Pinellas County Monitoring Program Review

Task 1: Technical Memorandum: Timeseries Trend Analysis

Submitted to:
Pinellas County Watershed Management

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1 Introduction

Pinellas County conducts routine sampling of its waterbodies eight times per year. Sampling includes fixed station locations in tributaries throughout the County (Figure 1-1) as well as a probabilistic (random sampling) design to sample the open bay estuarine waters (Figure 1-2). While sampling has been conducted since 1992 in Pinellas County waters, the sampling routine was redesigned and implemented and location of many sites moved in 2003. This report assesses data collected since 2003 through 2013 for all routine ambient monitoring data collected by the Pinellas County Department of Environment and Infrastructure's Watershed Management Division.

The objective of this report is to provide analytical results of statistical timeseries trend analysis for both the land based (fixed station) data and the estuarine and lake (probabilistic) data collected since 2003. To facilitate reporting the results of the trend analysis, Pinellas County was divided into 5 "Major Basins" based on previous management delineations used by either Pinellas County or by local Inter-governmental agencies. The major basins are depicted in Figure 1-3 below and include the Clearwater Harbor and Saint Joseph Sound management area in North Western Pinellas County (CHSJS), Boca Ciega Bay and adjacent waters (Boca Ciega), Southeast Pinellas County which drains principally to Middle Tampa Bay (MTB), and Northeast Pinellas which drains to Old Tampa Bay (OTB). Old Tampa Bay is further subdivided into North (OTB-North) and South (OTB-South) to distinguish the drainage areas associate with Lake Tarpon and that portion of OTB above the Courtney Campbell Causeway from the remainder of the large area of Old Tampa Bay. The specific waterbodies within each Major Basin along with station number Florida Department of Environmental Protection (FDEP) waterbody Identifier (WBID) and WBID class are listed in Table 1-1.

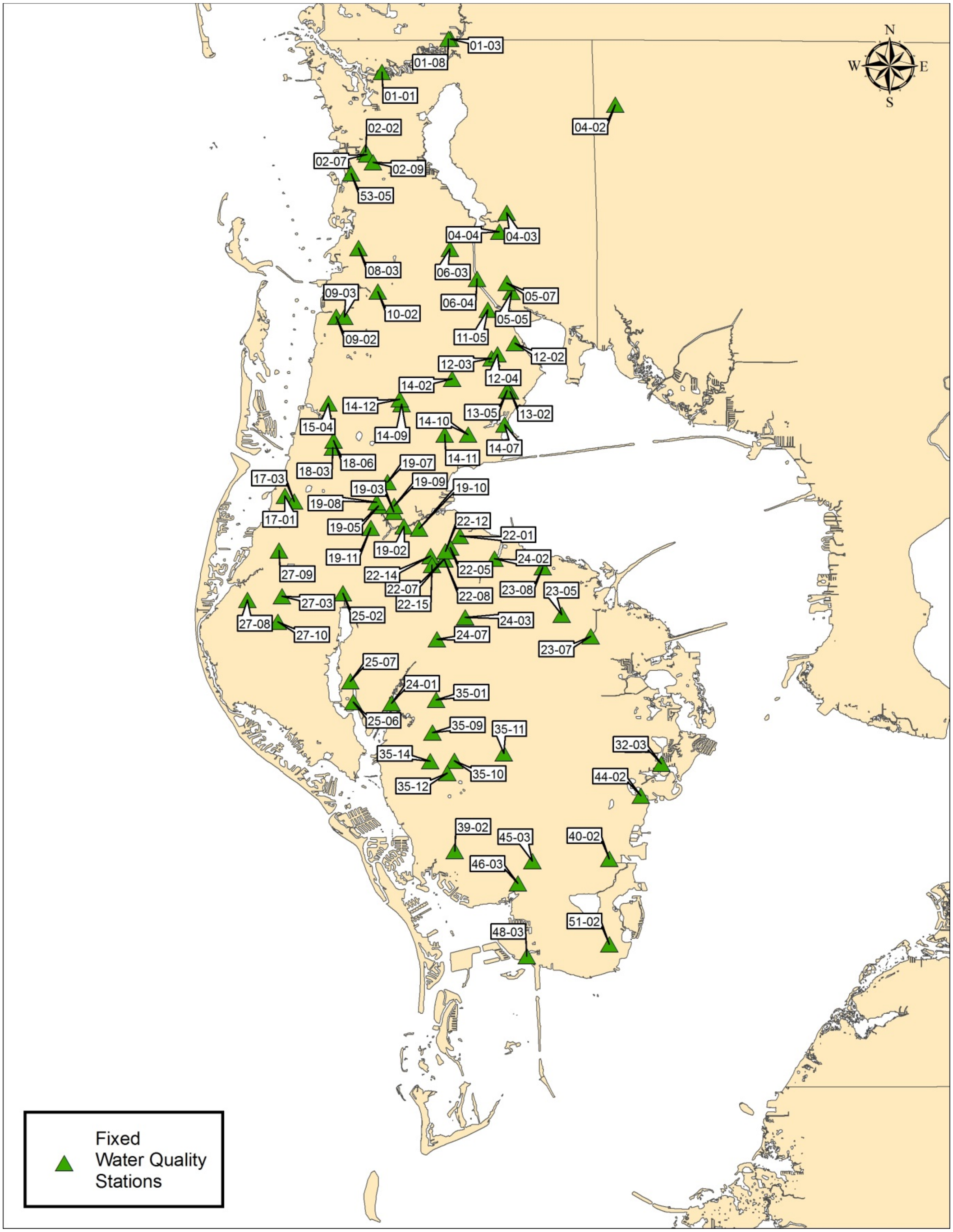

Figure 1-1. **Location of Pinellas County fixed station sampling sites in tributaries and lakes.**

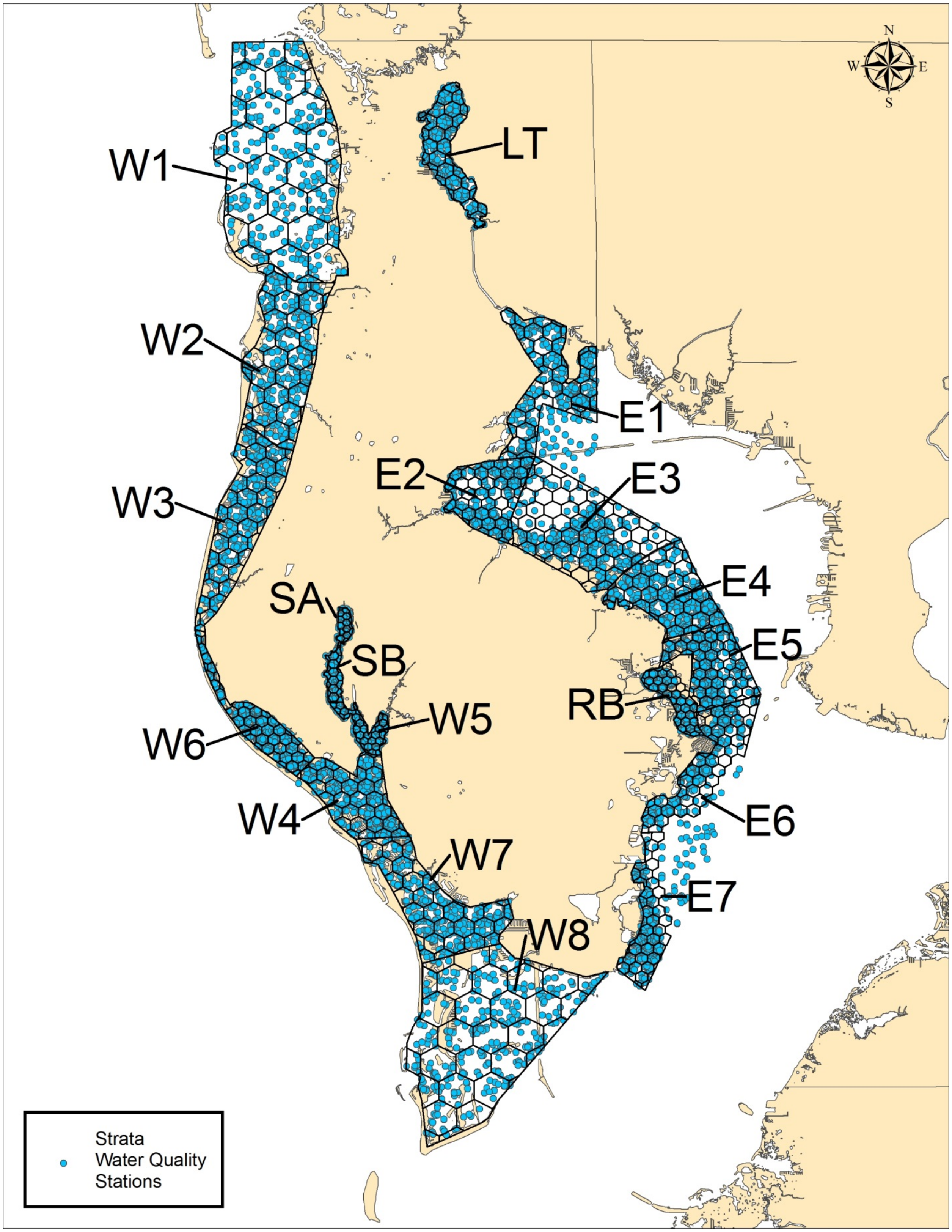

Figure 1-2. **Probabilistic sampling strata used for sampling estuarine waters, Lake Seminole and Lake Tarpon.**

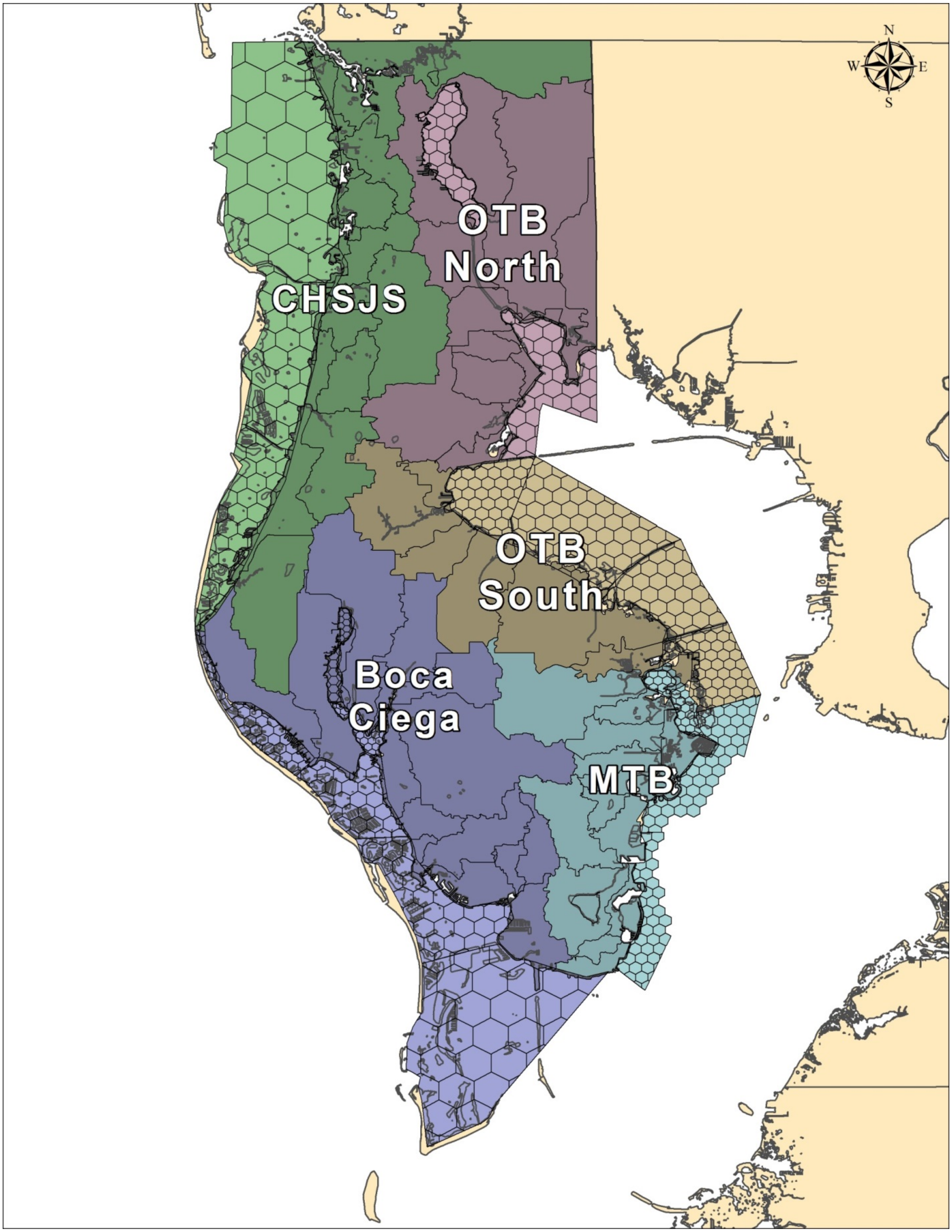

Figure 1-3. Major Basin geographic delineations for reporting trend results for individual stations and strata.

Table 1-1. Pinellas County monitoring station list for each Major Basin with waterbody name, FDEP WBID and WBID Class.							
Boca Ciega				**Clearwater Harbor and Saint Joseph Sound (CHSJS)**			
Station	WBID	Water Body	Class	Station	WBID	Water Body	Class
24-01	1641	Cross Canal (South)	3M	01-01	1440	Anclote River Tidal	3M
24-07	1641	Cross Canal (South)	3M	01-03	1440	Anclote River Tidal	3M
25-02	1618D	Starkey Basin	3F	01-08	1440	Anclote River Tidal	3M
25-06	1618D	Starkey Basin	3F	02-02	1508	Klosterman Bayou	3M
25-07	1618D	Starkey Basin	3F	02-07	1508	Klosterman Bayou	3M
35-01	1668B	Pinellas Park Ditch No 5 (Bonn Creek)	3F	02-09	1508A	Klosterman Bayou Run	3F
35-09	1668D	Bonn Creek	3F	08-03	1527B	Bee Branch	3F
35-10	1668A	St Joe Creek (Fresh Segment)	3F	09-02	1556	Cedar Creek (Tidal)	3M
35-11	1668A	St Joe Creek (Fresh Segment)	3F	09-03	1556A	Cedar Creek	3F
35-12	1668A	St Joe Creek (Fresh Segment)	3F	10-02	1538A	Curlew Creek Freshwater Segment	3F
35-14	1668A	St Joe Creek (Fresh Segment)	3F	15-04	1567B	Spring Branch	3F
39-02	1701	Bear Creek	3M	17-01	1614	Rattlesnake Creek	3F
45-03	1716A	34th Street Basin	3F	17-03	1614	Rattlesnake Creek	3F
46-03	1716D	Clam Bayou Drain (Tidal)	3M	18-03	1567C	Stevenson Creek (Fresh Segment)	3F
48-03	1709F	Frenchmans Creek - Basin U	2	18-06	1567C	Stevenson Creek (Fresh Segment)	3F
SA	1618	Lake Seminole	3F	27-03	1633B	Mckay Creek	3F
SB	1618	Lake Seminole	3F	27-08	1643	Church Creek	3F
W4	1528A	The Narrows	3M	27-09	1633B	Mckay Creek	3F
W5	1618C	Long Bayou/Cross Bayou	3M	27-10	1633B	Mckay Creek	3F
W6	1694B	Boca Ciega Bay (North)	3M	W1	8045D	St. Joseph Sound	3M
W7	1694A	Boca Ciega Bay (Central)	3M	W2	1528C	Clearwater Harbor (North)	3M
W8	1558N	Boca Ciega Bay (South)	2	W3	1528	Clearwater Harbor South	3M
Old Tampa Bay North (OTB-North)				Old Tampa Bay South (OTB-South)			
04-02	1474	Brooker Creek	3F	19-02	1604	Allen's Creek (Tidal)	3M
04-03	1474	Brooker Creek	3F	19-03	1604	Allen's Creek (Tidal)	3M
04-04	1474	Brooker Creek	3F	19-05	1604	Allen's Creek (Tidal)	3M

Table 1-1 cont'd.							
Old Tampa Bay North (OTB-North) cont'd.				Old Tampa Bay South (OTB-South) cont'd			
05-05	1530	Moccasin Creek Tidal	3M	19-07	1604B	Allen's Creek	3F
05-07	1530A	Moccasin Creek	3F	19-08	1604B	Allen's Creek	3F
06-03	1529	Cow Branch	3F	19-09	1604B	Allen's Creek	3F
06-04	1541B	Lake Tarpon Canal	3F	19-10	1604B	Allen's Creek	3F
11-05	1541C	Briar Creek	3F	19-11	1604B	Allen's Creek	3F
12-02	1569A	Bishop Creek	3F	22-01	1627B	Long Branch (Tidal)	3M
12-03	1569A	Bishop Creek	3F	22-05	1627	Long Branch	3F
12-04	1569A	Bishop Creek	3F	22-07	1627	Long Branch	3F
13-02	1575A	Mullet Creek	3F	22-08	1627	Long Branch	3F
13-05	1575A	Mullet Creek	3F	22-12	1627	Long Branch	3F
14-02	1603D	Lake Chautauqua	3F	22-14	1627	Long Branch	3F
14-07	1574A	Alligator Lake	3F	22-15	1627	Long Branch	3F
14-09	1603B	Harbor Lake Drain	3F	23-05	1624A	Roosevelt Basin (Freshwater Segment)	3F
14-10	1574	Alligator Creek	3F	23-07	1624A	Roosevelt Basin (Freshwater Segment)	3F
14-11	1574	Alligator Creek	3F	23-08	1624A	Roosevelt Basin (Freshwater Segment)	3F
14-12	1603B	Harbor Lake Drain	3F	24-02	1625	Cross Canal (North)	3M
E1	1558I	Old Tampa Bay	2	24-03	1625	Cross Canal (North)	3M
LT	1486A	Lake Tarpon	3F	E2	1558H	Old Tampa Bay	2
				E3	1558H	Old Tampa Bay	2
				E4	1558G	Old Tampa Bay	2
				E5	1558F	Old Tampa Bay	2
Middle Tampa Bay (MTB)							
32-03	1683	Smacks Bayou	2				
40-02	1696	Booker Creek	3F				
44-02	1700	Coffeepot Bayou	2				
51-02	1709D	Little Bayou - Basin Q	3M				
E6	1558C	Tampa Bay	2				
E7	1558B	Tampa Bay	2				
RB	1661G	Papys Bayou	2				

2 Methods

The core statistical trend used for this project is the seasonal Kendall Tau Test for Trend (Helsel and Hirsch 1982). Implementation of the procedure follows the description provide by Reckhow et al. (1993). This procedure is based upon Kendall Tau Fortran programs developed by the United States Environmental Protection Agency and available from the USEPA Laboratory in Corvallis, Oregon. Janicki Environmental has develop software to drive these Fortran programs and summarize the output for reporting using Statistical Analysis Systems (SAS Institute, 2011).

The "seasonal" aspect of the test was defined by the eight sampling periods currently used by Pinellas County for conducting their routine monitoring. For periods when Pinellas County utilized nine sampling periods, the samples were grouped into the eight sampling periods currently used and averaged. The eight sampling periods are defined as follows:

- Period 1: January 21st – March 12th
- Period 2: March 13th – May 2nd
- Period 3: May 3rd - June 11th
- Period 4: June 12th July 22nd
- Period 5: July 23rd – August 31st
- Period 6: September 1st – October 10th
- Period 7: October 11th – November 30th
- Period 8: December 1st – January 20th

Reckhow et al (1993) describe a multi-step process for implementing the Kendall Tau test for trend which is summarized in the following paragraphs below. For each step in the analysis, the procedure produces a page of graphical output and intermediate datasets that are combined and used to provide detailed results for each test as well as graphical output provided for each result on the water quality appendices.

In the first step of each trend analysis a time series plot of the raw timeseries is prepared for the period of record. Figure 2-1 provides a sample page of the actual output from a previous trend test. This figure provides a valuable overall view of the timeseries trend in the data.

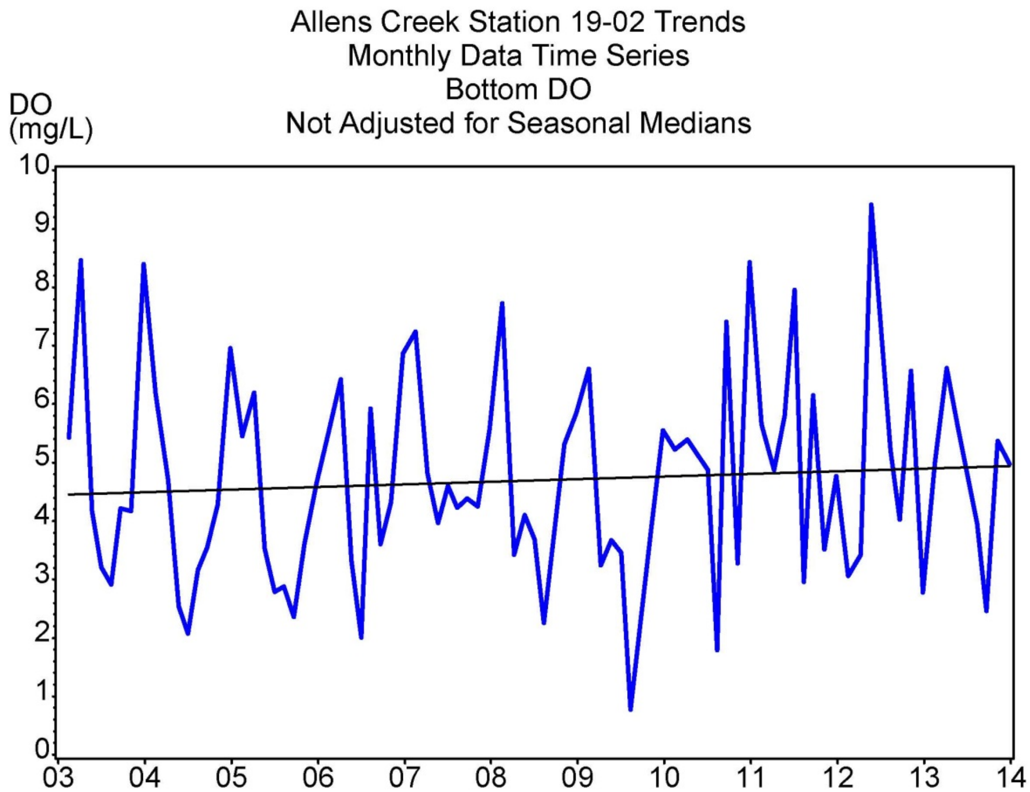

Figure 2-1. Sample trend results output for step 1.

In the second step of the trend analysis, the distribution of values for each sampling period are provided to describe the within and across season variability in the data across years (Figure 2-2). A complete set of univariate statistics is calculated and the figure provides a valuable overall view of the seasonality of the data.

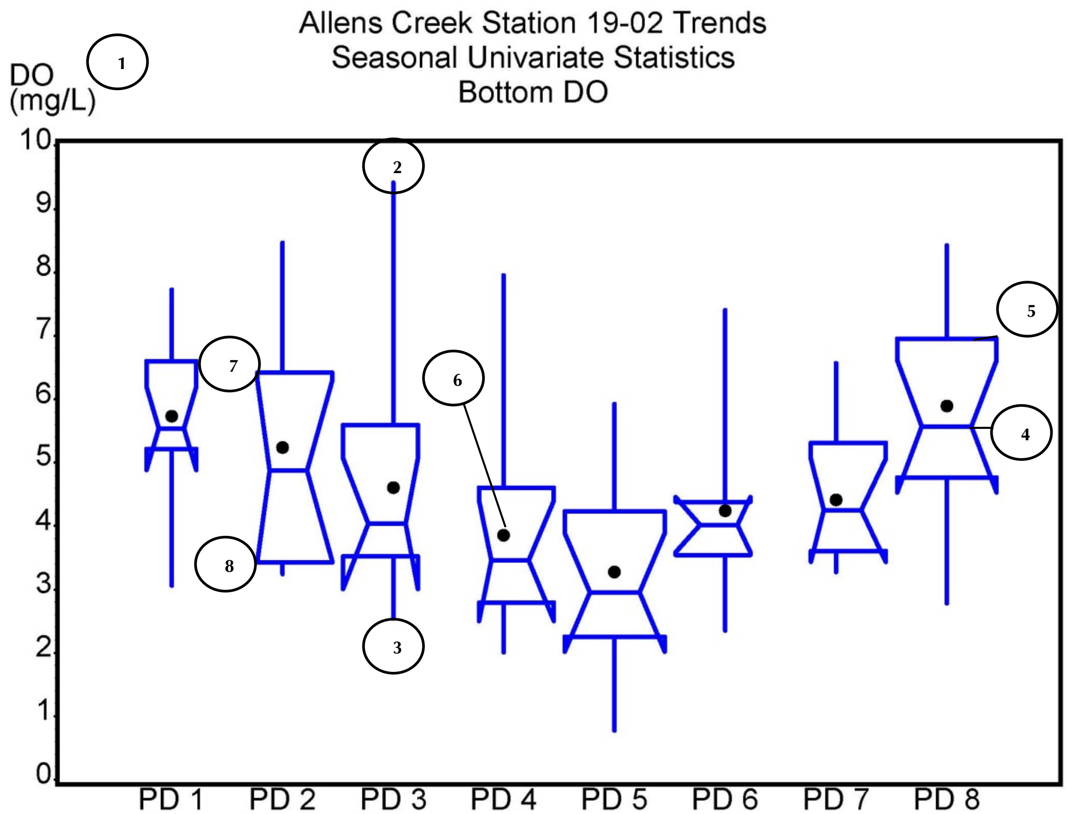

Figure 2-2. **Sample seasonal univariate results output for step 2.**

Figure 2-2 presents an example page from the results of the second step. The annotated labels indicate the following features: 1 = parameter of interest, 2 = the maximum value, 3 = the minimum value, 4 = the median value, 5 = the upper 95% confidence limit of the median value, 6 = the mean value, 7 = the 75th percentile, 8 = the 25th percentile and lower 95% confidence interval. If the confidence limits around the medians for any pair of seasons do not overlap, then the medians are considered to significantly different at an alpha level of 0.05.

In the third step of the analysis, a correlation analysis is performed for each seasonal value, the previous season's value, two seasons prior, etc., until correlation statistics have been calculated for all previous seasons up to 15 seasons prior. A table of these values is provided in the output.

In the fourth step of the analysis, a determination is made as to whether seasonality exists in the time series of data. An operationally defined and objective test to identify the presence of seasonality was applied.

A correlogram is provided as part of the output (example in Figure 2-3). If a correlation value on this plot is statistically significant then it will lie beyond the confidence limits shown. If the data presented by the plot have seasonality, then one would expect the 6-season lag values to be negatively correlated and the 12-season lag values to be positively

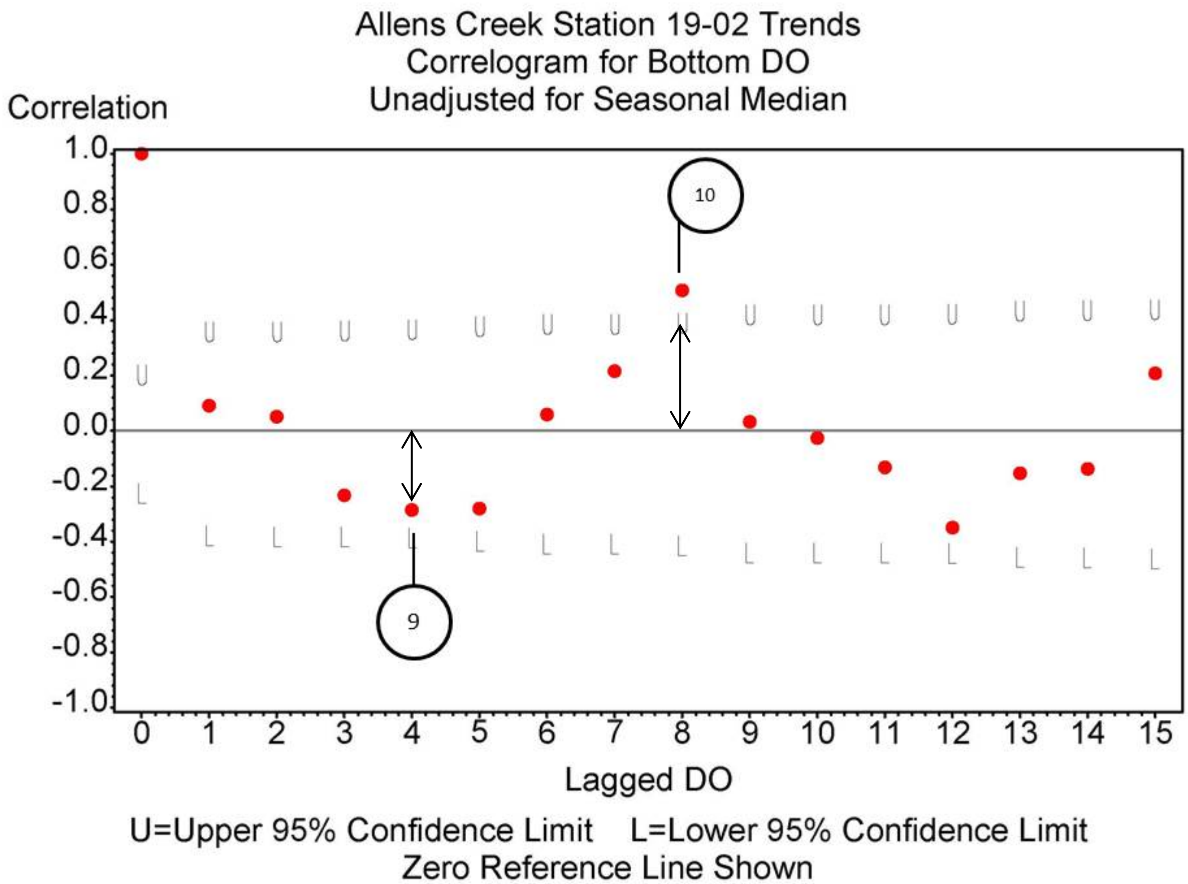

Figure 2-3. Sample seasonality test information output for step 4.

correlated. The objective test measures the proportional distance between the zero line and the lower 95% confidence limit for the 6-season lag correlation (label 9), and the proportional distance between the zero reference line and the upper 95% confidence limit for the 12-season lag correlation (label 10). If the sum of distance 9 and 10 are greater than 1, or if distance 10 is greater than 1 then seasonality is determined to exist.

