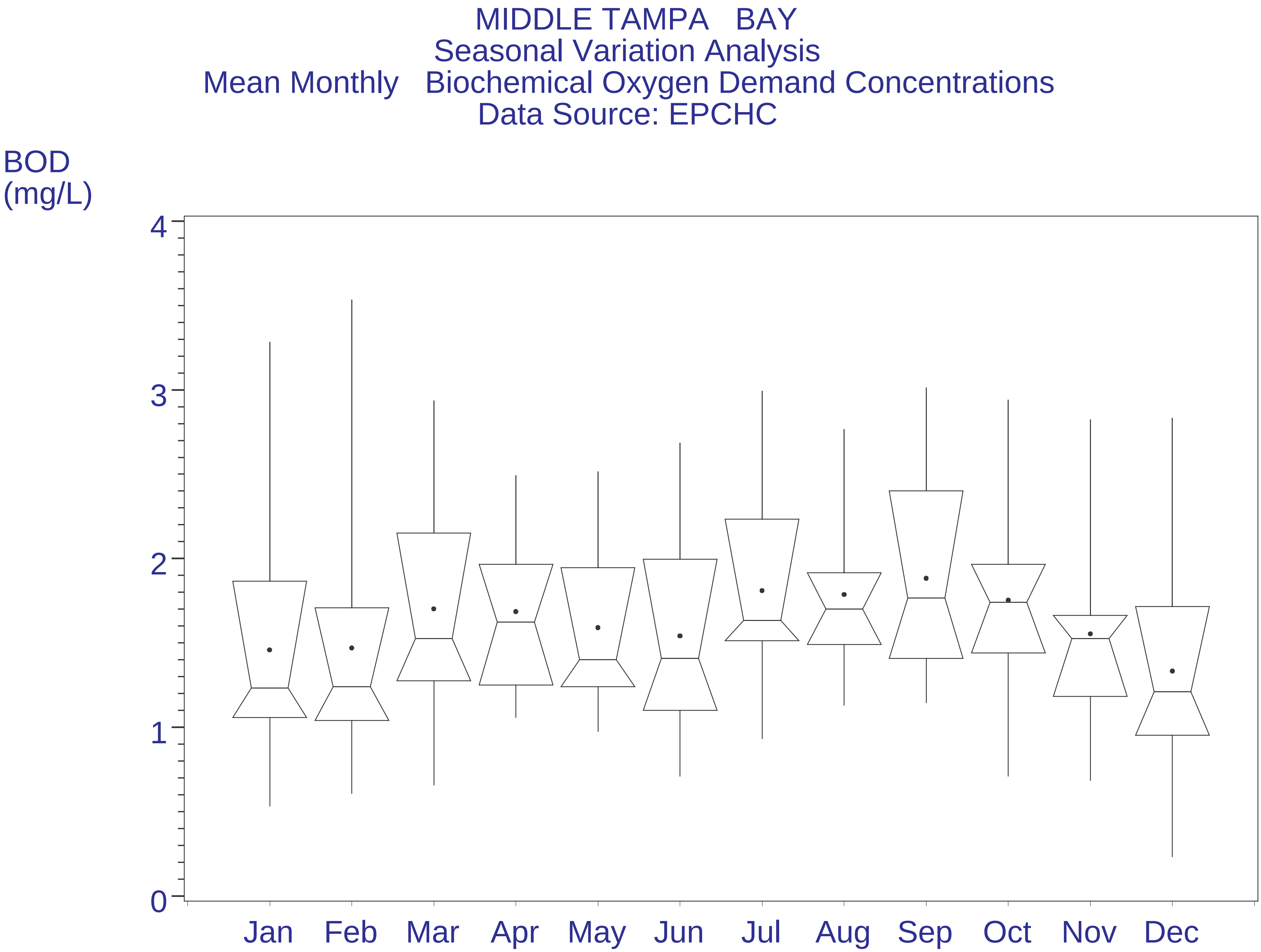
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay Total Phosphorus (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	297
Tau Statistic	-0.706
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.000
p Value Slope Statistic	-0.0266


MIDDLE TAMPA BAY
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
2.0
1.5
1.0
0.5
0.0
Observed Values
Predicted Values
1970
1975
1980
1985
1990
1995
2000

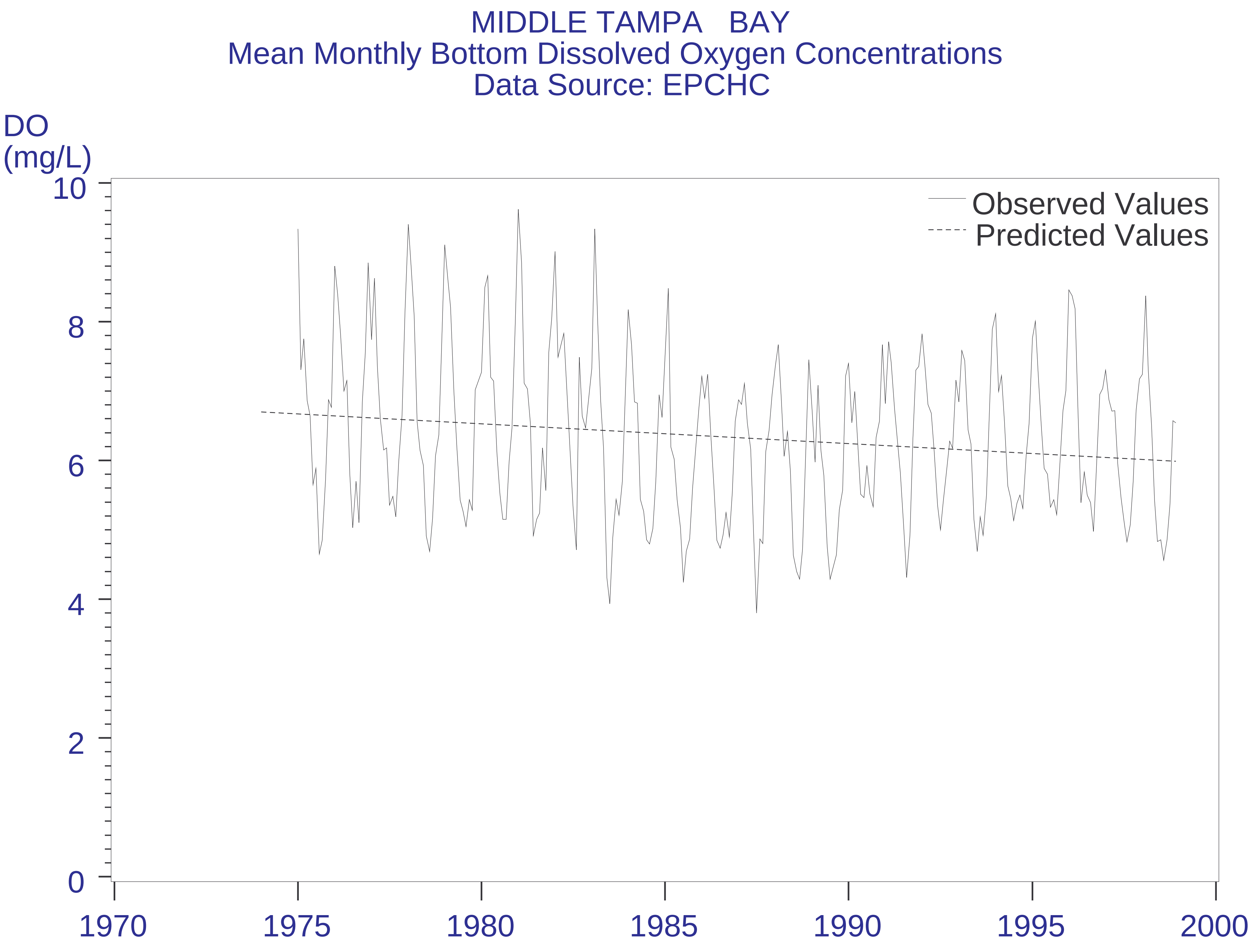

MIDDLE TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay BOD (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	297
Tau Statistic	-0.360
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.000
p Value Slope Statistic	-0.0385

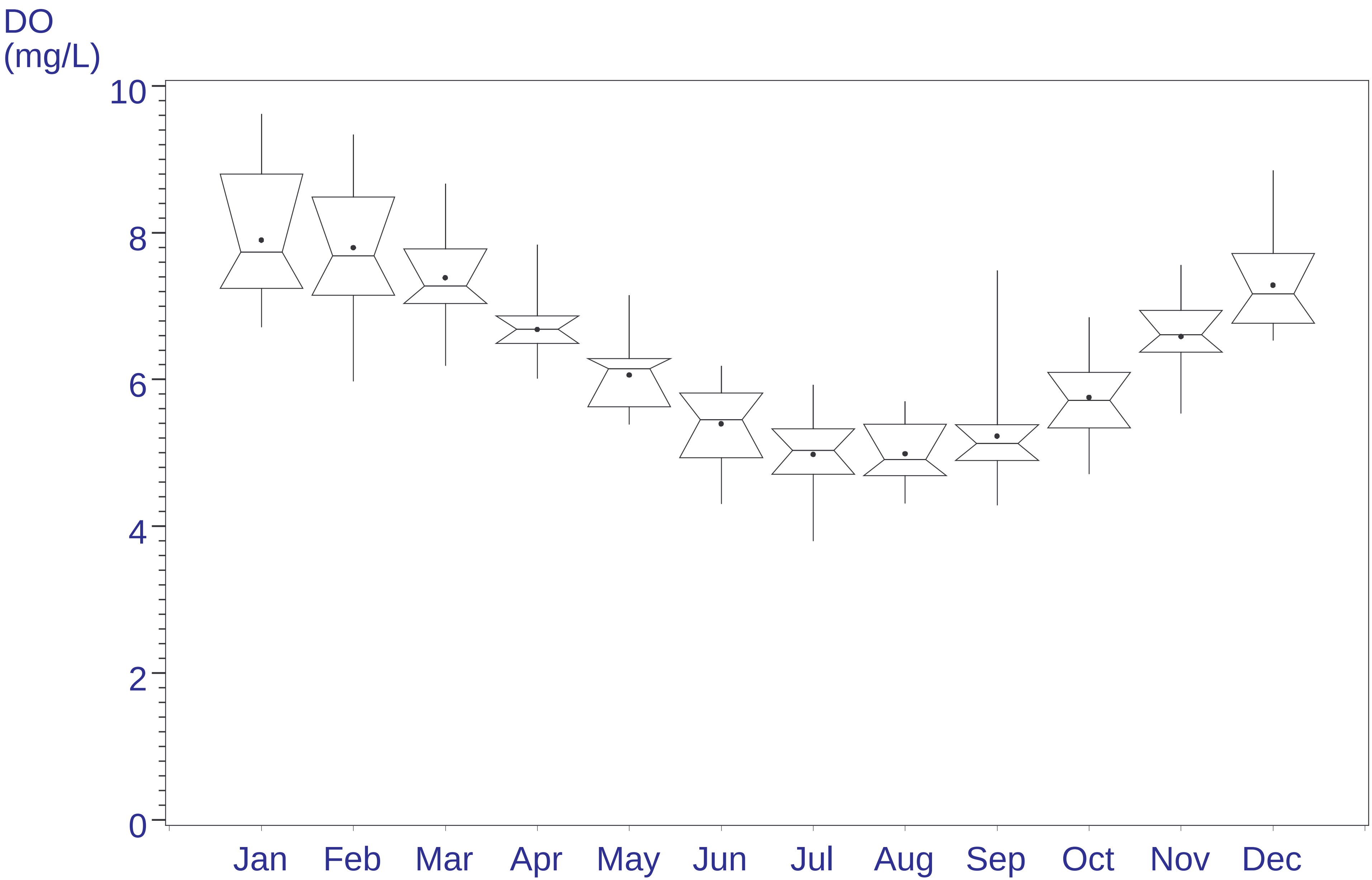

MIDDLE TAMPA BAY
Mean Monthly Biochemical Oxygen Demand Concentrations
Data Source: EPCHC
BOD (mg/L)
0
1
2
3
4
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


MIDDLE TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Biochemical Oxygen Demand Concentrations
Data Source: EPCHC
BOD
(mg/L)
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

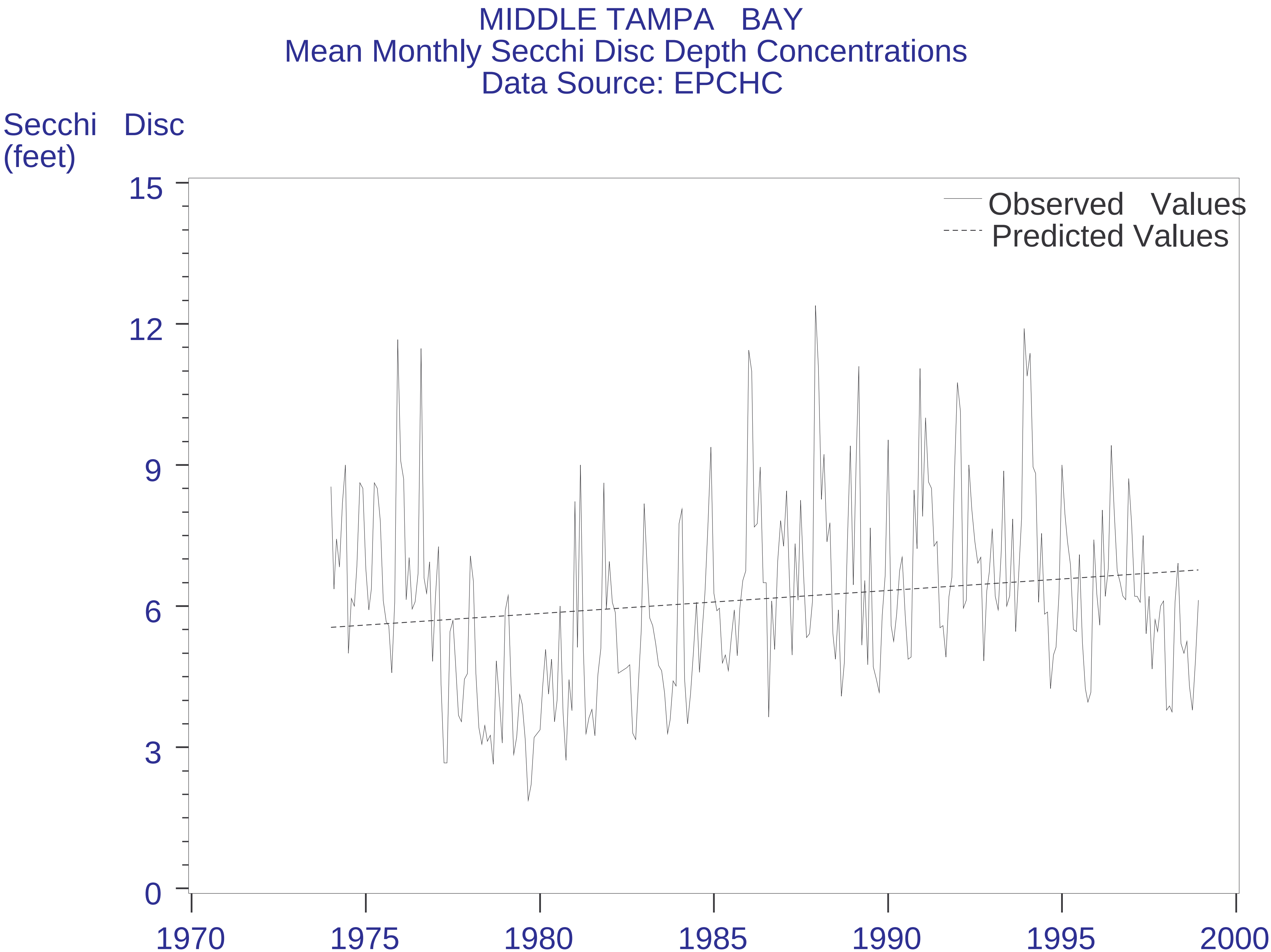
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay Bottom Dissolved Oxygen (mg/L) Data Source: EPCHC	
# of Years of Sampling	24
Number of Samples	280
Tau Statistic	-0.191
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.028
p Value Slope Statistic	-0.0200


MIDDLE TAMPA BAY
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: EPCHC
DO (mg/L)
Observed Values
Predicted Values
0
2
4
6
8
10
1970
1975
1980
1985
1990
1995
2000

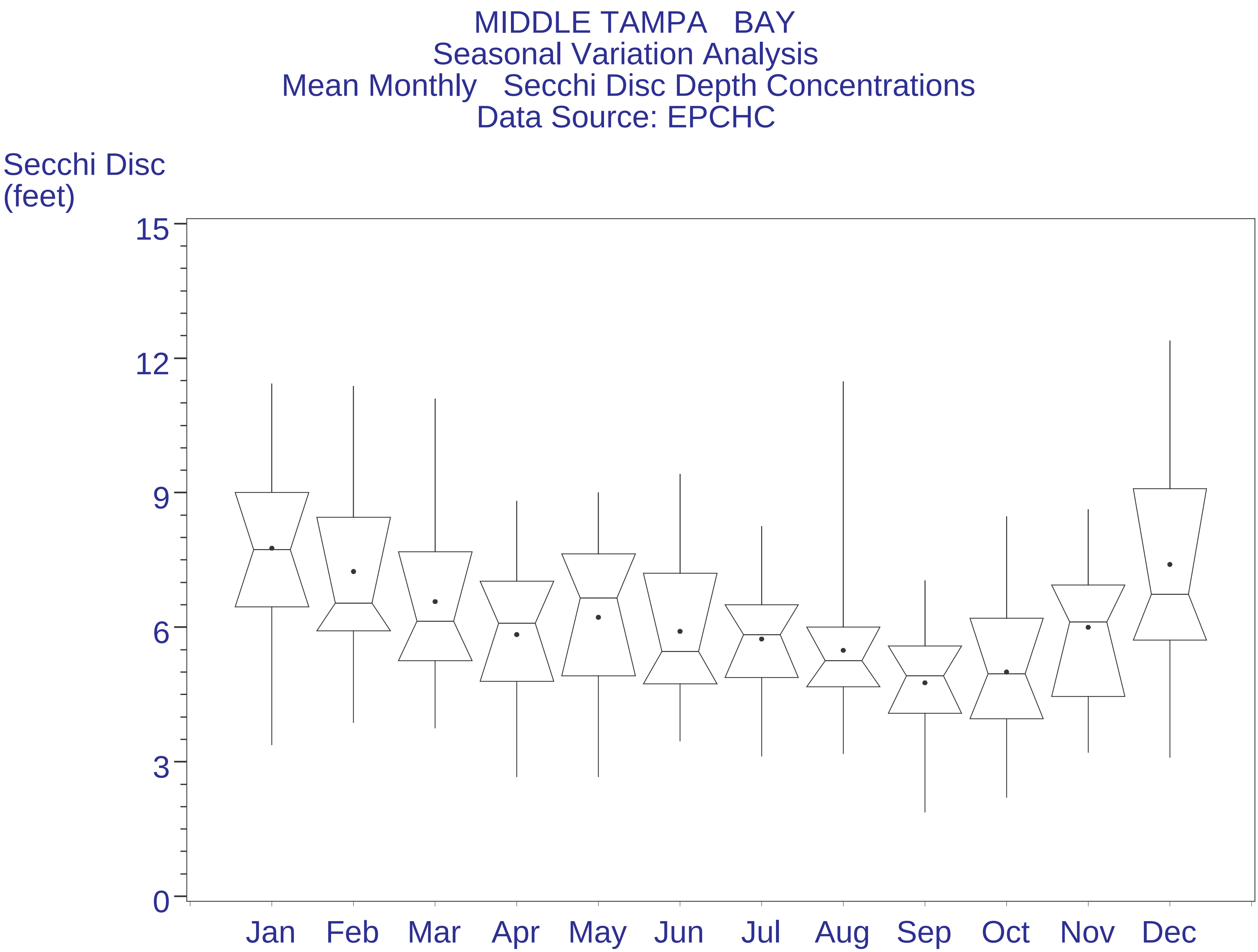
MIDDLE TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: EPCHC



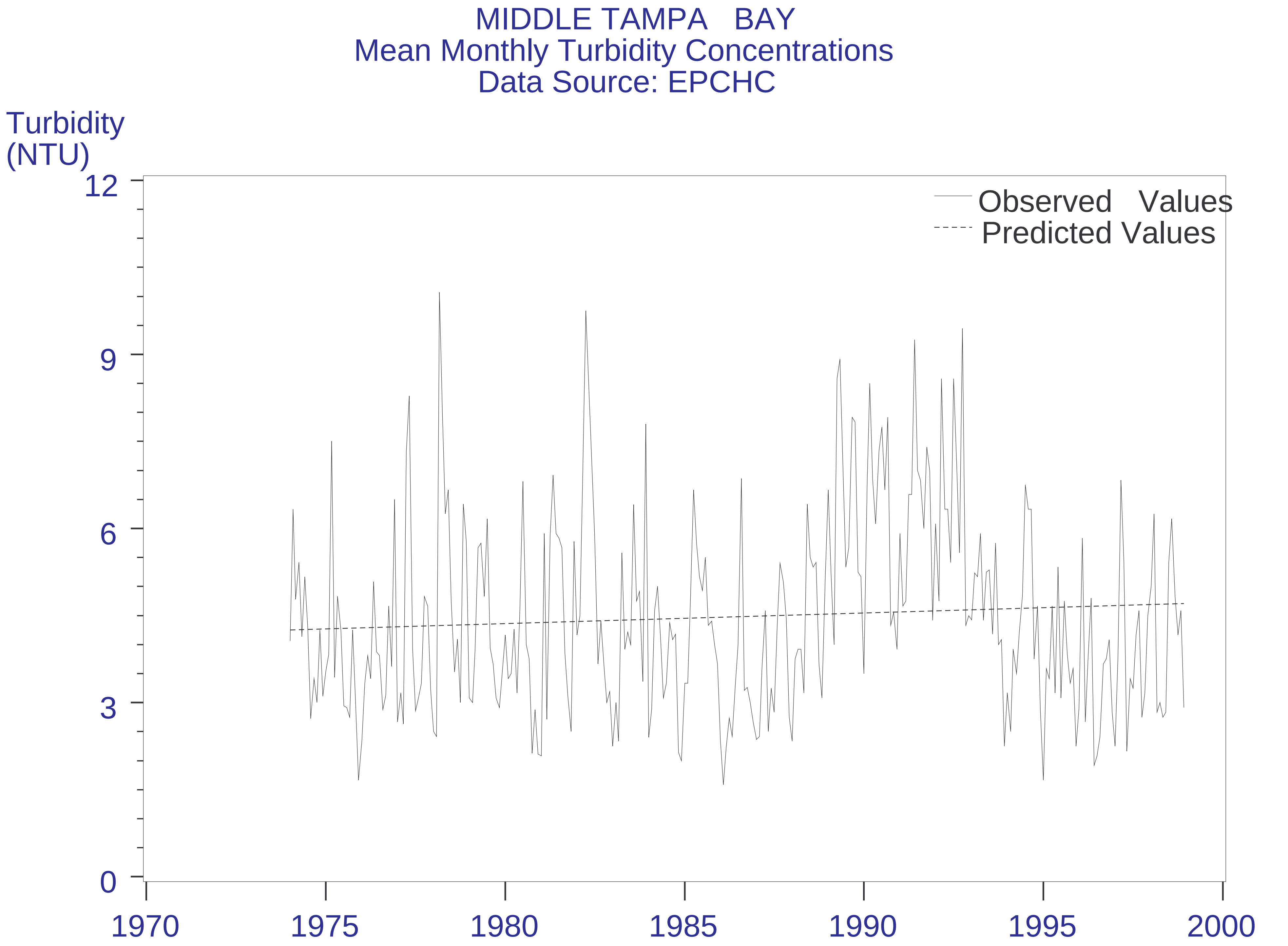
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay Secchi Disc Depth (feet) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	297
Tau Statistic	0.156
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.109
p Value Slope Statistic	0.0606

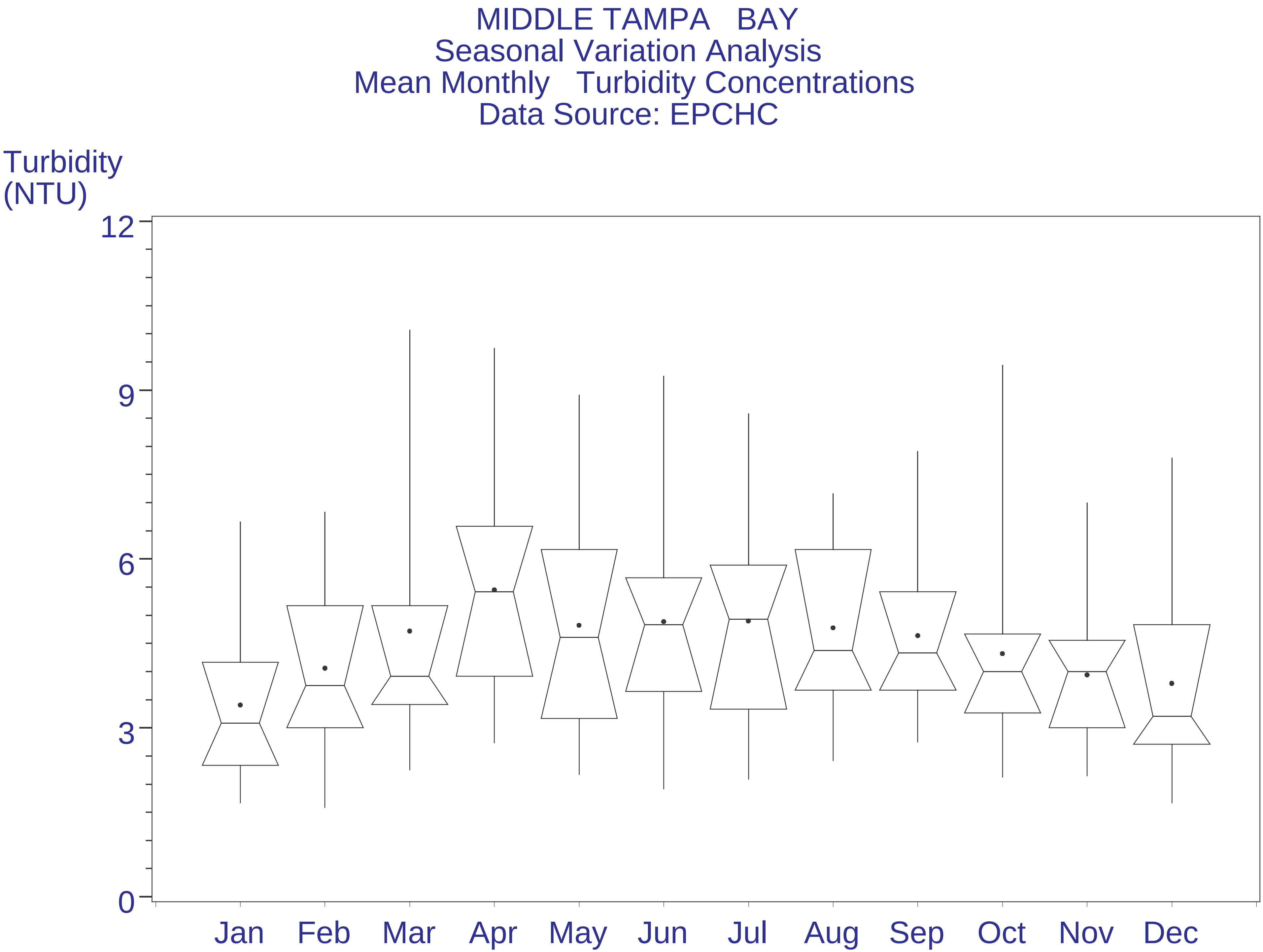


MIDDLE TAMPA BAY
Mean Monthly Secchi Disc Depth Concentrations
Data Source: EPCHC
Secchi Disc
(feet)
15
12
9
6
3
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


MIDDLE TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Secchi Disc Depth Concentrations
Data Source: EPCHC
Secchi Disc
(feet)
15
12
9
6
3
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

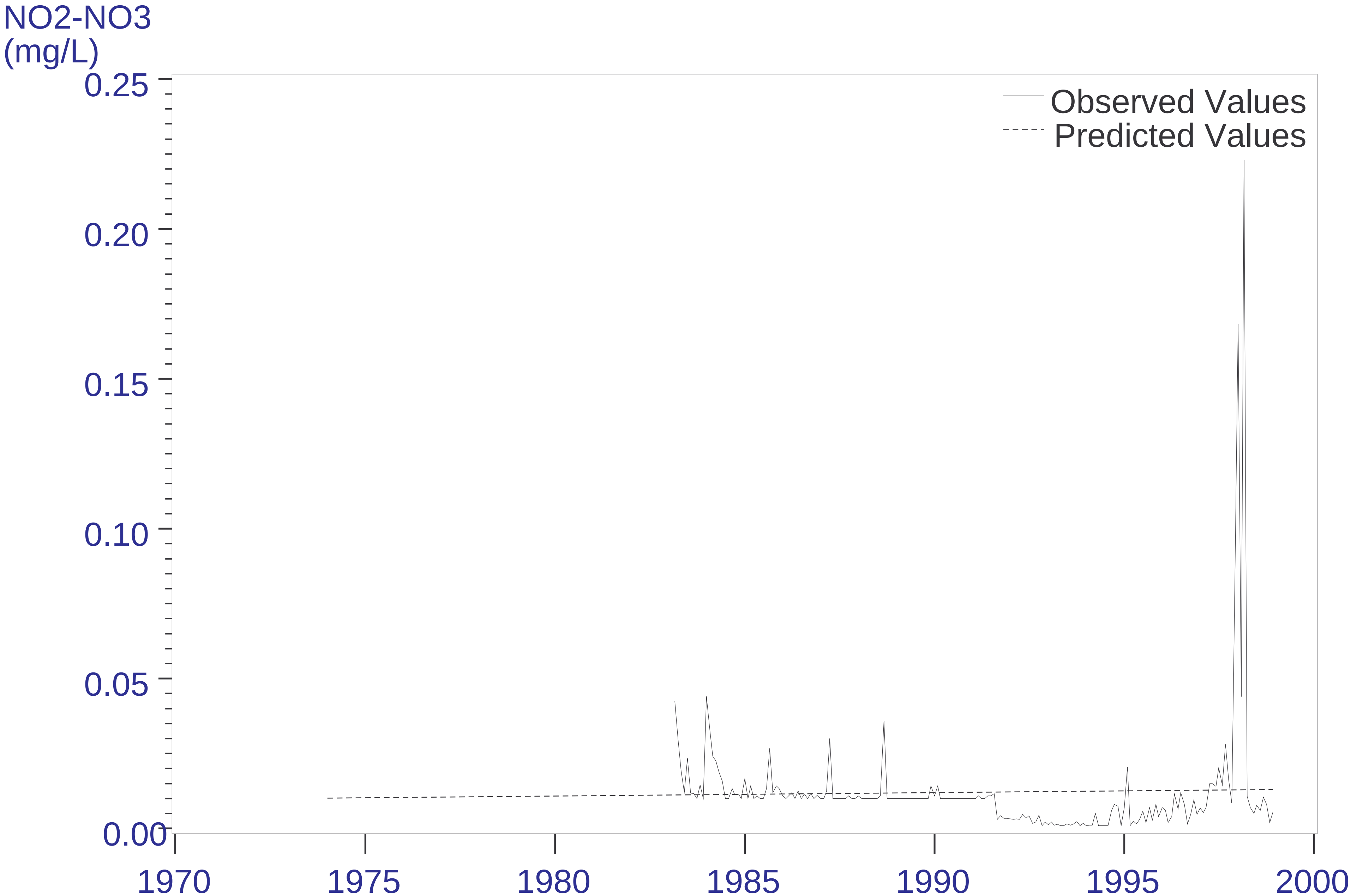
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay Turbidity (NTU) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	297
Tau Statistic	0.096
P-value without Serial Correlation	0.021
P-value with Serial Correlation	0.260
p Value Slope Statistic	0.0276

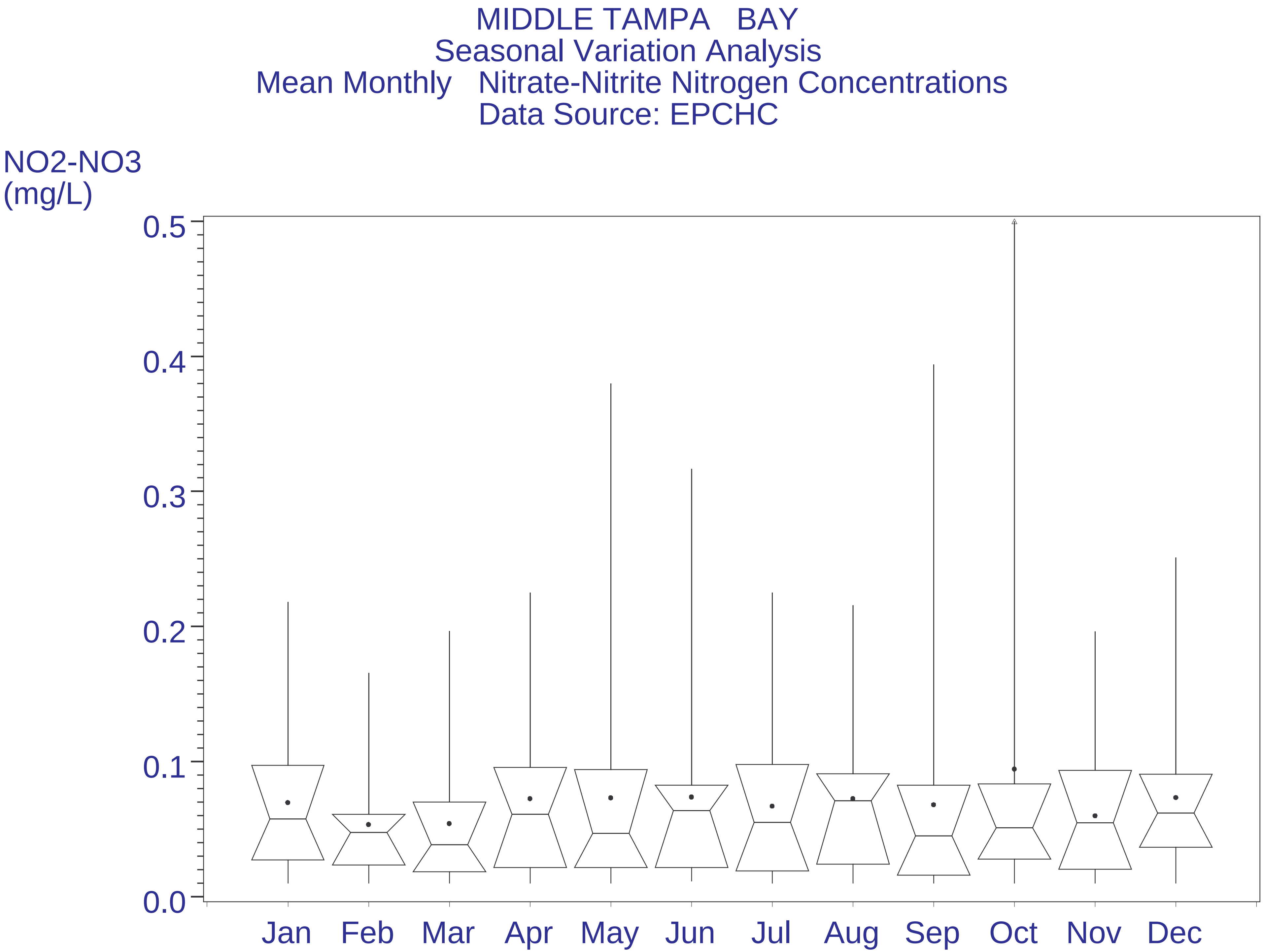

MIDDLE TAMPA BAY
Mean Monthly Turbidity Concentrations
Data Source: EPCHC
Turbidity
(NTU)
12
9
6
3
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


MIDDLE TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Turbidity Concentrations
Data Source: EPCHC
Turbidity
(NTU)
12
9
6
3
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay Nitrate-Nitrite Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	16
Number of Samples	190
Tau Statistic	-0.352
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.015
p Value Slope Statistic	-0.0005

MIDDLE TAMPA BAY
Mean Monthly Nitrite-Nitrate Nitrogen Concentrations
Data Source: EPCHC




MIDDLE TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Nitrate-Nitrite Nitrogen Concentrations
Data Source: EPCHC
NO2-NO3
(mg/L)
0.5
0.4
0.3
0.2
0.1
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

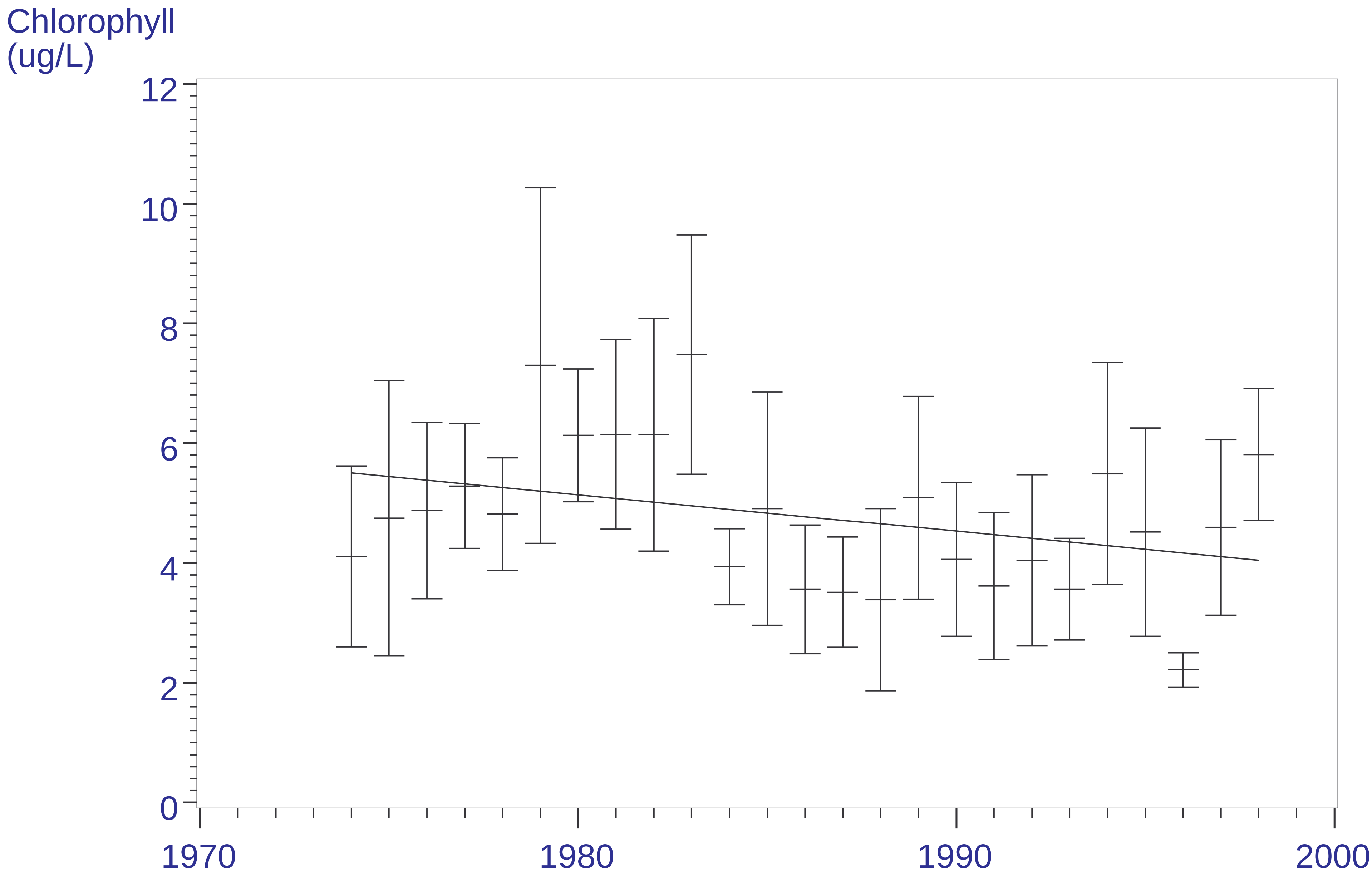
LOWER TAMPA BAY

APPENDIX A

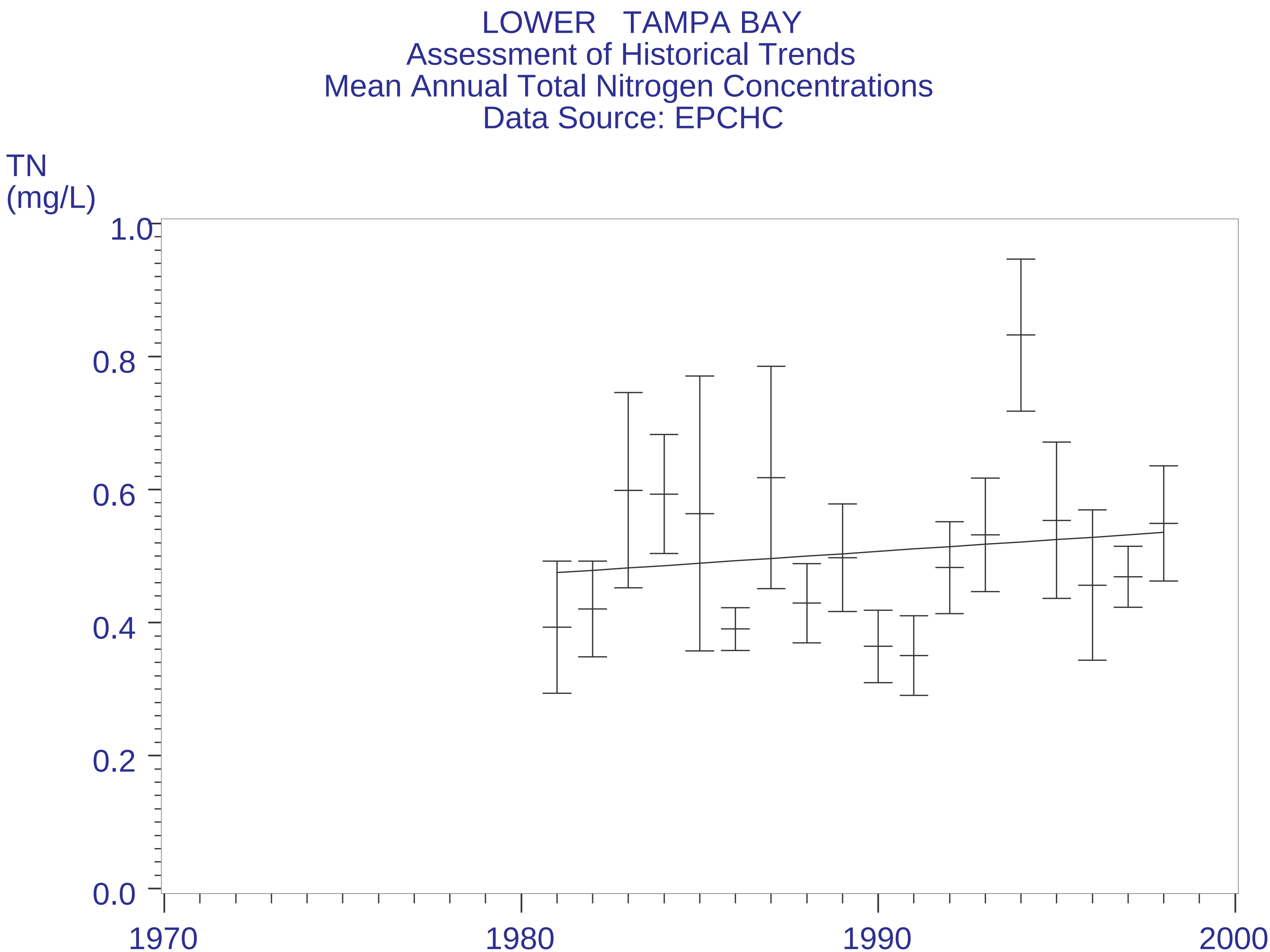
DETAILS OF PARAMETRIC AND NONPARAMETRIC METHODS FOR TREND DETECTION

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Lower Tampa Bay Chlorophyll a (ug/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	289
Mean Annual Slope Estimate	-0.061
Lower 95% Confidence Limit	-0.102
Upper 95% Confidence Limit	-0.019
p Value Slope Statistic	0.0046
Percent Change per Year	-0.013

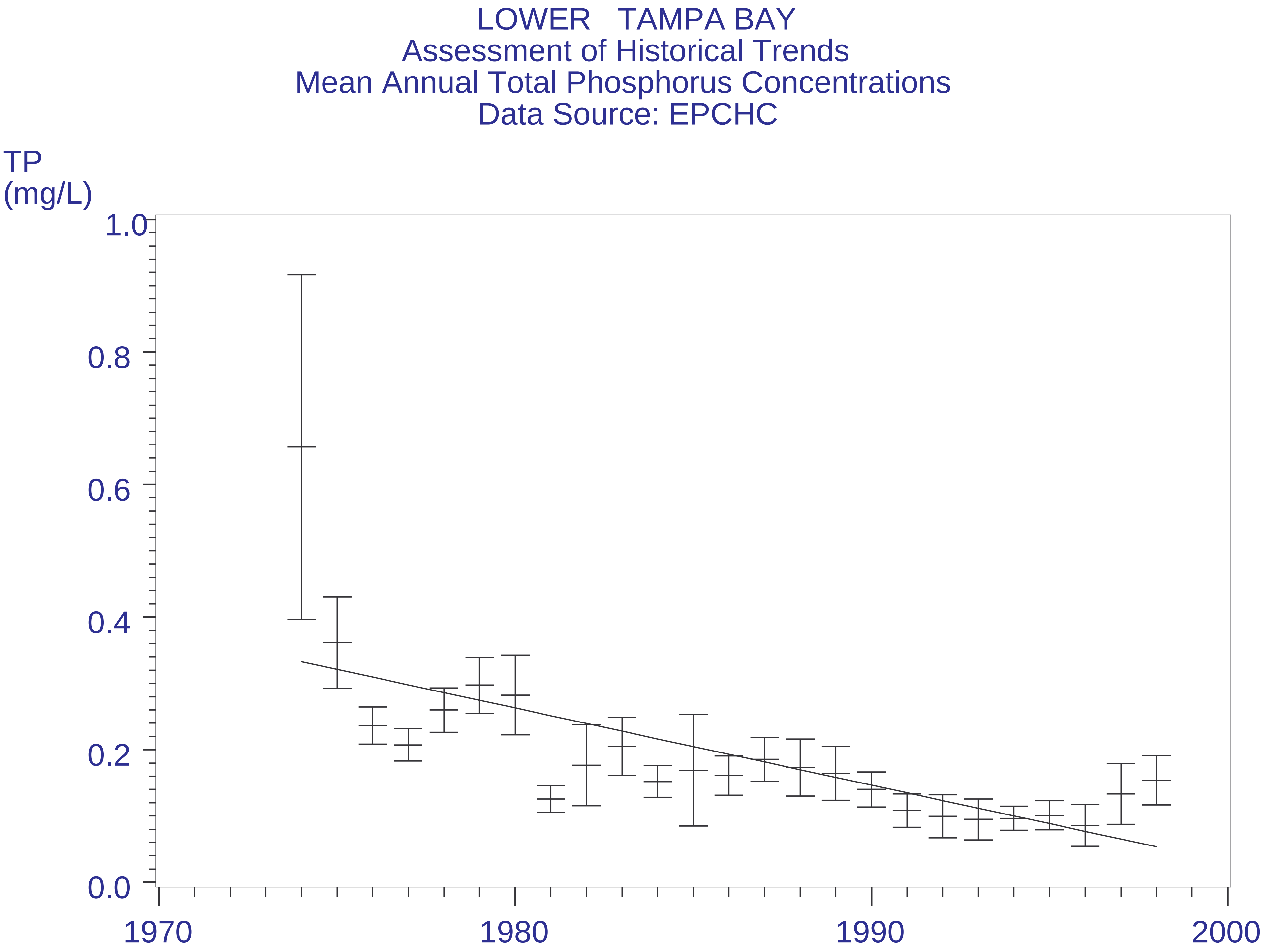
LOWER TAMPA BAY
Assessment of Historical Trends
Mean Annual Chlorophyll a Concentrations
Data Source: EPCHC



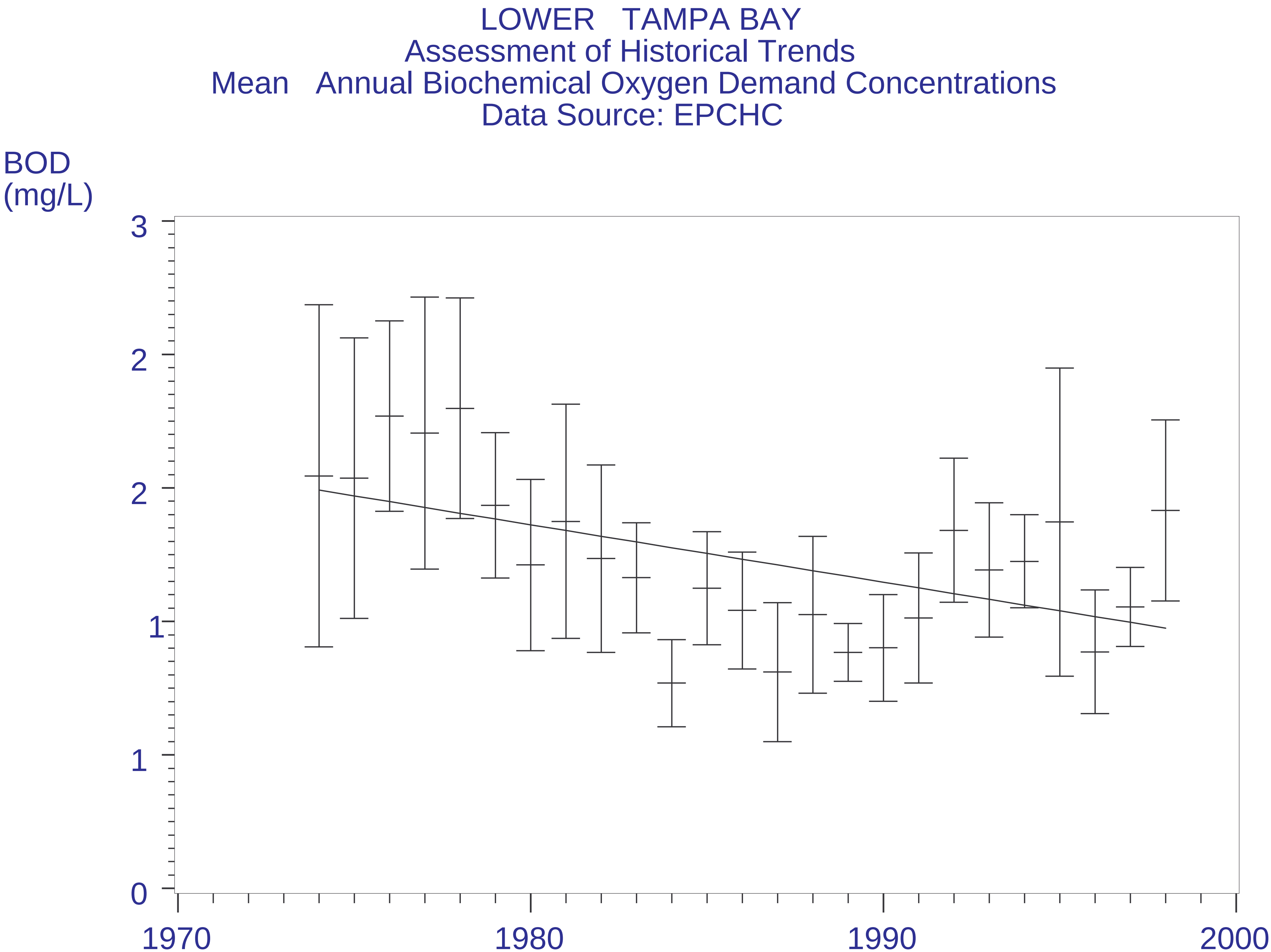
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Lower Tampa Bay Total Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	18
Number of Samples	172
Mean Annual Slope Estimate	0.004
Lower 95% Confidence Limit	-0.001
Upper 95% Confidence Limit	0.008
p Value Slope Statistic	0.1316
Percent Change per Year	0.007


LOWER TAMPA BAY
Assessment of Historical Trends
Mean Annual Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Lower Tampa Bay Total Phosphorus (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	283
Mean Annual Slope Estimate	-0.012
Lower 95% Confidence Limit	-0.014
Upper 95% Confidence Limit	-0.009
p Value Slope Statistic	0.0000
Percent Change per Year	-0.060

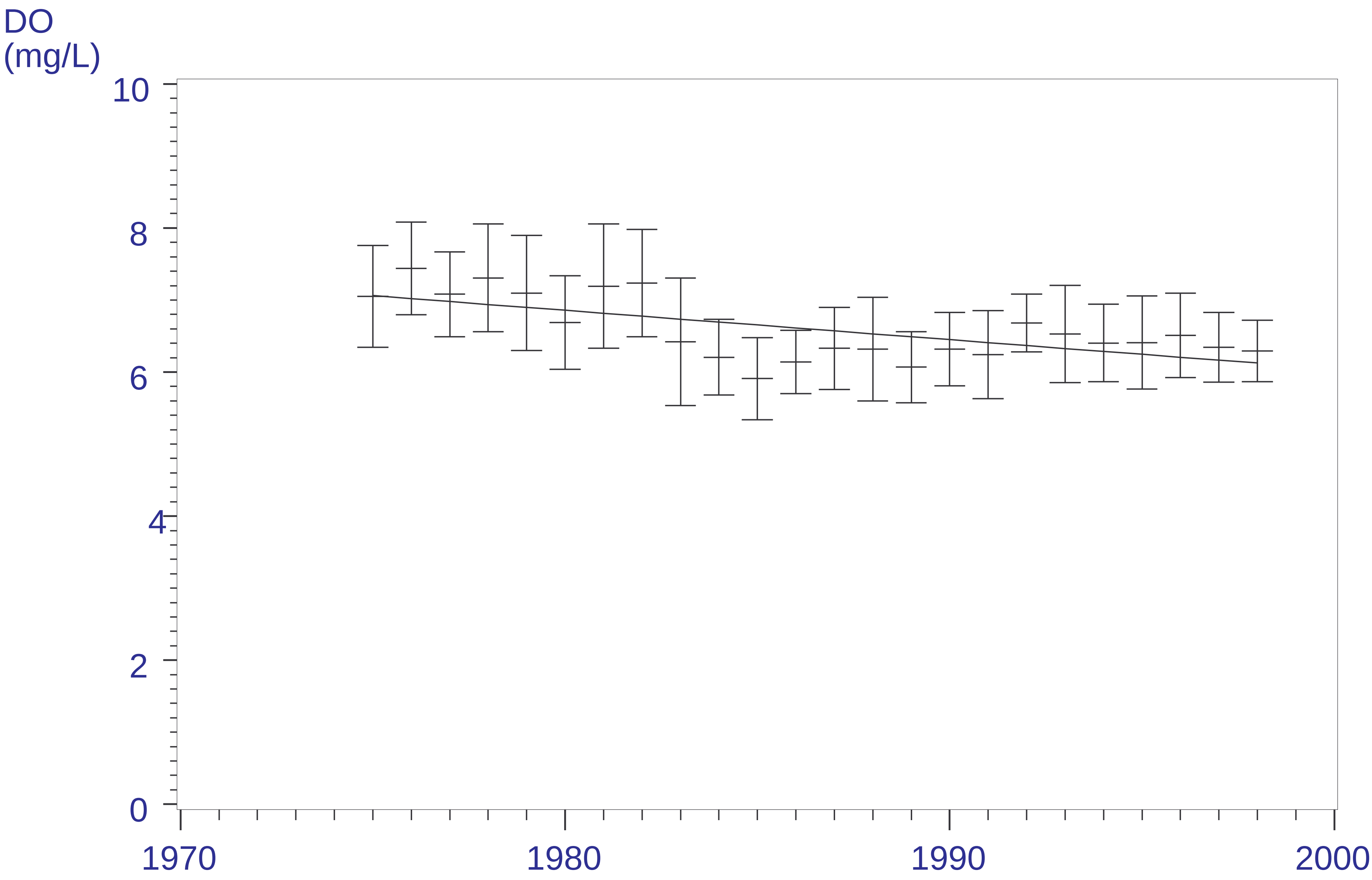

LOWER TAMPA BAY
Assessment of Historical Trends
Mean Annual Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Lower Tampa Bay BOD (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	287
Mean Annual Slope Estimate	-0.022
Lower 95% Confidence Limit	-0.033
Upper 95% Confidence Limit	-0.011
p Value Slope Statistic	0.0001
Percent Change per Year	-0.017


LOWER TAMPA BAY
Assessment of Historical Trends
Mean Annual Biochemical Oxygen Demand Concentrations
Data Source: EPCHC
BOD
(mg/L)
3
2
2
1
1
0
1970
1980
1990
2000

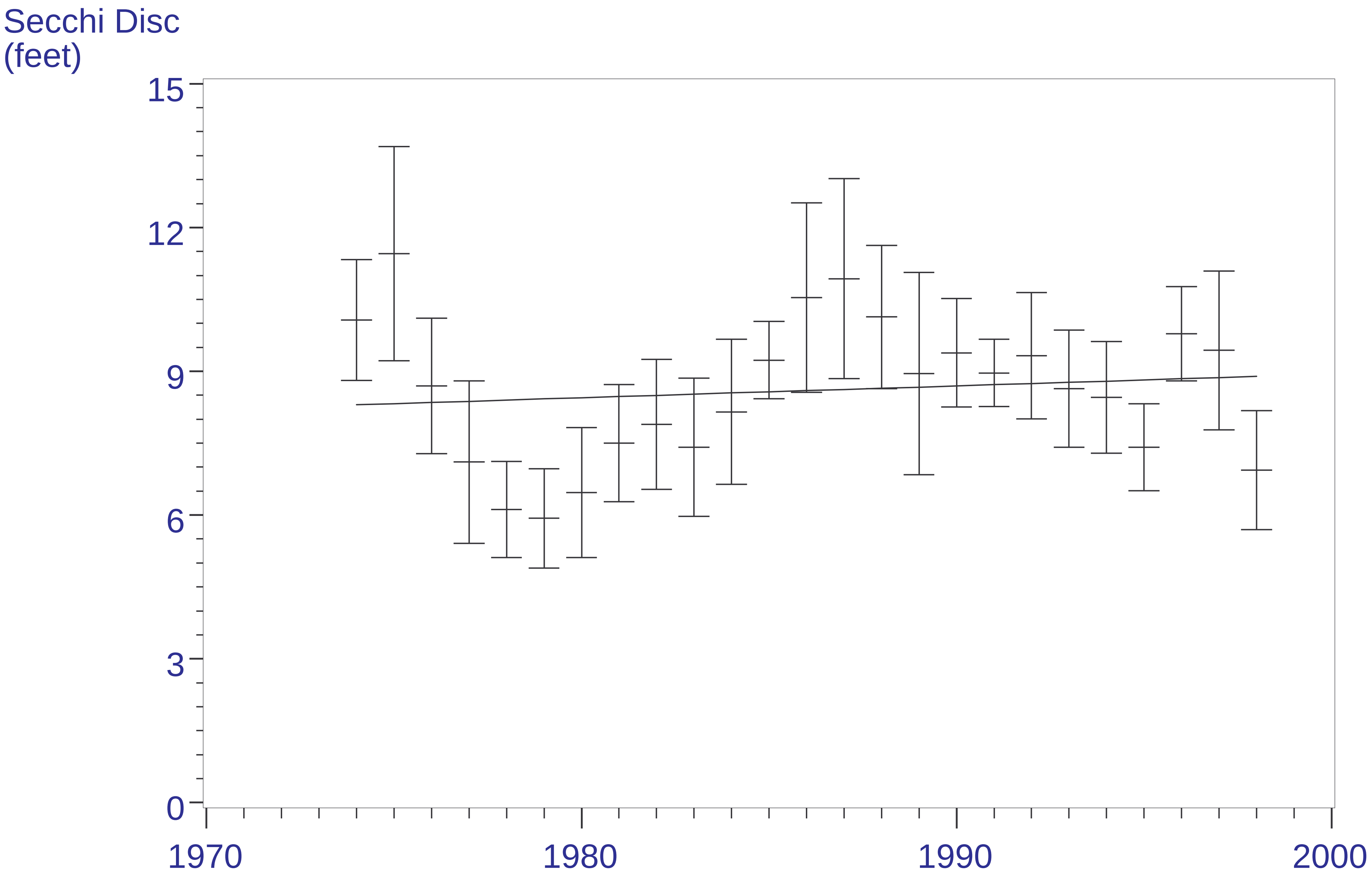
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Lower Tampa Bay Bottom Dissolved Oxygen (mg/L) Data Source: EPCHC	
# of Years of Sampling	24
Number of Samples	271
Mean Annual Slope Estimate	-0.041
Lower 95% Confidence Limit	-0.059
Upper 95% Confidence Limit	-0.023
p Value Slope Statistic	0.0000
Percent Change per Year	-0.006

LOWER TAMPA BAY
Assessment of Historical Trends
Mean Annual Bottom Dissolved Oxyen Concentrations
Data Source: EPCHC

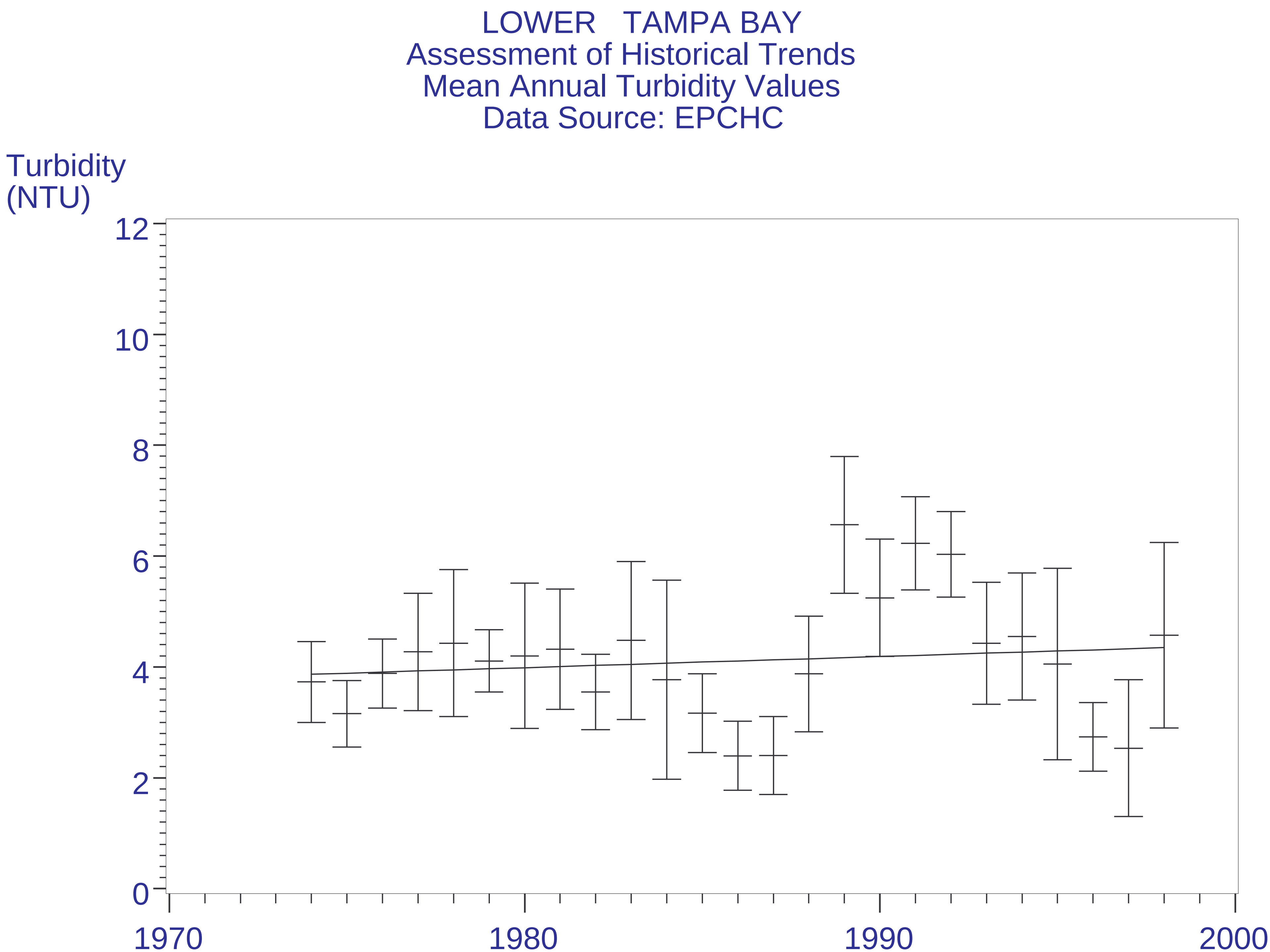


TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Lower Tampa Bay Secchi Disc Depth (feet) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	289
Mean Annual Slope Estimate	0.025
Lower 95% Confidence Limit	-0.014
Upper 95% Confidence Limit	0.063
p Value Slope Statistic	0.2059
Percent Change per Year	0.003

LOWER TAMPA BAY
Assessment of Historical Trends
Mean Annual Secchi Disc Depth
Data Source: EPCHC

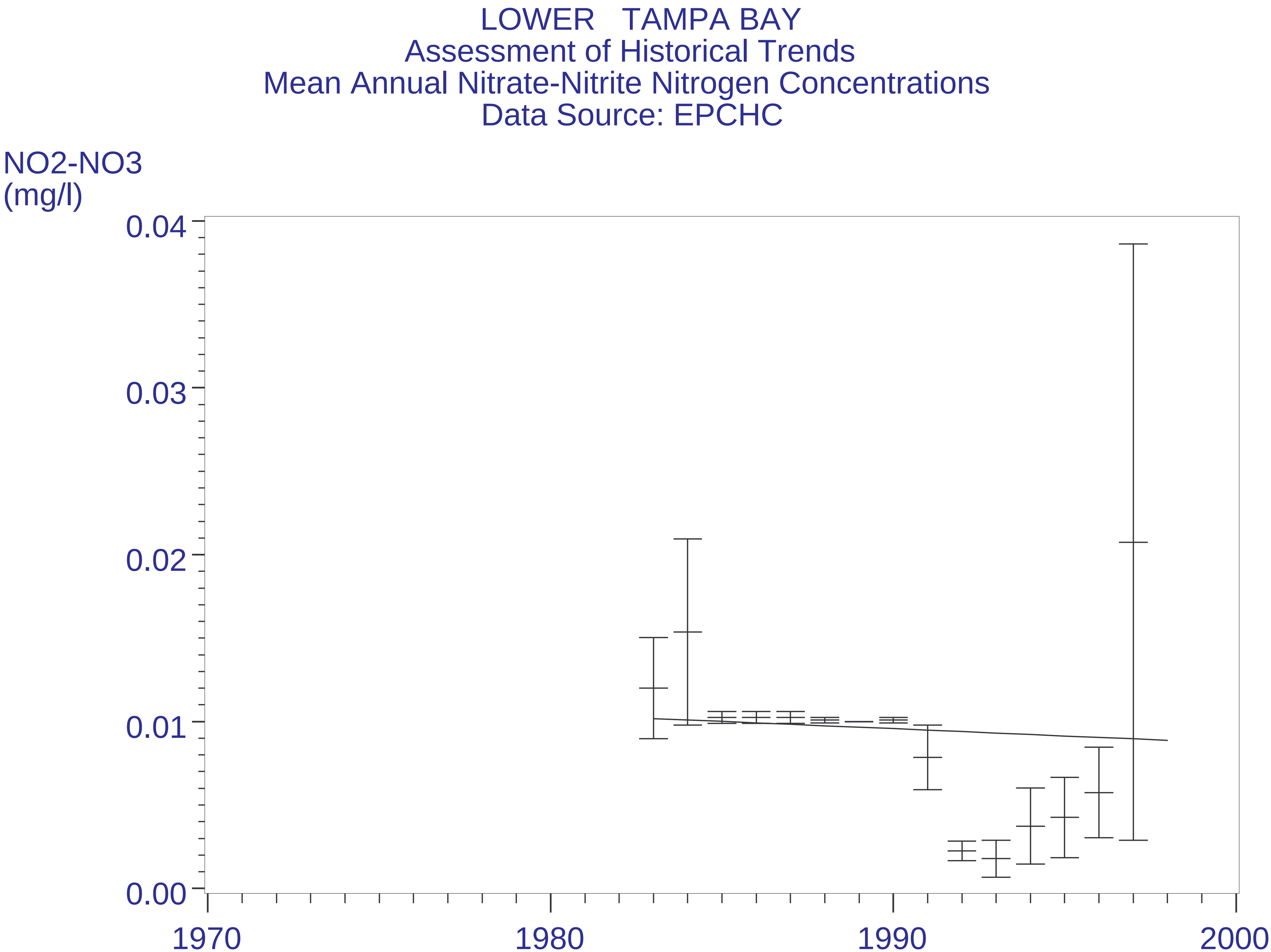


TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Lower Tampa Bay Turbidity (NTU) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	287
Mean Annual Slope Estimate	0.020
Lower 95% Confidence Limit	-0.010
Upper 95% Confidence Limit	0.050
p Value Slope Statistic	0.1913
Percent Change per Year	0.005



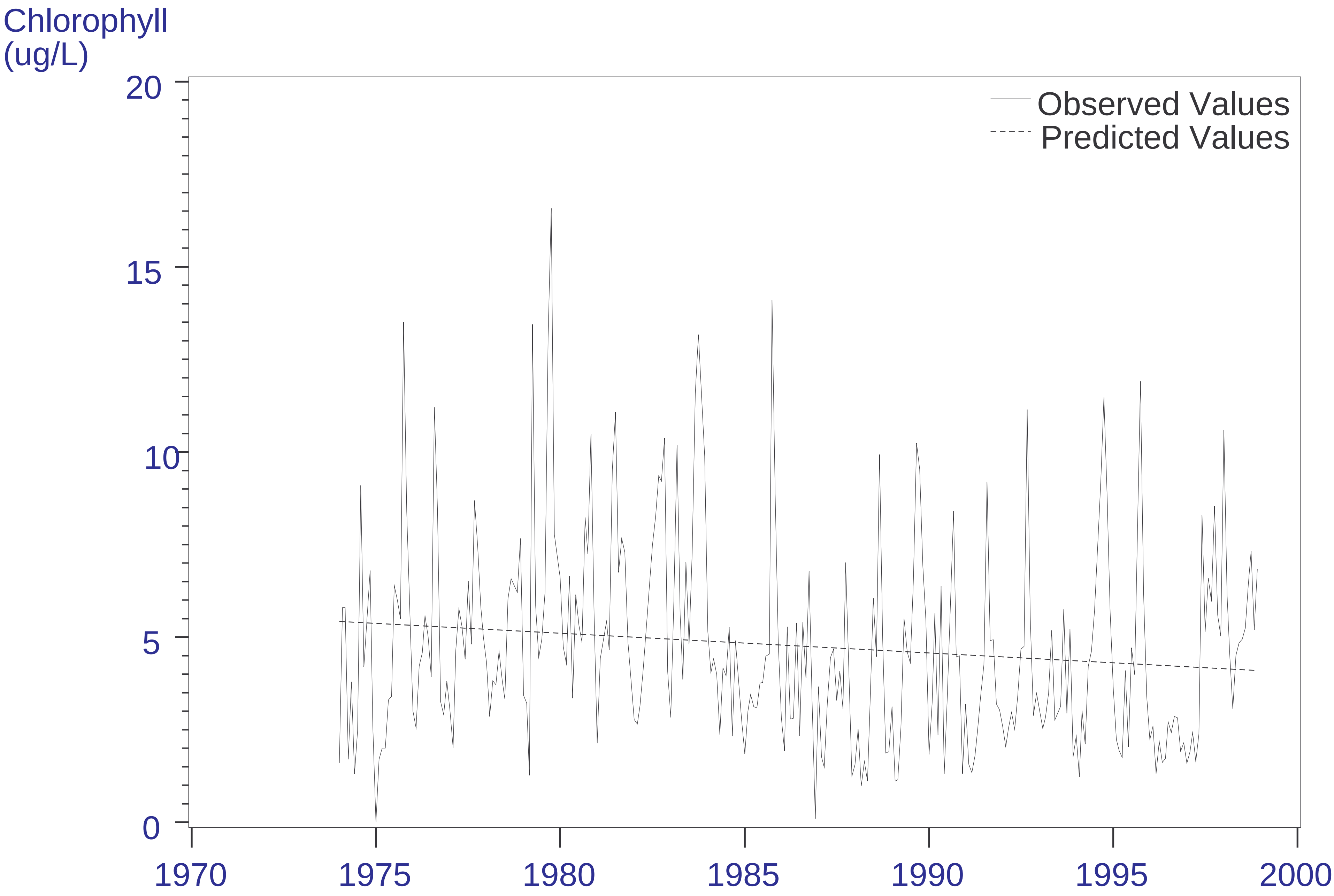
LOWER TAMPA BAY
Assessment of Historical Trends
Mean Annual Turbidity Values
Data Source: EPCHC
Turbidity
(NTU)
12
10
8
6
4
2
0
1970
1980
1990
2000

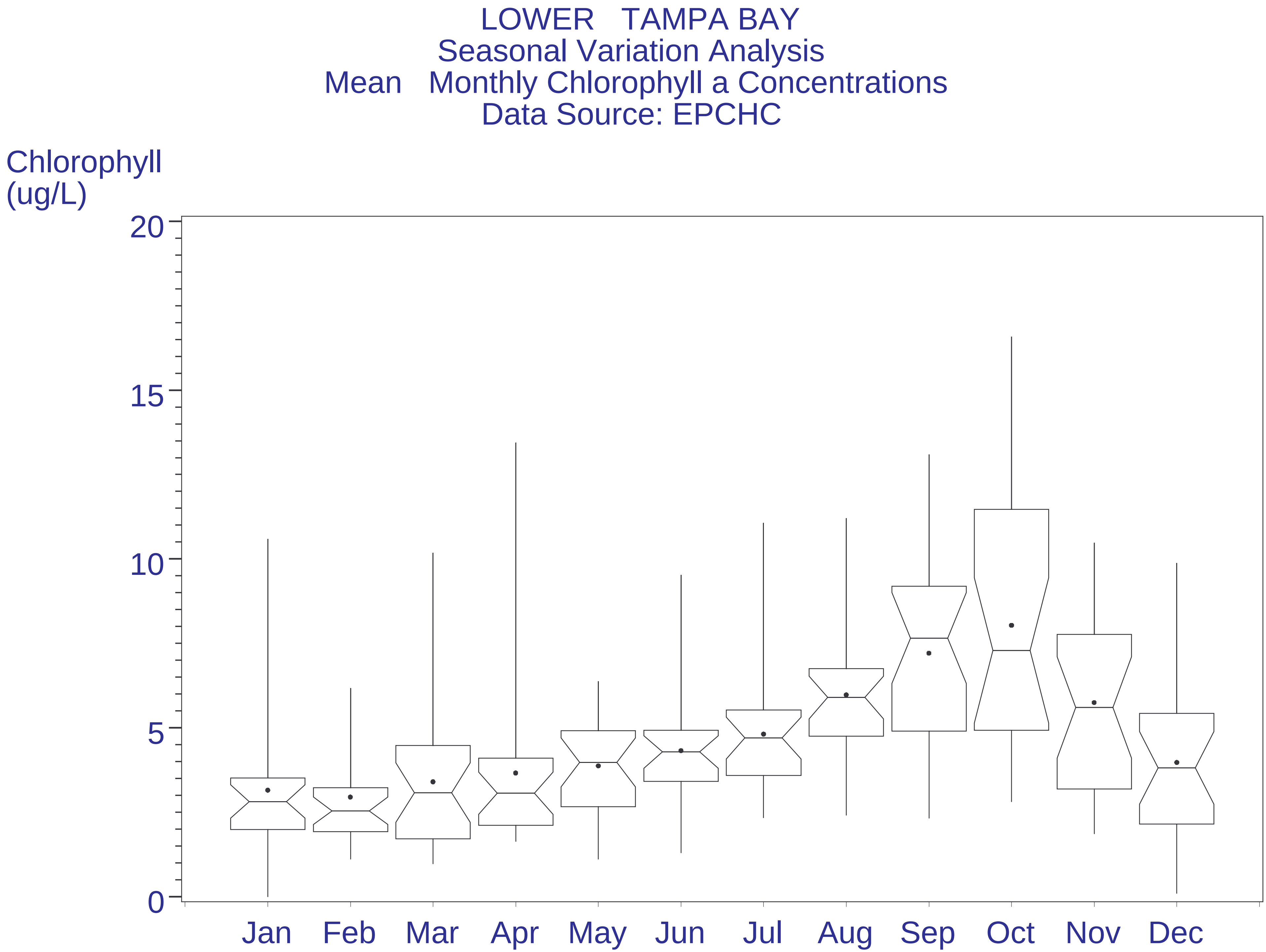
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Lower Tampa Bay Nitrate-Nitrite Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	16
Number of Samples	149
Mean Annual Slope Estimate	0.000
Lower 95% Confidence Limit	-0.001
Upper 95% Confidence Limit	0.001
p Value Slope Statistic	0.7840
Percent Change per Year	-0.009


LOWER TAMPA BAY
Assessment of Historical Trends
Mean Annual Nitrate-Nitrite Nitrogen Concentrations
Data Source: EPCHC
NO2-NO3
(mg/l)
0.04
0.03
0.02
0.01
0.00
1970
1980
1990
2000