If the data are determined to be seasonal, then the data are adjusted for season by subtracting the median seasonal value from each data point. The season-adjusted data are then applied to a Kendall Tau. The Kendall Tau test determines the slope of the time series of data, and p-values for various data conditions. Tables of these values are provided in the results (examples not shown). However, in all cases summary trend tables are provided showing the appropriate p values, slopes, and significance results for each trend.

The next step is to test the data for autocorrelation in a similar fashion to that completed to identify seasonality. In the first phase of this analysis, the season-adjusted data are de-trended by removing the effects of the slope identified. A diagnostic figure is then provided of these data (Figure 2-4).

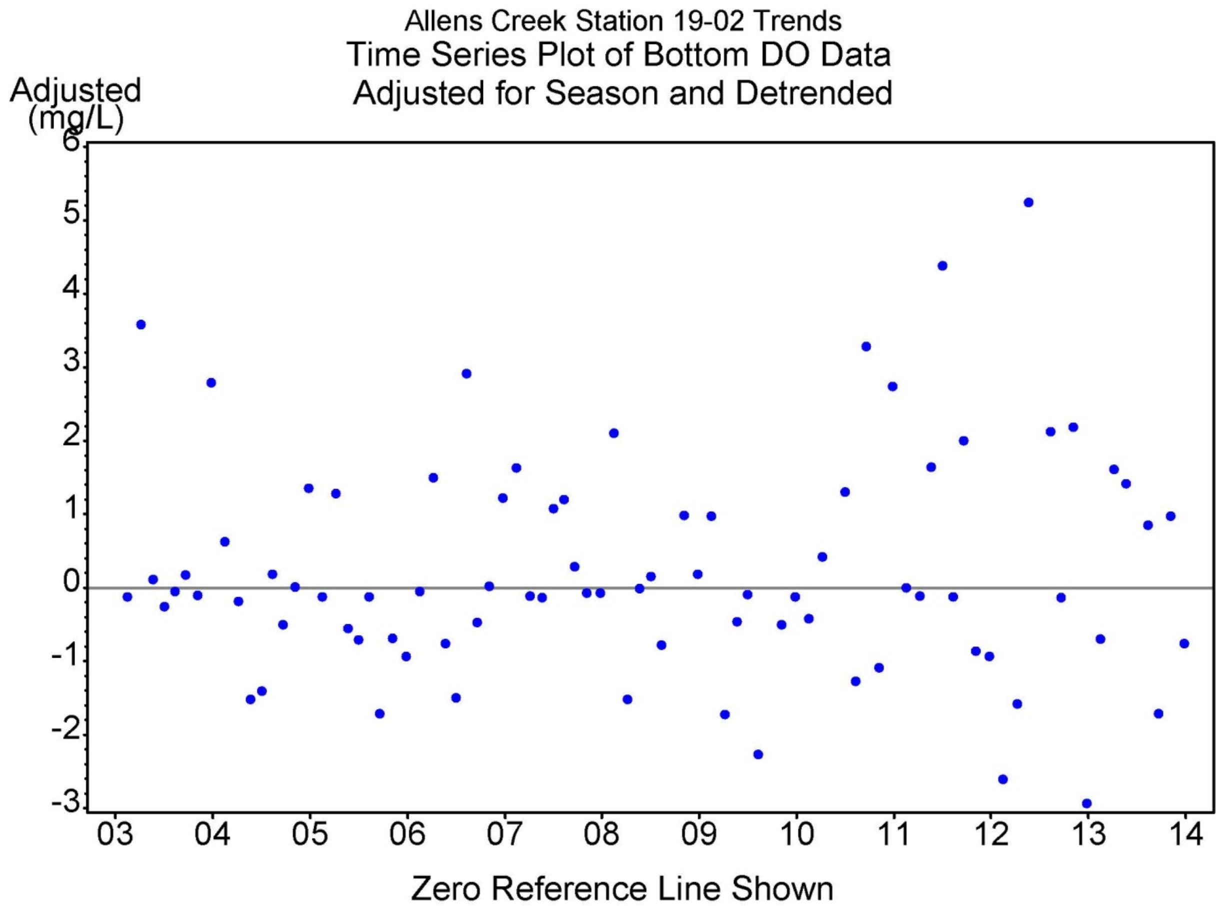

Figure 2-4. **An example of the season adjusted and de-trended data.**

In the next step of the analysis, the season adjusted and de-trended data are prepared in the form of a correlogram to test for the presence of autocorrelation in the time series. Figure 2-5 presents an example of this page of the detailed output. If the 1-season lag (label 11) or the 2-season lag (label 12) are significantly correlated with the present values, then the data are identified as auto-correlated and an adjustment is made to the p-value.

In the final step of each trend analysis the appropriate p-value (corrected for auto-correlation if necessary), significance assessment (based on alpha = 0.05), slope, autocorrelation assessment (present/absent), and seasonality assessment (present/absent) of the trend analysis are compiled and mapped to provide a results summary for each parameter across stations and also tabulated in a summary table of trend test results.

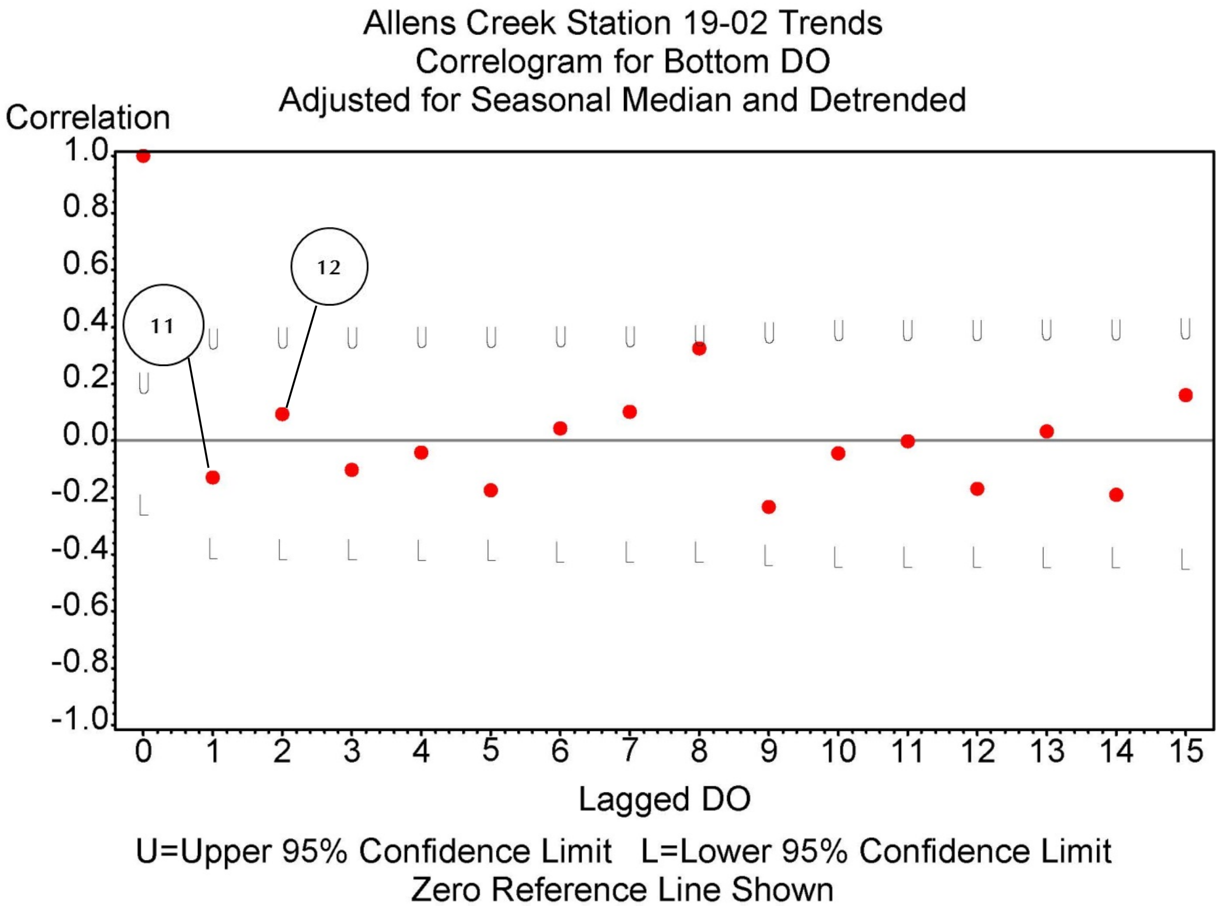

Figure 2-5. Sample autocorrelation test figure.

Because Pinellas County does not sample at fixed station sites when there is no freshwater inflow at the site at the time of sampling, the nominal minimal requirement of 60 samples necessary to conduct the trend test was relaxed to 40 samples. The test does allow for missing data so this artifact is handled appropriately in generating the test statistic and associated critical value used to assess significance. To define the magnitude of the trend for reporting purposes, the slope statistic was expressed as a proportion of the median value and a 10% threshold was used as an ad hoc definition of a "Large" versus "Small" trend. That is, when the slope estimate was greater than 10% of the median value across the period of record, the trend was reported to be of "Large" magnitude and otherwise "Small".

Due to the large number of station/parameter combinations tested, an adjustment was made to the p values when declaring significance of the findings for summarizing results of such a large number of comparisons. In essence, while each test criterion applied a type 1 error rate of 5% (i.e., alpha = 0.05), due to the number of tests conducted the probability of a type 1 error is inflated (see Benjamini and Hochberg 1995 for details). The Benjamini and Hochberg False Discovery Rate procedure was therefore applied to the results of the individual parameter tests to control the type 1 error rate at 5% which is the statistical norm.

3 Results

This report provides complete trend analysis information ranging from very broad regional patterns down to very detailed statistical analysis results. The chapter is formatted to allow the reader to “drill down” from broad scale summarizations of results to results for individual stations, sample levels (i.e., surface or bottom) and water quality parameters of interest. For the purposes of this report, “small trends” are defined as statistically significant trends with a rate of change less than 10% of the median value per year, and “large trends” are defined as statistically significant trends with a rate of change greater than or equal to 10% of the median value per year. Thus, “small trends” represent water quality conditions that are changing (either increasing or decreasing) at a lesser rate of change than for “large trends.” These are relative terms, and the precise rates of change (i.e. the slopes) are presented for each station/parameter in the detailed statistical appendices. The terms “large” and “small” do not imply either ecological significance or the lack of ecological significance. We further differentiate results based on the trend direction; however, It should be noted that while for most parameters increases in concentration equate to declining water quality, for some parameters (e.g., dissolved oxygen) increases are related to improving conditions. Lastly, the terms “surface waters” or “surface” trends define samples collected at or within 1 meter of the water surface while “bottom” refers to samples collected near the bottom.

Near bottom samples were collected only for in situ physical chemistry parameters including salinity, dissolved oxygen water temperature and pH. Results of trend analysis on “Bottom” samples resulted in no detected trends indicating stable conditions for all physical chemistry parameters throughout Pinellas County with a single exemption; a small magnitude increasing trend in bottom salinity in Alligator Lake (Station 14-07). Mid water samples were similarly stable throughout with the exception of a single increasing trend in salinity at the same Station in Alligator Lake (14-07) and a single increasing trend in dissolved oxygen in Stratum B of Lake Seminole. Based on these results, only the surface results are presented below; however, results for all station/level combinations are provided in Appendix A.

The results of the trend analysis for surface samples are summarized in several ways in the sections below. First, an overview of the results is provided by Major Basin for the principal water quality parameters used either as regulatory standards or indicative of changes in physical chemistry of the sampled waterbody. Next, results are summarized by parameter. Maps and tables are provided that describe the trends across Major Basins by parameter. Finally, an appendix is provided that contains hyperlinks to each individual station or strata monitoring by Pinellas County with sufficient information for reporting trend results (i.e., at least 40 samples). Each link corresponds to detailed station information for all parameters tested with graphics provided as described in the Methods section of this report.

3.1 Trend Summaries by Major Basin for Principal Constituents

The following paragraphs describe general trends by Major Basin for the principal water quality constituents (parameters) monitored by Pinellas County. These parameters include: Chlorophyll *a*

(Chla μg/l), Dissolved Oxygen (DO mg/l), Total Nitrogen (TN mg/l), Total Phosphorus (TP mg/l), Salinity (PSU), and Turbidity (NTU).

3.1.1 Boca Ciega

The Boca Ciega Major Basin includes all of Boca Ciega Bay as well as portions of the Intracoastal Waterway from Treasure Island to Madiera Beach, Tierra Verde to the south, and the watershed areas of Lake Seminole, Joe’s Creek, Niles Creek, and portions of Cross Bayou. Between 2003 and 2013 In Boca Ciega there was a single decreasing trend in Chla, two increasing trends in DO (Lake Seminole Strata A and B), four decreasing trends in TN, seven decreasing trends in TP, a single increasing trend in salinity, and a single increasing and three decreasing trends in turbidity (Figure 3-1).

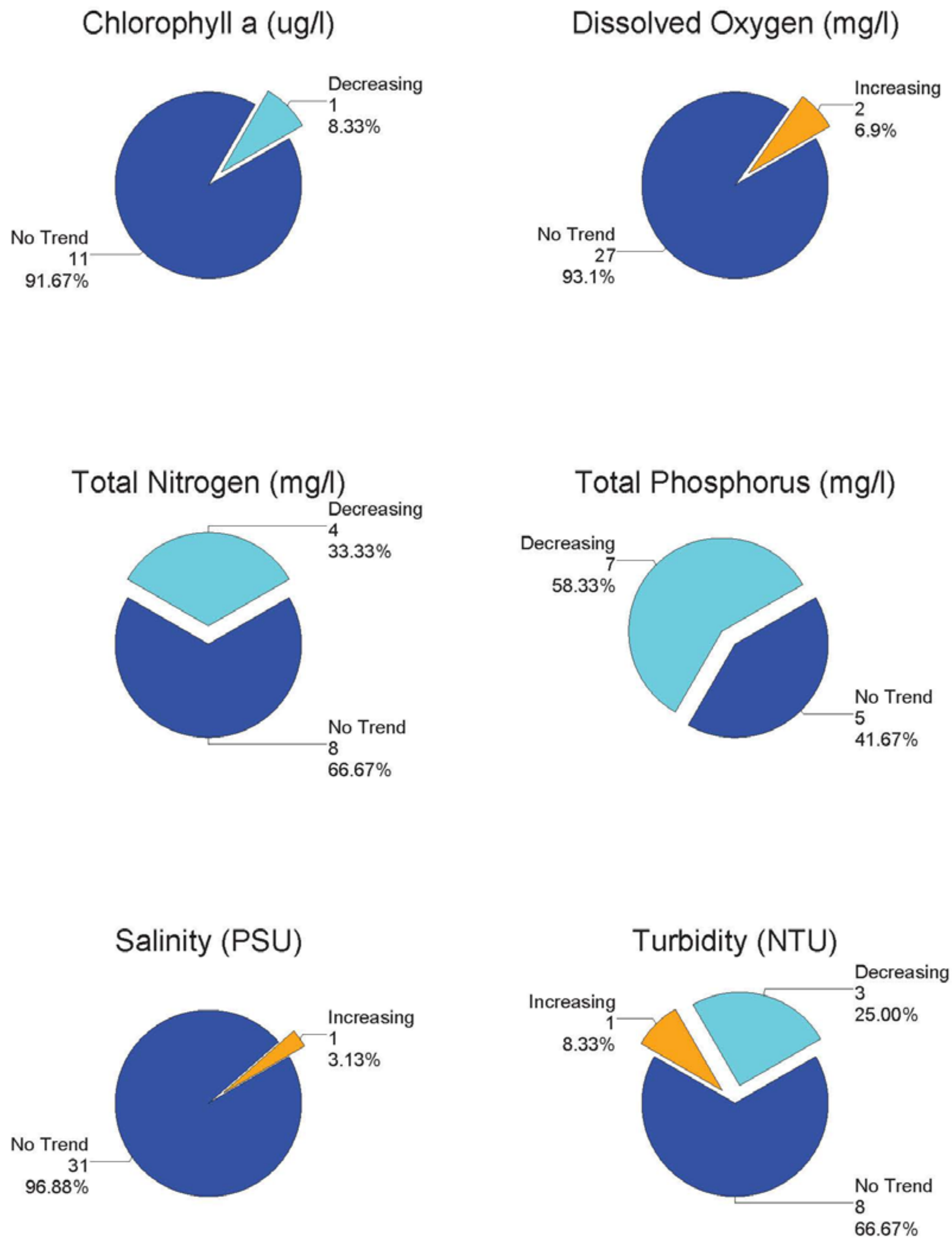

Figure 3-1. Distribution of trend test results for principal water quality parameters measured in Boca Ciega.

3.1.2 Clearwater Harbor and Saint Joseph Sound (CHSJS)

There were no trends in Chla in CHSJS, a single decreasing trend in DO equivalent to 3.7% of all tests conducted, three decreasing trends in TN (ca 19% of TN tests) , a single increasing trend in TP, seven increasing trends in salinity (ca 25%), and three increasing and two decreasing trends in turbidity (Figure 3-2).

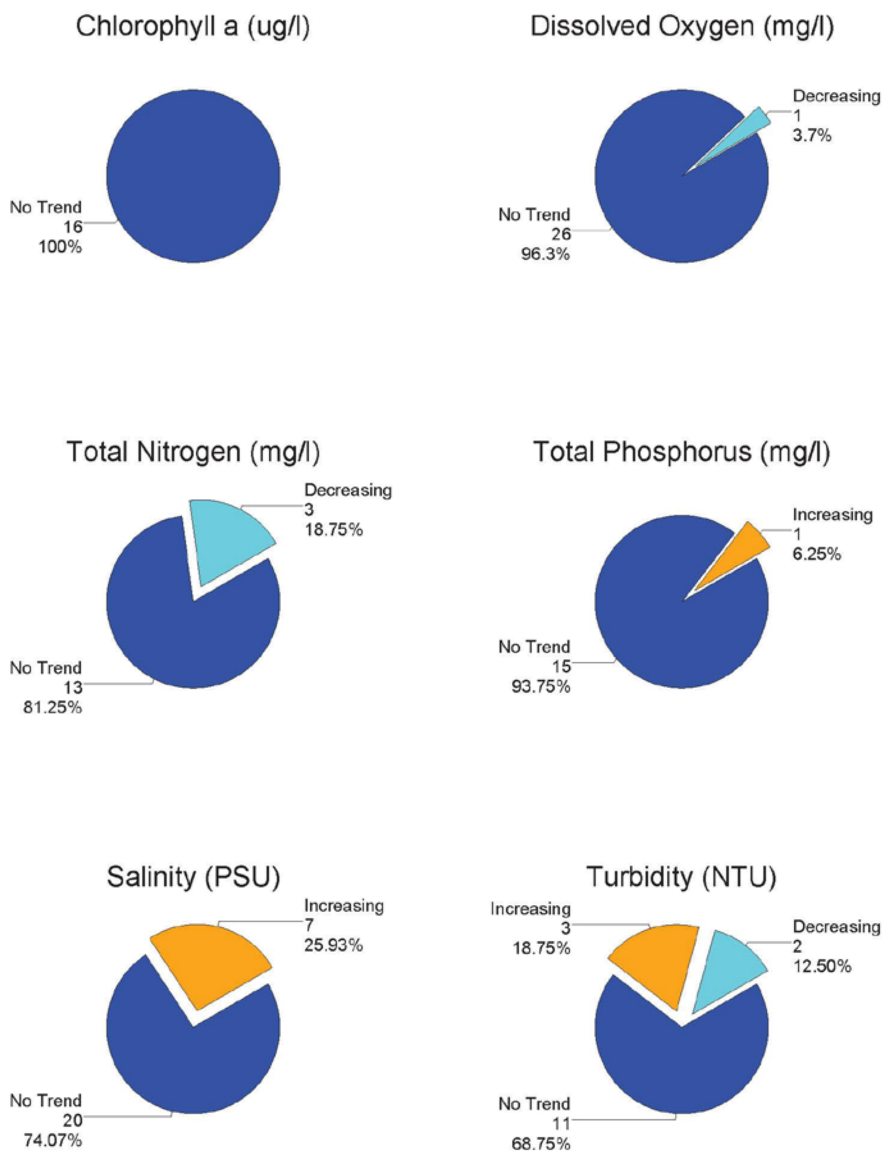

Figure 3-2. Distribution of trend test results for principal water quality parameters measured in Clearwater Harbor and Saint Joseph Sound.

3.1.3 Middle Tampa Bay (MTB)

In Middle Tampa Bay, TP was decreasing in all estuarine strata (i.e. E6, E7 and RB). No fixed site land based stations contained enough data for trend testing. No other trends for any of the principal parameters resulted from the trend tests after accounting for multiple comparisons (Figure 3-3) .

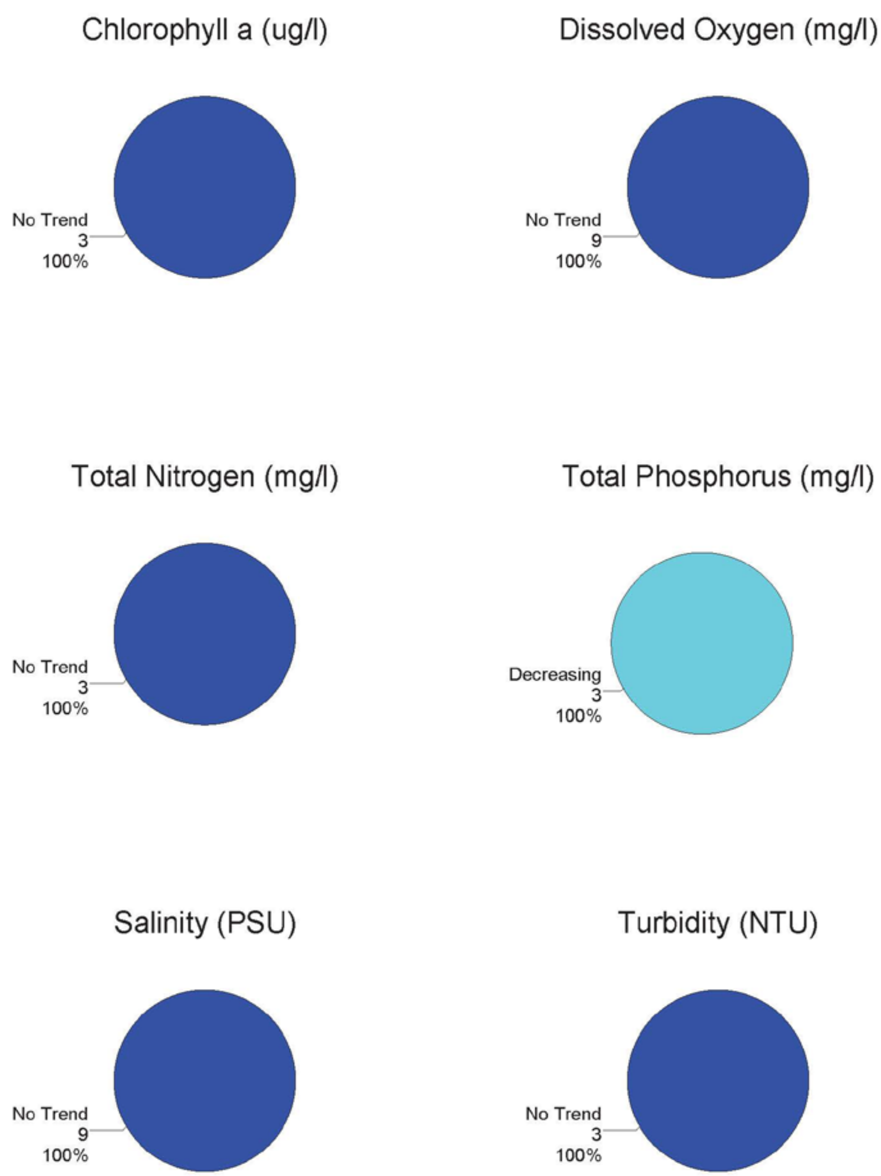

Figure 3-3. Distribution of trend test results for principal water quality parameters measured in Middle Tampa Bay.

3.1.4 Old Tampa Bay North (OTB–North)

In Old Tampa Bay North, there were no trends in Chla or DO, two decreasing trends in TN (ca 16%), one decreasing TP trend, five increasing salinity trends (ca. 23%), and 2 increasing and three decreasing trends in turbidity (Figure 3-4).

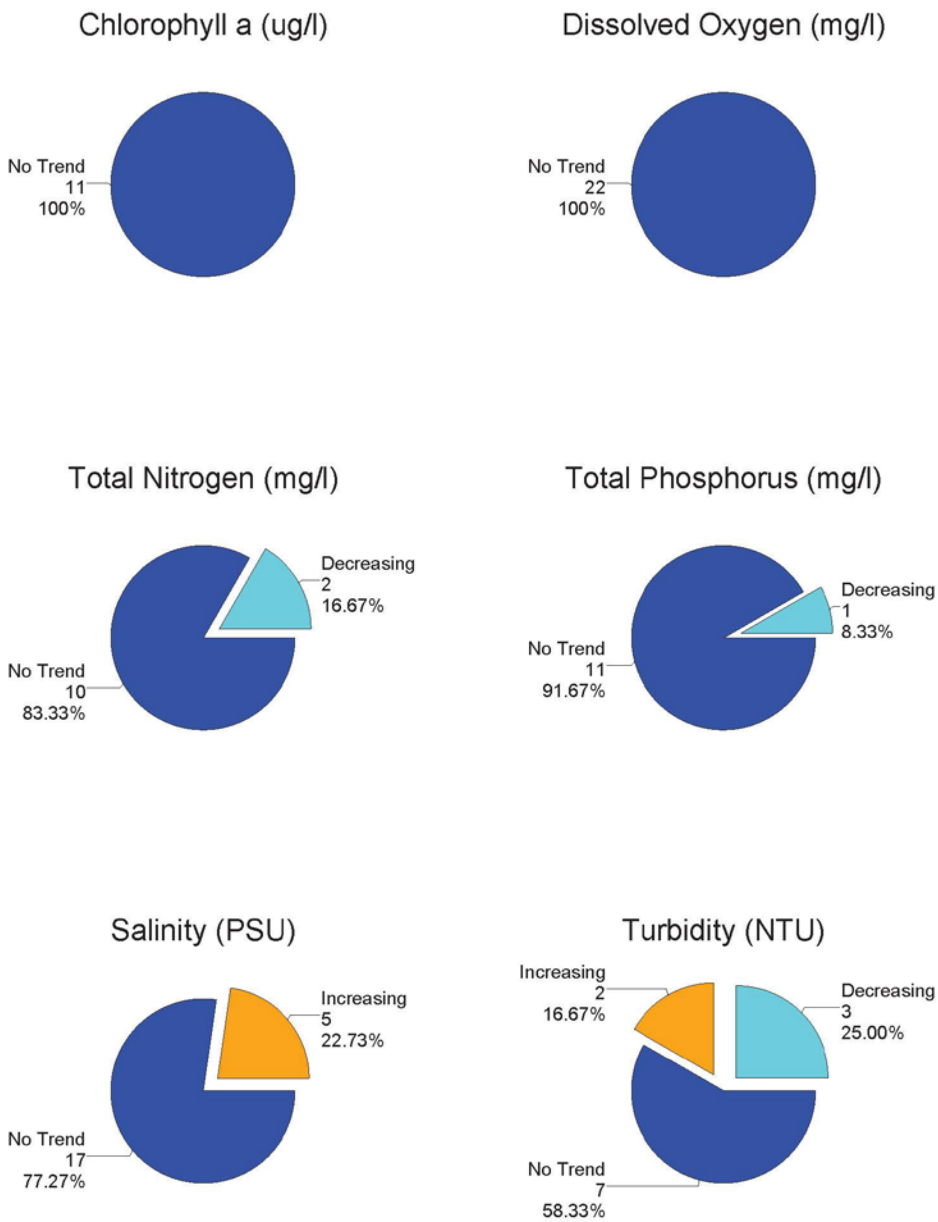

Figure 3-4. Distribution of trend test results for principal water quality parameters measured in Old Tampa Bay North.