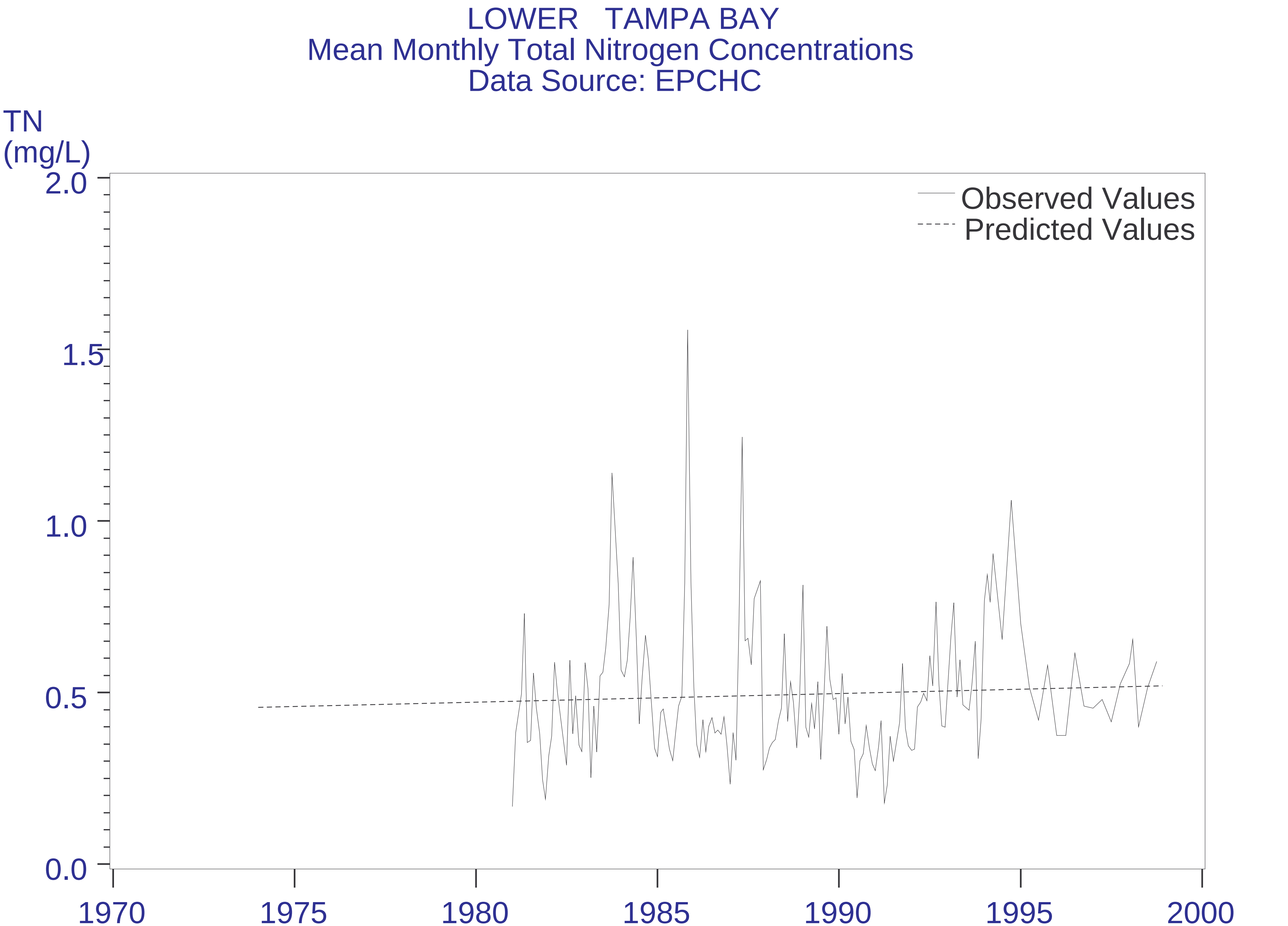
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Lower Tampa Bay Chlorophyll a (ug/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	289
Tau Statistic	-0.152
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.048
p Value Slope Statistic	-0.0570

LOWER TAMPA BAY
Mean Monthly Chlorophyll a Concentrations
Data Source: EPCHC

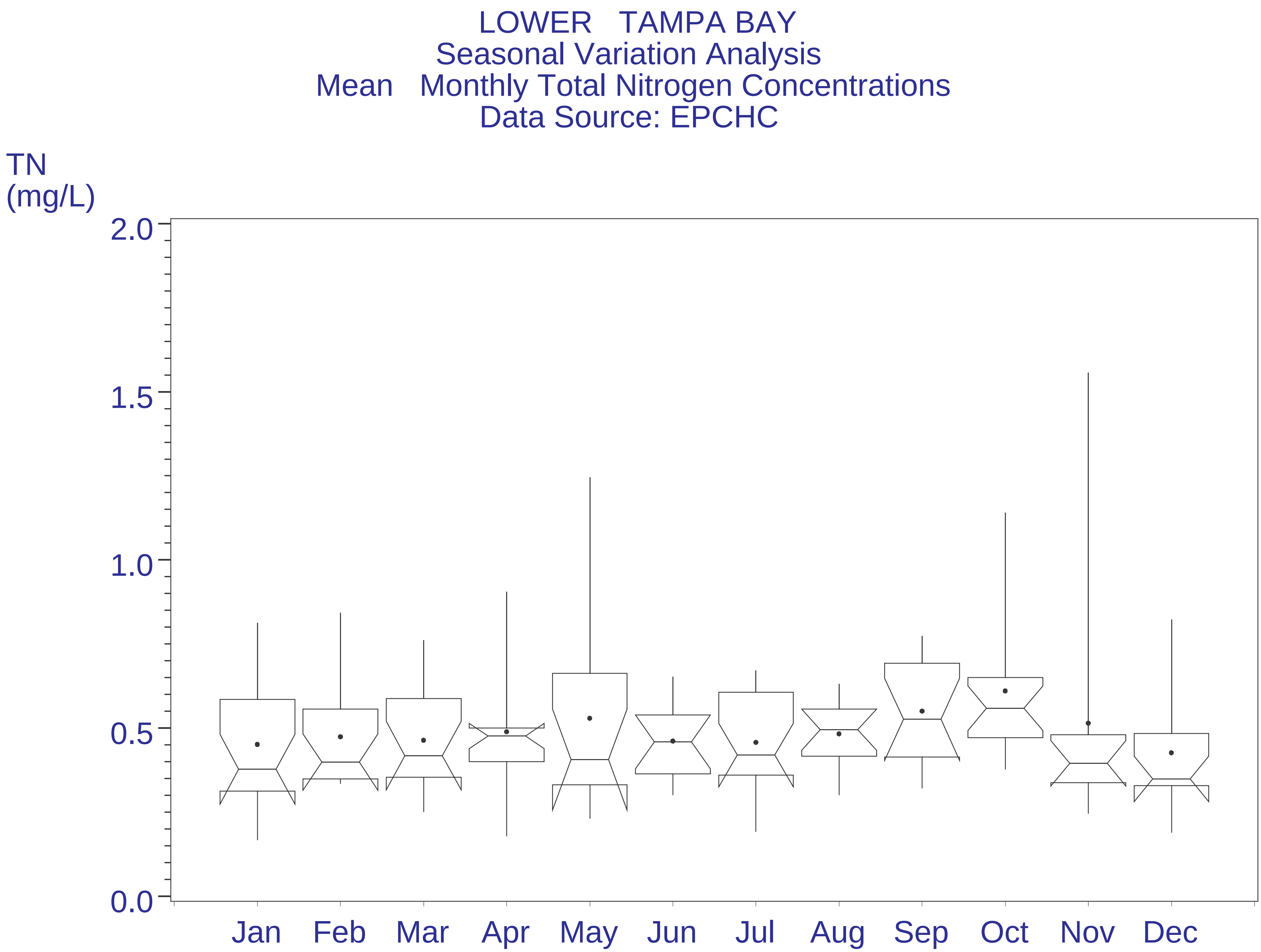



LOWER TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Chlorophyll a Concentrations
Data Source: EPCHC
Chlorophyll
(ug/L)
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

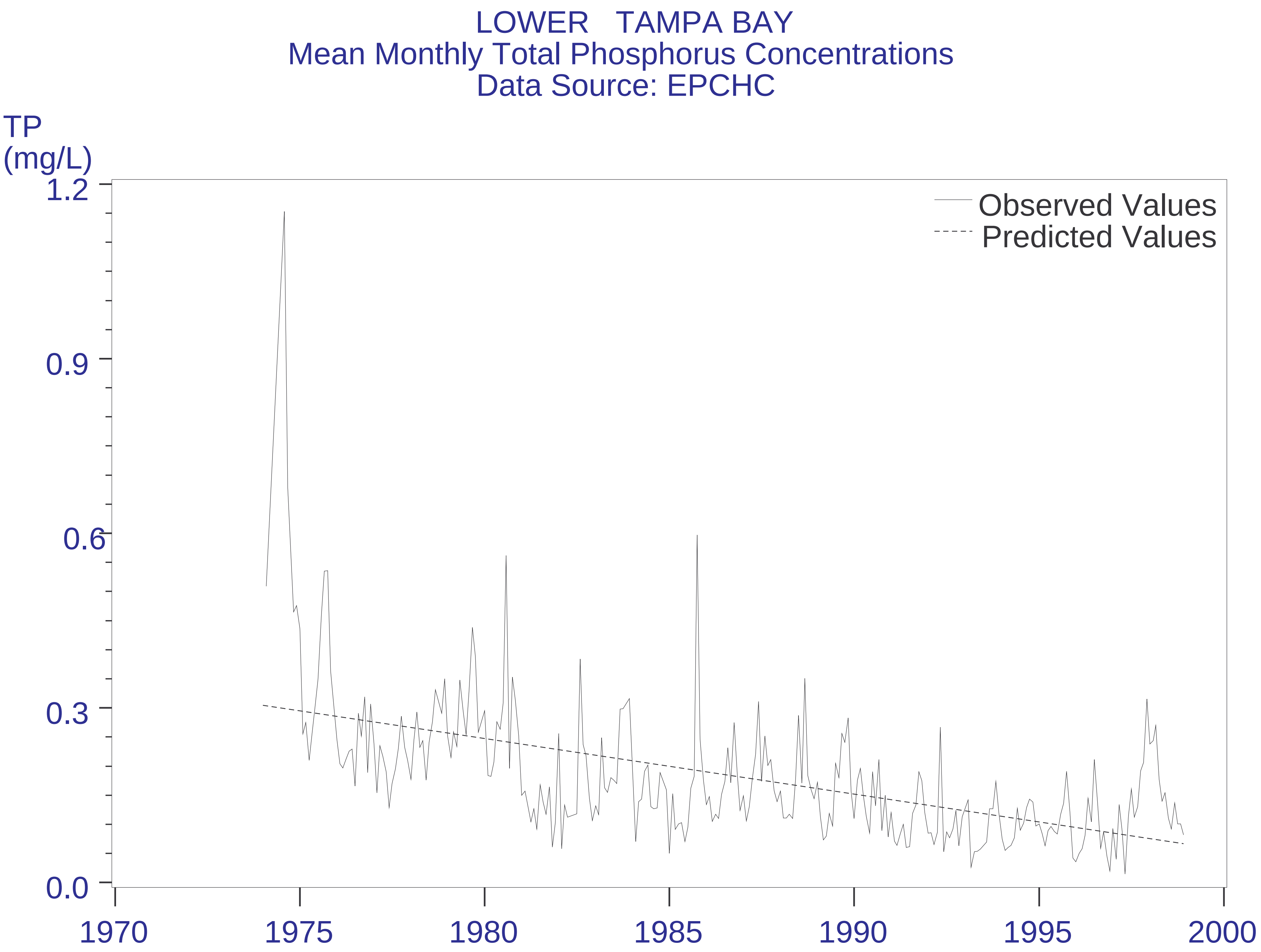
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Lower Tampa Bay Total Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	18
Number of Samples	172
Tau Statistic	0.059
P-value without Serial Correlation	0.311
P-value with Serial Correlation	0.554
p Value Slope Statistic	0.0026

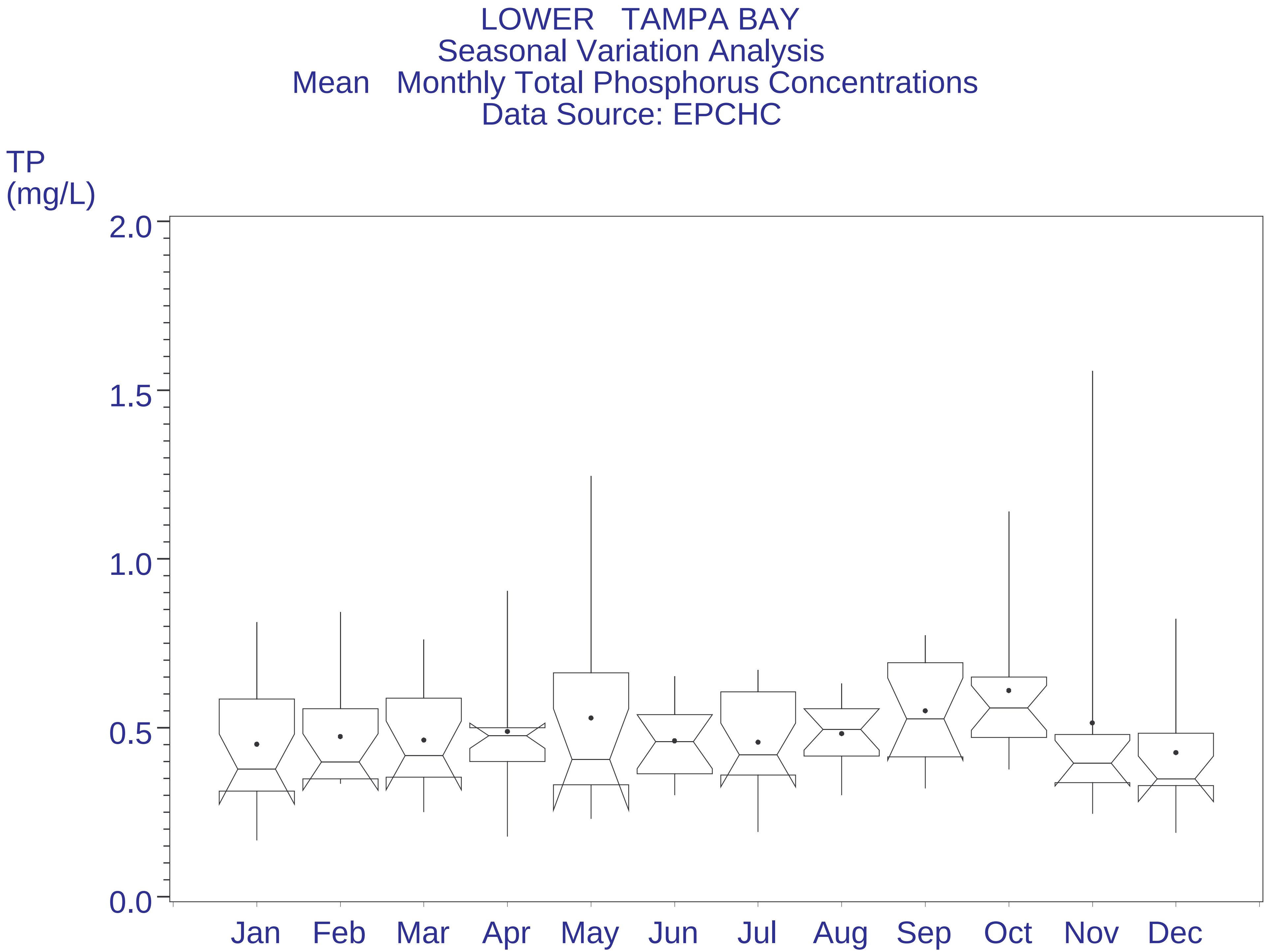


LOWER TAMPA BAY
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
2.0
1.5
1.0
0.5
0.0
Observed Values
Predicted Values
1970
1975
1980
1985
1990
1995
2000


LOWER TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

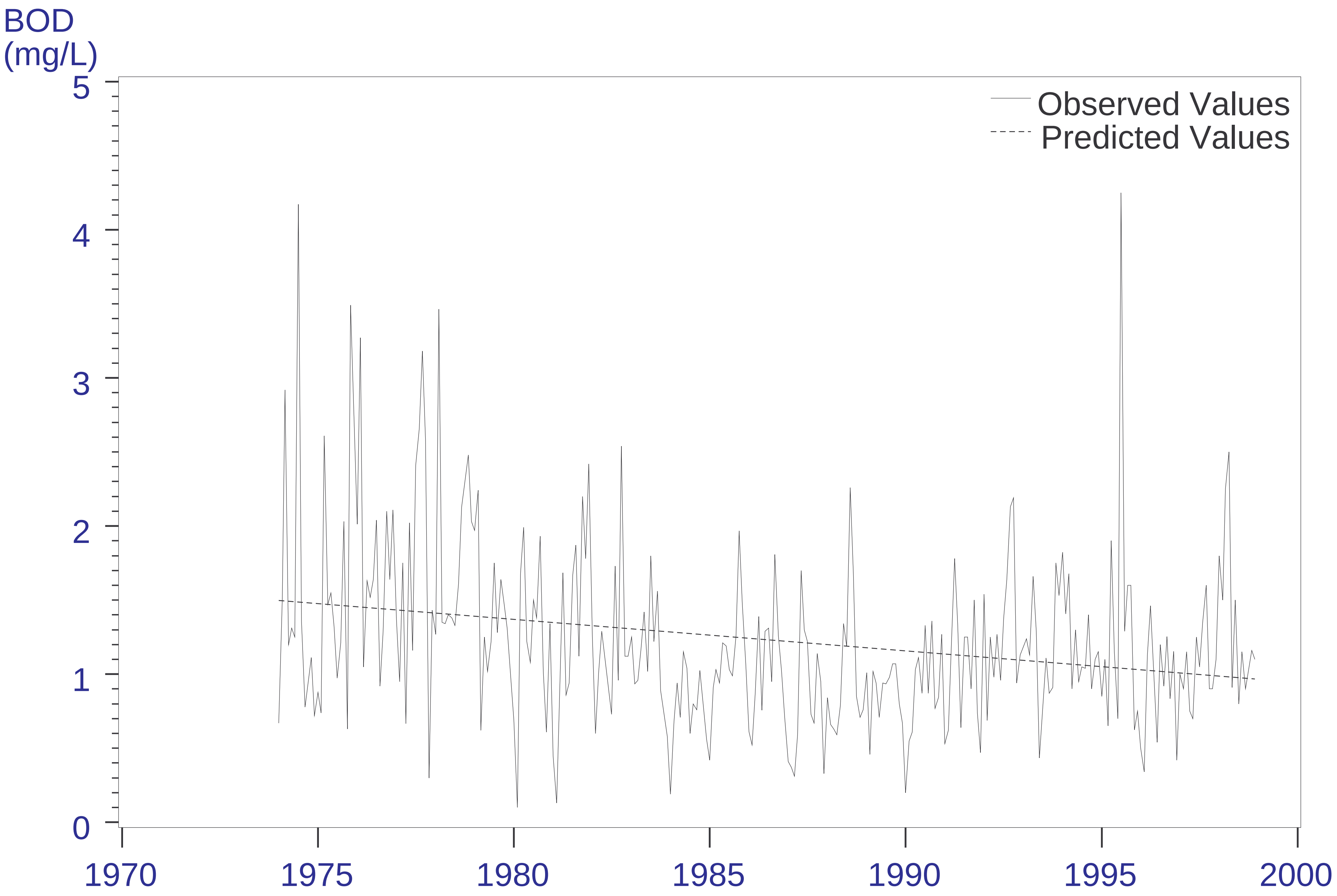
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Lower Tampa Bay Total Phosphorus (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	283
Tau Statistic	-0.493
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.000
p Value Slope Statistic	-0.0081

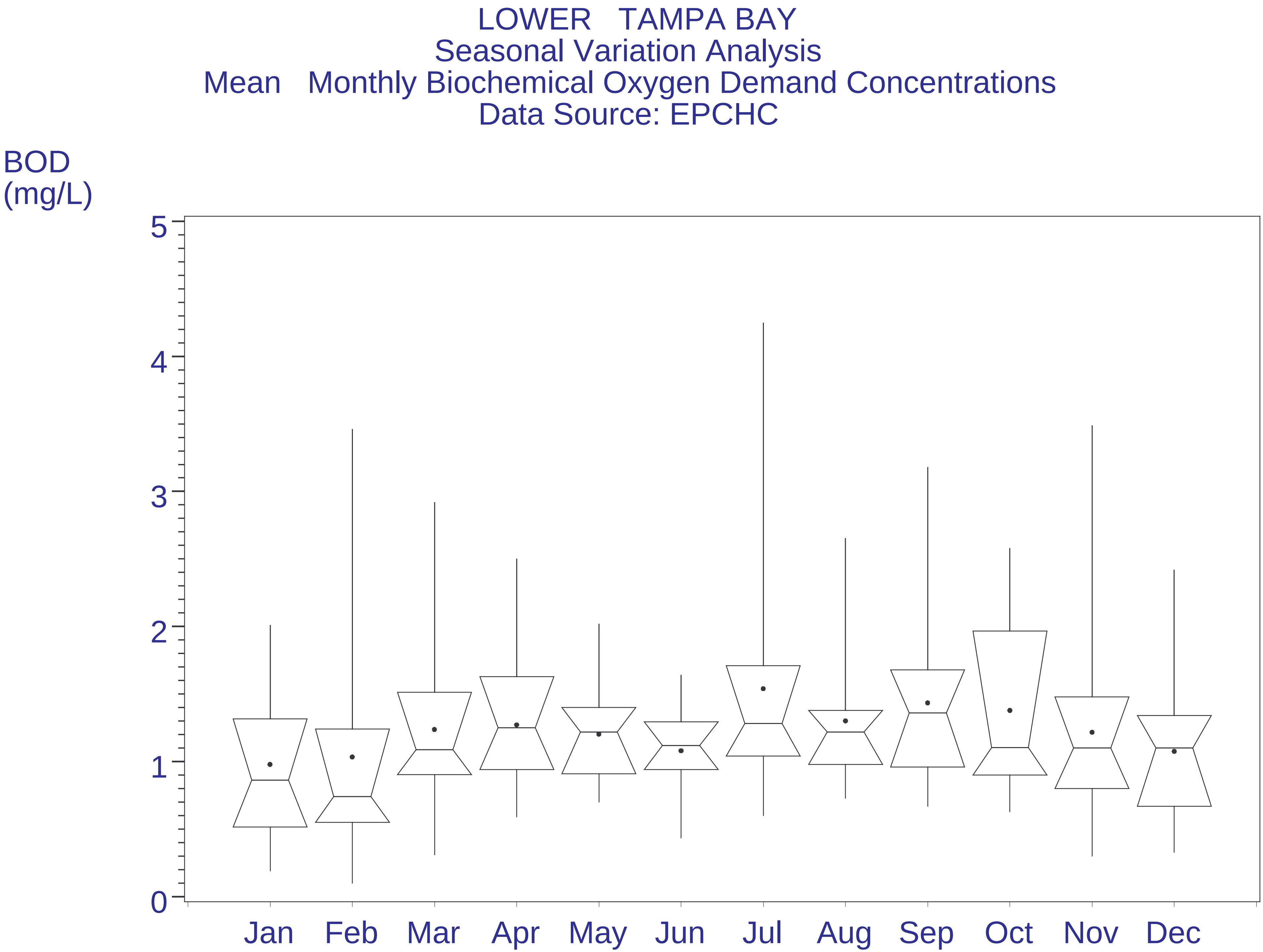

LOWER TAMPA BAY
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
1.2
0.9
0.6
0.3
0.0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


LOWER TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

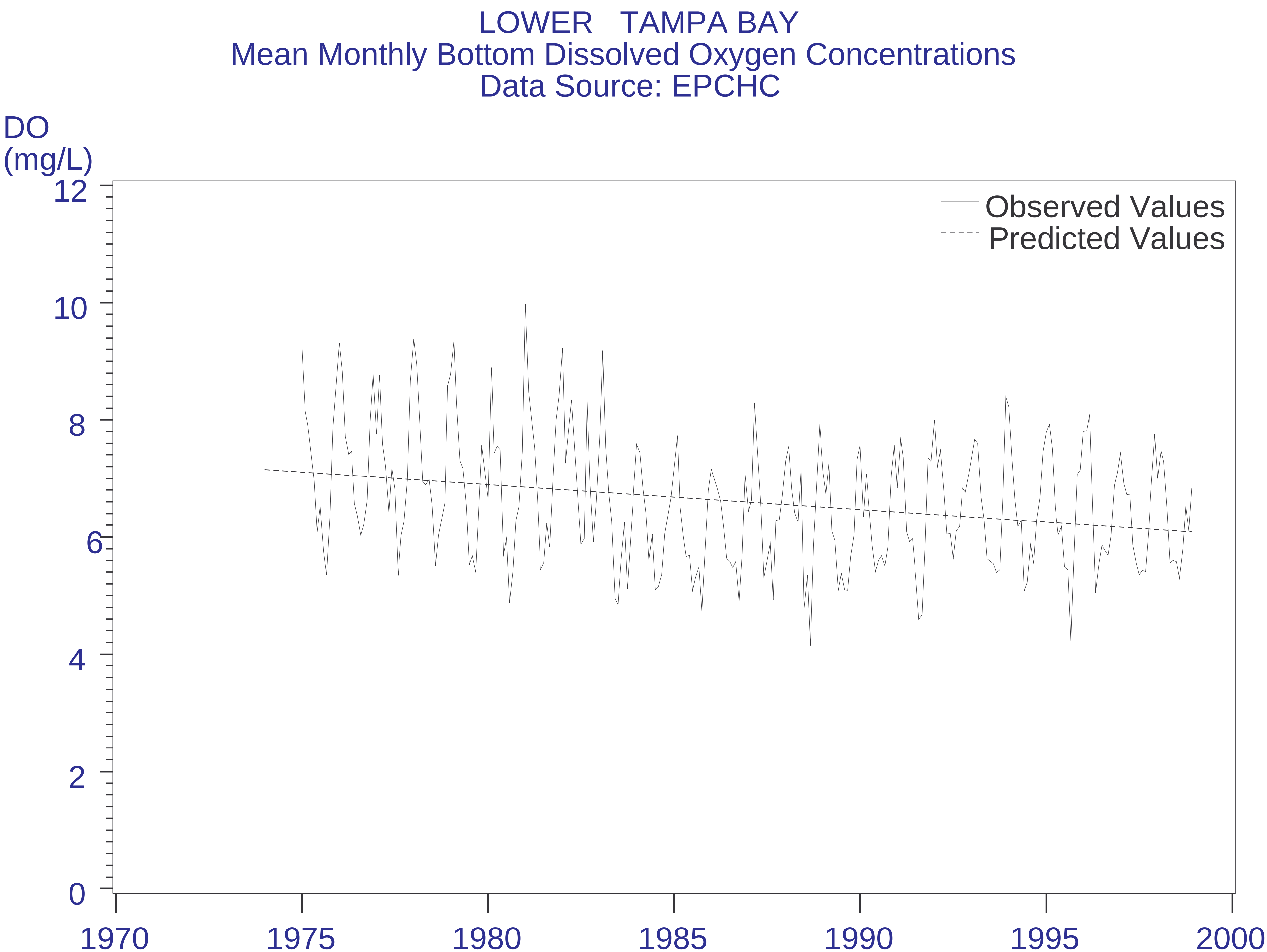
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Lower Tampa Bay BOD (mg/L) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	287
Tau Statistic	-0.171
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.020
p Value Slope Statistic	-0.0167

LOWER TAMPA BAY
Mean Monthly Biochemical Oxygen Demand Concentrations
Data Source: EPCHC



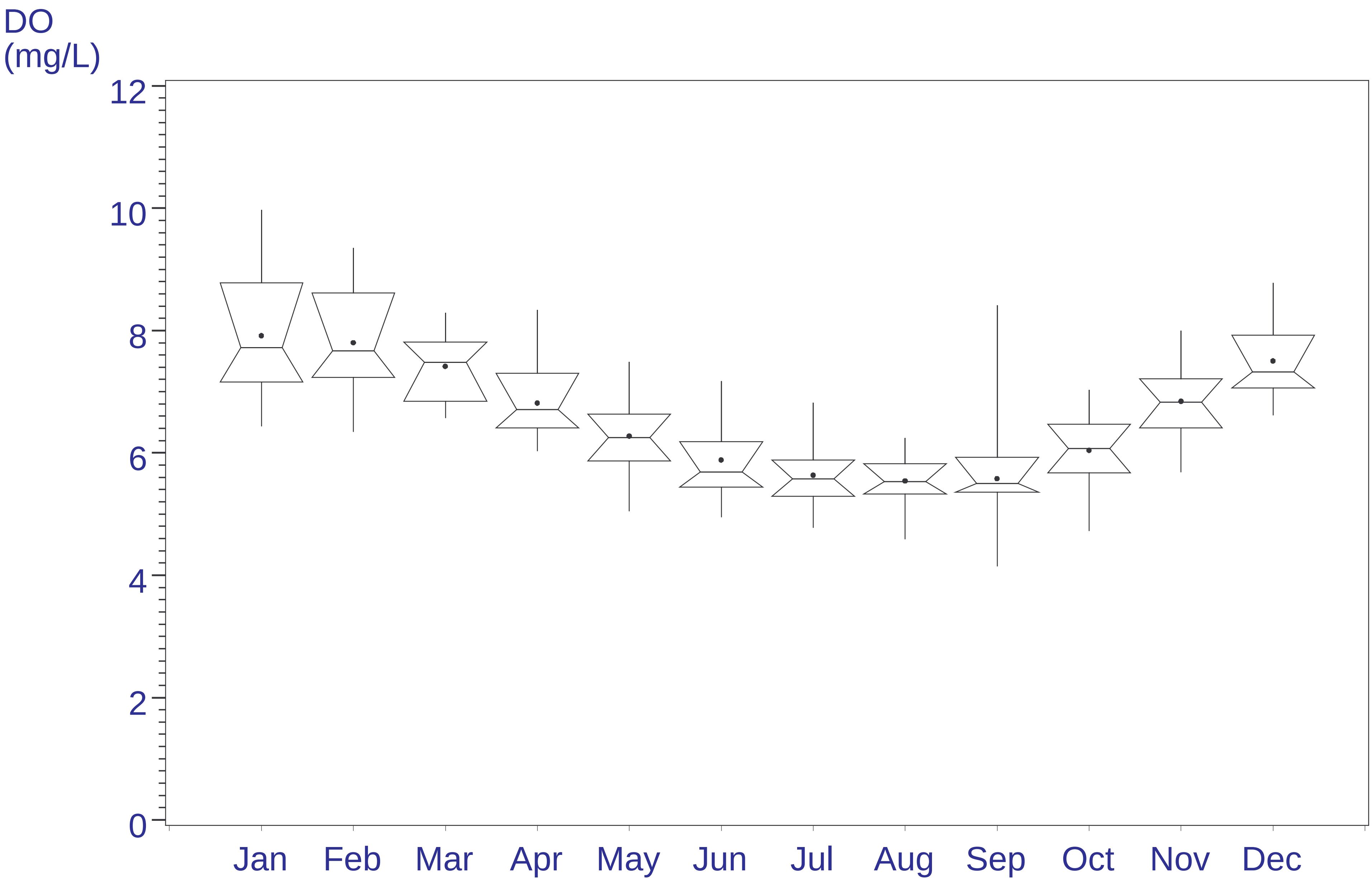

LOWER TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Biochemical Oxygen Demand Concentrations
Data Source: EPCHC
BOD
(mg/L)
0
1
2
3
4
5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Lower Tampa Bay Bottom Dissolved Oxygen (mg/L) Data Source: EPCHC	
# of Years of Sampling	24
Number of Samples	271
Tau Statistic	-0.267
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.004
p Value Slope Statistic	-0.0371



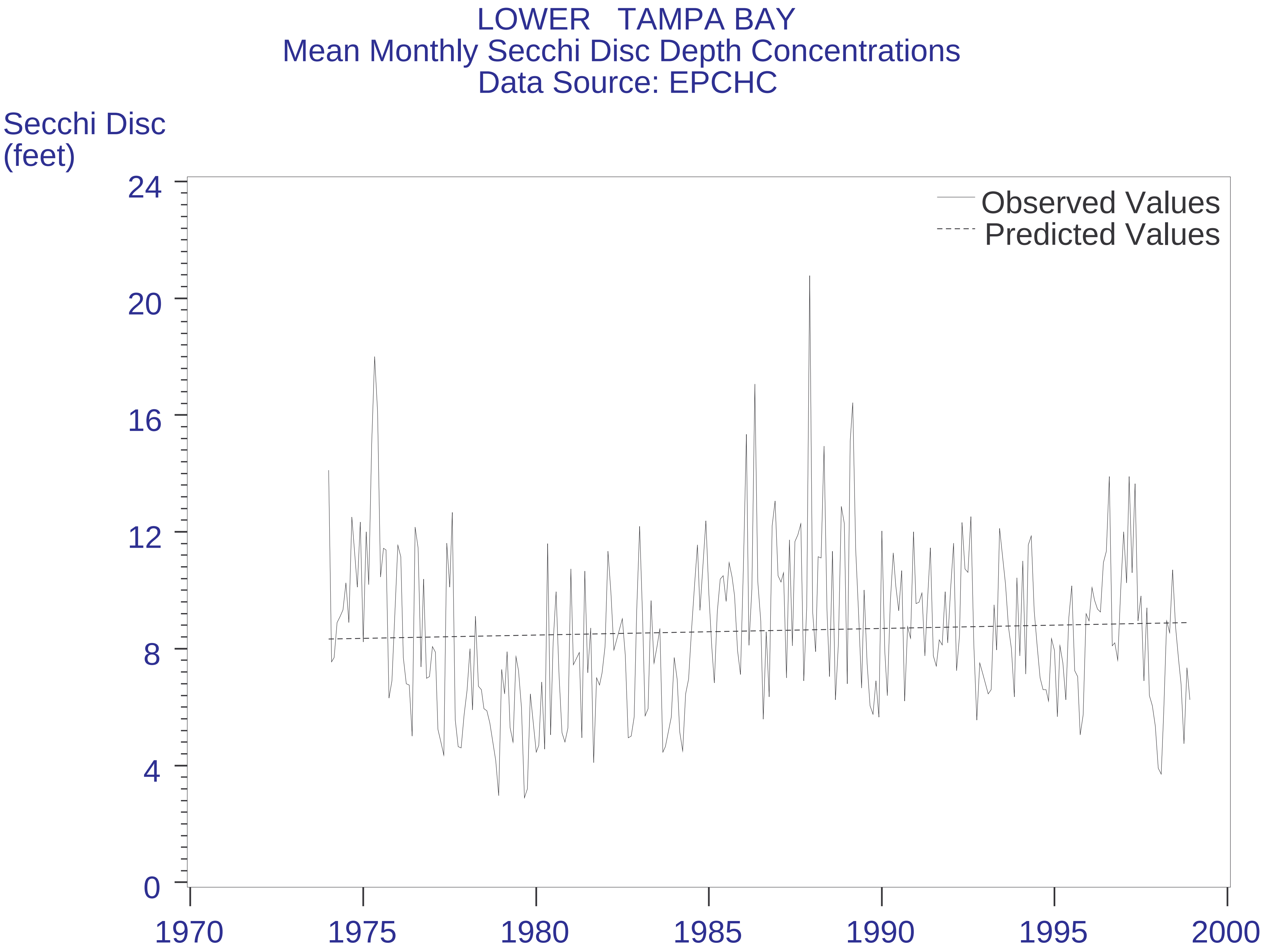
LOWER TAMPA BAY
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: EPCHC
DO
(mg/L)
12
10
8
6
4
2
0
Observed Values
Predicted Values
1970
1975
1980
1985
1990
1995
2000

LOWER TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: EPCHC

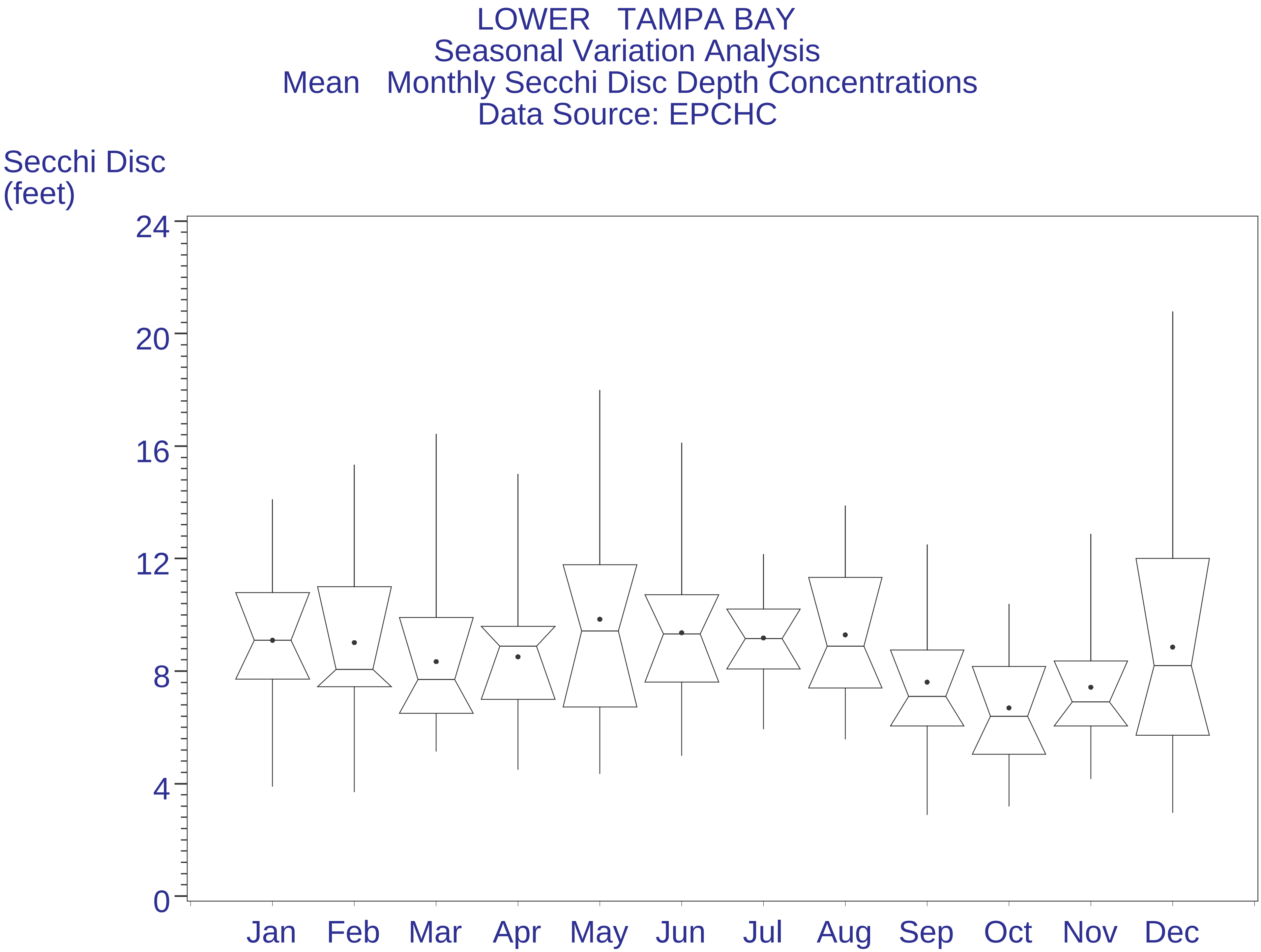


TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Lower Tampa Bay Secchi Disc Depth (feet) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	289
Tau Statistic	0.066
P-value without Serial Correlation	0.118
P-value with Serial Correlation	0.418
p Value Slope Statistic	0.0363

APPENDIX B

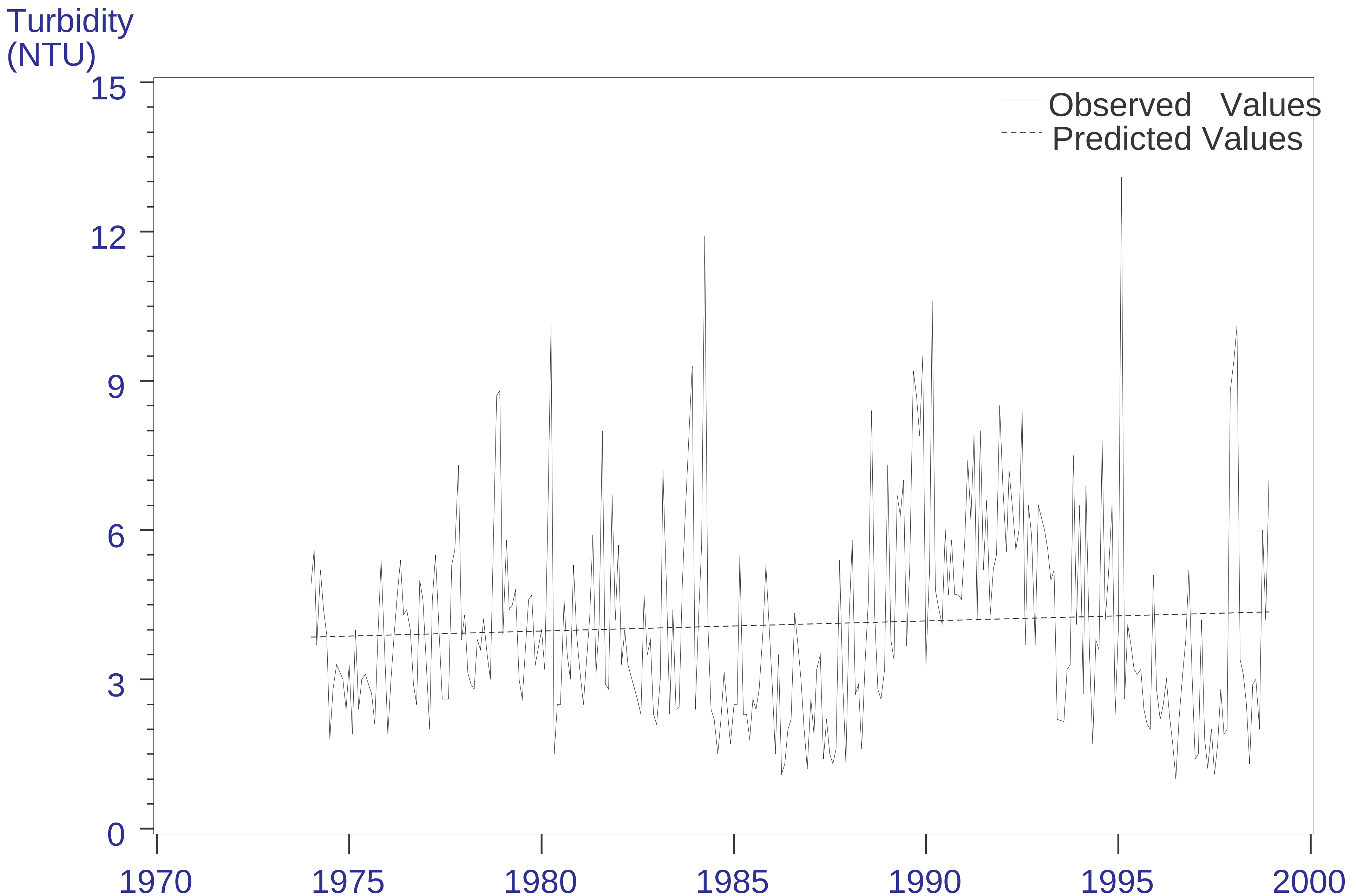


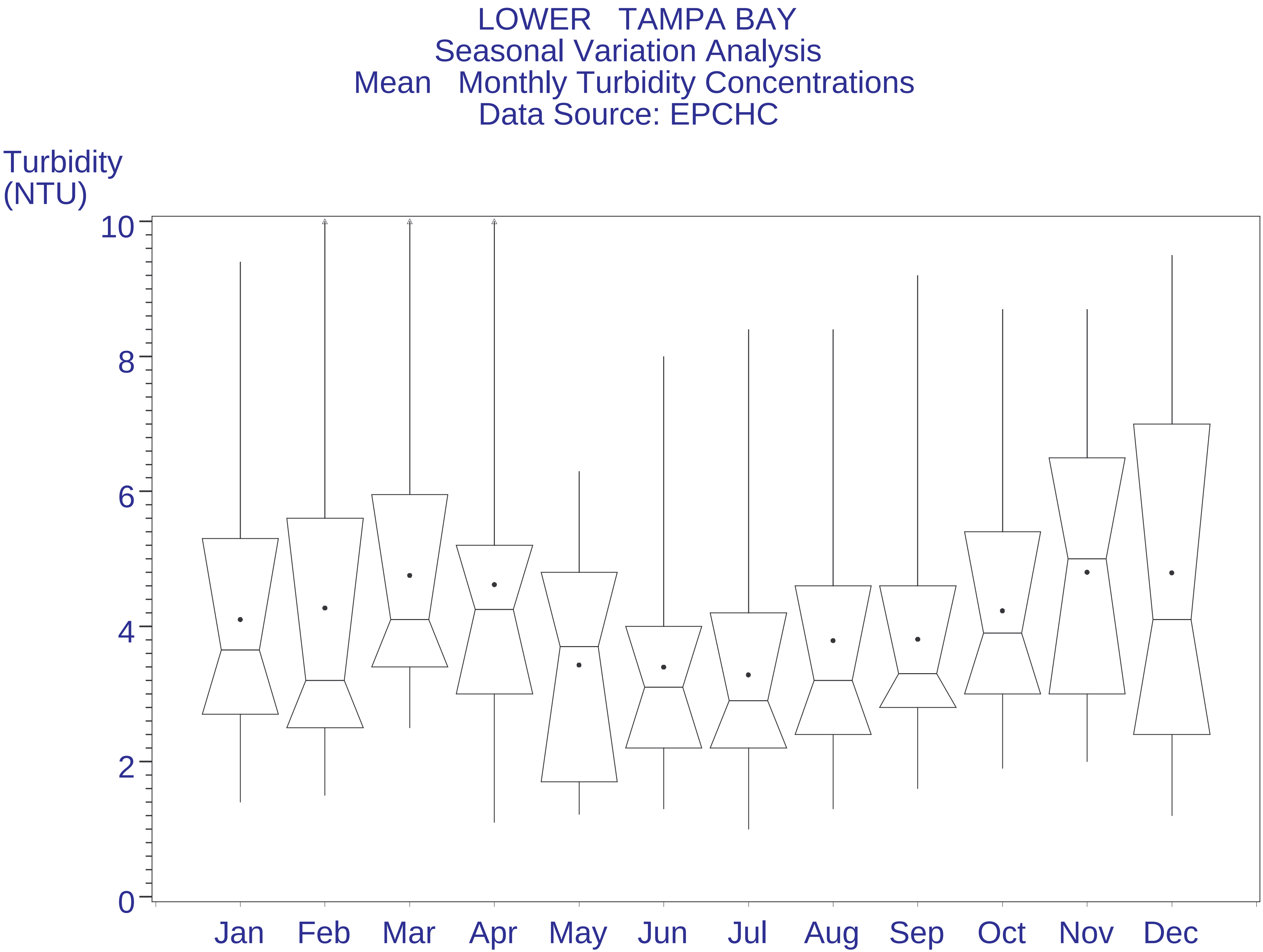
LOWER TAMPA BAY
Mean Monthly Secchi Disc Depth Concentrations
Data Source: EPCHC
Secchi Disc
(feet)
24
20
16
12
8
4
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


LOWER TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Secchi Disc Depth Concentrations
Data Source: EPCHC
Secchi Disc
(feet)
24
20
16
12
8
4
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

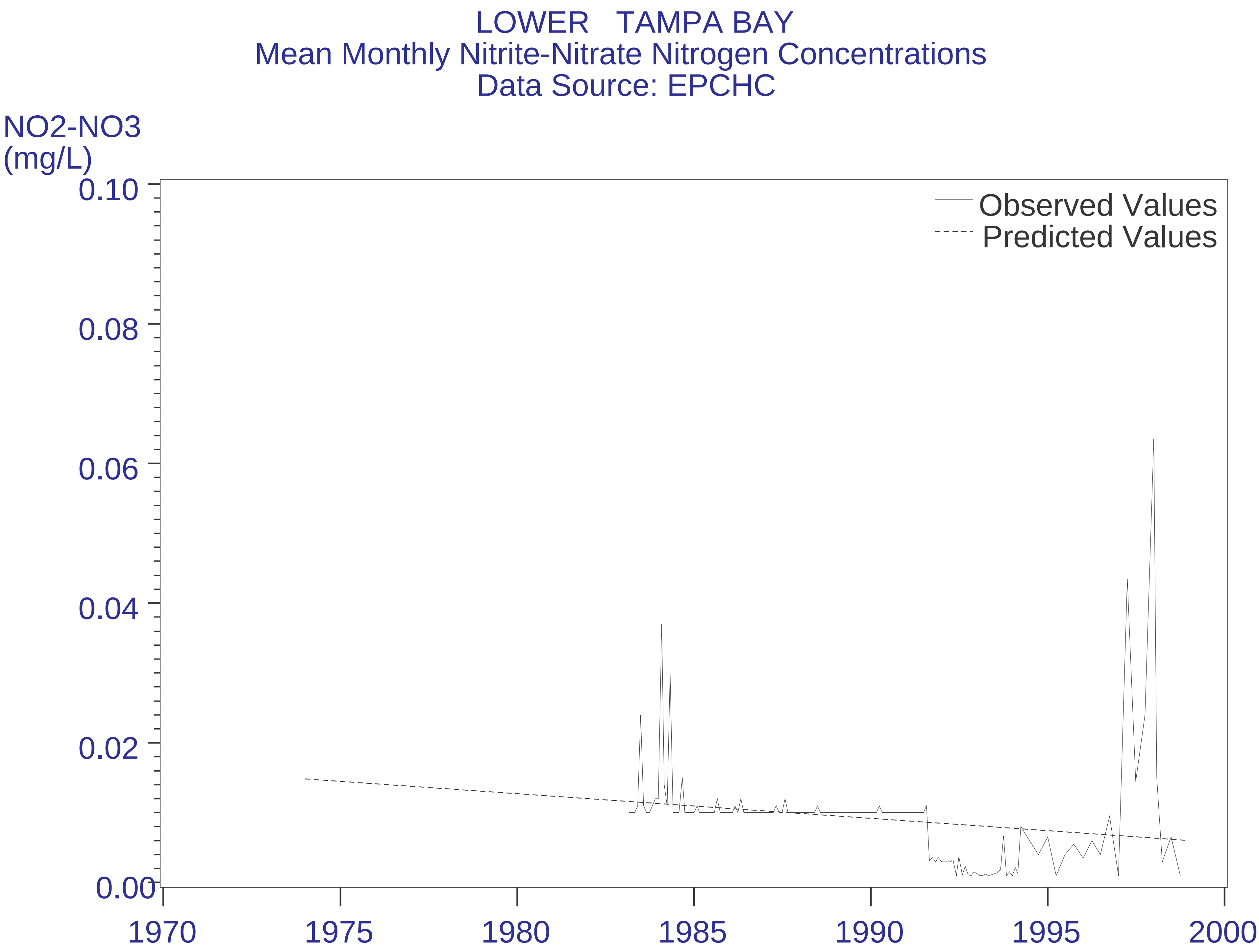
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Lower Tampa Bay Turbidity (NTU) Data Source: EPCHC	
# of Years of Sampling	25
Number of Samples	287
Tau Statistic	-0.016
P-value without Serial Correlation	0.714
P-value with Serial Correlation	0.861
p Value Slope Statistic	-0.0050

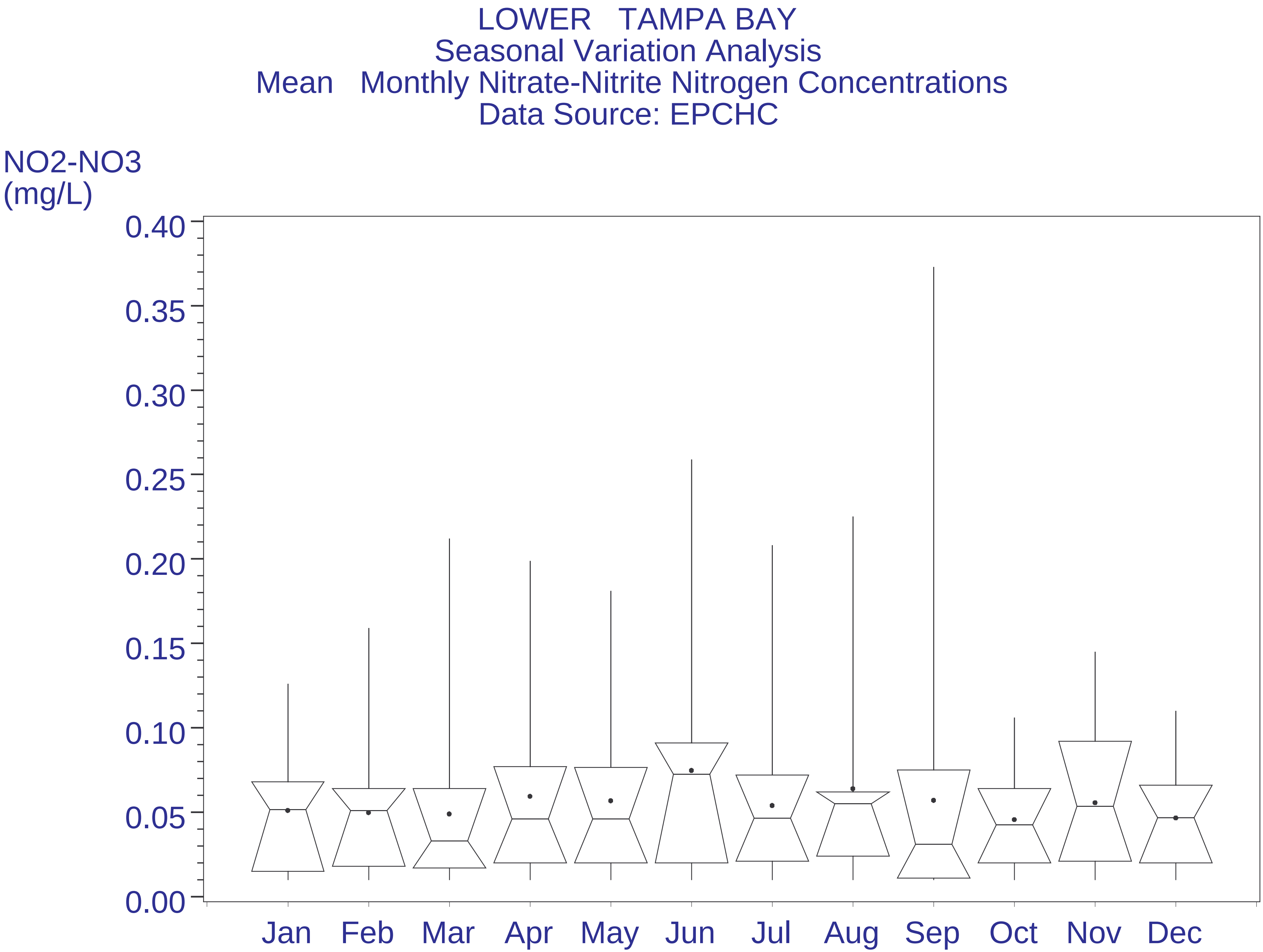
LOWER TAMPA BAY
Mean Monthly Turbidity Concentrations
Data Source: EPCHC




LOWER TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Turbidity Concentrations
Data Source: EPCHC
Turbidity
(NTU)
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Lower Tampa Bay Nitrate-Nitrite Nitrogen (mg/L) Data Source: EPCHC	
# of Years of Sampling	16
Number of Samples	149
Tau Statistic	-0.427
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.002
p Value Slope Statistic	-0.0004


LOWER TAMPA BAY
Mean Monthly Nitrite-Nitrate Nitrogen Concentrations
Data Source: EPCHC
NO2-NO3
(mg/L)
0.10
0.08
0.06
0.04
0.02
0.00
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

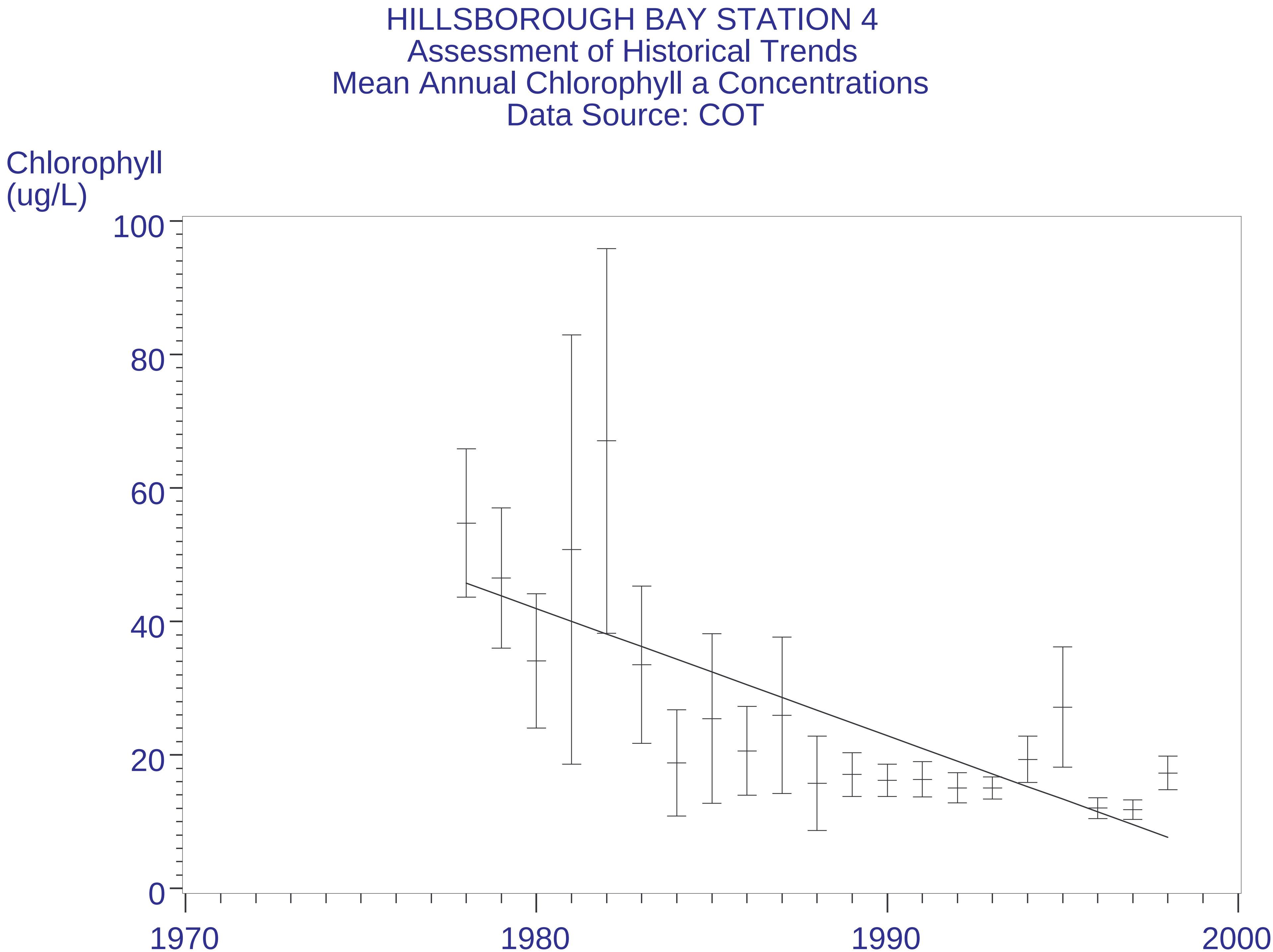

LOWER TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Nitrate-Nitrite Nitrogen Concentrations
Data Source: EPCHC
NO2-NO3
(mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

APPENDIX C

TREND RESULTS AND WATER QUALITY DATA PLOTS, CITY OF TAMPA BAY STUDY GROUP

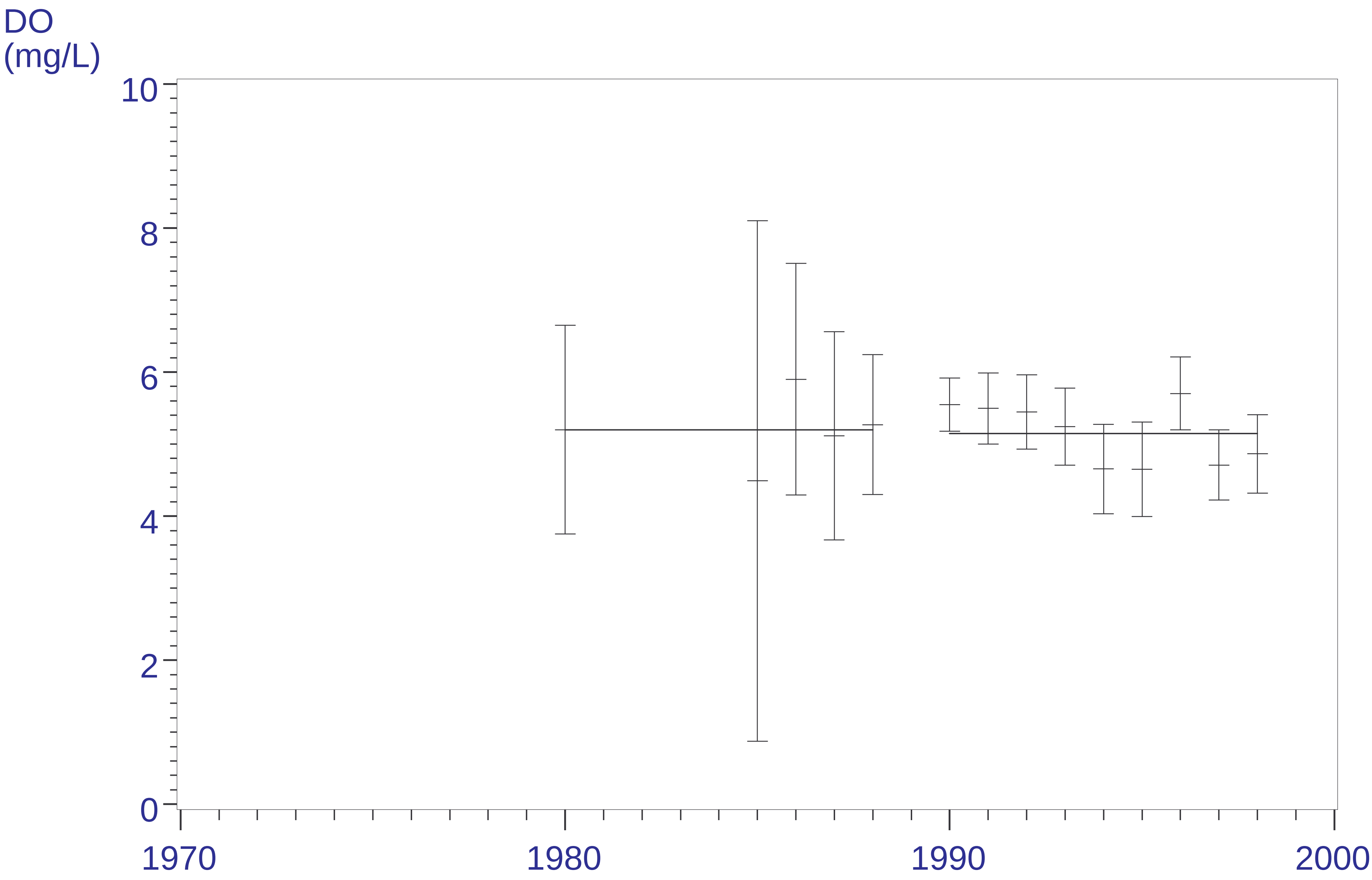
STATION 4
HILLSBOROUGH BAY

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay - Station 4 Chlorophyll a (ug/L) Data Source: COT	
# of Years of Sampling	21
Number of Samples	794
Mean Annual Slope Estimate	-1.905
Lower 95% Confidence Limit	-2.346
Upper 95% Confidence Limit	-1.464
p Value Slope Statistic	0.0000
Percent Change per Year	-0.071

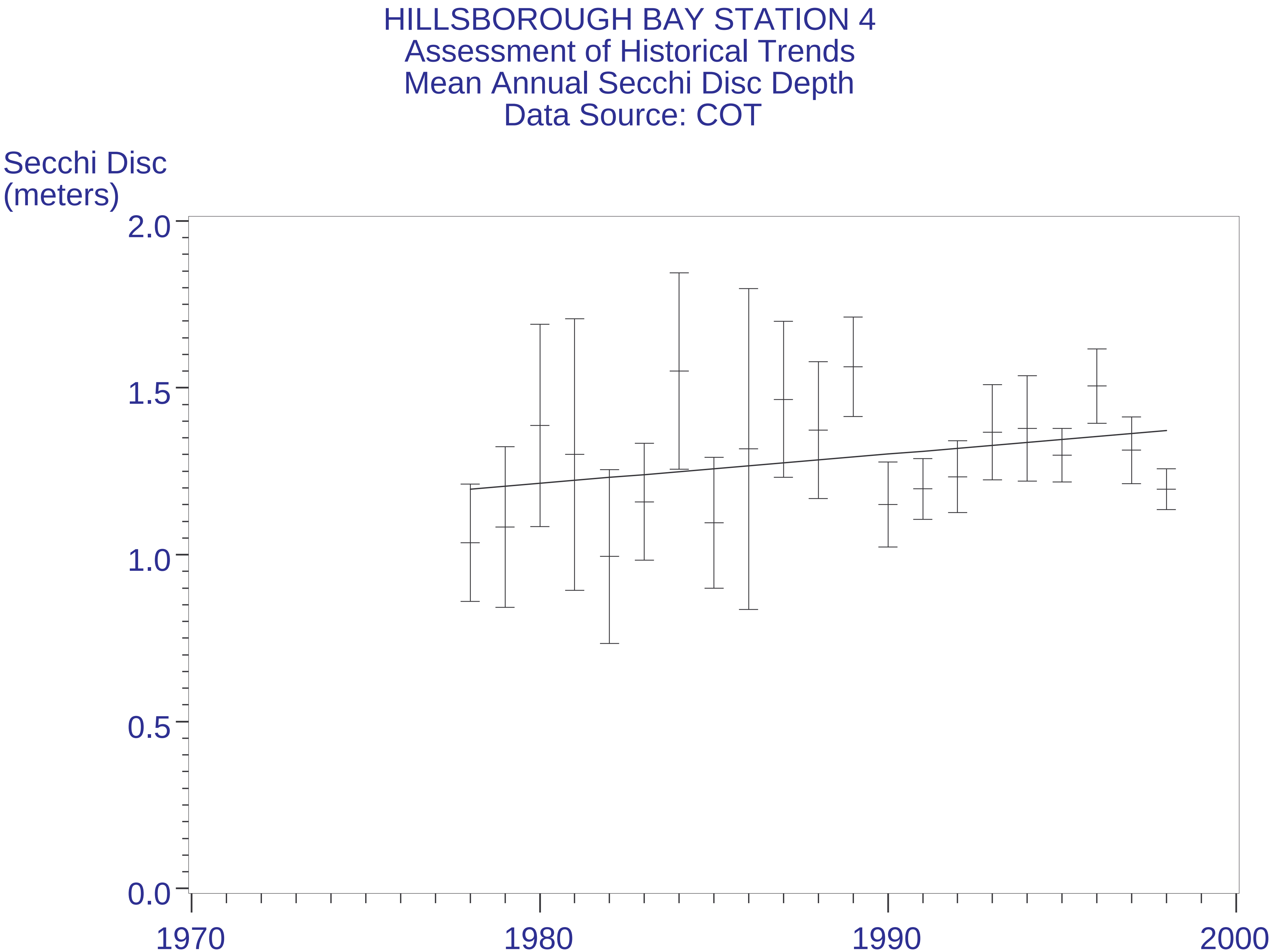

HILLSBOROUGH BAY STATION 4
Assessment of Historical Trends
Mean Annual Chlorophyll a Concentrations
Data Source: COT
Chlorophyll
(ug/L)
100
80
60
40
20
0
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay - Station 4 Bottom Dissolved Oxygen (mg/L) Data Source: COT	
# of Years of Sampling	15
Number of Samples	681
Mean Annual Slope Estimate	-0.049
Lower 95% Confidence Limit	-0.777
Upper 95% Confidence Limit	0.679
p Value Slope Statistic	
Percent Change per Year	

HILLSBOROUGH BAY STATION 4
Assessment of Historical Trends
Mean Annual Bottom Dissolved Oxyen Concentrations
Data Source: COT

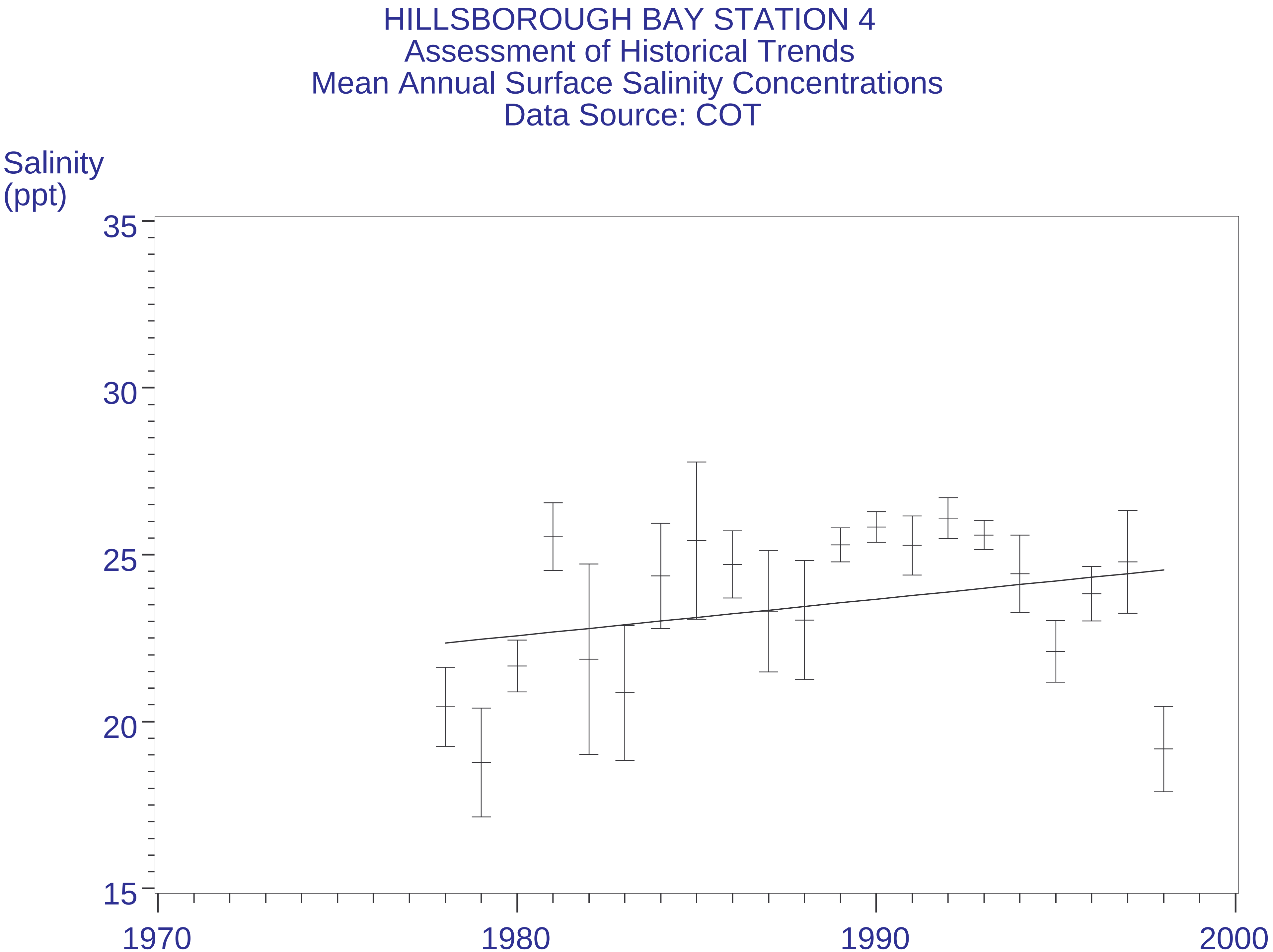


TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay - Station 4 Secchi Disc Depth (feet) Data Source: COT	
# of Years of Sampling	21
Number of Samples	819
Mean Annual Slope Estimate	0.009
Lower 95% Confidence Limit	0.002
Upper 95% Confidence Limit	0.016
p Value Slope Statistic	0.0167
Percent Change per Year	0.007



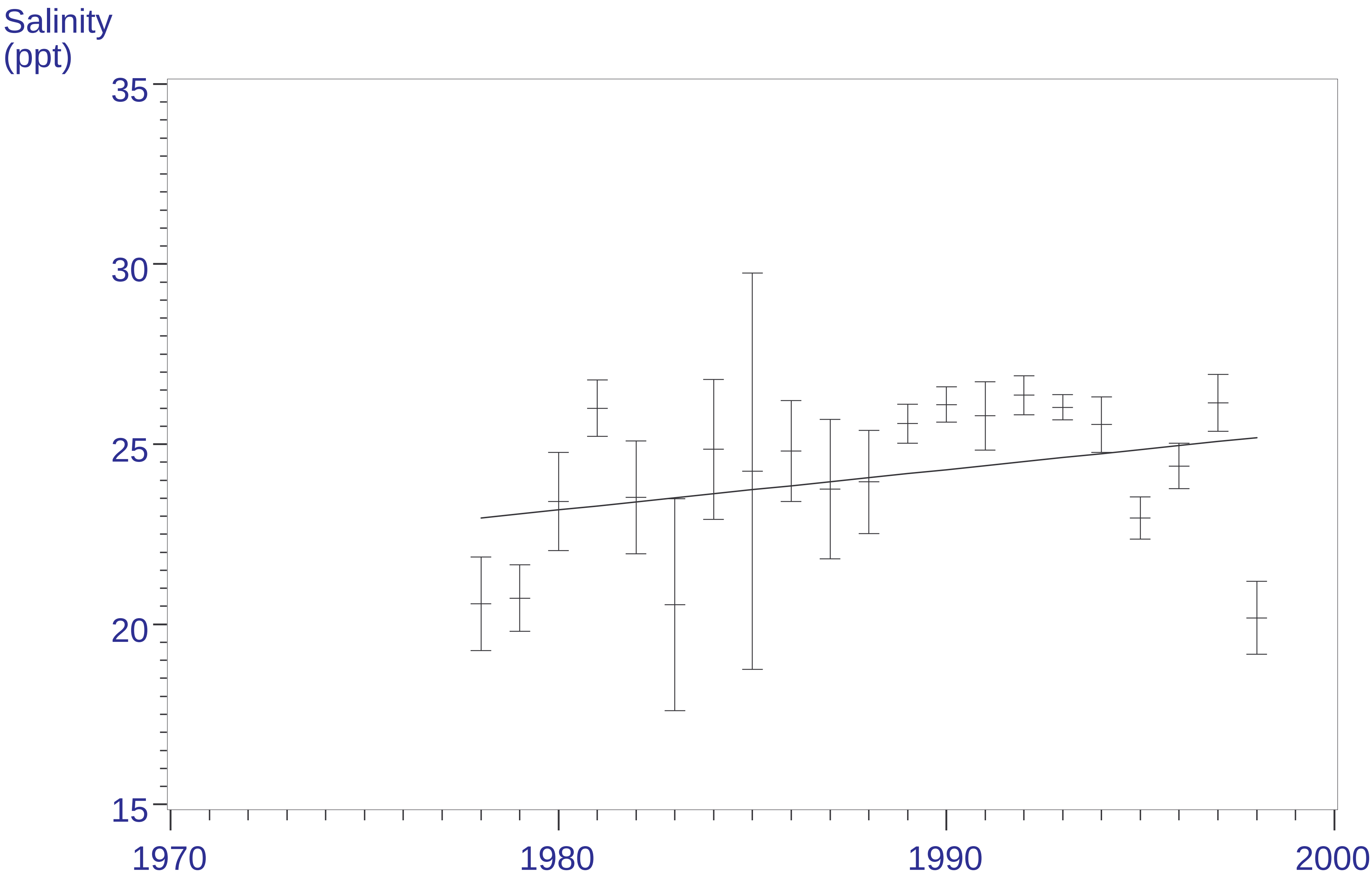
HILLSBOROUGH BAY STATION 4
Assessment of Historical Trends
Mean Annual Secchi Disc Depth
Data Source: COT
Secchi Disc
(meters)
2.0
1.5
1.0
0.5
0.0
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay - Station 4 Surface Salinity (ppt) Data Source: COT	
# of Years of Sampling	21
Number of Samples	770
Mean Annual Slope Estimate	0.110
Lower 95% Confidence Limit	0.061
Upper 95% Confidence Limit	0.158
p Value Slope Statistic	0.0000
Percent Change per Year	0.005

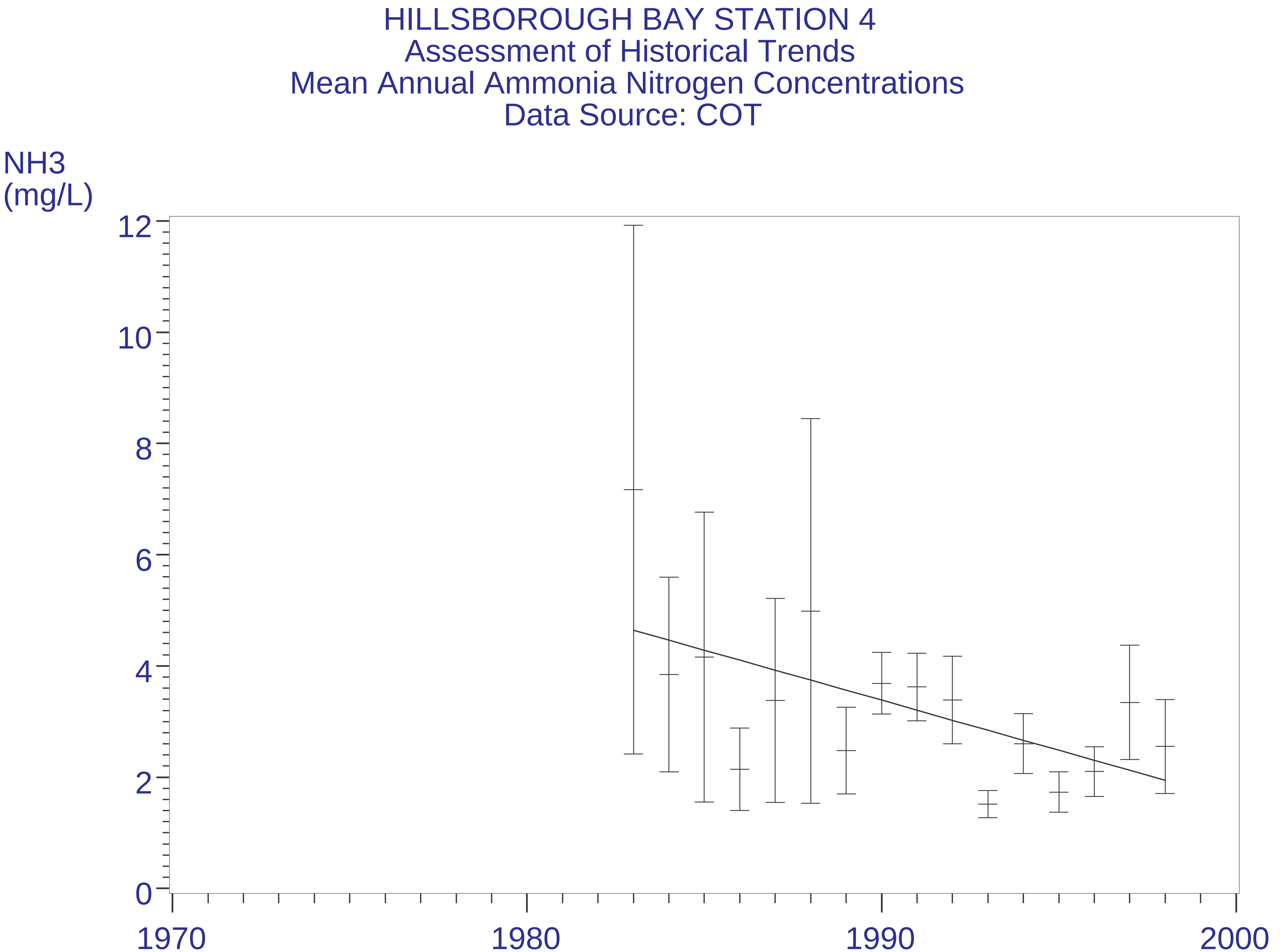

HILLSBOROUGH BAY STATION 4
Assessment of Historical Trends
Mean Annual Surface Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay - Station 4 Bottom Salinity (ppt) Data Source: COT	
# of Years of Sampling	21
Number of Samples	719
Mean Annual Slope Estimate	0.112
Lower 95% Confidence Limit	0.066
Upper 95% Confidence Limit	0.157
p Value Slope Statistic	0.0000
Percent Change per Year	0.005