3.1.5 Old Tampa Bay South (OTB-South)

In Old Tampa Bay South, there was a single decreasing Chla trend, three decreasing DO trends (ca. 12%), no trends in TN, seven decreasing trends in TP (ca 54%), no trends in salinity, and a single increasing trend in turbidity (Figure 3-5).

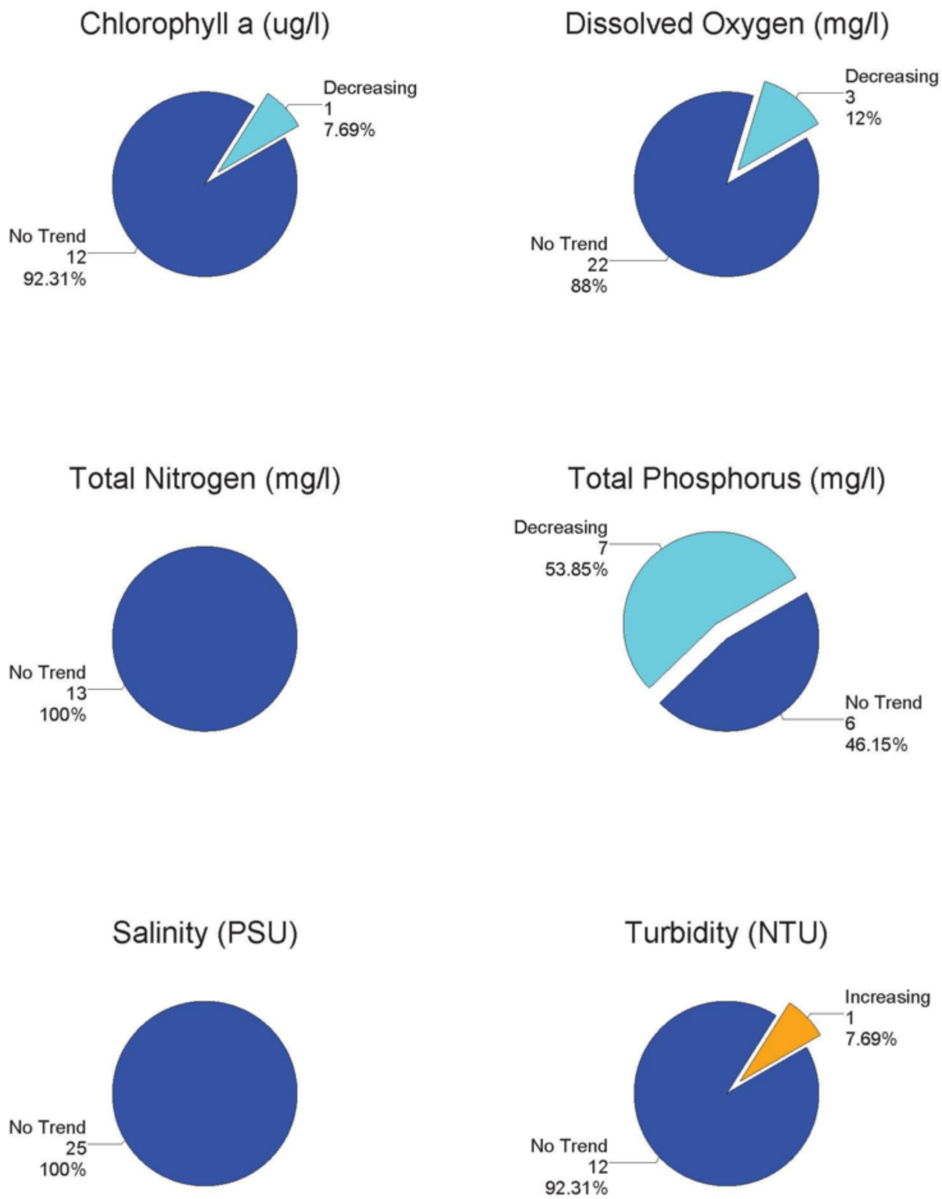

Figure 3-5. Distribution of trend test results for principal water quality parameters measured in Old Tampa Bay South.

3.2 Basin Summaries by Parameter

This section summarizes the trend results for both fixed station tributary and lake sampling as well as probabilistic sampling in estuarine and major lakes by parameter in alphabetical order.

3.2.1 Biological Oxygen Demand (BOD mg/l)

Biological Oxygen Demand (BOD) was collected only in Lake Seminole (Strata A and B) and in Lake Tarpon. These data were collected using the probabilistic design and were aggregated by sampling period for the purposes of conducting the trend test. In all strata, BOD values were stable over time with no significant trends detected (Figure 3-6: Table 3-1). Since the statistical test was not significant the slope was set to zero.

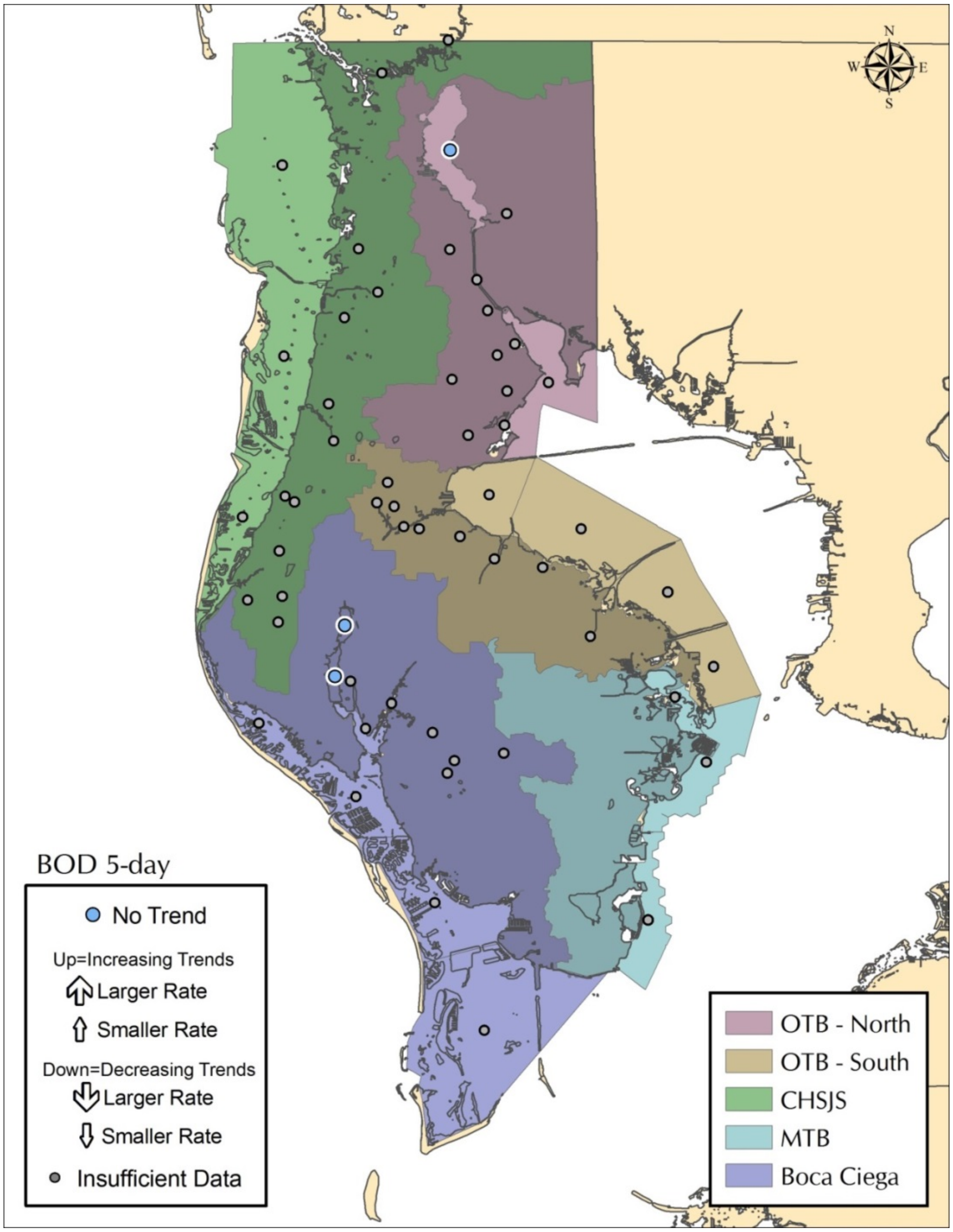

Figure 3-6. **Summary of seasonal Kendal Tau trend test results for Biological Oxygen Demand.**

Table 3-1. **Summary of Biological Oxygen Demand trends for all stations/strata with sufficient data for testing.**

Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Lake Seminole A	SA	BOD5	0.326	0.489	No Trend	0
Boca Ciega	Lake Seminole B	SB	BOD5	0.256	0.768	No Trend	0
OTB - North	Lake Tarpon	LT	BOD5	0.365	0.365	No Trend	0

3.2.2 Chlorophyll *a* (Chla μg/l):

Chlorophyll *a* concentrations were mostly stable throughout Pinellas County between 2003 and 2013. Only 2 of the possible 55 stations or strata with sufficient data resulted in significant trends after accounting for multiple comparisons. The significant chlorophyll trends were both decreasing in magnitude, indicating improving water quality conditions in Lake Seminole (Stratum B) and Allen's Creek (19-08). Chlorophyll concentrations at Allen's Creek station 19-08 were found to be decreasing by-0.15 µg/l/year and were as well below regulatory criteria. Chlorophyll concentrations in 2003 averaged ca. 4.5 µg/l in 2003 and decreased to near 2 µg/l by 2013 at station 19-08. An additional 8 stations which would have otherwise been considered statistically significant were identified as potential false positive values by the Benjamini and Hochberg correction for multiple comparisons. Five negative slopes and 3 positive slopes met that definition and the slope statistic is provided for these stations in Table 3-2 as an indication to the reader of the non-statistical trend direction but is reported as "No Trend" and mapped as such.

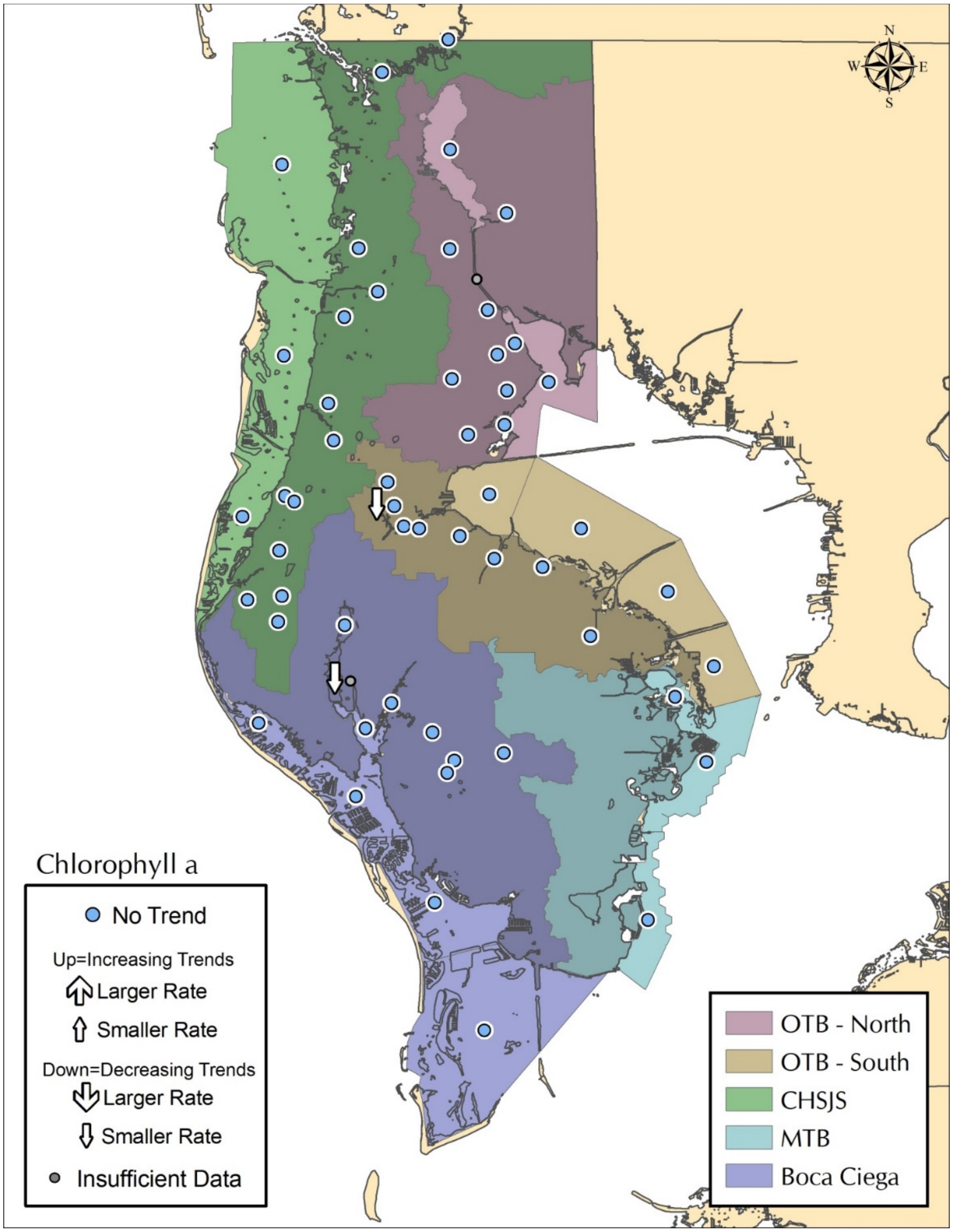

Figure 3-7. Summary of seasonal Kendal Tau trend test results for Chlorophyll a.

Table 3-2. Summary of Chlorophyll a trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	Chl_a	0.032	0.166	No Trend	0.7423
Boca Ciega	Joes Creek	35-09	Chl_a	0.184	0.552	No Trend	0
Boca Ciega	Joes Creek	35-10	Chl_a	0.480	0.751	No Trend	0
Boca Ciega	Joes Creek	35-11	Chl_a	0.921	0.947	No Trend	0
Boca Ciega	Miles Creek	35-12	Chl_a	0.087	0.315	No Trend	0
Boca Ciega	SA	SA	Chl_a	0.022	0.214	No Trend	-2.525
Boca Ciega	SB	SB	Chl_a	0.000	0.000	Decreasing	-4
Boca Ciega	W4	W4	Chl_a	0.931	1.000	No Trend	0
Boca Ciega	W5	W5	Chl_a	0.792	1.000	No Trend	0
Boca Ciega	W6	W6	Chl_a	0.564	1.000	No Trend	0
Boca Ciega	W7	W7	Chl_a	0.089	0.565	No Trend	0
Boca Ciega	W8	W8	Chl_a	0.333	1.000	No Trend	0
CHSJS	Anclote River	01-01	Chl_a	0.691	0.956	No Trend	0
CHSJS	Cedar Creek	09-03	Chl_a	0.869	0.920	No Trend	0
CHSJS	Church Creek	27-08	Chl_a	0.060	0.269	No Trend	0
CHSJS	Curlew Creek	10-02	Chl_a	0.082	0.327	No Trend	0
CHSJS	Anclote River	01-08	Chl_a	0.834	0.938	No Trend	0
CHSJS	McKay Creek	27-03	Chl_a	0.195	0.501	No Trend	0
CHSJS	McKay Creek	27-09	Chl_a	0.187	0.518	No Trend	0
CHSJS	McKay Creek	27-10	Chl_a	0.364	0.690	No Trend	0
CHSJS	Rattlesnake	17-01	Chl_a	0.159	0.520	No Trend	0
CHSJS	Rattlesnake	17-03	Chl_a	0.798	0.991	No Trend	0
CHSJS	Smith Creek	08-03	Chl_a	0.341	0.682	No Trend	0
CHSJS	Spring Branch	15-04	Chl_a	0.455	0.780	No Trend	0
CHSJS	Stevenson	18-06	Chl_a	0.806	0.968	No Trend	0
CHSJS	W1	W1	Chl_a	0.172	0.653	No Trend	0
CHSJS	W2	W2	Chl_a	0.718	1.000	No Trend	0
CHSJS	W3	W3	Chl_a	0.976	1.000	No Trend	0
MTB	E6	E6	Chl_a	0.370	1.000	No Trend	0
MTB	E7	E7	Chl_a	0.947	1.000	No Trend	0
MTB	RB	RB	Chl_a	0.147	0.696	No Trend	0
OTB - North	Alligator Creek	14-10	Chl_a	0.019	0.114	No Trend	1.12
OTB - North	Alligator Lake	14-07	Chl_a	0.003	0.054	No Trend	-0.733
OTB - North	Briar Creek	11-05	Chl_a	1.000	1.000	No Trend	0
OTB - North	Brooker Creek	04-03	Chl_a	0.464	0.759	No Trend	0
OTB - North	Cow Branch	06-03	Chl_a	0.006	0.066	No Trend	-0.0438
OTB - North	E1	E1	Chl_a	0.716	1.000	No Trend	0
OTB - North	LT	LT	Chl_a	1.000	1.000	No Trend	0
OTB - North	Lake Chautauqua	14-02	Chl_a	0.006	0.056	No Trend	-0.125
OTB - North	Mullet Creek	13-05	Chl_a	0.019	0.137	No Trend	-0.5
OTB - North	North Bishop	12-02	Chl_a	0.702	0.936	No Trend	0

Table 3-2. Summary of Chlorophyll a trends for all stations/strata with sufficient data for testing.							
OTB - North	S. Bishop	12-04	Chl_a	0.507	0.730	No Trend	0
OTB - South	Allens Creek	19-02	Chl_a	0.209	0.470	No Trend	0
OTB - South	Allens Creek	19-07	Chl_a	0.506	0.759	No Trend	0
OTB - South	Allens Creek	19-08	Chl_a	0.001	0.036	Decreasing	-0.15
OTB - South	Allens Creek	19-09	Chl_a	0.201	0.482	No Trend	0
OTB - South	Allens Creek	19-10	Chl_a	0.250	0.529	No Trend	0
OTB - South	Cross Bayou	24-02	Chl_a	0.449	0.808	No Trend	0
OTB - South	E2	E2	Chl_a	0.496	1.000	No Trend	0
OTB - South	E3	E3	Chl_a	0.887	1.000	No Trend	0
OTB - South	E4	E4	Chl_a	0.378	0.898	No Trend	0
OTB - South	E5	E5	Chl_a	0.689	1.000	No Trend	0
OTB - South	Longbranch	22-01	Chl_a	0.724	0.931	No Trend	0
OTB - South	Roosevelt	23-07	Chl_a	0.814	0.945	No Trend	0
OTB - South	Roosevelt	23-08	Chl_a	0.868	0.947	No Trend	0

3.2.3 Color (Colored Dissolved Organic Matter PCU)

Color is measured routinely in Lakes Seminole, Tarpon and Chautauqua and was collected as part of a special study in Old Tampa Bay between 2005 and 2008 which corresponded to a very wet period to a dry period. . Color concentrations were decreasing in Lakes Seminole (both strata) and in three of the six strata in OTB. However in Lake Chautauqua, color concentrations significantly increased over the same period of record (Figure 3-8). One additional strata (E1) was identified as a false positive result (Table 3-3).

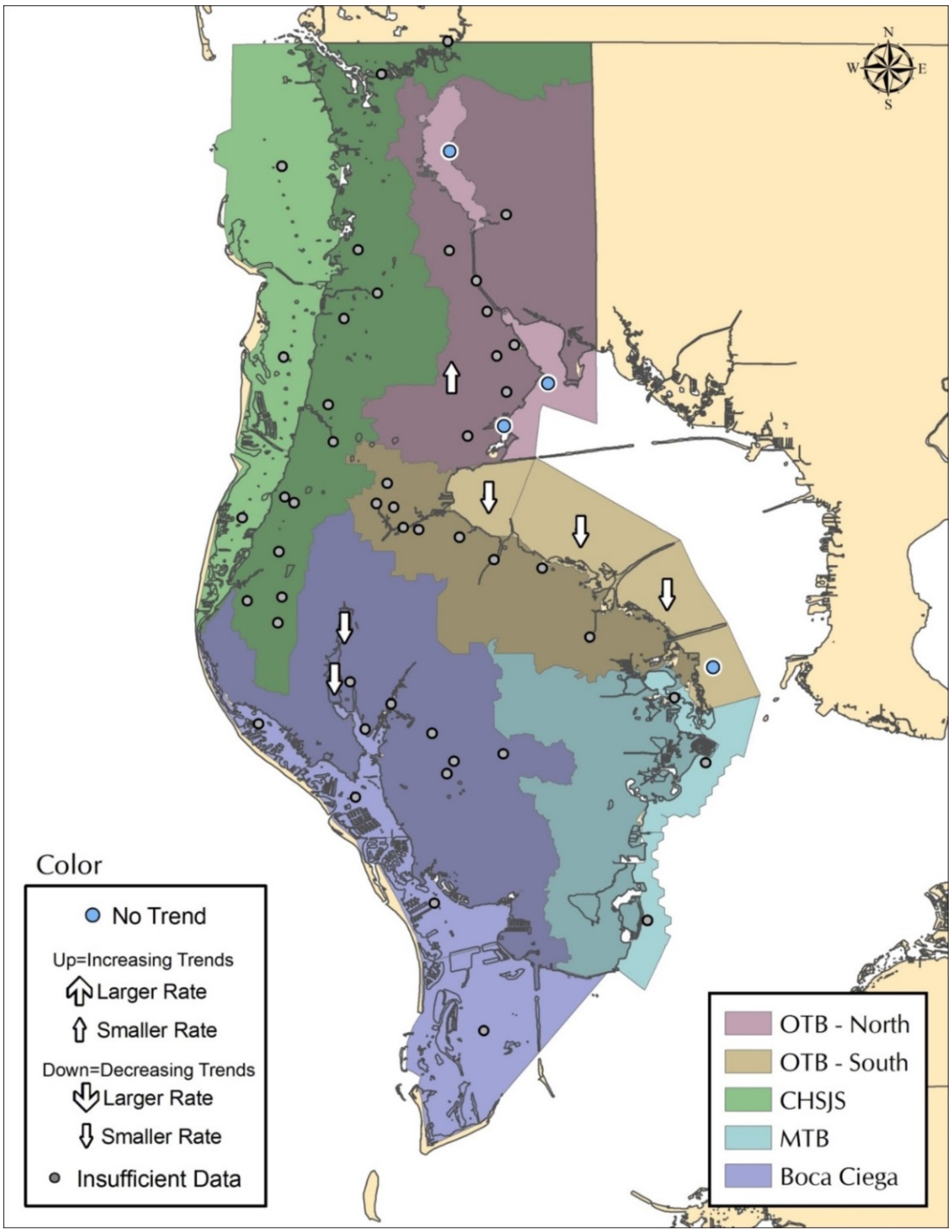

Figure 3-8. Summary of seasonal Kendal Tau trend test results for Color.

Table 3-3. Summary of Color trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	SA	SA	Color	0.0073	0.0117	Decreasing	-4.375
Boca Ciega	SB	SB	Color	0.0000	0.0000	Decreasing	-5
OTB - North	Alligator Lake	14-07	Color	0.0906	0.0906	No Trend	0
OTB - North	E1*	E1	Color	0.0410	0.0547	No Trend	-7.282
OTB - North	LT	14-02	Color	0.4146	0.4146	No Trend	0
OTB - North	Lake Chautauqua	LT	Color	0.0001	0.0001	Increasing	5
OTB - South	E2*	E2	Color	0.0001	0.0003	Decreasing	-5.790
OTB - South	E3*	E3	Color	0.0000	0.0002	Decreasing	-5.427
OTB - South	E4*	E4	Color	0.0002	0.0005	Decreasing	-5.623
OTB - South	E5*	E5	Color	0.0740	0.0846	No Trend	0

Note: * Color collected as part of a special study in Old Tampa Bay between 2005 and 2008

3.2.4 Dissolved Oxygen (mg/l):

Surface dissolved oxygen (DO) concentrations were also mostly stable over the period of record (Figure 3-9). Three decreasing and one increasing trend in DO resulted from the trend tests. The single increasing trend in DO was in Lake Seminole, Stratum B. The three decreasing trends were Allen's Creek (station 19-10), Cross Bayou (Station 24-02) and Rattlesnake Creek (17-03) (Table 3-4). An additional four increasing and three decreasing trends were identified as false positive results.

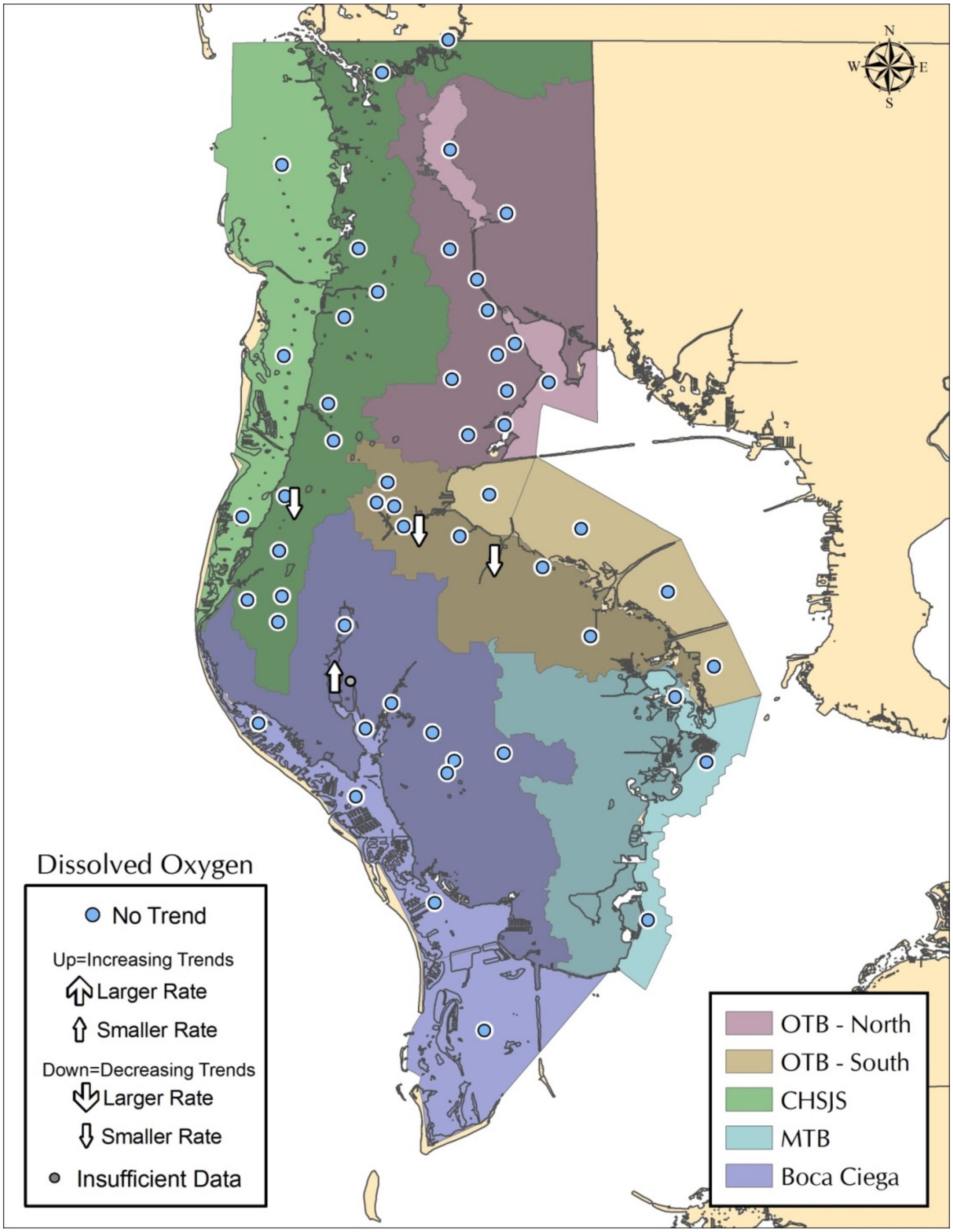

Figure 3-9. **Summary of seasonal Kendal Tau trend test results for Dissolved Oxygen (mg/l).**

Table 3-4. Summary of Dissolved Oxygen trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	DO	0.723	0.958	No Trend	0
Boca Ciega	Joes Creek	35-09	DO	0.205	0.517	No Trend	0
Boca Ciega	Joes Creek	35-10	DO	0.768	0.905	No Trend	0
Boca Ciega	Joes Creek	35-11	DO	0.588	0.945	No Trend	0
Boca Ciega	Miles Creek	35-12	DO	0.127	0.395	No Trend	0
Boca Ciega	SA	SA	DO	0.048	0.455	No Trend	0.1118
Boca Ciega	SB	SB	DO	0.001	0.017	Increasing	0.1247
Boca Ciega	W4	W4	DO	0.309	0.588	No Trend	0
Boca Ciega	W5	W5	DO	0.751	0.839	No Trend	0
Boca Ciega	W6	W6	DO	0.601	0.761	No Trend	0
Boca Ciega	W7	W7	DO	0.380	0.656	No Trend	0
Boca Ciega	W8	W8	DO	0.640	0.759	No Trend	0
CHSJS	Anclote River	01-01	DO	0.259	0.549	No Trend	0
CHSJS	Cedar Creek	09-03	DO	0.688	1.000	No Trend	0
CHSJS	Church Creek	27-08	DO	0.220	0.530	No Trend	0
CHSJS	Curlew Creek	10-02	DO	0.926	0.944	No Trend	0
CHSJS	Anclote River	01-08	DO	0.137	0.363	No Trend	0
CHSJS	McKay Creek	27-03	DO	0.916	0.952	No Trend	0
CHSJS	McKay Creek	27-03	DO	0.916	0.952	No Trend	0
CHSJS	McKay Creek	27-09	DO	0.655	1.000	No Trend	0
CHSJS	McKay Creek	27-10	DO	0.783	0.902	No Trend	0
CHSJS	Rattlesnake	17-01	DO	0.013	0.099	No Trend	0.1019
CHSJS	Rattlesnake	17-03	DO	0.004	0.048	Decreasing	-0.13
CHSJS	Smith Creek	08-03	DO	0.693	0.993	No Trend	0
CHSJS	Spring Branch	15-04	DO	0.074	0.326	No Trend	0
CHSJS	Stevenson	18-06	DO	0.660	1.000	No Trend	0
CHSJS	W1	W1	DO	0.222	0.527	No Trend	0
CHSJS	W2	W2	DO	0.419	0.612	No Trend	0
CHSJS	W3	W3	DO	0.285	0.603	No Trend	0
MTB	E6	E6	DO	0.758	0.800	No Trend	0
MTB	E7	E7	DO	0.141	0.447	No Trend	0
MTB	RB	RB	DO	0.085	0.403	No Trend	0
OTB - North	Alligator Creek	14-10	DO	0.024	0.141	No Trend	0.298
OTB - North	Alligator Lake	14-07	DO	0.099	0.351	No Trend	0
OTB - North	Briar Creek	11-05	DO	0.485	0.952	No Trend	0
OTB - North	Brooker Creek	04-03	DO	0.748	0.922	No Trend	0
OTB - North	Cow Branch	06-03	DO	0.455	0.927	No Trend	0
OTB - North	E1	E1	DO	0.589	0.800	No Trend	0

Table 3-4.	Summary of Dissolved Oxygen trends for all stations/strata with sufficient data for testing.						
OTB - North	LT	LT	DO	0.120	0.455	No Trend	0
OTB - North	Lake Chautauqua	14-02	DO	0.583	0.997	No Trend	0
OTB - North	Mullet Creek	13-05	DO	0.010	0.086	No Trend	-0.31
OTB - North	North Bishop	12-02	DO	0.878	0.931	No Trend	0
OTB - North	S. Bishop	12-04	DO	1.000	1.000	No Trend	0
OTB - North	Tarpon Bypass	06-04	DO	0.487	0.922	No Trend	0
OTB - South	Allens Creek	19-02	DO	0.789	0.854	No Trend	0
OTB - South	Allens Creek	19-07	DO	0.041	0.219	No Trend	0.05875
OTB - South	Allens Creek	19-08	DO	0.070	0.337	No Trend	0
OTB - South	Allens Creek	19-09	DO	0.017	0.112	No Trend	-0.0825
OTB - South	Allens Creek	19-10	DO	0.001	0.033	Decreasing	-0.12
OTB - South	Cross Bayou	24-02	DO	0.002	0.035	Decreasing	-0.212
OTB - South	E2	E2	DO	0.182	0.494	No Trend	0
OTB - South	E3	E3	DO	1.000	1.000	No Trend	0
OTB - South	E4	E4	DO	0.070	0.440	No Trend	0
OTB - South	E5	E5	DO	0.381	0.603	No Trend	0
OTB - South	Longbranch	22-01	DO	0.124	0.410	No Trend	0
OTB - South	Roosevelt	23-07	DO	0.009	0.095	No Trend	-0.31
OTB - South	Roosevelt	23-08	DO	0.756	0.911	No Trend	0

3.2.5 Dissolved Oxygen Percent Saturation (DO %Sat)

Dissolved Oxygen measured as percent saturation takes into account the effect of temperature (and to a lesser extent salinity) on waters ability to hold oxygen. Higher temperatures reduce the capacity of water to hold oxygen which is seen in the typically depressed dissolved oxygen concentrations in summertime measurements in Florida. Percent saturation was calculated based on temperature (and salinity in estuarine waters) for this assessment until 2013 when DO %Sat was measured using field instrumentation. Fewer trends resulted when using DO %Sat (Figure 3-10) with only a single significant trend at station 19-10 in Allen's Creek.

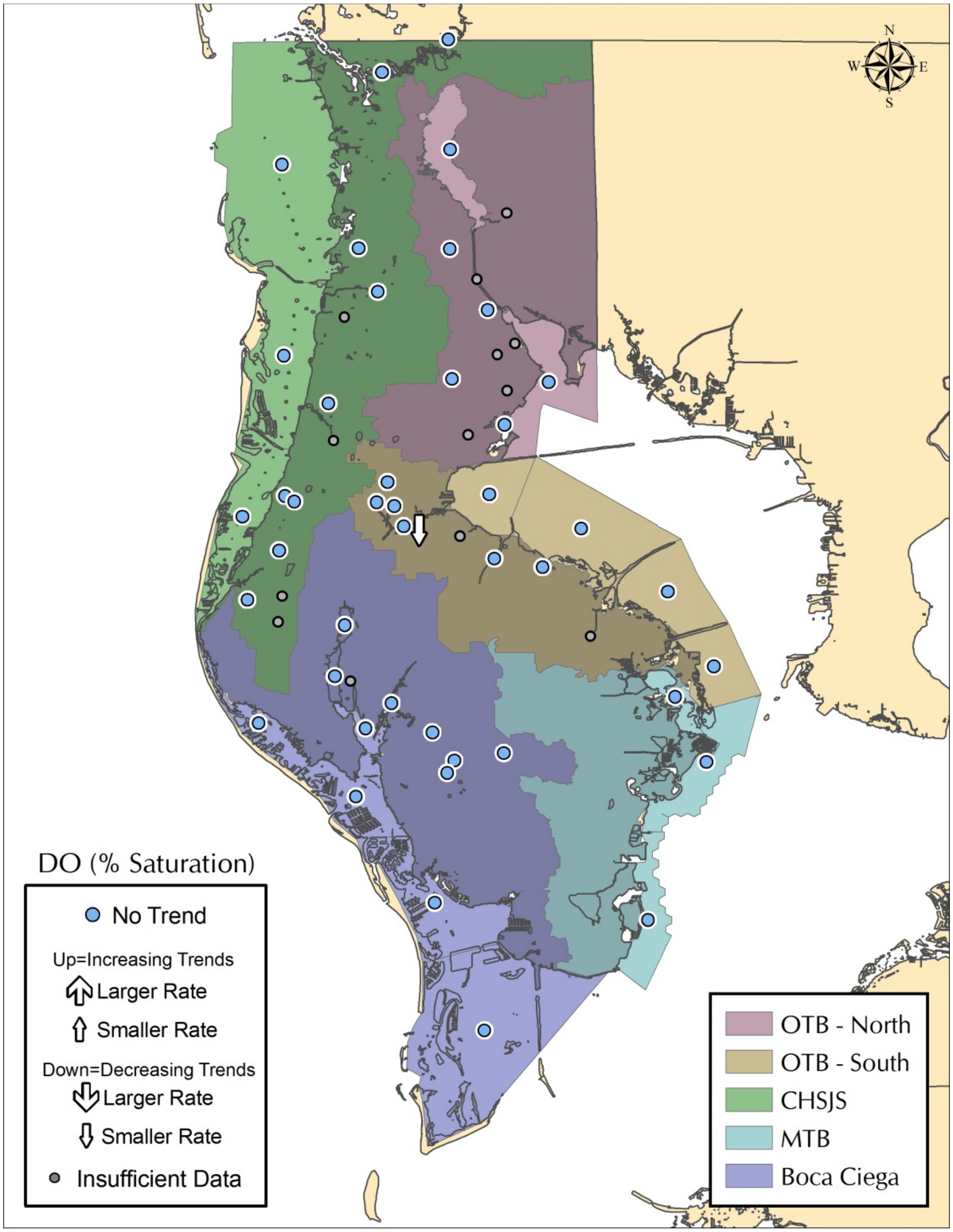

Figure 3-10. Summary of seasonal Kendal Tau trend test results for DO %sat.

3.2.6 Light Attenuation (LiCor 1/m):

Light Attenuation as measured by the Licor Instrument was routinely measured in all estuarine strata and was stable over the period of record for all strata tested (Figure 3-11: Table 3-5). Accounting for multiple comparisons had no effect on the outcome of the trend tests for LiCor.

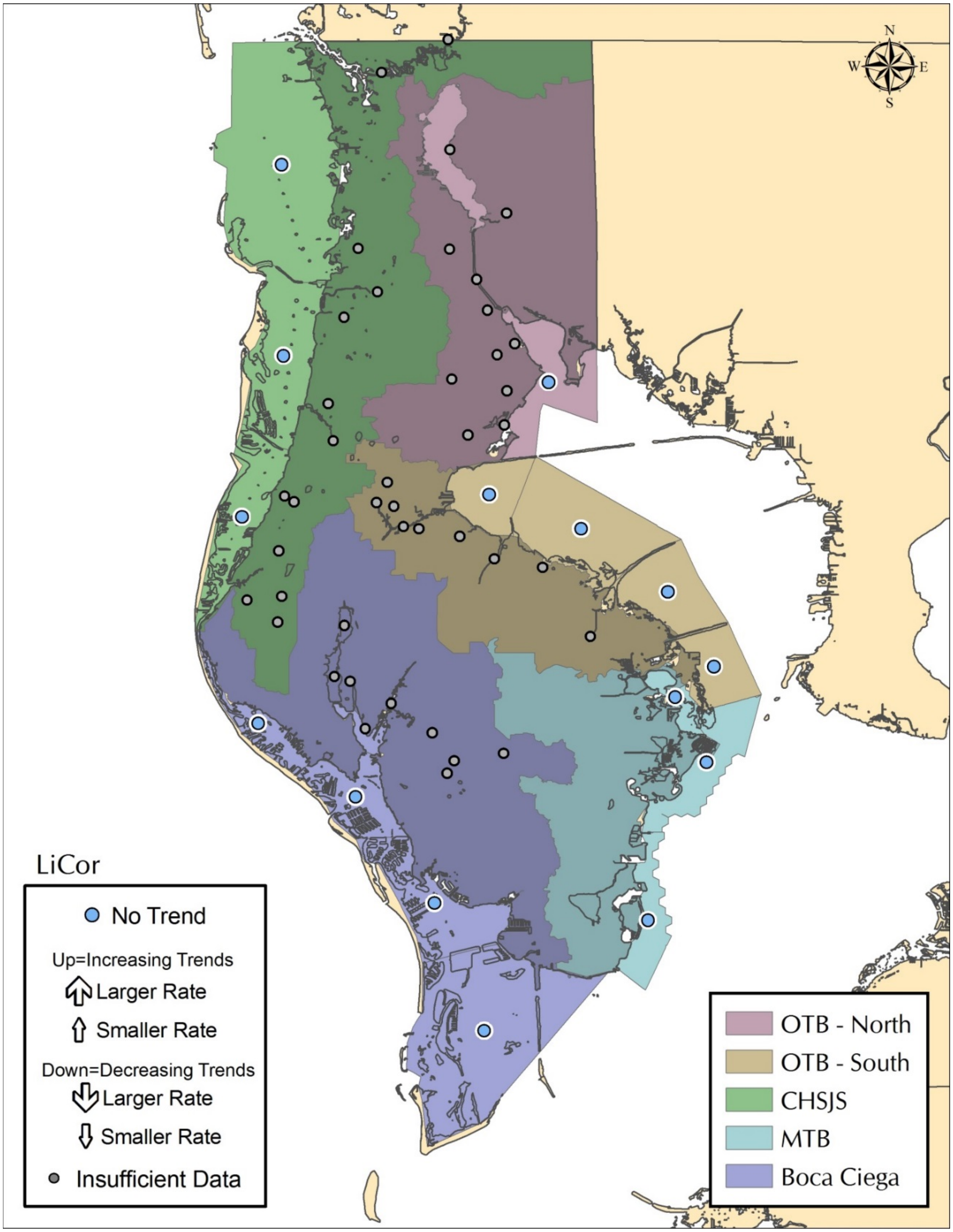

Figure 3-11. Summary of seasonal Kendal Tau trend test results for LiCor.

Table 3-5. Summary of Light attenuation (LiCor) for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	W4	W4	LiCor	0.5640	1.0000	No Trend	0
Boca Ciega	W6	W6	LiCor	0.3920	1.0000	No Trend	0
Boca Ciega	W7	W7	LiCor	0.5528	1.0000	No Trend	0
Boca Ciega	W8	W8	LiCor	0.7280	1.0000	No Trend	0
CHSJS	W1	W1	LiCor	1.0000	1.0000	No Trend	0
CHSJS	W2	W2	LiCor	0.5670	1.0000	No Trend	0
CHSJS	W3	W3	LiCor	0.5390	1.0000	No Trend	0
MTB	E6	E6	LiCor	1.0000	1.0000	No Trend	0
MTB	E7	E7	LiCor	0.6900	1.0000	No Trend	0
MTB	RB	RB	LiCor	1.0000	1.0000	No Trend	0
OTB - North	E1	E1	LiCor	0.1917	1.0000	No Trend	0
OTB - South	E2	E2	LiCor	0.4870	1.0000	No Trend	0
OTB - South	E3	E3	LiCor	1.0000	1.0000	No Trend	0
OTB - South	E4	E4	LiCor	0.4700	1.0000	No Trend	0
OTB - South	E5	E5	LiCor	1.0000	1.0000	No Trend	0

3.2.7 Nitrogen as Ammonia (NH3 mg/l):

There were six decreasing trends in Ammonia and the other 50 stations were stable over time (Figure 3-12 Table 3-6). The six stations with decreasing trends including Cross Bayou station 24-01, two of the three stations in Joes Creek (35-09 and 35-11), Miles Creek station 35-12, Rattlesnake Creek (17-01) and Smith Creek (08-03). An additional six decreasing trends were identified as false positive results along with one increasing trend (Table 3-6).

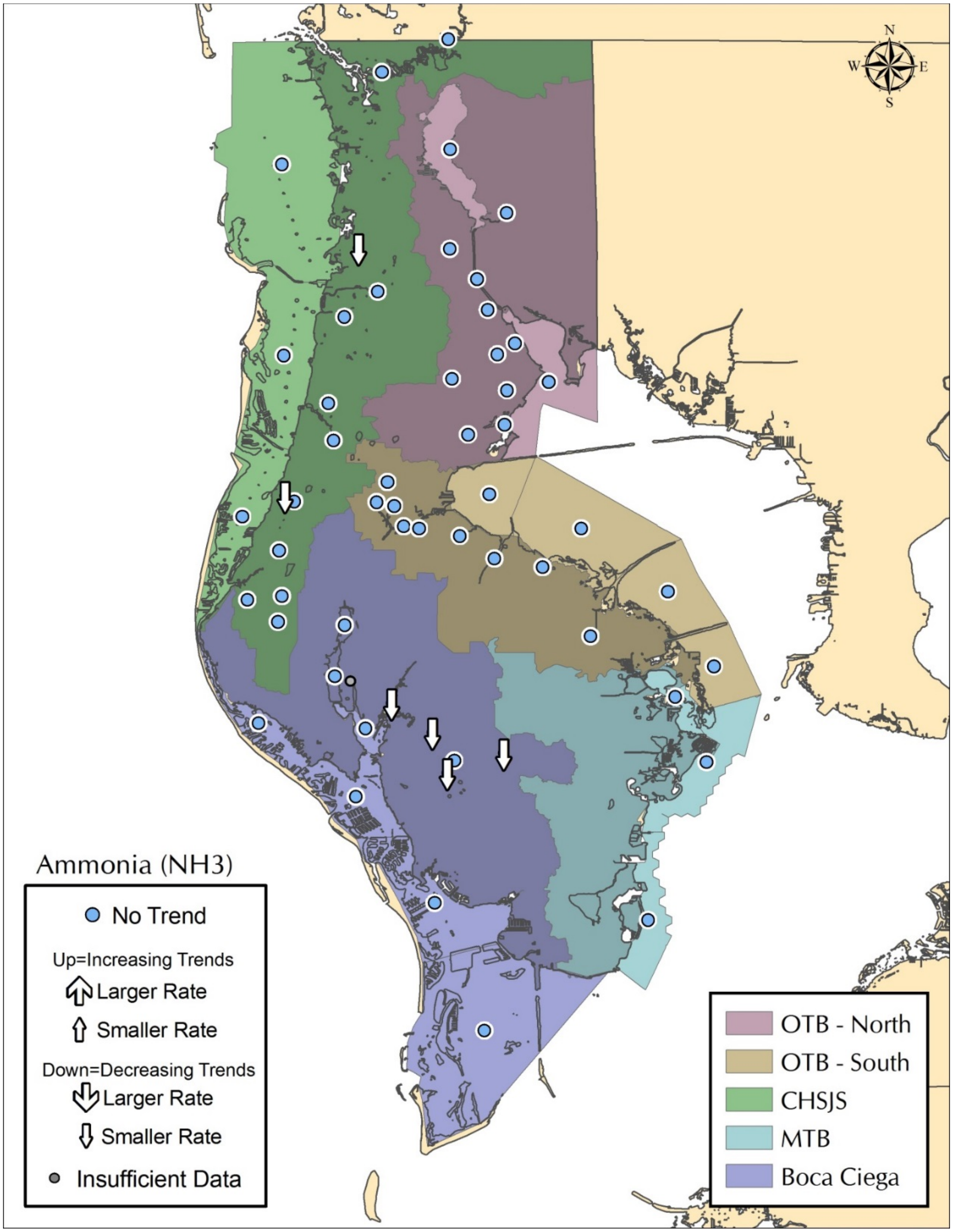

Figure 3-12. Summary of seasonal Kendal Tau trend test results for Ammonia.

Table 3-6. Summary of Ammonia trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	NH3	0.000	0.002	Decreasing	-0.0099
Boca Ciega	Joes Creek	35-09	NH3	0.000	0.002	Decreasing	-0.0085
Boca Ciega	Joes Creek	35-10	NH3	0.030	0.111	No Trend	-0.002
Boca Ciega	Joes Creek	35-11	NH3	0.002	0.011	Decreasing	-0.0038
Boca Ciega	Miles Creek	35-12	NH3	0.001	0.009	Decreasing	-0.008
Boca Ciega	SA	SA	NH3	1.000	1.000	No Trend	0
Boca Ciega	SB	SB	NH3	1.000	1.000	No Trend	0
Boca Ciega	W4	W4	NH3	1.000	1.000	No Trend	0
Boca Ciega	W5	W5	NH3	0.082	0.312	No Trend	0
Boca Ciega	W6	W6	NH3	1.000	1.000	No Trend	0
Boca Ciega	W7	W7	NH3	1.000	1.000	No Trend	0
Boca Ciega	W8	W8	NH3	1.000	1.000	No Trend	0
CHSJS	Anclote River	01-01	NH3	1.000	1.000	No Trend	0
CHSJS	Cedar Creek	09-03	NH3	1.000	1.000	No Trend	0
CHSJS	Church Creek	27-08	NH3	1.000	1.000	No Trend	0
CHSJS	Curlew Creek	10-02	NH3	0.041	0.117	No Trend	-0.001
CHSJS	Anclote River	01-08	NH3	1.000	1.000	No Trend	0
CHSJS	McKay Creek	27-03	NH3	0.500	0.804	No Trend	0
CHSJS	McKay Creek	27-09	NH3	0.025	0.103	No Trend	-0.002
CHSJS	McKay Creek	27-10	NH3	1.000	1.000	No Trend	0
CHSJS	Rattlesnake	17-01	NH3	0.000	0.004	Decreasing	-0.0063
CHSJS	Rattlesnake	17-03	NH3	1.000	1.000	No Trend	0
CHSJS	Smith Creek	08-03	NH3	0.004	0.025	Decreasing	-0.001
CHSJS	Spring Branch	15-04	NH3	0.024	0.111	No Trend	-0.006
CHSJS	Stevenson	18-06	NH3	1.000	1.000	No Trend	0
CHSJS	W1	W1	NH3	1.000	1.000	No Trend	0
CHSJS	W2	W2	NH3	1.000	1.000	No Trend	0
CHSJS	W3	W3	NH3	1.000	1.000	No Trend	0
MTB	E6	E6	NH3	1.000	1.000	No Trend	0
MTB	E7	E7	NH3	1.000	1.000	No Trend	0
MTB	RB	RB	NH3	1.000	1.000	No Trend	0
OTB - North	Alligator Creek	14-10	NH3	1.000	1.000	No Trend	0
OTB - North	Alligator Lake	14-07	NH3	1.000	1.000	No Trend	0
OTB - North	Briar Creek	11-05	NH3	1.000	1.000	No Trend	0
OTB - North	Brooker Creek	04-03	NH3	0.095	0.234	No Trend	0
OTB - North	Cow Branch	06-03	NH3	1.000	1.000	No Trend	0
OTB - North	E1	E1	NH3	1.000	1.000	No Trend	0
OTB - North	LT	LT	NH3	1.000	1.000	No Trend	0

Table 3-6. Summary of Ammonia trends for all stations/strata with sufficient data for testing.							
OTB - North	Lake Chautauqua	14-02	NH3	1.000	1.000	No Trend	0
OTB - North	Mullet Creek	13-05	NH3	1.000	1.000	No Trend	0
OTB - North	North Bishop	12-02	NH3	1.000	1.000	No Trend	0
OTB - North	S. Bishop	12-04	NH3	1.000	1.000	No Trend	0
OTB - North	Tarpon Bypass	06-04	NH3	0.146	0.300	No Trend	0
OTB - South	Allens Creek	19-02	NH3	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-07	NH3	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-08	NH3	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-09	NH3	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-10	NH3	0.017	0.090	No Trend	0.005
OTB - South	Cross Bayou	24-02	NH3	0.032	0.108	No Trend	-0.007
OTB - South	E2	E2	NH3	1.000	1.000	No Trend	0
OTB - South	E3	E3	NH3	1.000	1.000	No Trend	0
OTB - South	E4	E4	NH3	1.000	1.000	No Trend	0
OTB - South	E5	E5	NH3	1.000	1.000	No Trend	0
OTB - South	Longbranch	22-01	NH3	0.159	0.310	No Trend	0
OTB - South	Roosevelt	23-07	NH3	1.000	1.000	No Trend	0
OTB - South	Roosevelt	23-08	NH3	0.040	0.123	No Trend	-0.01

3.2.8 Nitrate - Nitrite as Nitrogen (NO23 mg/l)

There were seven statistically significant decreasing trends in NO23 comparisons including Joe's Creek (35-10), Strata W5, Curlew Creek (10-02), Rattlesnake (17-01 and 17-03), Smith Creek (08-03), and Briar Creek (11-05) indicating improving conditions at these stations (Figure 3-13). No increasing trends resulted from the trend tests. An additional two decreasing and one increasing trend were identified as false positive results (Table 3-7).

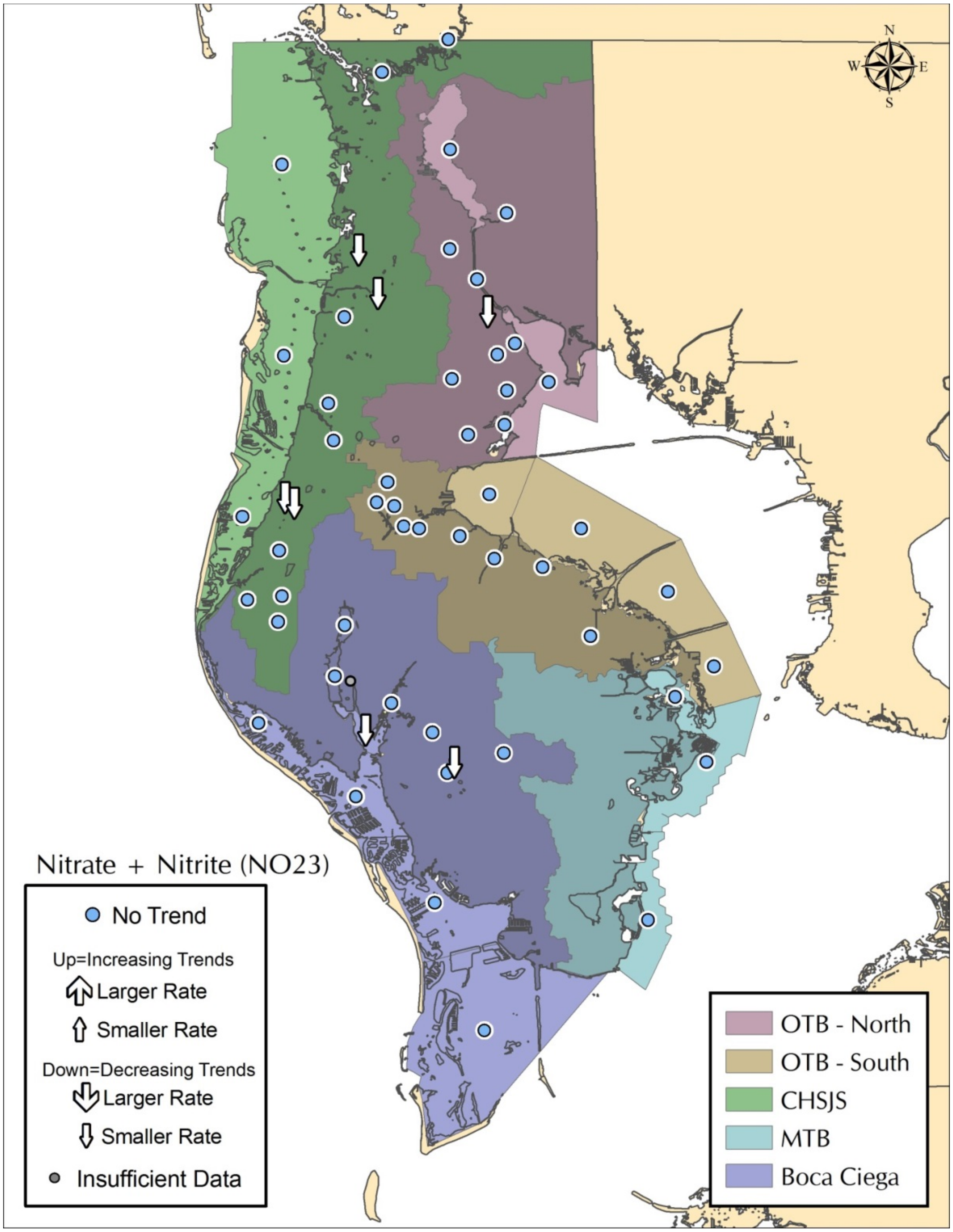

Figure 3-13. Summary of seasonal Kendal Tau trend test results for Nitrate-Nitrite.