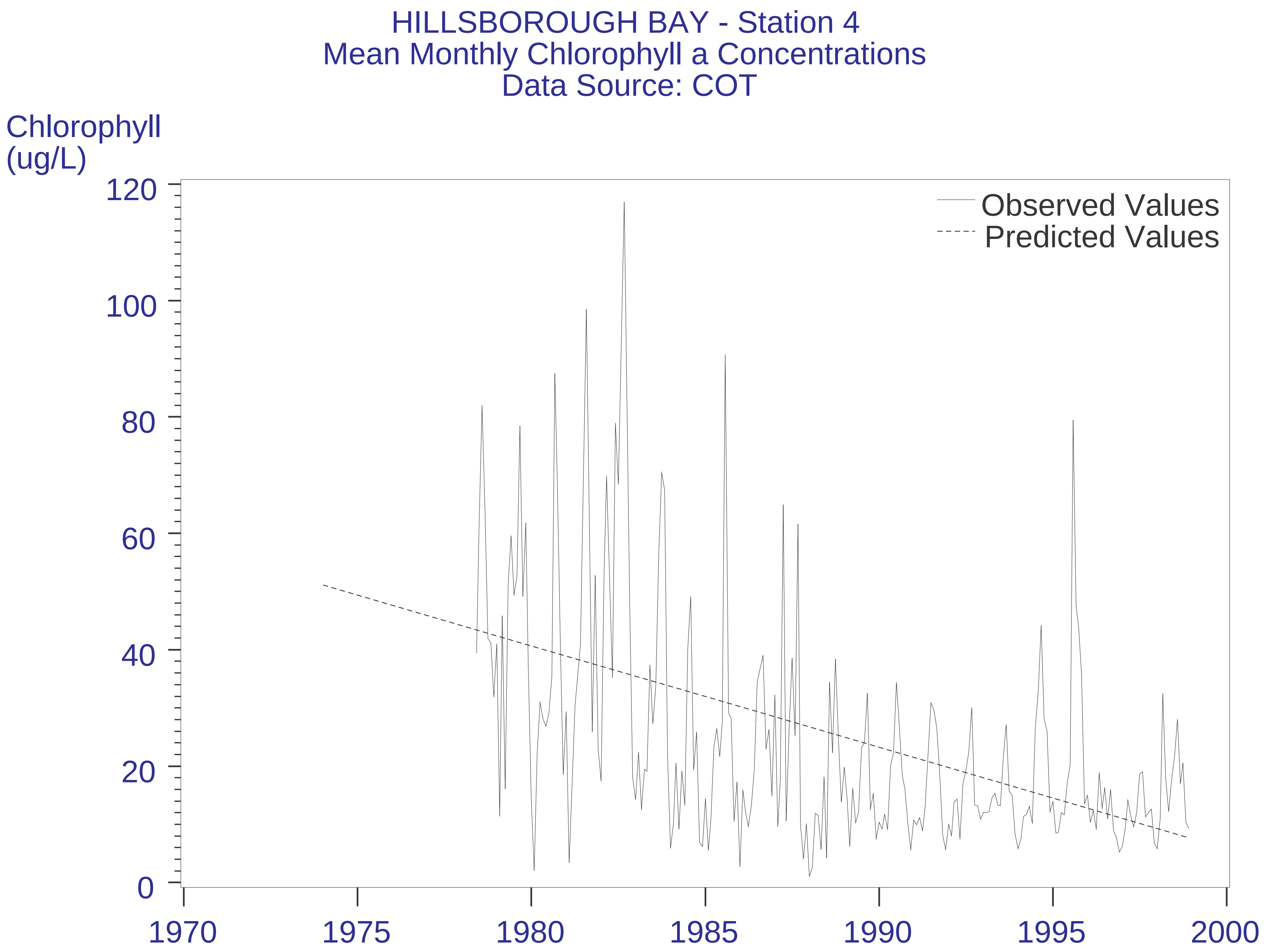
HILLSBOROUGH BAY STATION 4
Assessment of Historical Trends
Mean Annual Bottom Salinity Concentrations
Data Source: COT

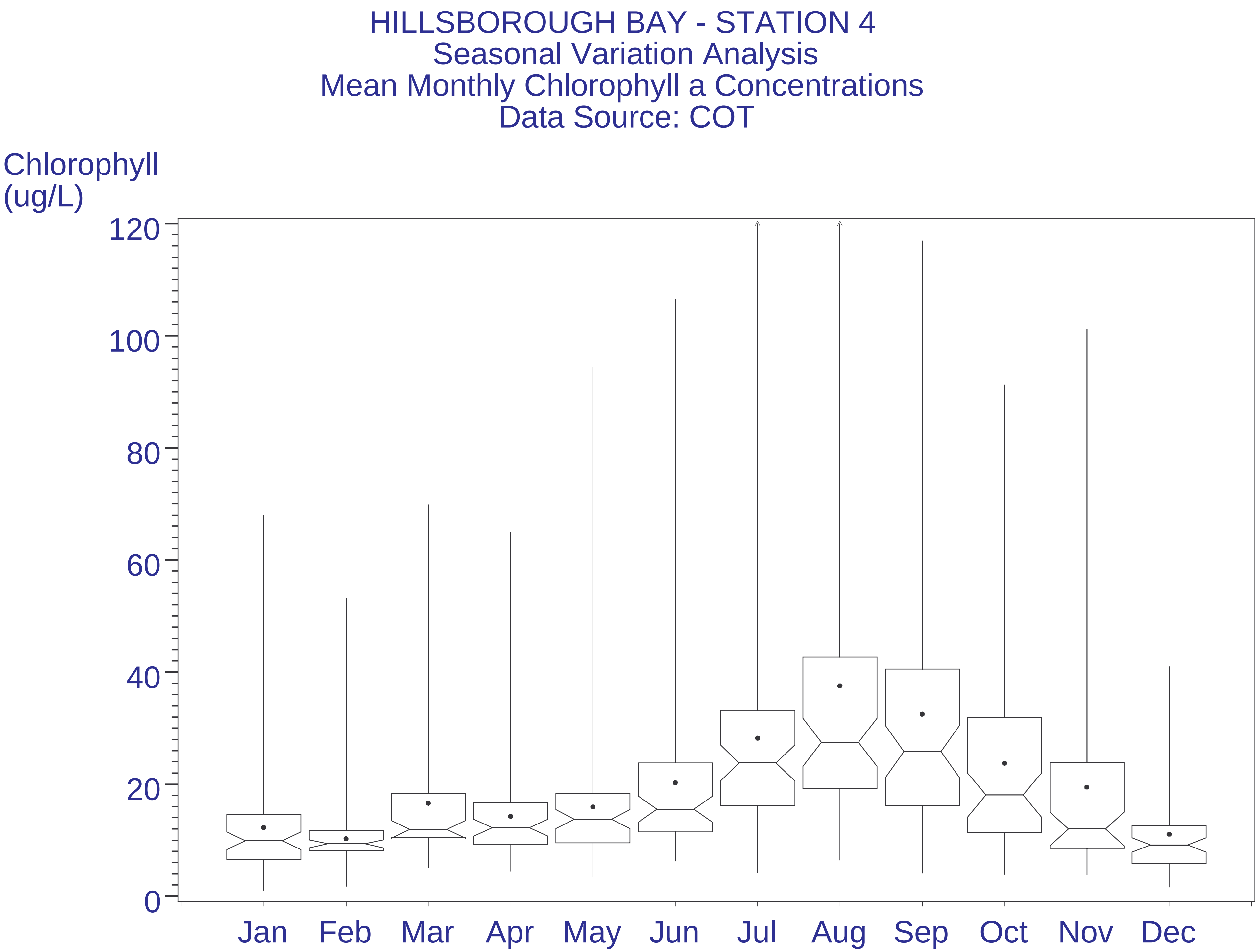


TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Hillsborough Bay - Station 4 Ammonia Nitrogen (mg/L) Data Source: COT	
# of Years of Sampling	16
Number of Samples	710
Mean Annual Slope Estimate	-0.180
Lower 95% Confidence Limit	-0.303
Upper 95% Confidence Limit	-0.056
p Value Slope Statistic	0.0043
Percent Change per Year	-0.055

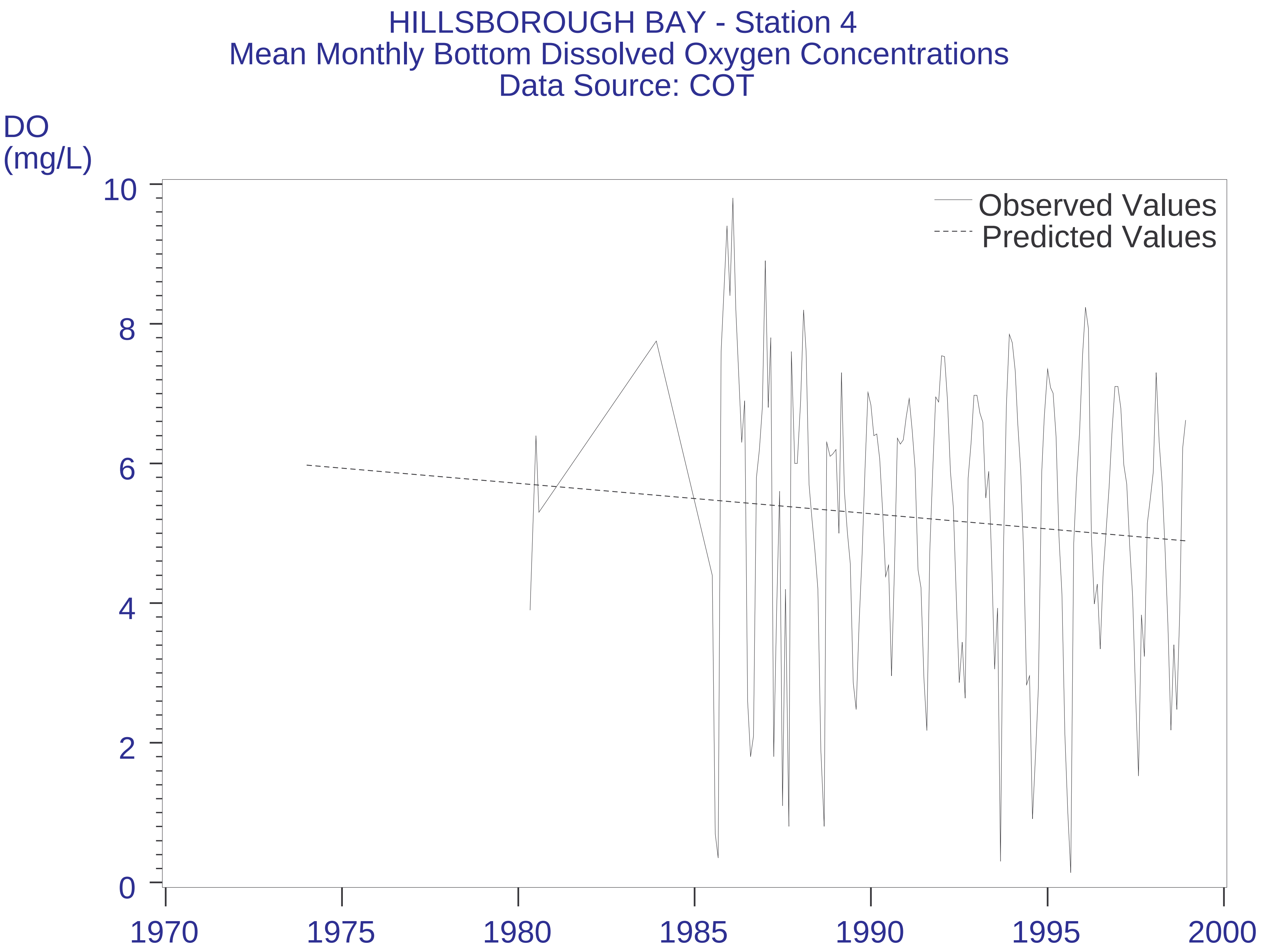

HILLSBOROUGH BAY STATION 4
Assessment of Historical Trends
Mean Annual Ammonia Nitrogen Concentrations
Data Source: COT
NH3
(mg/L)
12
10
8
6
4
2
0
1970
1980
1990
2000

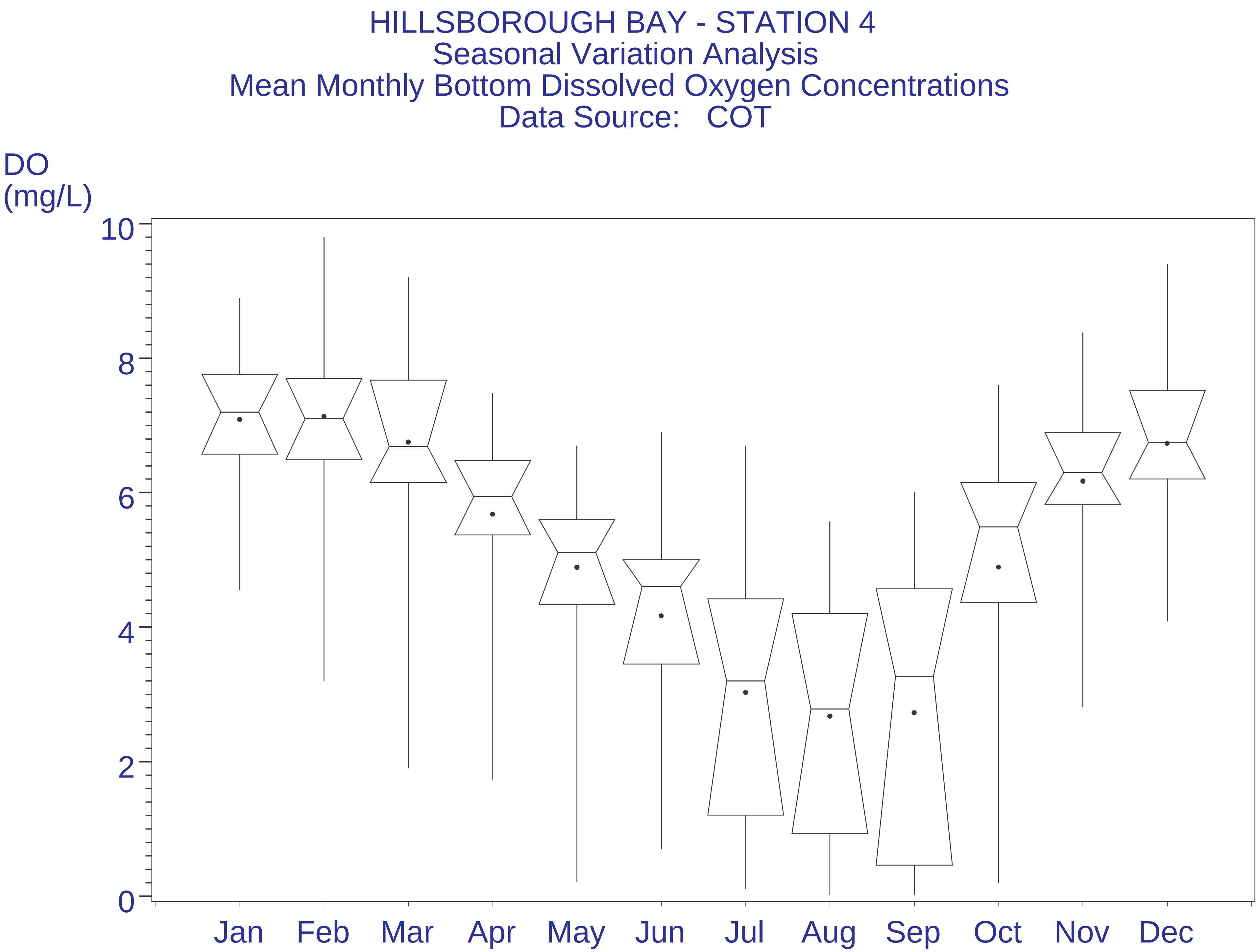
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay - Station 4 Chlorophyll a (ug/L) Data Source: Bay Study Group	
# of Years of Sampling	21
Number of Samples	794
Tau Statistic	-0.403
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.000
p Value Slope Statistic	-1.0605


HILLSBOROUGH BAY - Station 4
Mean Monthly Chlorophyll a Concentrations
Data Source: COT
Chlorophyll
(ug/L)
120
100
80
60
40
20
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

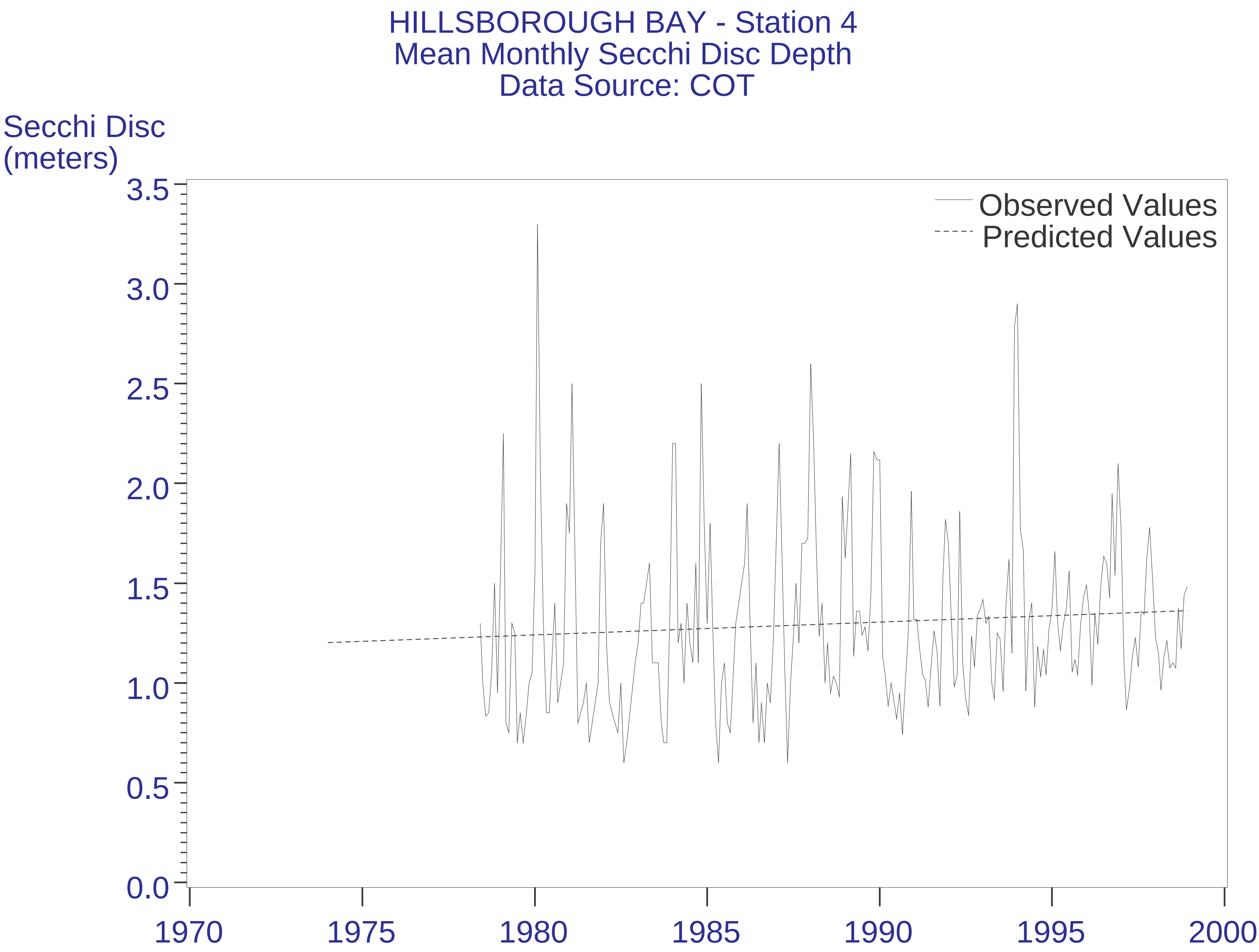

HILLSBOROUGH BAY - STATION 4
Seasonal Variation Analysis
Mean Monthly Chlorophyll a Concentrations
Data Source: COT
Chlorophyll
(ug/L)
0
20
40
60
80
100
120
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay - Station 4 Bottom Dissolved Oxygen (mg/L) Data Source: Bay Study Group	
# of Years of Sampling	15
Number of Samples	681
Tau Statistic	-0.166
P-value without Serial Correlation	0.005
P-value with Serial Correlation	0.038
p Value Slope Statistic	-0.0605


HILLSBOROUGH BAY - Station 4
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: COT
DO
(mg/L)
0
2
4
6
8
10
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

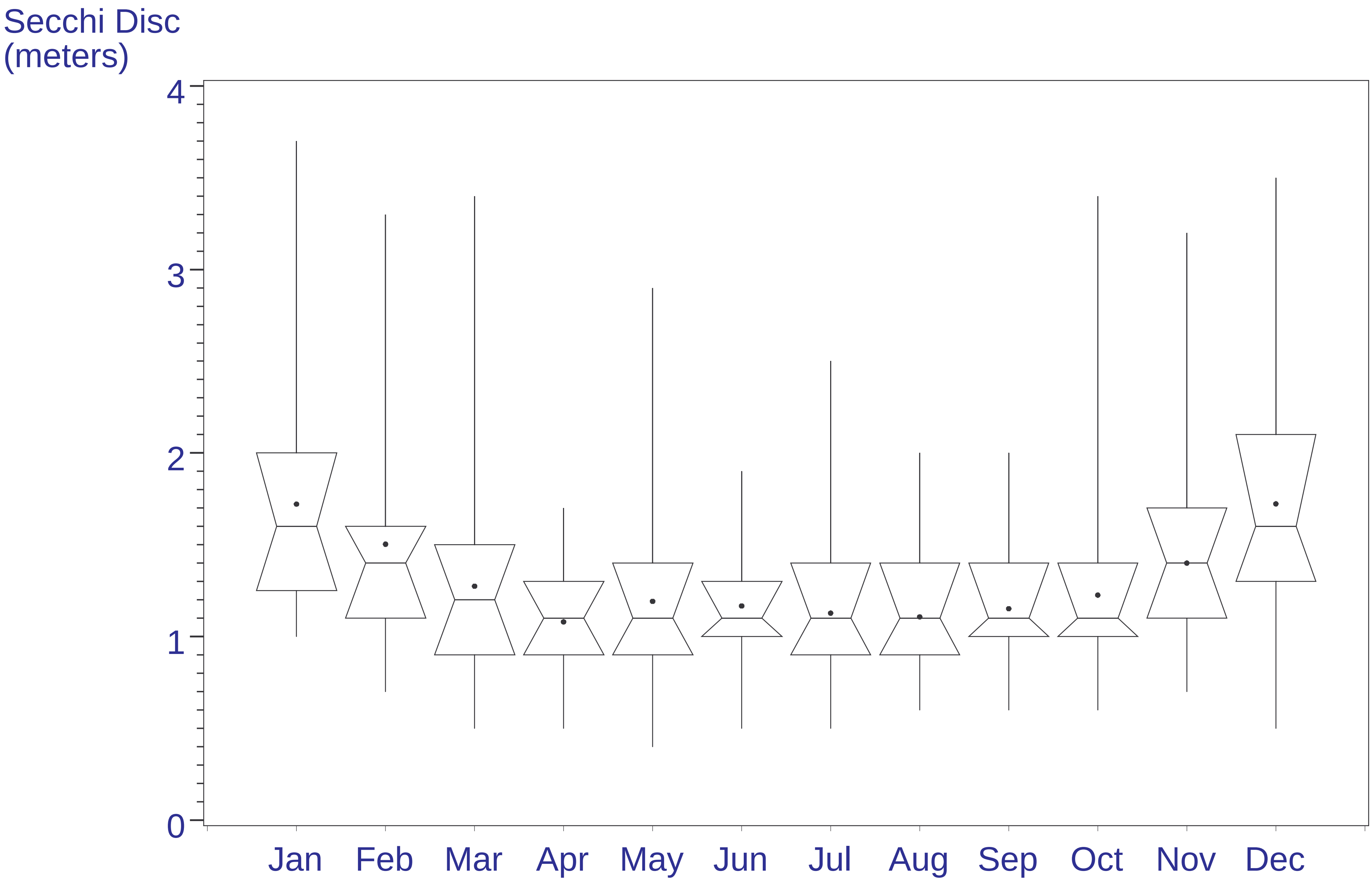

HILLSBOROUGH BAY - STATION 4
Seasonal Variation Analysis
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: COT
DO
(mg/L)
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay - Station 4 Secchi Disc Depth (m) Data Source: Bay Study Group	
# of Years of Sampling	21
Number of Samples	819
Tau Statistic	0.142
P-value without Serial Correlation	0.002
P-value with Serial Correlation	0.080
p Value Slope Statistic	0.0111

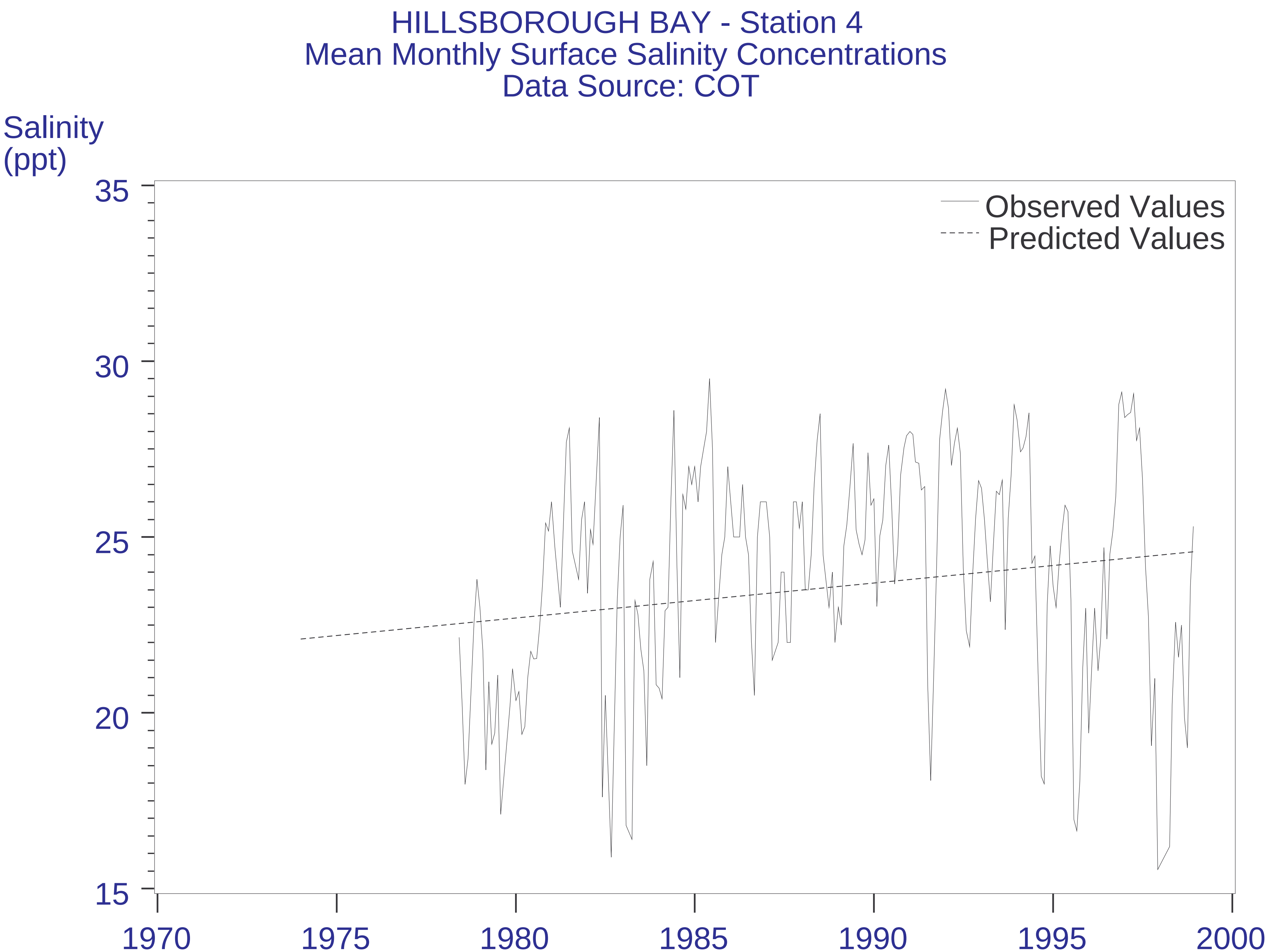


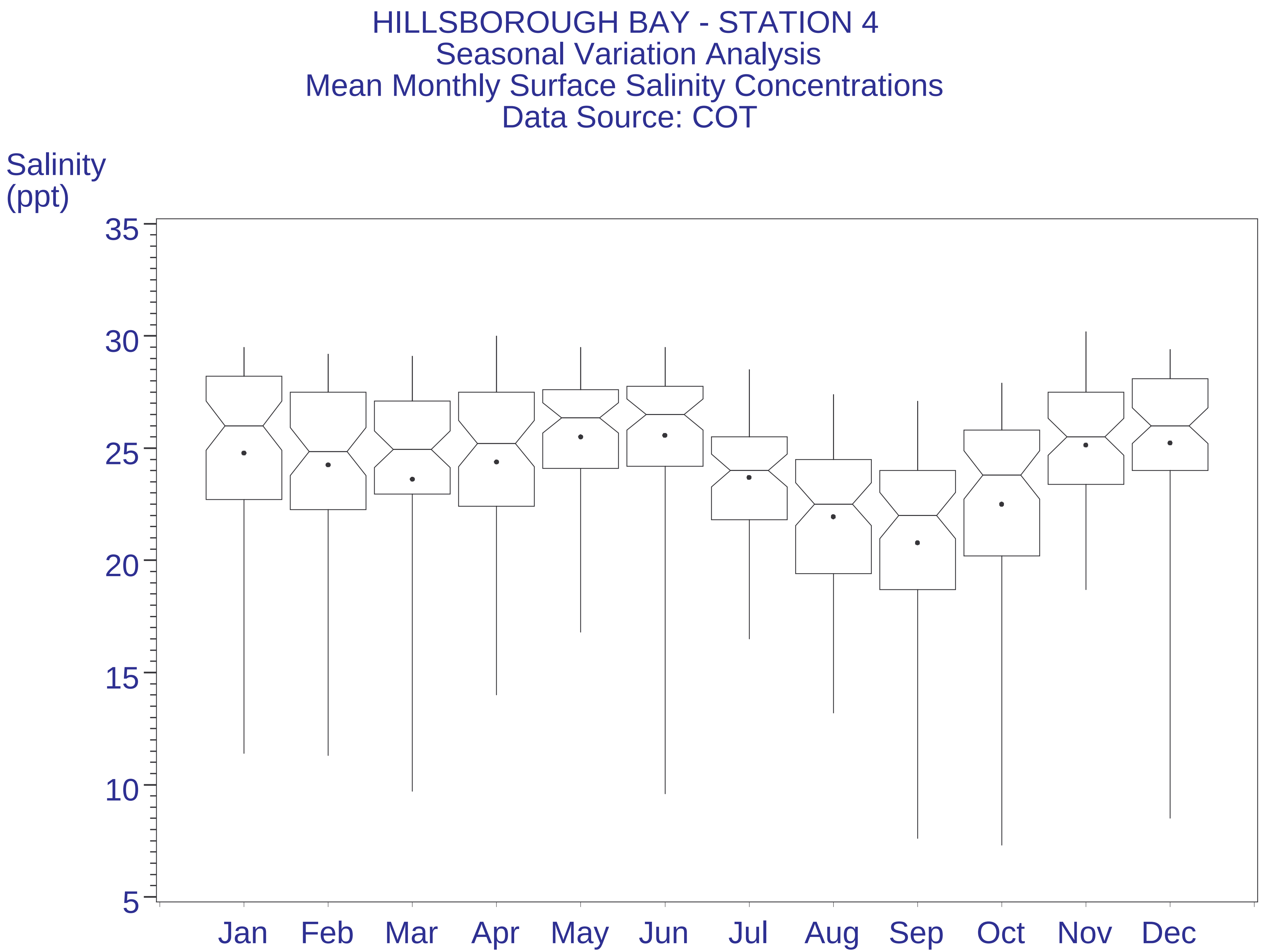
HILLSBOROUGH BAY - Station 4
Mean Monthly Secchi Disc Depth
Data Source: COT
Secchi Disc
(meters)
Observed Values
Predicted Values
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000

HILLSBOROUGH BAY - STATION 4
Seasonal Variation Analysis
Mean Monthly Secchi Disc Depth
Data Source: COT



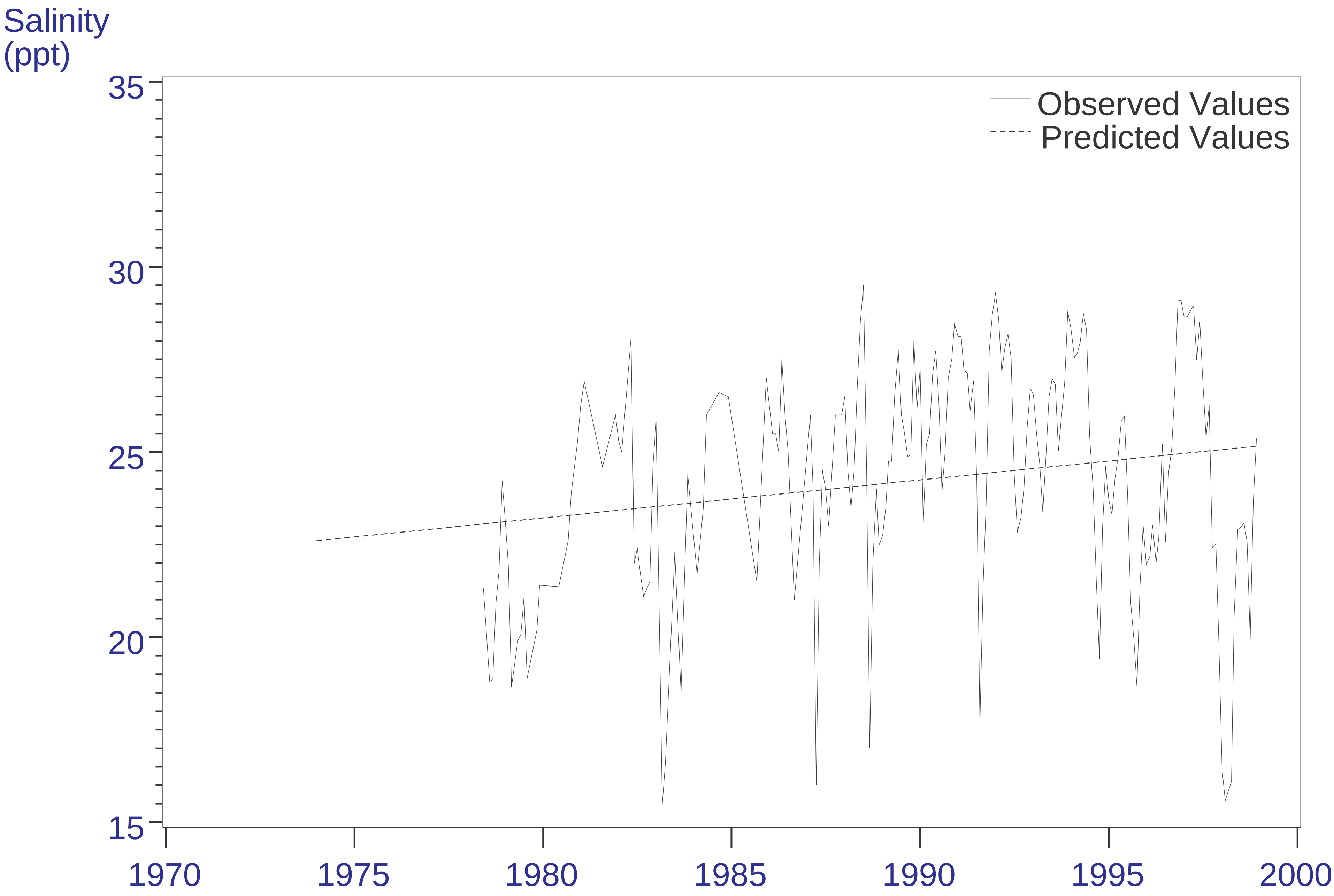
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay - Station 4 Surface Salinity (ppt) Data Source: Bay Study Group	
# of Years of Sampling	21
Number of Samples	770
Tau Statistic	0.181
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.072
p Value Slope Statistic	0.1400

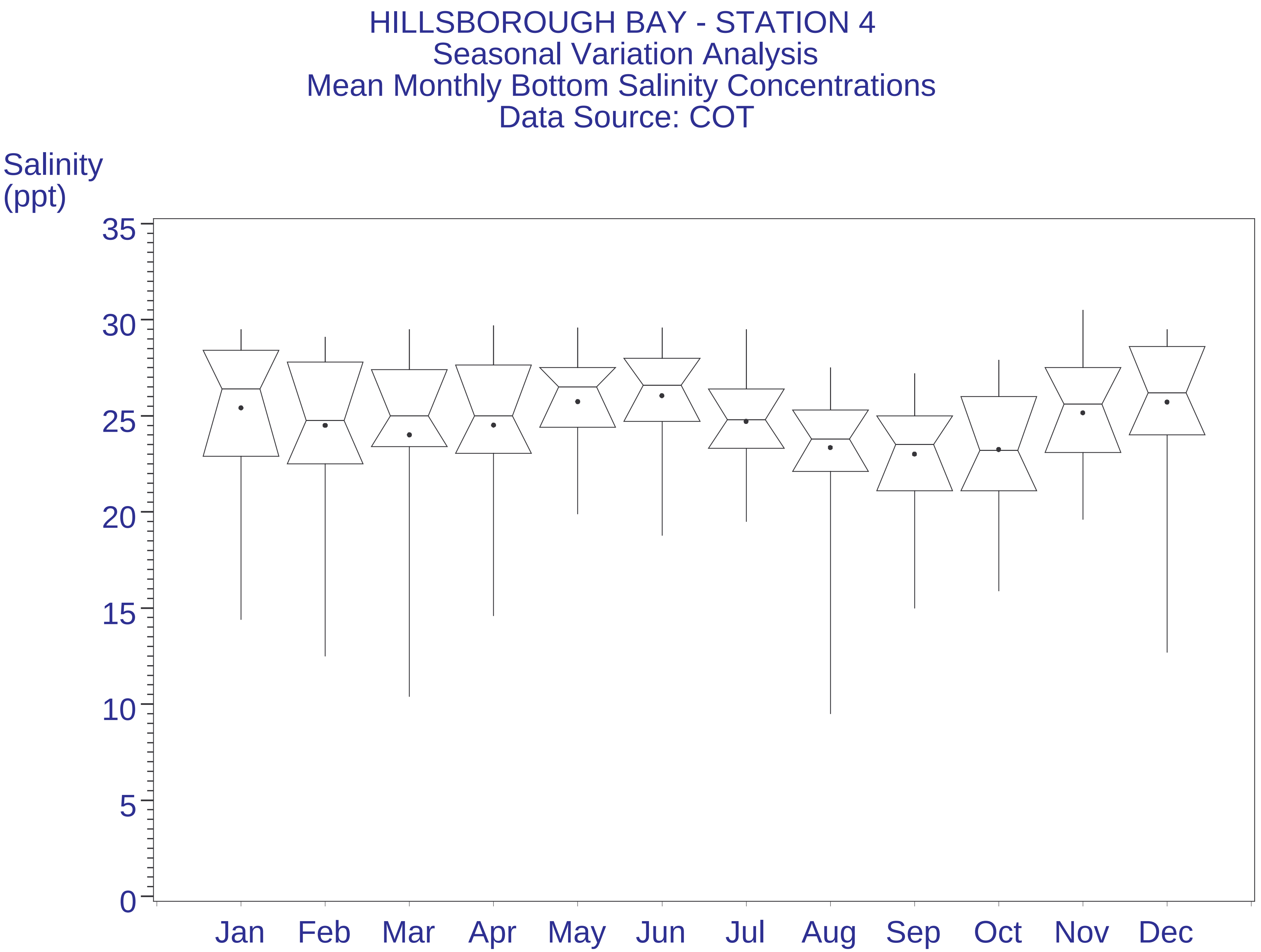

HILLSBOROUGH BAY - Station 4
Mean Monthly Surface Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


HILLSBOROUGH BAY - STATION 4
Seasonal Variation Analysis
Mean Monthly Surface Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
10
5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay - Station 4 Bottom Salinity (ppt) Data Source: Bay Study Group	
# of Years of Sampling	21
Number of Samples	719
Tau Statistic	0.164
P-value without Serial Correlation	0.002
P-value with Serial Correlation	0.128
p Value Slope Statistic	0.1225

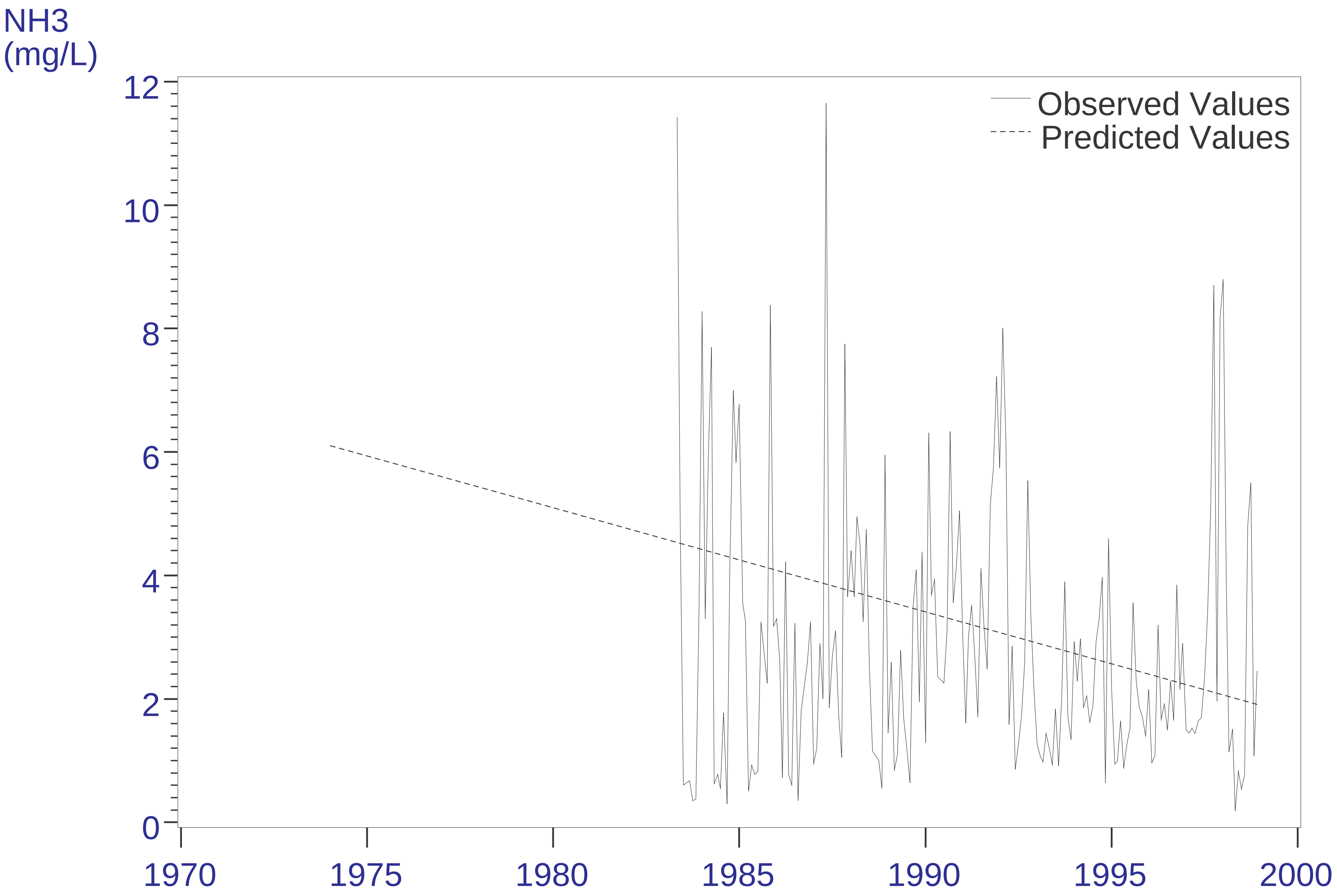
HILLSBOROUGH BAY - Station 4
Mean Monthly Bottom Salinity Concentrations
Data Source: COT

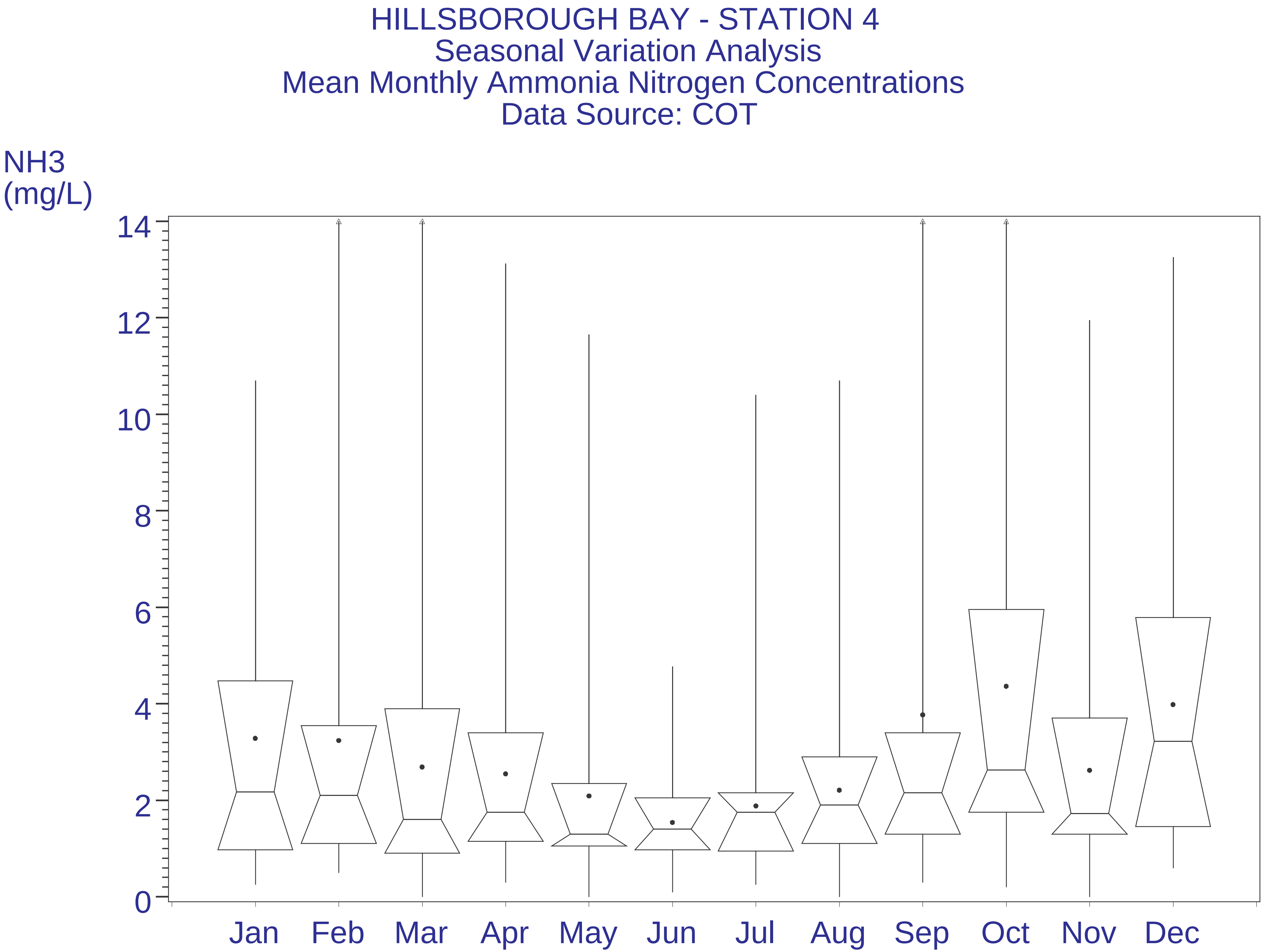



HILLSBOROUGH BAY - STATION 4
Seasonal Variation Analysis
Mean Monthly Bottom Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay - Station 4 Ammonia Nitrogen (mg/L) Data Source: Bay Study Group	
# of Years of Sampling	16
Number of Samples	710
Tau Statistic	-0.093
P-value without Serial Correlation	0.086
P-value with Serial Correlation	0.218
p Value Slope Statistic	-0.0474

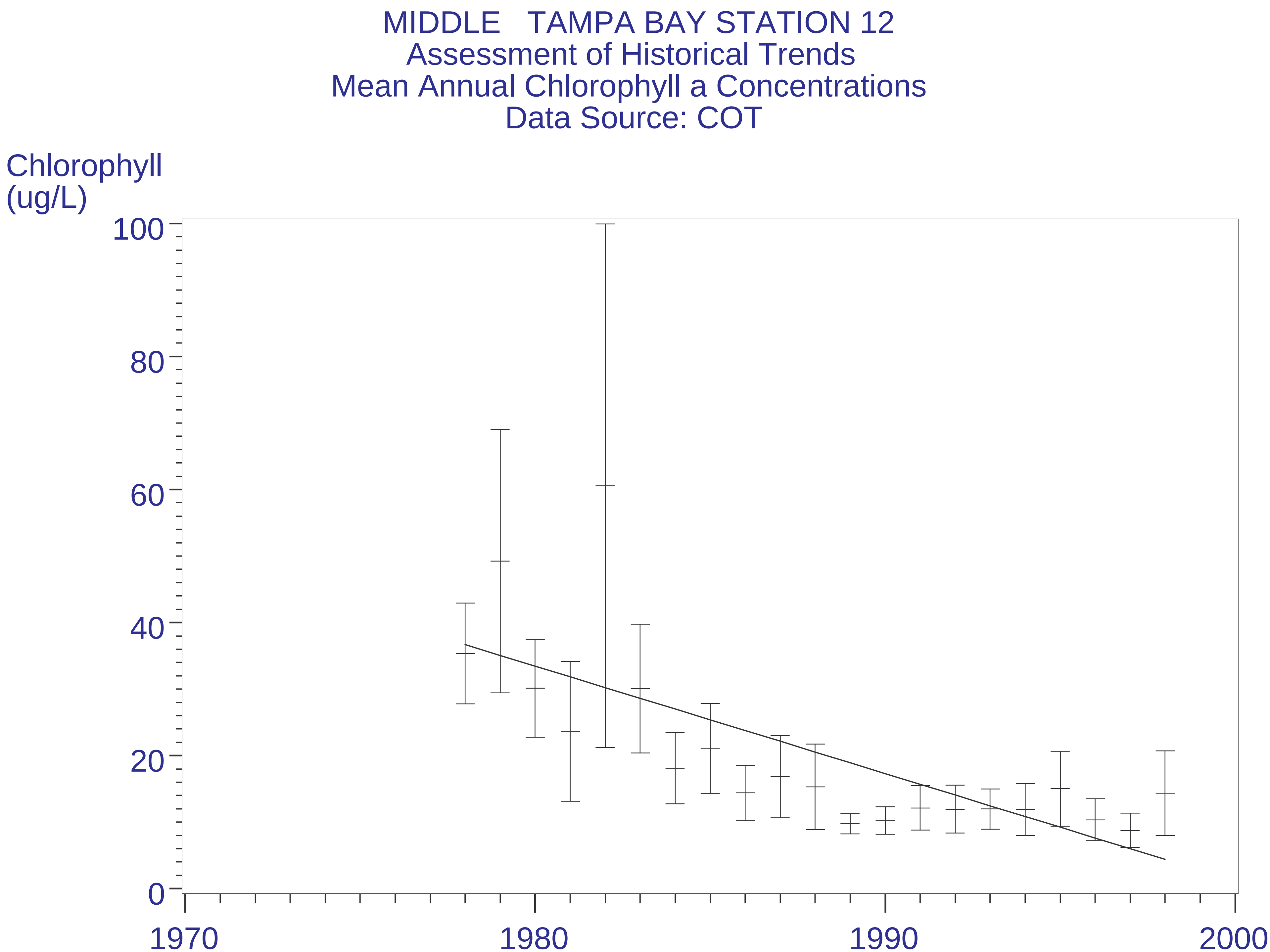
HILLSBOROUGH BAY - Station 4
Mean Monthly Ammonia Nitrogen Concentrations
Data Source: COT



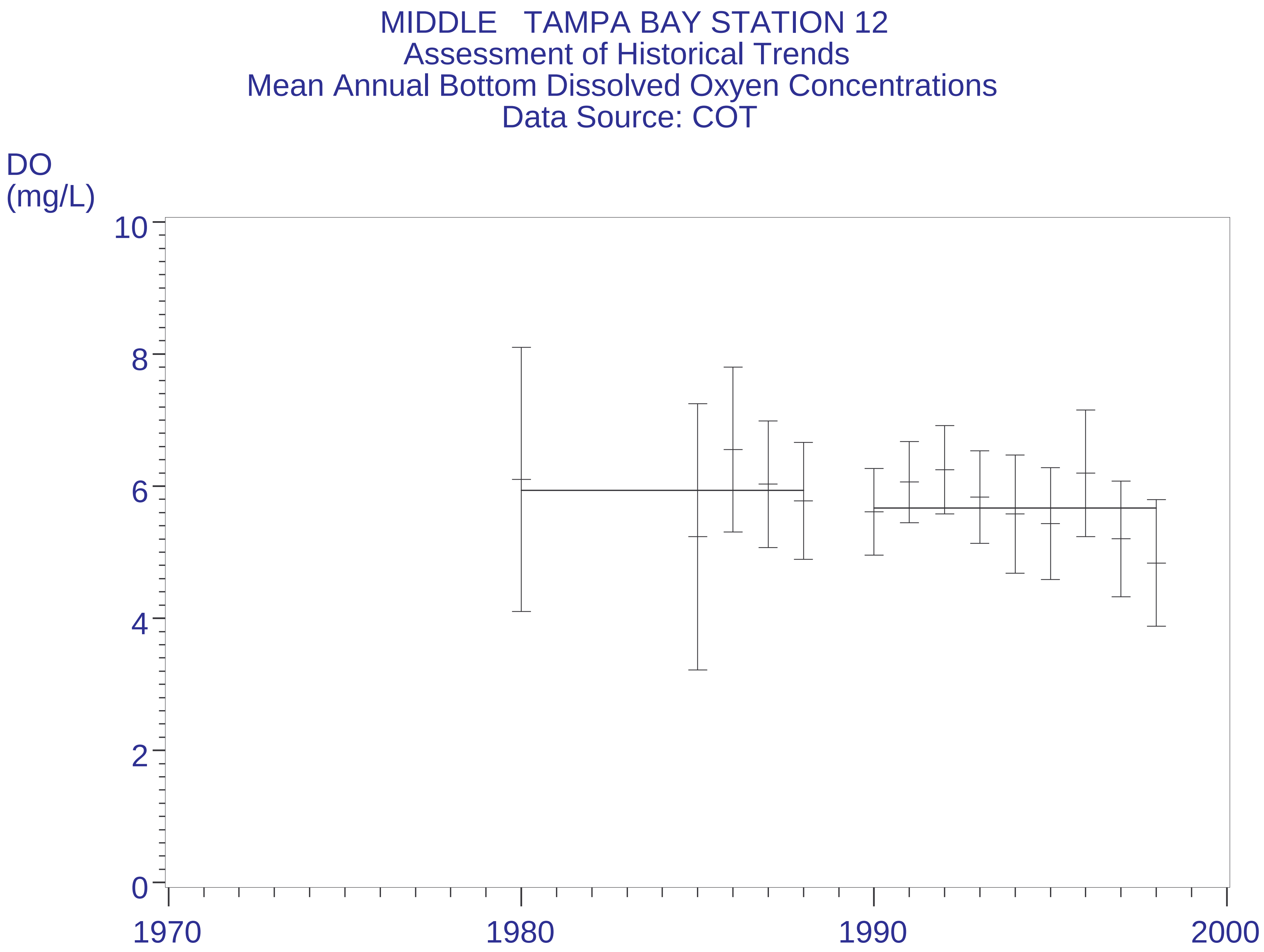

HILLSBOROUGH BAY - STATION 4
Seasonal Variation Analysis
Mean Monthly Ammonia Nitrogen Concentrations
Data Source: COT
NH3
(mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

STATION 12
MIDDLE TAMPA BAY

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 12 Chlorophyll a (ug/L) Data Source: Bay Study Group	
# of Years of Sampling	21
Number of Samples	275
Mean Annual Slope Estimate	-1.613
Lower 95% Confidence Limit	-2.042
Upper 95% Confidence Limit	-1.184
p Value Slope Statistic	0.0000
Percent Change per Year	-0.079


MIDDLE TAMPA BAY STATION 12
Assessment of Historical Trends
Mean Annual Chlorophyll a Concentrations
Data Source: COT
Chlorophyll
(ug/L)
100
80
60
40
20
0
1970
1980
1990
2000

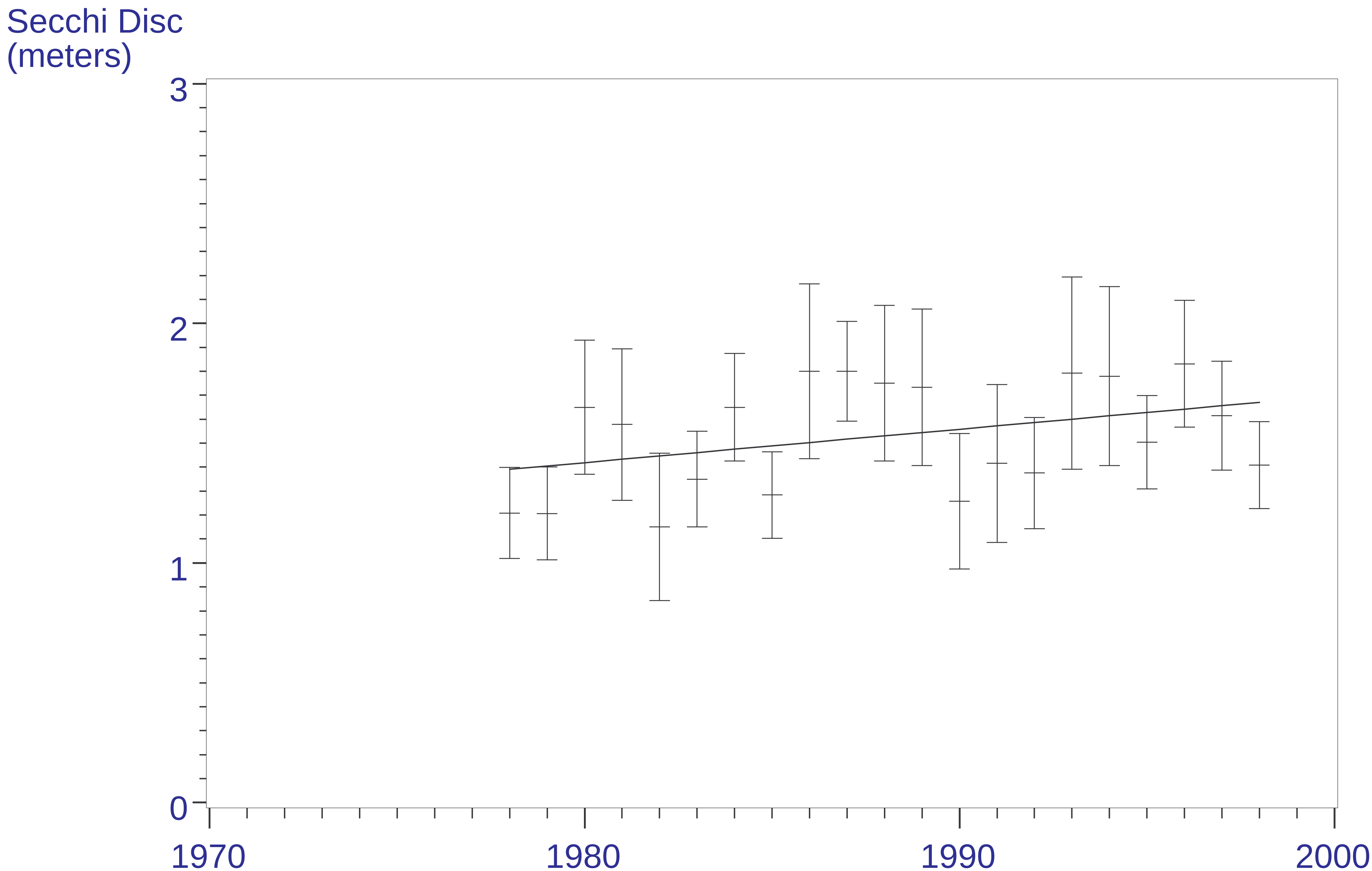
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 12 Bottom Dissolved Oxygen (mg/L) Data Source: Bay Study Group	
# of Years of Sampling	15
Number of Samples	163
Mean Annual Slope Estimate	-0.271
Lower 95% Confidence Limit	-0.888
Upper 95% Confidence Limit	0.345
p Value Slope Statistic	N/A
Percent Change per Year	N/A



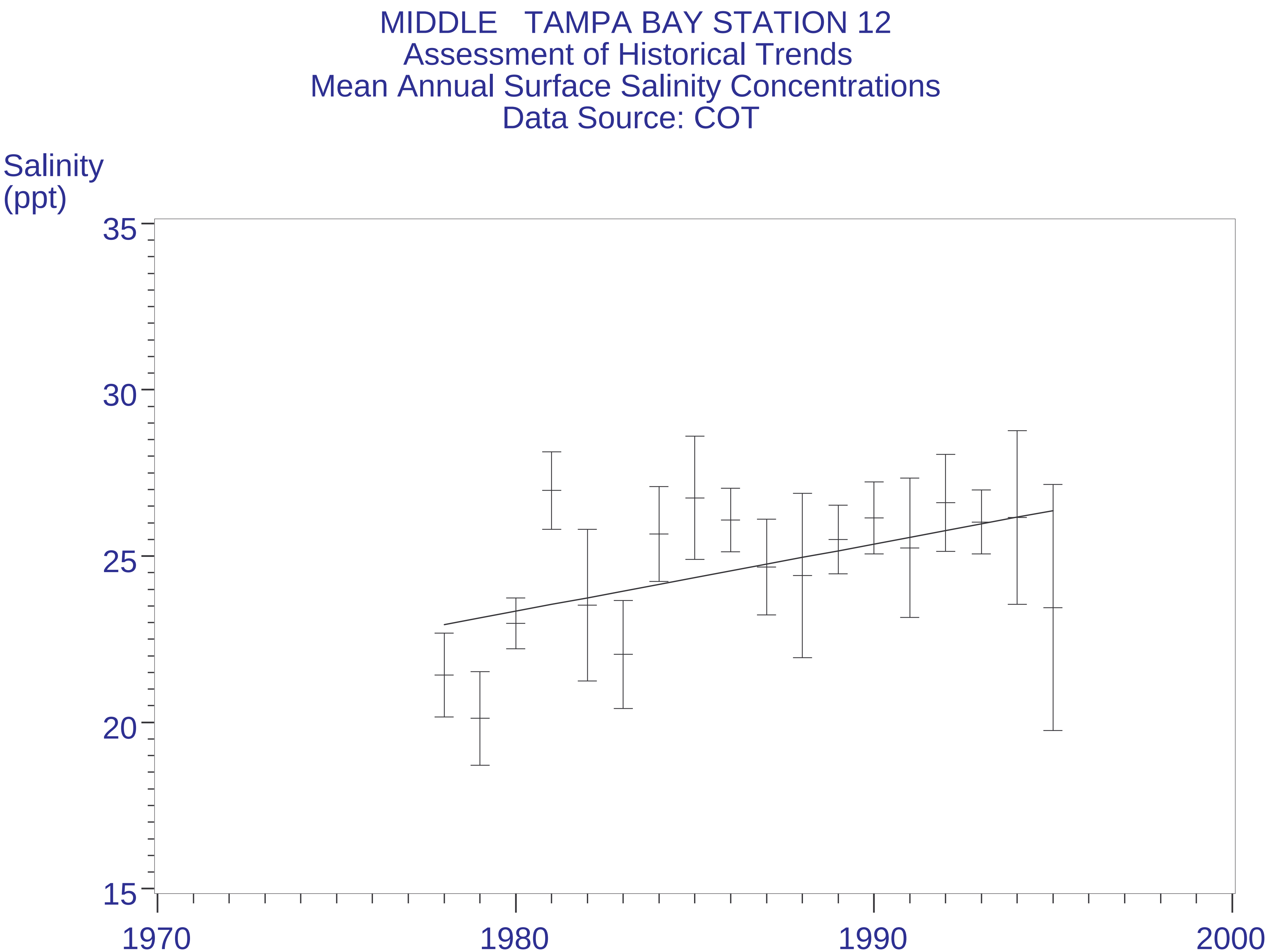
MIDDLE TAMPA BAY STATION 12
Assessment of Historical Trends
Mean Annual Bottom Dissolved Oxyen Concentrations
Data Source: COT
DO
(mg/L)
10
8
6
4
2
0
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 12 Secchi Disc Depth (m) Data Source: Bay Study Group	
# of Years of Sampling	21
Number of Samples	272
Mean Annual Slope Estimate	0.014
Lower 95% Confidence Limit	0.005
Upper 95% Confidence Limit	0.023
p Value Slope Statistic	0.0019
Percent Change per Year	0.009

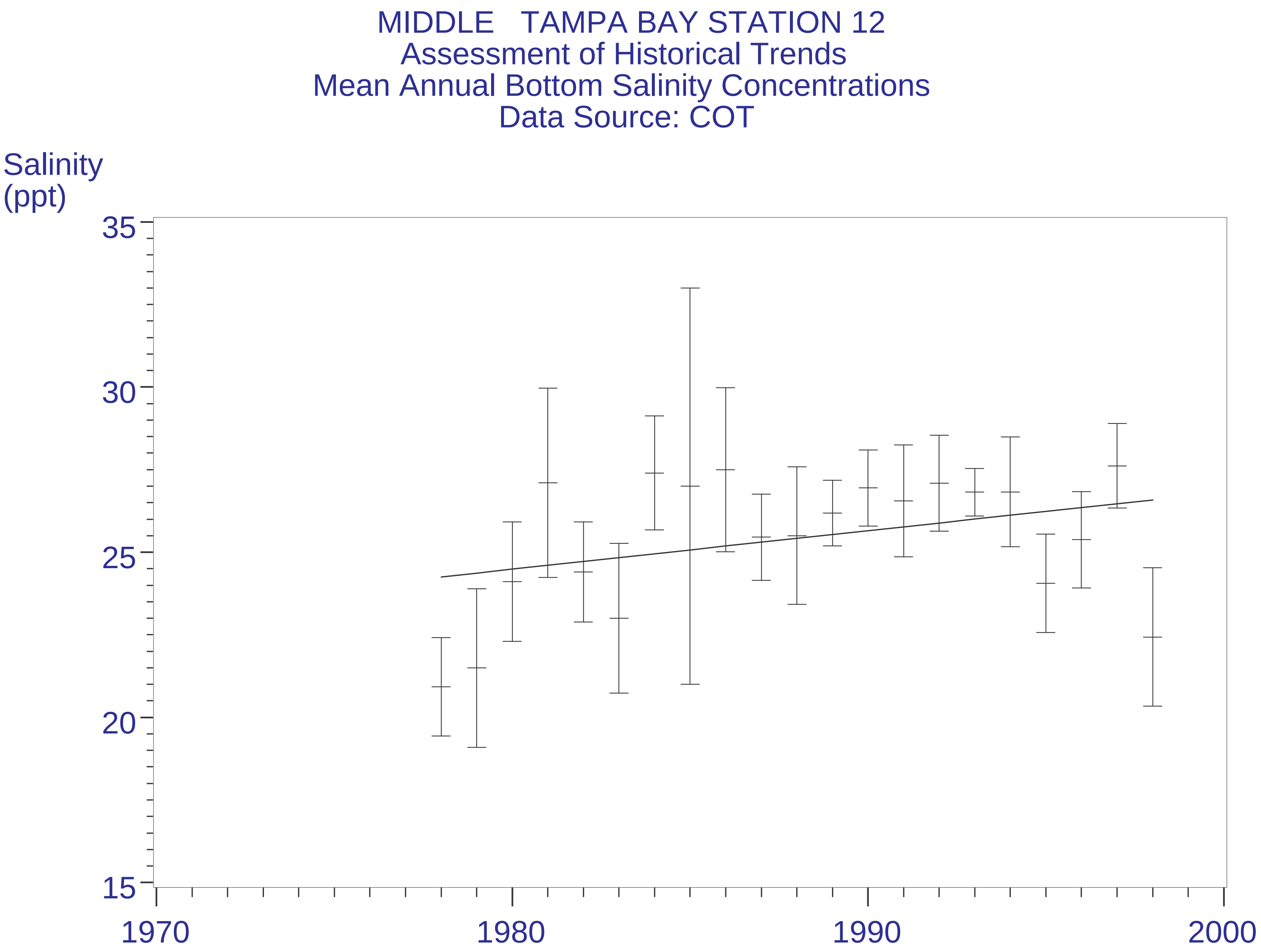
MIDDLE TAMPA BAY STATION 12
Assessment of Historical Trends
Mean Annual Secchi Disc Depth
Data Source: COT



TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 12 Surface Salinity (ppt) Data Source: Bay Study Group	
# of Years of Sampling	18
Number of Samples	225
Mean Annual Slope Estimate	0.202
Lower 95% Confidence Limit	0.110
Upper 95% Confidence Limit	0.294
p Value Slope Statistic	0.0000
Percent Change per Year	0.008


MIDDLE TAMPA BAY STATION 12
Assessment of Historical Trends
Mean Annual Surface Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
1970
1980
1990
2000

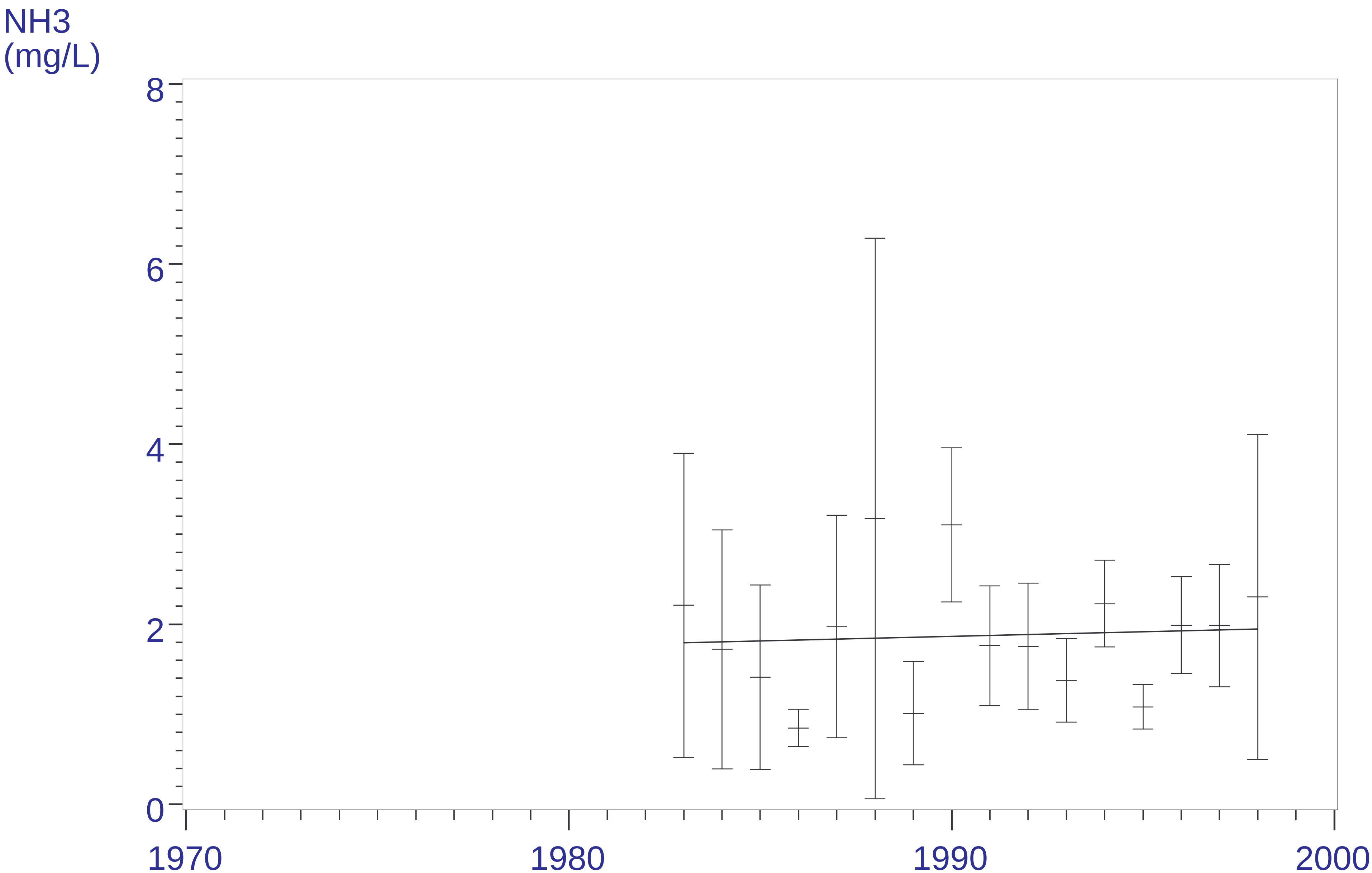
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 12 Bottom Salinity (ppt) Data Source: Bay Study Group	
# of Years of Sampling	21
Number of Samples	190
Mean Annual Slope Estimate	0.117
Lower 95% Confidence Limit	0.048
Upper 95% Confidence Limit	0.185
p Value Slope Statistic	0.0009
Percent Change per Year	0.005



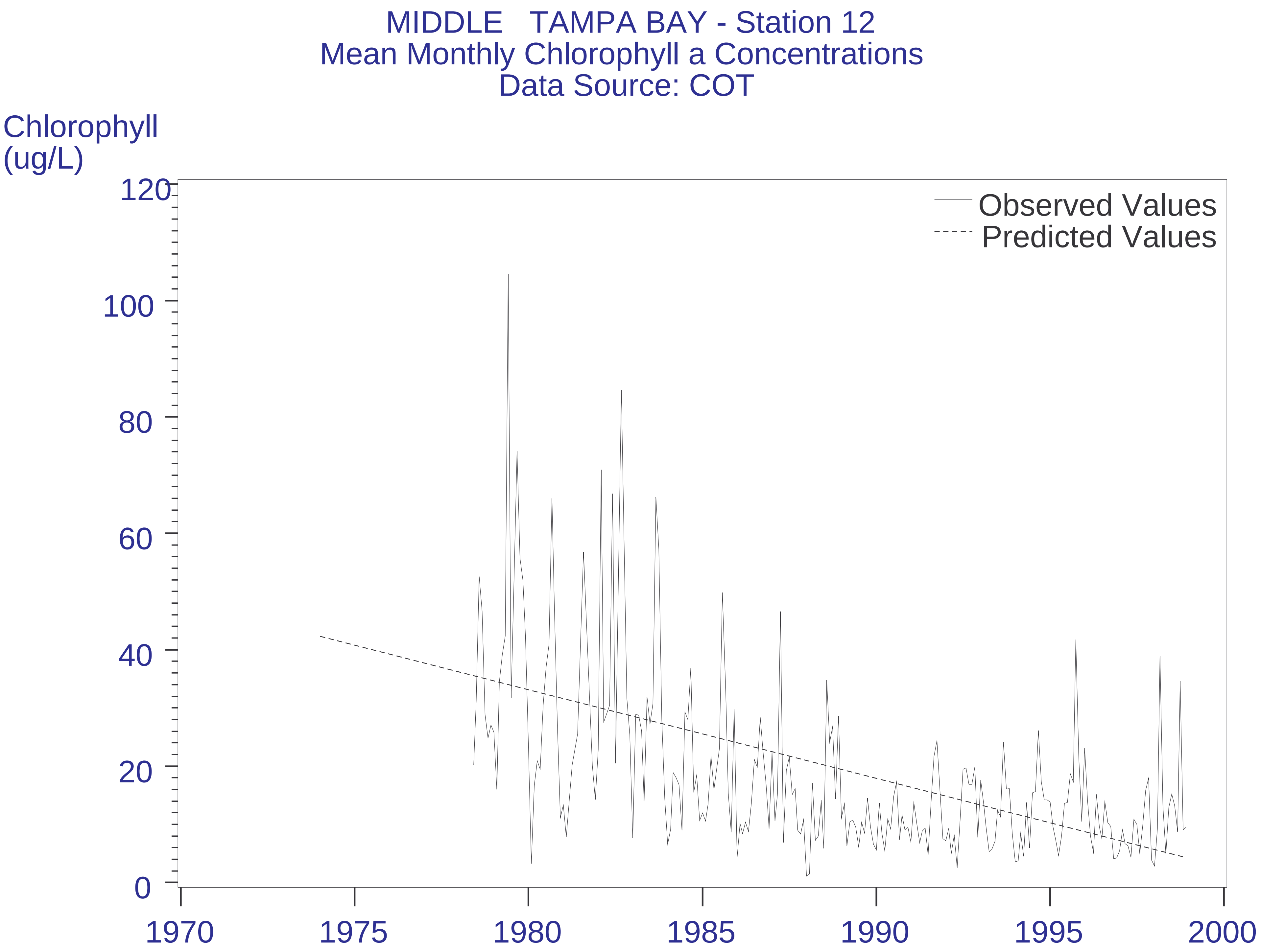
MIDDLE TAMPA BAY STATION 12
Assessment of Historical Trends
Mean Annual Bottom Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
1970
1980
1990
2000

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 12 Ammonia Nitrogen (mg/L) Data Source: Bay Study Group	
# of Years of Sampling	16
Number of Samples	193
Mean Annual Slope Estimate	0.010
Lower 95% Confidence Limit	-0.058
Upper 95% Confidence Limit	0.079
p Value Slope Statistic	0.7684
Percent Change per Year	0.006