Table 3-7. Summary of Nitrate- Nitrite trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	NOX	0.014	0.052	No Trend	-0.0043
Boca Ciega	Joes Creek	35-09	NOX	0.013	0.054	No Trend	-0.0073
Boca Ciega	Joes Creek	35-10	NOX	0.001	0.010	Decreasing	-0.0077
Boca Ciega	Joes Creek	35-11	NOX	1.000	1.000	No Trend	0
Boca Ciega	Miles Creek	35-12	NOX	0.458	0.706	No Trend	0
Boca Ciega	SA	SA	NOX	1.000	1.000	No Trend	0
Boca Ciega	SB	SB	NOX	1.000	1.000	No Trend	0
Boca Ciega	W4	W4	NOX	1.000	1.000	No Trend	0
Boca Ciega	W5	W5	NOX	0.001	0.006	Decreasing	-0.0013
Boca Ciega	W6	W6	NOX	1.000	1.000	No Trend	0
Boca Ciega	W7	W7	NOX	1.000	1.000	No Trend	0
Boca Ciega	W8	W8	NOX	1.000	1.000	No Trend	0
CHSJS	Anclote River	01-01	NOX	1.000	1.000	No Trend	0
CHSJS	Cedar Creek	09-03	NOX	0.872	0.978	No Trend	0
CHSJS	Church Creek	27-08	NOX	0.424	0.682	No Trend	0
CHSJS	Curlew Creek	10-02	NOX	0.009	0.049	Decreasing	-0.0215
CHSJS	Anclote River	01-08	NOX	1.000	1.000	No Trend	0
CHSJS	McKay Creek	27-03	NOX	0.075	0.253	No Trend	0
CHSJS	McKay Creek	27-09	NOX	0.225	0.521	No Trend	0
CHSJS	McKay Creek	27-10	NOX	1.000	1.000	No Trend	0
CHSJS	Rattlesnake	17-01	NOX	0.002	0.015	Decreasing	-0.04
CHSJS	Rattlesnake	17-03	NOX	0.000	0.001	Decreasing	-0.017
CHSJS	Smith Creek	08-03	NOX	0.001	0.010	Decreasing	-0.0271
CHSJS	Spring Branch	15-04	NOX	0.348	0.757	No Trend	0
CHSJS	Stevenson	18-06	NOX	0.009	0.056	No Trend	-0.013
CHSJS	W1	W1	NOX	1.000	1.000	No Trend	0
CHSJS	W2	W2	NOX	1.000	1.000	No Trend	0
CHSJS	W3	W3	NOX	1.000	1.000	No Trend	0
MTB	E6	E6	NOX	1.000	1.000	No Trend	0
MTB	E7	E7	NOX	1.000	1.000	No Trend	0
MTB	RB	RB	NOX	1.000	1.000	No Trend	0
OTB - North	Alligator Creek	14-10	NOX	1.000	1.000	No Trend	0
OTB - North	Alligator Lake	14-07	NOX	1.000	1.000	No Trend	0
OTB - North	Briar Creek	11-05	NOX	0.001	0.009	Decreasing	-0.009
OTB - North	Brooker Creek	04-03	NOX	1.000	1.000	No Trend	0
OTB - North	Cow Branch	06-03	NOX	0.221	0.545	No Trend	0
OTB - North	E1	E1	NOX	1.000	1.000	No Trend	0
OTB - North	LT	LT	NOX	1.000	1.000	No Trend	0
OTB - North	Lake Chautauqua	14-02	NOX	1.000	1.000	No Trend	0

Table 3-7.	Summary of Nitrate- Nitrite trends for all stations/strata with sufficient data for testing.						
OTB - North	Mullet Creek	13-05	NOX	0.738	0.942	No Trend	0
OTB - North	North Bishop	12-02	NOX	1.000	1.000	No Trend	0
OTB - North	S. Bishop	12-04	NOX	0.474	0.702	No Trend	0
OTB - North	Tarpon Bypass	06-04	NOX	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-02	NOX	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-07	NOX	0.137	0.362	No Trend	0
OTB - South	Allens Creek	19-08	NOX	0.665	0.946	No Trend	0
OTB - South	Allens Creek	19-09	NOX	0.011	0.052	No Trend	0.01
OTB - South	Allens Creek	19-10	NOX	0.363	0.746	No Trend	0
OTB - South	Cross Bayou	24-02	NOX	1.000	1.000	No Trend	0
OTB - South	E2	E2	NOX	1.000	1.000	No Trend	0
OTB - South	E3	E3	NOX	1.000	1.000	No Trend	0
OTB - South	E4	E4	NOX	1.000	1.000	No Trend	0
OTB - South	E5	E5	NOX	1.000	1.000	No Trend	0
OTB - South	Longbranch	22-01	NOX	1.000	1.000	No Trend	0
OTB - South	Roosevelt	23-07	NOX	0.077	0.238	No Trend	0
OTB - South	Roosevelt	23-08	NOX	1.000	1.000	No Trend	0

3.2.9 Orthophosphate (OP mg/l)

There were 10 decreasing, 2 increasing and 44 stable OP trends (Figure 3-14). The increasing trends occurred in Smith Creek (08-03) and Spring Branch (15-04).Decreasing trends were evident in Cross Bayou (24-01), and many of the estuarine strata including W5, W8, Riviera Bay, All 5 estuarine strata in Old Tampa Bay (E1-E5), as well as the fixed station site in Roosevelt (23-08) (Table 3-8).

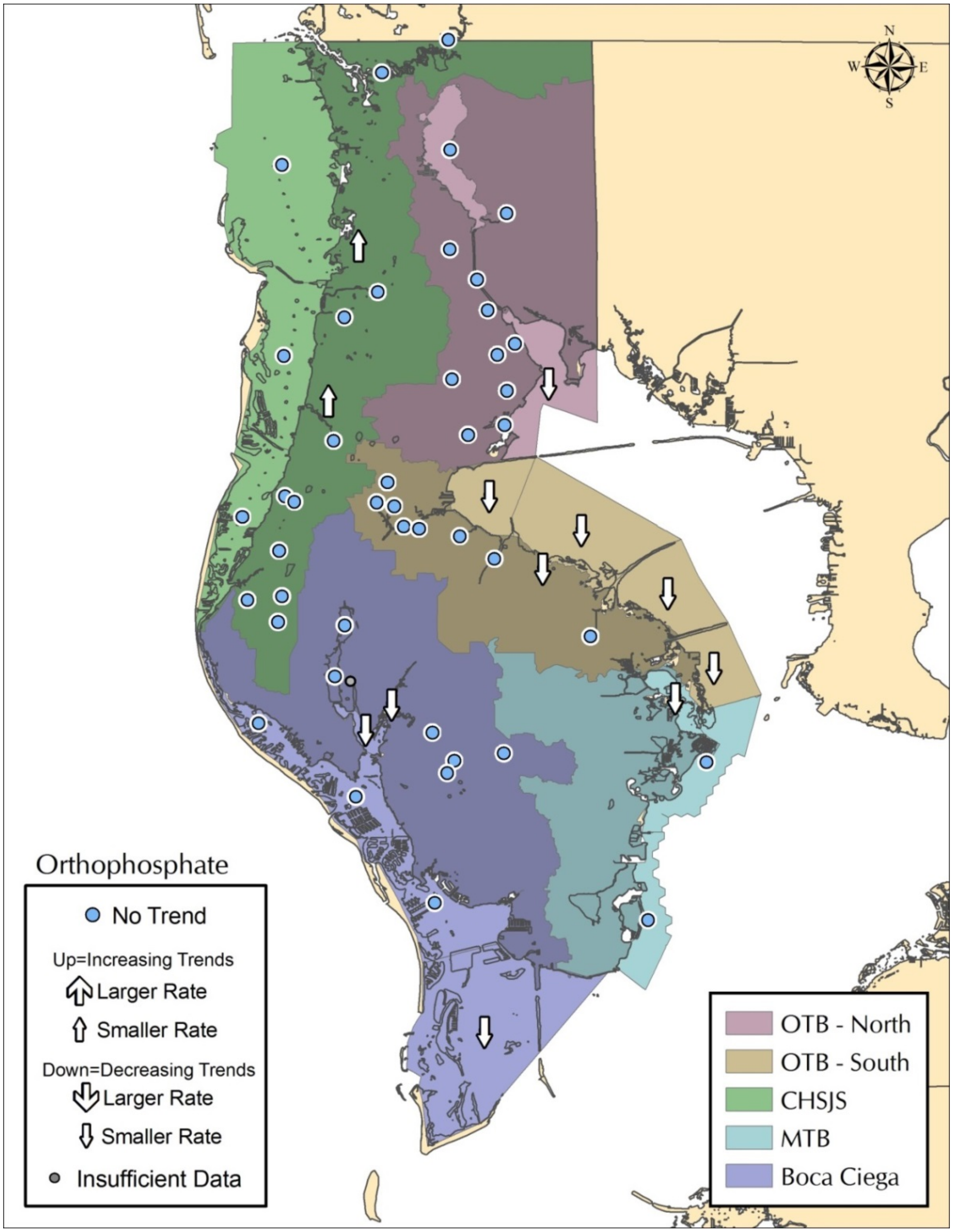

Figure 3-14. Summary of seasonal Kendal Tau trend test results for Orthophosphate.

Table 3-8. Summary of Orthophosphate trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	OP	0.001	0.009	Decreasing	-0.008
Boca Ciega	Joes Creek	35-09	OP	1.000	1.000	No Trend	0
Boca Ciega	Joes Creek	35-10	OP	1.000	1.000	No Trend	0
Boca Ciega	Joes Creek	35-11	OP	0.011	0.051	No Trend	0.001
Boca Ciega	Miles Creek	35-12	OP	1.000	1.000	No Trend	0
Boca Ciega	SA	SA	OP	1.000	1.000	No Trend	0
Boca Ciega	SB	SB	OP	1.000	1.000	No Trend	0
Boca Ciega	W4	W4	OP	1.000	1.000	No Trend	0
Boca Ciega	W5	W5	OP	0.000	0.000	Decreasing	-0.005
Boca Ciega	W6	W6	OP	1.000	1.000	No Trend	0
Boca Ciega	W7	W7	OP	1.000	1.000	No Trend	0
Boca Ciega	W8	W8	OP	0.014	0.019	Decreasing	-0.001
CHSJS	Anclote River	01-01	OP	1.000	1.000	No Trend	0
CHSJS	Cedar Creek	09-03	OP	1.000	1.000	No Trend	0
CHSJS	Church Creek	27-08	OP	0.078	0.222	No Trend	0
CHSJS	Curlew Creek	10-02	OP	1.000	1.000	No Trend	0
CHSJS	Anclote River	01-08	OP	1.000	1.000	No Trend	0
CHSJS	McKay Creek	27-03	OP	1.000	1.000	No Trend	0
CHSJS	McKay Creek	27-09	OP	0.180	0.351	No Trend	0
CHSJS	McKay Creek	27-10	OP	1.000	1.000	No Trend	0
CHSJS	Rattlesnake	17-01	OP	1.000	1.000	No Trend	0
CHSJS	Rattlesnake	17-03	OP	0.018	0.072	No Trend	0.003
CHSJS	Smith Creek	08-03	OP	0.000	0.007	Increasing	0.0025
CHSJS	Spring Branch	15-04	OP	0.001	0.012	Increasing	0.01
CHSJS	Stevenson	18-06	OP	1.000	1.000	No Trend	0
CHSJS	W1	W1	OP	1.000	1.000	No Trend	0
CHSJS	W2	W2	OP	1.000	1.000	No Trend	0
CHSJS	W3	W3	OP	1.000	1.000	No Trend	0
MTB	E6	E6	OP	0.059	0.062	No Trend	0
MTB	E7	E7	OP	0.143	0.143	No Trend	0
MTB	RB	RB	OP	0.000	0.001	Decreasing	-0.0045
OTB - North	Alligator Creek	14-10	OP	0.113	0.279	No Trend	0
OTB - North	Alligator Lake	14-07	OP	1.000	1.000	No Trend	0
OTB - North	Briar Creek	11-05	OP	1.000	1.000	No Trend	0
OTB - North	Brooker Creek	04-03	OP	1.000	1.000	No Trend	0
OTB - North	Cow Branch	06-03	OP	0.172	0.353	No Trend	0
OTB - North	E1	E1	OP	0.000	0.000	Decreasing	-0.0042
OTB - North	LT	LT	OP	1.000	1.000	No Trend	0
OTB - North	Lake Chautauqua	14-02	OP	1.000	1.000	No Trend	0

Table 3-8.	Summary of Orthophosphate trends for all stations/strata with sufficient data for testing.						
OTB - North	Mullet Creek	13-05	OP	0.057	0.175	No Trend	0
OTB - North	North Bishop	12-02	OP	0.140	0.324	No Trend	0
OTB - North	S. Bishop	12-04	OP	1.000	1.000	No Trend	0
OTB - North	Tarpon Bypass	06-04	OP	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-02	OP	0.272	0.438	No Trend	0
OTB - South	Allens Creek	19-07	OP	0.035	0.118	No Trend	0.003
OTB - South	Allens Creek	19-08	OP	0.460	0.681	No Trend	0
OTB - South	Allens Creek	19-09	OP	0.027	0.100	No Trend	0.005
OTB - South	Allens Creek	19-10	OP	1.000	1.000	No Trend	0
OTB - South	Cross Bayou	24-02	OP	0.106	0.280	No Trend	0
OTB - South	E2	E2	OP	0.000	0.001	Decreasing	-0.0043
OTB - South	E3	E3	OP	0.015	0.019	Decreasing	-0.00255
OTB - South	E4	E4	OP	0.004	0.007	Decreasing	-0.0028
OTB - South	E5	E5	OP	0.001	0.001	Decreasing	-0.0035
OTB - South	Longbranch	22-01	OP	1.000	1.000	No Trend	0
OTB - South	Roosevelt	23-07	OP	1.000	1.000	No Trend	0
OTB - South	Roosevelt	23-08	OP	0.004	0.024	Decreasing	-0.0044

3.2.10 pH (pH mg/l)

Two decreasing trends in pH, a single increasing trend in pH, and 56 stations with stable timeseries resulted from the trend tests (Figure 3-15). The decreasing trends were located in Miles Creek (35-09), and Mullet Creek (13-05) and one increasing pH Trend located in Allen's creek (19-02) (Table 3-9).

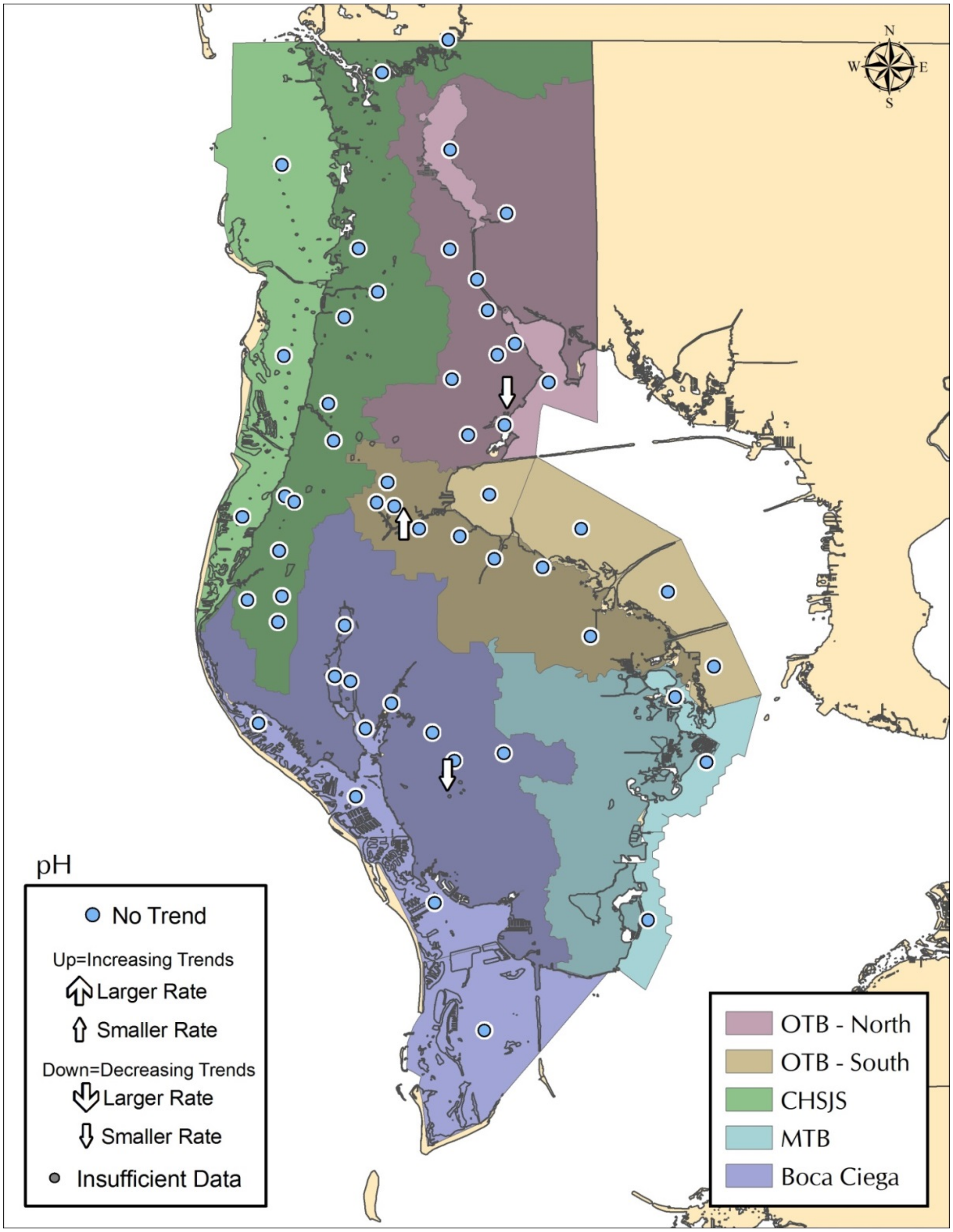

Figure 3-15. Summary of seasonal Kendal Tau trend test results for pH.

Table 3-9. Summary of pH trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	pH	0.656	0.799	No Trend	0
Boca Ciega	Joes Creek	35-09	pH	0.186	0.347	No Trend	0
Boca Ciega	Joes Creek	35-10	pH	0.269	0.430	No Trend	0
Boca Ciega	Joes Creek	35-11	pH	0.689	0.804	No Trend	0
Boca Ciega	Miles Creek	35-12	pH	0.002	0.048	Decreasing	-0.0125
Boca Ciega	SA	SA	pH	0.121	0.255	No Trend	0
Boca Ciega	SB	SB	pH	0.615	0.687	No Trend	0
Boca Ciega	Seminole Bypass	25-07	pH	0.251	0.413	No Trend	0
Boca Ciega	W4	W4	pH	0.180	0.342	No Trend	0
Boca Ciega	W5	W5	pH	0.755	0.797	No Trend	0
Boca Ciega	W6	W6	pH	0.293	0.371	No Trend	0
Boca Ciega	W7	W7	pH	0.263	0.357	No Trend	0
Boca Ciega	W8	W8	pH	0.218	0.346	No Trend	0
CHSJS	Anclote River	01-01	pH	0.142	0.347	No Trend	0
CHSJS	Cedar Creek	09-03	pH	0.810	0.825	No Trend	0
CHSJS	Church Creek	27-08	pH	0.174	0.336	No Trend	0
CHSJS	Curlew Creek	10-02	pH	1.000	1.000	No Trend	0
CHSJS	Anclote River	01-08	pH	0.060	0.281	No Trend	0
CHSJS	McKay Creek	27-03	pH	0.472	0.660	No Trend	0
CHSJS	McKay Creek	27-03	pH	0.472	0.660	No Trend	0
CHSJS	McKay Creek	27-09	pH	0.496	0.661	No Trend	0
CHSJS	McKay Creek	27-10	pH	0.313	0.487	No Trend	0
CHSJS	Rattlesnake	17-01	pH	0.140	0.413	No Trend	0
CHSJS	Rattlesnake	17-03	pH	0.009	0.072	No Trend	-0.02
CHSJS	Smith Creek	08-03	pH	0.757	0.865	No Trend	0
CHSJS	Spring Branch	15-04	pH	0.008	0.075	No Trend	-0.02
CHSJS	Stevenson	18-06	pH	0.088	0.290	No Trend	0
CHSJS	W1	W1	pH	0.015	0.138	No Trend	0.011369
CHSJS	W2	W2	pH	0.211	0.364	No Trend	0
CHSJS	W3	W3	pH	0.094	0.255	No Trend	0
MTB	E6	E6	pH	0.055	0.174	No Trend	0
MTB	E7	E7	pH	0.029	0.184	No Trend	0.01
MTB	RB	RB	pH	0.107	0.254	No Trend	0
OTB - North	Alligator Creek	14-10	pH	0.771	0.800	No Trend	0
OTB - North	Alligator Lake	14-07	pH	0.070	0.261	No Trend	0
OTB - North	Briar Creek	11-05	pH	0.129	0.401	No Trend	0
OTB - North	Brooker Creek	04-03	pH	0.757	0.815	No Trend	0
OTB - North	Cow Branch	06-03	pH	0.154	0.359	No Trend	0
OTB - North	E1	E1	pH	0.011	0.209	No Trend	0.012
OTB - North	LT	LT	pH	0.955	0.955	No Trend	0

Table 3-9.	Summary of pH trends for all stations/strata with sufficient data for testing.						
OTB - North	Lake Chautauqua	14-02	pH	0.155	0.322	No Trend	0
OTB - North	Mullet Creek	13-05	pH	0.001	0.029	Decreasing	-0.05
OTB - North	North Bishop	12-02	pH	0.142	0.398	No Trend	0
OTB - North	S. Bishop	12-04	pH	0.078	0.273	No Trend	0
OTB - North	Tarpon Bypass	06-04	pH	0.204	0.369	No Trend	0
OTB - South	Allens Creek	19-02	pH	0.004	0.045	Increasing	0.023
OTB - South	Allens Creek	19-07	pH	0.581	0.757	No Trend	0
OTB - South	Allens Creek	19-08	pH	0.488	0.667	No Trend	0
OTB - South	Allens Creek	19-09	pH	0.015	0.105	No Trend	-0.017
OTB - South	Allens Creek	19-10	pH	0.380	0.546	No Trend	0
OTB - South	Cross Bayou	24-02	pH	0.364	0.536	No Trend	0
OTB - South	Cross Bayou	24-02	pH	0.364	0.536	No Trend	0
OTB - South	E2	E2	pH	0.219	0.320	No Trend	0
OTB - South	E3	E3	pH	0.054	0.205	No Trend	0
OTB - South	E4	E4	pH	0.371	0.441	No Trend	0
OTB - South	E5	E5	pH	0.044	0.209	No Trend	0.01
OTB - South	Longbranch	22-01	pH	0.166	0.331	No Trend	0
OTB - South	Roosevelt	23-07	pH	0.027	0.168	No Trend	-0.02
OTB - South	Roosevelt	23-08	pH	0.763	0.806	No Trend	0

3.2.11 Salinity (PSU)

There were 11 increasing trends in salinity and 46 stations with stable salinity over the period of record (Figure 3-16). There were no decreasing trends in salinity. Stations with increasing salinity included Miles Creek (35-12), Cedar Creek (09-03), Church Creek (27-08), McKay Creek (27-03 and 27-10), Rattlesnake Creek (17-01 and 17-03), Alligator Lake (14-07), Briar Creek (11-05), and Cow Branch (06-03). An additional 7 stations with increasing trends were identified as false positive results. (Table 3-10).

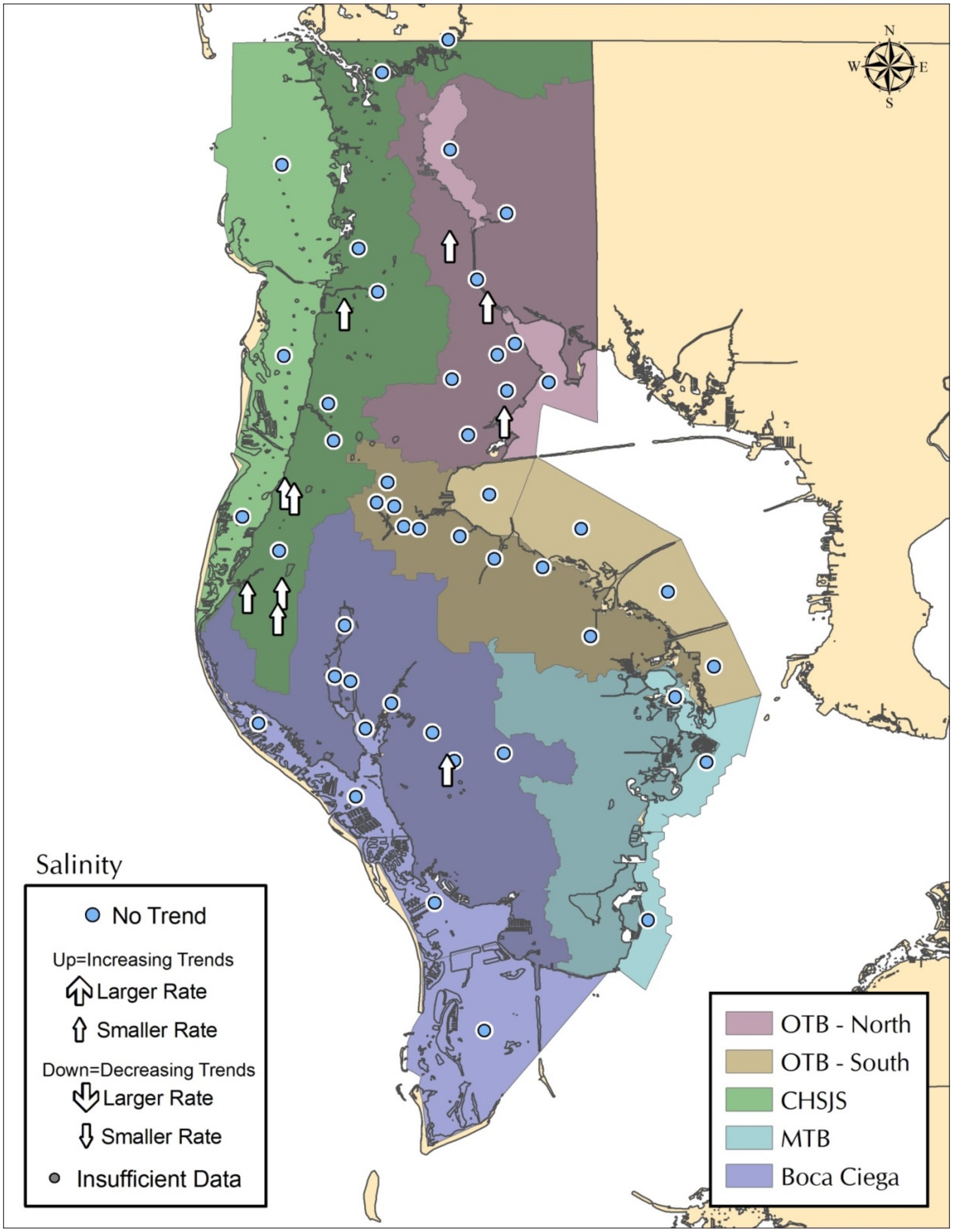

Figure 3-16. Summary of seasonal Kendal Tau trend test results for Salinity.

Table 3-10. Summary of Salinity trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	Salinity	0.546	0.626	No Trend	0
Boca Ciega	Joes Creek	35-09	Salinity	0.458	0.600	No Trend	0
Boca Ciega	Joes Creek	35-10	Salinity	1.000	1.000	No Trend	0
Boca Ciega	Joes Creek	35-11	Salinity	1.000	1.000	No Trend	0
Boca Ciega	Miles Creek	35-12	Salinity	0.006	0.030	Increasing	0.006
Boca Ciega	SA	SA	Salinity	0.833	0.879	No Trend	0
Boca Ciega	SB	SB	Salinity	0.940	0.940	No Trend	0
Boca Ciega	Seminole Bypass	25-07	Salinity	0.074	0.171	No Trend	0
Boca Ciega	Seminole Bypass	25-07	Salinity	0.074	0.171	No Trend	0
Boca Ciega	W4	W4	Salinity	0.148	0.561	No Trend	0
Boca Ciega	W5	W5	Salinity	0.024	0.224	No Trend	0.535
Boca Ciega	W6	W6	Salinity	0.514	0.610	No Trend	0
Boca Ciega	W7	W7	Salinity	0.409	0.555	No Trend	0
Boca Ciega	W8	W8	Salinity	0.615	0.687	No Trend	0
CHSJS	Anclote River	01-01	Salinity	0.020	0.069	No Trend	0.3346
CHSJS	Cedar Creek	09-03	Salinity	0.003	0.017	Increasing	0.012
CHSJS	Church Creek	27-08	Salinity	0.000	0.000	Increasing	0.006
CHSJS	Curlew Creek	10-02	Salinity	0.118	0.250	No Trend	0
CHSJS	Anclote River	01-08	Salinity	0.224	0.362	No Trend	0
CHSJS	McKay Creek	27-03	Salinity	0.000	0.003	Increasing	0.005
CHSJS	McKay Creek	27-09	Salinity	1.000	1.000	No Trend	0
CHSJS	McKay Creek	27-10	Salinity	0.000	0.002	Increasing	0.0025
CHSJS	Rattlesnake	17-01	Salinity	0.000	0.000	Increasing	0.012
CHSJS	Rattlesnake	17-03	Salinity	0.001	0.006	Increasing	0.003
CHSJS	Smith Creek	08-03	Salinity	0.445	0.597	No Trend	0
CHSJS	Spring Branch	15-04	Salinity	0.266	0.418	No Trend	0
CHSJS	Stevenson	18-06	Salinity	0.501	0.612	No Trend	0
CHSJS	W1	W1	Salinity	0.036	0.171	No Trend	0.1646
CHSJS	W2	W2	Salinity	0.015	0.277	No Trend	0.1406
CHSJS	W3	W3	Salinity	0.025	0.157	No Trend	0.1348
MTB	E6	E6	Salinity	0.289	0.785	No Trend	0
MTB	E7	E7	Salinity	0.264	0.837	No Trend	0
MTB	RB	RB	Salinity	0.374	0.711	No Trend	0
OTB - North	Alligator Creek	14-10	Salinity	1.000	1.000	No Trend	0
OTB - North	Alligator Lake	14-07	Salinity	0.000	0.000	Increasing	0.0038
OTB - North	Briar Creek	11-05	Salinity	0.000	0.000	Increasing	0.01
OTB - North	Brooker Creek	04-03	Salinity	0.131	0.241	No Trend	0
OTB - North	Cow Branch	06-03	Salinity	0.010	0.046	Increasing	0.006
OTB - North	E1	E1	Salinity	0.400	0.585	No Trend	0

Table 3-10.	Summary of Salinity trends for all stations/strata with sufficient data for testing.						
OTB - North	LT	LT	Salinity	0.455	0.576	No Trend	0
OTB - North	Lake Chautauqua	14-02	Salinity	0.024	0.068	No Trend	0.0041
OTB - North	Mullet Creek	13-05	Salinity	0.013	0.055	No Trend	0.007
OTB - North	North Bishop	12-02	Salinity	0.279	0.415	No Trend	0
OTB - North	S. Bishop	12-04	Salinity	0.110	0.242	No Trend	0
OTB - North	Tarpon Bypass	06-04	Salinity	0.131	0.266	No Trend	0
OTB - South	Allens Creek	19-02	Salinity	0.283	0.389	No Trend	0
OTB - South	Allens Creek	19-07	Salinity	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-08	Salinity	0.072	0.179	No Trend	0
OTB - South	Allens Creek	19-09	Salinity	0.267	0.408	No Trend	0
OTB - South	Allens Creek	19-10	Salinity	0.152	0.270	No Trend	0
OTB - South	Cross Bayou	24-02	Salinity	0.558	0.614	No Trend	0
OTB - South	Cross Bayou	24-02	Salinity	0.558	0.614	No Trend	0
OTB - South	E2	E2	Salinity	0.388	0.615	No Trend	0
OTB - South	E3	E3	Salinity	0.300	0.713	No Trend	0
OTB - South	E4	E4	Salinity	0.352	0.744	No Trend	0
OTB - South	E5	E5	Salinity	0.377	0.651	No Trend	0
OTB - South	Longbranch	22-01	Salinity	0.873	0.889	No Trend	0
OTB - South	Roosevelt	23-07	Salinity	0.057	0.157	No Trend	0
OTB - South	Roosevelt	23-08	Salinity	0.064	0.168	No Trend	0

3.2.12 Secchi Disk (1/m)

No trends in secchi disk were evident in the timeseries data (Figure 3-17) although multiple comparisons excluded both strata in Lake Seminole with increasing slopes indicating potentially, but not statistically significant improvements in secchi disk depth (Table 3-11). Interestingly, the results for transmissivity presented in section 3.2.18 were similar but statistically significant in both Strata suggesting that transmissivity may be a more powerful metric for measuring water clarity that secchi disk depth though transmissivity only measures a specific wavelength of light horizontally through the water column.