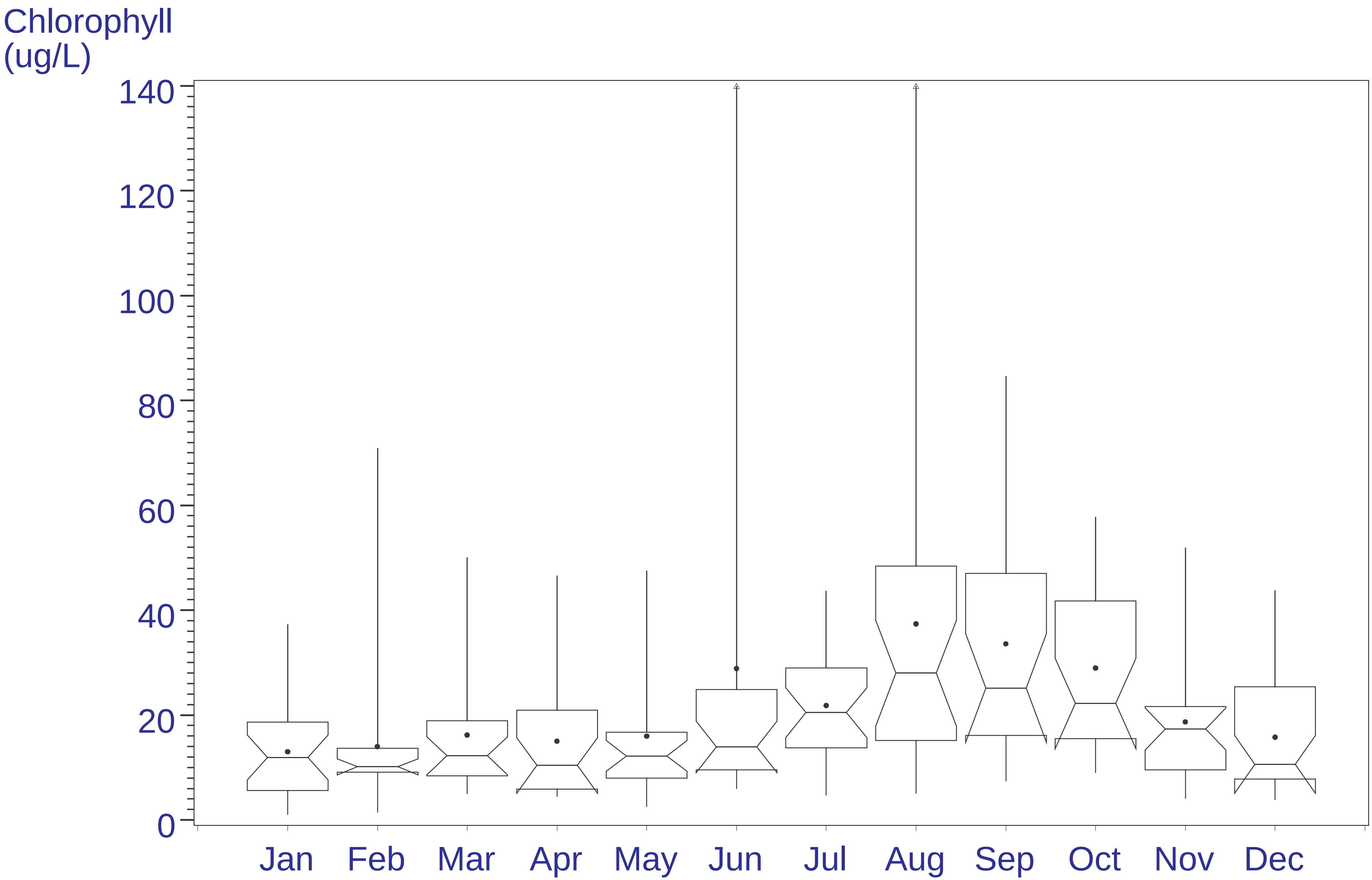
MIDDLE TAMPA BAY STATION 12
Assessment of Historical Trends
Mean Annual Ammonia Nitrogen Concentrations
Data Source: COT



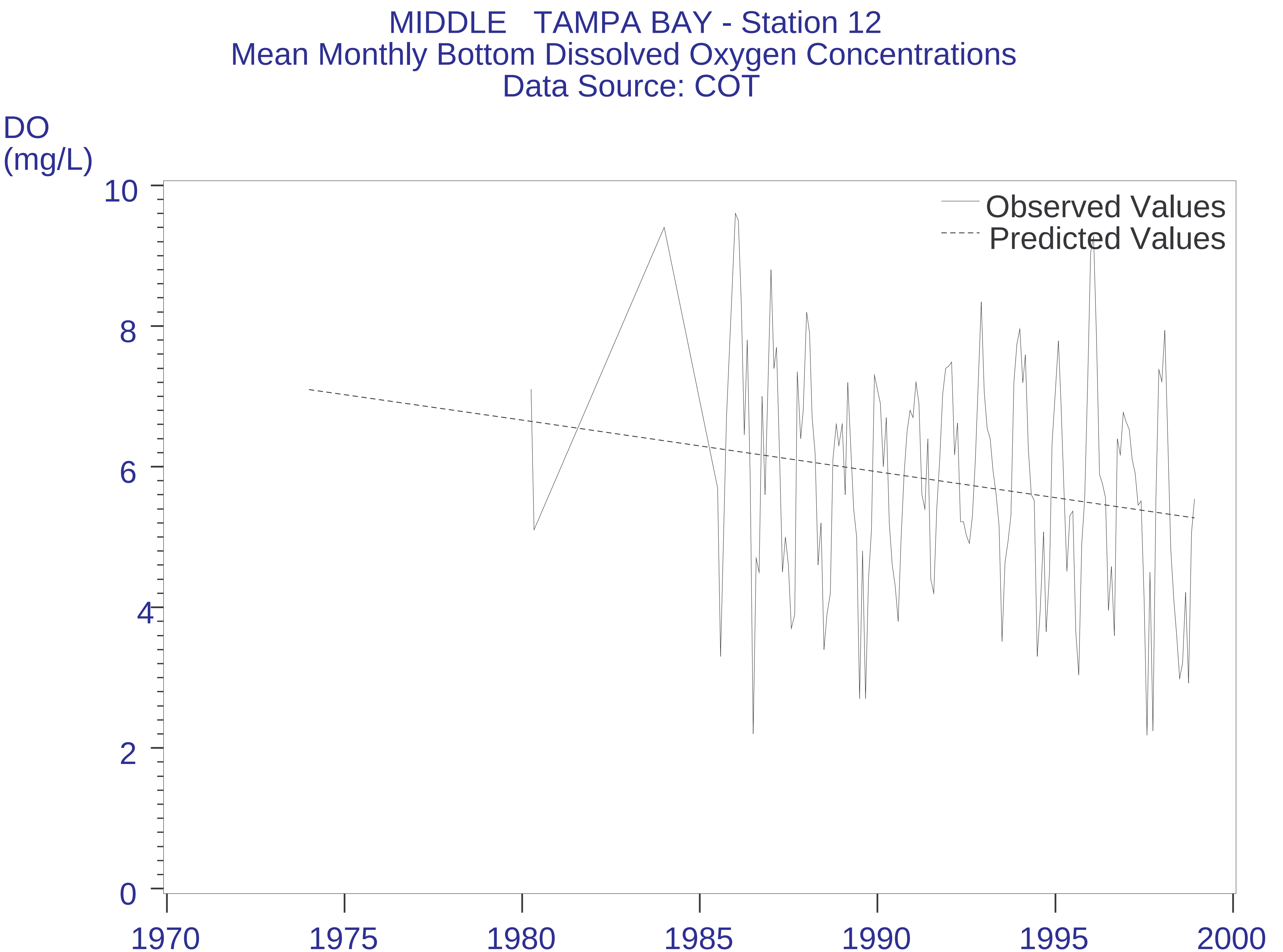
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 12 Chlorophyll a (ug/L) Data Source: Bay Study Group	
# of Years of Sampling	21
Number of Samples	275
Tau Statistic	-0.446
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.000
p Value Slope Statistic	-0.9849

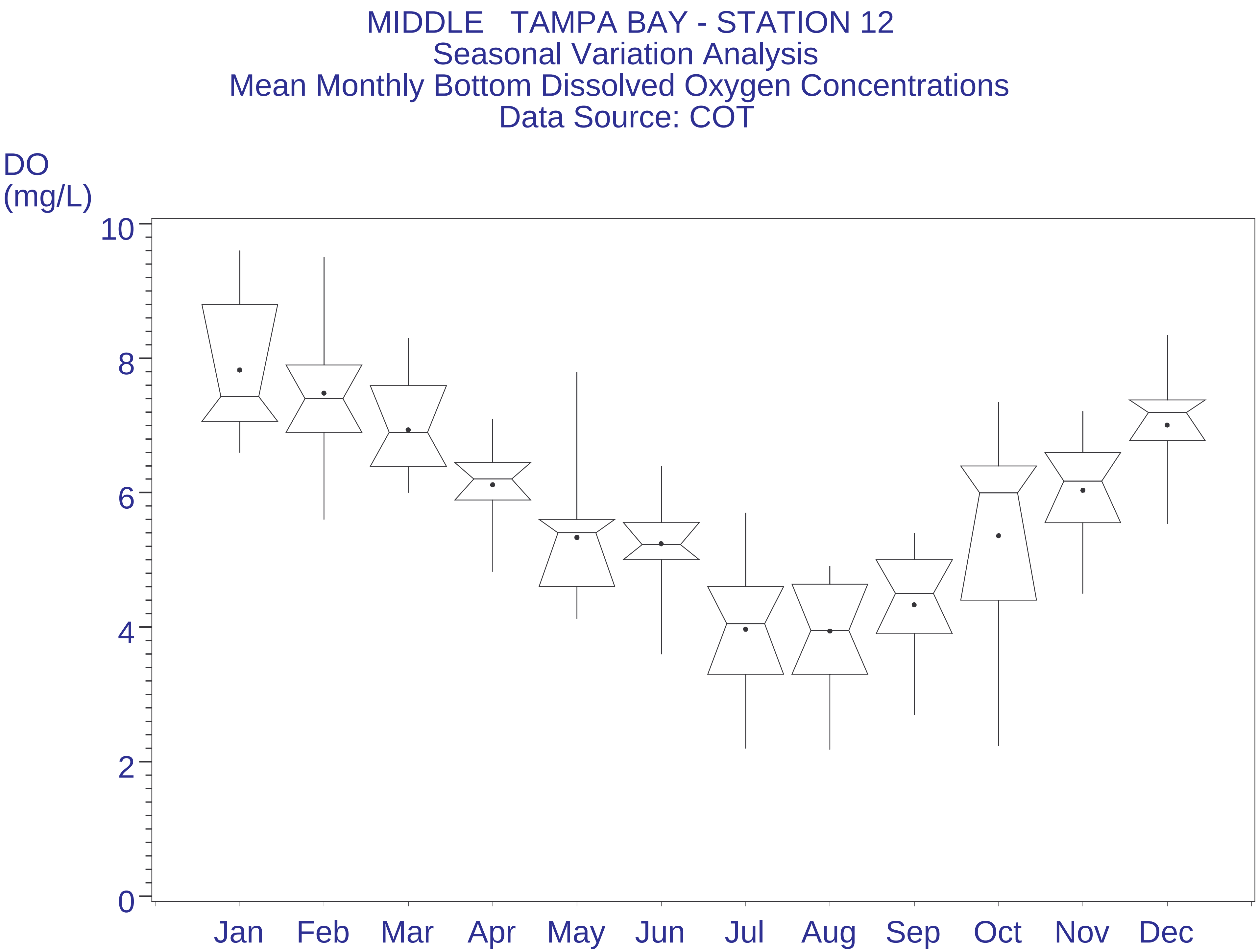

MIDDLE TAMPA BAY - Station 12
Mean Monthly Chlorophyll a Concentrations
Data Source: COT
Chlorophyll
(ug/L)
Observed Values
Predicted Values
120
100
80
60
40
20
0
1970
1975
1980
1985
1990
1995
2000

MIDDLE TAMPA BAY - STATION 12
Seasonal Variation Analysis
Mean Monthly Chlorophyll a Concentrations
Data Source: COT

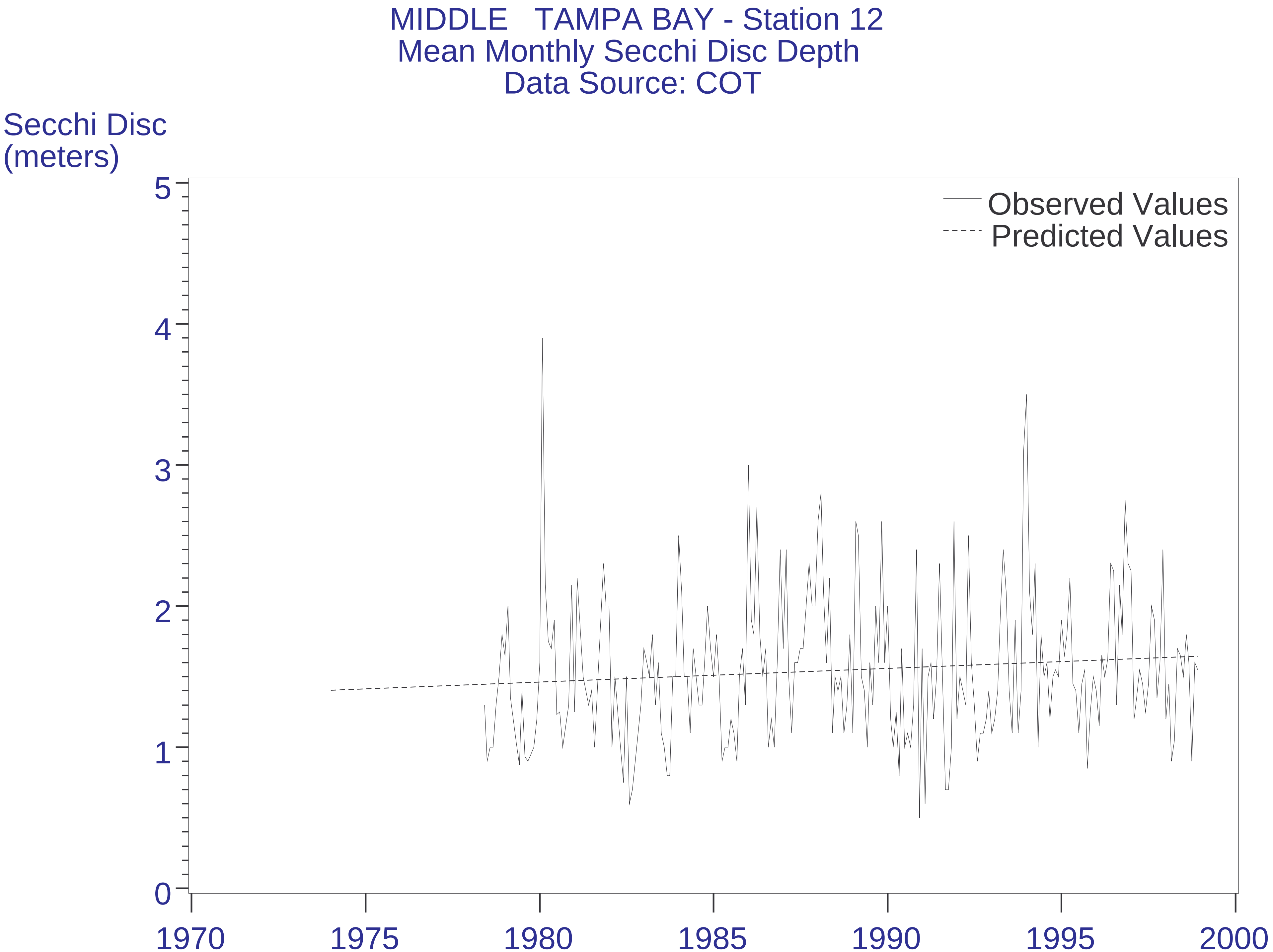


TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 12 Bottom Dissolved Oxygen (mg/L) Data Source: Bay Study Group	
# of Years of Sampling	15
Number of Samples	163
Tau Statistic	-0.164
P-value without Serial Correlation	0.006
P-value with Serial Correlation	0.093
p Value Slope Statistic	-0.0500

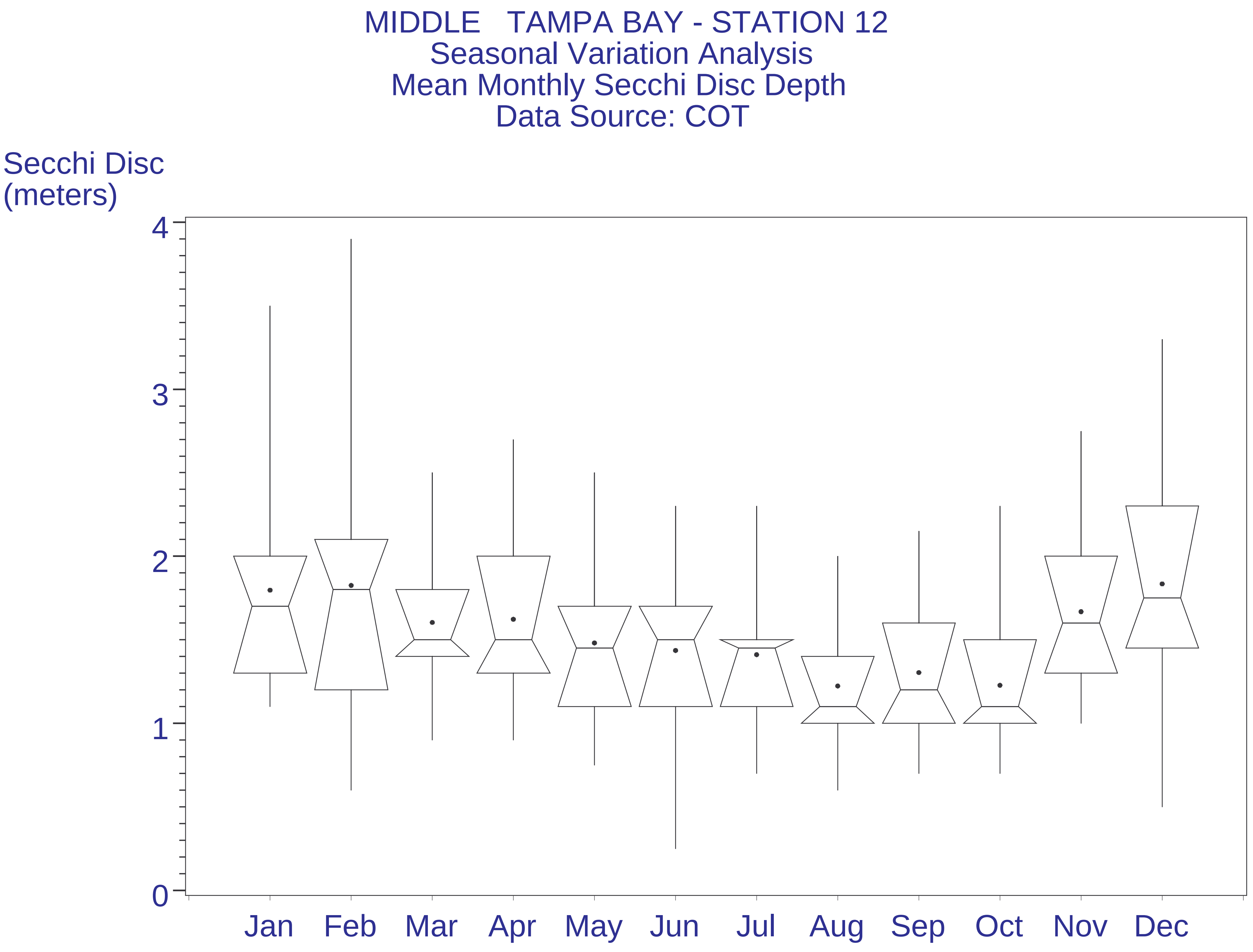

MIDDLE TAMPA BAY - Station 12
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: COT
DO
(mg/L)
10
8
6
4
2
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


MIDDLE TAMPA BAY - STATION 12
Seasonal Variation Analysis
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: COT
DO
(mg/L)
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 12 Secchi Disc Depth (m) Data Source: Bay Study Group	
# of Years of Sampling	21
Number of Samples	272
Tau Statistic	0.122
P-value without Serial Correlation	0.009
P-value with Serial Correlation	0.113
p Value Slope Statistic	0.0126

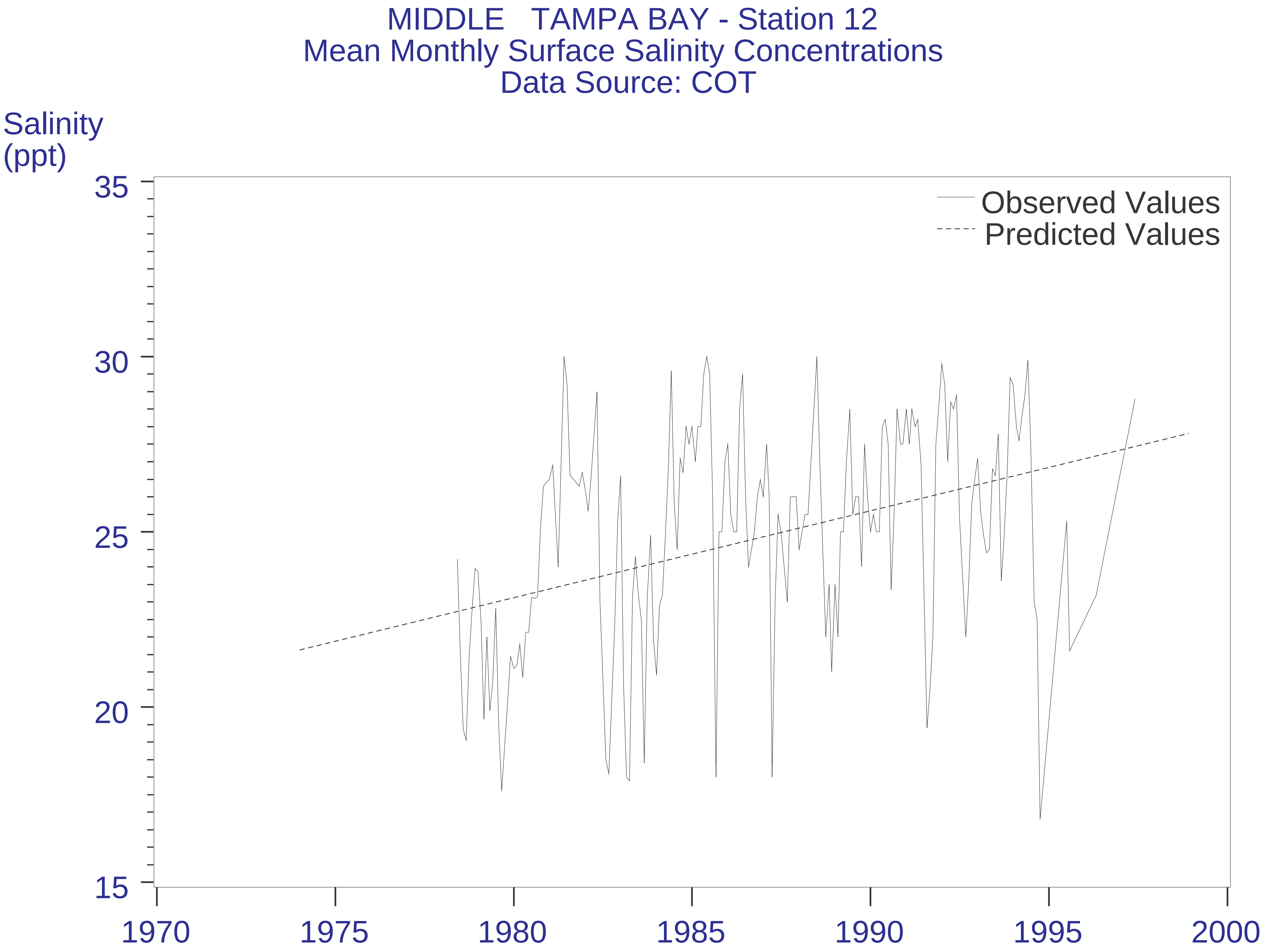


MIDDLE TAMPA BAY - Station 12
Mean Monthly Secchi Disc Depth
Data Source: COT
Secchi Disc
(meters)
5
4
3
2
1
0
Observed Values
Predicted Values
1970
1975
1980
1985
1990
1995
2000

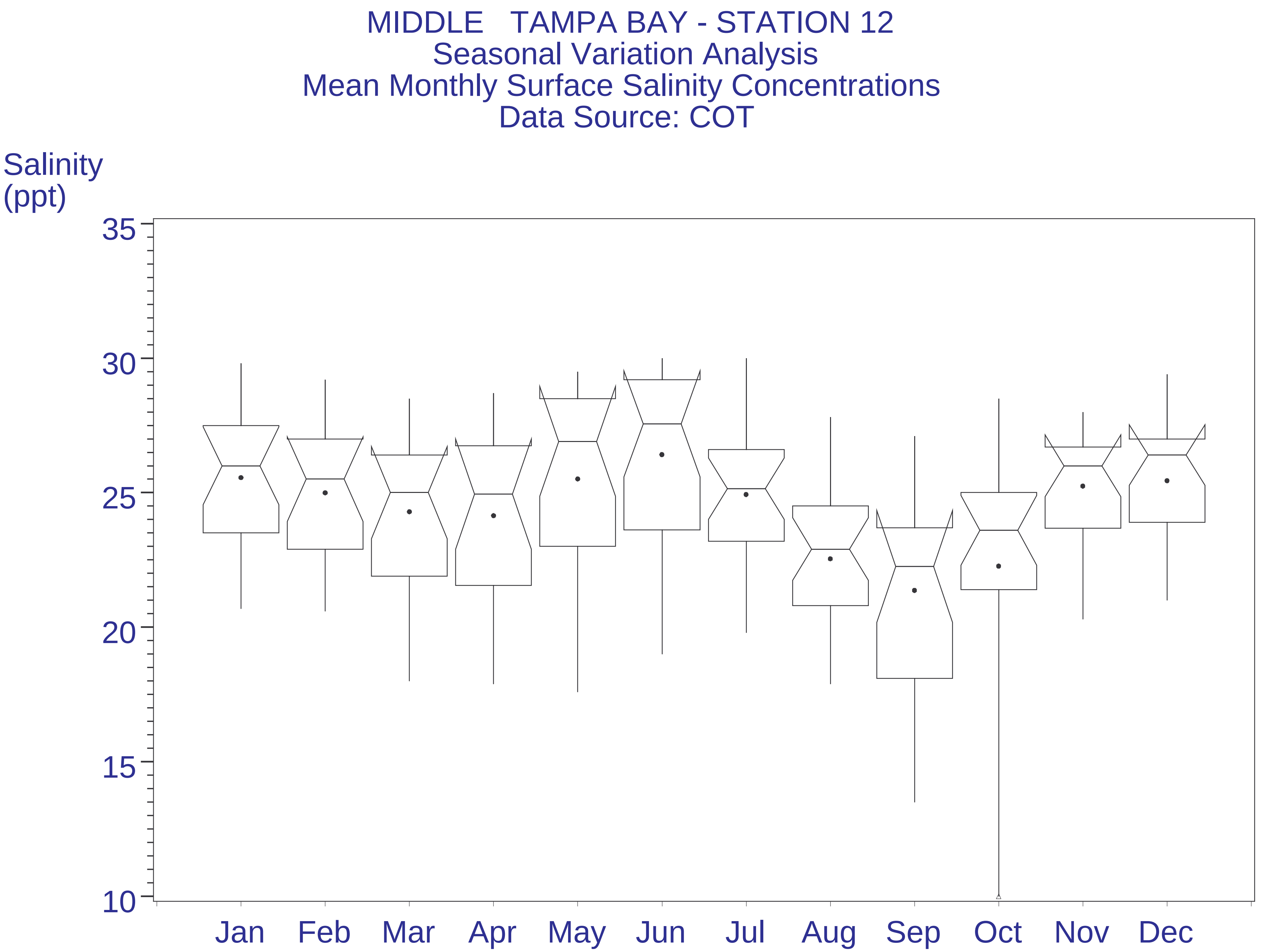


MIDDLE TAMPA BAY - STATION 12
Seasonal Variation Analysis
Mean Monthly Secchi Disc Depth
Data Source: COT
Secchi Disc
(meters)
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

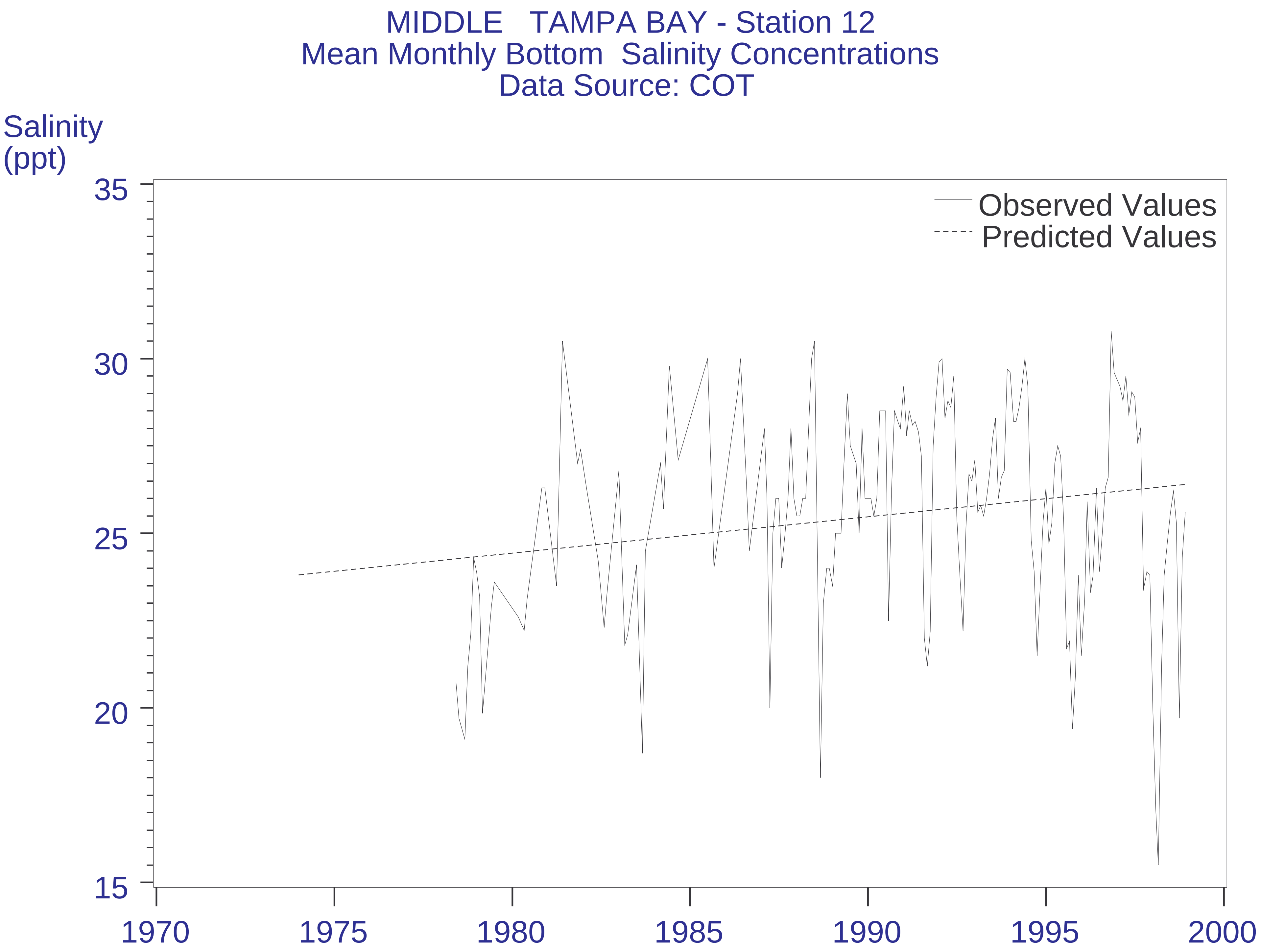
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 12 Surface Salinity (ppt) Data Source: Bay Study Group	
# of Years of Sampling	18
Number of Samples	225
Tau Statistic	0.284
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.010
p Value Slope Statistic	0.2500



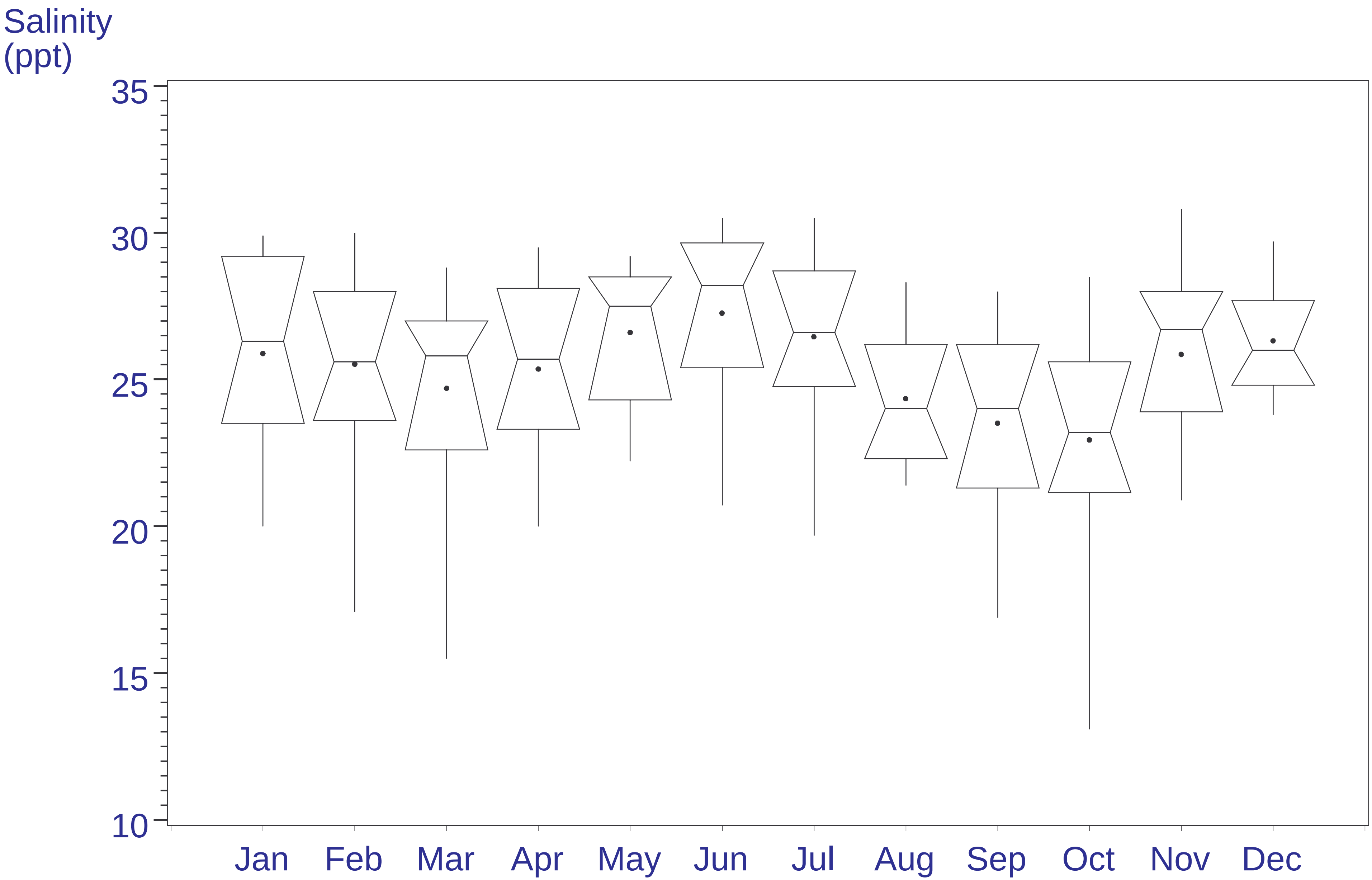
MIDDLE TAMPA BAY - Station 12
Mean Monthly Surface Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


MIDDLE TAMPA BAY - STATION 12
Seasonal Variation Analysis
Mean Monthly Surface Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

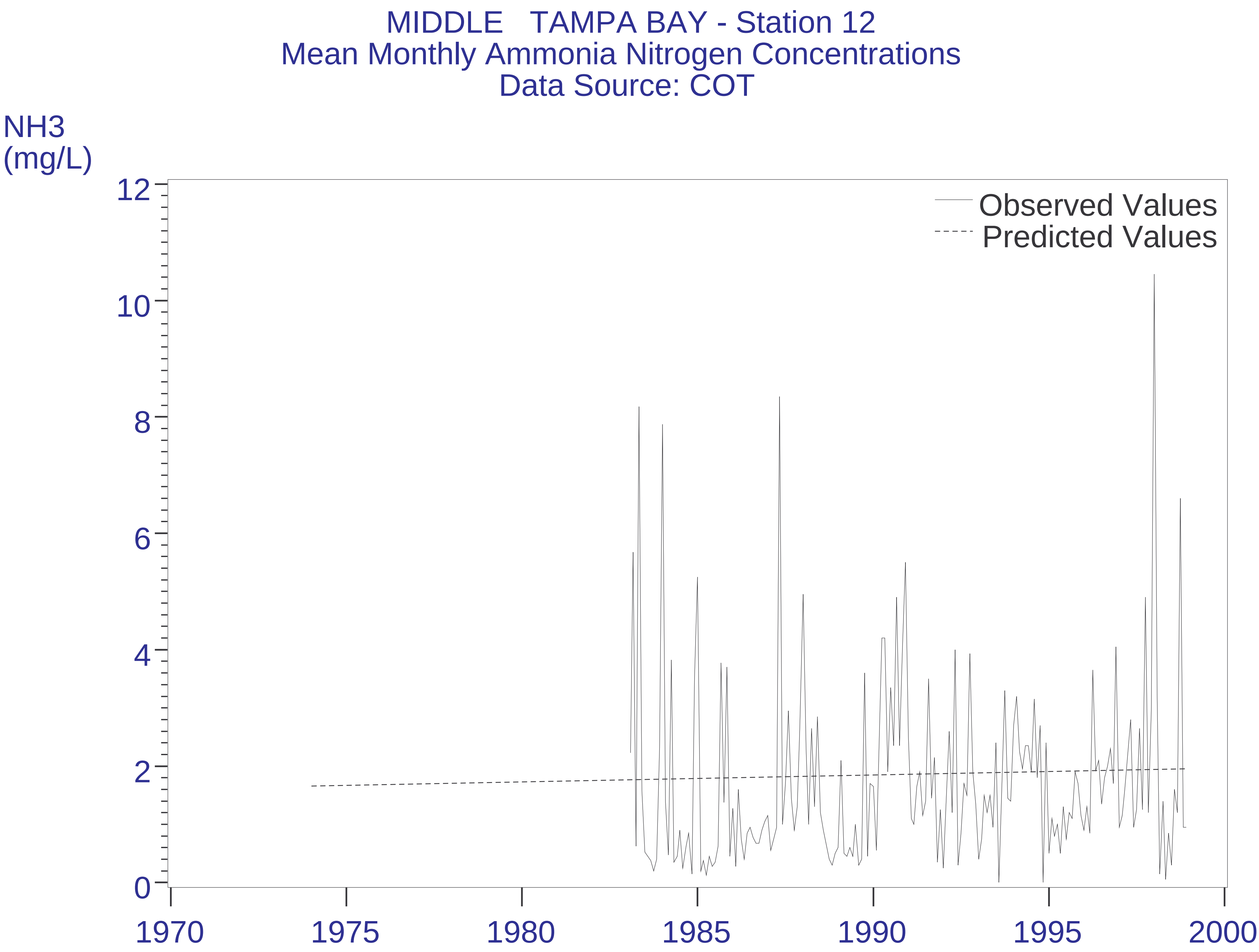
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 12 Bottom Salinity (ppt) Data Source: Bay Study Group	
# of Years of Sampling	21
Number of Samples	190
Tau Statistic	0.103
P-value without Serial Correlation	0.066
P-value with Serial Correlation	0.299
p Value Slope Statistic	0.1000

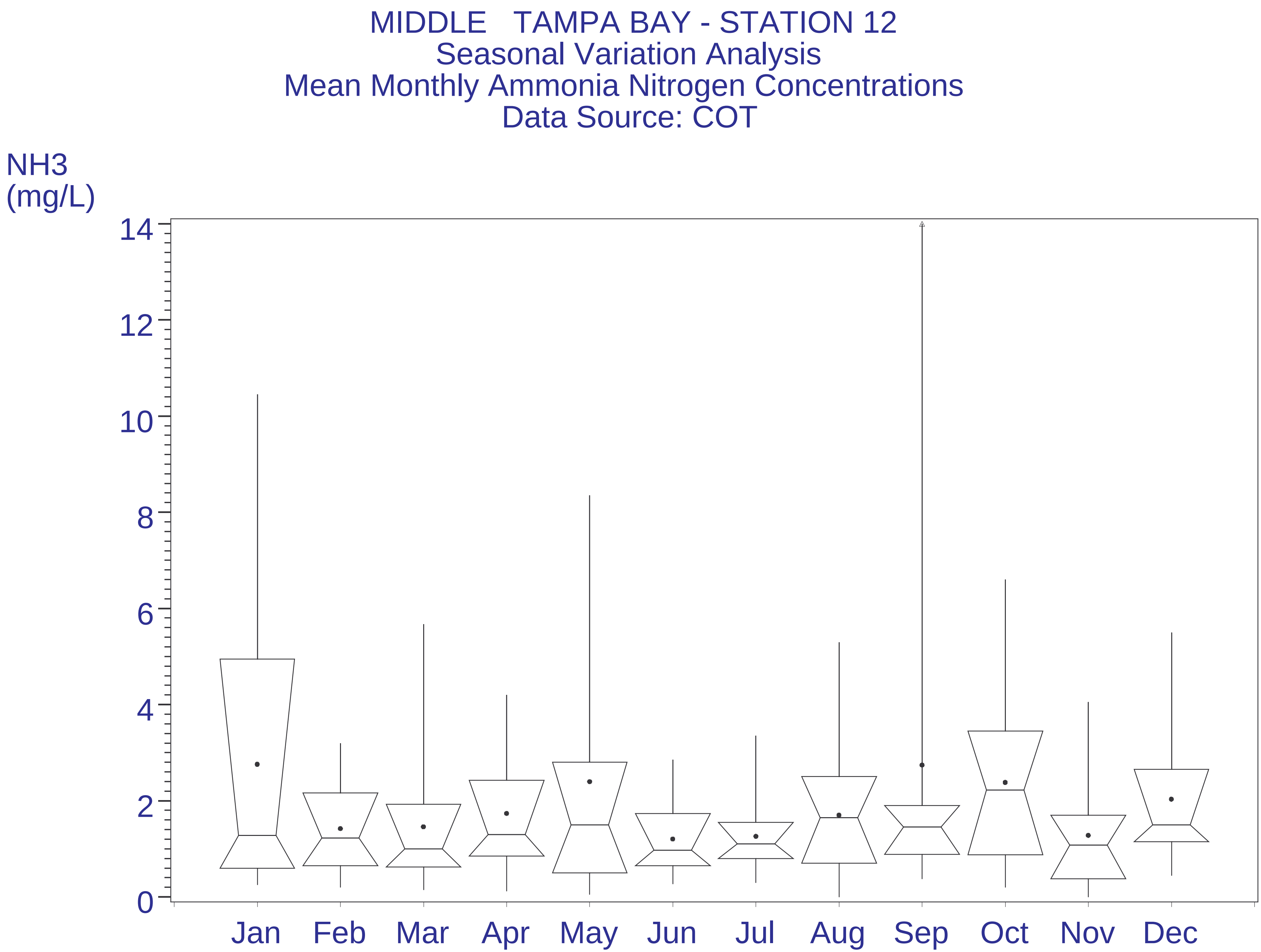

MIDDLE TAMPA BAY - Station 12
Mean Monthly Bottom Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

MIDDLE TAMPA BAY - STATION 12
Seasonal Variation Analysis
Mean Monthly Bottom Salinity Concentrations
Data Source: COT



TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 12 Ammonia Nitrogen (mg/L) Data Source: Bay Study Group	
# of Years of Sampling	16
Number of Samples	193
Tau Statistic	0.145
P-value without Serial Correlation	0.007
P-value with Serial Correlation	0.097
p Value Slope Statistic	0.0477

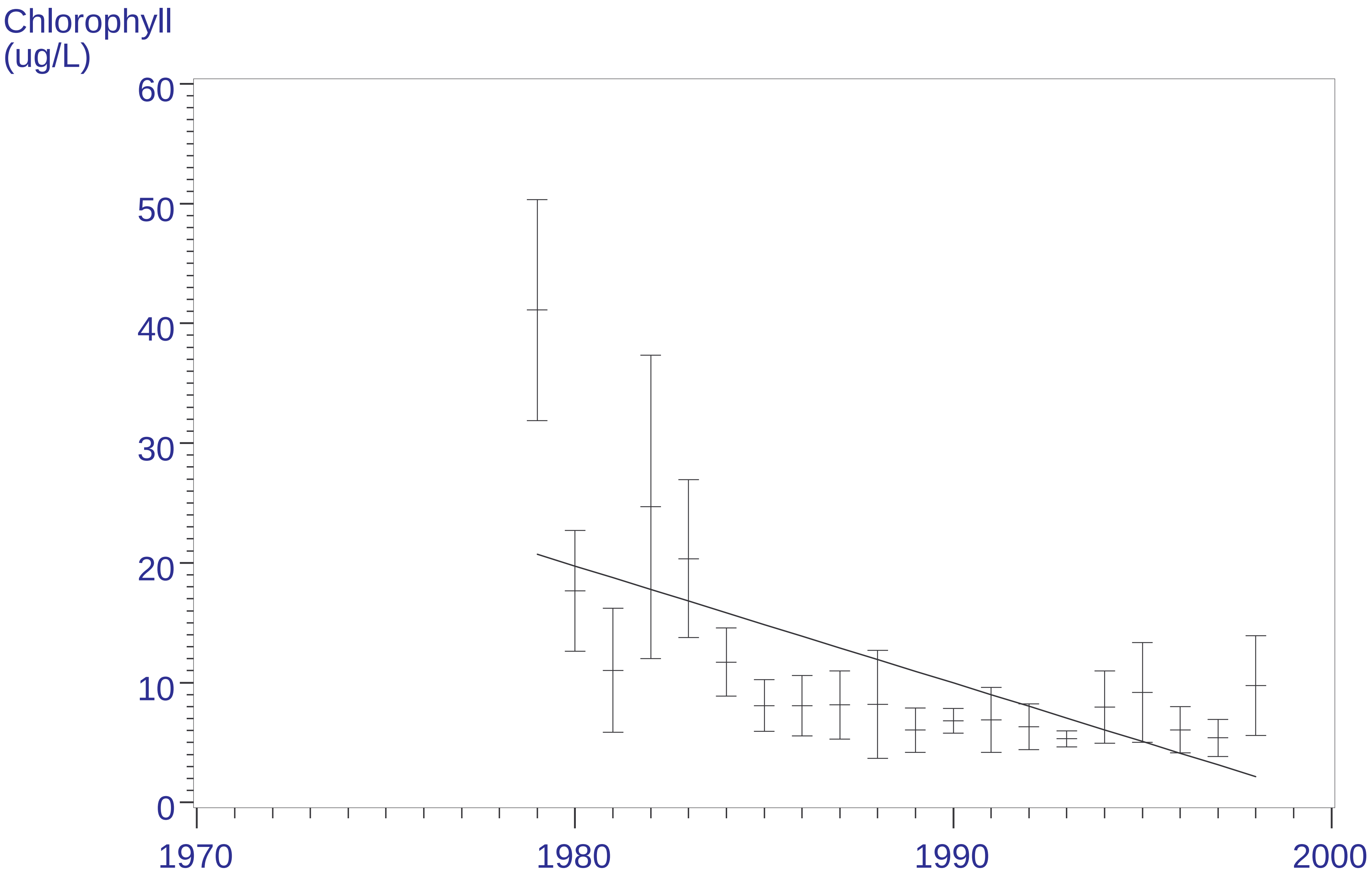

MIDDLE TAMPA BAY - Station 12
Mean Monthly Ammonia Nitrogen Concentrations
Data Source: COT
NH3
(mg/L)
0
2
4
6
8
10
12
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


MIDDLE TAMPA BAY - STATION 12
Seasonal Variation Analysis
Mean Monthly Ammonia Nitrogen Concentrations
Data Source: COT
NH3
(mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

STATION 13
MIDDLE TAMPA BAY

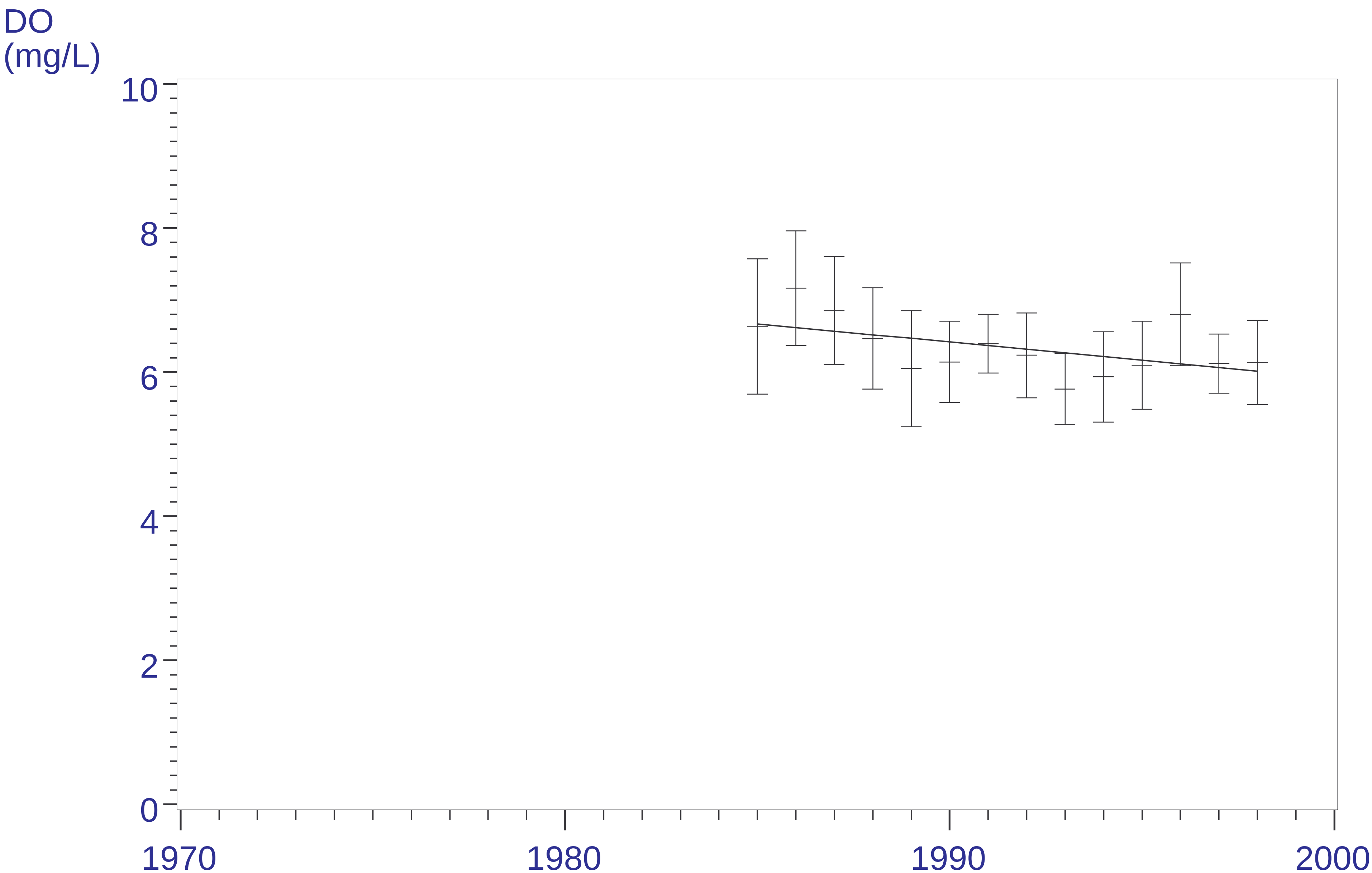
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 13 Chlorophyll a (ug/L) Data Source: Bay Study Group	
# of Years of Sampling	20
Number of Samples	256
Mean Annual Slope Estimate	0.976
Lower 95% Confidence Limit	-1.197
Upper 95% Confidence Limit	-0.755
p Value Slope Statistic	0.0000
Percent Change per Year	-0.085

MIDDLE TAMPA BAY STATION 13
Assessment of Historical Trends
Mean Annual Chlorophyll a Concentrations
Data Source: COT

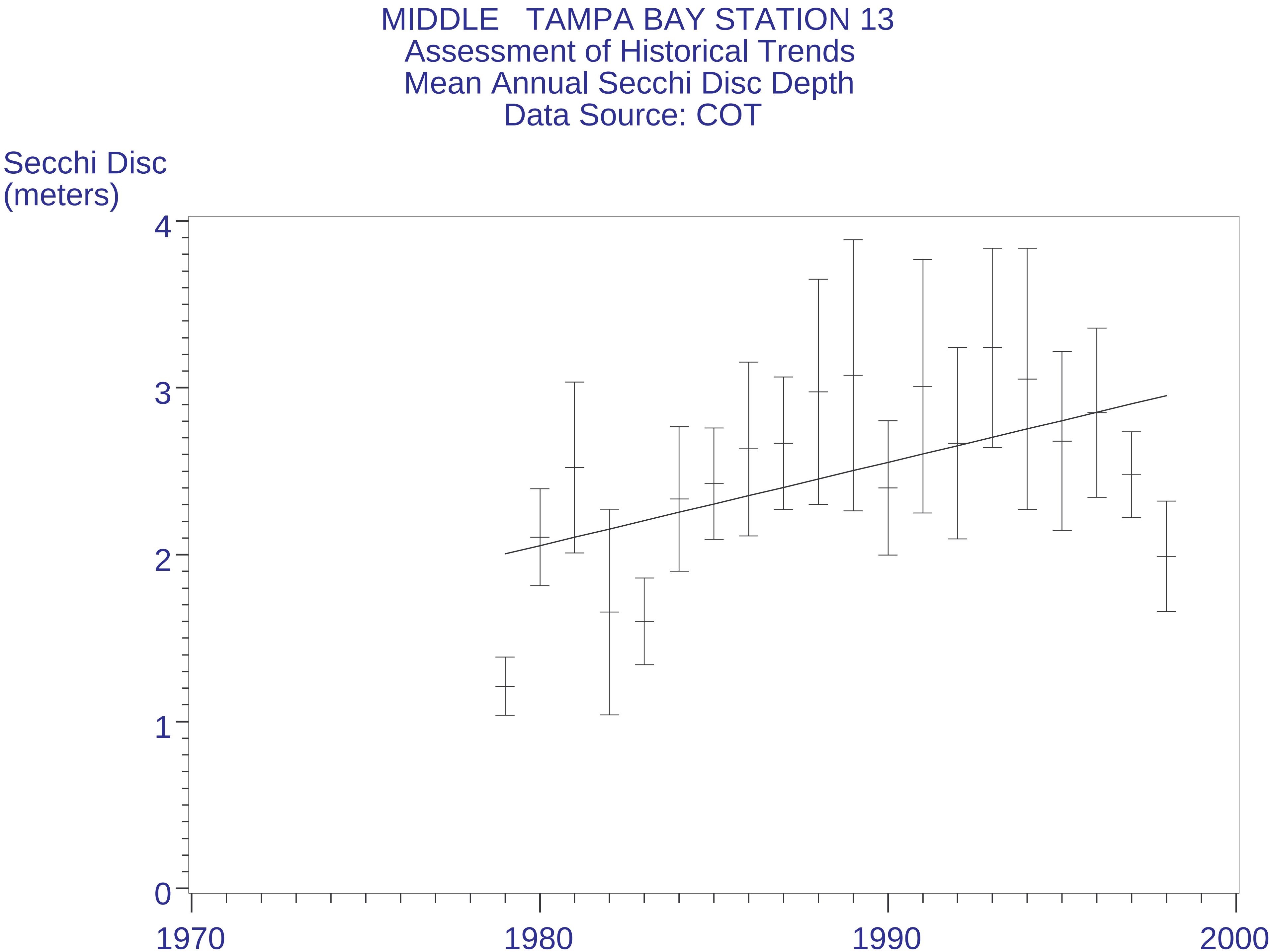


TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 13 Bottom Dissolved Oxygen (mg/L) Data Source: Bay Study Group	
# of Years of Sampling	14
Number of Samples	173
Mean Annual Slope Estimate	-0.051
Lower 95% Confidence Limit	-0.097
Upper 95% Confidence Limit	-0.004
p Value Slope Statistic	0.0329
Percent Change per Year	-0.008

MIDDLE TAMPA BAY STATION 13
Assessment of Historical Trends
Mean Annual Bottom Dissolved Oxyen Concentrations
Data Source: COT

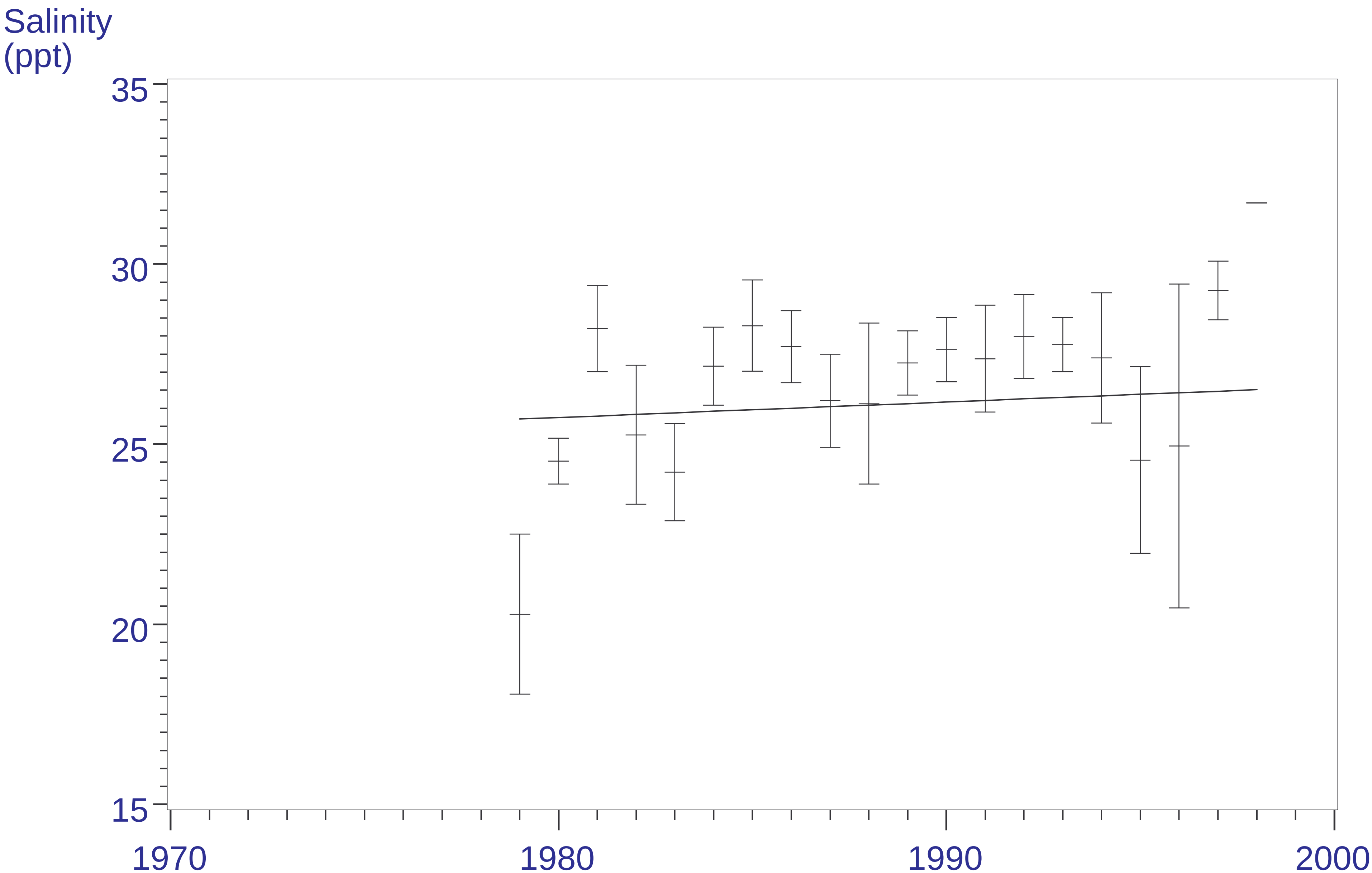


TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 13 Secchi Disc Depth (m) Data Source: Bay Study Group	
# of Years of Sampling	20
Number of Samples	260
Mean Annual Slope Estimate	0.050
Lower 95% Confidence Limit	0.034
Upper 95% Confidence Limit	0.066
p Value Slope Statistic	0.0000
Percent Change per Year	0.020


MIDDLE TAMPA BAY STATION 13
Assessment of Historical Trends
Mean Annual Secchi Disc Depth
Data Source: COT
Secchi Disc
(meters)
4
3
2
1
0
1970
1980
1990
2000

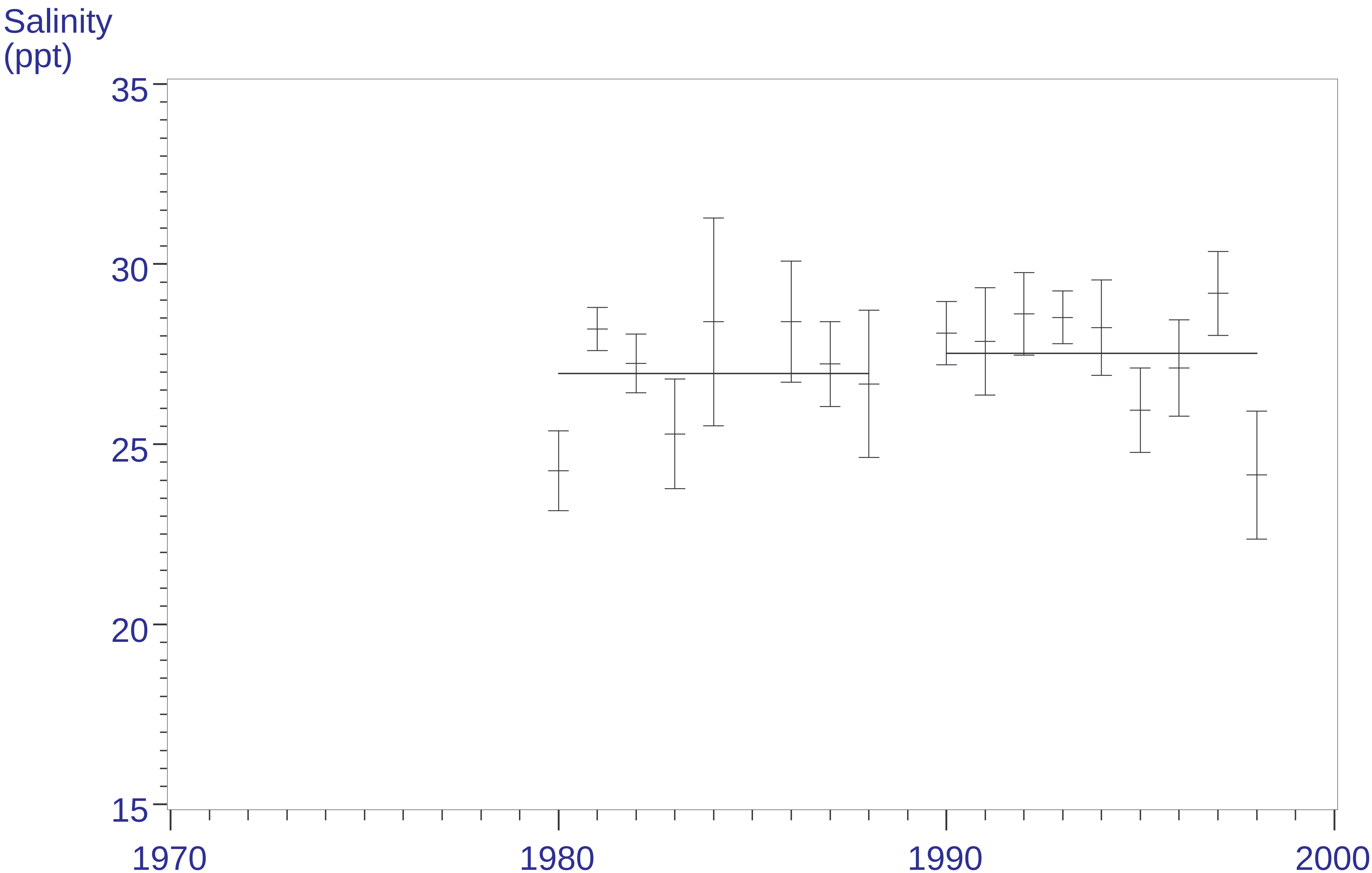
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 13 Surface Salinity (ppt) Data Source: Bay Study Group	
# of Years of Sampling	20
Number of Samples	209
Mean Annual Slope Estimate	0.043
Lower 95% Confidence Limit	-0.138
Upper 95% Confidence Limit	0.223
p Value Slope Statistic	0.6407
Percent Change per Year	0.002

MIDDLE TAMPA BAY STATION 13
Assessment of Historical Trends
Mean Annual Surface Salinity Concentrations
Data Source: COT



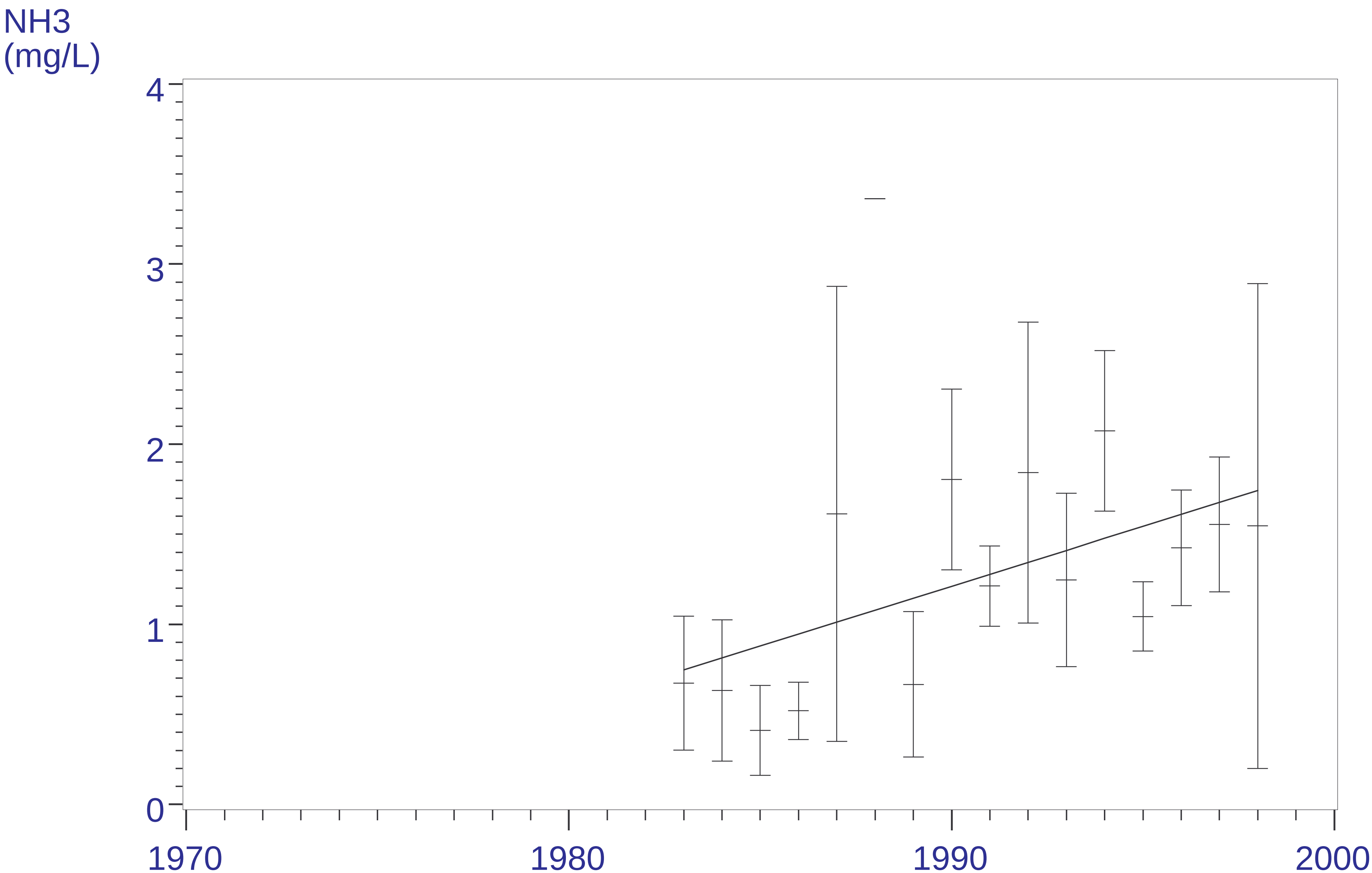
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 13 Bottom Salinity (ppt) Data Source: Bay Study Group	
# of Years of Sampling	18
Number of Samples	80
Mean Annual Slope Estimate	0.560
Lower 95% Confidence Limit	-0.297
Upper 95% Confidence Limit	1.417
p Value Slope Statistic	N/A
Percent Change per Year	N/A

MIDDLE TAMPA BAY STATION 13
Assessment of Historical Trends
Mean Annual Bottom Salinity Concentrations
Data Source: COT

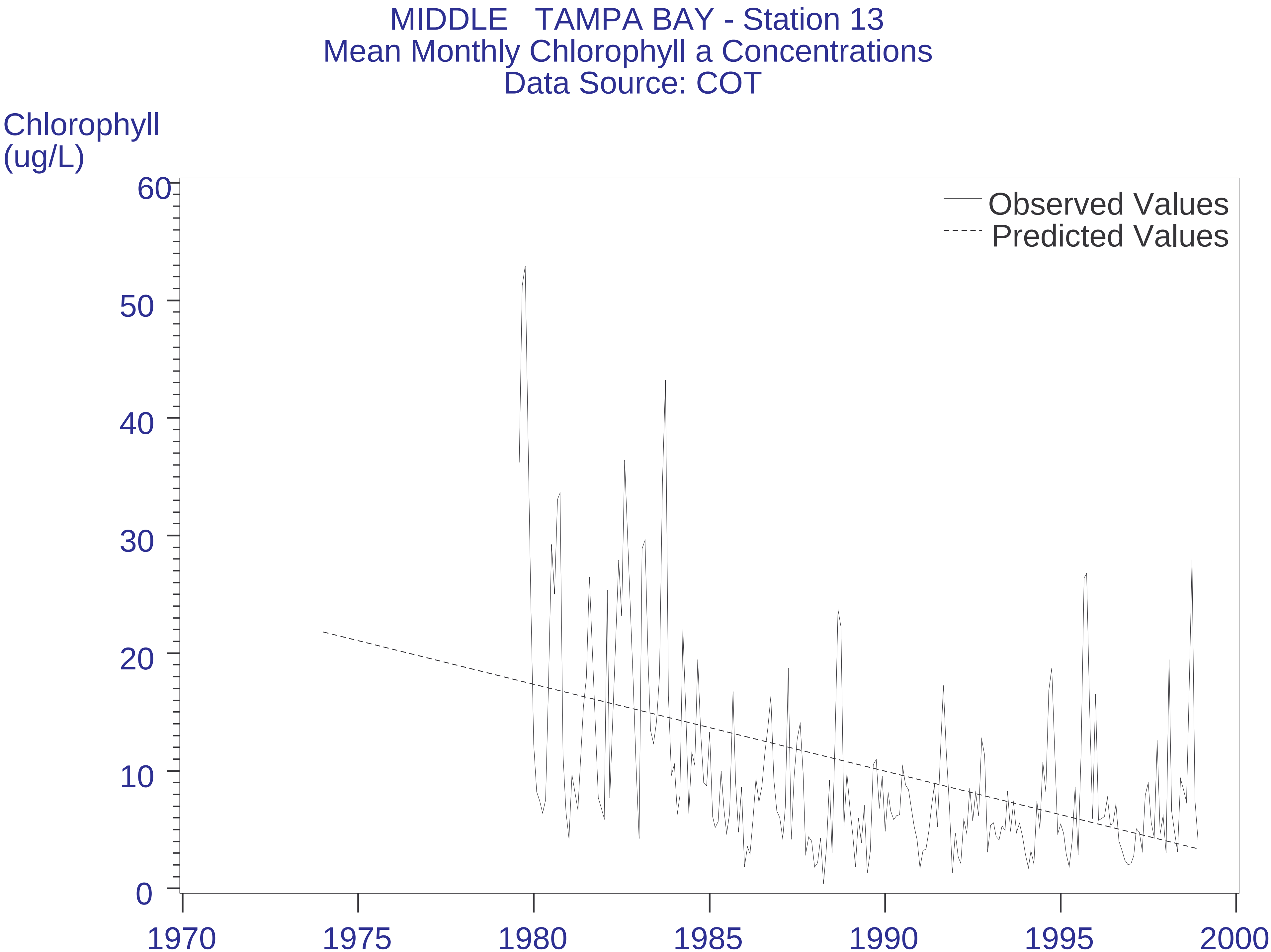


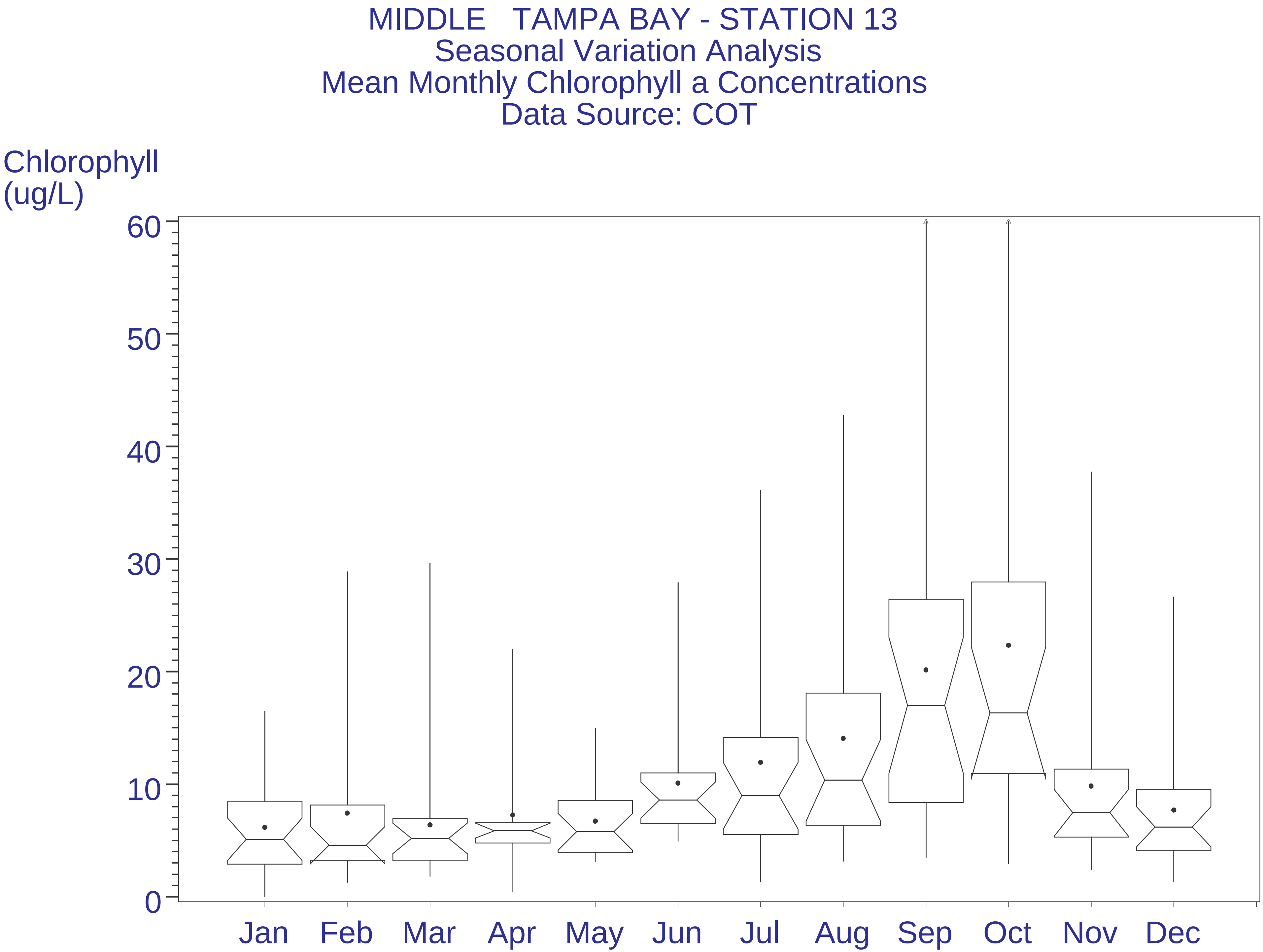
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Parametric Tests Middle Tampa Bay - Station 13 Ammonia Nitrogen (mg/L) Data Source: Bay Study Group	
# of Years of Sampling	16
Number of Samples	204
Mean Annual Slope Estimate	0.066
Lower 95% Confidence Limit	0.029
Upper 95% Confidence Limit	0.104
p Value Slope Statistic	0.0006
Percent Change per Year	0.053

MIDDLE TAMPA BAY STATION 13
Assessment of Historical Trends
Mean Annual Ammonia Nitrogen Concentrations
Data Source: COT

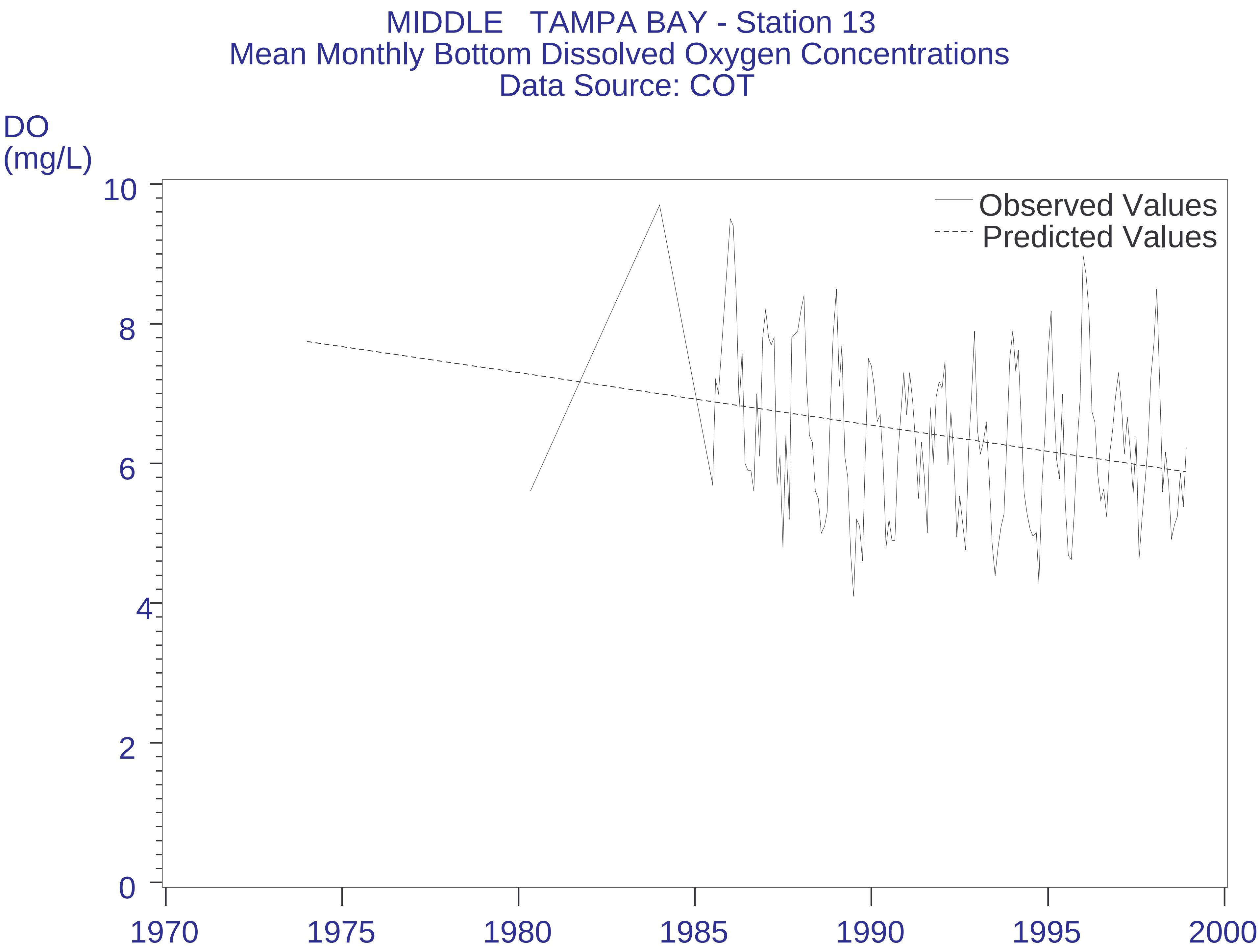


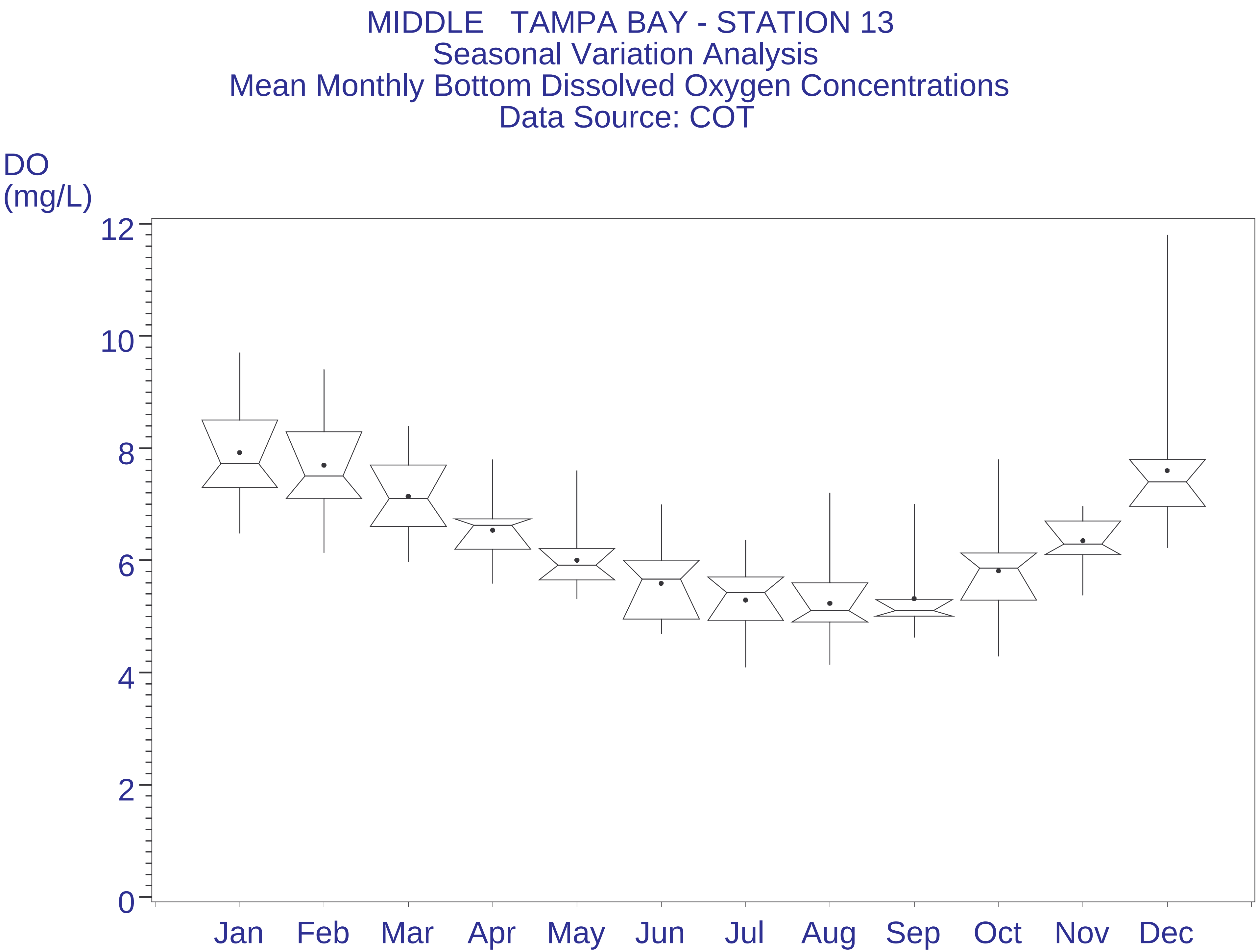
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 13 Chlorophyll a (ug/L) Data Source: Bay Study Group	
# of Years of Sampling	20
Number of Samples	256
Tau Statistic	-0.356
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.001
p Value Slope Statistic	-0.4207


MIDDLE TAMPA BAY - Station 13
Mean Monthly Chlorophyll a Concentrations
Data Source: COT
Chlorophyll
(ug/L)
Observed Values
Predicted Values
0
10
20
30
40
50
60
1970
1975
1980
1985
1990
1995
2000


MIDDLE TAMPA BAY - STATION 13
Seasonal Variation Analysis
Mean Monthly Chlorophyll a Concentrations
Data Source: COT
Chlorophyll
(ug/L)
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

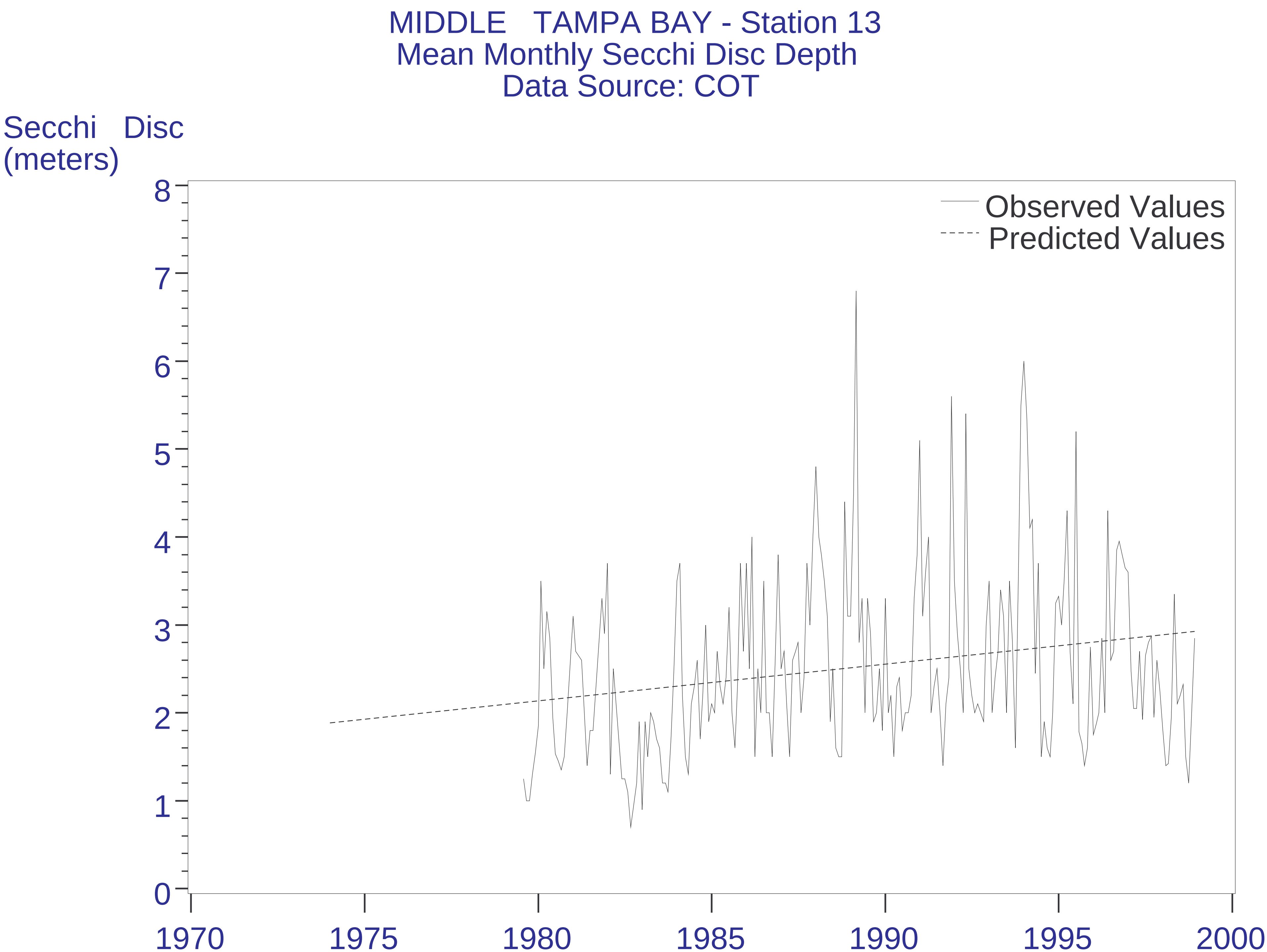
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 13 Bottom Dissolved Oxygen (mg/L) Data Source: Bay Study Group	
# of Years of Sampling	14
Number of Samples	173
Tau Statistic	-0.220
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.052
p Value Slope Statistic	-0.0502

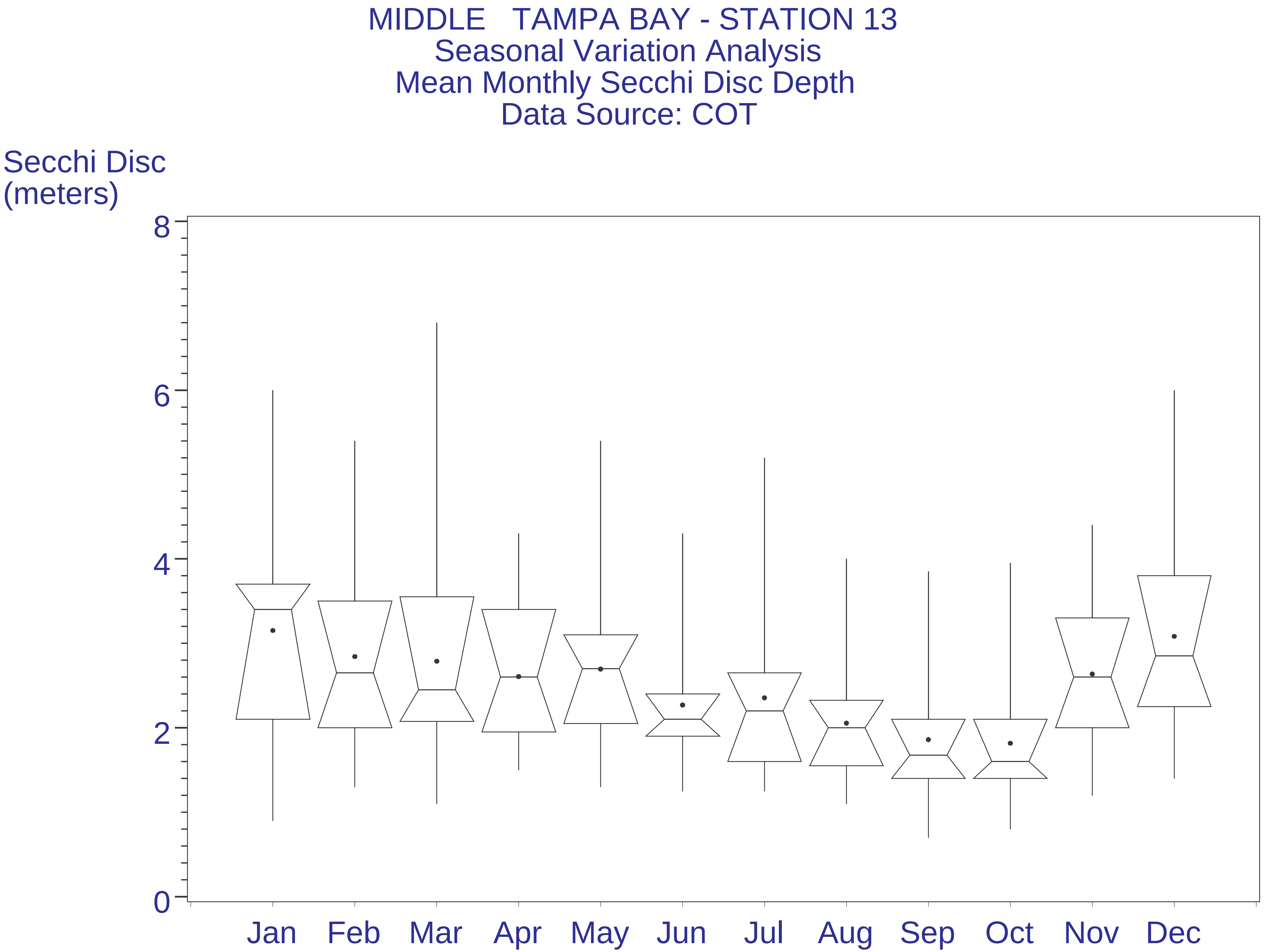

MIDDLE TAMPA BAY - Station 13
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: COT
DO
(mg/L)
10
8
6
4
2
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values



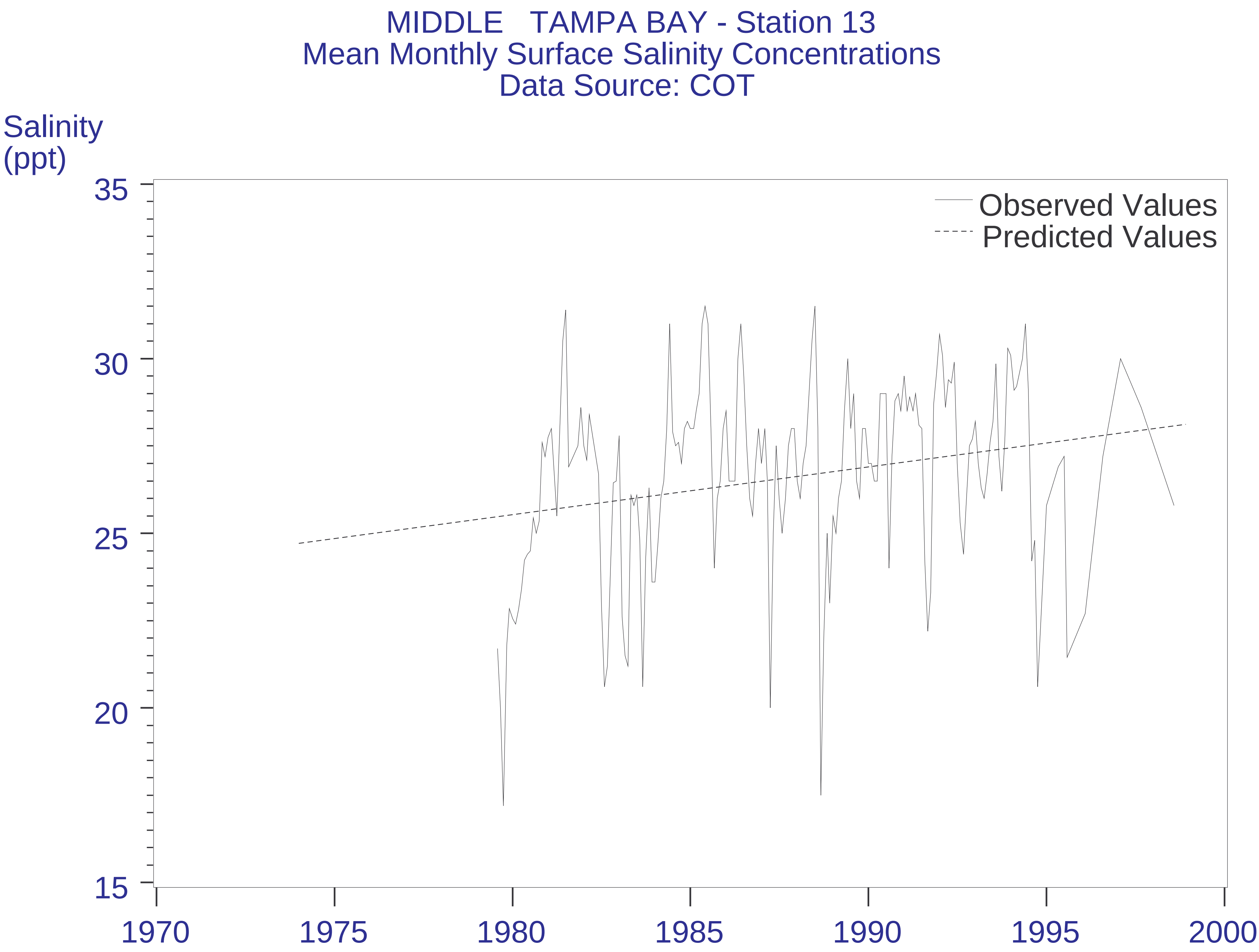
MIDDLE TAMPA BAY - STATION 13
Seasonal Variation Analysis
Mean Monthly Bottom Dissolved Oxygen Concentrations
Data Source: COT
DO
(mg/L)
0
2
4
6
8
10
12
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

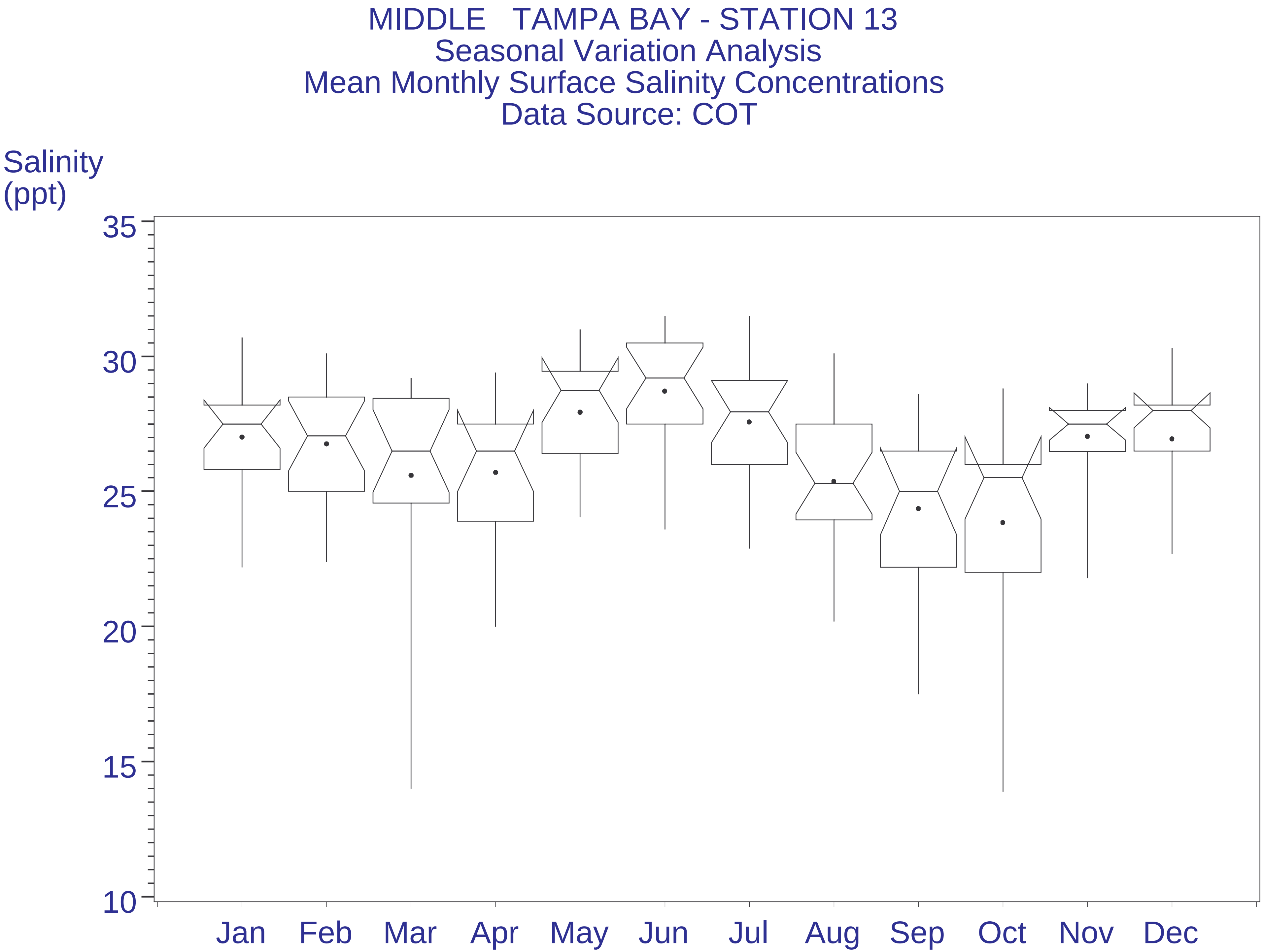
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 13 Secchi Disc Depth (m) Data Source: Bay Study Group	
# of Years of Sampling	20
Number of Samples	260
Tau Statistic	0.192
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.020
p Value Slope Statistic	0.0400


MIDDLE TAMPA BAY - Station 13
Mean Monthly Secchi Disc Depth
Data Source: COT
Secchi Disc
(meters)
Observed Values
Predicted Values
0
1
2
3
4
5
6
7
8
1970
1975
1980
1985
1990
1995
2000

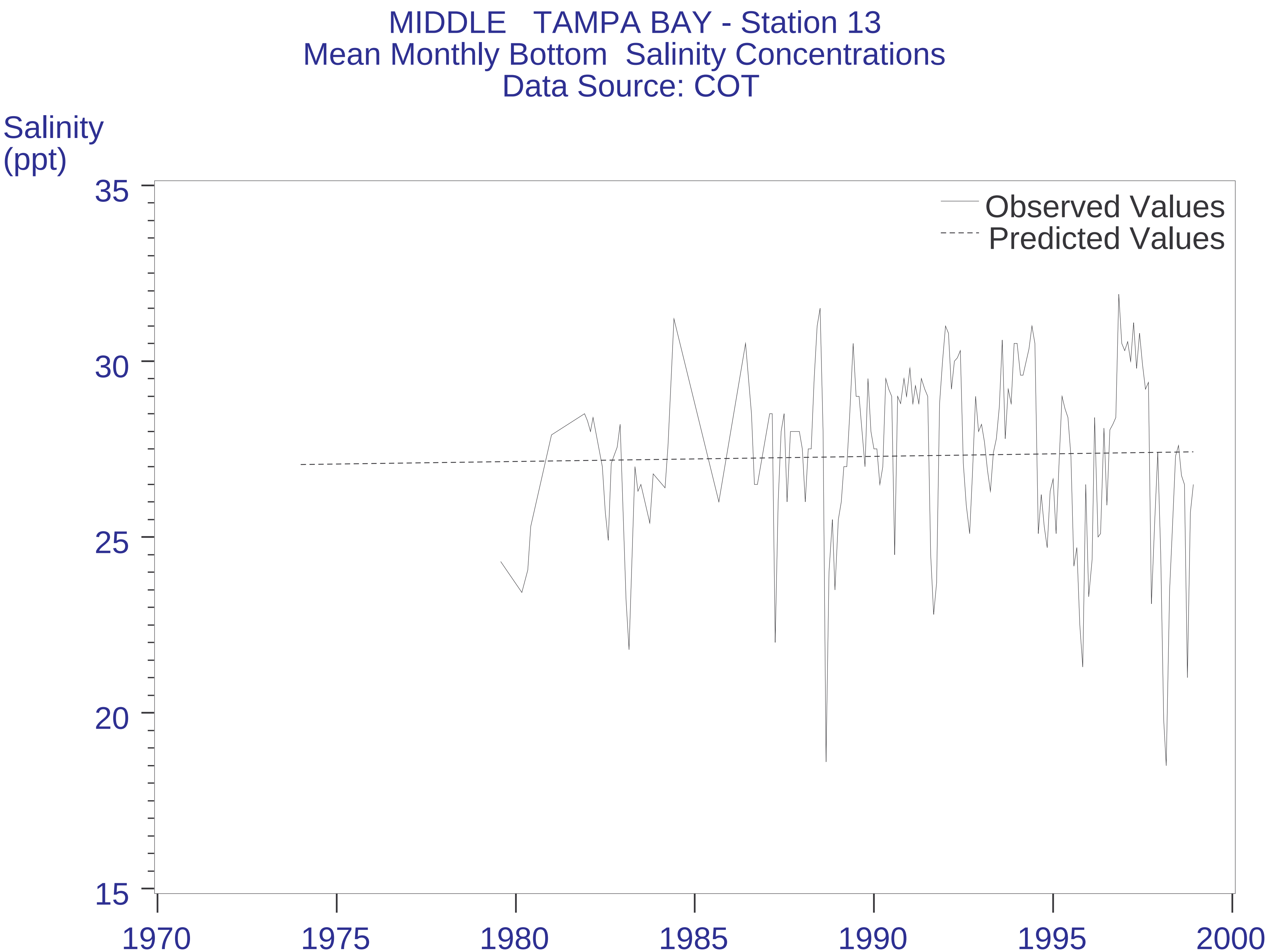

MIDDLE TAMPA BAY - STATION 13
Seasonal Variation Analysis
Mean Monthly Secchi Disc Depth
Data Source: COT
Secchi Disc
(meters)
0
2
4
6
8
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 13 Surface Salinity (ppt) Data Source: Bay Study Group	
# of Years of Sampling	20
Number of Samples	209
Tau Statistic	0.229
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.020
p Value Slope Statistic	0.1667

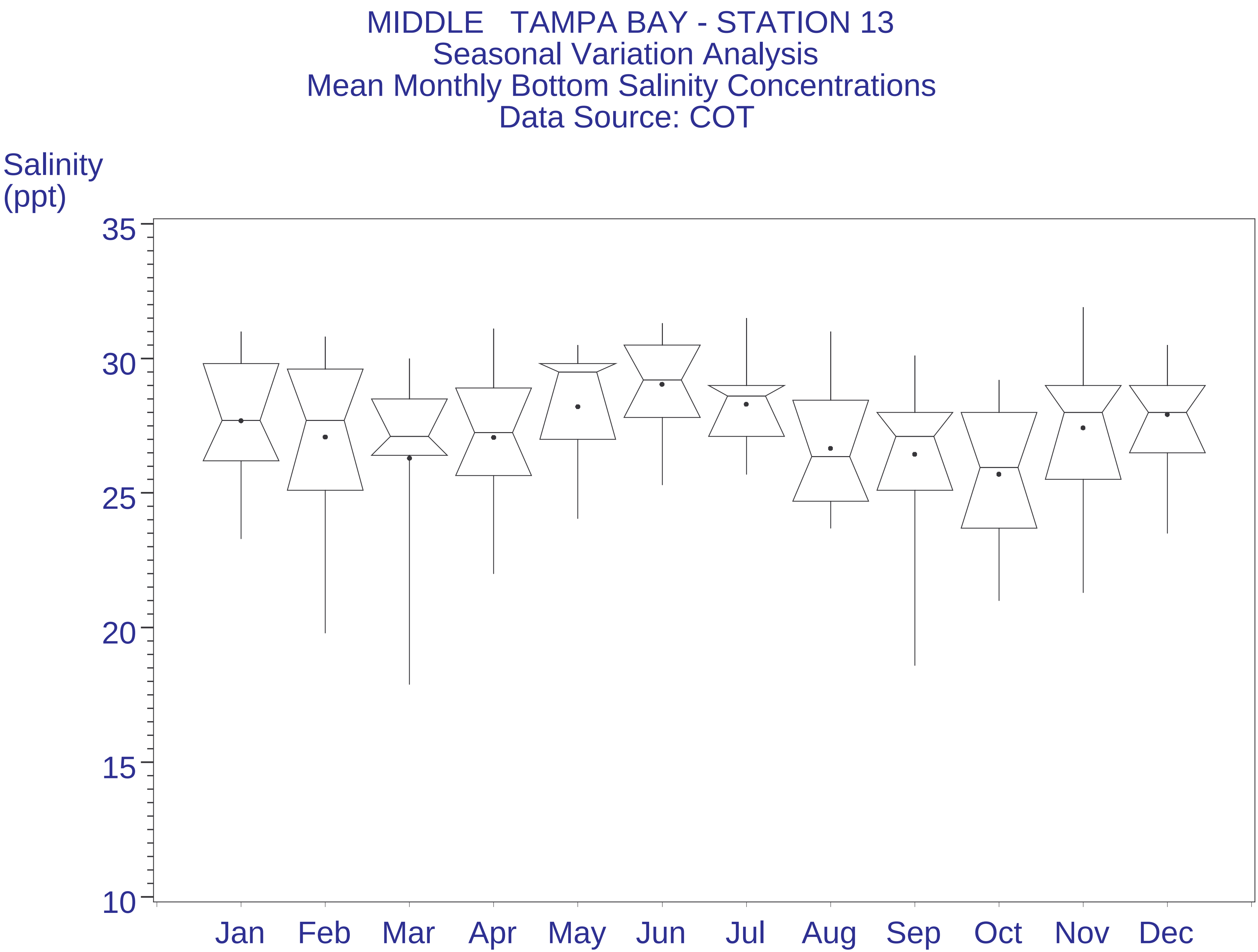

MIDDLE TAMPA BAY - Station 13
Mean Monthly Surface Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
Observed Values
Predicted Values
1970
1975
1980
1985
1990
1995
2000


MIDDLE TAMPA BAY - STATION 13
Seasonal Variation Analysis
Mean Monthly Surface Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 13 Bottom Salinity (ppt) Data Source: Bay Study Group	
# of Years of Sampling	18
Number of Samples	80
Tau Statistic	0.045
P-value without Serial Correlation	0.435
P-value with Serial Correlation	0.633
p Value Slope Statistic	0.0236

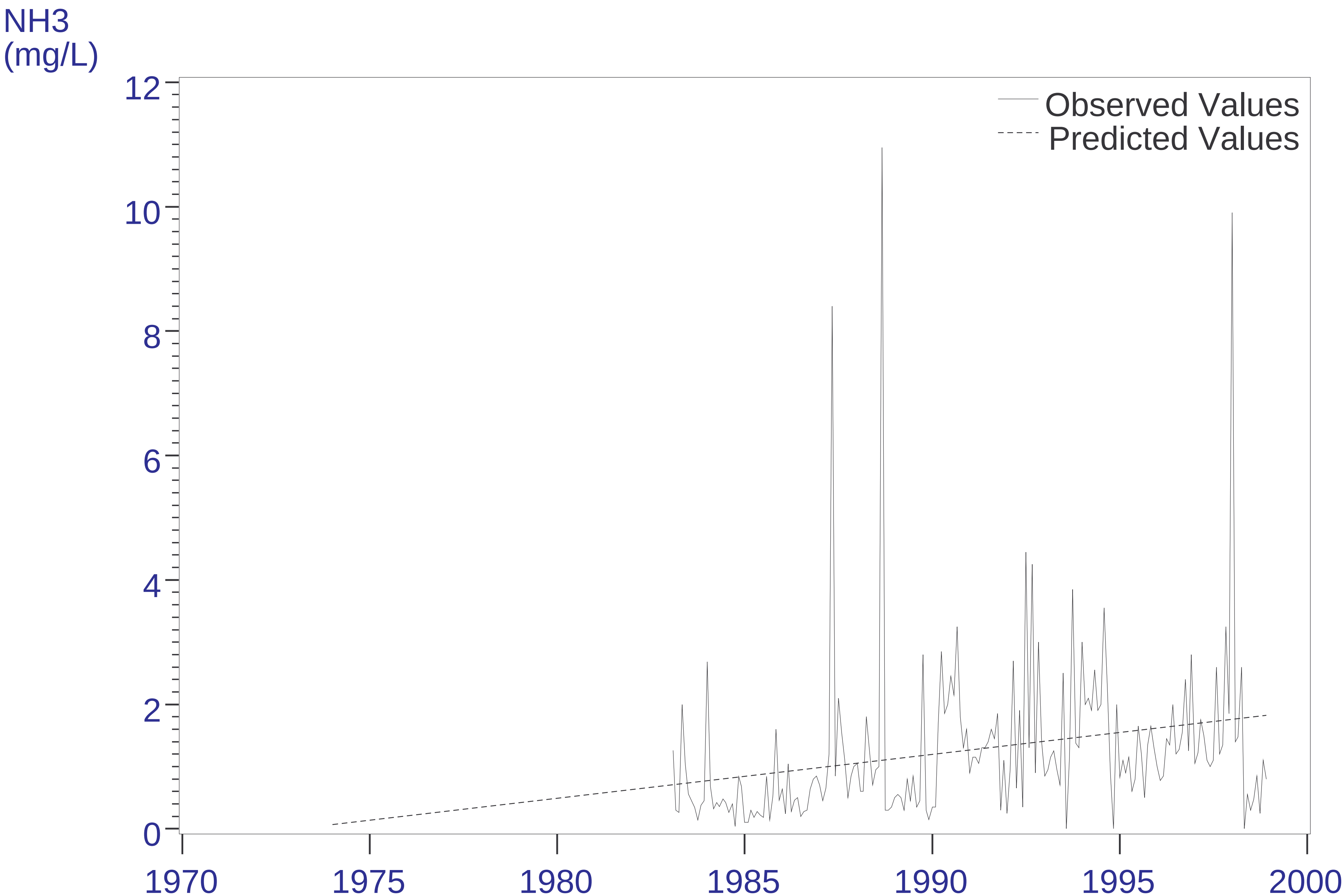


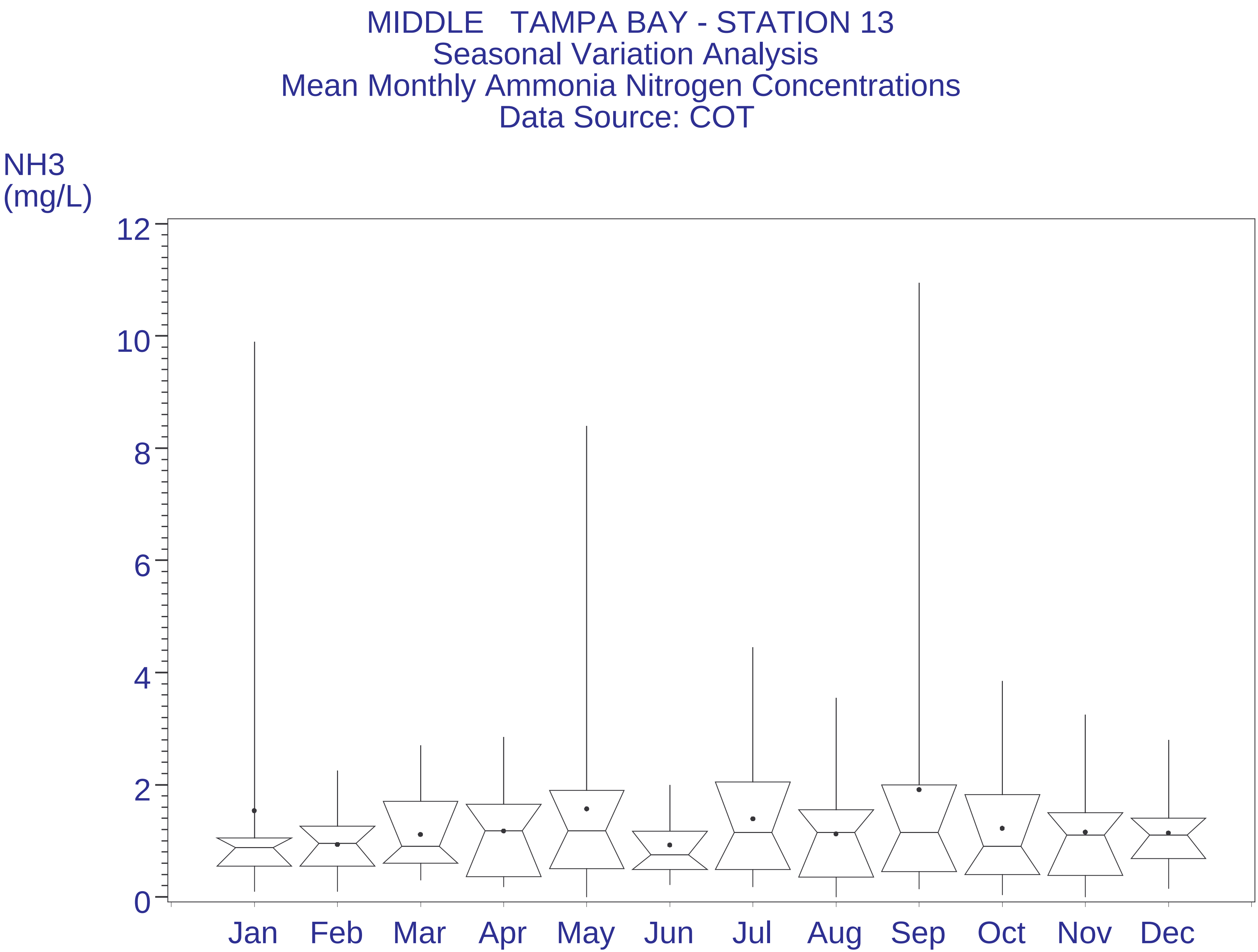
MIDDLE TAMPA BAY - Station 13
Mean Monthly Bottom Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


MIDDLE TAMPA BAY - STATION 13
Seasonal Variation Analysis
Mean Monthly Bottom Salinity Concentrations
Data Source: COT
Salinity
(ppt)
35
30
25
20
15
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay - Station 13 Ammonia Nitrogen (mg/L) Data Source: Bay Study Group	
# of Years of Sampling	16
Number of Samples	204
Tau Statistic	0.312
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.006
p Value Slope Statistic	0.0678

MIDDLE TAMPA BAY - Station 13
Mean Monthly Ammonia Nitrogen Concentrations
Data Source: COT



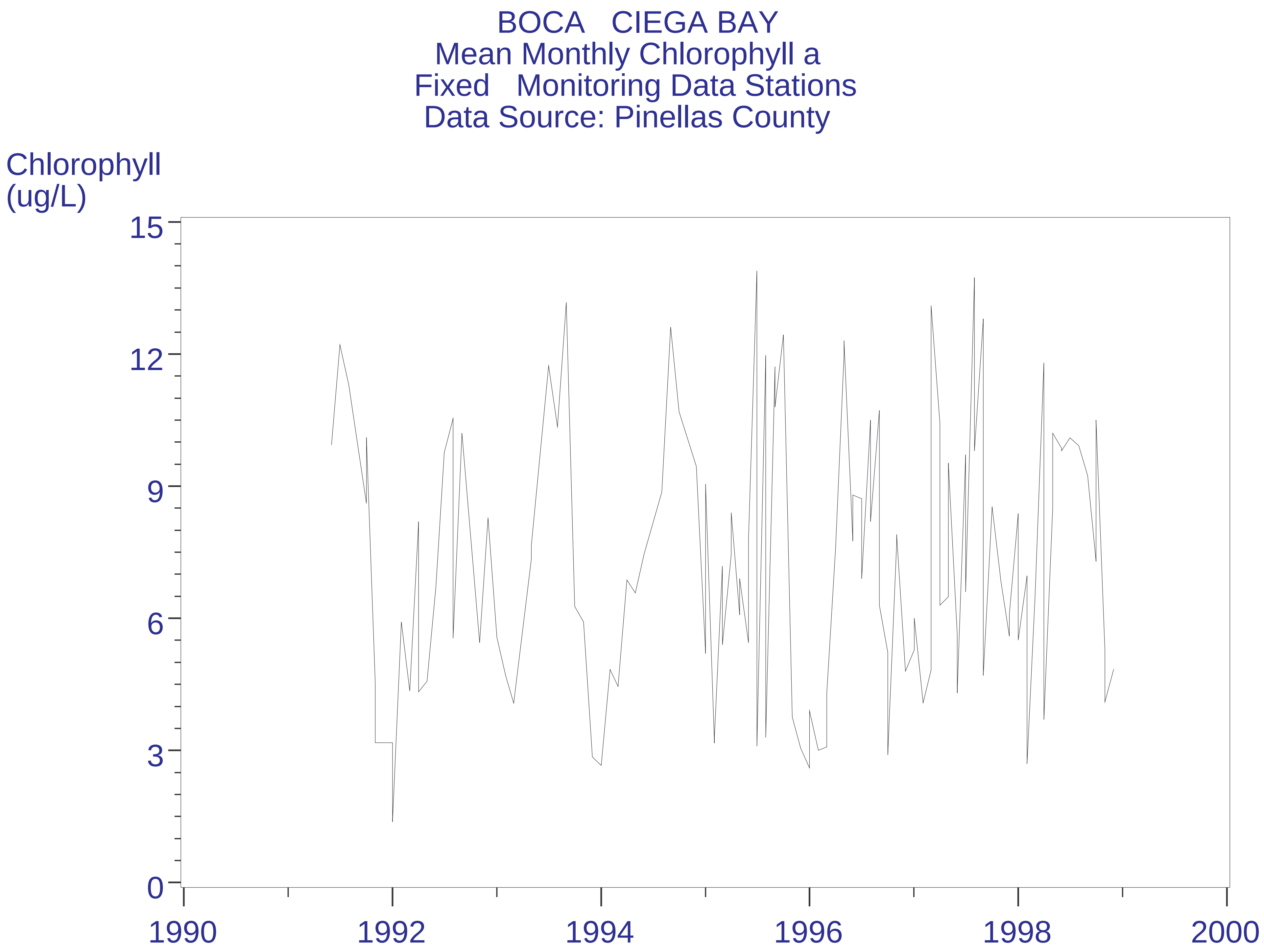


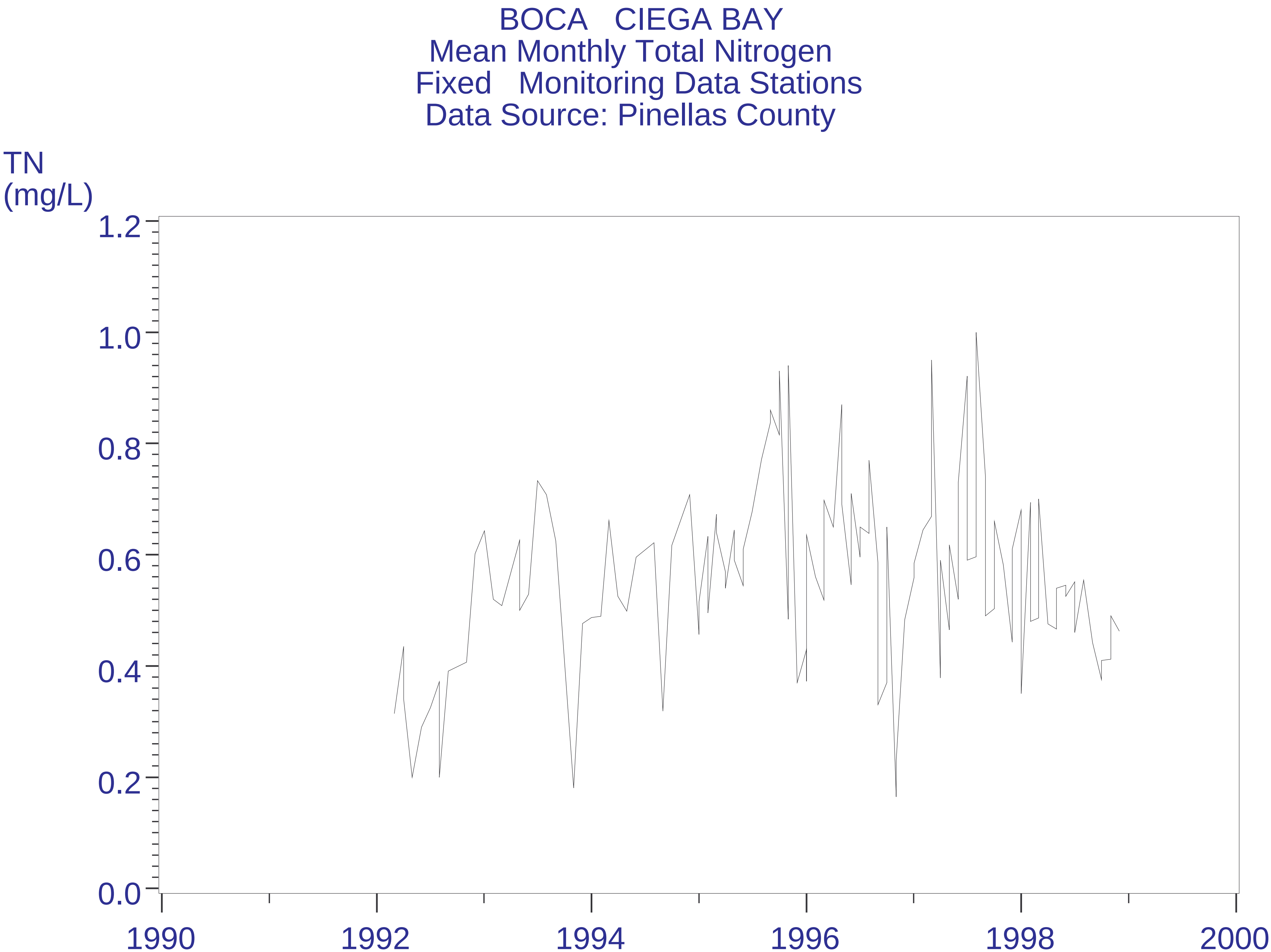
MIDDLE TAMPA BAY - STATION 13
Seasonal Variation Analysis
Mean Monthly Ammonia Nitrogen Concentrations
Data Source: COT
NH3
(mg/L)
0
2
4
6
8
10
12
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

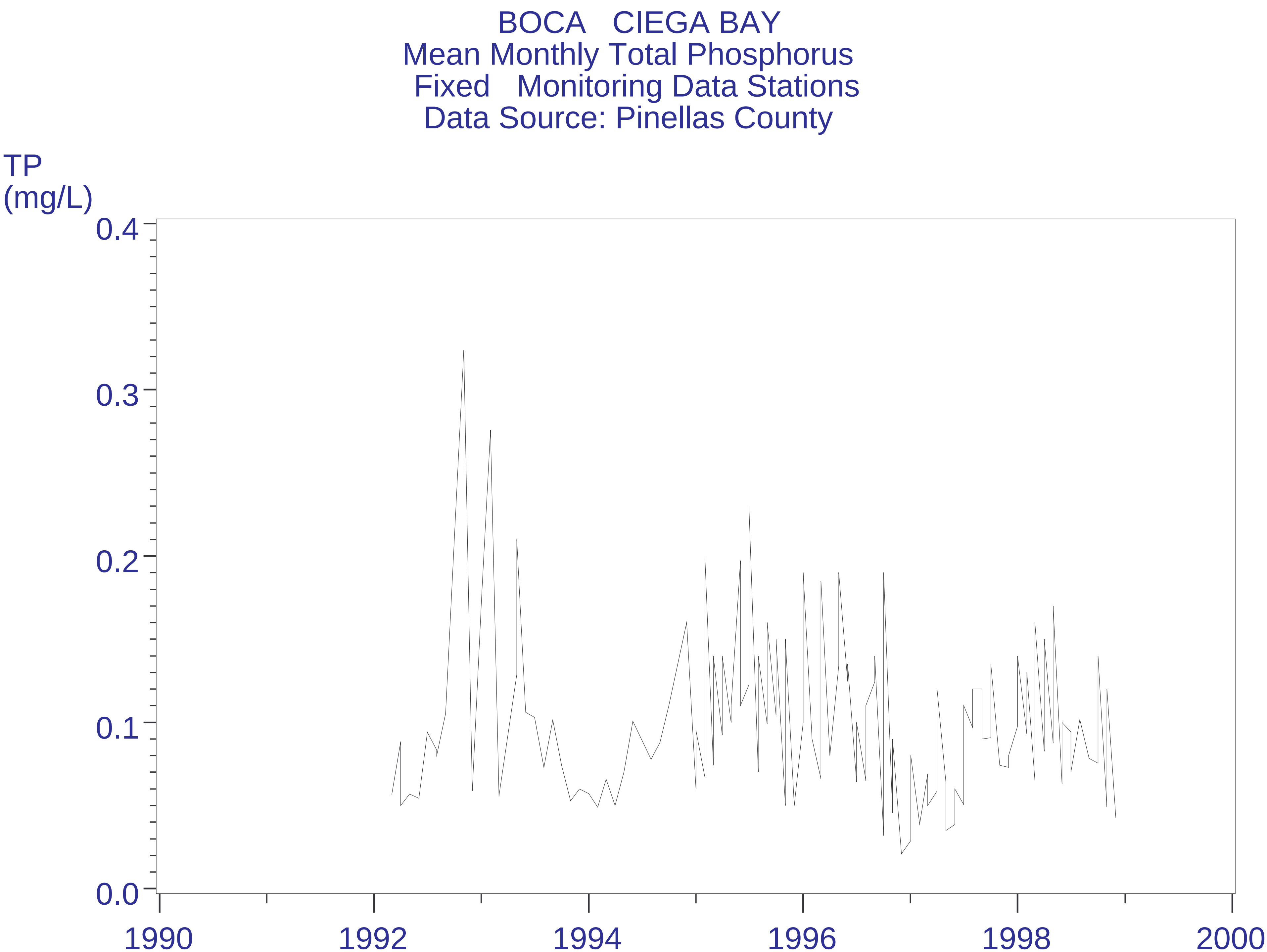
APPENDIX D

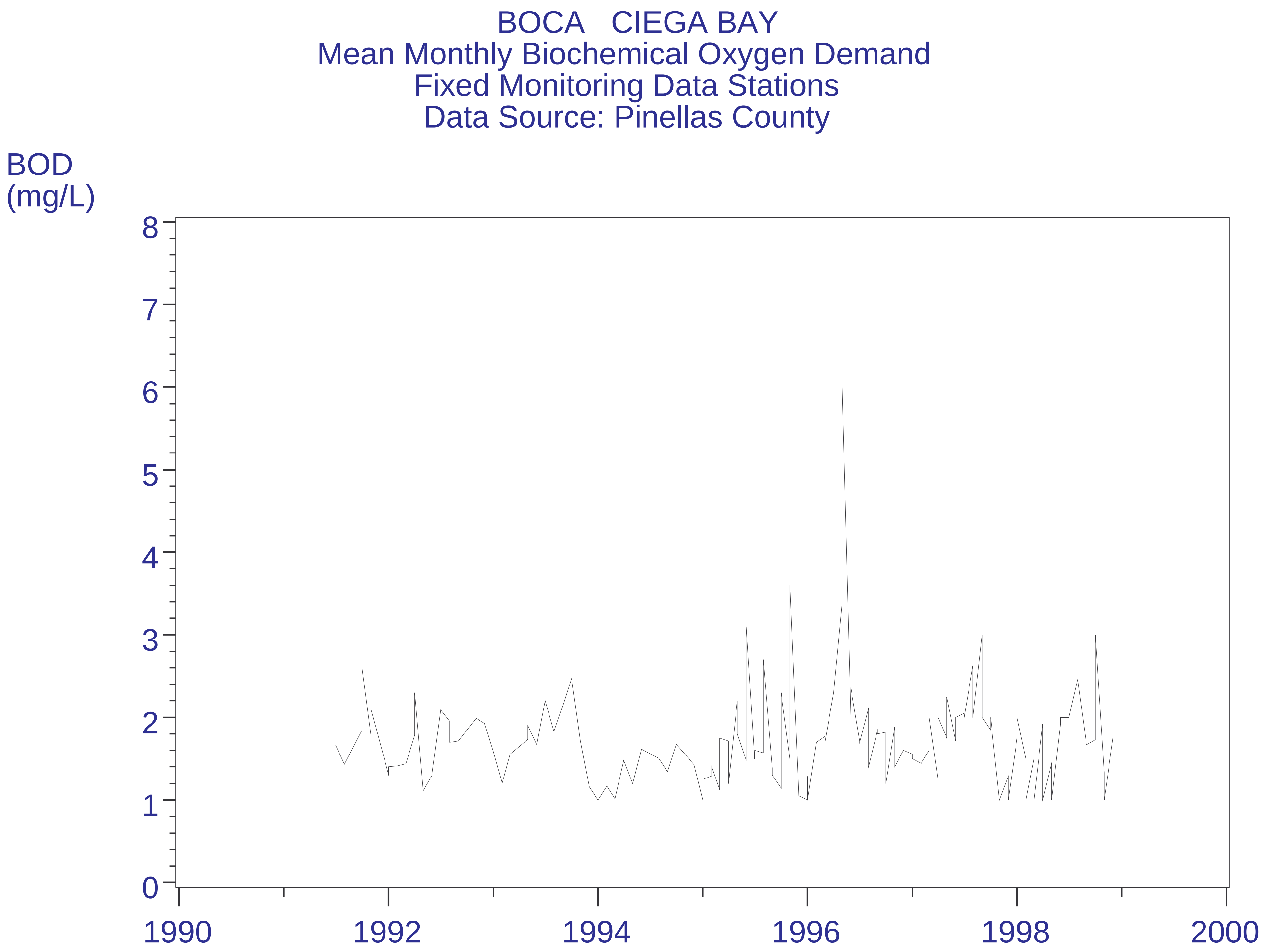
WATER QUALITY DATA PLOTS,
PINELLAS COUNTY DEM – BOCA CIEGA BAY

FIXED STATION MONITORING DATA

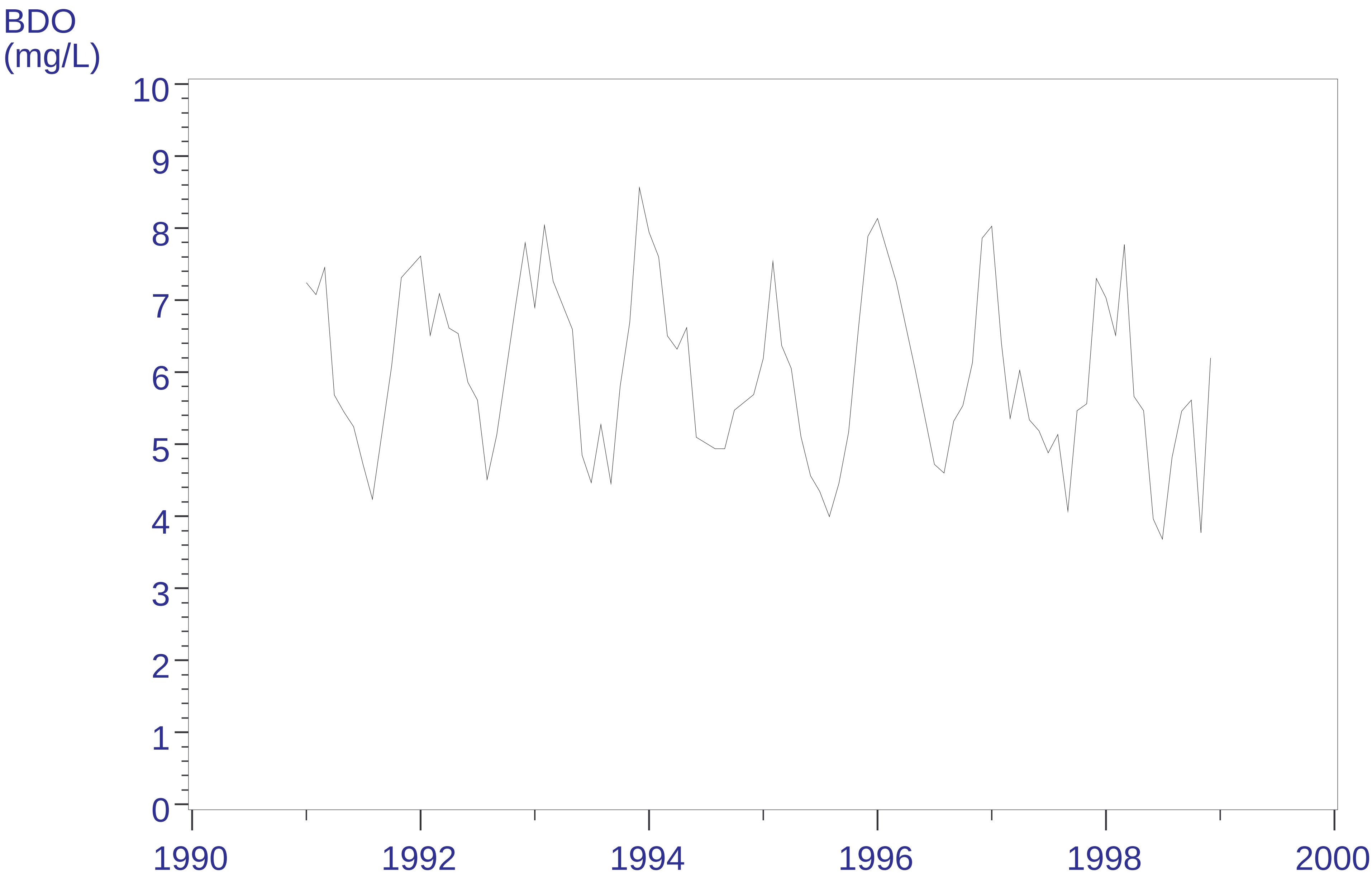

BOCA CIEGA BAY
Mean Monthly Chlorophyll a
Fixed Monitoring Data Stations
Data Source: Pinellas County
Chlorophyll
(ug/L)
15
12
9
6
3
0
1990
1992
1994
1996
1998
2000

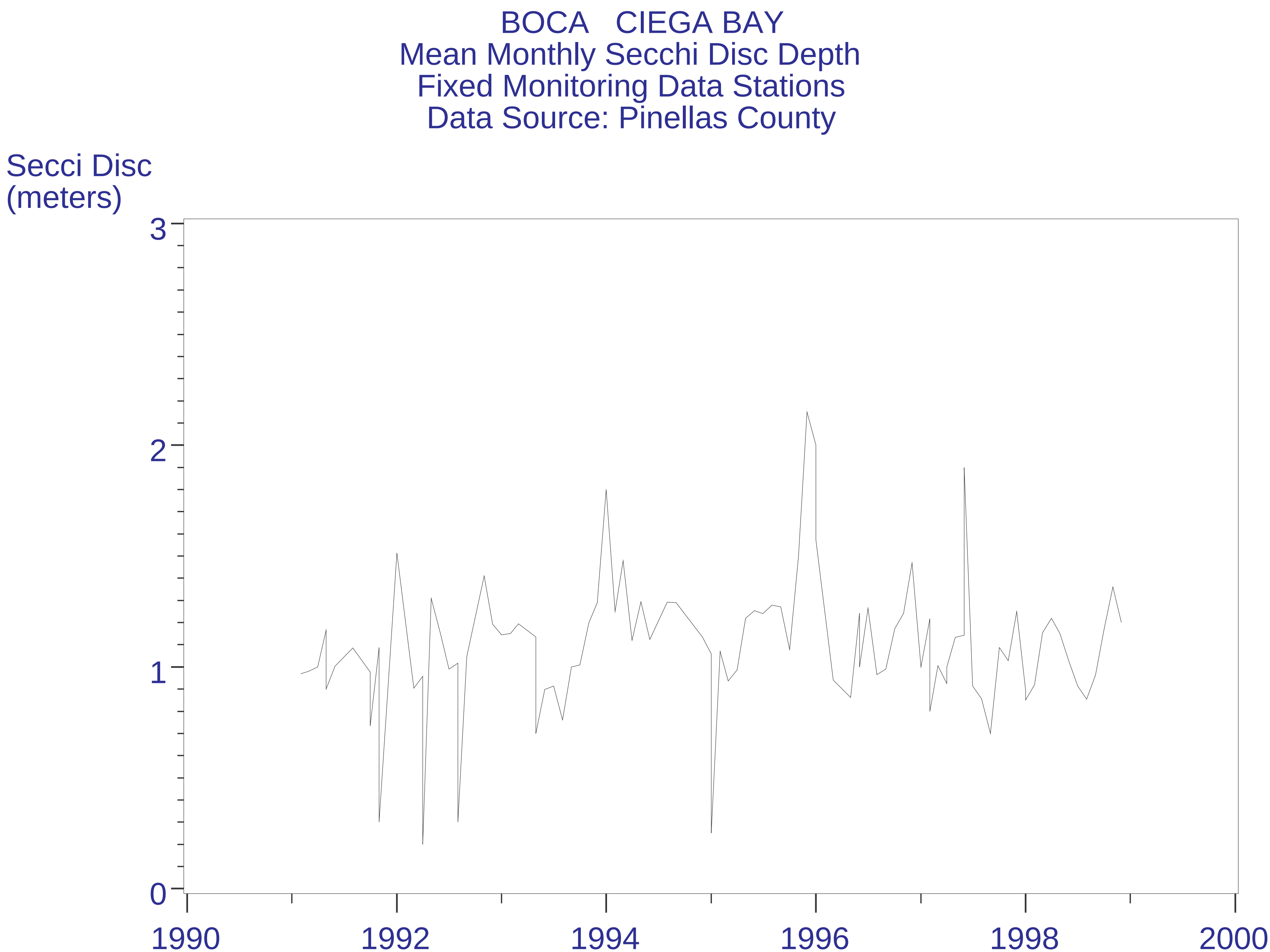

BOCA CIEGA BAY
Mean Monthly Total Nitrogen
Fixed Monitoring Data Stations
Data Source: Pinellas County
TN
(mg/L)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1990
1992
1994
1996
1998
2000

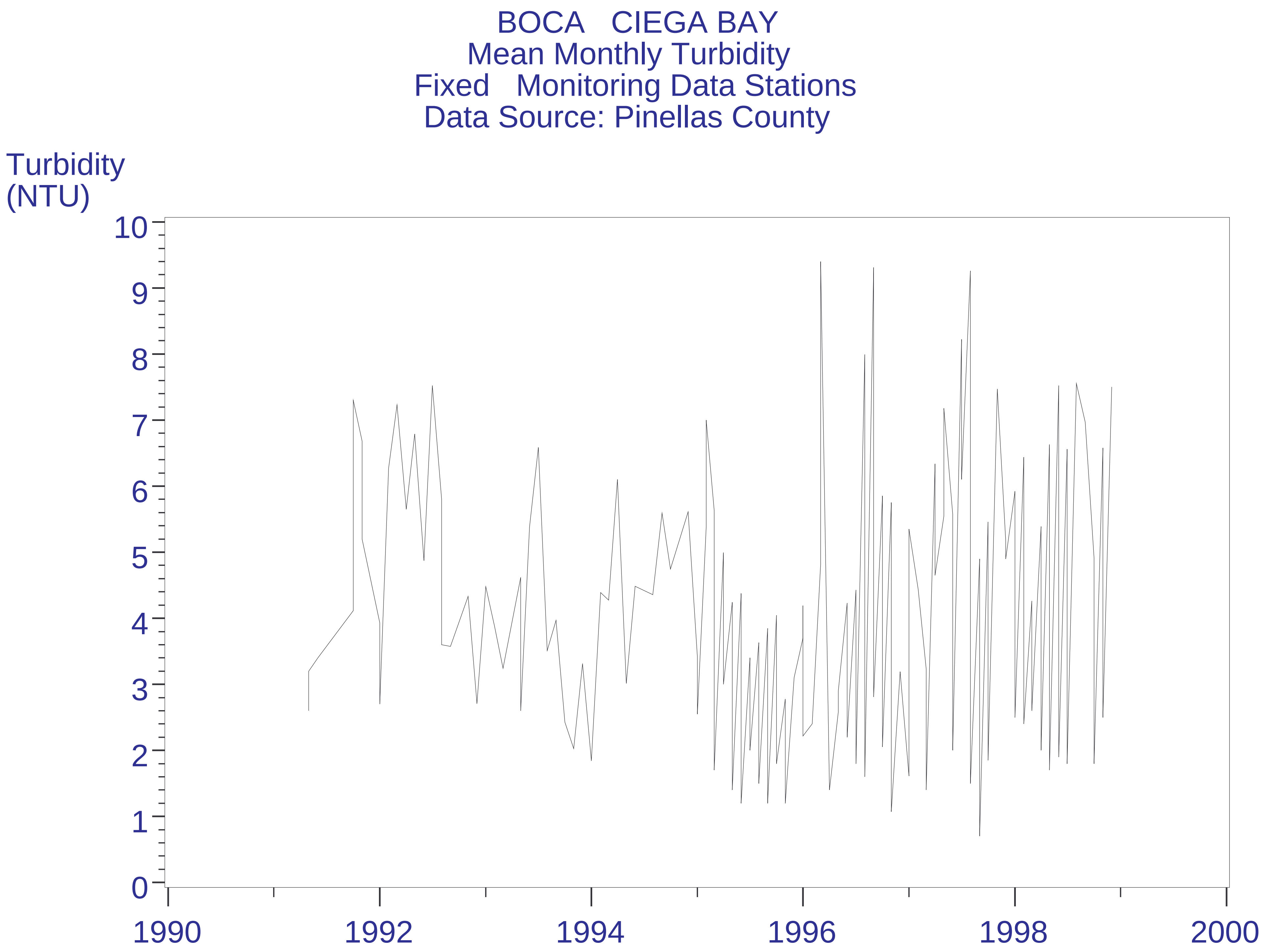

BOCA CIEGA BAY
Mean Monthly Total Phosphorus
Fixed Monitoring Data Stations
Data Source: Pinellas County
TP
(mg/L)
0.4
0.3
0.2
0.1
0.0
1990
1992
1994
1996
1998
2000


BOCA CIEGA BAY
Mean Monthly Biochemical Oxygen Demand
Fixed Monitoring Data Stations
Data Source: Pinellas County
BOD
(mg/L)
0
1
2
3
4
5
6
7
8
1990
1992
1994
1996
1998
2000

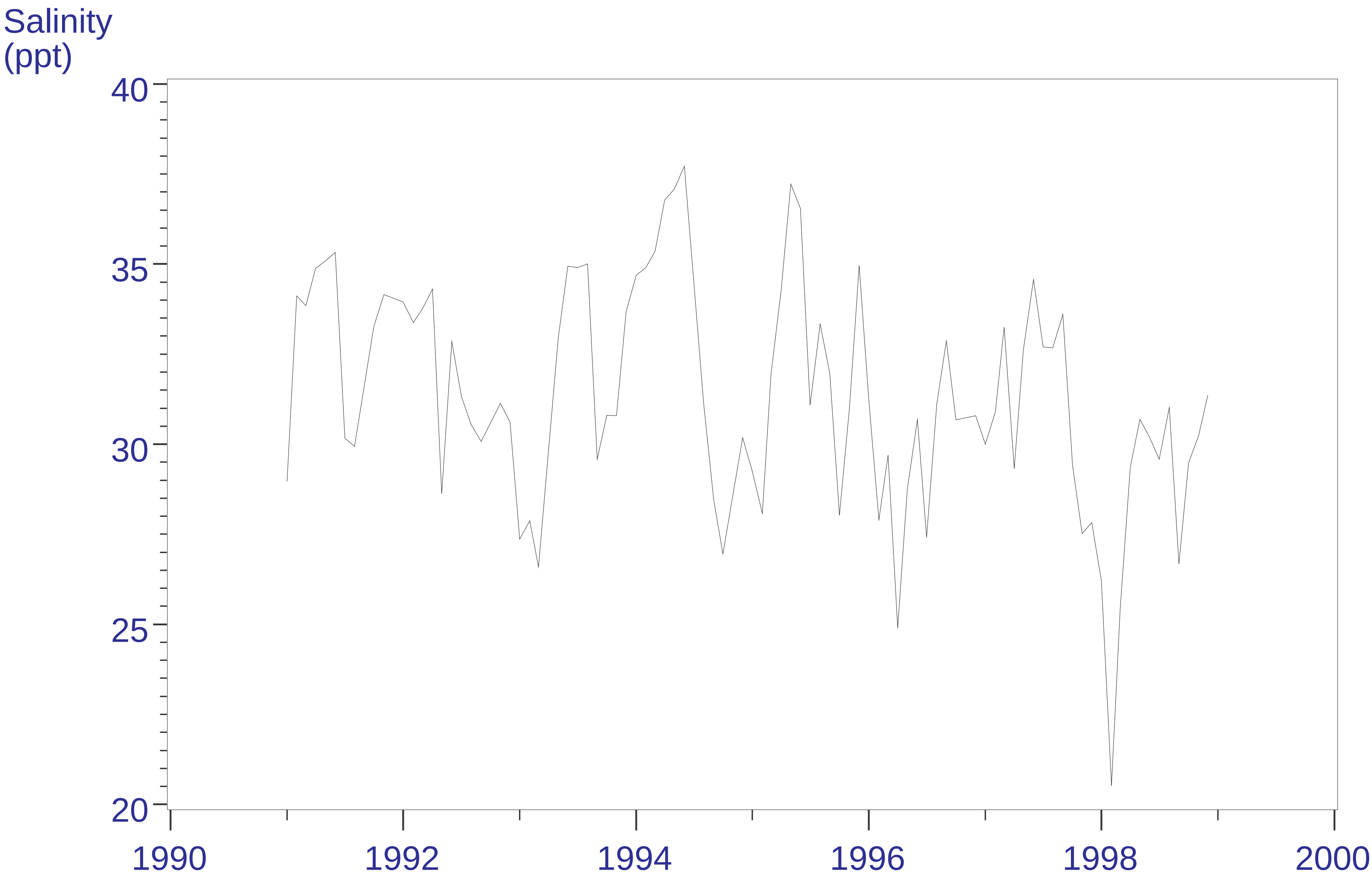
BOCA CIEGA BAY
Mean Monthly Bottom Dissolved Oxygen
Fixed Monitoring Data Stations
Data Source: Pinellas County

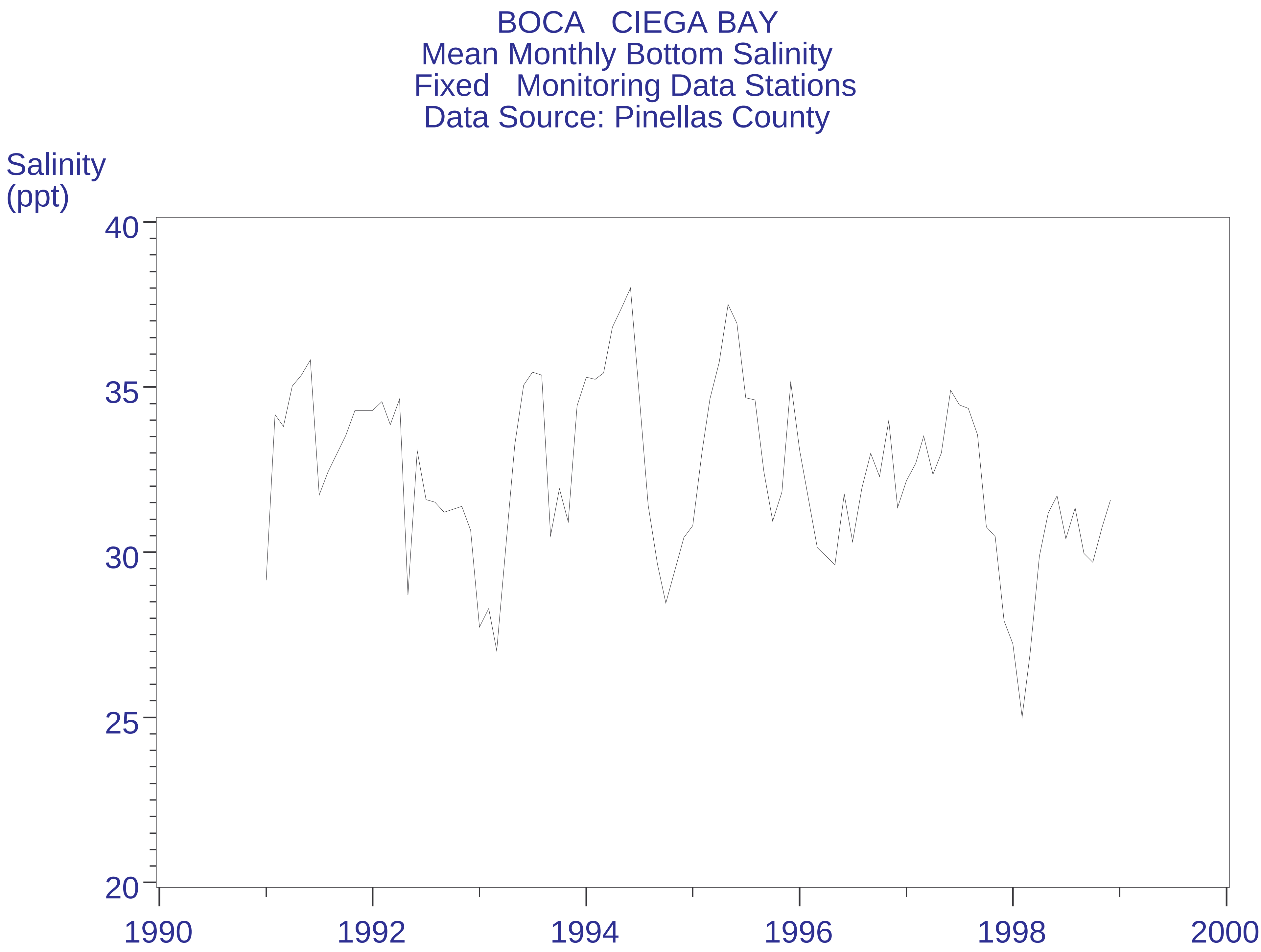



BOCA CIEGA BAY
Mean Monthly Secchi Disc Depth
Fixed Monitoring Data Stations
Data Source: Pinellas County
Secci Disc
(meters)
3
2
1
0
1990
1992
1994
1996
1998
2000

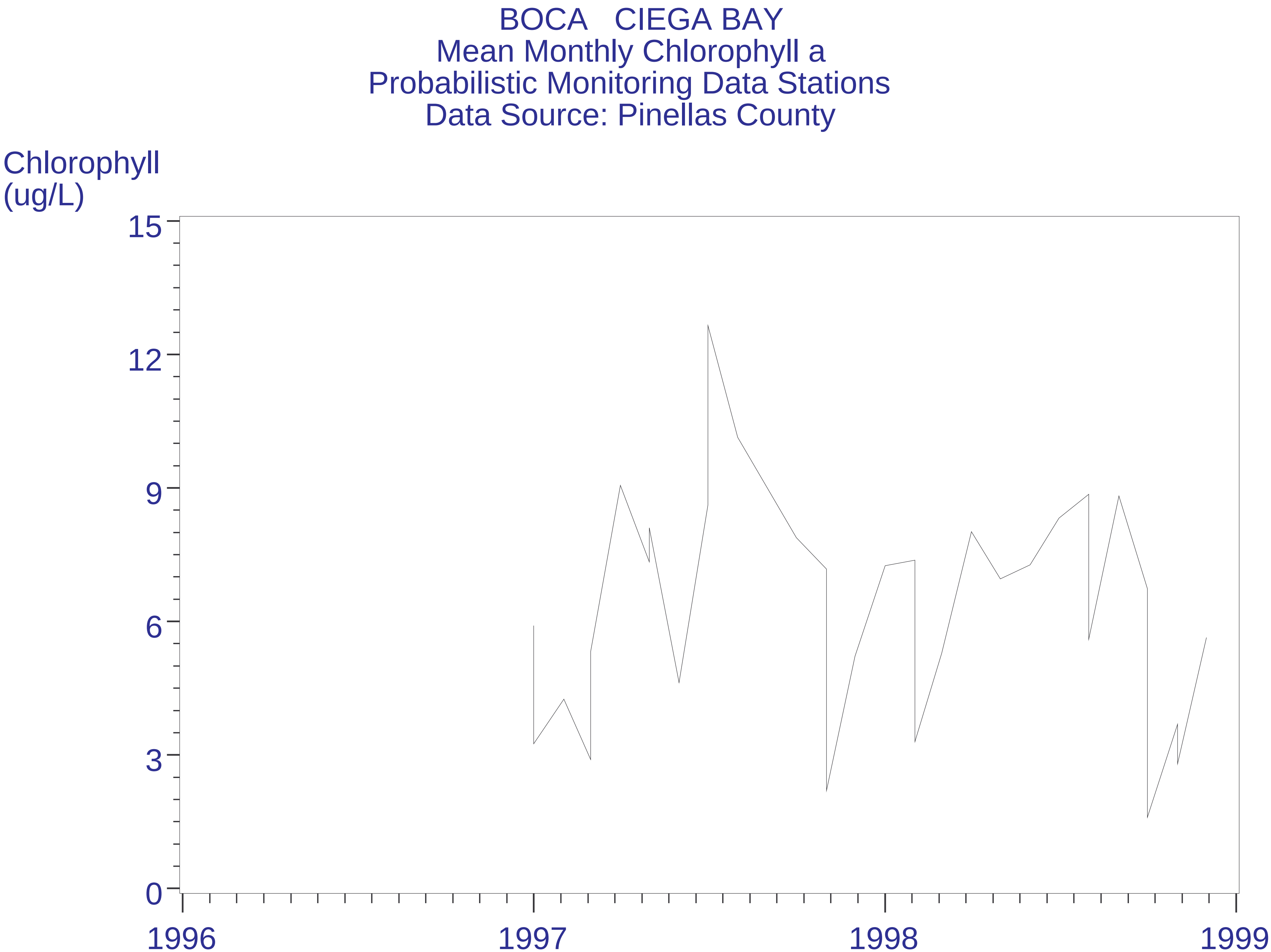

BOCA CIEGA BAY
Mean Monthly Turbidity
Fixed Monitoring Data Stations
Data Source: Pinellas County
Turbidity
(NTU)
10
9
8
7
6
5
4
3
2
1
0
1990
1992
1994
1996
1998
2000

BOCA CIEGA BAY
Mean Monthly Surface Salinity
Fixed Monitoring Data Stations
Data Source: Pinellas County