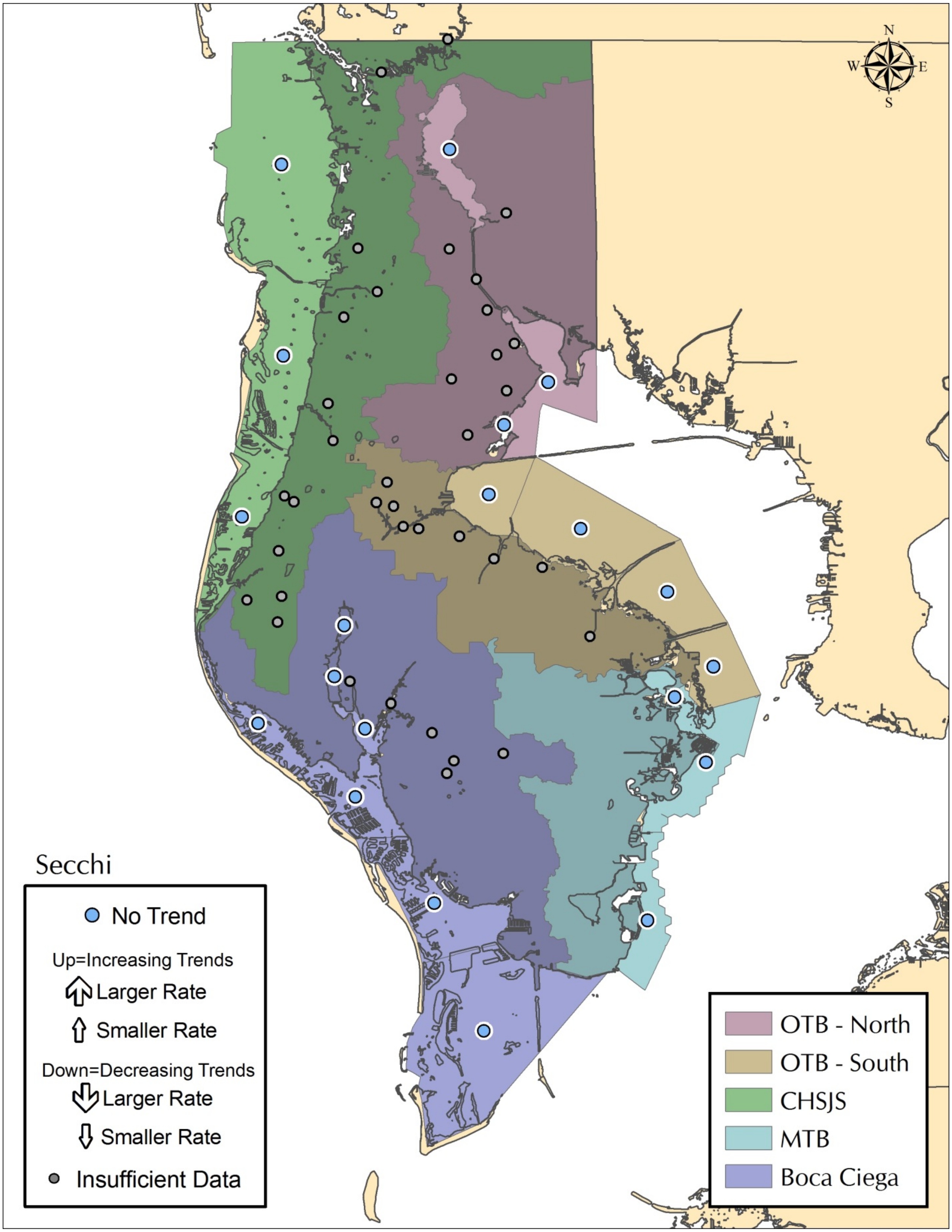

Figure 3-17. **Summary of seasonal Kendal Tau trend test results for Secchi Disk.**

Table 3-11. Summary of Secchi Disk trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	SA	SA	Secchi	0.016	0.295	No Trend	0.0083
Boca Ciega	SB	SB	Secchi	0.025	0.236	No Trend	0.0056
Boca Ciega	W4	W4	Secchi	0.073	0.341	No Trend	0
Boca Ciega	W5	W5	Secchi	0.587	0.699	No Trend	0
Boca Ciega	W6	W6	Secchi	0.211	0.657	No Trend	0
Boca Ciega	W7	W7	Secchi	0.484	0.821	No Trend	0
Boca Ciega	W8	W8	Secchi	0.544	0.725	No Trend	0
CHSJS	W1	W1	Secchi	0.726	0.813	No Trend	0
CHSJS	W2	W2	Secchi	0.578	0.719	No Trend	0
CHSJS	W3	W3	Secchi	0.378	0.784	No Trend	0
MTB	E6	E6	Secchi	0.873	0.873	No Trend	0
MTB	E7	E7	Secchi	0.080	0.299	No Trend	0
MTB	SB	RB	Secchi	0.535	0.768	No Trend	0
OTB - North	Alligator Lake	14-07	Secchi	1.000	1.000	No Trend	0
OTB - North	E1	E1	Secchi	0.780	0.824	No Trend	0
OTB - North	LT	LT	Secchi	0.484	0.903	No Trend	0
OTB - South	E2	E2	Secchi	0.292	0.779	No Trend	0
OTB - South	E3	E3	Secchi	0.293	0.685	No Trend	0
OTB - South	E4	E4	Secchi	0.530	0.824	No Trend	0
OTB - South	E5	E5	Secchi	0.068	0.423	No Trend	0

3.2.13 Water Temperature (^{O}C)

Water Temperature was stable over time after accounting for seasonal variation and multiple comparisons (

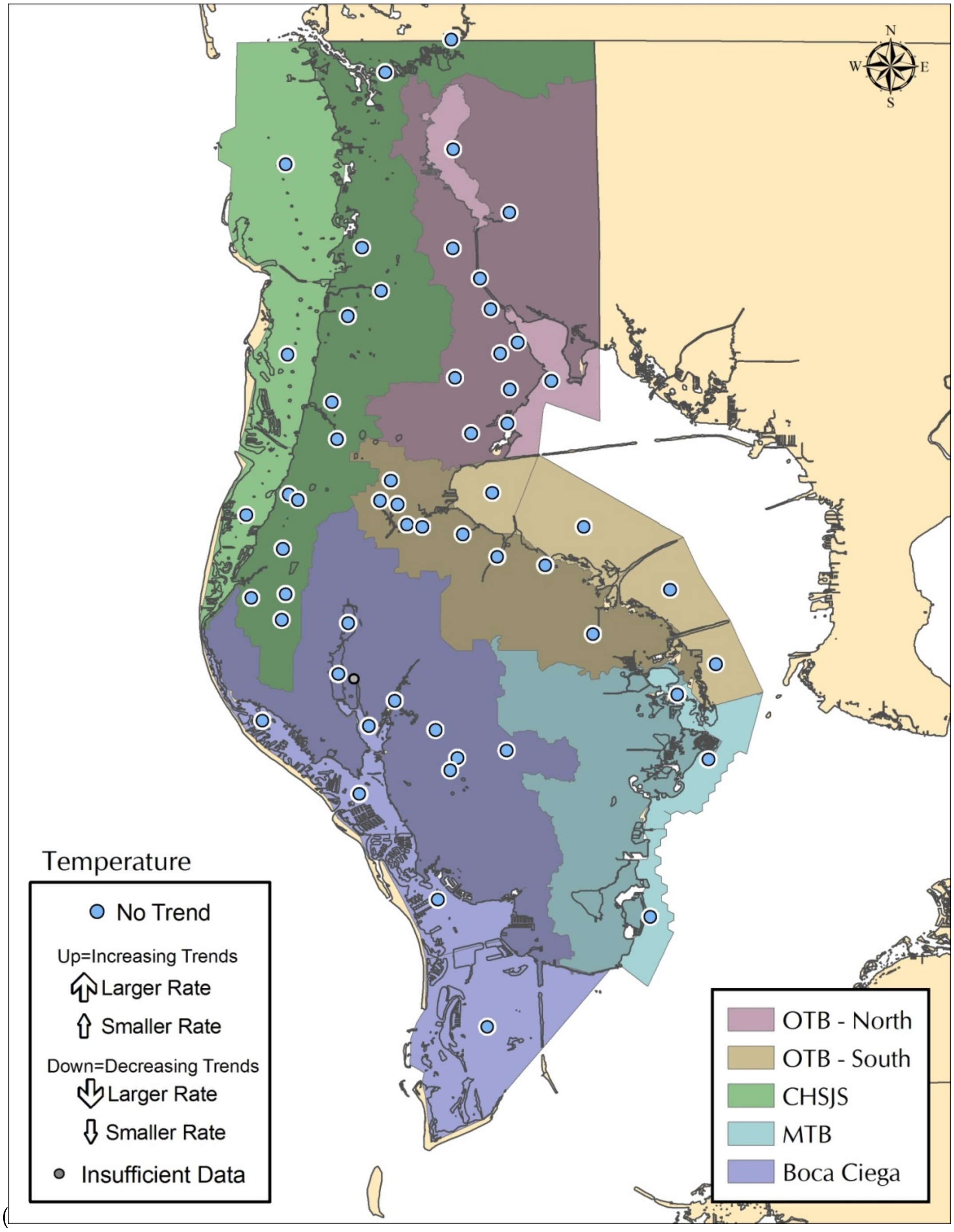

Figure 3-18) though four increasing slopes and two decreasing slopes were identified as false positives (Table 3-12).

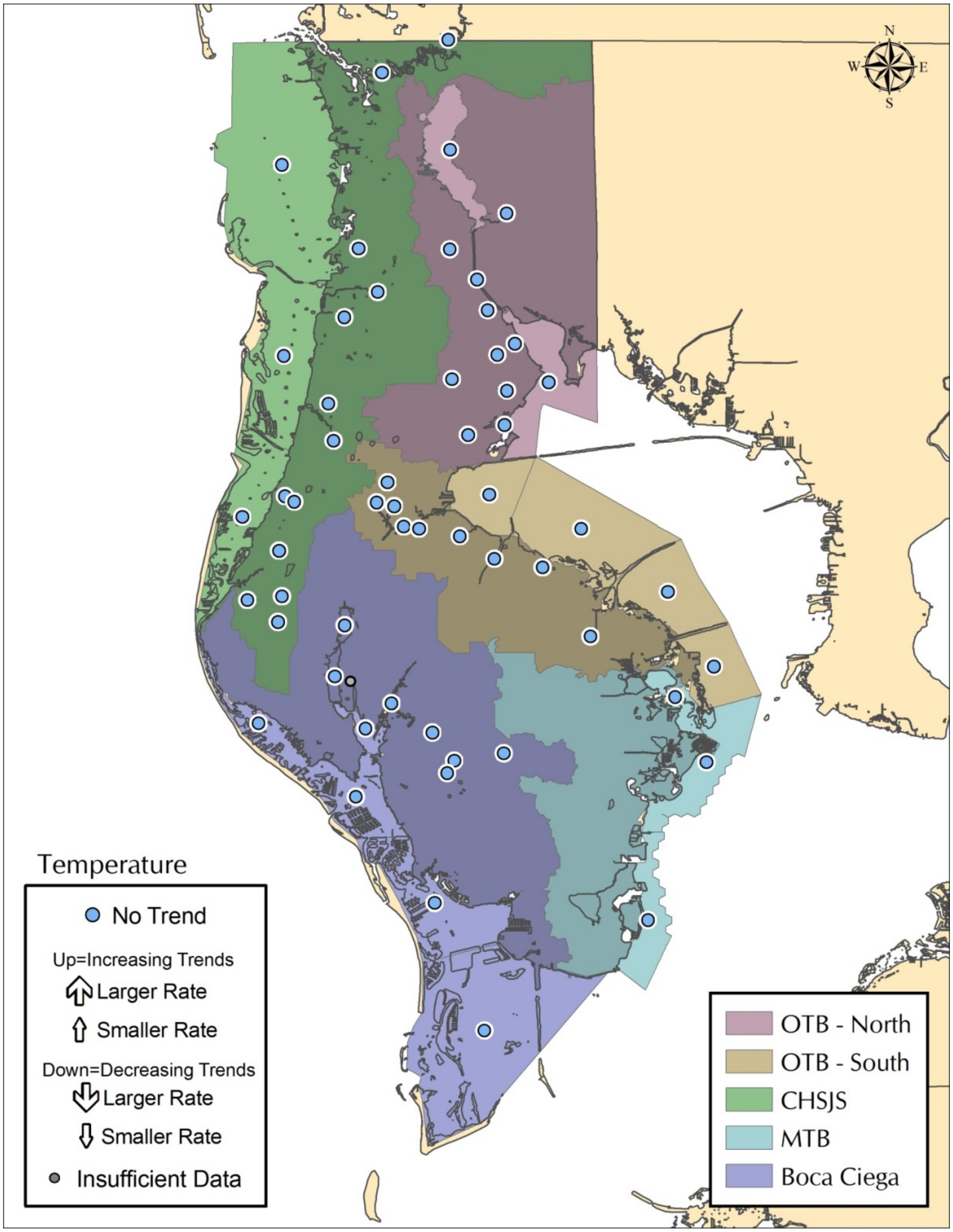

Figure 3-18. Summary of seasonal Kendal Tau trend test results for Water Temperature.

Table 3-12. Summary of Water Temperature trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	Temp_Water	0.527	0.716	No Trend	0
Boca Ciega	Joes Creek	35-09	Temp_Water	0.225	0.746	No Trend	0
Boca Ciega	Joes Creek	35-10	Temp_Water	0.275	0.728	No Trend	0
Boca Ciega	Joes Creek	35-11	Temp_Water	0.816	0.865	No Trend	0
Boca Ciega	Miles Creek	35-12	Temp_Water	0.104	0.461	No Trend	0
Boca Ciega	SA	SA	Temp_Water	0.119	0.452	No Trend	0
Boca Ciega	SB	SB	Temp_Water	0.558	0.758	No Trend	0
Boca Ciega	W4	W4	Temp_Water	0.311	0.591	No Trend	0
Boca Ciega	W5	W5	Temp_Water	0.677	0.804	No Trend	0
Boca Ciega	W6	W6	Temp_Water	0.976	0.976	No Trend	0
Boca Ciega	W7	W7	Temp_Water	0.207	0.491	No Trend	0
Boca Ciega	W8	W8	Temp_Water	0.028	0.526	No Trend	0.1128
CHSJS	Anclote River	01-01	Temp_Water	0.431	0.673	No Trend	0
CHSJS	Cedar Creek	09-03	Temp_Water	0.739	0.870	No Trend	0
CHSJS	Church Creek	27-08	Temp_Water	0.389	0.665	No Trend	0
CHSJS	Curlew Creek	10-02	Temp_Water	0.761	0.877	No Trend	0
CHSJS	Anclote River	01-08	Temp_Water	0.037	0.392	No Trend	-0.2333
CHSJS	McKay Creek	27-03	Temp_Water	0.503	0.740	No Trend	0
CHSJS	McKay Creek	27-03	Temp_Water	0.503	0.740	No Trend	0
CHSJS	McKay Creek	27-09	Temp_Water	0.149	0.565	No Trend	0
CHSJS	McKay Creek	27-10	Temp_Water	0.538	0.713	No Trend	0
CHSJS	Rattlesnake	17-01	Temp_Water	0.372	0.729	No Trend	0
CHSJS	Rattlesnake	17-03	Temp_Water	0.333	0.679	No Trend	0
CHSJS	Smith Creek	08-03	Temp_Water	0.721	0.868	No Trend	0
CHSJS	Spring Branch	15-04	Temp_Water	0.465	0.703	No Trend	0
CHSJS	Stevenson	18-06	Temp_Water	0.138	0.564	No Trend	0
CHSJS	W1	W1	Temp_Water	0.507	0.741	No Trend	0
CHSJS	W2	W2	Temp_Water	0.198	0.537	No Trend	0
CHSJS	W3	W3	Temp_Water	0.079	0.375	No Trend	0
MTB	E6	E6	Temp_Water	0.155	0.492	No Trend	0
MTB	E7	E7	Temp_Water	0.037	0.349	No Trend	0.1499
MTB	RB	RB	Temp_Water	0.234	0.495	No Trend	0
OTB - North	Alligator Creek	14-10	Temp_Water	0.905	0.905	No Trend	0
OTB - North	Alligator Lake	14-07	Temp_Water	0.237	0.661	No Trend	0
OTB - North	Briar Creek	11-05	Temp_Water	0.094	0.455	No Trend	0
OTB - North	Brooker Creek	04-03	Temp_Water	0.388	0.685	No Trend	0
OTB - North	Cow Branch	06-03	Temp_Water	0.678	0.835	No Trend	0
OTB - North	E1	E1	Temp_Water	0.829	0.927	No Trend	0
OTB - North	LT	LT	Temp_Water	0.478	0.756	No Trend	0
OTB - North	Lake Chautauqua	14-02	Temp_Water	0.275	0.633	No Trend	0

Table 3-12.	Summary of Water Temperature trends for all stations/strata with sufficient data for testing.						
OTB - North	Mullet Creek	13-05	Temp_Water	0.777	0.876	No Trend	0
OTB - North	North Bishop	12-02	Temp_Water	0.300	0.636	No Trend	0
OTB - North	S. Bishop	12-04	Temp_Water	0.284	0.626	No Trend	0
OTB - North	Tarpon Bypass	06-04	Temp_Water	0.650	0.820	No Trend	0
OTB - South	Allens Creek	19-02	Temp_Water	0.066	0.391	No Trend	0
OTB - South	Allens Creek	19-07	Temp_Water	0.030	0.800	No Trend	0.1086
OTB - South	Allens Creek	19-08	Temp_Water	0.173	0.610	No Trend	0
OTB - South	Allens Creek	19-09	Temp_Water	0.581	0.750	No Trend	0
OTB - South	Allens Creek	19-10	Temp_Water	0.086	0.456	No Trend	0
OTB - South	Cross Bayou	24-02	Temp_Water	0.891	0.908	No Trend	0
OTB - South	Cross Bayou	24-02	Temp_Water	0.891	0.908	No Trend	0
OTB - South	E2	E2	Temp_Water	0.975	1.000	No Trend	0
OTB - South	E3	E3	Temp_Water	0.074	0.466	No Trend	0
OTB - South	E4	E4	Temp_Water	0.609	0.772	No Trend	0
OTB - South	E5	E5	Temp_Water	0.317	0.547	No Trend	0
OTB - South	Longbranch	22-01	Temp_Water	0.791	0.873	No Trend	0
OTB - South	Roosevelt	23-07	Temp_Water	0.047	0.413	No Trend	-0.218
OTB - South	Roosevelt	23-08	Temp_Water	0.005	0.274	No Trend	-0.2117

3.2.14 Total Kjeldahl Nitrogen (TKN mg/l)

There were six decreasing trends in TKN (Figure 3-19). Decreasing trends were found in Cross Bayou (24-01), Joe's Creek (35-11), Lake Seminole (Stratum B), Curlew Creek (10-02), Smith Creek (08-03), and Allen's Creek (19-08). An additional 10 stations with decreasing slopes were identified as false positive results (Table 3-13).

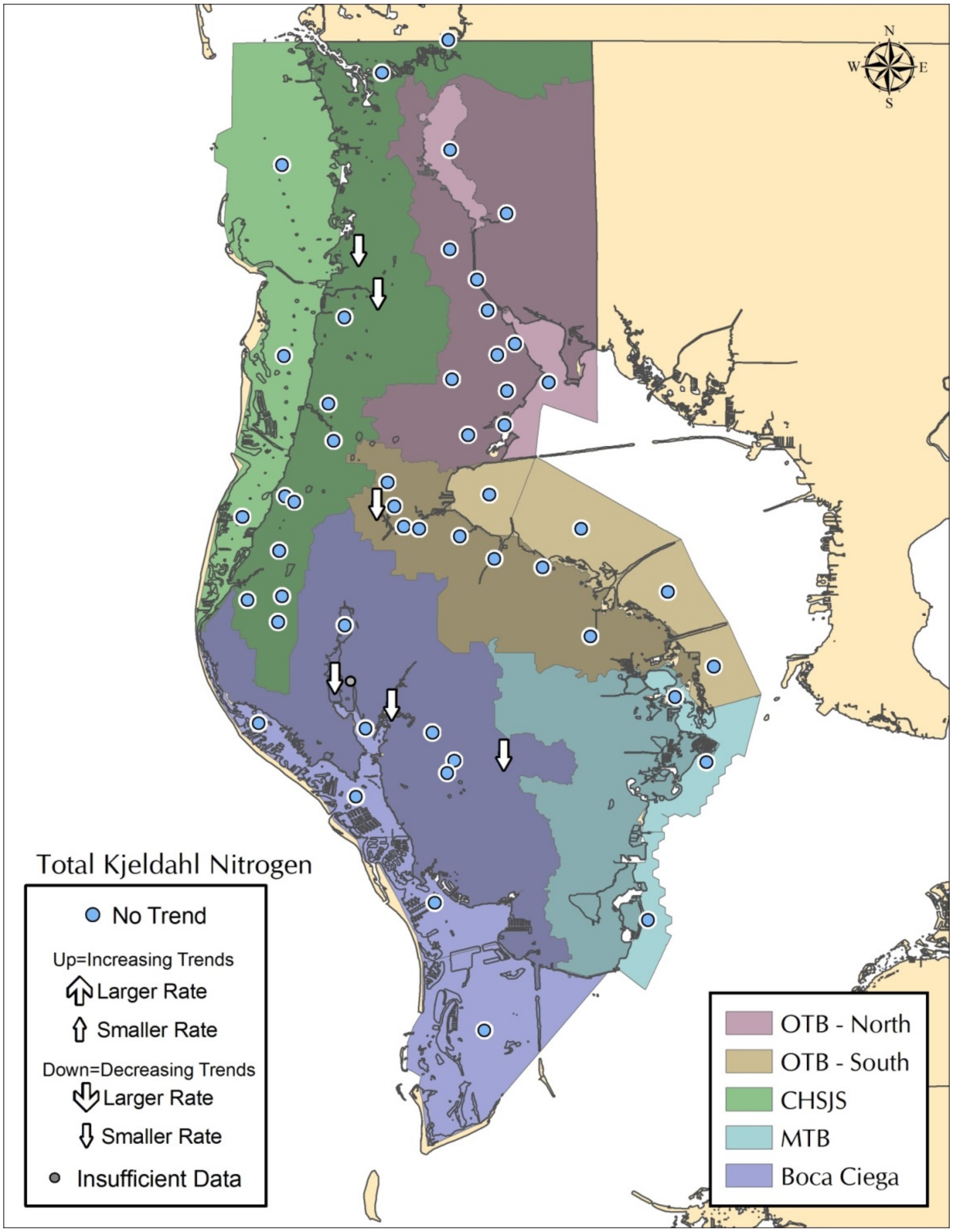

Figure 3-19. Summary of seasonal Kendal Tau trend test results for Total Kjeldahl Nitrogen.

Table 3-13. Summary of Total Kjeldahl Nitrogen trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	TKN	0.006	0.044	Decreasing	-0.023
Boca Ciega	Joes Creek	35-09	TKN	0.224	0.360	No Trend	0
Boca Ciega	Joes Creek	35-10	TKN	0.099	0.215	No Trend	0
Boca Ciega	Joes Creek	35-11	TKN	0.000	0.004	Decreasing	-0.02
Boca Ciega	Miles Creek	35-12	TKN	0.712	0.775	No Trend	0
Boca Ciega	SA	SA	TKN	0.012	0.114	No Trend	-0.0666
Boca Ciega	SB	SB	TKN	0.002	0.032	Decreasing	-0.0805
Boca Ciega	W4	W4	TKN	0.557	0.882	No Trend	0
Boca Ciega	W5	W5	TKN	0.058	0.219	No Trend	0
Boca Ciega	W6	W6	TKN	0.044	0.209	No Trend	-0.008
Boca Ciega	W7	W7	TKN	0.028	0.180	No Trend	-0.0091
Boca Ciega	W8	W8	TKN	0.538	0.929	No Trend	0
CHSJS	Anclote River	01-01	TKN	0.544	0.610	No Trend	0
CHSJS	Cedar Creek	09-03	TKN	0.467	0.576	No Trend	0
CHSJS	Church Creek	27-08	TKN	0.014	0.065	No Trend	-0.016
CHSJS	Curlew Creek	10-02	TKN	0.001	0.019	Decreasing	-0.016
CHSJS	Anclote River	01-08	TKN	0.081	0.188	No Trend	0
CHSJS	McKay Creek	27-03	TKN	0.258	0.398	No Trend	0
CHSJS	McKay Creek	27-09	TKN	0.059	0.145	No Trend	0
CHSJS	McKay Creek	27-10	TKN	1.000	1.000	No Trend	0
CHSJS	Rattlesnake	17-01	TKN	0.010	0.060	No Trend	-0.0272
CHSJS	Rattlesnake	17-03	TKN	0.113	0.220	No Trend	0
CHSJS	Smith Creek	08-03	TKN	0.004	0.037	Decreasing	-0.013
CHSJS	Spring Branch	15-04	TKN	0.863	0.887	No Trend	0
CHSJS	Stevenson	18-06	TKN	0.409	0.540	No Trend	0
CHSJS	W1	W1	TKN	0.634	0.861	No Trend	0
CHSJS	W2	W2	TKN	0.240	0.507	No Trend	0
CHSJS	W3	W3	TKN	0.069	0.219	No Trend	0
MTB	E6	E6	TKN	0.153	0.363	No Trend	0
MTB	E7	E7	TKN	0.107	0.290	No Trend	0
MTB	RB	RB	TKN	0.708	0.841	No Trend	0
OTB - North	Alligator Creek	14-10	TKN	0.174	0.307	No Trend	0
OTB - North	Alligator Lake	14-07	TKN	0.029	0.098	No Trend	-0.011
OTB - North	Briar Creek	11-05	TKN	0.047	0.145	No Trend	-0.014
OTB - North	Brooker Creek	04-03	TKN	0.527	0.629	No Trend	0
OTB - North	Cow Branch	06-03	TKN	0.324	0.461	No Trend	0
OTB - North	E1	E1	TKN	0.614	0.897	No Trend	0
OTB - North	LT	LT	TKN	0.931	0.931	No Trend	0
OTB - North	Lake Chautauqua	14-02	TKN	0.362	0.496	No Trend	0

Table 3-13. Summary of Total Kjeldahl Nitrogen trends for all stations/strata with sufficient data for testing.							
OTB - North	Mullet Creek	13-05	TKN	0.109	0.224	No Trend	0
OTB - North	North Bishop	12-02	TKN	0.304	0.449	No Trend	0
OTB - North	S. Bishop	12-04	TKN	0.195	0.328	No Trend	0
OTB - North	Tarpon Bypass	06-04	TKN	0.820	0.867	No Trend	0
OTB - South	Allens Creek	19-02	TKN	0.418	0.533	No Trend	0
OTB - South	Allens Creek	19-07	TKN	0.149	0.276	No Trend	0
OTB - South	Allens Creek	19-08	TKN	0.001	0.012	Decreasing	-0.018
OTB - South	Allens Creek	19-09	TKN	0.023	0.095	No Trend	-0.01
OTB - South	Allens Creek	19-10	TKN	0.536	0.620	No Trend	0
OTB - South	Cross Bayou	24-02	TKN	0.011	0.058	No Trend	-0.023
OTB - South	E2	E2	TKN	0.867	0.915	No Trend	0
OTB - South	E3	E3	TKN	0.484	0.920	No Trend	0
OTB - South	E4	E4	TKN	0.654	0.829	No Trend	0
OTB - South	E5	E5	TKN	0.840	0.939	No Trend	0
OTB - South	Longbranch	22-01	TKN	0.028	0.104	No Trend	-0.015
OTB - South	Roosevelt	23-07	TKN	0.054	0.154	No Trend	0
OTB - South	Roosevelt	23-08	TKN	0.054	0.143	No Trend	0

3.2.15 Total Nitrogen (TN mg/l)

Nine stations had decreasing trends in TN (

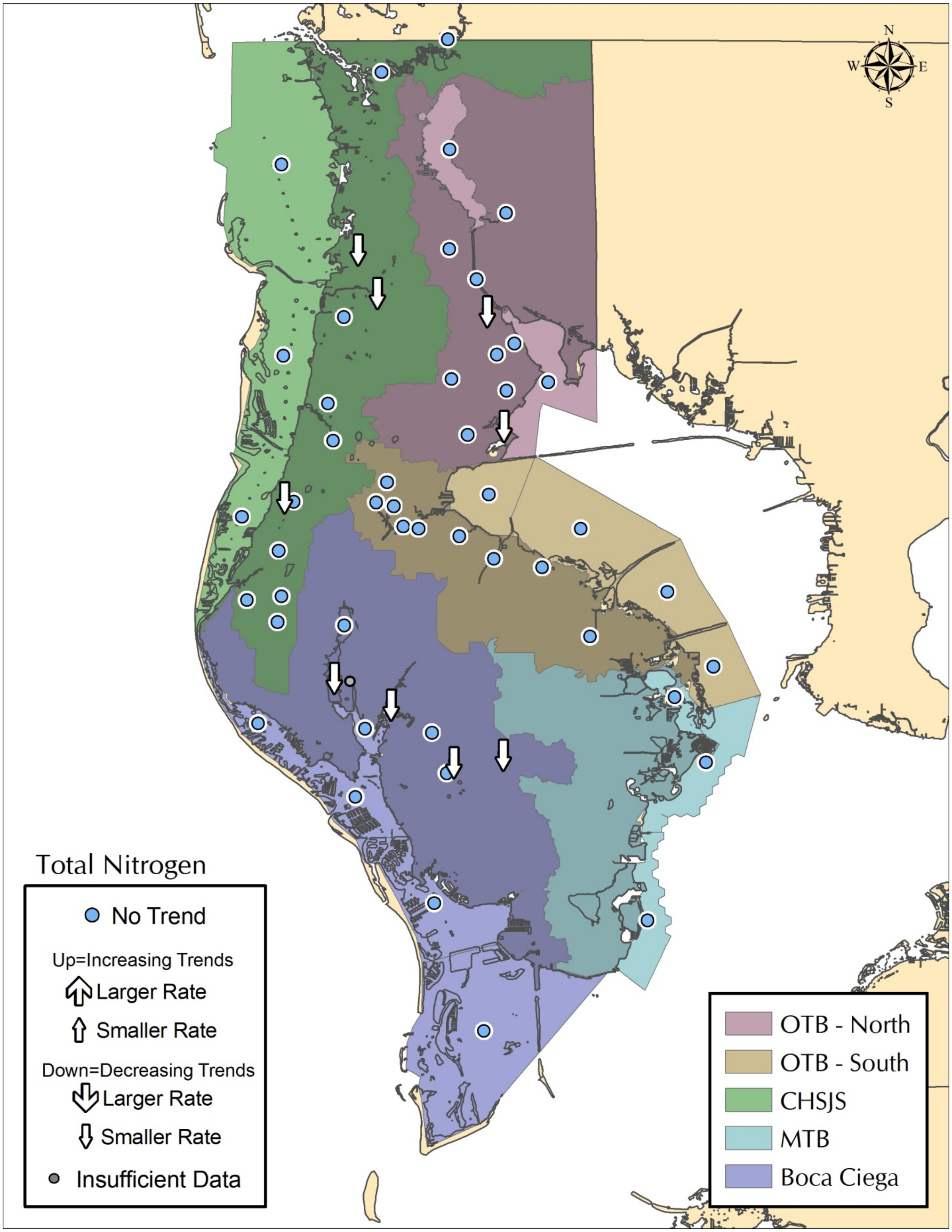

Figure 3-20) and no stations had increasing trends. Decreasing trends were found in Cross Bayou (24-01), Joe's Creek (35-10 and 35-11) Lake Seminole (Stratum B), Curlew Creek (10-02), Rattlesnake Creek (17-01), Smith Creek (08-03), Alligator Lake (14-07), and Briar Creek (11-05). Eight additional decreasing slopes and 2 increasing slopes were identified as false positives (Table 3-14).

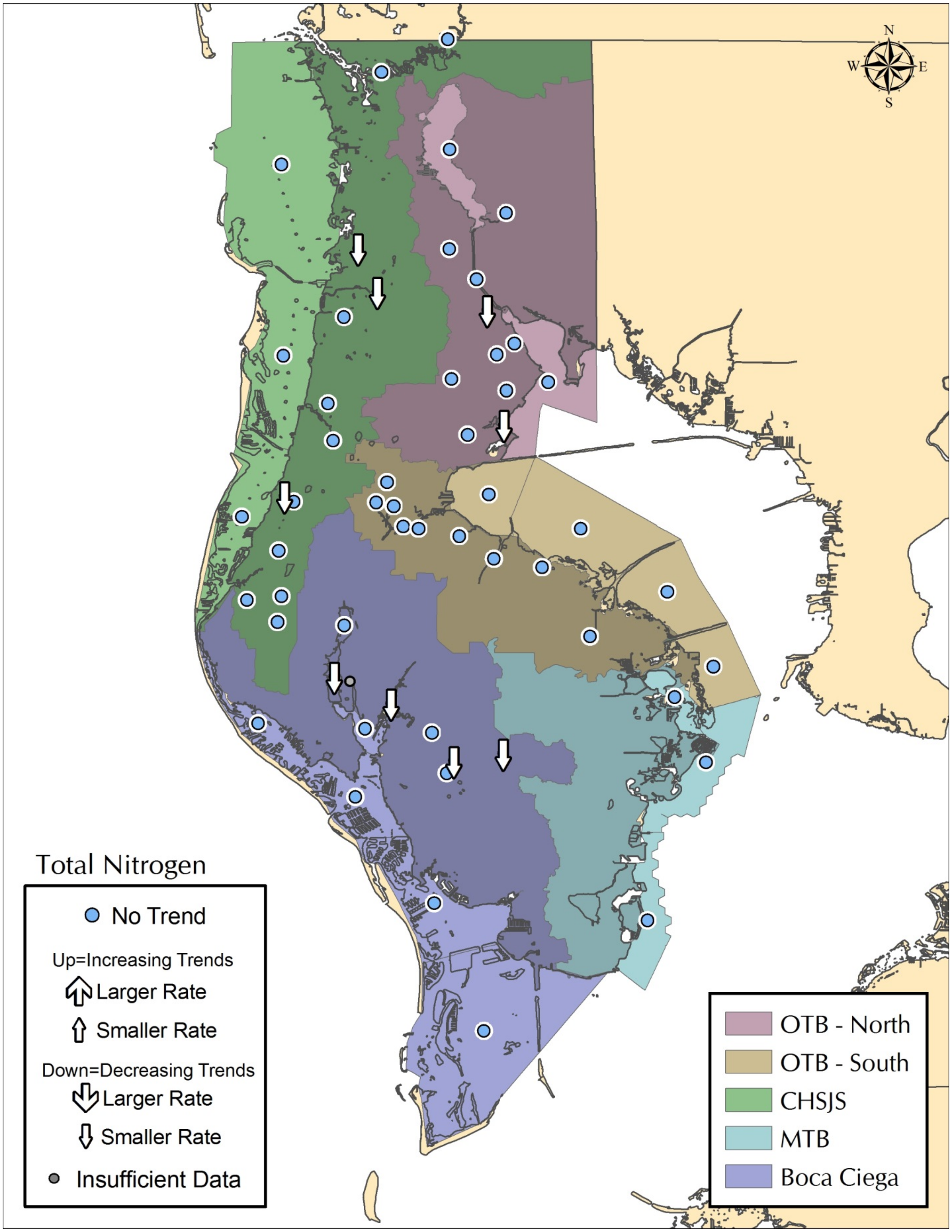

Figure 3-20. **Summary of seasonal Kendal Tau trend test results for Total Nitrogen.**

Table 3-14. Summary of Total Nitrogen trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	TN	0.001	0.009	Decreasing	-0.033
Boca Ciega	Joes Creek	35-09	TN	0.015	0.062	No Trend	-0.02
Boca Ciega	Joes Creek	35-10	TN	0.001	0.007	Decreasing	-0.018
Boca Ciega	Joes Creek	35-11	TN	0.000	0.001	Decreasing	-0.025
Boca Ciega	Miles Creek	35-12	TN	0.806	0.932	No Trend	0
Boca Ciega	SA	SA	TN	0.017	0.159	No Trend	-0.0664
Boca Ciega	SB	SB	TN	0.001	0.027	Decreasing	-0.0805
Boca Ciega	W4	W4	TN	0.371	0.587	No Trend	0
Boca Ciega	W5	W5	TN	0.025	0.160	No Trend	-0.0198
Boca Ciega	W6	W6	TN	0.054	0.204	No Trend	0
Boca Ciega	W7	W7	TN	0.027	0.129	No Trend	-0.0105
Boca Ciega	W8	W8	TN	0.370	0.639	No Trend	0
CHSJS	Anclote River	01-01	TN	0.637	0.786	No Trend	0
CHSJS	Cedar Creek	09-03	TN	0.872	0.978	No Trend	0
CHSJS	Church Creek	27-08	TN	0.532	0.729	No Trend	0
CHSJS	Curlew Creek	10-02	TN	0.003	0.016	Decreasing	-0.038
CHSJS	Anclote River	01-08	TN	0.108	0.250	No Trend	0
CHSJS	McKay Creek	27-03	TN	0.135	0.278	No Trend	0
CHSJS	McKay Creek	27-09	TN	0.055	0.135	No Trend	0
CHSJS	McKay Creek	27-10	TN	0.890	0.969	No Trend	0
CHSJS	Rattlesnake	17-01	TN	0.000	0.000	Decreasing	-0.079
CHSJS	Rattlesnake	17-03	TN	0.016	0.059	No Trend	-0.025
CHSJS	Smith Creek	08-03	TN	0.000	0.000	Decreasing	-0.0395
CHSJS	Spring Branch	15-04	TN	0.945	0.945	No Trend	0
CHSJS	Stevenson	18-06	TN	0.124	0.270	No Trend	0
CHSJS	W1	W1	TN	0.356	0.676	No Trend	0
CHSJS	W2	W2	TN	0.208	0.439	No Trend	0
CHSJS	W3	W3	TN	0.093	0.295	No Trend	0
MTB	E6	E6	TN	0.205	0.556	No Trend	0
MTB	E7	E7	TN	0.206	0.489	No Trend	0
MTB	RB	RB	TN	0.687	0.768	No Trend	0
OTB - North	Alligator Creek	14-10	TN	0.019	0.064	No Trend	0.026
OTB - North	Alligator Lake	14-07	TN	0.010	0.046	Decreasing	-0.012
OTB - North	Briar Creek	11-05	TN	0.002	0.012	Decreasing	-0.021
OTB - North	Brooker Creek	04-03	TN	0.476	0.677	No Trend	0
OTB - North	Cow Branch	06-03	TN	0.733	0.875	No Trend	0
OTB - North	E1	E1	TN	0.417	0.609	No Trend	0
OTB - North	LT	LT	TN	0.780	0.780	No Trend	0
OTB - North	Lake Chautauqua	14-02	TN	0.377	0.606	No Trend	0

Table 3-14. Summary of Total Nitrogen trends for all stations/strata with sufficient data for testing.							
OTB - North	Mullet Creek	13-05	TN	0.144	0.280	No Trend	0
OTB - North	North Bishop	12-02	TN	0.281	0.494	No Trend	0
OTB - North	S. Bishop	12-04	TN	0.444	0.657	No Trend	0
OTB - North	Tarpon Bypass	06-04	TN	0.545	0.721	No Trend	0
OTB - South	Allens Creek	19-02	TN	0.419	0.646	No Trend	0
OTB - South	Allens Creek	19-07	TN	0.902	0.954	No Trend	0
OTB - South	Allens Creek	19-08	TN	0.250	0.462	No Trend	0
OTB - South	Allens Creek	19-09	TN	0.905	0.930	No Trend	0
OTB - South	Allens Creek	19-10	TN	0.606	0.773	No Trend	0
OTB - South	Cross Bayou	24-02	TN	0.021	0.065	No Trend	-0.023
OTB - South	E2	E2	TN	0.467	0.634	No Trend	0
OTB - South	E3	E3	TN	0.563	0.713	No Trend	0
OTB - South	E4	E4	TN	0.620	0.736	No Trend	0
OTB - South	E5	E5	TN	0.730	0.770	No Trend	0
OTB - South	Longbranch	22-01	TN	0.043	0.114	No Trend	-0.018
OTB - South	Roosevelt	23-07	TN	0.364	0.612	No Trend	0
OTB - South	Roosevelt	23-08	TN	0.026	0.074	No Trend	-0.025

3.2.16 Total Phosphorus (TP mg/l)

There were 18 decreasing trends in TP and one increasing trend (

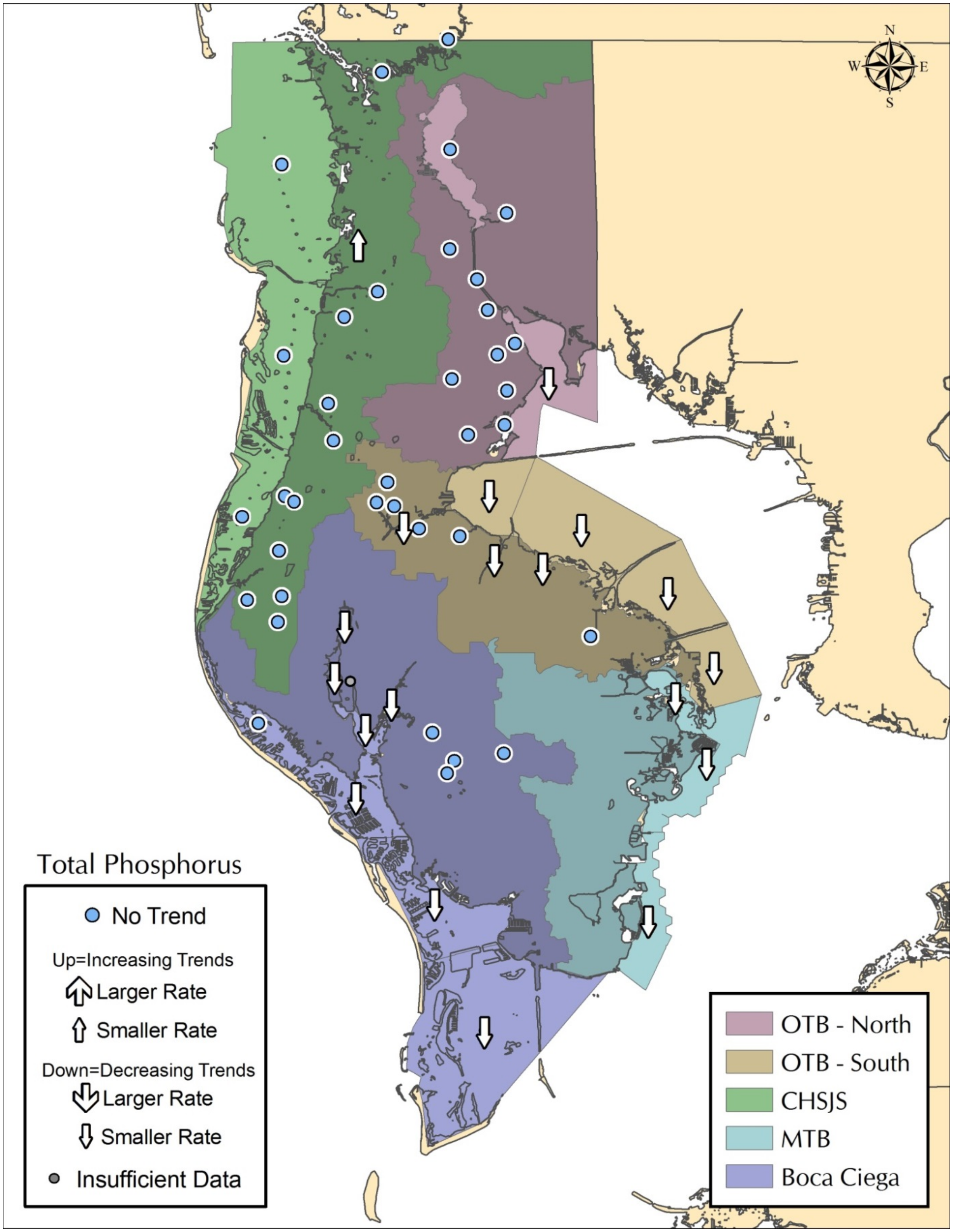

Figure 3-21). The single increasing trend was located in Smith Creek (08-03). Decreasing trends included stations in Cross Bayou (24-01), Lake Seminole (both Strata), Strata W5, W6, W7, W8, E6,

E7 and Riviera Bay in Middle Tampa Bay, E1-E5 in Old Tampa Bay, as well as Allen's Creek (19-02), Cross Bayou (24-02) and the Roosevelt station (23-08: Table 3-15). An additional three decreasing and two increasing trends were identified as potential false positive results.

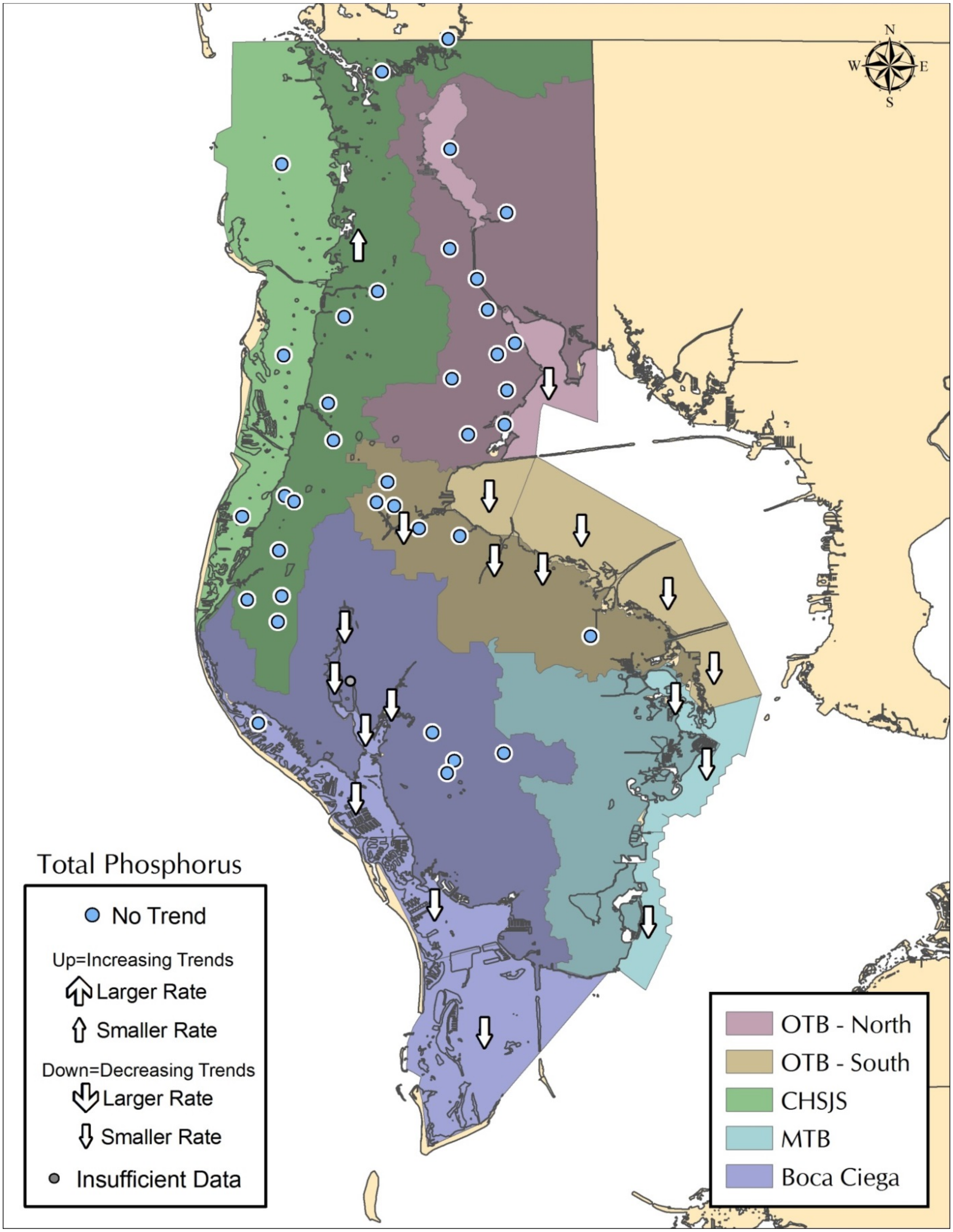

Figure 3-21. Summary of seasonal Kendal Tau trend test results for Total Phosphorus.

Table 3-15. Summary of Total Phosphorus trends for all stations/strata with sufficient data for testing.							
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	TP	0.000	0.000	Decreasing	-0.012
Boca Ciega	Joes Creek	35-09	TP	1.000	1.000	No Trend	0
Boca Ciega	Joes Creek	35-10	TP	1.000	1.000	No Trend	0
Boca Ciega	Joes Creek	35-11	TP	1.000	1.000	No Trend	0
Boca Ciega	Miles Creek	35-12	TP	0.206	0.476	No Trend	0
Boca Ciega	SA	SA	TP	0.000	0.000	Decreasing	-0.005
Boca Ciega	SB	SB	TP	0.000	0.000	Decreasing	-0.0036
Boca Ciega	W4	W4	TP	1.000	1.000	No Trend	0
Boca Ciega	W5	W5	TP	0.000	0.000	Decreasing	-0.0095
Boca Ciega	W6	W6	TP	0.012	0.016	Decreasing	-0.002
Boca Ciega	W7	W7	TP	0.003	0.004	Decreasing	-0.003
Boca Ciega	W8	W8	TP	0.000	0.000	Decreasing	-0.003
CHSJS	Anclote River	01-01	TP	0.206	0.508	No Trend	0
CHSJS	Cedar Creek	09-03	TP	0.133	0.352	No Trend	0
CHSJS	Church Creek	27-08	TP	1.000	1.000	No Trend	0
CHSJS	Curlew Creek	10-02	TP	0.263	0.541	No Trend	0
CHSJS	Anclote River	01-08	TP	1.000	1.000	No Trend	0
CHSJS	McKay Creek	27-03	TP	1.000	1.000	No Trend	0
CHSJS	McKay Creek	27-09	TP	0.646	0.854	No Trend	0
CHSJS	McKay Creek	27-10	TP	1.000	1.000	No Trend	0
CHSJS	Rattlesnake	17-01	TP	1.000	1.000	No Trend	0
CHSJS	Rattlesnake	17-03	TP	0.046	0.213	No Trend	0.003
CHSJS	Smith Creek	08-03	TP	0.001	0.015	Increasing	0.0025
CHSJS	Spring Branch	15-04	TP	0.026	0.137	No Trend	0.008
CHSJS	Stevenson	18-06	TP	0.483	0.745	No Trend	0
CHSJS	W1	W1	TP	1.000	1.000	No Trend	0
CHSJS	W2	W2	TP	0.653	0.730	No Trend	0
CHSJS	W3	W3	TP	0.071	0.090	No Trend	0
MTB	E6	E6	TP	0.000	0.000	Decreasing	-0.0066
MTB	E7	E7	TP	0.000	0.000	Decreasing	-0.005
MTB	RB	RB	TP	0.000	0.000	Decreasing	-0.0065
OTB - North	Alligator Creek	14-10	TP	1.000	1.000	No Trend	0
OTB - North	Alligator Lake	14-07	TP	0.014	0.084	No Trend	-0.0035
OTB - North	Briar Creek	11-05	TP	1.000	1.000	No Trend	0
OTB - North	Brooker Creek	04-03	TP	0.228	0.496	No Trend	0
OTB - North	Cow Branch	06-03	TP	1.000	1.000	No Trend	0

Table 3-15.	Summary of Total Phosphorus trends for all stations/strata with sufficient data for testing.						
OTB - North	E1	E1	TP	0.000	0.000	Decreasing	-0.0066
OTB - North	LT	LT	TP	0.077	0.091	No Trend	0
OTB - North	Lake Chautauqua	14-02	TP	1.000	1.000	No Trend	0
OTB - North	Mullet Creek	13-05	TP	0.379	0.637	No Trend	0
OTB - North	North Bishop	12-02	TP	0.081	0.271	No Trend	0
OTB - North	S. Bishop	12-04	TP	0.333	0.617	No Trend	0
OTB - North	Tarpon Bypass	06-04	TP	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-02	TP	0.004	0.030	Decreasing	-0.004
OTB - South	Allens Creek	19-07	TP	0.100	0.308	No Trend	0
OTB - South	Allens Creek	19-08	TP	0.048	0.197	No Trend	-0.003
OTB - South	Allens Creek	19-09	TP	0.340	0.599	No Trend	0
OTB - South	Allens Creek	19-10	TP	0.107	0.305	No Trend	0
OTB - South	Cross Bayou	24-02	TP	0.001	0.012	Decreasing	-0.005
OTB - South	E2	E2	TP	0.001	0.001	Decreasing	-0.0061
OTB - South	E3	E3	TP	0.000	0.000	Decreasing	-0.0065
OTB - South	E4	E4	TP	0.000	0.000	Decreasing	-0.0056
OTB - South	E5	E5	TP	0.000	0.000	Decreasing	-0.0064
OTB - South	Longbranch	22-01	TP	1.000	1.000	No Trend	0
OTB - South	Roosevelt	23-07	TP	0.385	0.619	No Trend	0
OTB - South	Roosevelt	23-08	TP	0.003	0.028	Decreasing	-0.0058

3.2.17 Total Suspended Solids (TSS mg/l)

There were no increasing trends in TSS and four decreasing trends (Figure 3-22). Four decreasing trends were observed including Joe's Creek (35-11), Lake Seminole (both Strata), and Alligator Lake (14-07). An additional 8 decreasing and two increasing trends were identified as false positive results after accounting for multiple comparisons (Table 3-16).