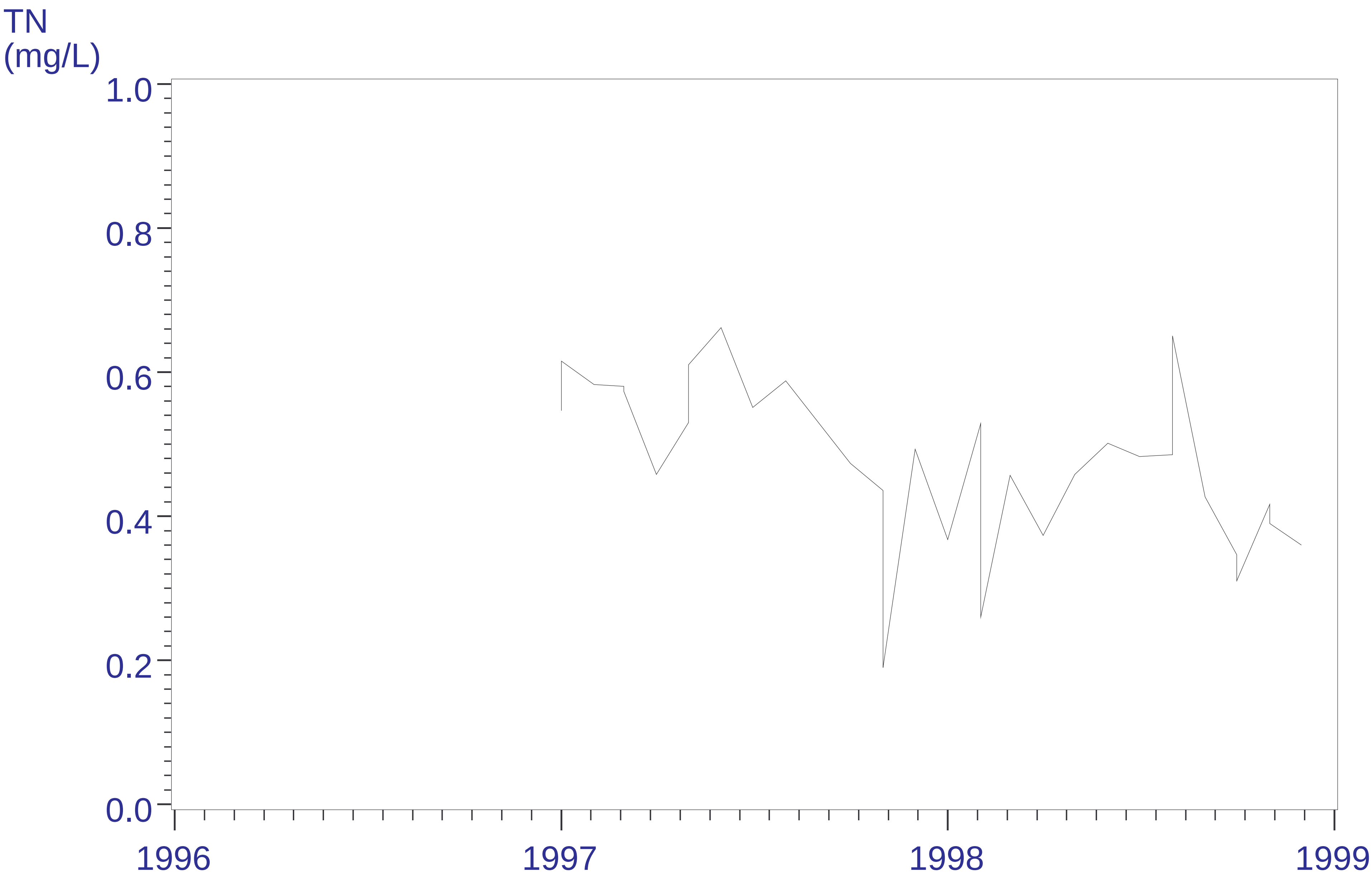

BOCA CIEGA BAY
Mean Monthly Bottom Salinity
Fixed Monitoring Data Stations
Data Source: Pinellas County
Salinity
(ppt)
40
35
30
25
20
1990
1992
1994
1996
1998
2000

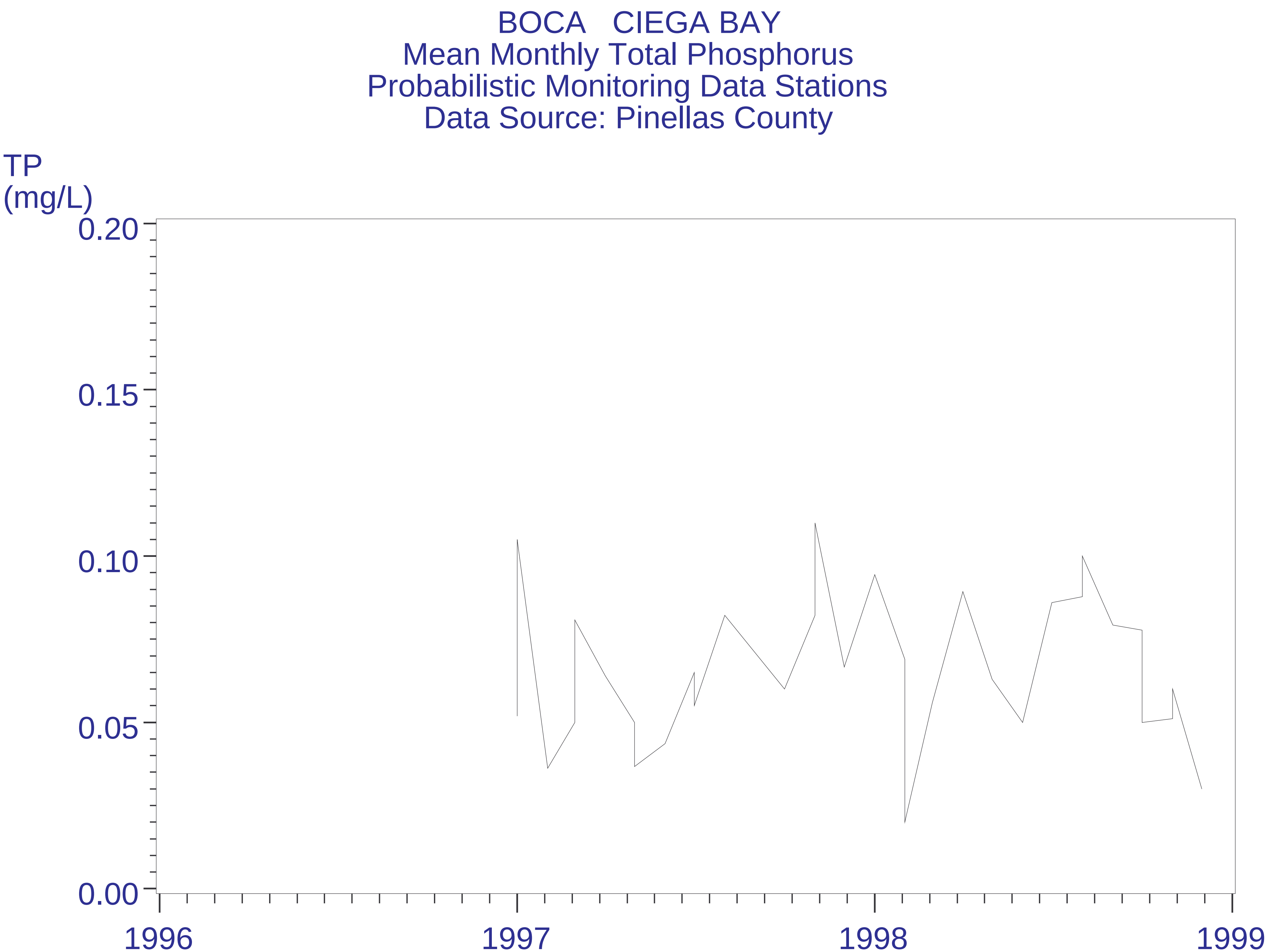
PROBABILISTIC STATION MONITORING DATA

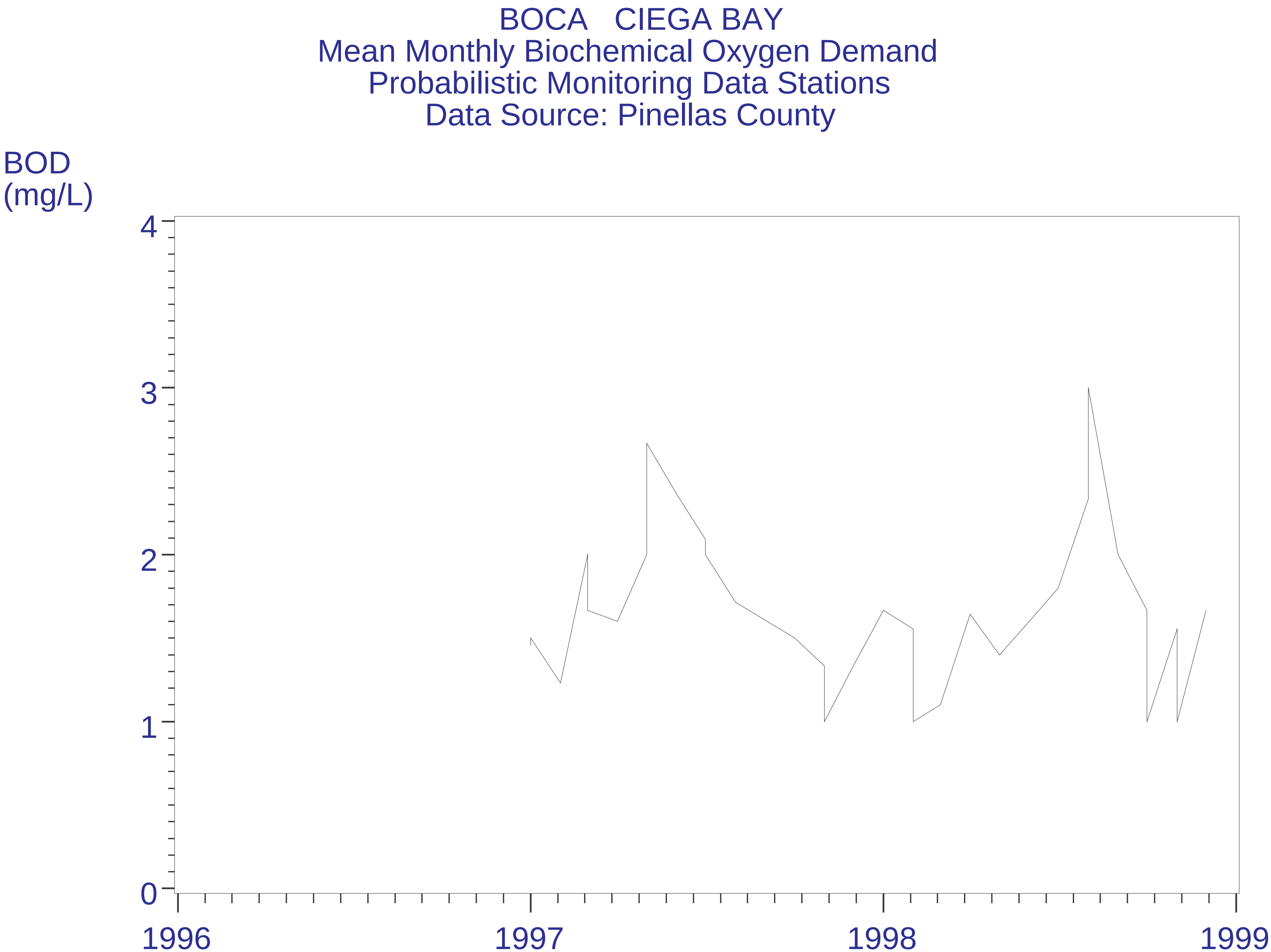


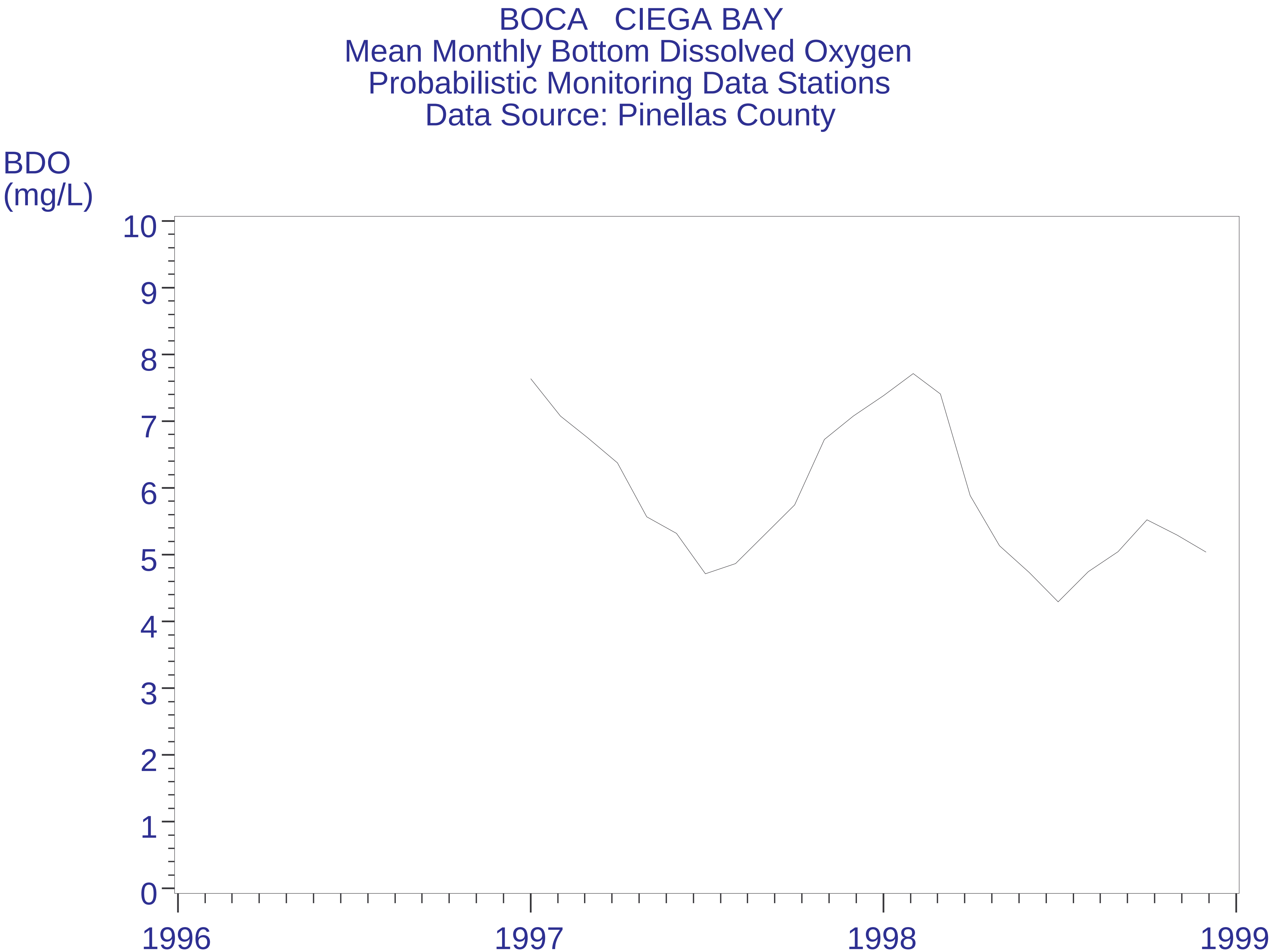
BOCA CIEGA BAY
Mean Monthly Chlorophyll a
Probabilistic Monitoring Data Stations
Data Source: Pinellas County
Chlorophyll
(ug/L)
15
12
9
6
3
0
1996
1997
1998
1999

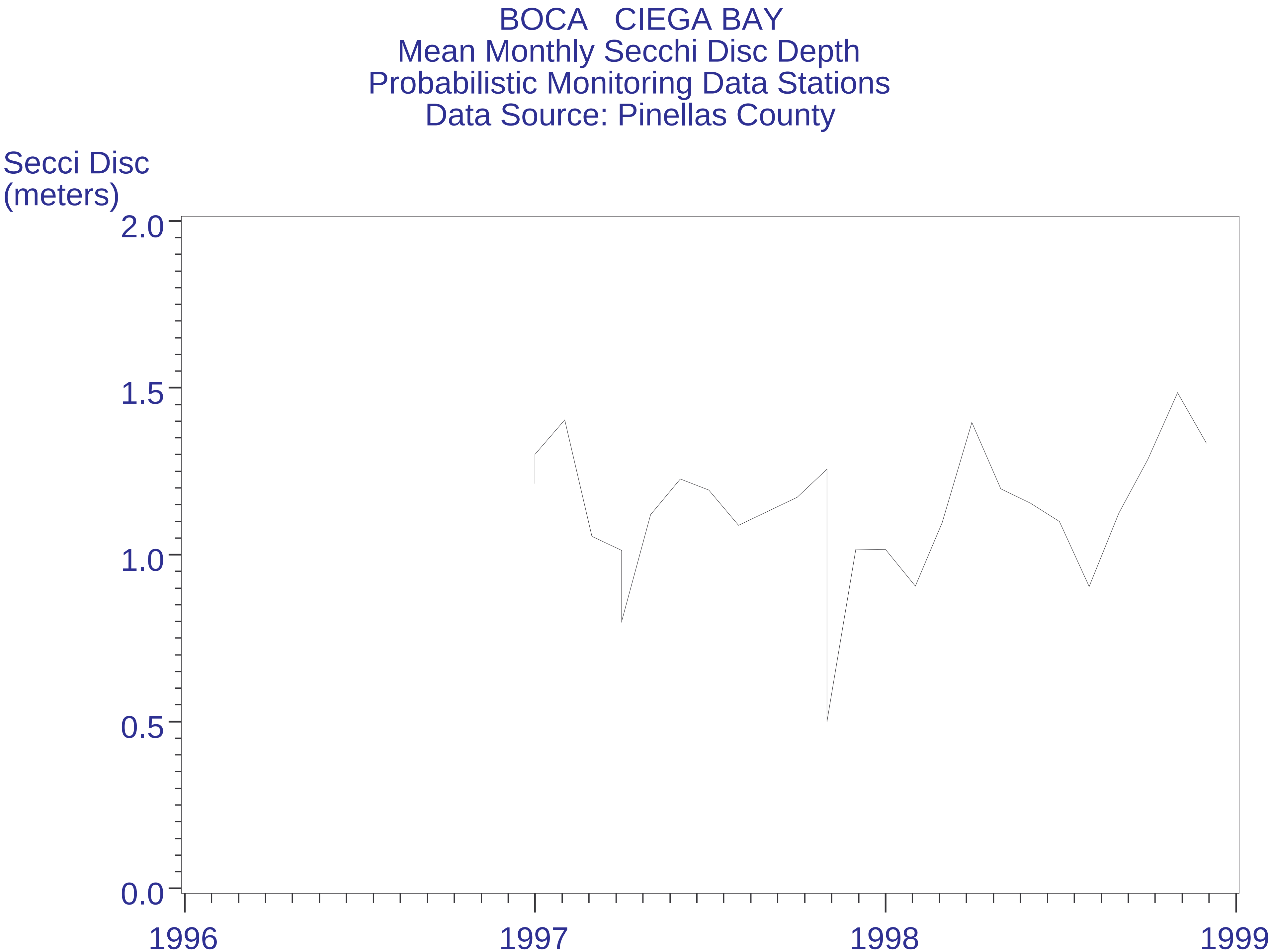
BOCA CIEGA BAY
Mean Monthly Total Nitrogen
Probabilistic Monitoring Data Stations
Data Source: Pinellas County



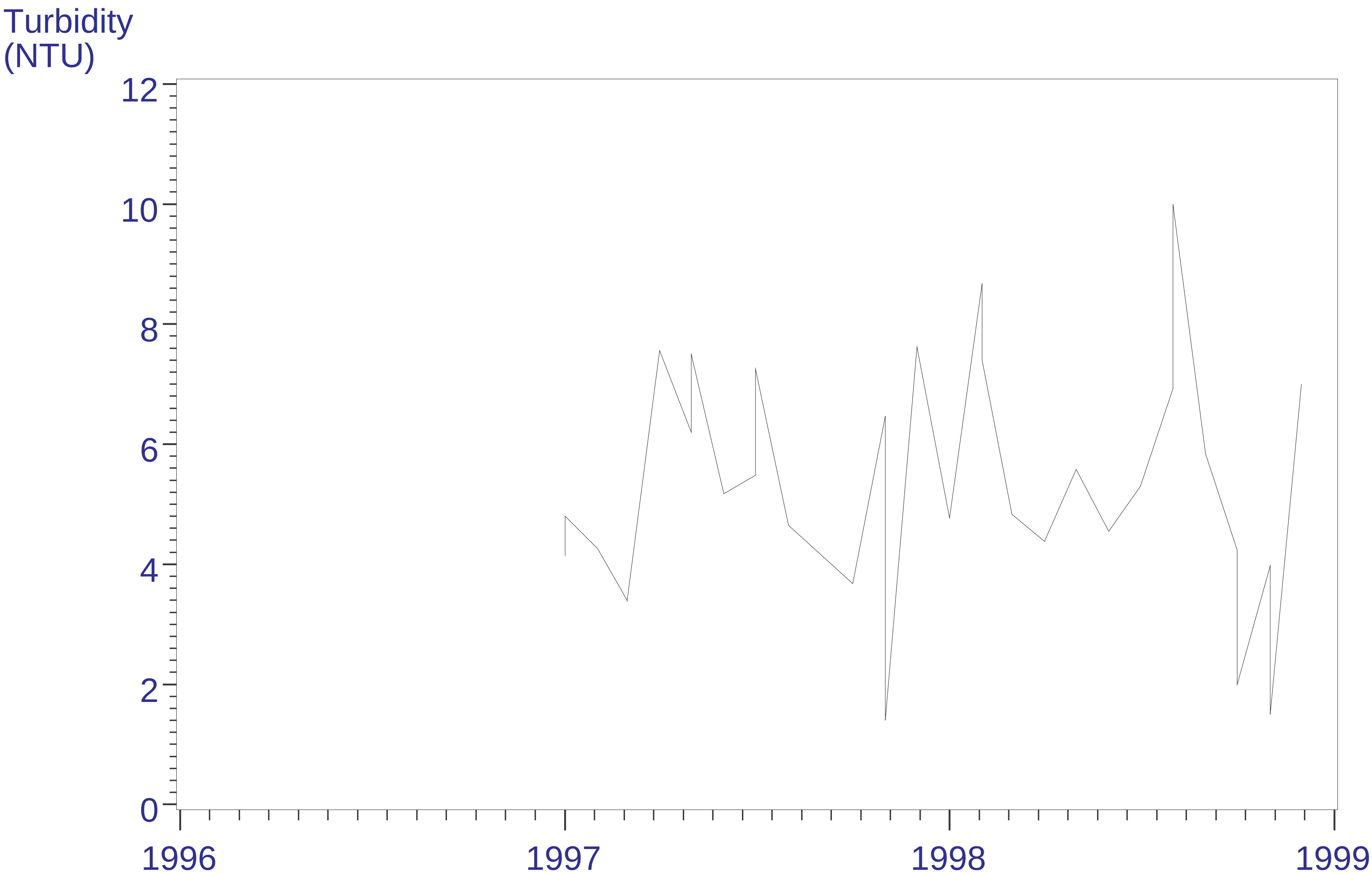

BOCA CIEGA BAY
Mean Monthly Total Phosphorus
Probabilistic Monitoring Data Stations
Data Source: Pinellas County
TP
(mg/L)
0.20
0.15
0.10
0.05
0.00
1996
1997
1998
1999


BOCA CIEGA BAY
Mean Monthly Biochemical Oxygen Demand
Probabilistic Monitoring Data Stations
Data Source: Pinellas County
BOD
(mg/L)
4
3
2
1
0
1996
1997
1998
1999

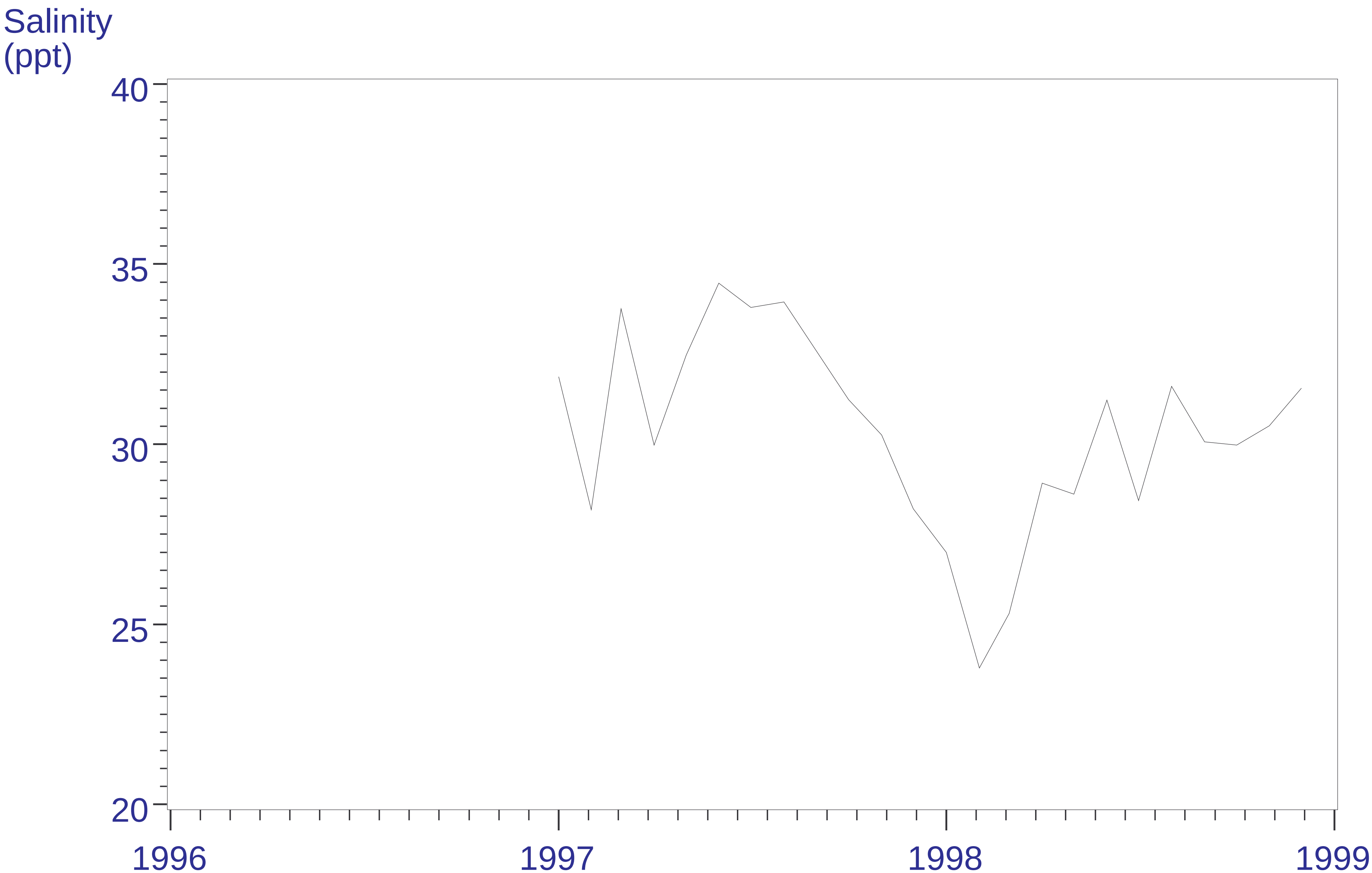

BOCA CIEGA BAY
Mean Monthly Bottom Dissolved Oxygen
Probabilistic Monitoring Data Stations
Data Source: Pinellas County
BDO
(mg/L)
10
9
8
7
6
5
4
3
2
1
0
1996
1997
1998
1999


BOCA CIEGA BAY
Mean Monthly Secchi Disc Depth
Probabilistic Monitoring Data Stations
Data Source: Pinellas County
Secci Disc
(meters)
2.0
1.5
1.0
0.5
0.0
1996
1997
1998
1999

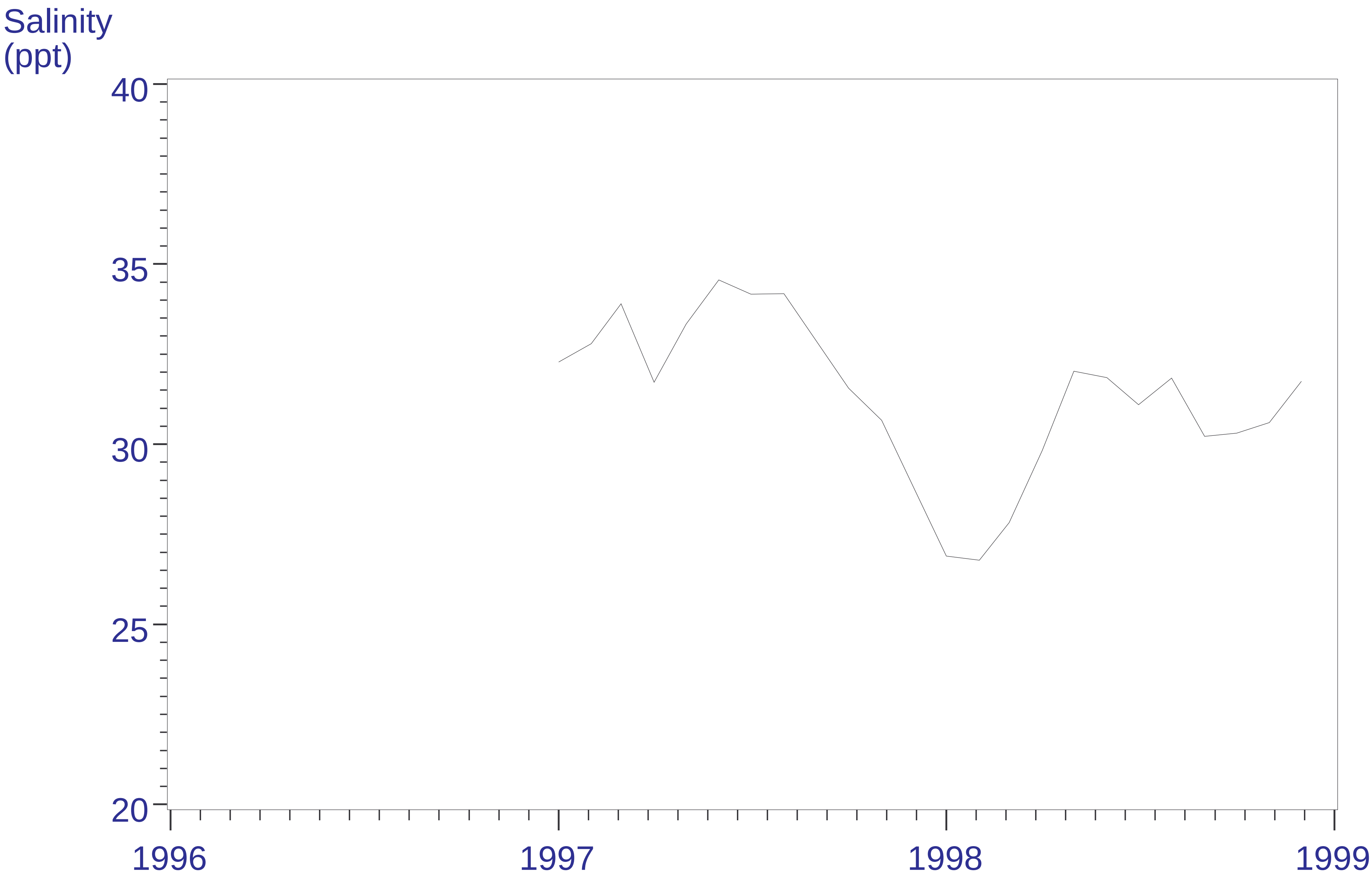
BOCA   CIEGA BAY
Mean Monthly Turbidity
Probabilistic   Monitoring Data Stations
Data Source: Pinellas County



BOCA CIEGA BAY
Mean Monthly Surface Salinity
Probabilistic Monitoring Data Stations
Data Source: Pinellas County



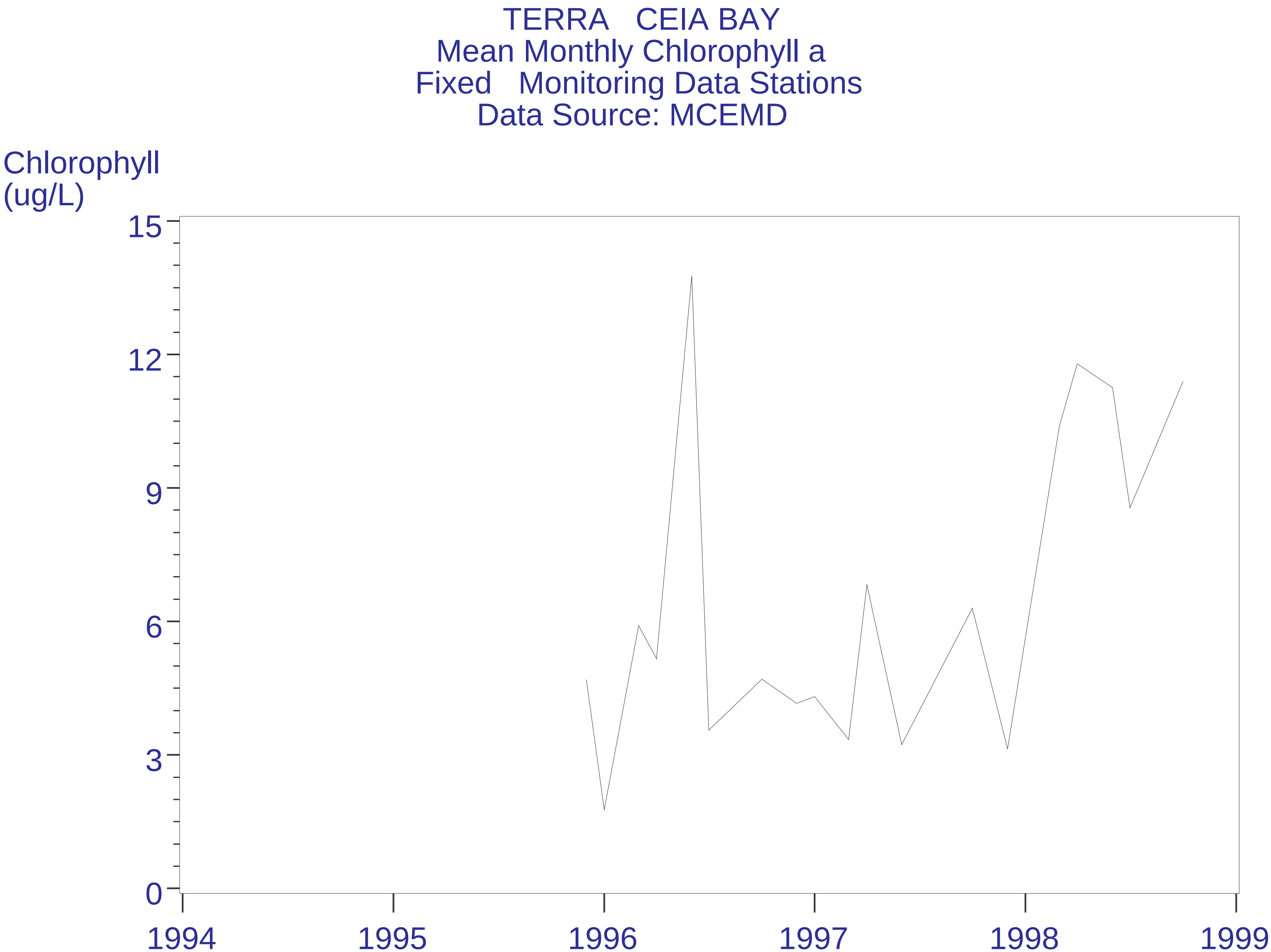
BOCA CIEGA BAY
Mean Monthly Bottom Salinity
Probabilistic Monitoring Data Stations
Data Source: Pinellas County



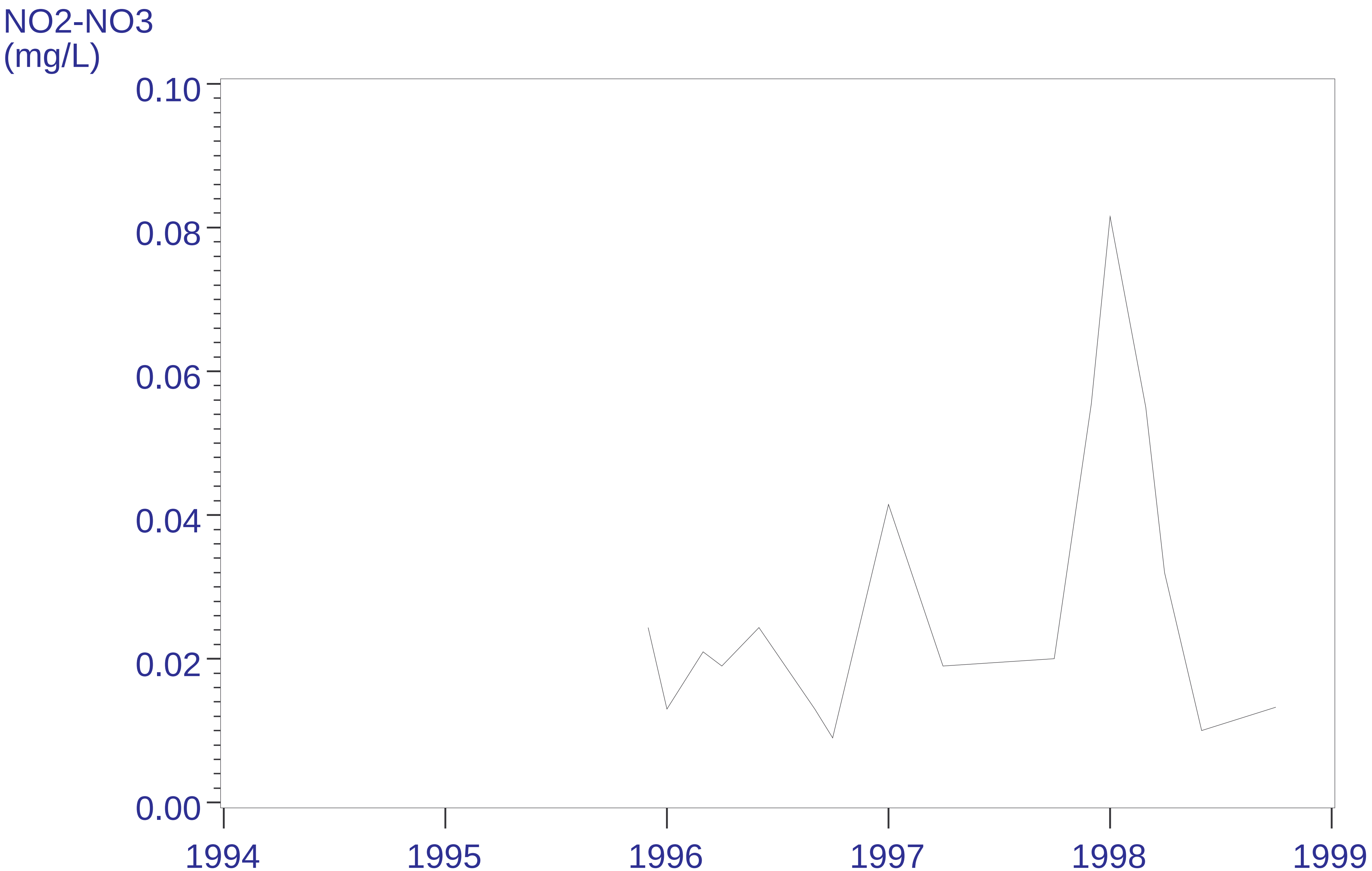
APPENDIX E

WATER QUALITY DATA PLOTS,
MANATEE COUNTY EMD
TERRA CEIA BAY AND MANATEE RIVER

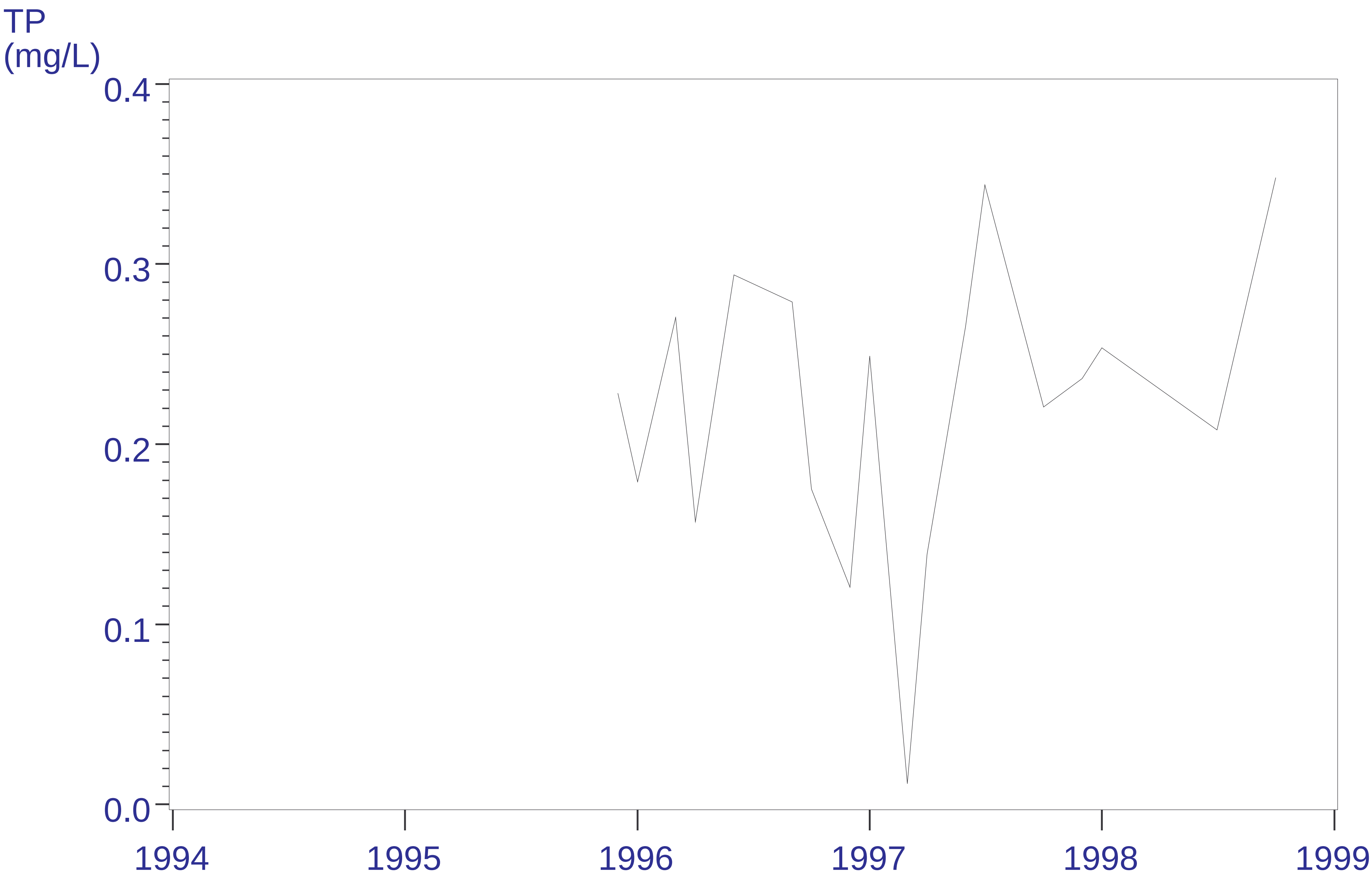
TERRA CEIA BAY

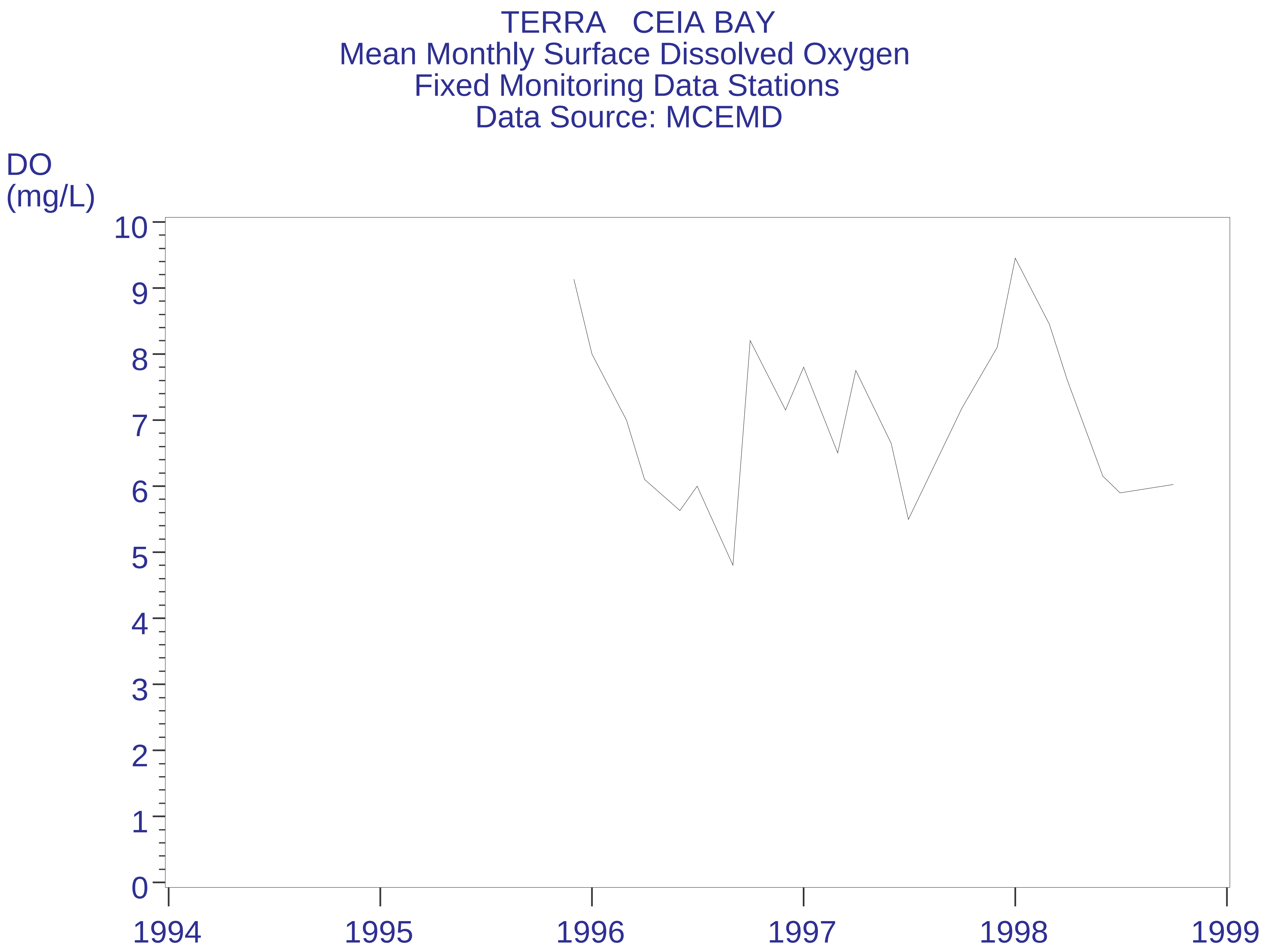

TERRA CEIA BAY
Mean Monthly Chlorophyll a
Fixed Monitoring Data Stations
Data Source: MCEMD
Chlorophyll
(ug/L)
15
12
9
6
3
0
1994
1995
1996
1997
1998
1999

TERRA CEIA BAY
Mean Monthly Nitrite-Nitrate Nitrogen
Fixed Monitoring Data Stations
Data Source: MCEMD

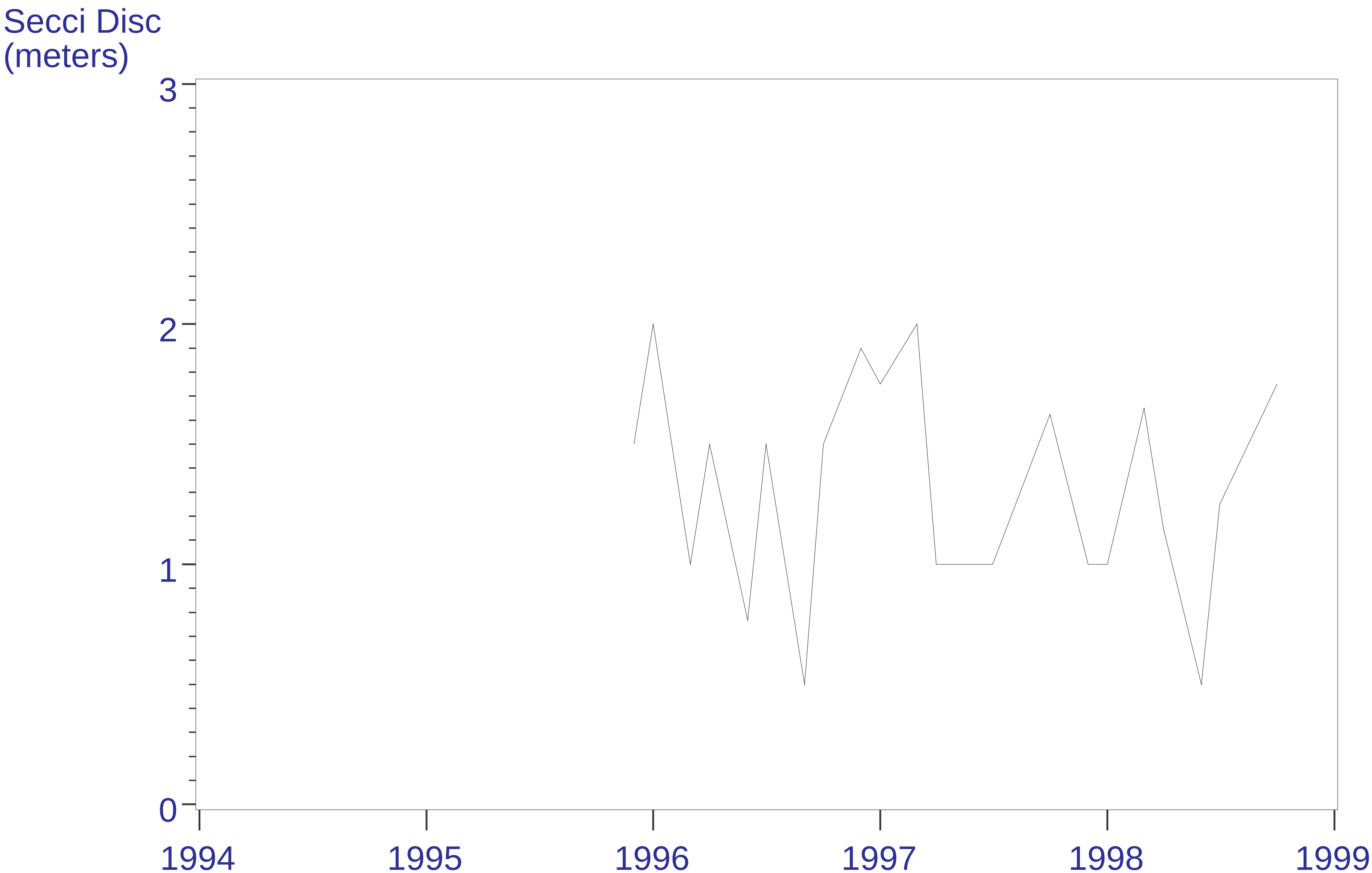


TERRA CEIA BAY
Mean Monthly Total Phosphorus
Fixed Monitoring Data Stations
Data Source: MCEMD

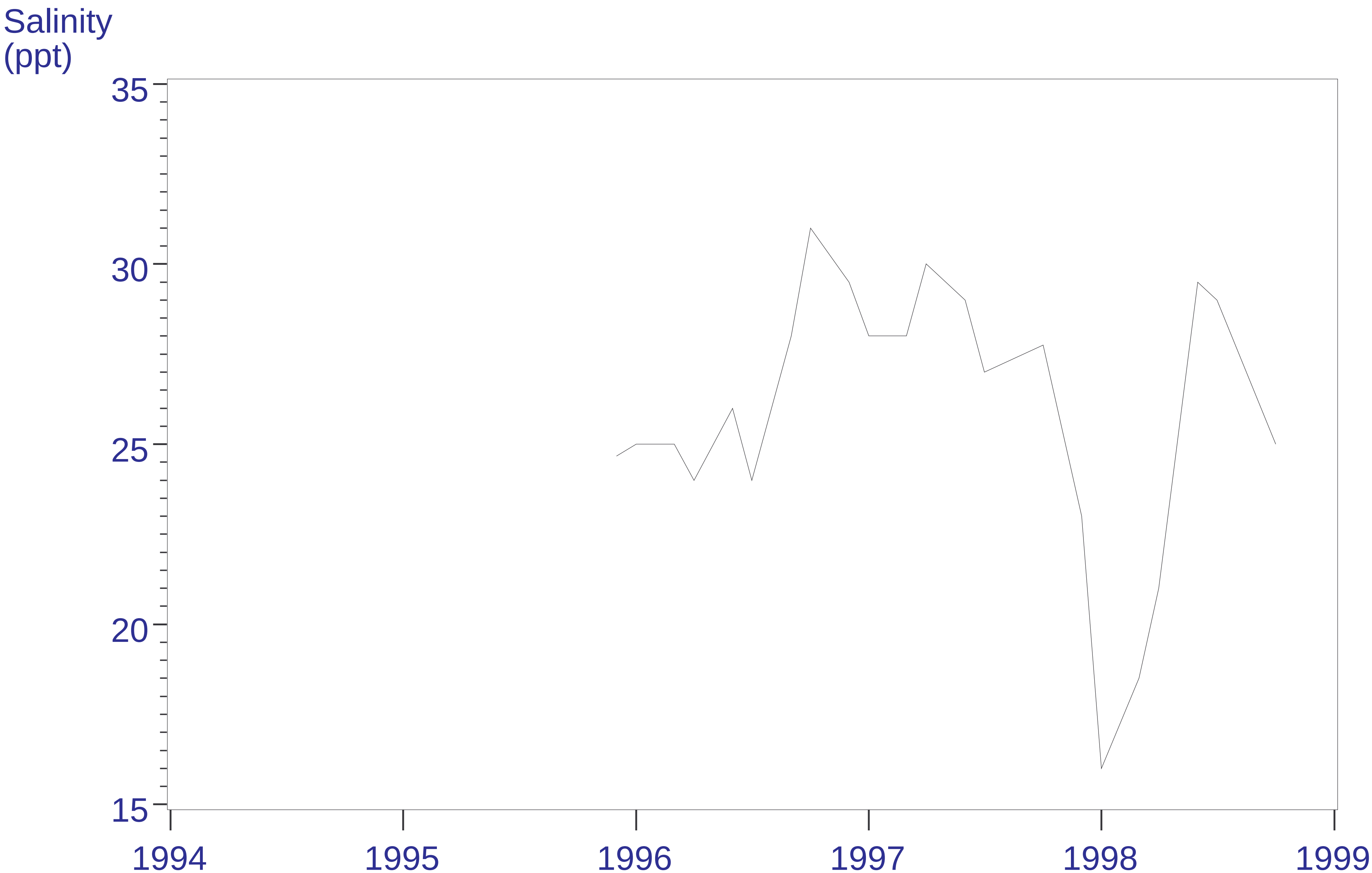



TERRA CEIA BAY
Mean Monthly Surface Dissolved Oxygen
Fixed Monitoring Data Stations
Data Source: MCEMD
DO
(mg/L)
10
9
8
7
6
5
4
3
2
1
0
1994
1995
1996
1997
1998
1999

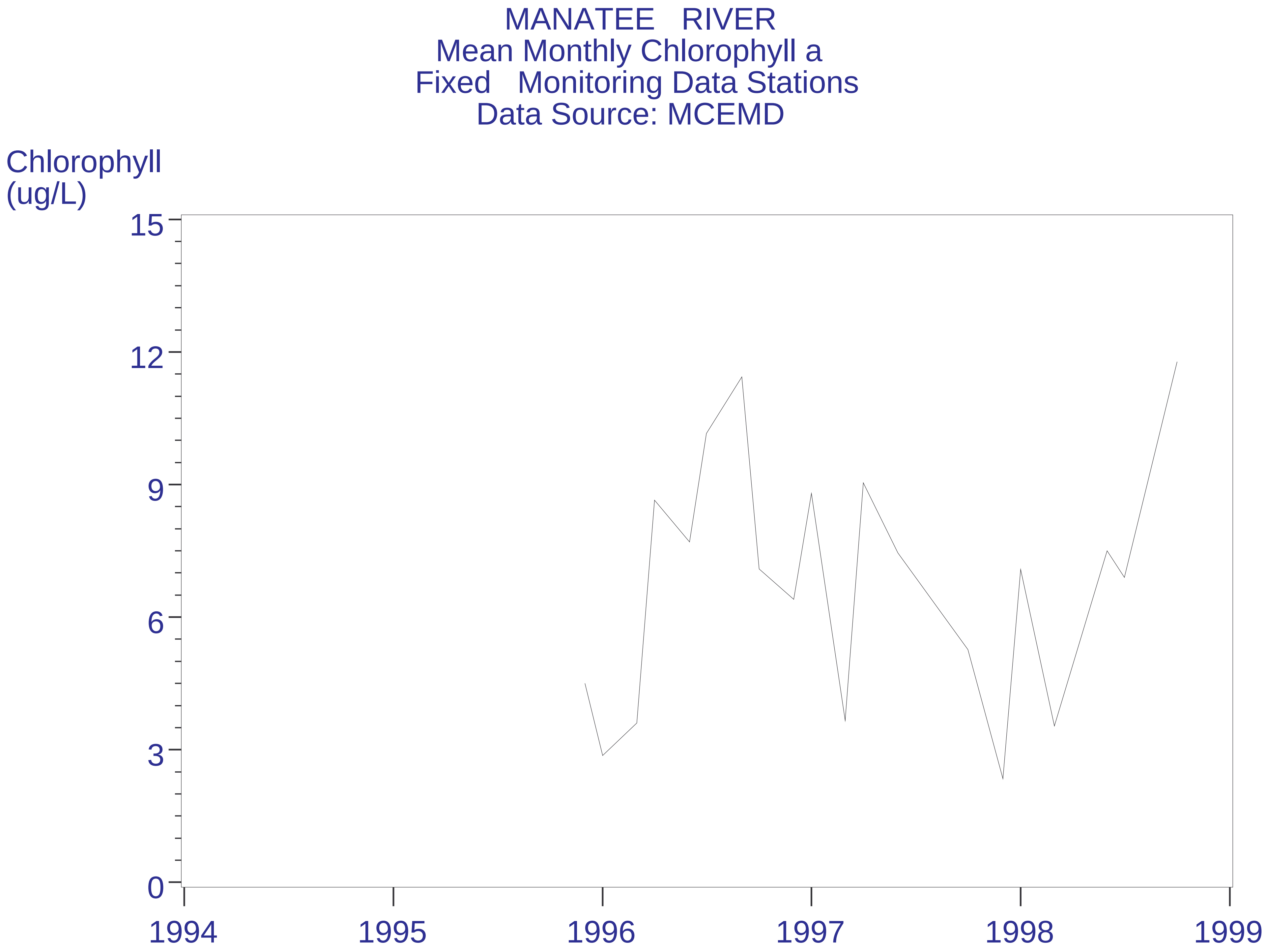
TERRA CEIA BAY
Mean Monthly Secchi Disc Depth
Fixed Monitoring Data Stations
Data Source: MCEMD

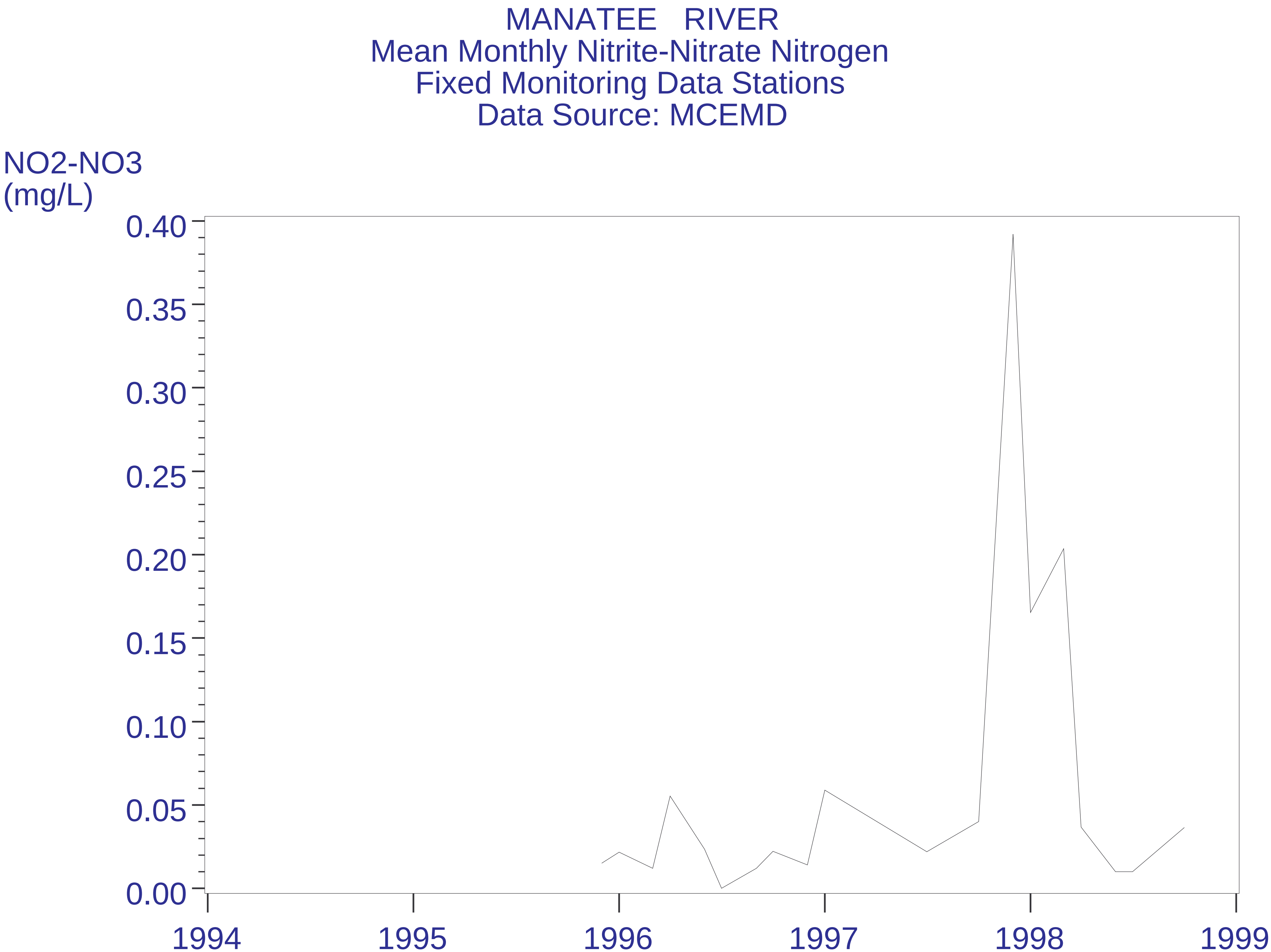


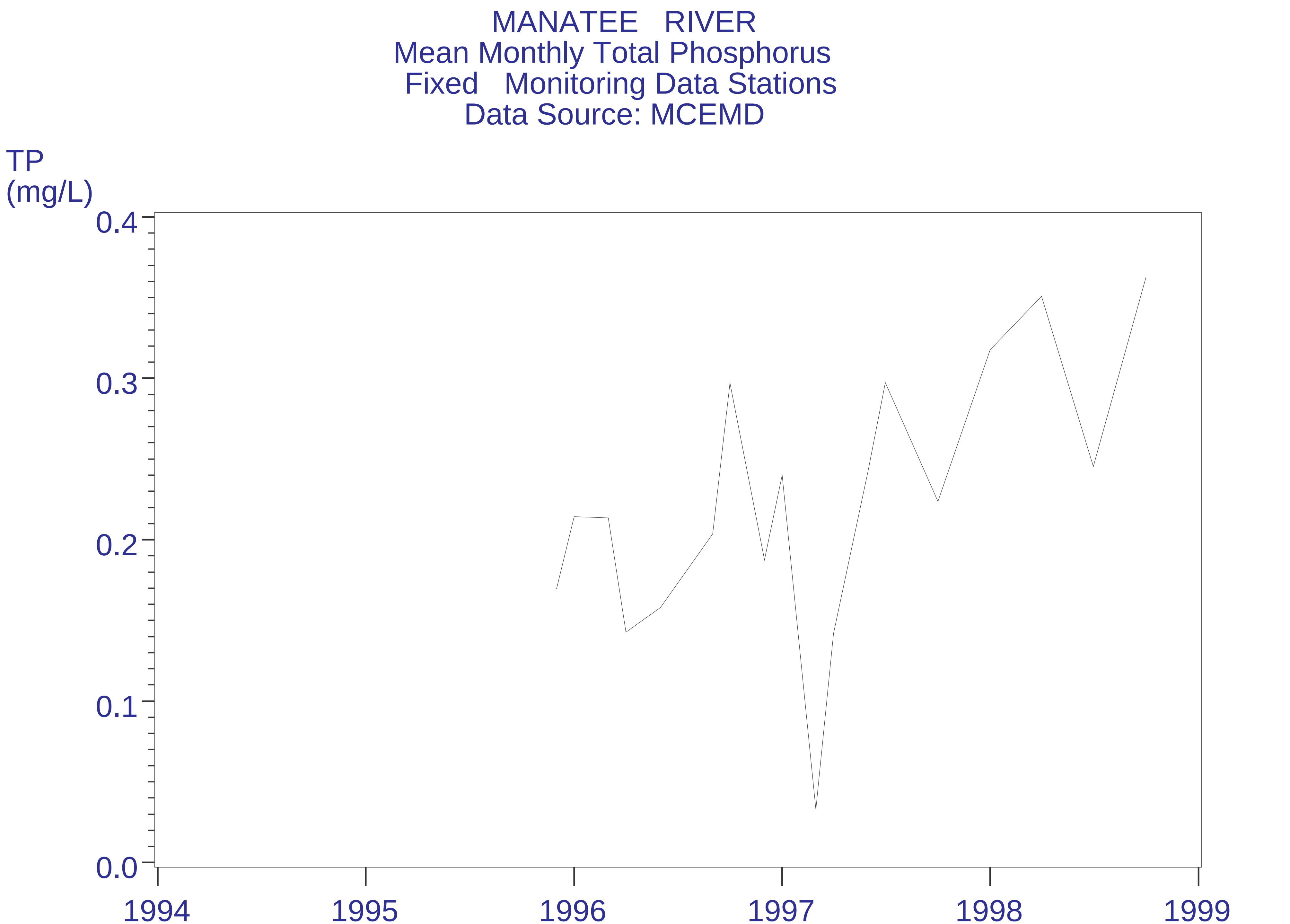
TERRA CEIA BAY
Mean Monthly Bottom Salinity
Fixed Monitoring Data Stations
Data Source: MCEMD



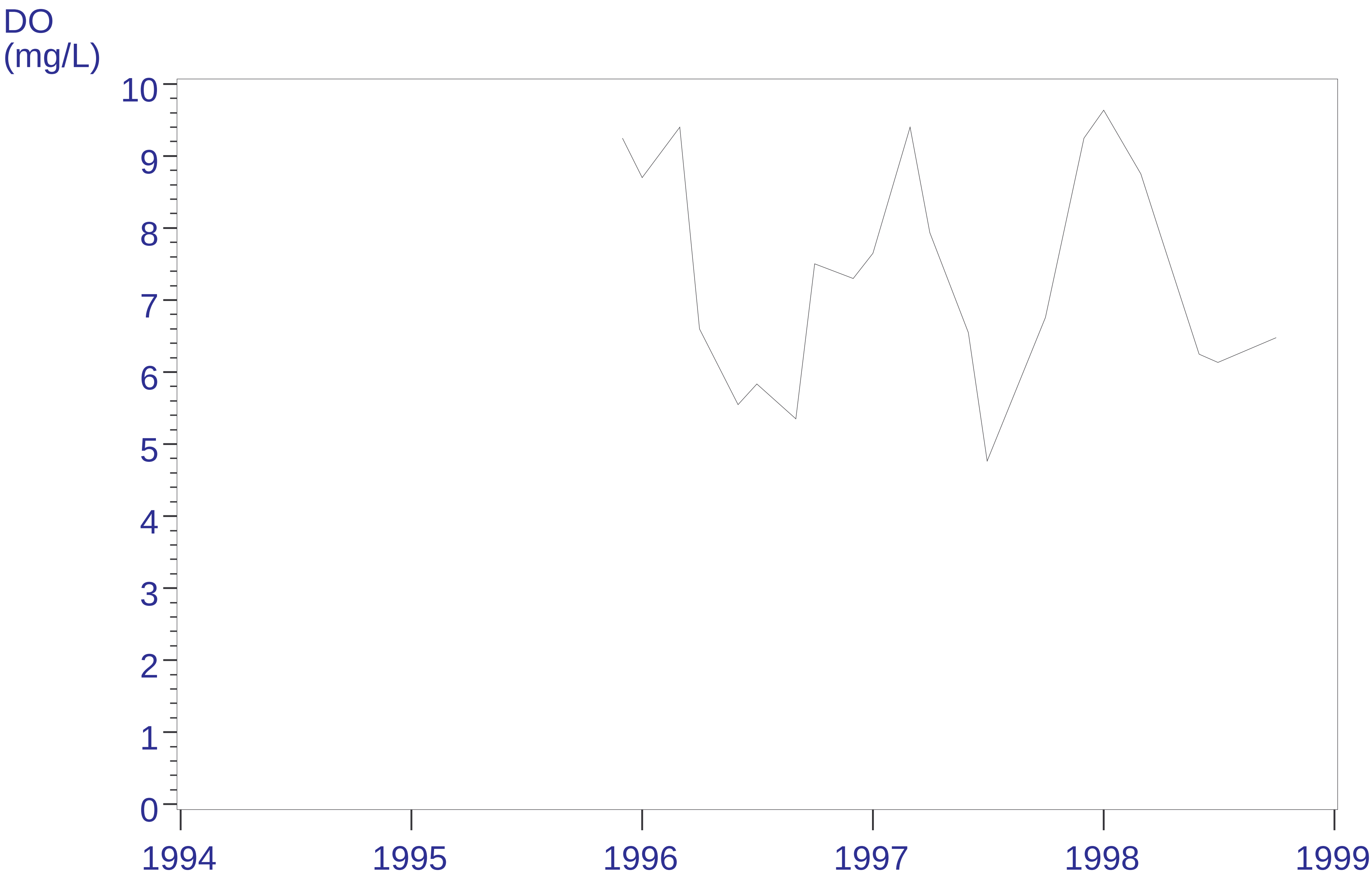
MANATEE RIVER

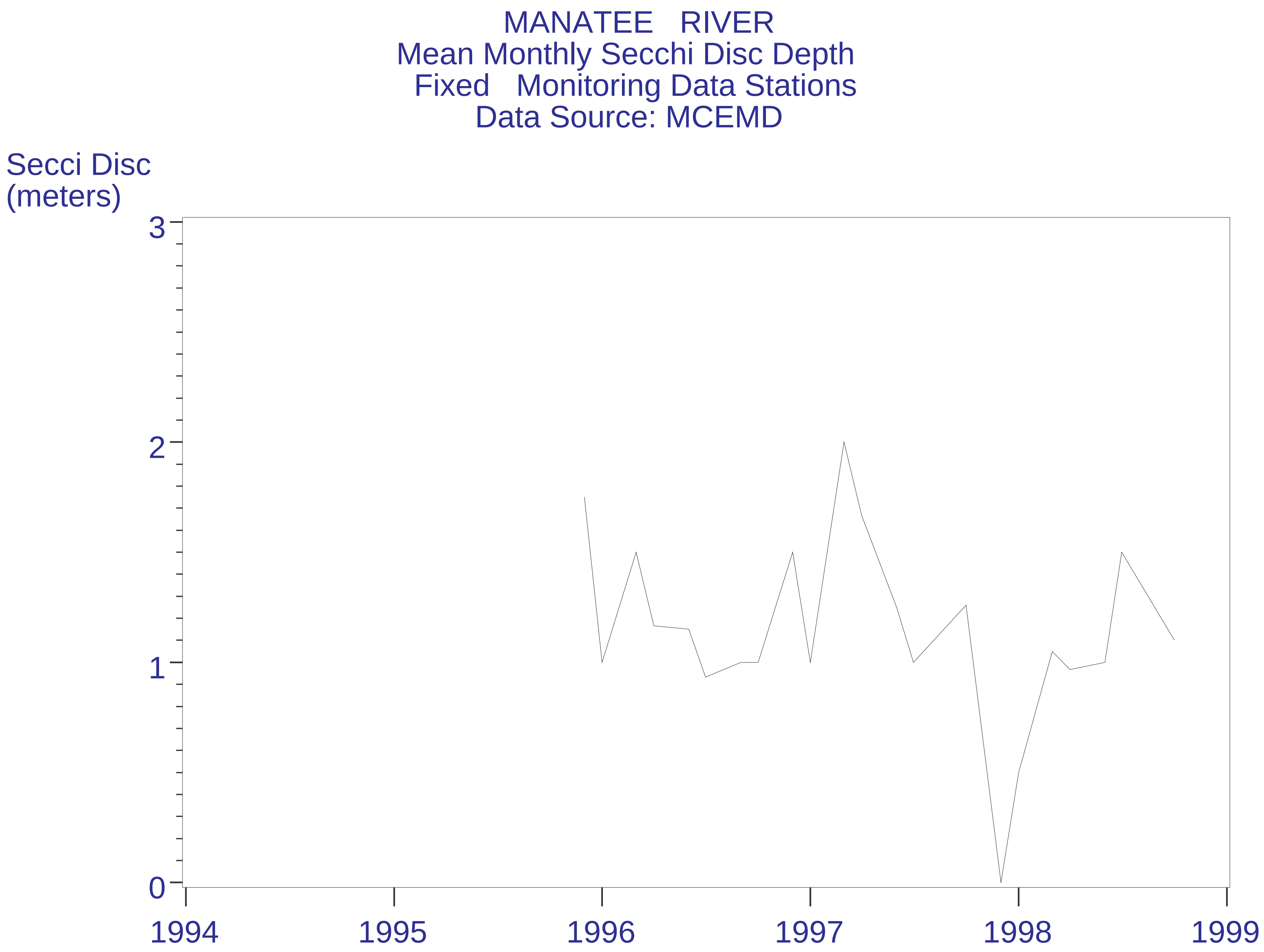

MANATEE RIVER
Mean Monthly Chlorophyll a
Fixed Monitoring Data Stations
Data Source: MCEMD
Chlorophyll
(ug/L)
15
12
9
6
3
0
1994
1995
1996
1997
1998
1999


MANATEE RIVER
Mean Monthly Nitrite-Nitrate Nitrogen
Fixed Monitoring Data Stations
Data Source: MCEMD
NO2-NO3
(mg/L)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1994
1995
1996
1997
1998
1999

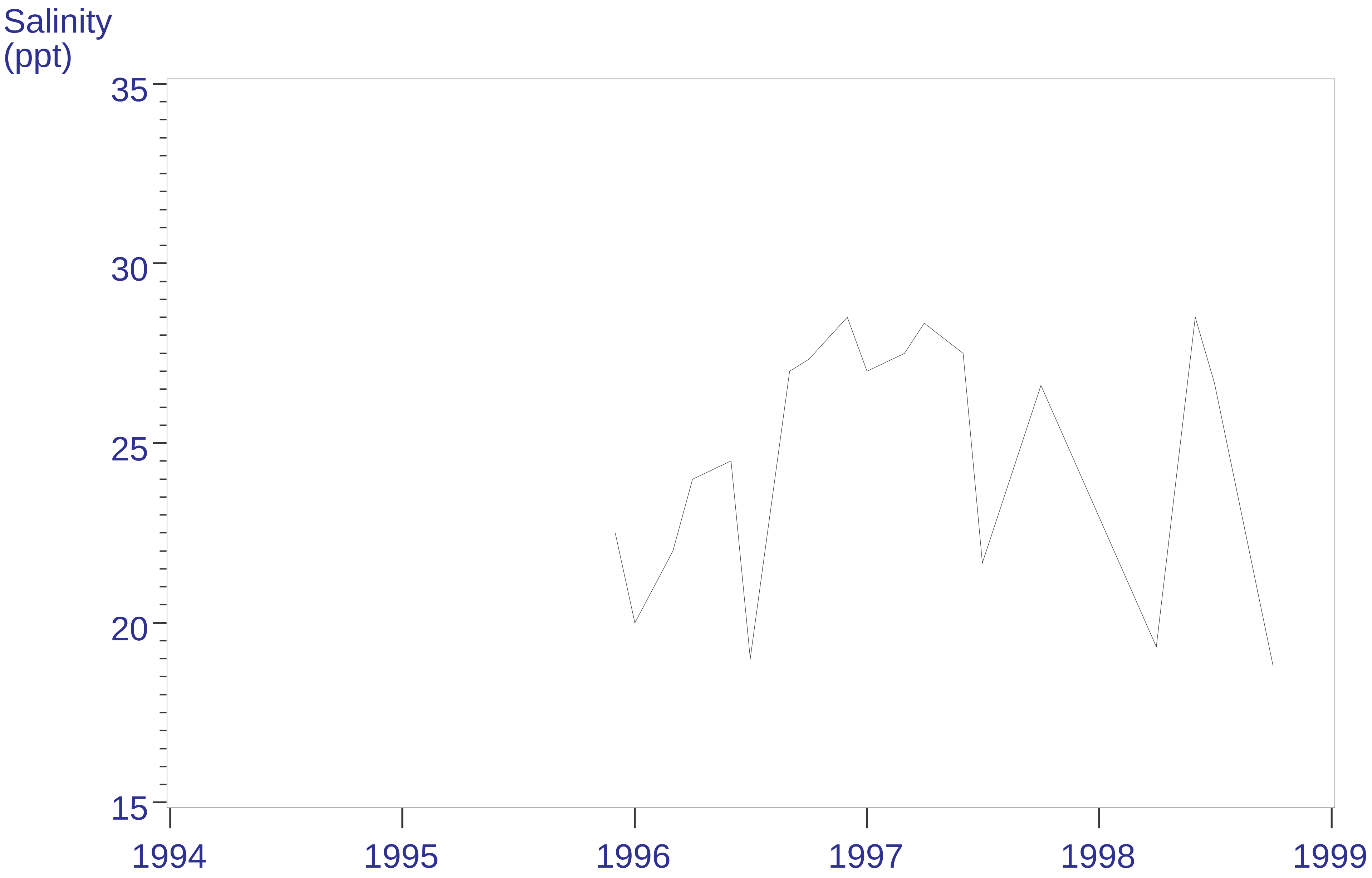

MANATEE RIVER
Mean Monthly Total Phosphorus
Fixed Monitoring Data Stations
Data Source: MCEMD
TP
(mg/L)
0.4
0.3
0.2
0.1
0.0
1994
1995
1996
1997
1998
1999

MANATEE RIVER
Mean Monthly Surface Dissolved Oxygen
Fixed Monitoring Data Stations
Data Source: MCEMD



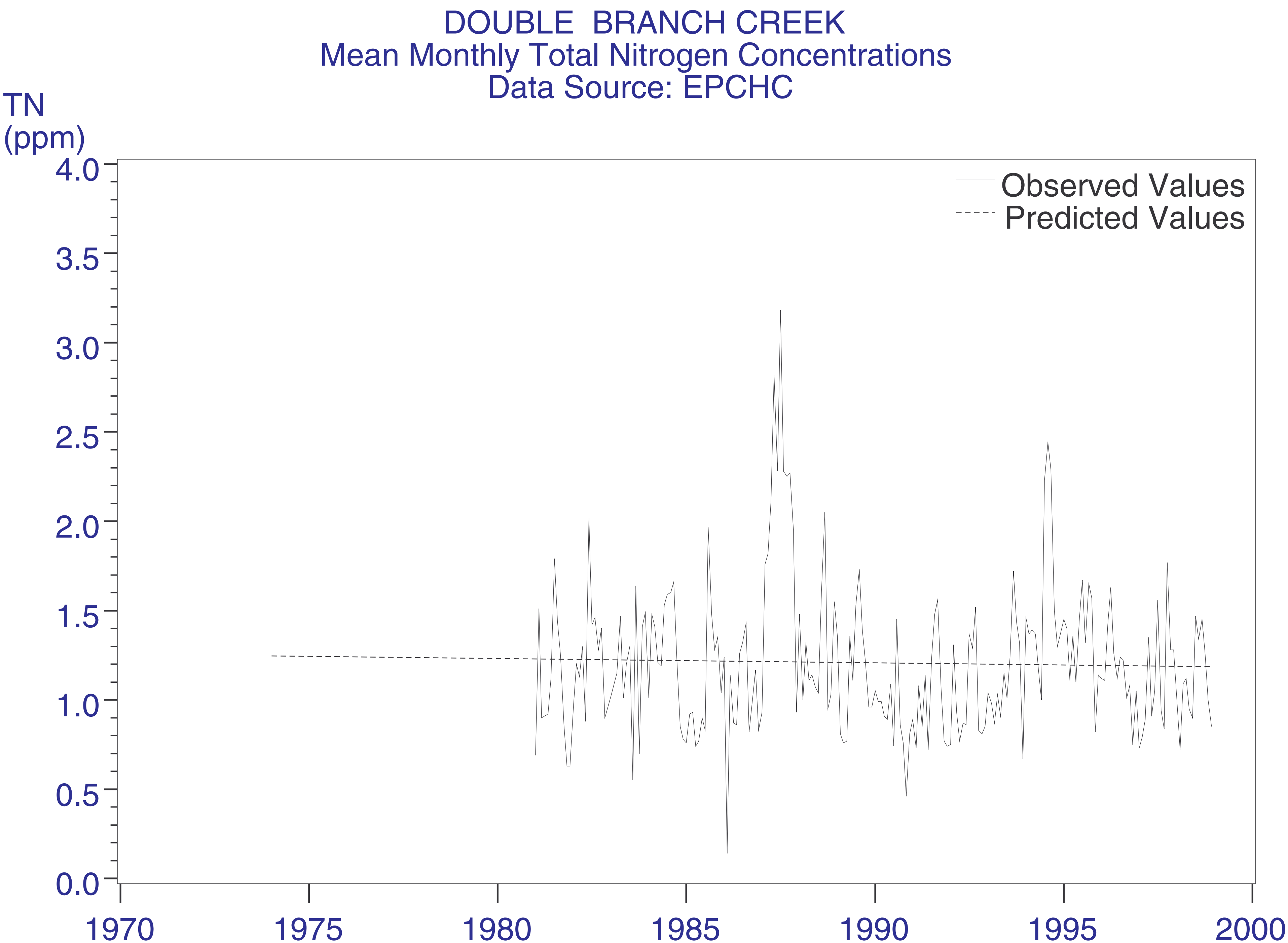

MANATEE RIVER
Mean Monthly Secchi Disc Depth
Fixed Monitoring Data Stations
Data Source: MCEMD
Secci Disc
(meters)
3
2
1
0
1994
1995
1996
1997
1998
1999

MANATEE RIVER
Mean Monthly Bottom Salinity
Fixed Monitoring Data Stations
Data Source: MCEMD

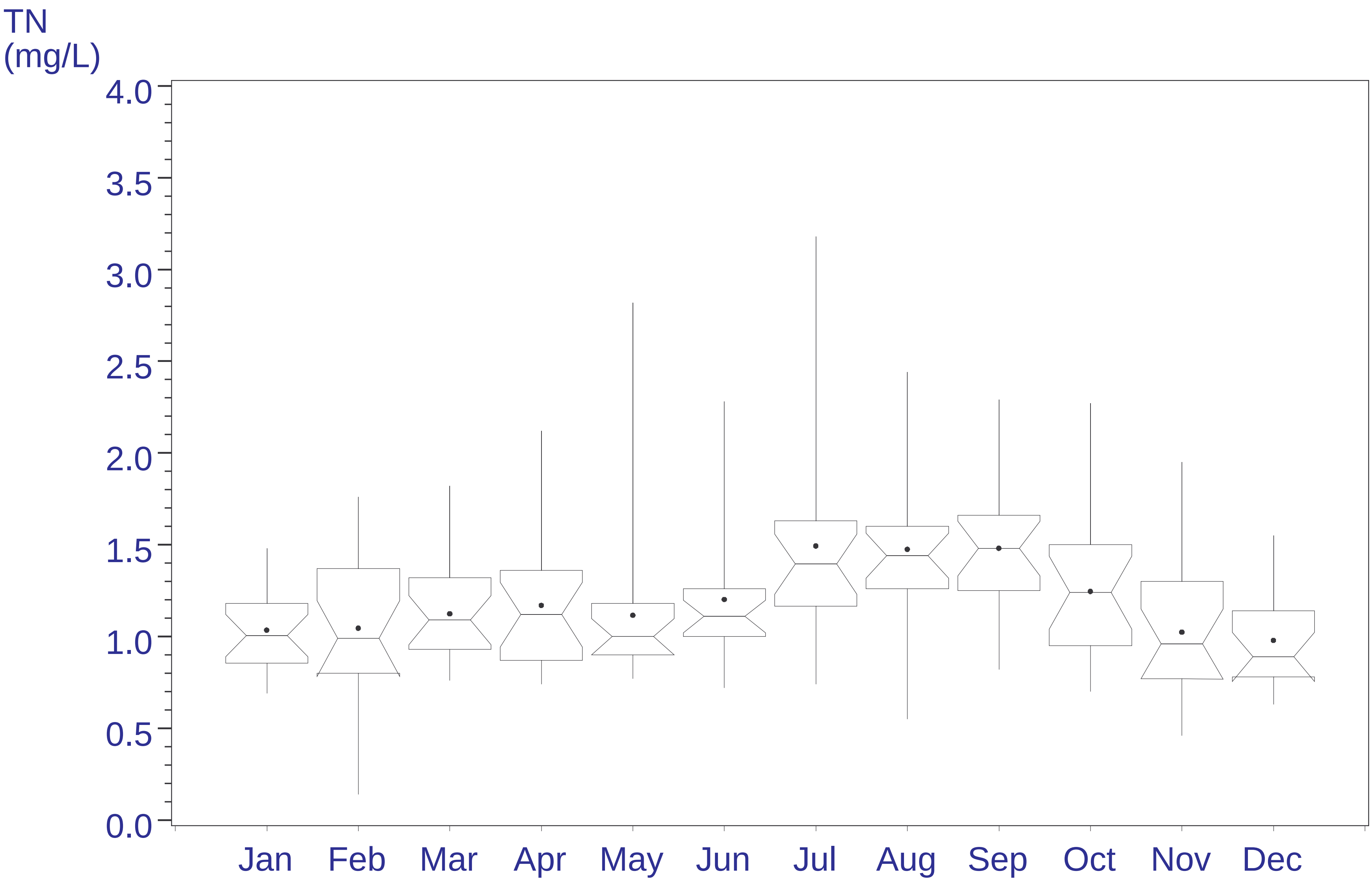


APPENDIX F

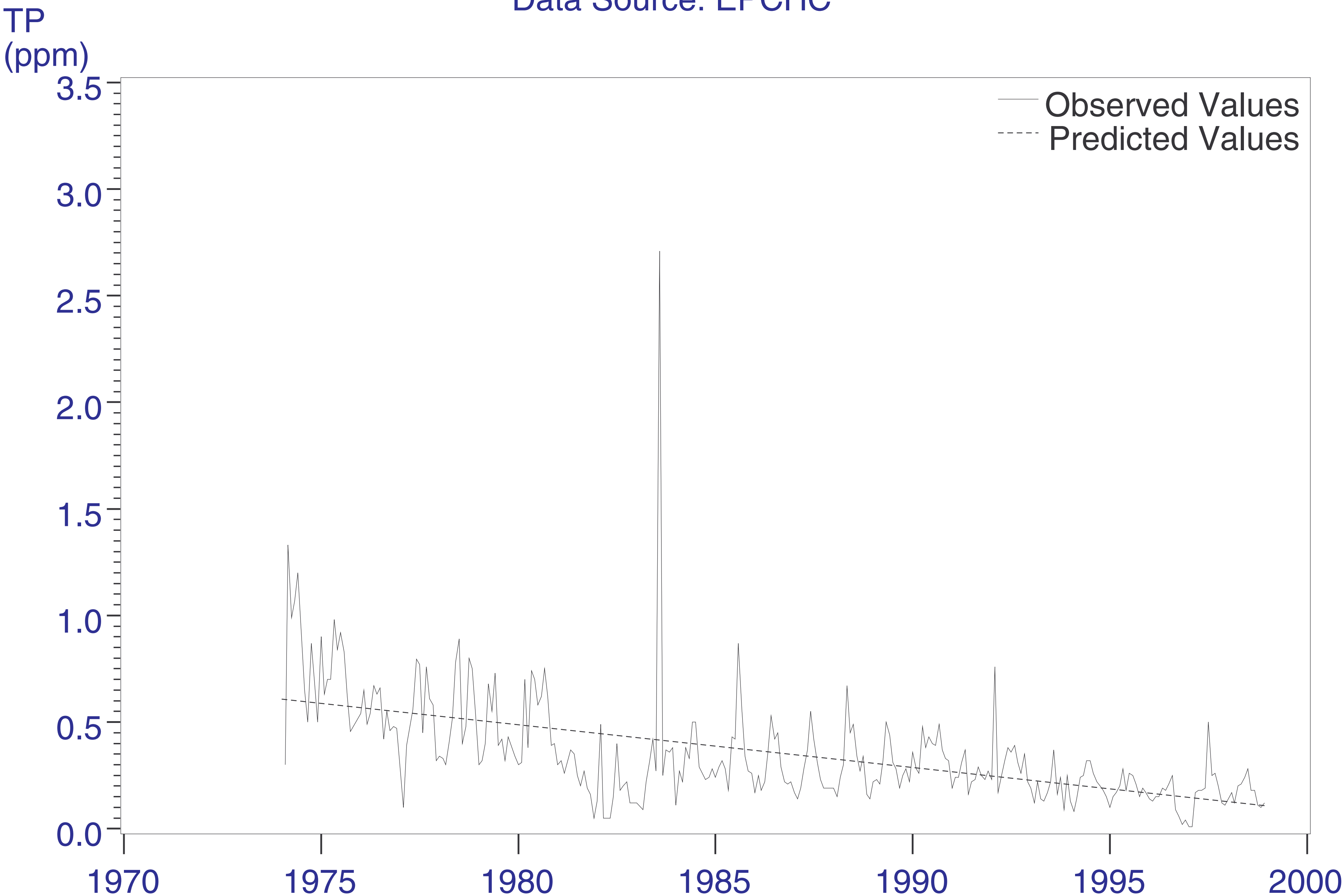
TRIBUTARY TREND RESULTS AND WATER QUALITY DATA PLOTS, EPCHC


DOUBLE BRANCH CREEK
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(ppm)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

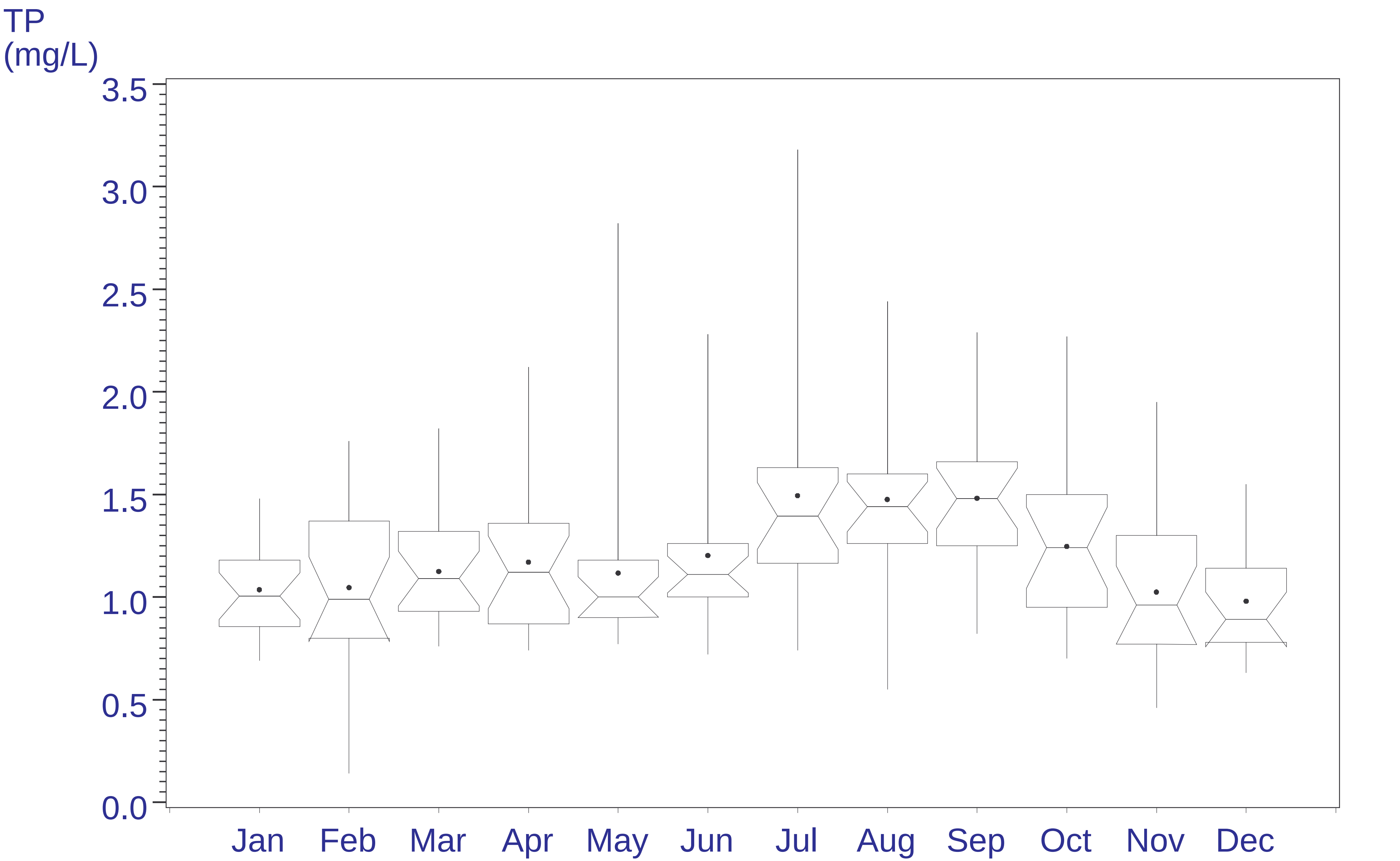
DOUBLE BRANCH CREEK
Seasonal Variation Analysis
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC

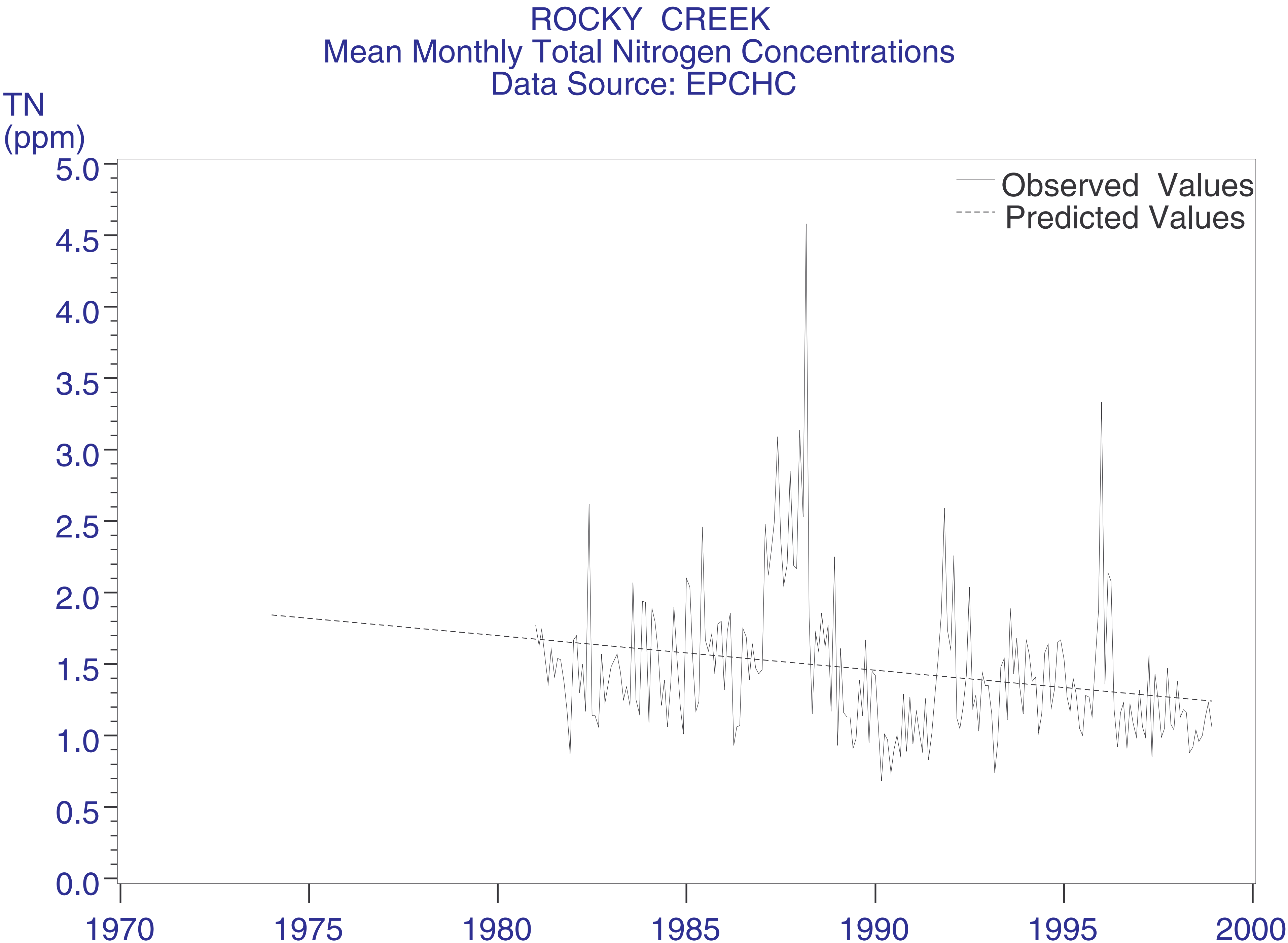


DOUBLE BRANCH CREEK
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC

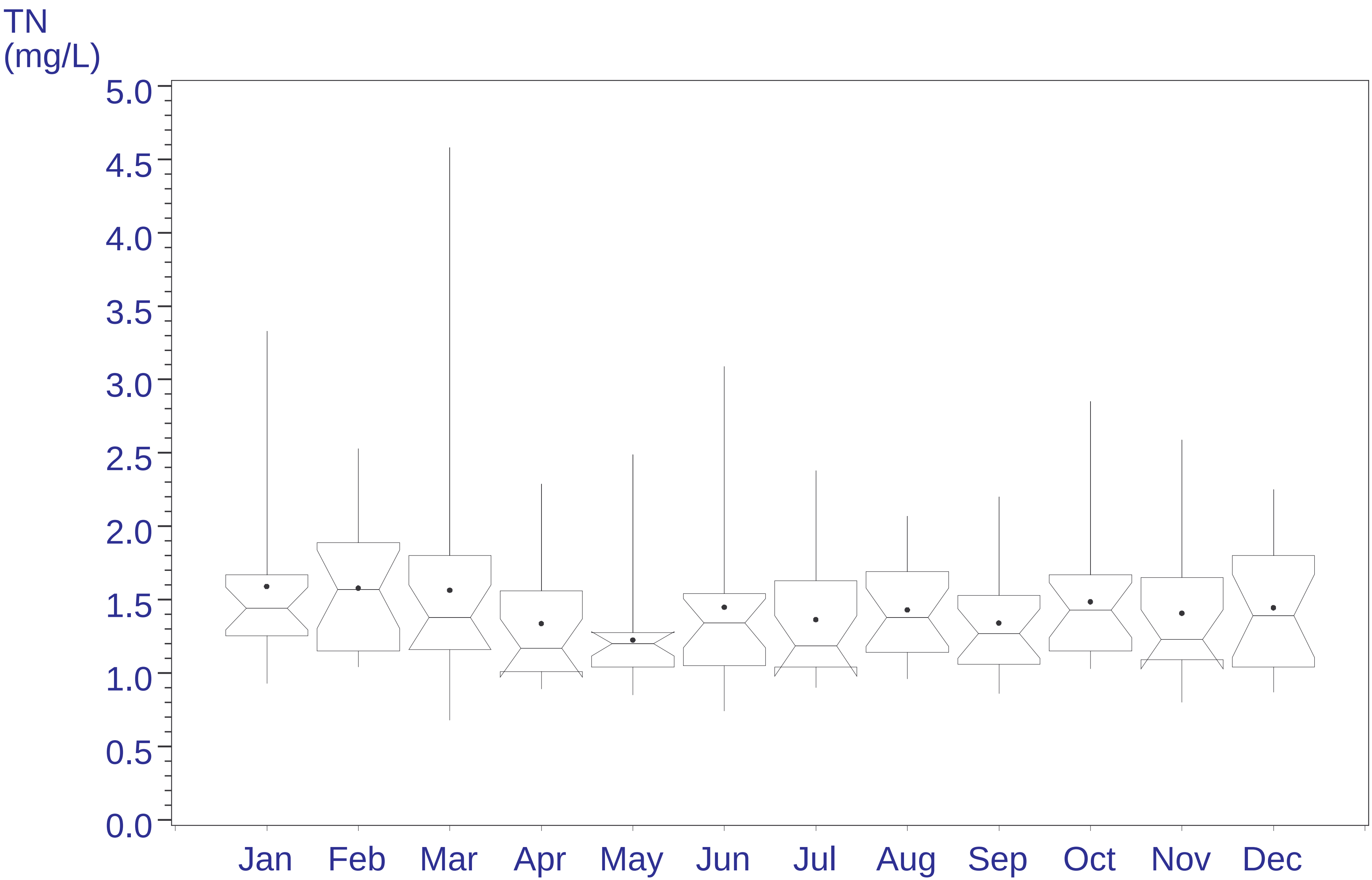


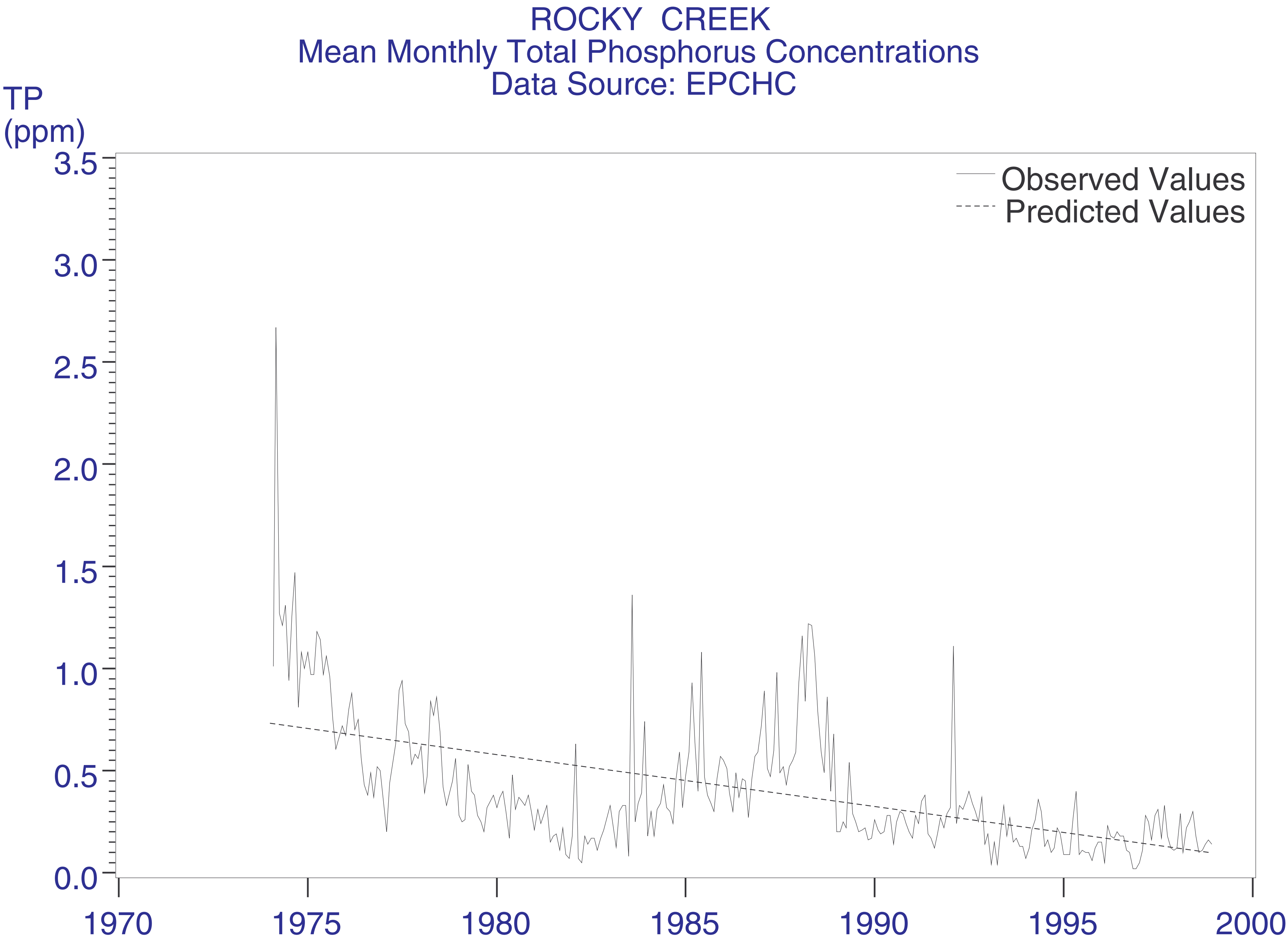
DOUBLE BRANCH CREEK
Seasonal Variation Analysis
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC




ROCKY CREEK
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(ppm)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

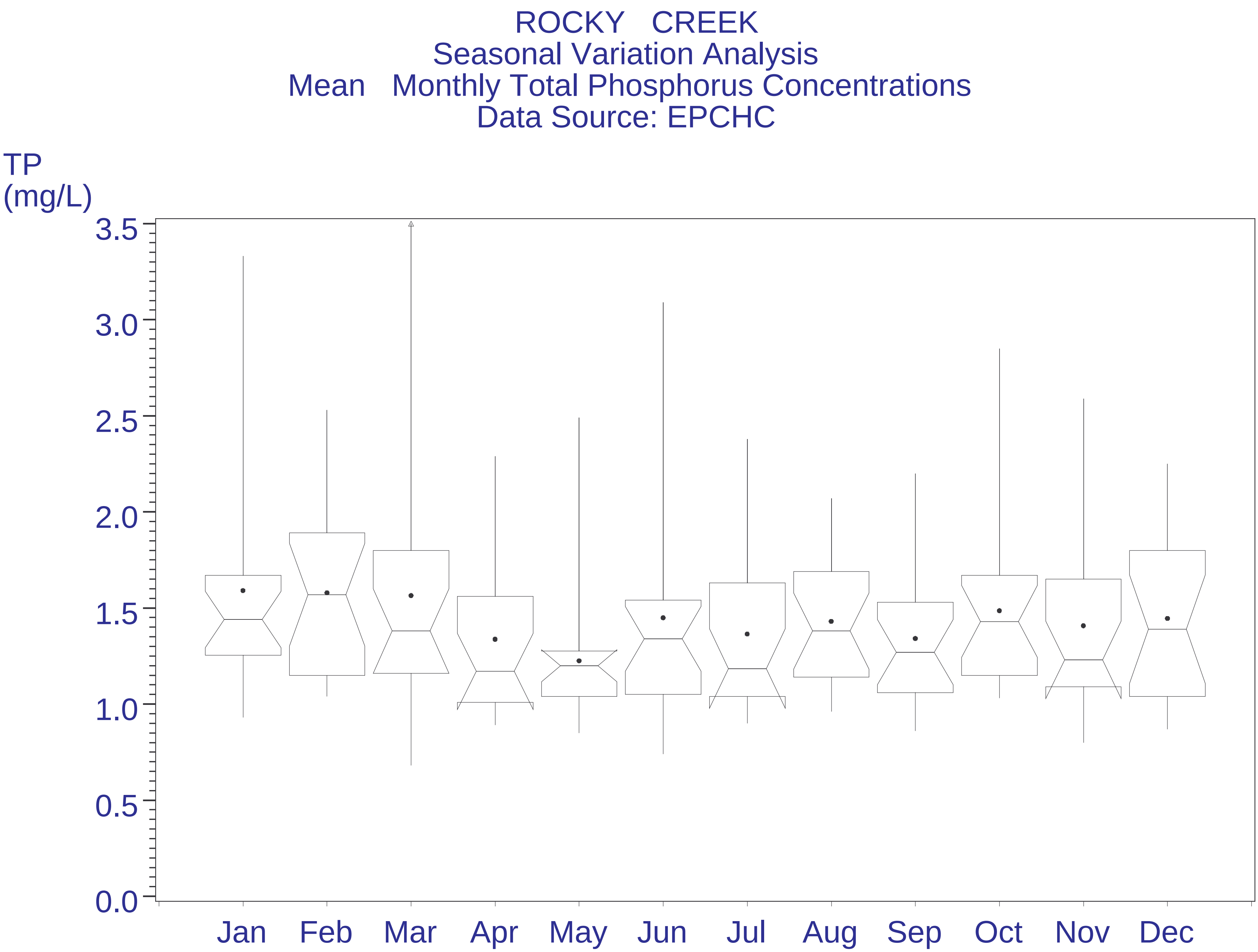
ROCKY CREEK
Seasonal Variation Analysis
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC

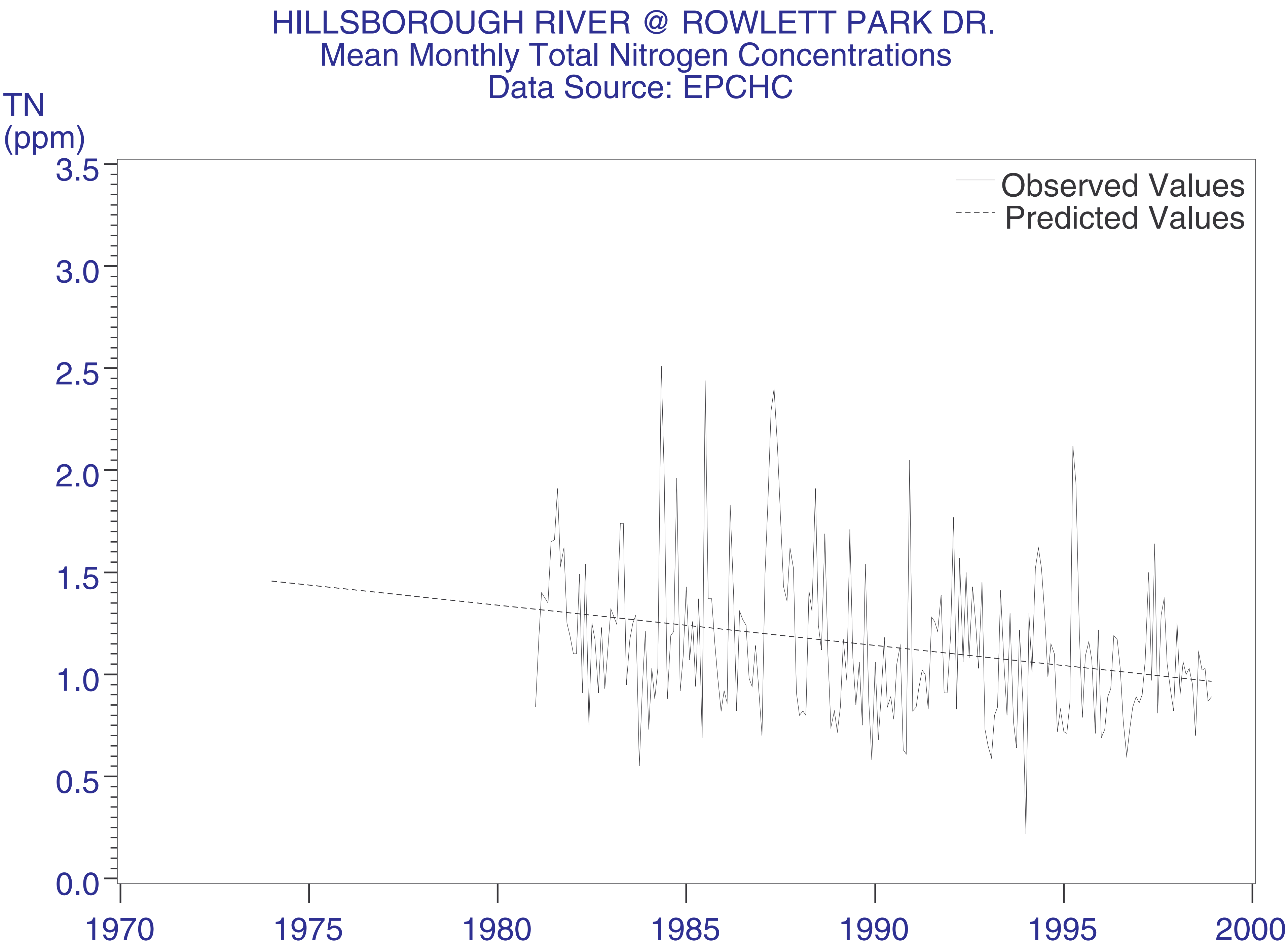


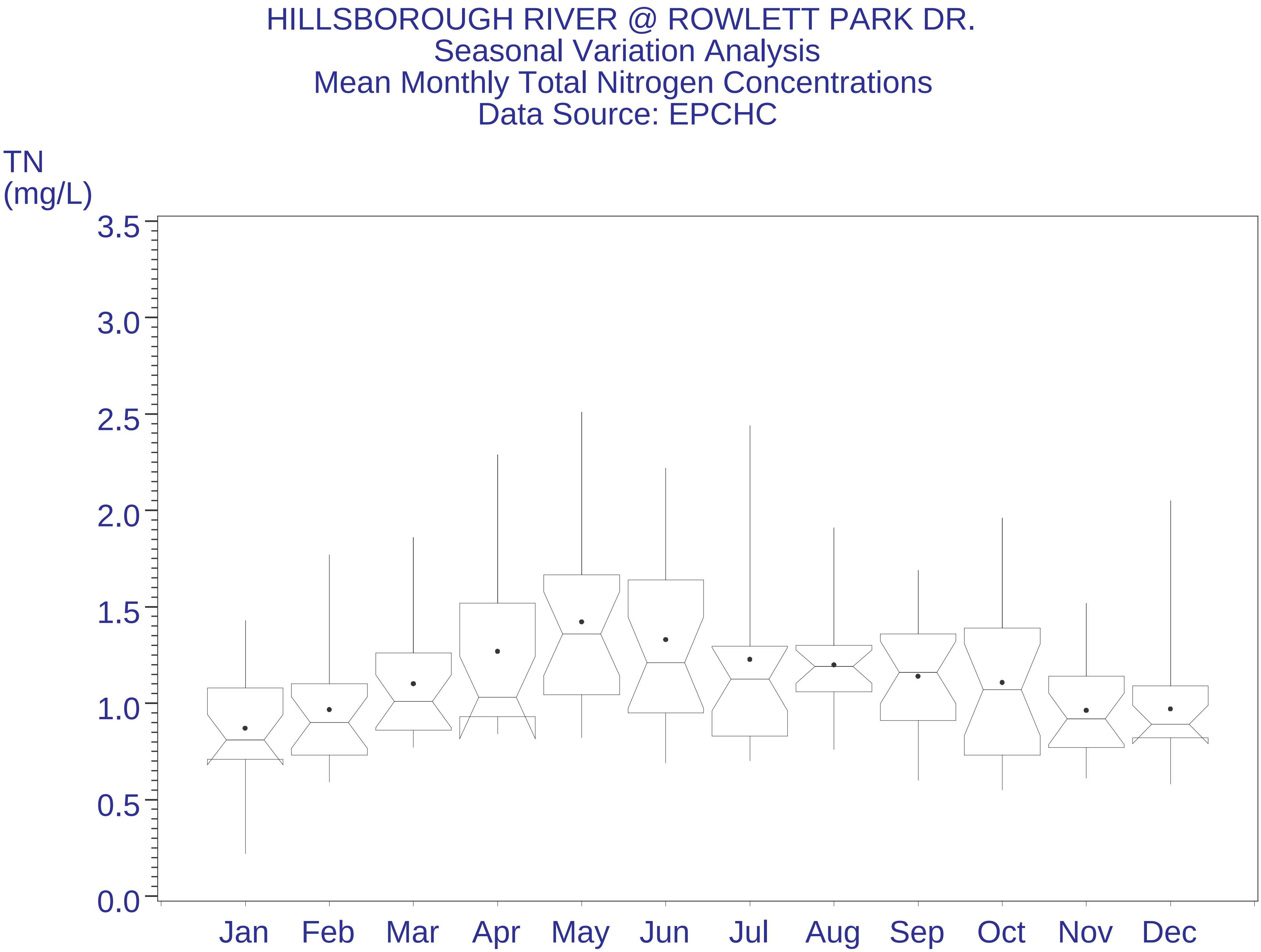


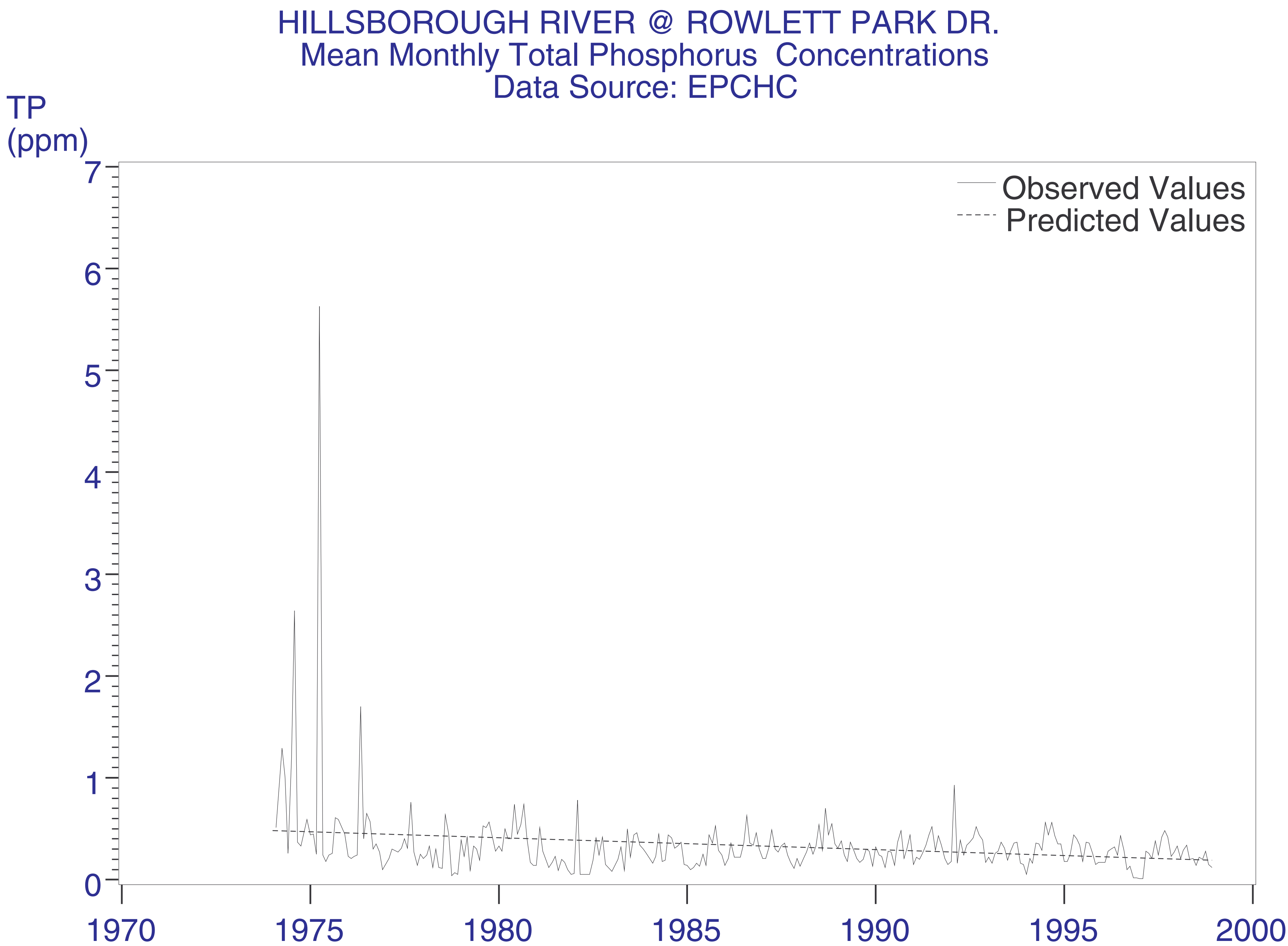
ROCKY CREEK
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(ppm)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

APPENDIX F

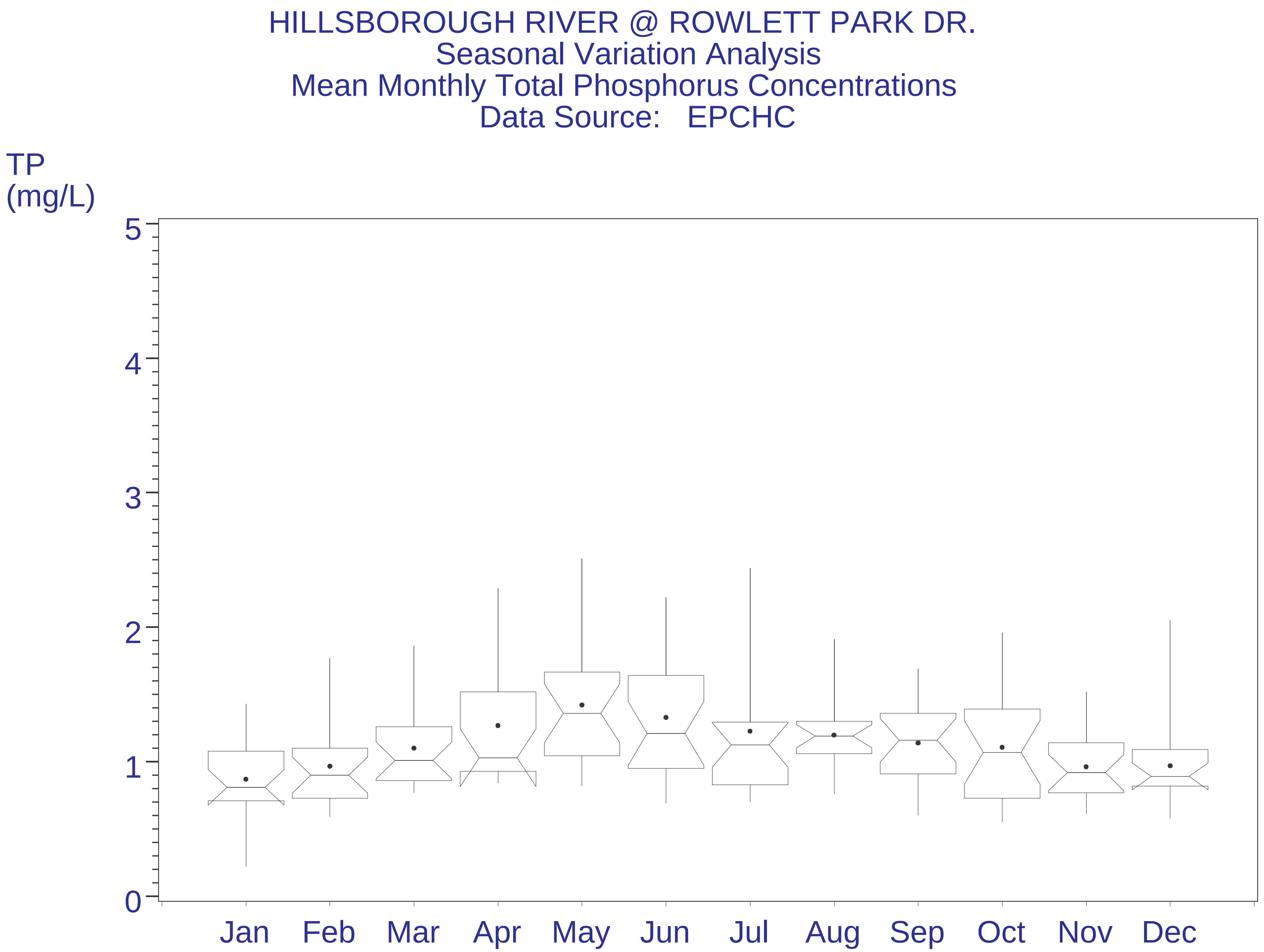

ROCKY CREEK
Seasonal Variation Analysis
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

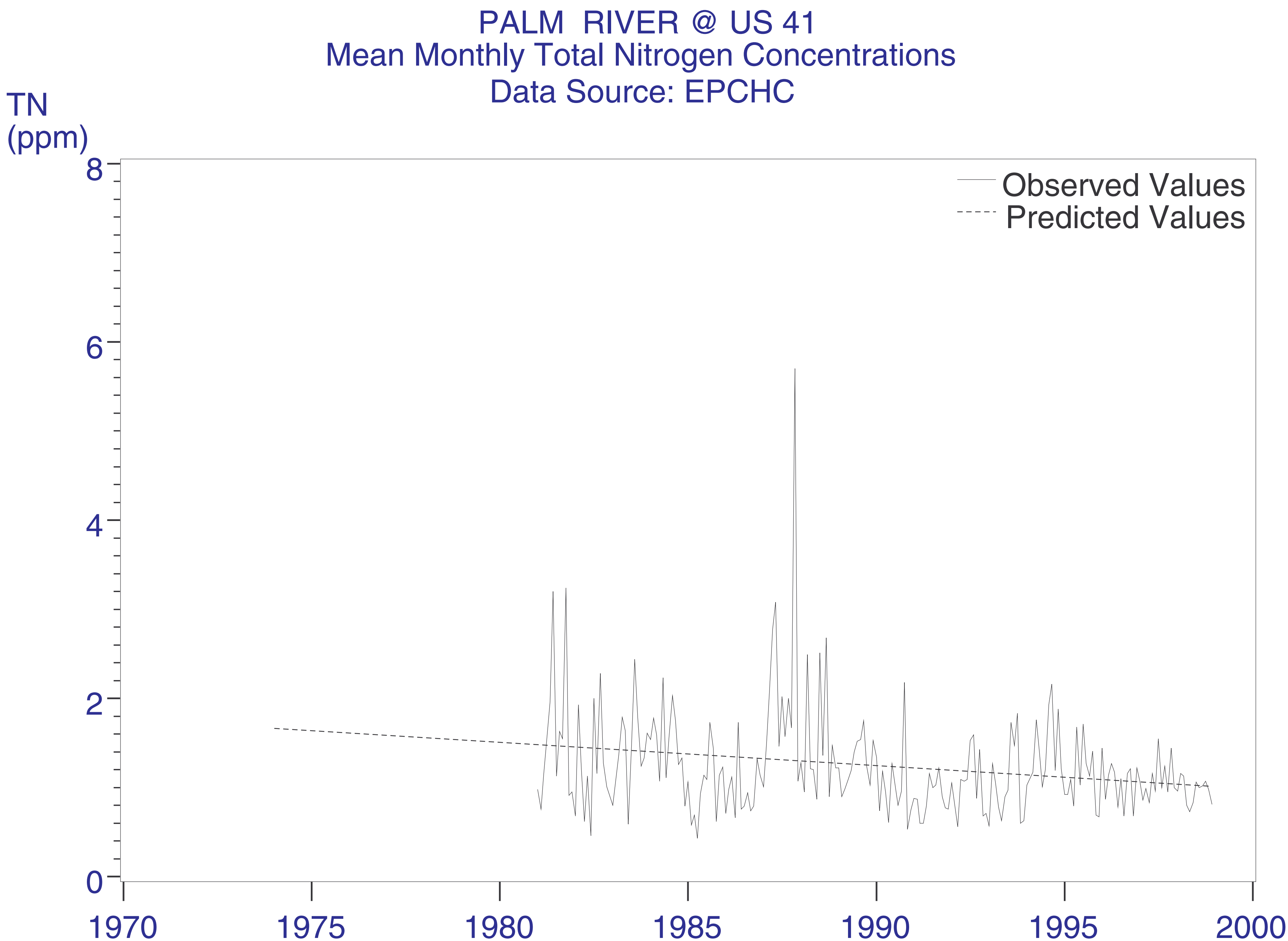

HILLSBOROUGH RIVER @ ROWLETT PARK DR.
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(ppm)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Observed Values
Predicted Values
1970
1975
1980
1985
1990
1995
2000

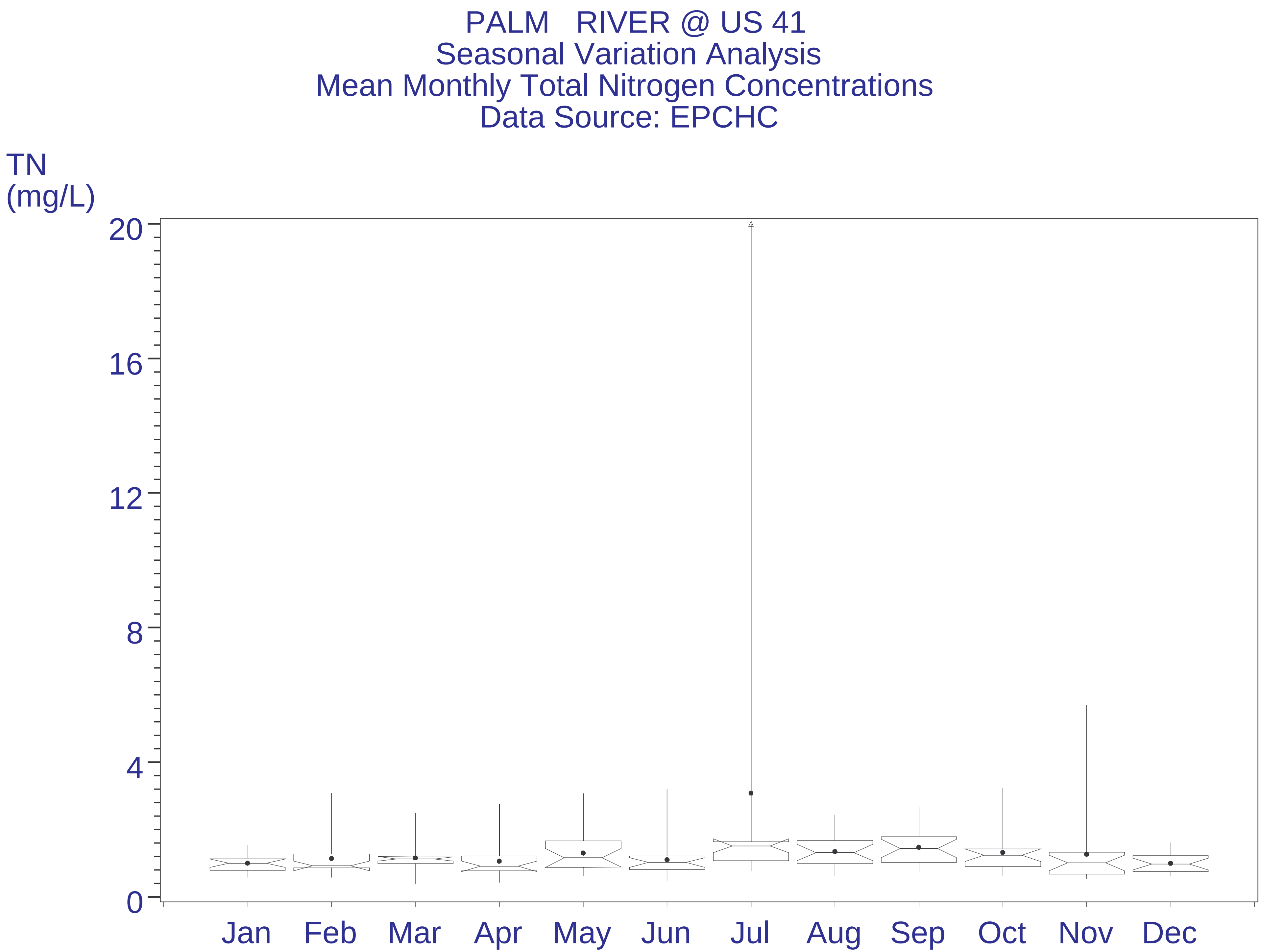

HILLSBOROUGH RIVER @ ROWLETT PARK DR.
Seasonal Variation Analysis
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

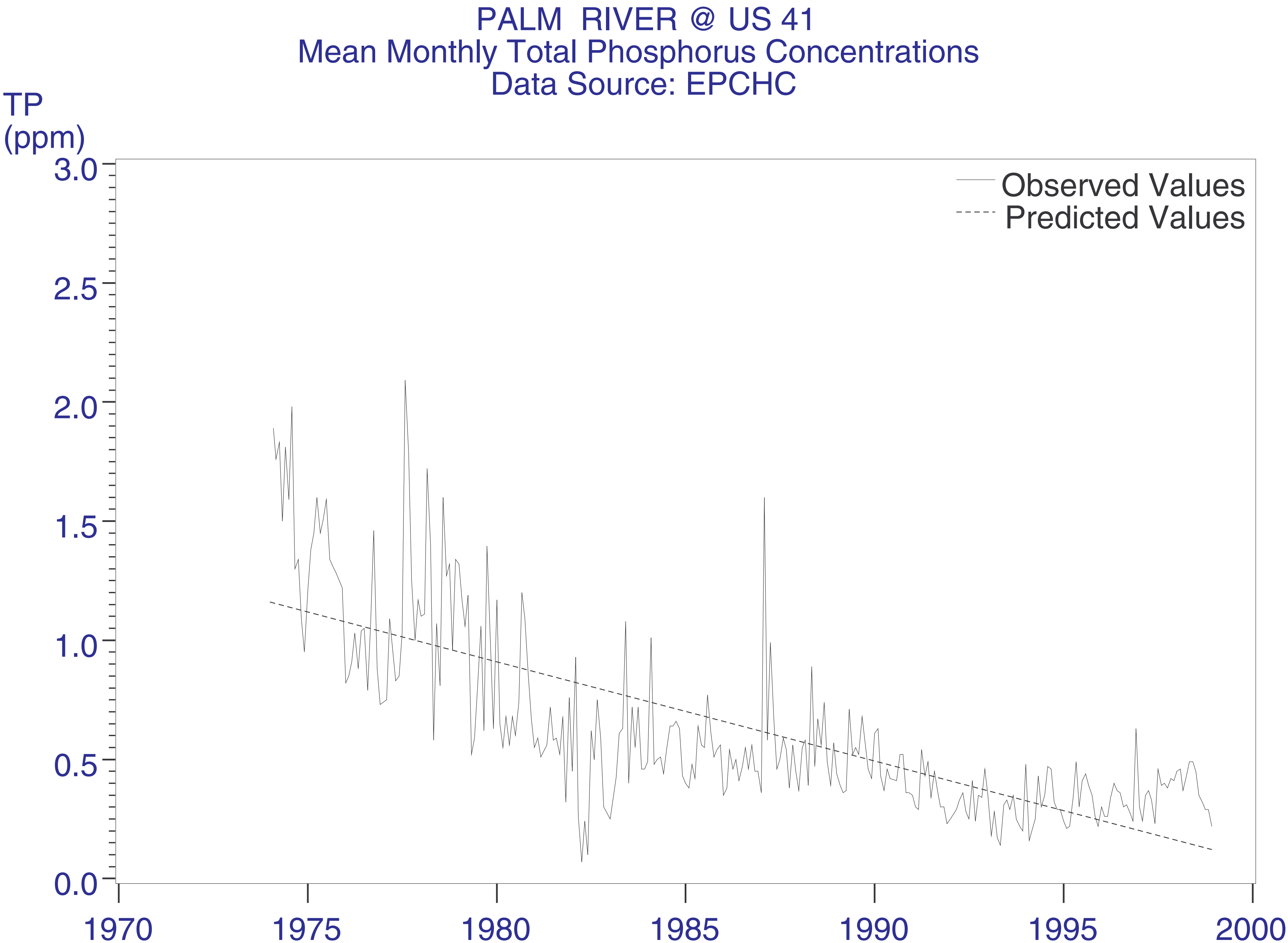

HILLSBOROUGH RIVER @ ROWLETT PARK DR.
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(ppm)
Observed Values
Predicted Values
0
1
2
3
4
5
6
7
1970
1975
1980
1985
1990
1995
2000

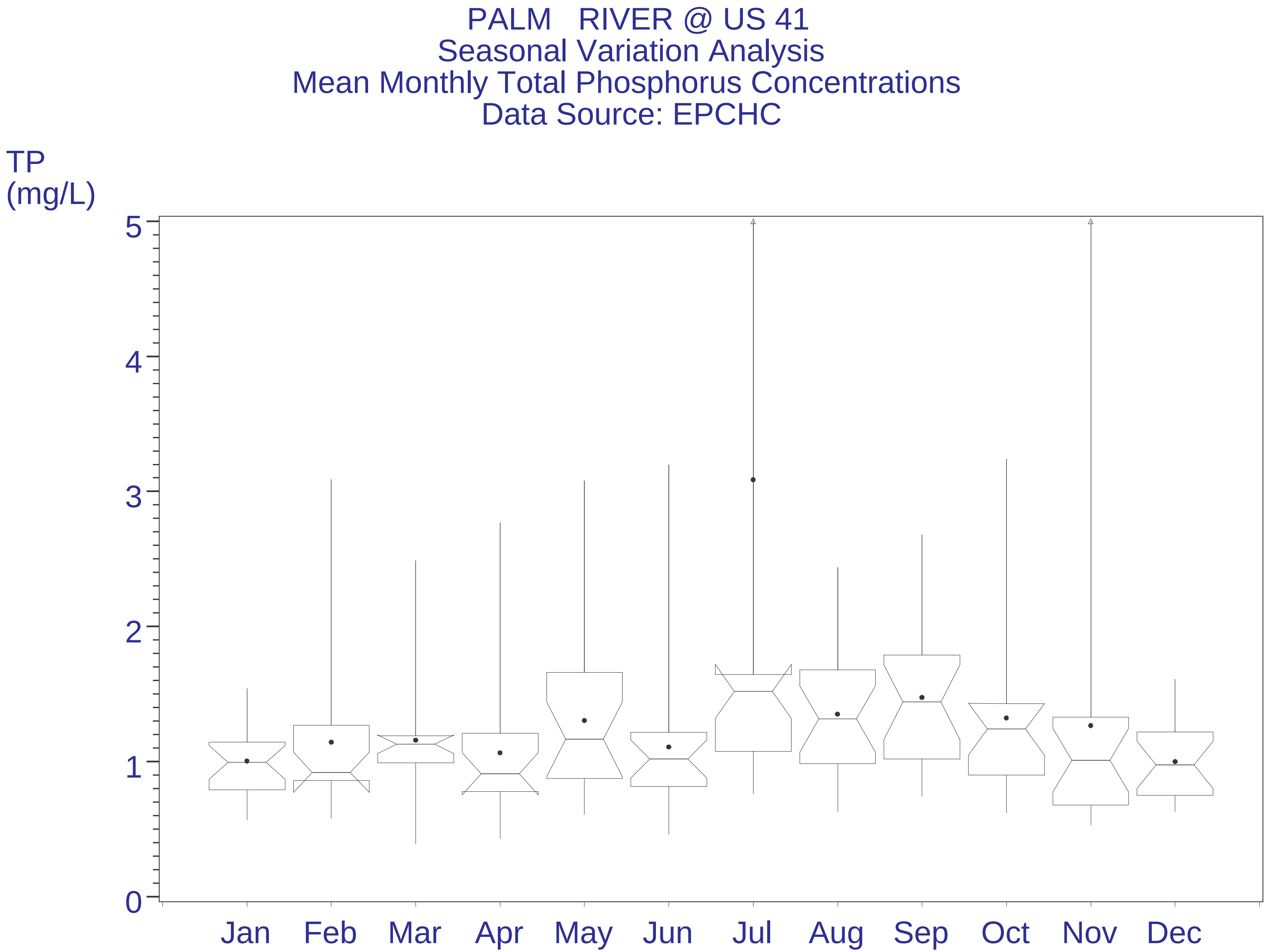
APPENDIX F

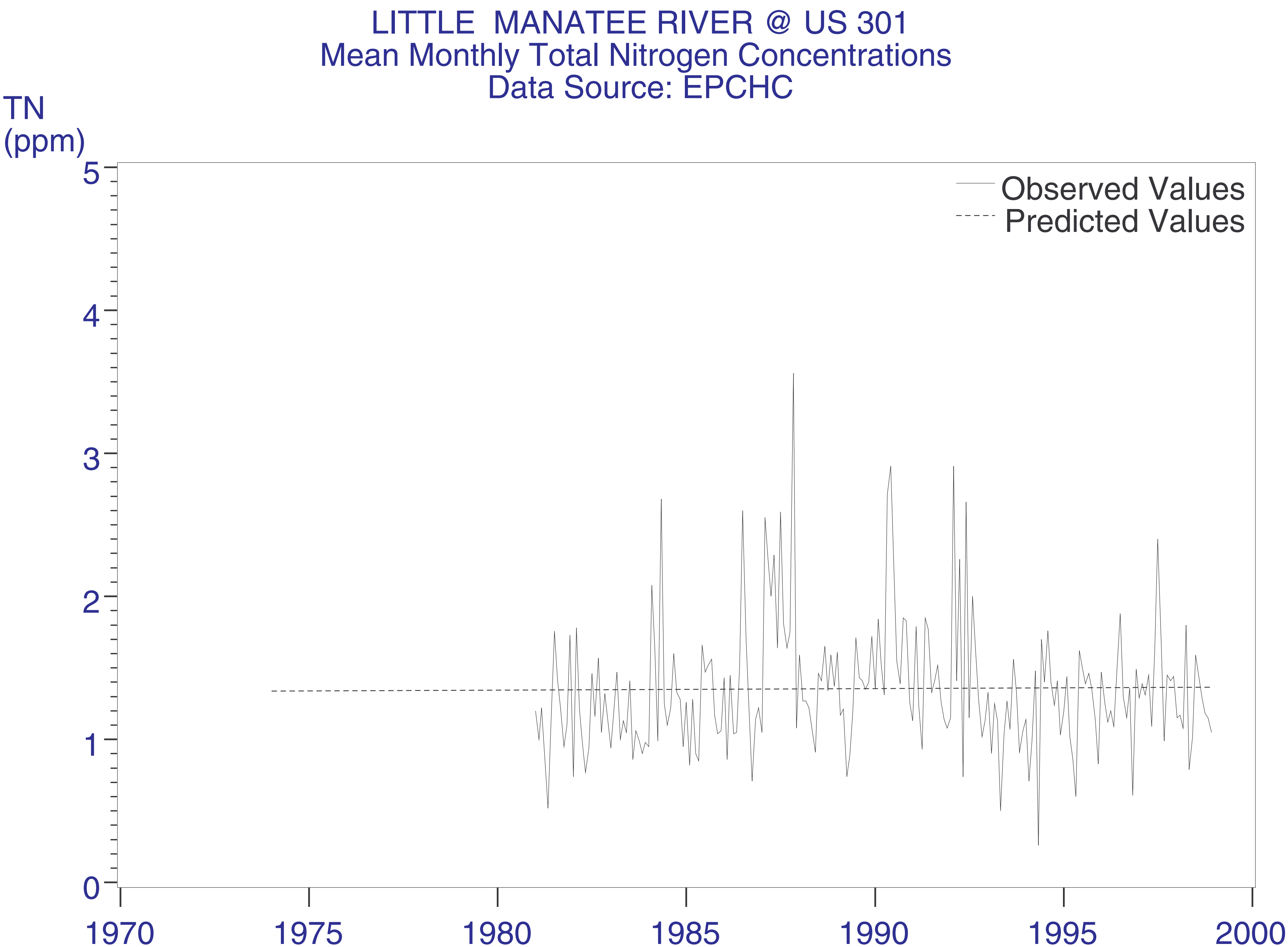

HILLSBOROUGH RIVER @ ROWLETT PARK DR.
Seasonal Variation Analysis
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
0
1
2
3
4
5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


PALM RIVER @ US 41
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(ppm)
8
6
4
2
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


PALM RIVER @ US 41
Seasonal Variation Analysis
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(mg/L)
20
16
12
8
4
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

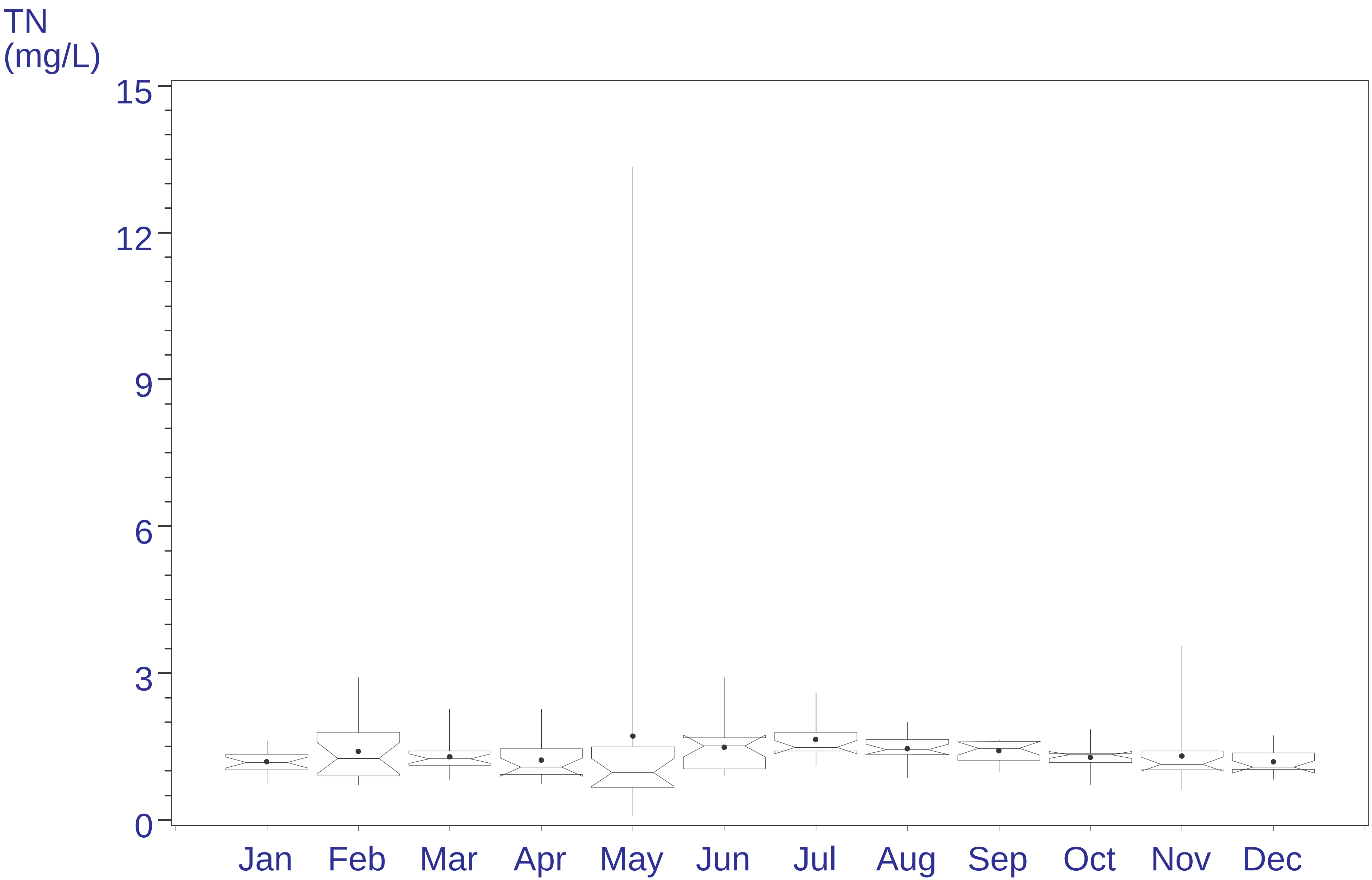

PALM RIVER @ US 41
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(ppm)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

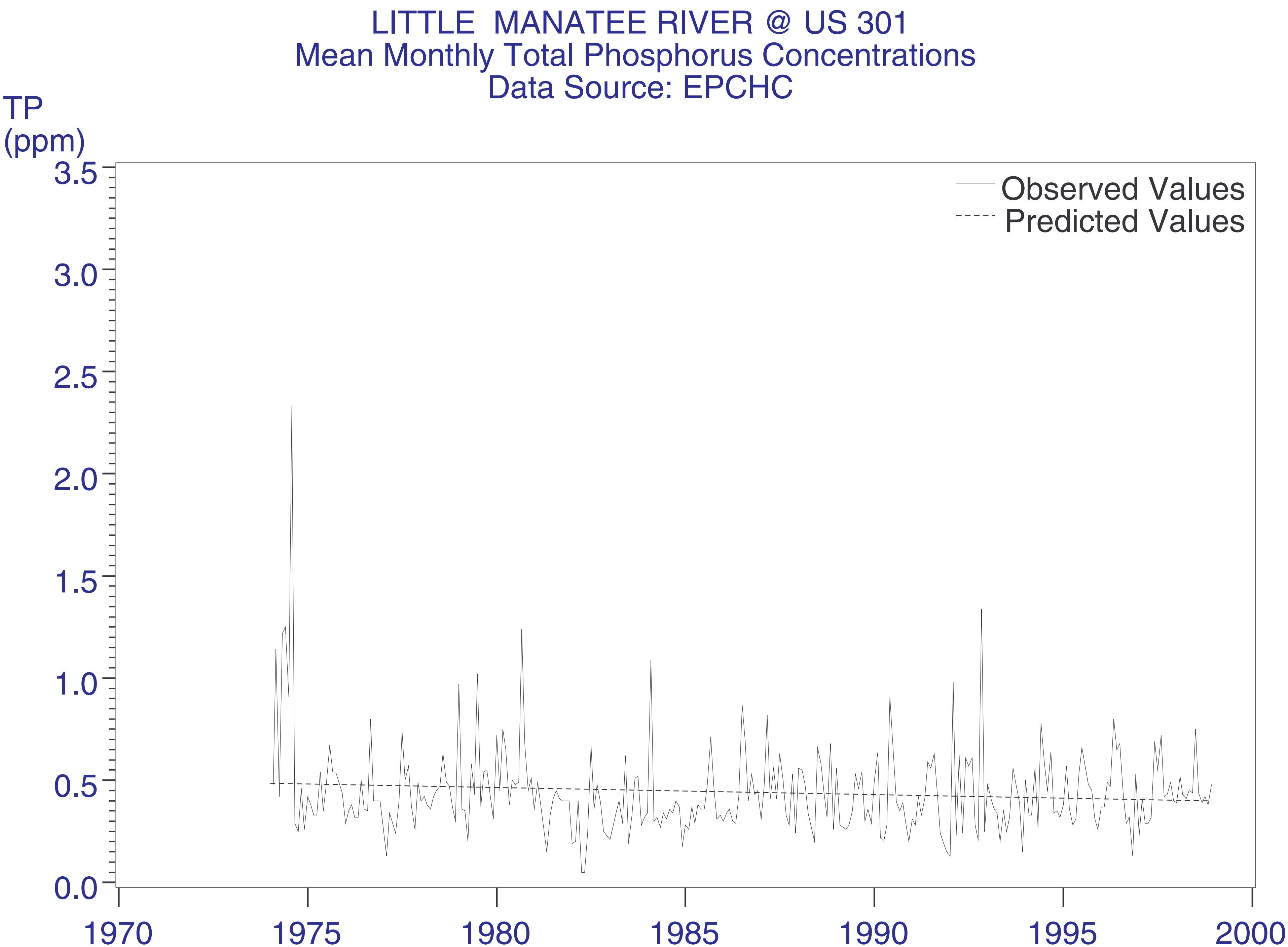

PALM RIVER @ US 41
Seasonal Variation Analysis
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


LITTLE MANATEE RIVER @ US 301
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(ppm)
5
4
3
2
1
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

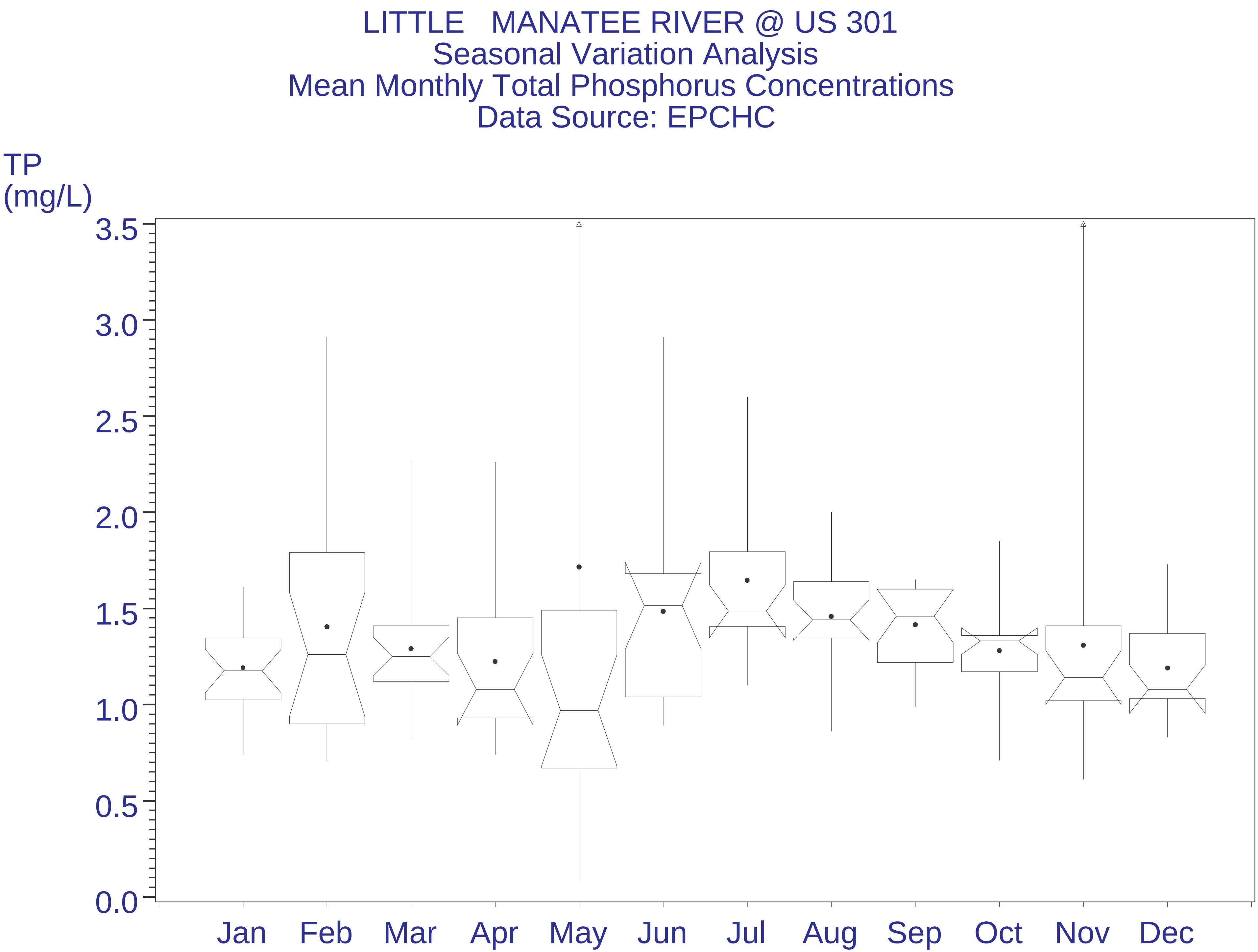
APPENDIX F

LITTLE MANATEE RIVER @ US 301
Seasonal Variation Analysis
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC