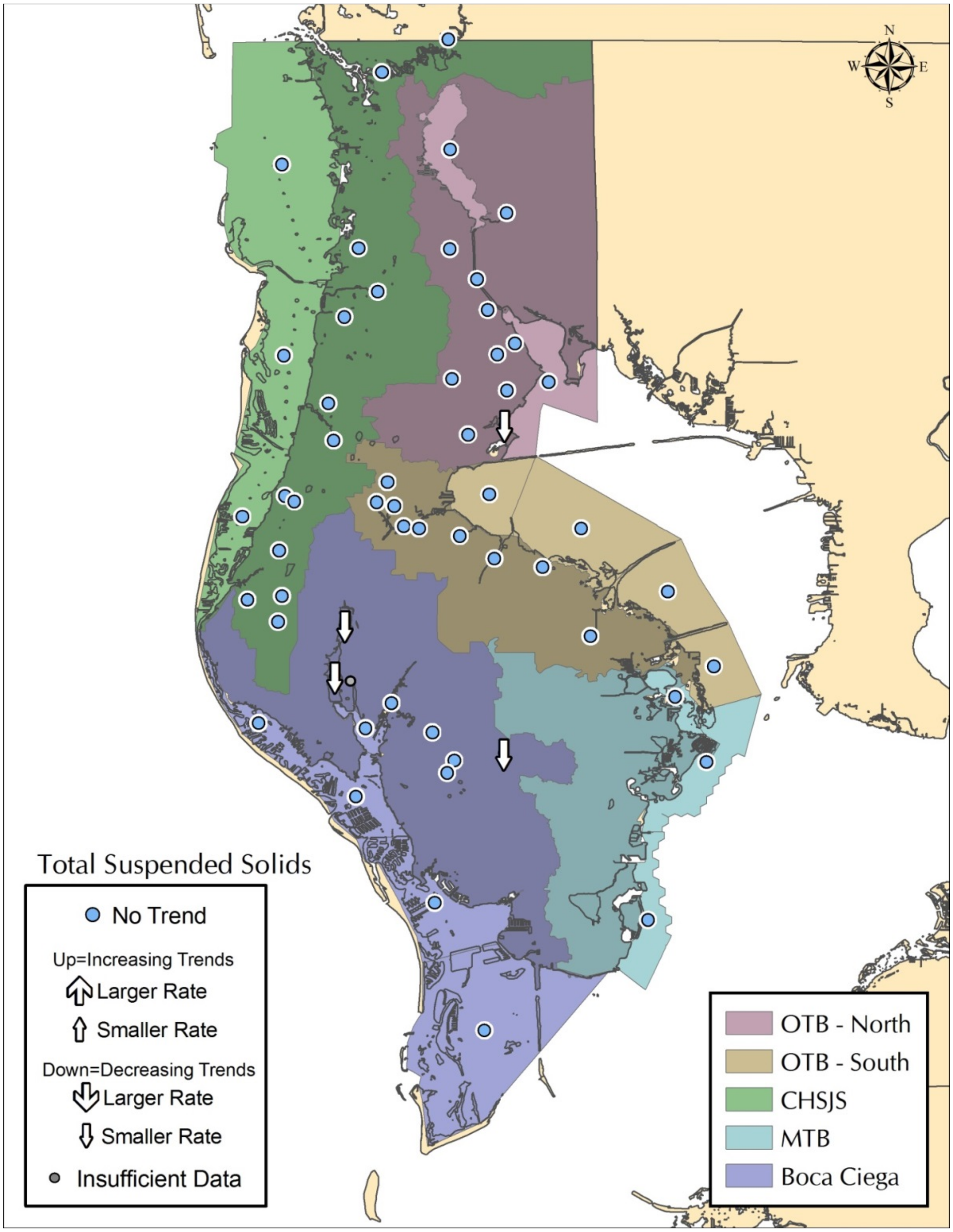

Figure 3-22. Summary of seasonal Kendal Tau trend test results for Total Suspended Solids.

Table 3-16.	**Summary of Total Suspended Solids trends for all stations/strata with sufficient data for testing.**						
Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	TSS	1.000	1.000	No Trend	0
Boca Ciega	Joes Creek	35-09	TSS	0.045	0.208	No Trend	0.2
Boca Ciega	Joes Creek	35-10	TSS	1.000	1.000	No Trend	0
Boca Ciega	Joes Creek	35-11	TSS	0.000	0.000	Decreasing	-0.4444
Boca Ciega	Miles Creek	35-12	TSS	1.000	1.000	No Trend	0
Boca Ciega	SA	SA	TSS	0.000	0.000	Decreasing	-1.7
Boca Ciega	SB	SB	TSS	0.000	0.000	Decreasing	-1.625
Boca Ciega	W4	W4	TSS	0.340	0.430	No Trend	0
Boca Ciega	W5	W5	TSS	0.628	0.663	No Trend	0
Boca Ciega	W6	W6	TSS	0.385	0.457	No Trend	0
Boca Ciega	W7	W7	TSS	0.011	0.070	No Trend	-0.571
Boca Ciega	W8	W8	TSS	0.024	0.076	No Trend	-0.452
CHSJS	Anclote River	01-01	TSS	1.000	1.000	No Trend	0
CHSJS	Cedar Creek	09-03	TSS	1.000	1.000	No Trend	0
CHSJS	Church Creek	27-08	TSS	0.009	0.111	No Trend	-0.317
CHSJS	Curlew Creek	10-02	TSS	1.000	1.000	No Trend	0
CHSJS	Anclote River	01-08	TSS	0.280	0.648	No Trend	0
CHSJS	McKay Creek	27-03	TSS	1.000	1.000	No Trend	0
CHSJS	McKay Creek	27-09	TSS	0.106	0.436	No Trend	0
CHSJS	McKay Creek	27-10	TSS	1.000	1.000	No Trend	0
CHSJS	Rattlesnake	17-01	TSS	0.023	0.140	No Trend	-0.166
CHSJS	Rattlesnake	17-03	TSS	1.000	1.000	No Trend	0
CHSJS	Smith Creek	08-03	TSS	1.000	1.000	No Trend	0
CHSJS	Spring Branch	15-04	TSS	1.000	1.000	No Trend	0
CHSJS	Stevenson	18-06	TSS	1.000	1.000	No Trend	0
CHSJS	W1	W1	TSS	0.041	0.111	No Trend	-0.444
CHSJS	W2	W2	TSS	0.099	0.188	No Trend	0
CHSJS	W3	W3	TSS	0.065	0.137	No Trend	0
MTB	E6	E6	TSS	0.594	0.664	No Trend	0
MTB	E7	E7	TSS	0.204	0.277	No Trend	0
MTB	RB	RB	TSS	0.130	0.190	No Trend	0
OTB - North	Alligator Creek	14-10	TSS	0.041	0.218	No Trend	0.25
OTB - North	Alligator Lake	14-07	TSS	0.000	0.000	Decreasing	-0.4
OTB - North	Briar Creek	11-05	TSS	0.120	0.404	No Trend	0
OTB - North	Brooker Creek	04-03	TSS	1.000	1.000	No Trend	0
OTB - North	Cow Branch	06-03	TSS	1.000	1.000	No Trend	0
OTB - North	E1	E1	TSS	0.124	0.197	No Trend	0
OTB - North	LT	LT	TSS	0.720	0.720	No Trend	0
OTB - North	Lake Chautauqua	14-02	TSS	1.000	1.000	No Trend	0

Table 3-16.	Summary of Total Suspended Solids trends for all stations/strata with sufficient data for testing.						
OTB - North	Mullet Creek	13-05	TSS	0.379	0.738	No Trend	0
OTB - North	North Bishop	12-02	TSS	0.120	0.442	No Trend	0
OTB - North	S. Bishop	12-04	TSS	1.000	1.000	No Trend	0
OTB - North	Tarpon Bypass	06-04	TSS	0.234	0.618	No Trend	0
OTB - South	Allens Creek	19-02	TSS	0.516	0.764	No Trend	0
OTB - South	Allens Creek	19-07	TSS	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-08	TSS	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-09	TSS	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-10	TSS	1.000	1.000	No Trend	0
OTB - South	Cross Bayou	24-02	TSS	0.728	0.869	No Trend	0
OTB - South	E2	E2	TSS	0.015	0.069	No Trend	-0.3946
OTB - South	E3	E3	TSS	0.015	0.057	No Trend	-0.4
OTB - South	E4	E4	TSS	0.047	0.112	No Trend	-0.357
OTB - South	E5	E5	TSS	0.119	0.206	No Trend	0
OTB - South	Longbranch	22-01	TSS	0.415	0.698	No Trend	0
OTB - South	Roosevelt	23-07	TSS	0.211	0.601	No Trend	0
OTB - South	Roosevelt	23-08	TSS	1.000	1.000	No Trend	0

3.2.18 Transmissivity (%)

The transmissometer used by Pinellas County measures the amount light that is transmitted at a specific wave length (660 nm; red light) over a fixed distance (10 cm path length). Both absorption and scattering by particles affect the amount of light lost along the pathway and therefore the transmissometer is a measure of water clarity in the horizontal plane. Pinellas County reports transmission as percent transmittance, which is the ratio of the sample to a clean water reference expressed as percentage voltage. Transmissivity is only recorded for the probabilistic design in estuarine waters, and in lakes Tarpon and Seminole. Transsmissivity was stable throughout the estuarine waters over the 2003-2013 time period and was found to be significantly increasing in both strata of Lake Seminole (Figure 3-23).

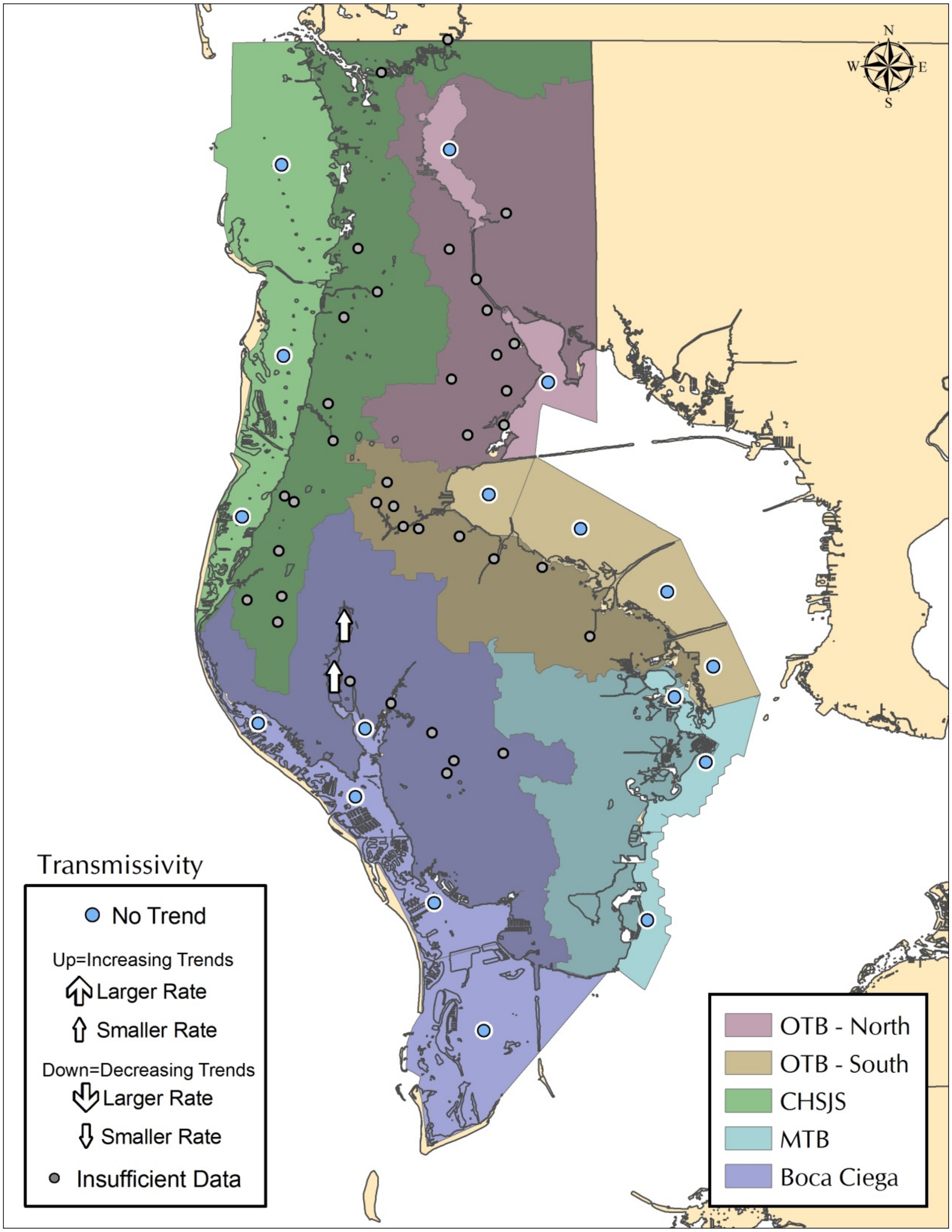

Figure 3-23. Summary of seasonal Kendal Tau trend test results for Transmissivity.

3.2.19 Turbidity (NTU)

The results of trend test on turbidity were quite mixed with an approximately equal number of increasing and decreasing trends. Turbidity significantly decreased at eight stations and increased at 7 stations over the period of record (

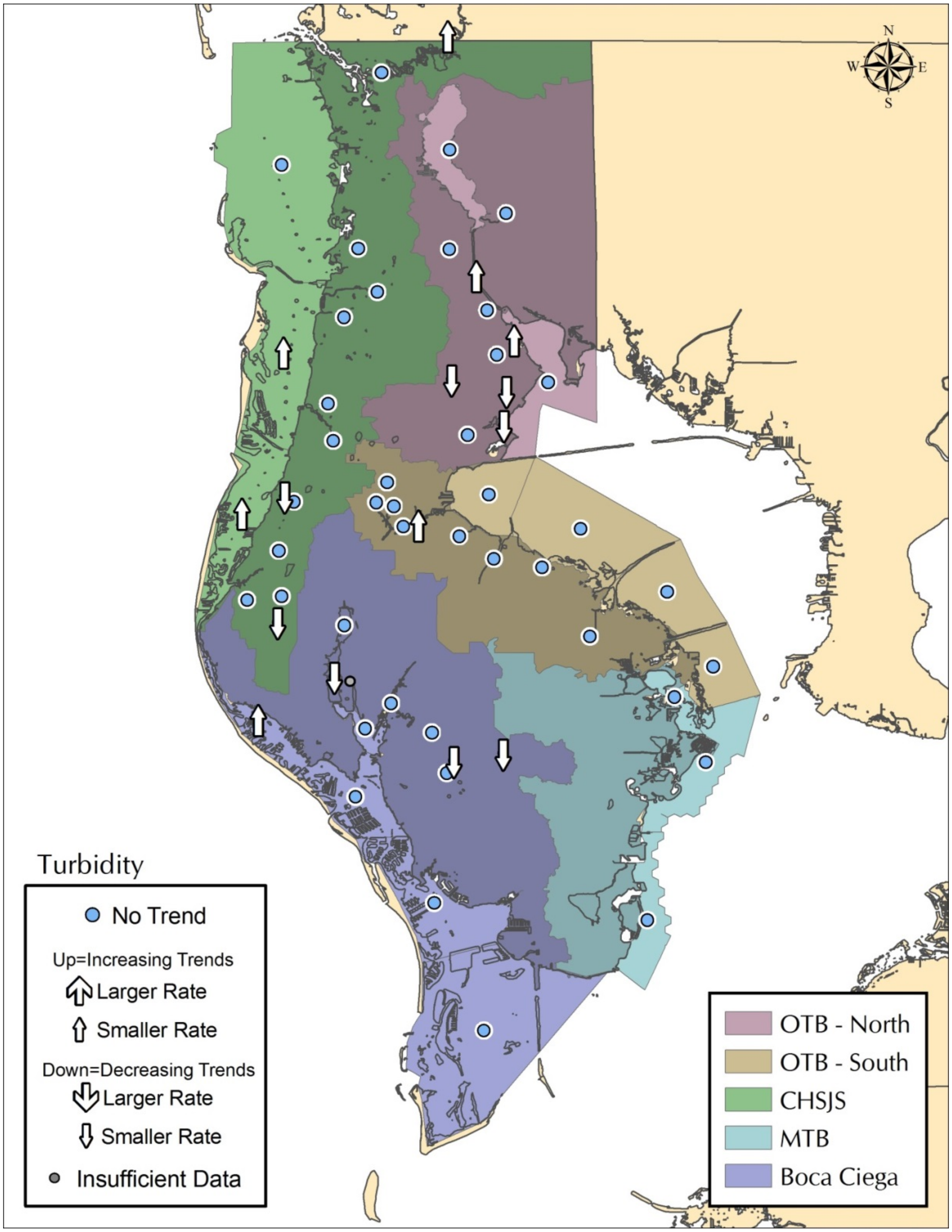

Figure 3-24). Turbidity decreased at two stations in Joe's Creek (35-10 and 35-11), in Lake Seminole (Stratum B), McKay Creek (27-10) and Rattlesnake Creek (17-01), Alligator Lake (14-07), Lake Chautauqua (14-02) and Mullet Creek (13-05). Increasing trends were observed at Strata W4, Anclote River (01-08), W2, and W3, North Bishop Creek (12-02), Tarpon Bypass Canal (06-04), and Allen's Creek (19-10) (Table 3-17). An additional 3 increasing and 3 decreasing trends were identified as false positive results when accounting for multiple comparisons.

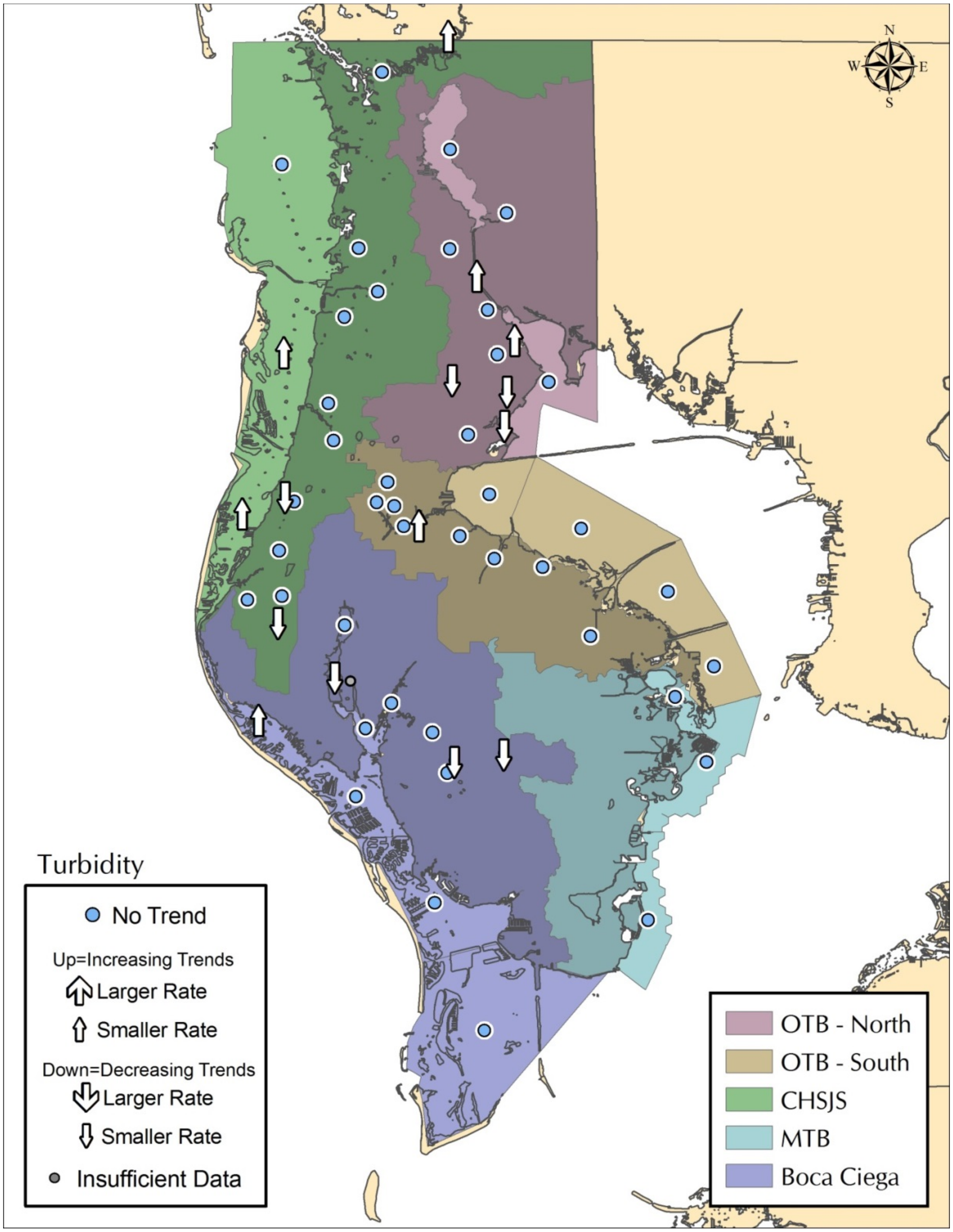

Figure 3-24. Summary of seasonal Kendal Tau trend test results for Turbidity.

Table 3-17. Summary of Turbidity trends for all stations/strata with sufficient data for testing.

Major Basin	Waterbody	Station	Parameter	P Value	Adjusted P	Trend Direction	Slope
Boca Ciega	Cross Bayou	24-01	Turbidity	0.029	0.077	No Trend	0.08

Table 3-17.	Summary of Turbidity trends for all stations/strata with sufficient data for testing.						
Boca Ciega	Joes Creek	35-09	Turbidity	0.030	0.074	No Trend	0.115
Boca Ciega	Joes Creek	35-10	Turbidity	0.007	0.037	Decreasing	-0.067
Boca Ciega	Joes Creek	35-11	Turbidity	0.000	0.000	Decreasing	-0.1833
Boca Ciega	Miles Creek	35-12	Turbidity	0.280	0.471	No Trend	0
Boca Ciega	SA	SA	Turbidity	0.034	0.107	No Trend	-0.4307
Boca Ciega	SB	SB	Turbidity	0.000	0.002	Decreasing	-0.7330
Boca Ciega	W4	W4	Turbidity	0.009	0.041	Increasing	0.3156
Boca Ciega	W5	W5	Turbidity	0.236	0.345	No Trend	0
Boca Ciega	W6	W6	Turbidity	0.047	0.129	No Trend	0.3
Boca Ciega	W7	W7	Turbidity	0.297	0.403	No Trend	0
Boca Ciega	W8	W8	Turbidity	0.078	0.165	No Trend	0
CHSJS	Anclote River	01-01	Turbidity	1.000	1.000	No Trend	0
CHSJS	Cedar Creek	09-03	Turbidity	0.019	0.059	No Trend	0.125
CHSJS	Church Creek	27-08	Turbidity	0.317	0.510	No Trend	0
CHSJS	Curlew Creek	10-02	Turbidity	0.384	0.546	No Trend	0
CHSJS	Anclote River	01-08	Turbidity	0.011	0.044	Increasing	0.1
CHSJS	McKay Creek	27-03	Turbidity	1.000	1.000	No Trend	0
CHSJS	McKay Creek	27-09	Turbidity	1.000	1.000	No Trend	0
CHSJS	McKay Creek	27-10	Turbidity	0.009	0.042	Decreasing	-0.05
CHSJS	Rattlesnake	17-01	Turbidity	0.001	0.008	Decreasing	-0.1
CHSJS	Rattlesnake	17-03	Turbidity	0.443	0.607	No Trend	0
CHSJS	Smith Creek	08-03	Turbidity	1.000	1.000	No Trend	0
CHSJS	Spring Branch	15-04	Turbidity	0.139	0.245	No Trend	0
CHSJS	Stevenson	18-06	Turbidity	0.118	0.218	No Trend	0
CHSJS	W1	W1	Turbidity	0.022	0.084	No Trend	0.055
CHSJS	W2	W2	Turbidity	0.006	0.038	Increasing	0.107
CHSJS	W3	W3	Turbidity	0.004	0.038	Increasing	0.2
MTB	E6	E6	Turbidity	0.590	0.701	No Trend	0
MTB	E7	E7	Turbidity	0.216	0.342	No Trend	0
MTB	RB	RB	Turbidity	0.141	0.244	No Trend	0
OTB - North	Alligator Creek	14-10	Turbidity	0.352	0.520	No Trend	0
OTB - North	Alligator Lake	14-07	Turbidity	0.000	0.000	Decreasing	-0.15
OTB - North	Briar Creek	11-05	Turbidity	0.329	0.507	No Trend	0
OTB - North	Brooker Creek	04-03	Turbidity	0.045	0.104	No Trend	0.04
OTB - North	Cow Branch	06-03	Turbidity	0.103	0.201	No Trend	0
OTB - North	E1	E1	Turbidity	1.000	1.000	No Trend	0
OTB - North	LT	LT	Turbidity	0.069	0.163	No Trend	0
OTB - North	Lake Chautauqua	14-02	Turbidity	0.011	0.037	Decreasing	-0.029
OTB - North	Mullet Creek	13-05	Turbidity	0.011	0.041	Decreasing	-0.245
OTB - North	North Bishop	12-02	Turbidity	0.004	0.025	Increasing	0.2381
OTB - North	S. Bishop	12-04	Turbidity	0.019	0.054	No Trend	-0.1

Table 3-17. Summary of Turbidity trends for all stations/strata with sufficient data for testing.							
OTB - North	Tarpon Bypass	06-04	Turbidity	0.000	0.000	Increasing	0.1
OTB - South	Allens Creek	19-02	Turbidity	0.083	0.170	No Trend	0
OTB - South	Allens Creek	19-07	Turbidity	0.684	0.844	No Trend	0
OTB - South	Allens Creek	19-08	Turbidity	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-09	Turbidity	1.000	1.000	No Trend	0
OTB - South	Allens Creek	19-10	Turbidity	0.002	0.015	Increasing	0.2613
OTB - South	Cross Bayou	24-02	Turbidity	0.877	0.954	No Trend	0
OTB - South	E2	E2	Turbidity	0.780	0.823	No Trend	0
OTB - South	E3	E3	Turbidity	0.491	0.622	No Trend	0
OTB - South	E4	E4	Turbidity	0.123	0.233	No Trend	0
OTB - South	E5	E5	Turbidity	0.604	0.675	No Trend	0
OTB - South	Longbranch	22-01	Turbidity	0.047	0.102	No Trend	0.05
OTB - South	Roosevelt	23-07	Turbidity	0.910	0.935	No Trend	0
OTB - South	Roosevelt	23-08	Turbidity	0.596	0.788	No Trend	0

4 Summary of Kendall Tau Trend Test Results

In total 786 trend tests of surface water quality samples were conducted for this report. Of those tests, 81 resulted in statistically significant decreasing trends after accounting for multiple comparisons and 24 tests were found to be increasing in magnitude over the 2003 – 2013 time period. Salinity accounted for nearly half of the increasing trends. The remaining trends were stable over time indicating stable water quality conditions. Total phosphorus trends were found to be improving over time in many stations, particularly in the estuarine strata tested. Total nitrogen and total kjeldahl nitrogen were found to be decreasing at many fixed station sites in the watershed. Dissolved oxygen was stable at most sites, and secchi disk, water temperature and LiCor were stable throughout all tests conducted. The individual station results for all parameters tested are provided in Appendix A as a hyperlinked document that will allow the user to drill down to find individual station results with all accompanying detailed statistical output. In the next section of this report, parametric trend tests are conducted along with power analysis to estimate the relative merits of adding covariates as explanatory variables in the trend test and to estimate the power of the sampling program to detect trends in these parameters under alternative sampling intensities and temporal assessment scales.

5 Parametric Trend Detection and Power Analysis

The purpose of this analysis was to:

- Compare the relative power of a parametric statistical timeseries model that was constructed in analogous fashion to the nonparametric seasonal Kendall Tau approach described above by incorporating a seasonal term and a variance component to account for autocorrelation in the timeseries.

- Attempt to add explanatory terms to the parametric model to account for explanatory factors that may affect the observed timeseries.
- Use the parametric model to create a simulation dataset containing the estimated timeseries for a particular parameter of interest and include natural variability.
- Conduct power analysis to evaluate the relative gains and losses in power by adjusting the annual sampling frequency of Pinellas County's monitoring program, and
- provide an expectation of the relative magnitude of change that could be detected over time by the sampling program with statistical certainty under the current and potential alternative designs.

5.1 Comparing Parametric and Kendall Tau Test Results:

Ninety three comparisons were conducted between the parametric timeseries model with only time and season as explanatory variables and the nonparametric KT test. For 88% of those tests, the outcome was identical, either identifying no trend or a decreasing trend. This results in a Cohen's Kappa Coefficient of 0.80 indicative of substantial agreement between the models (Cohen 1960). The Kendall Tau test was somewhat more powerful than the parametric test in that an additional 7 decreasing trends and 4 increasing trends were detected using the KT approach when the parametric approach yielded a result of no trend (Table 5-4-1). Adjustments for multiple comparisons were not considered for either the KT or parametric analysis for this assessment.

Table 5-4-1. Comparison of Parametric timeseries test and nonparametric Kendall Tau test

	Kendall Tau		
Parametric	Decreasing	Increasing	No Trend
Decreasing	12	0	0
Increasing	0	0	0
No Trend	7	4	70

Table 5-4-2. Strata identified as having a significant trend based on the Kendall Tau test and not significant using the parametric test.				
Strata	Parameter	Level	Parametric	Kendall Tau
E2	Total Phosphorus (mg/l)	Surface	No_Trend	Decreasing
SA	Total Nitrogen (mg/l)	Surface	No_Trend	Decreasing
SB	Total Nitrogen (mg/l)	Surface	No_Trend	Decreasing
W6	Total Phosphorus (mg/l)	Surface	No_Trend	Decreasing
W7	Total Nitrogen (mg/l)	Surface	No_Trend	Decreasing
W7	Total Phosphorus (mg/l)	Surface	No_Trend	Decreasing
W8	Total Phosphorus (mg/l)	Surface	No_Trend	Decreasing
SA	Dissolved Oxygen (mg/l)	Bottom	No_Trend	Increasing
SA	Dissolved Oxygen (mg/l)	Surface	No_Trend	Increasing
SB	Dissolved Oxygen (mg/l)	Bottom	No_