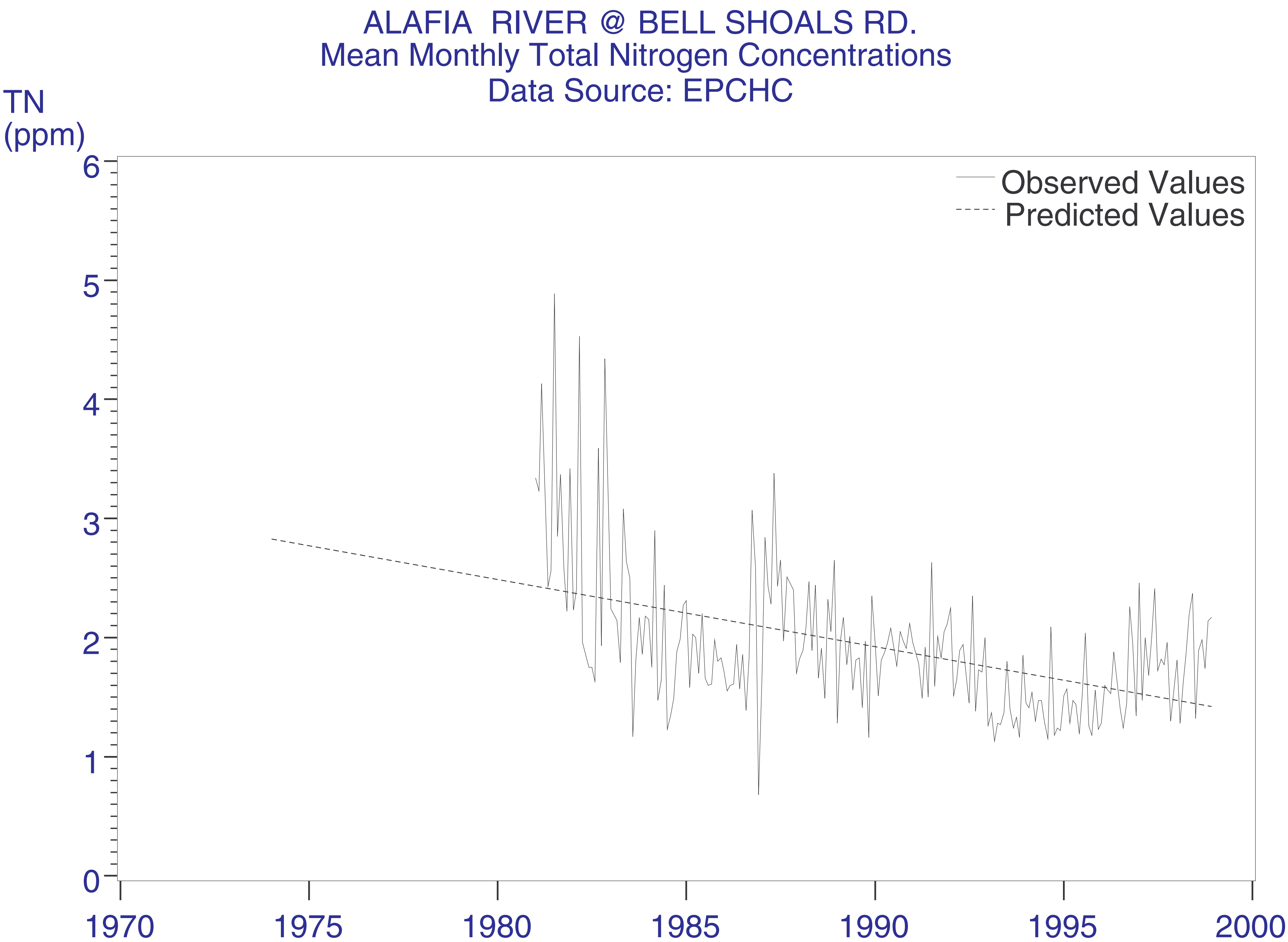




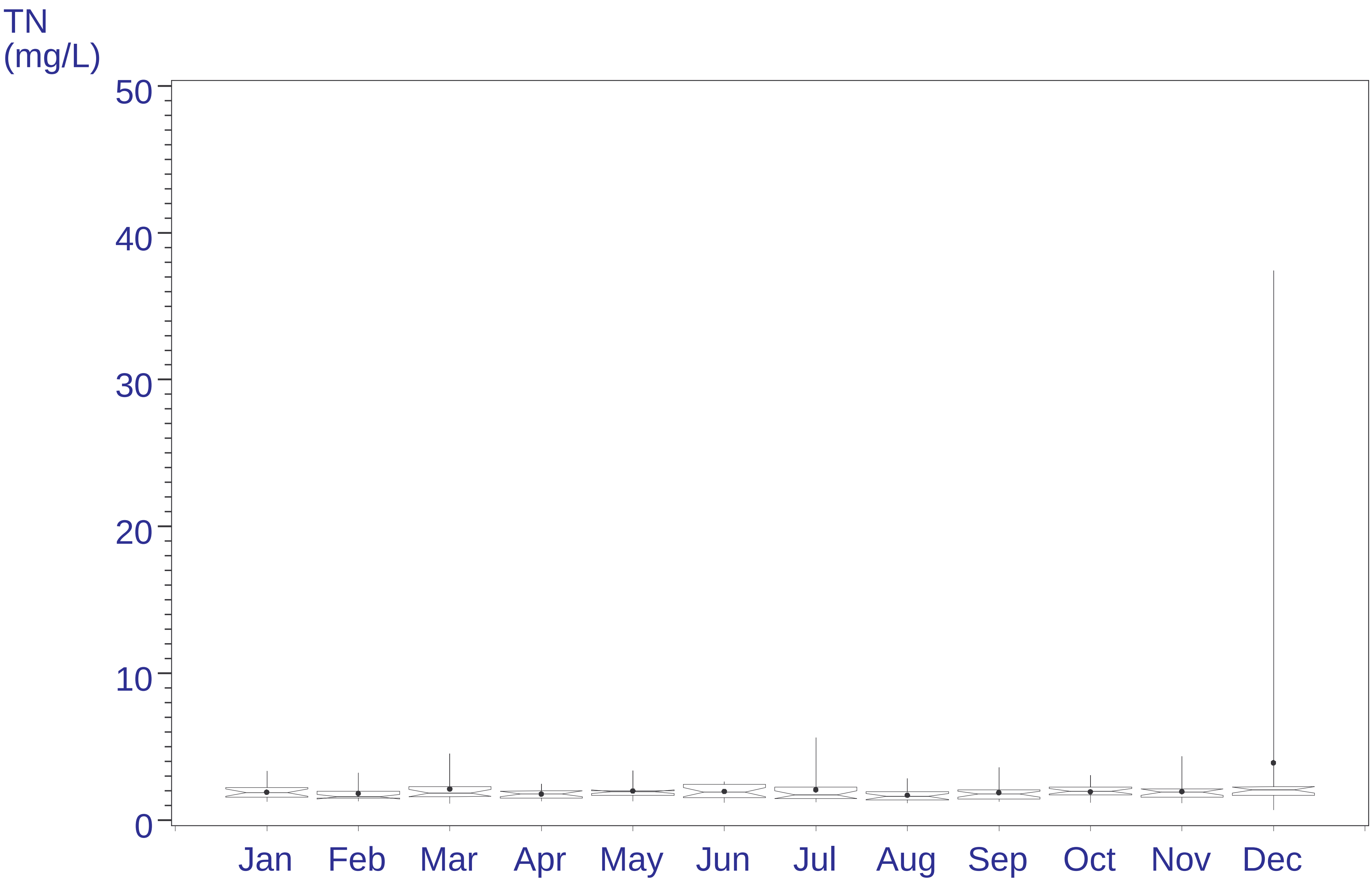
LITTLE MANATEE RIVER @ US 301
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(ppm)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

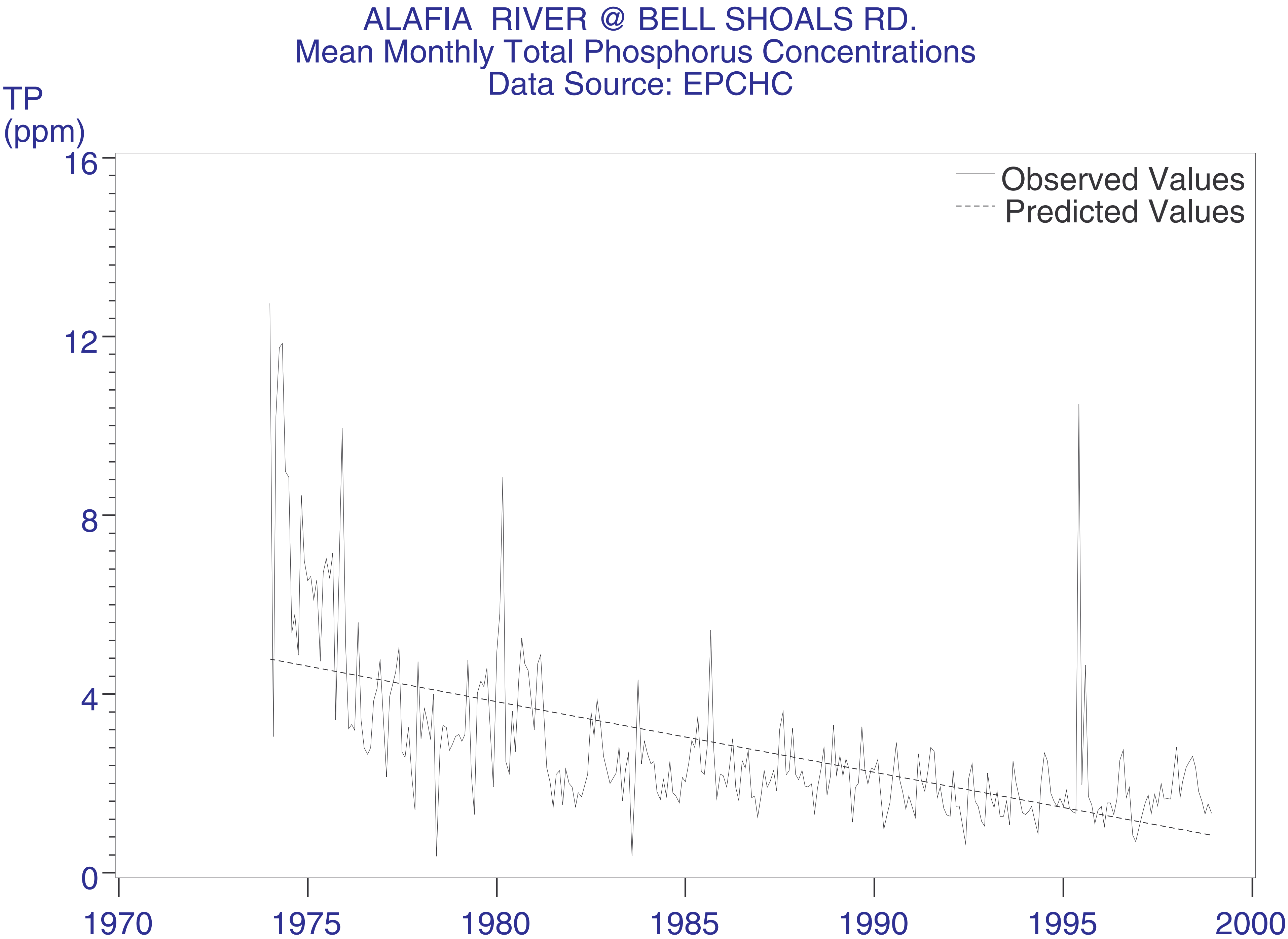


LITTLE MANATEE RIVER @ US 301
Seasonal Variation Analysis
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

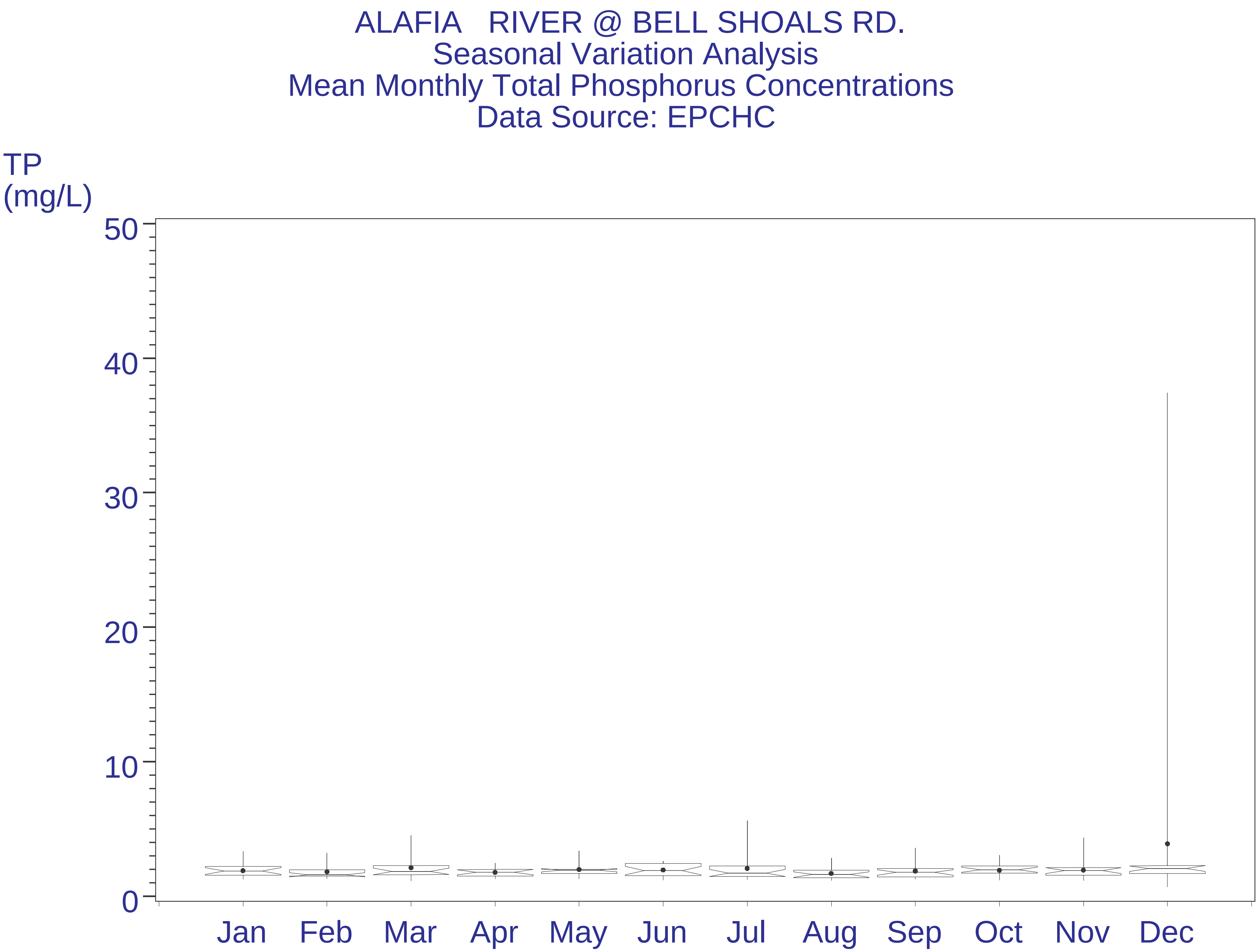

ALAFIA RIVER @ BELL SHOALS RD.
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC
TN
(ppm)
0
1
2
3
4
5
6
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

ALAFIA RIVER @ BELL SHOALS RD.
Seasonal Variation Analysis
Mean Monthly Total Nitrogen Concentrations
Data Source: EPCHC




ALAFIA RIVER @ BELL SHOALS RD.
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(ppm)
16
12
8
4
0
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

APPENDIX F

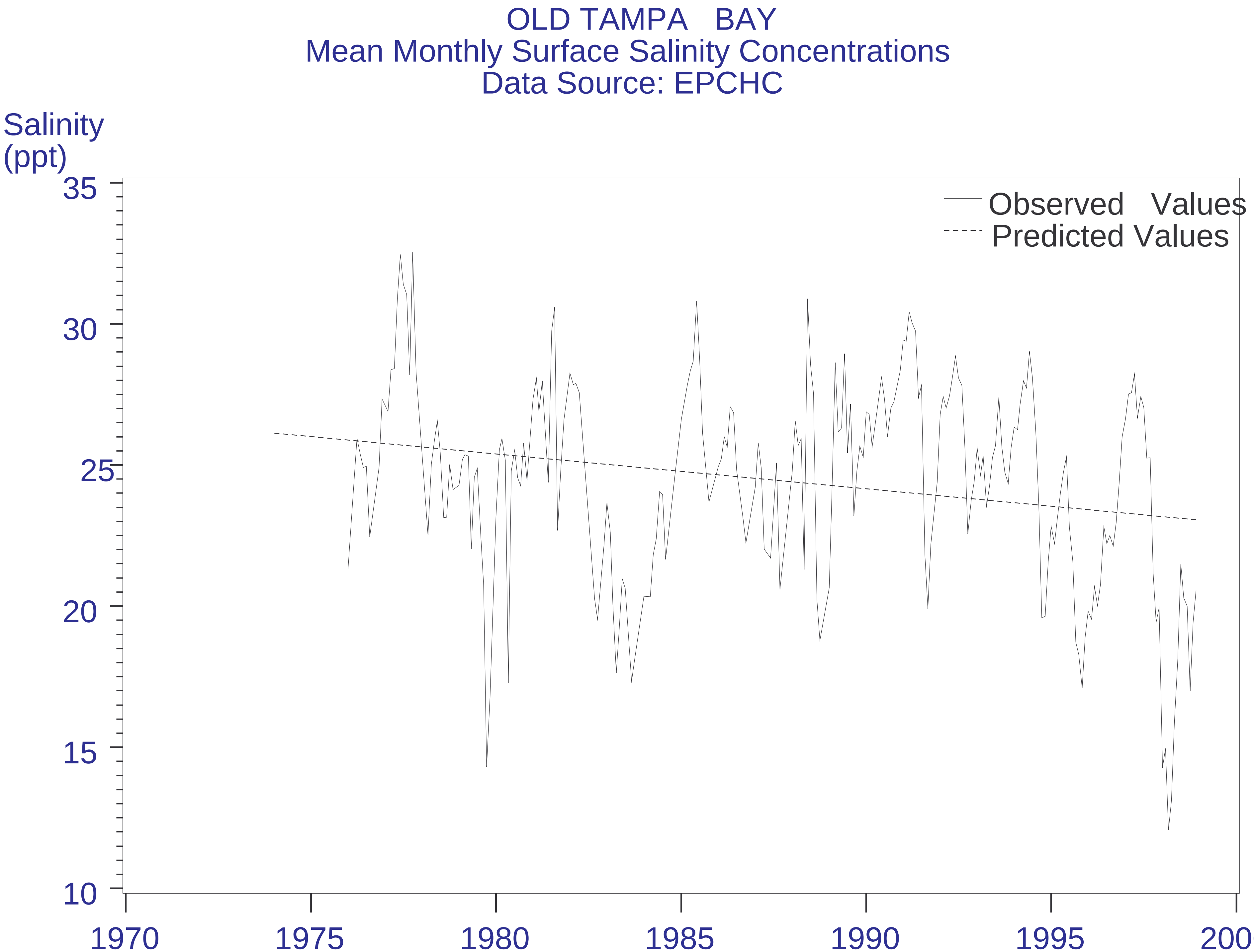

ALAFIA RIVER @ BELL SHOALS RD.
Seasonal Variation Analysis
Mean Monthly Total Phosphorus Concentrations
Data Source: EPCHC
TP
(mg/L)
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

APPENDIX G

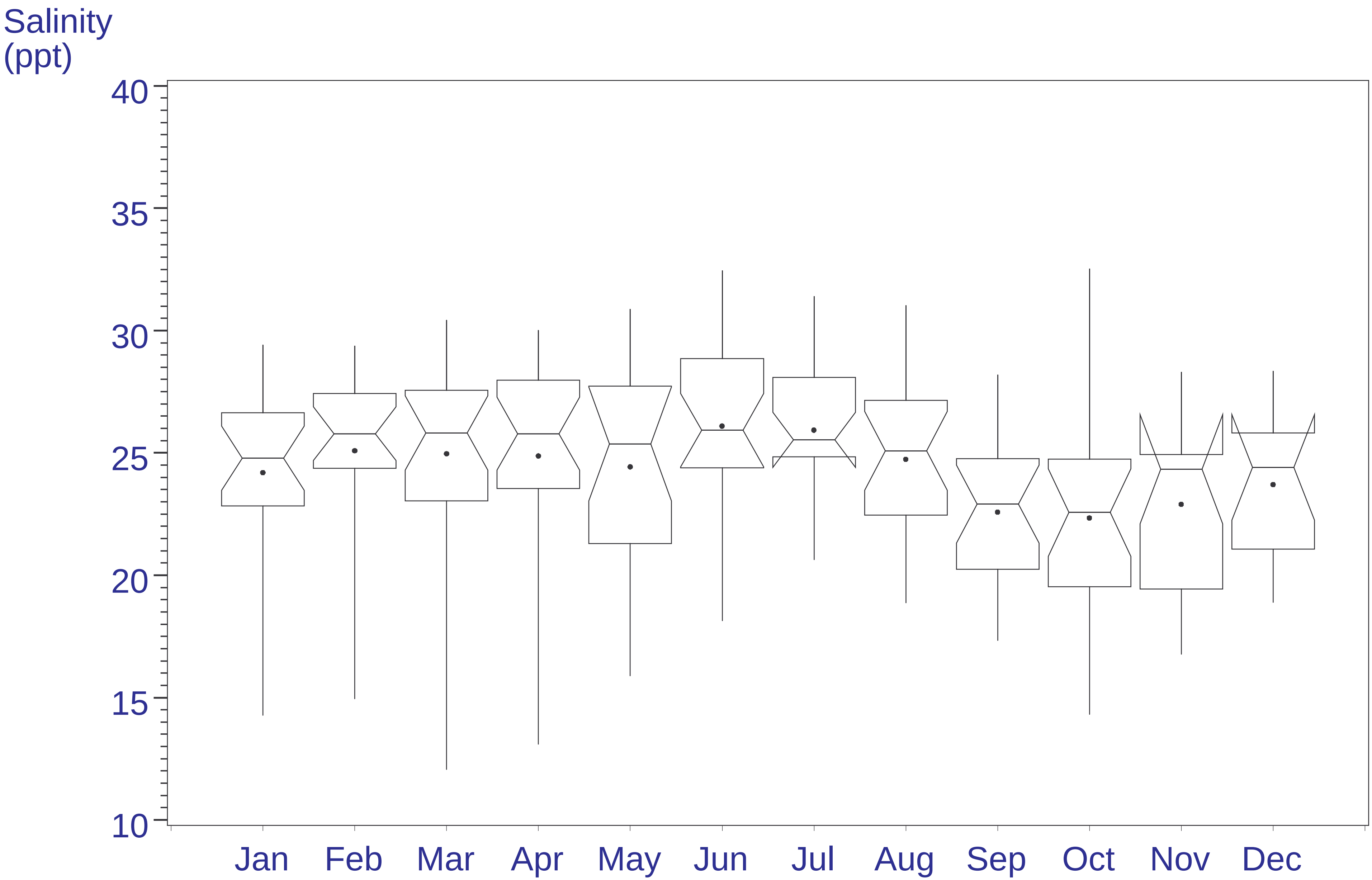
TREND RESULTS AND DATA PLOTS, EPCHC SALINITY

OLD TAMPA BAY

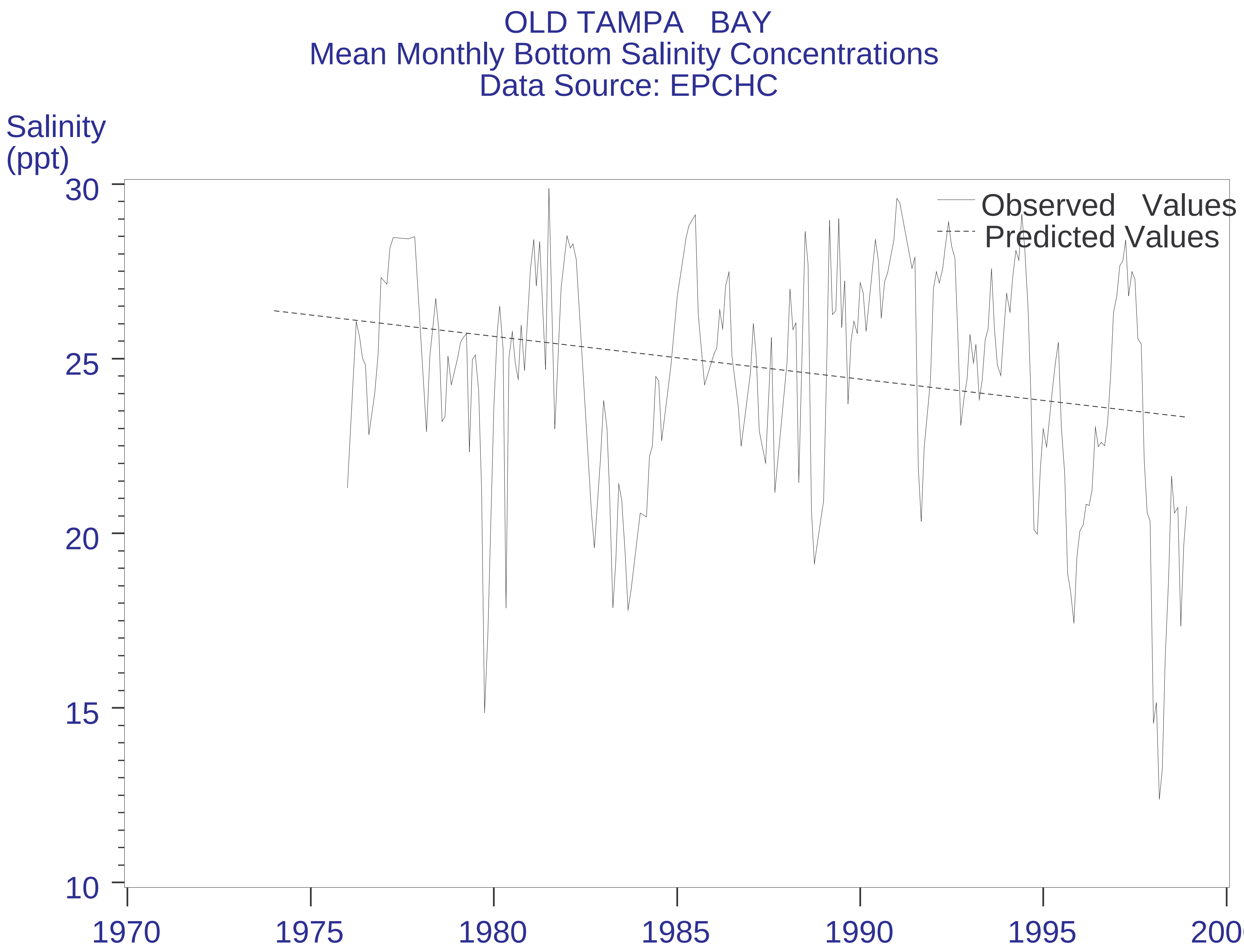
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Old Tampa Bay Surface Salinity (ppt) Data Source: EPCHC	
# of Years of Sampling	23
Number of Samples	235
Tau Statistic	-0.123
P-value without Serial Correlation	0.010
P-value with Serial Correlation	0.293
p Value Slope Statistic	-0.0909


OLD TAMPA BAY
Mean Monthly Surface Salinity Concentrations
Data Source: EPCHC
Salinity
(ppt)
35
30
25
20
15
10
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

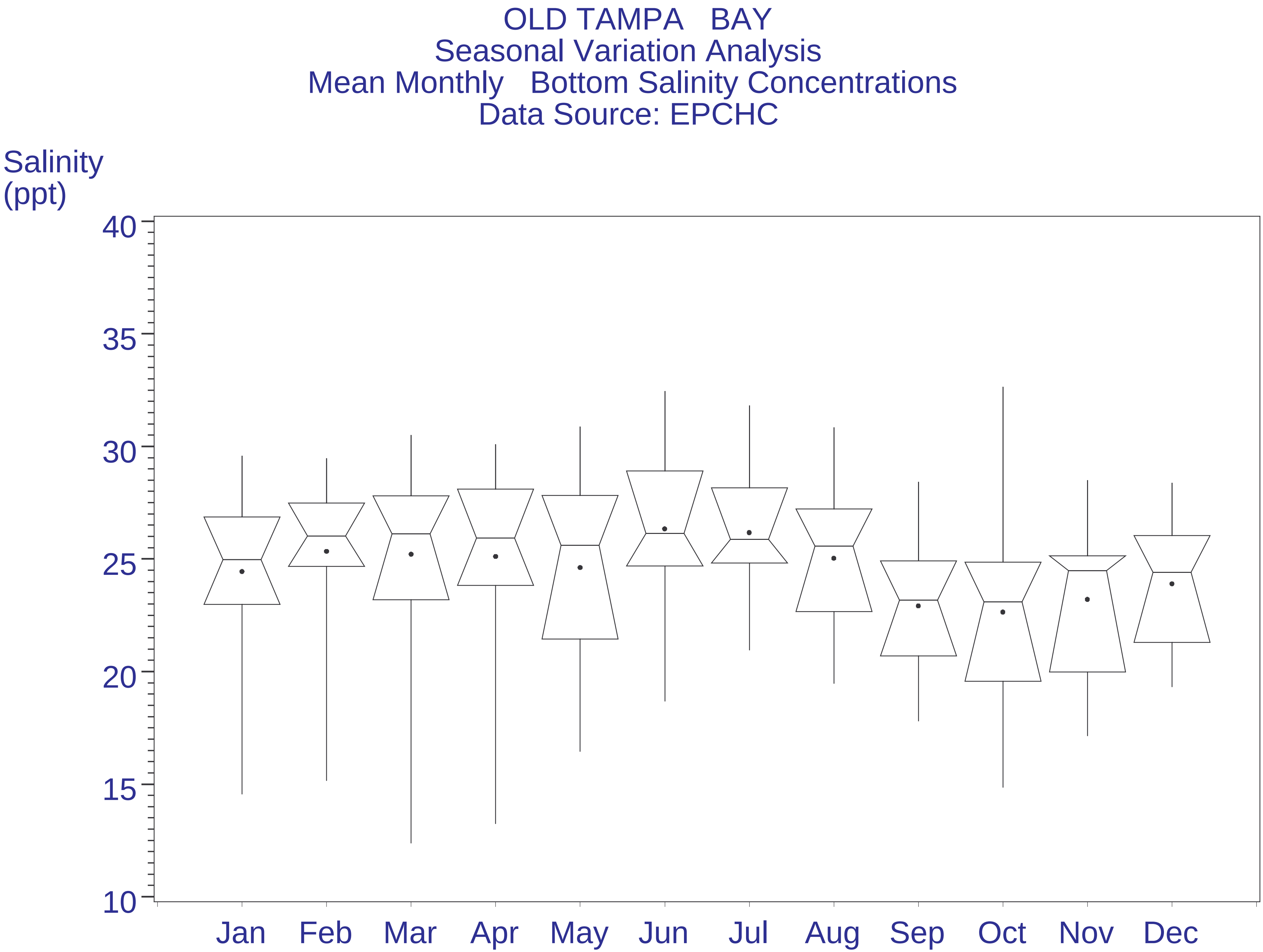
OLD TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Surface Salinity Concentrations
Data Source: EPCHC



TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Old Tampa Bay Bottom Salinity (ppt) Data Source: EPCHC	
# of Years of Sampling	23
Number of Samples	235
Tau Statistic	-0.129
P-value without Serial Correlation	0.007
P-value with Serial Correlation	0.271
p Value Slope Statistic	-0.0901



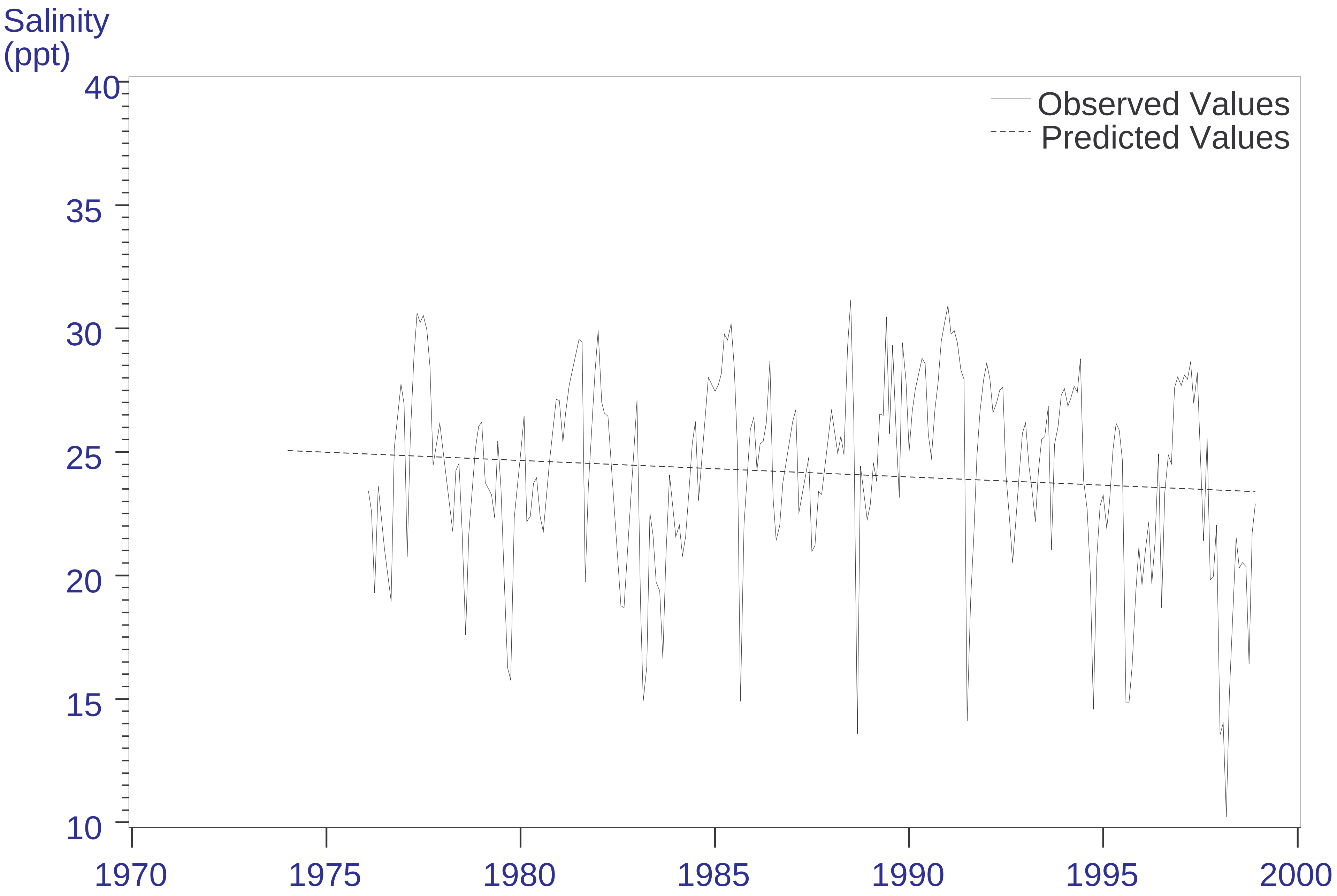
OLD TAMPA BAY
Mean Monthly Bottom Salinity Concentrations
Data Source: EPCHC
Salinity
(ppt)
30
25
20
15
10
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

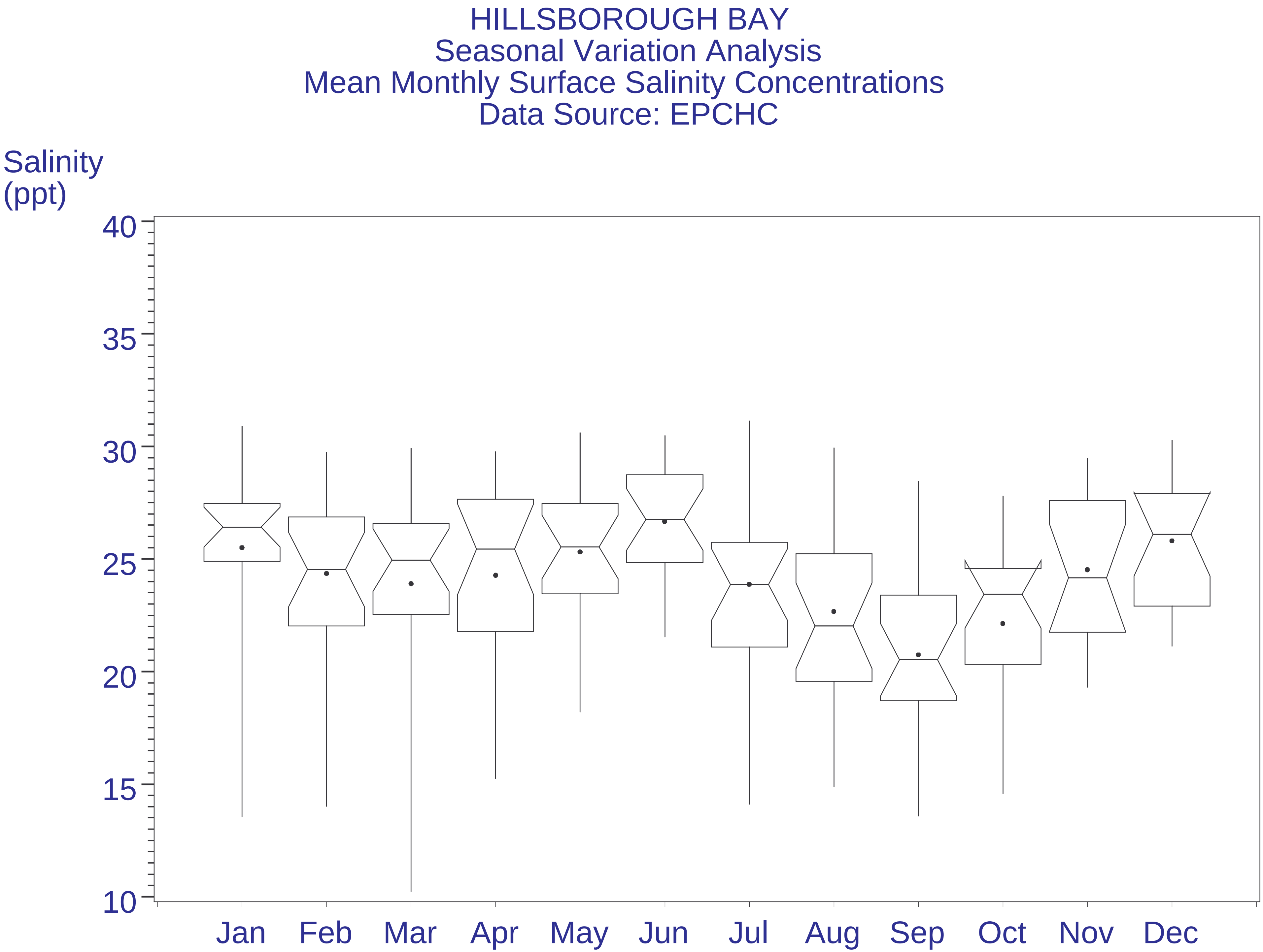

OLD TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Bottom Salinity Concentrations
Data Source: EPCHC
Salinity
(ppt)
40
35
30
25
20
15
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

HILLSBOROUGH BAY

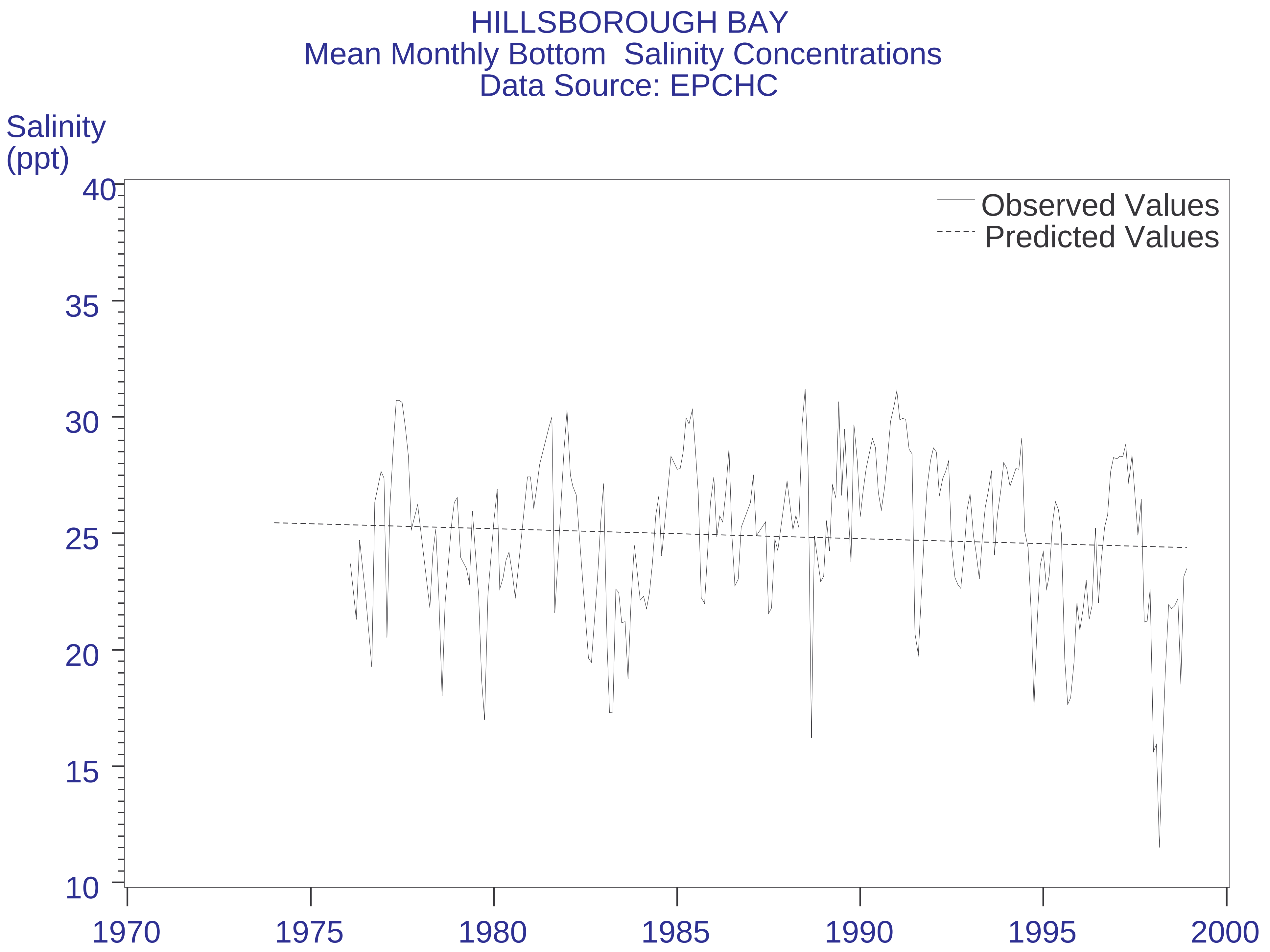
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay Surface Salinity (ppt) Data Source: EPCHC	
# of Years of Sampling	23
Number of Samples	241
Tau Statistic	-0.043
P-value without Serial Correlation	0.362
P-value with Serial Correlation	0.654
p Value Slope Statistic	-0.0350

HILLSBOROUGH BAY
Mean Monthly Surface Salinity Concentrations
Data Source: EPCHC

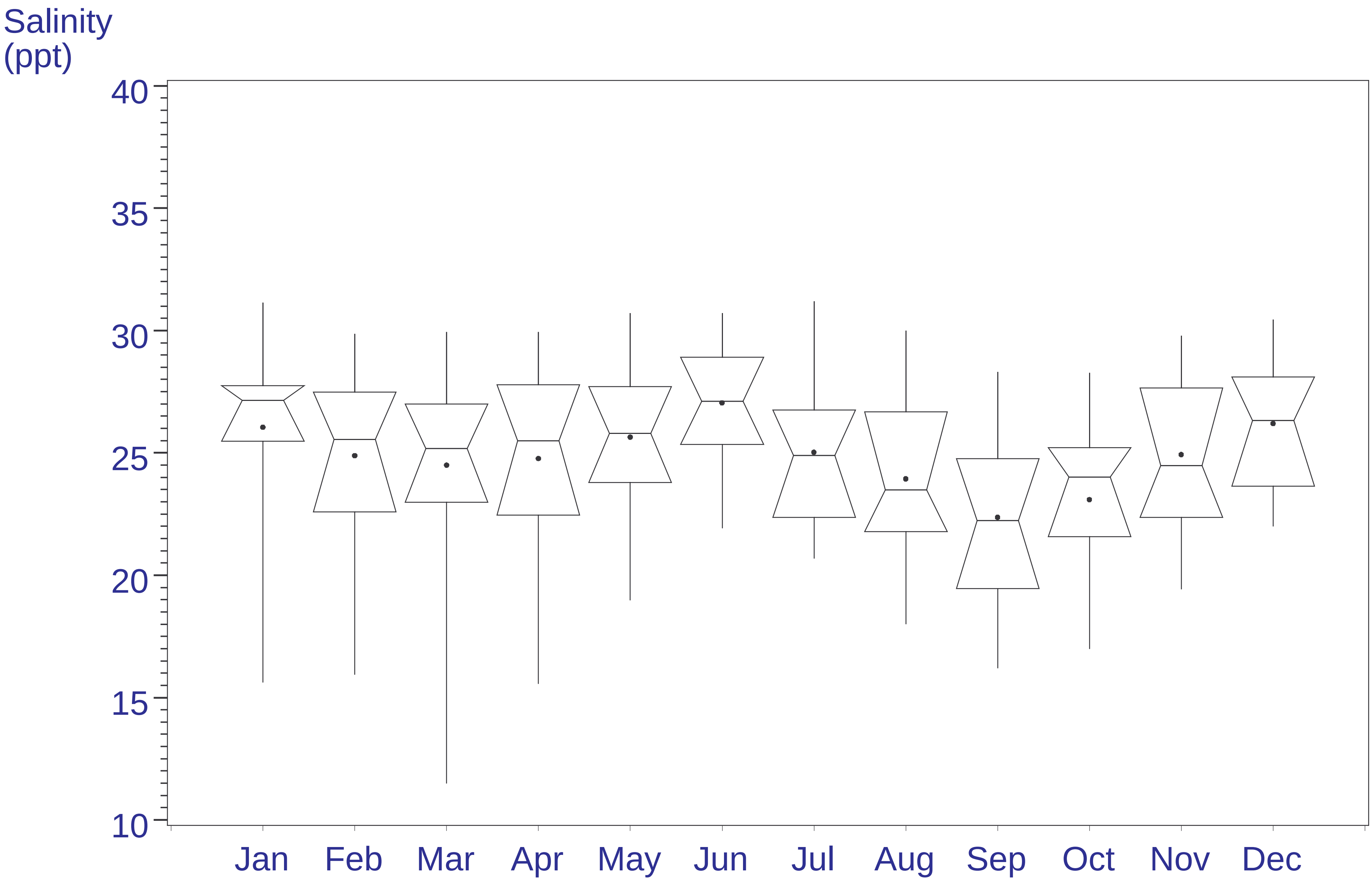



HILLSBOROUGH BAY
Seasonal Variation Analysis
Mean Monthly Surface Salinity Concentrations
Data Source: EPCHC
Salinity
(ppt)
40
35
30
25
20
15
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Hillsborough Bay Bottom Salinity (ppt) Data Source: EPCHC	
# of Years of Sampling	23
Number of Samples	241
Tau Statistic	-0.018
P-value without Serial Correlation	0.706
P-value with Serial Correlation	0.857
p Value Slope Statistic	-0.0194


HILLSBOROUGH BAY
Mean Monthly Bottom Salinity Concentrations
Data Source: EPCHC
Salinity
(ppt)
40
35
30
25
20
15
10
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values

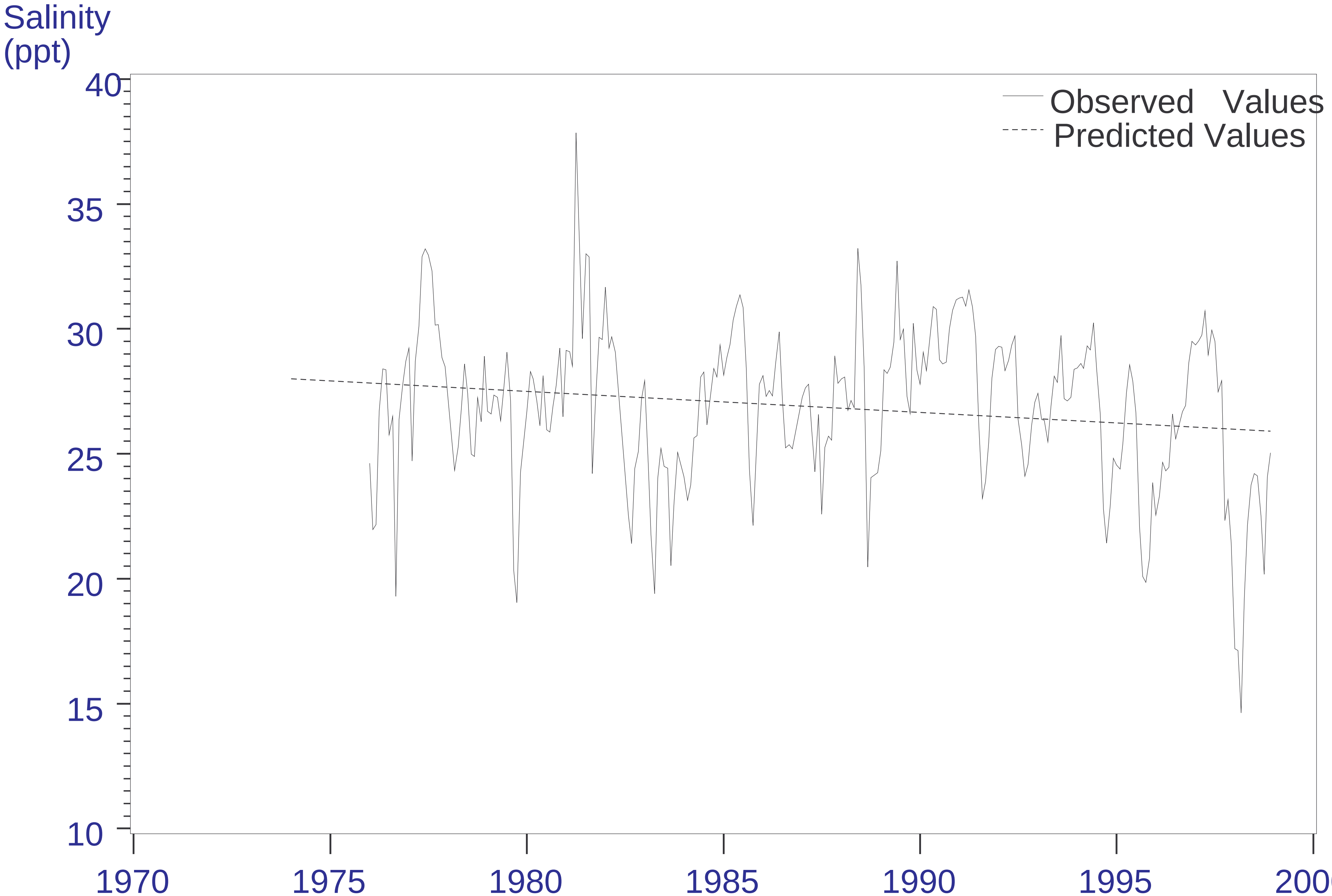
HILLSBOROUGH BAY
Seasonal Variation Analysis
Mean Monthly Bottom Salinity Concentrations
Data Source: EPCHC



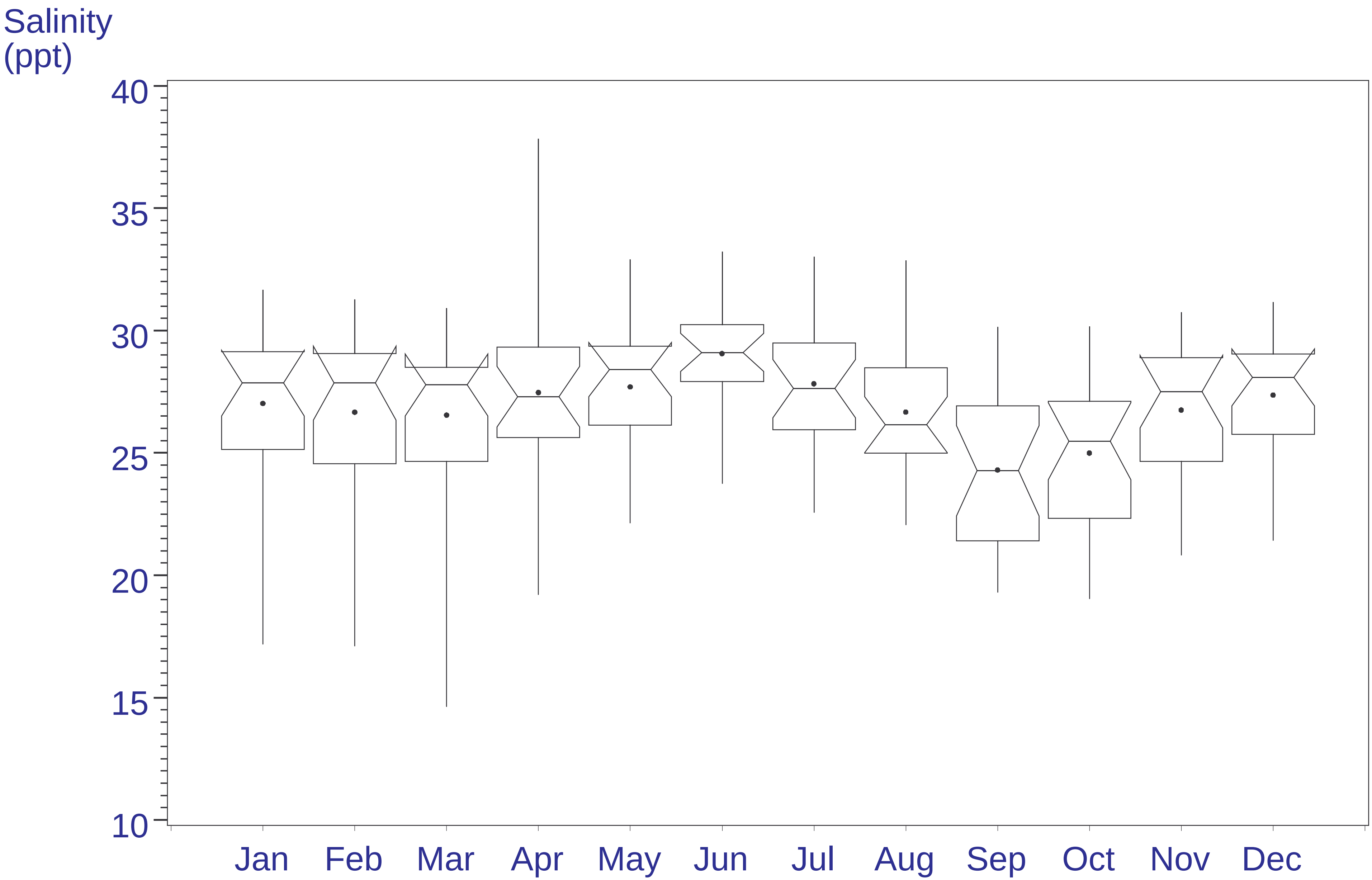
MIDDLE TAMPA BAY

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay Surface Salinity (ppt) Data Source: EPCHC	
# of Years of Sampling	23
Number of Samples	262
Tau Statistic	-0.076
P-value without Serial Correlation	0.089
P-value with Serial Correlation	0.447
p Value Slope Statistic	-0.0528

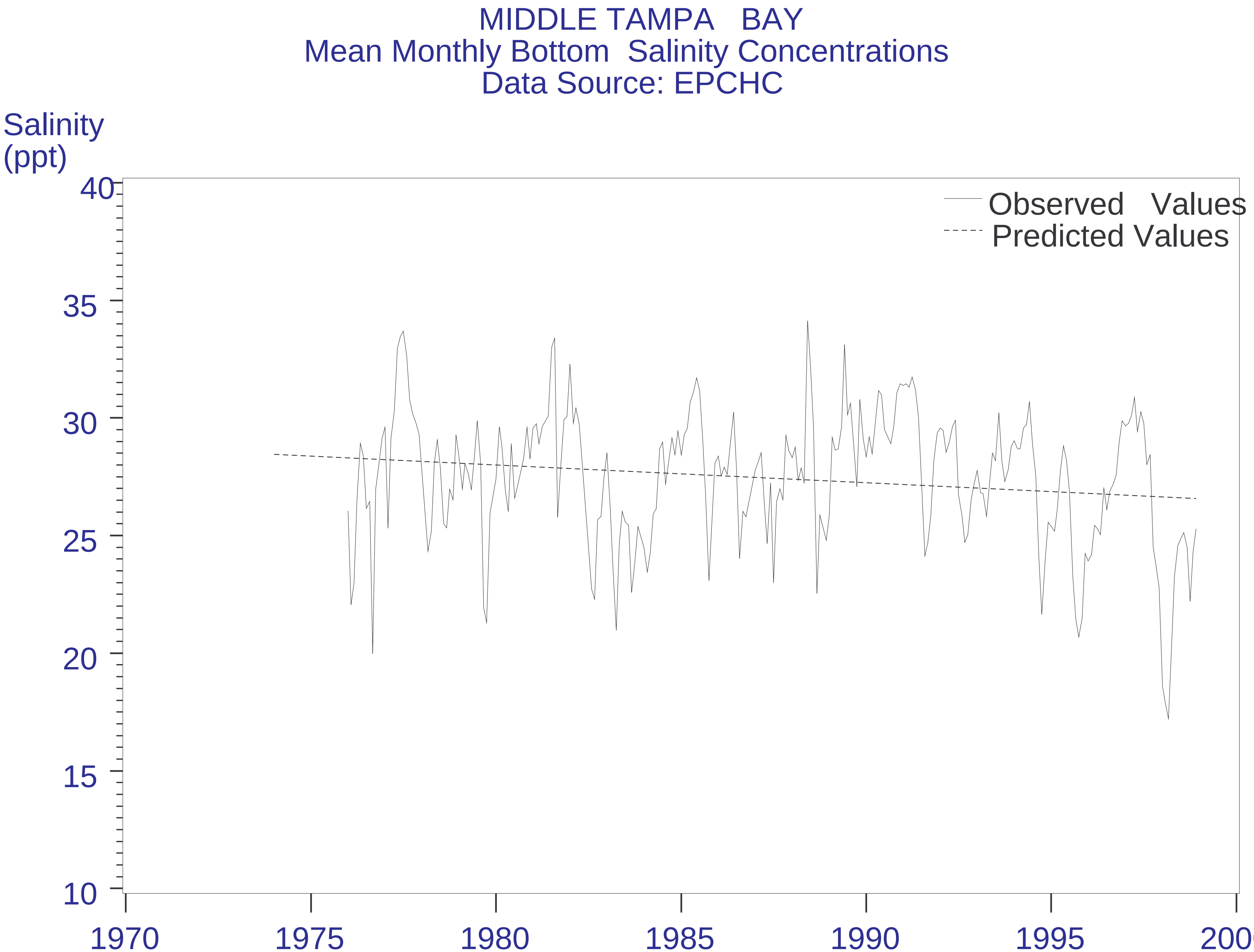
MIDDLE TAMPA BAY
Mean Monthly Surface Salinity Concentrations
Data Source: EPCHC



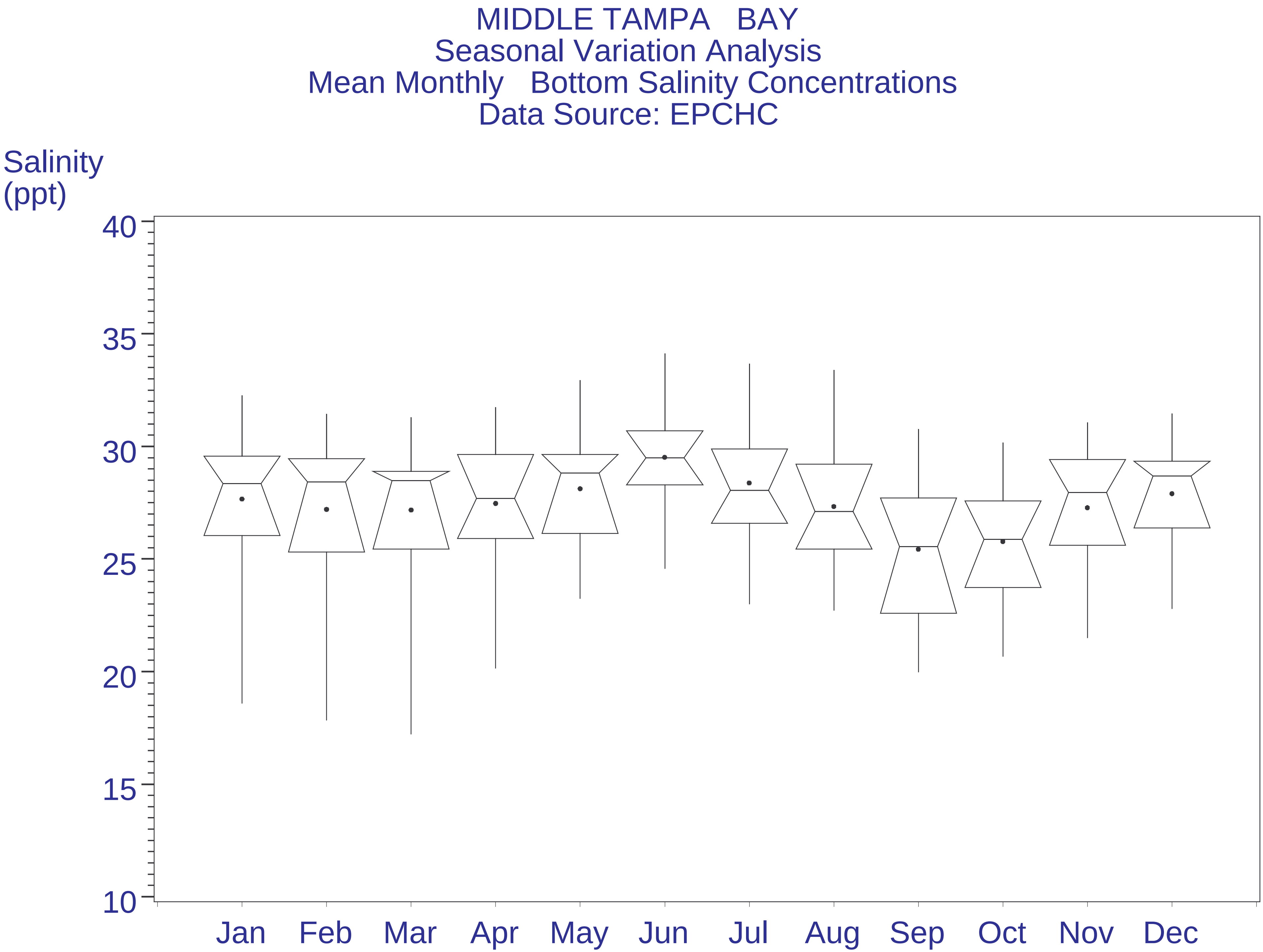
MIDDLE TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Surface Salinity Concentrations
Data Source: EPCHC



TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Middle Tampa Bay Bottom Salinity (ppt) Data Source: EPCHC	
# of Years of Sampling	23
Number of Samples	262
Tau Statistic	-0.100
P-value without Serial Correlation	0.025
P-value with Serial Correlation	0.313
p Value Slope Statistic	-0.0573

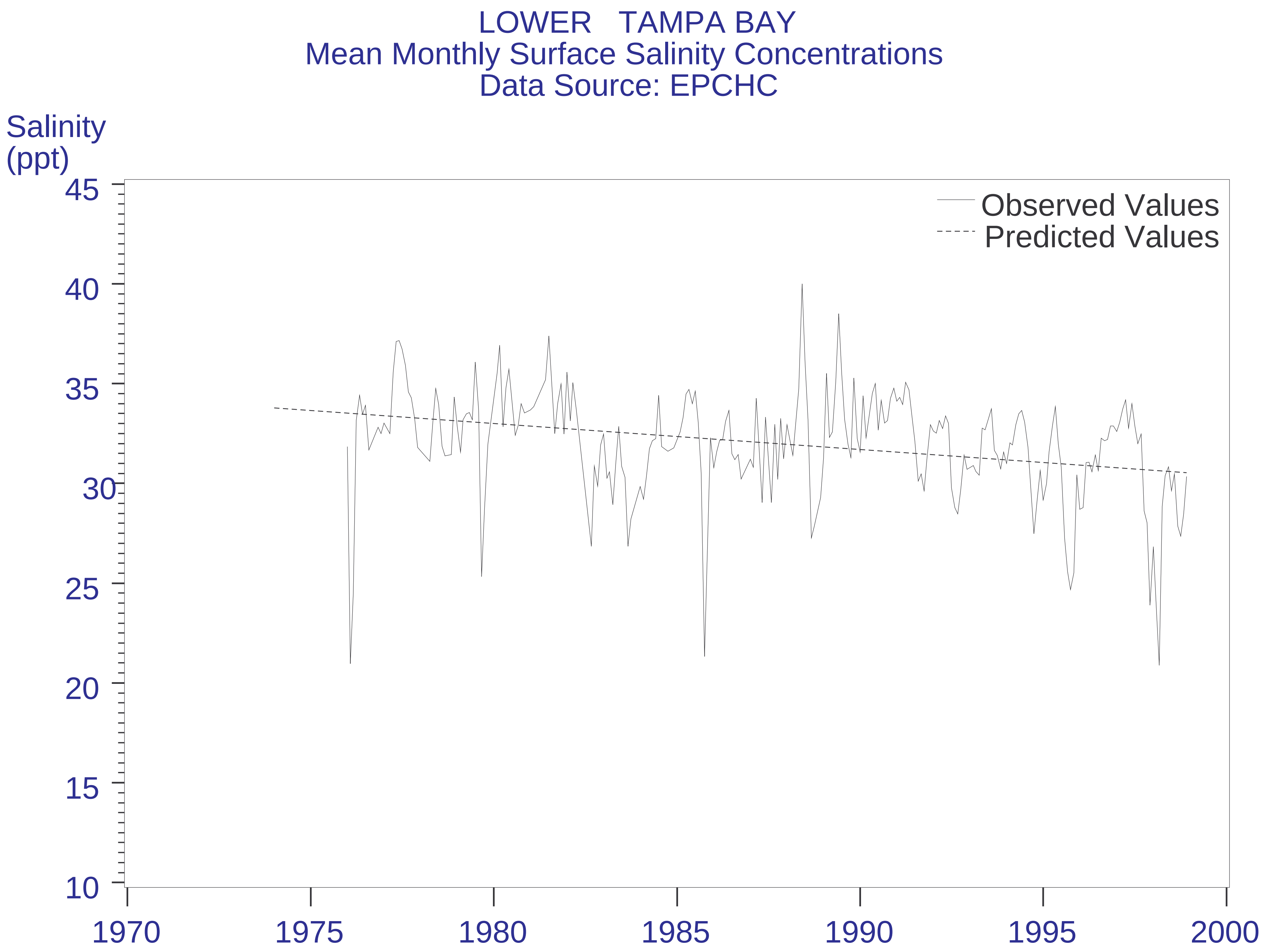


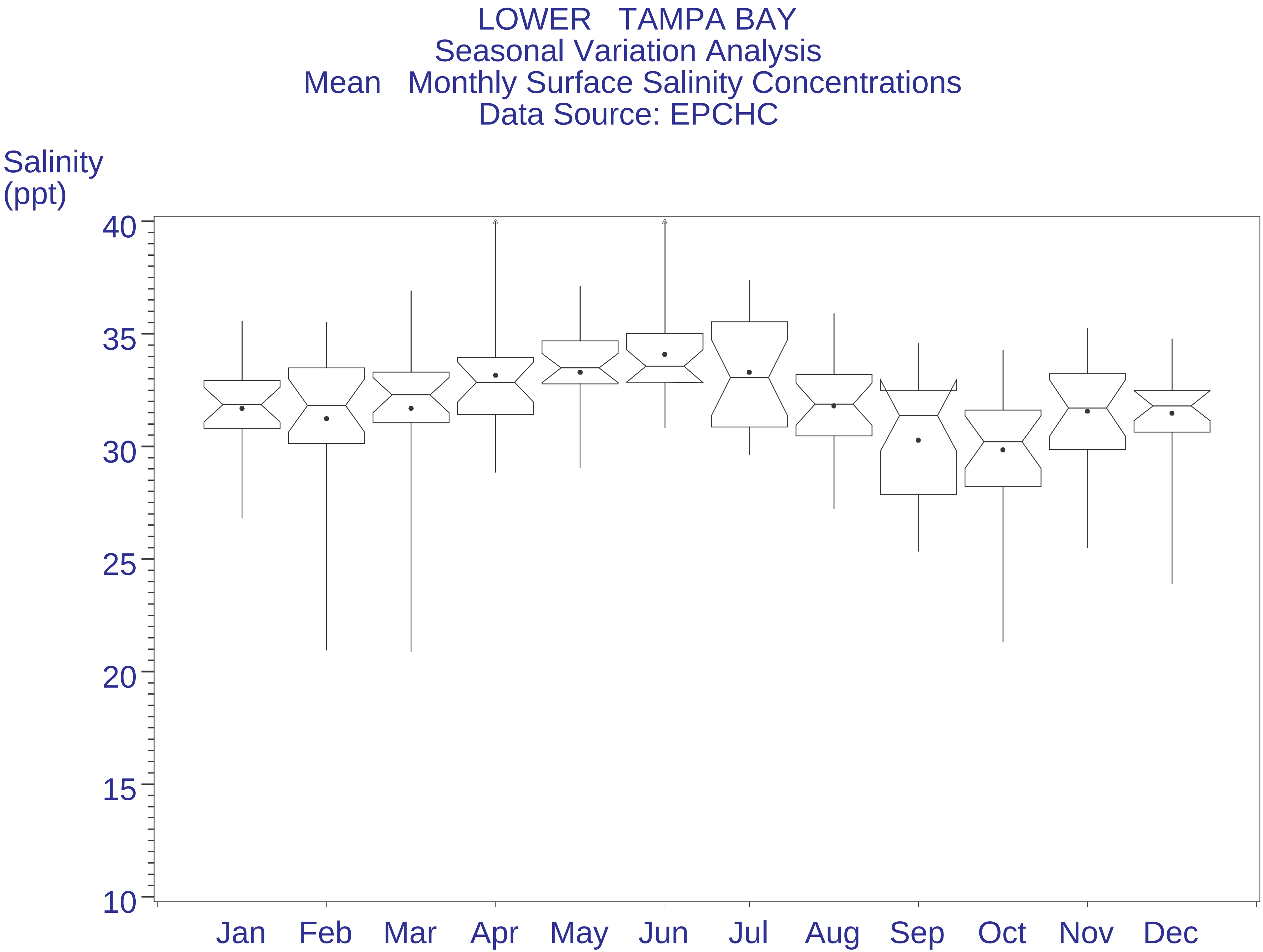
MIDDLE TAMPA BAY
Mean Monthly Bottom Salinity Concentrations
Data Source: EPCHC
Salinity (ppt)
40
35
30
25
20
15
10
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


MIDDLE TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Bottom Salinity Concentrations
Data Source: EPCHC
Salinity
(ppt)
40
35
30
25
20
15
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

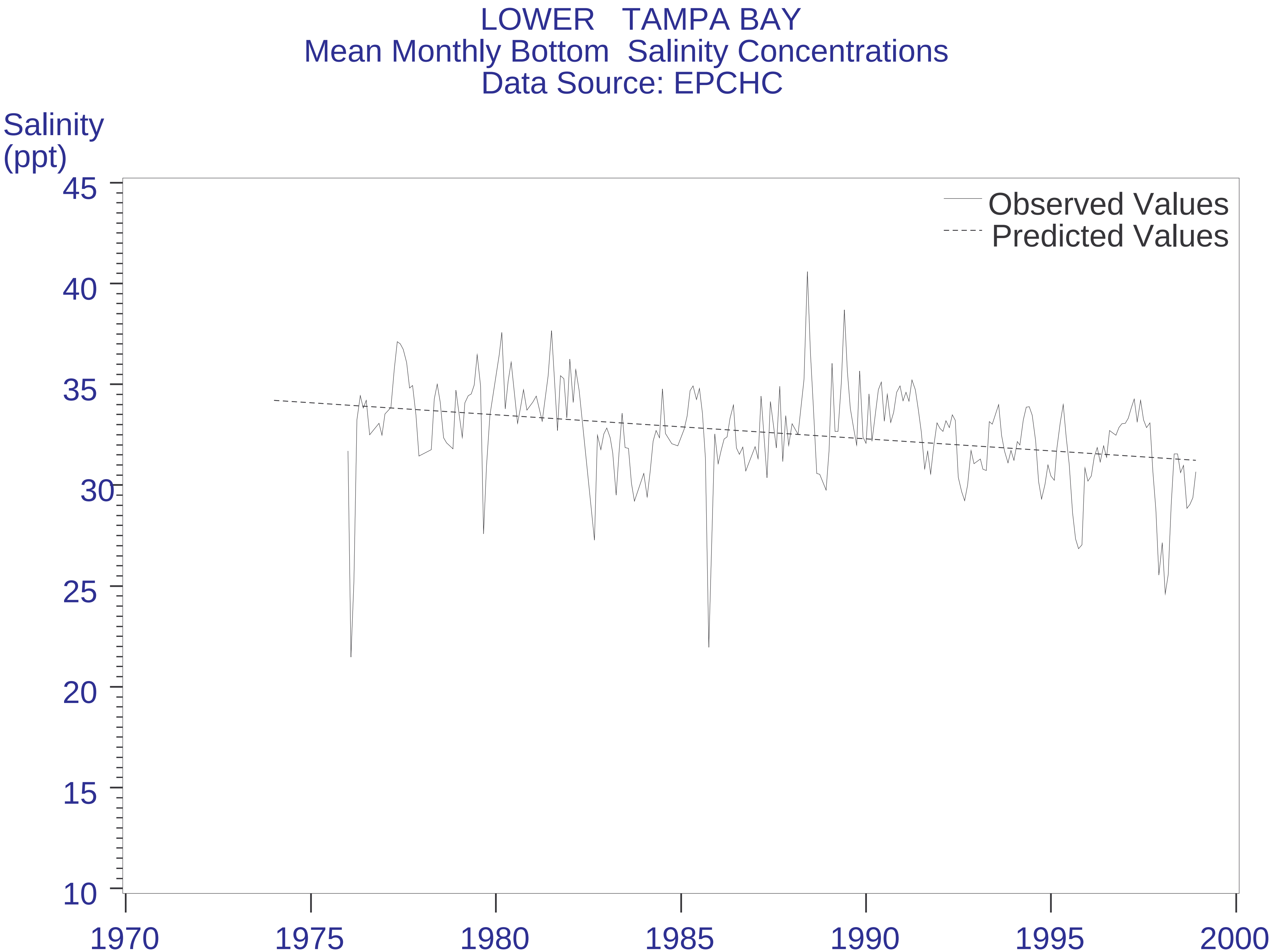
LOWER TAMPA BAY

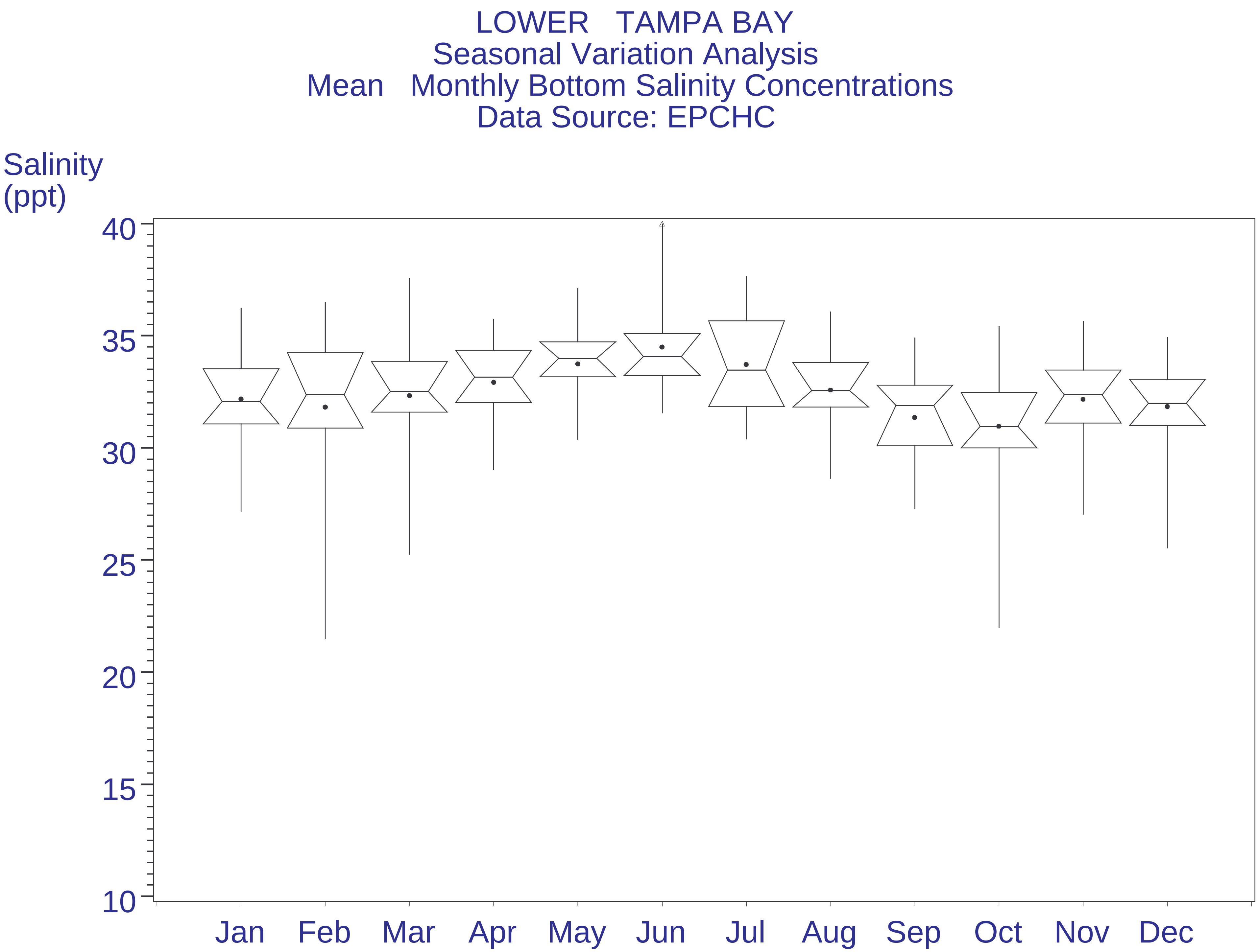
TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Lower Tampa Bay Surface Salinity (ppt) Data Source: EPCHC	
# of Years of Sampling	23
Number of Samples	242
Tau Statistic	-0.262
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.012
p Value Slope Statistic	-0.1188


LOWER TAMPA BAY
Mean Monthly Surface Salinity Concentrations
Data Source: EPCHC
Salinity
(ppt)
45
40
35
30
25
20
15
10
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


LOWER TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Surface Salinity Concentrations
Data Source: EPCHC
Salinity
(ppt)
40
35
30
25
20
15
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

TAMPA BAY ESTUARY PROGRAM Temporal Trend Analysis Results Nonparametric Tests Lower Tampa Bay Bottom Salinity (ppt) Data Source: EPCHC	
# of Years of Sampling	23
Number of Samples	242
Tau Statistic	-0.293
P-value without Serial Correlation	0.000
P-value with Serial Correlation	0.007
p Value Slope Statistic	-0.1288


LOWER TAMPA BAY
Mean Monthly Bottom Salinity Concentrations
Data Source: EPCHC
Salinity
(ppt)
45
40
35
30
25
20
15
10
1970
1975
1980
1985
1990
1995
2000
Observed Values
Predicted Values


LOWER TAMPA BAY
Seasonal Variation Analysis
Mean Monthly Bottom Salinity Concentrations
Data Source: EPCHC
Salinity
(ppt)
40
35
30
25
20
15
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec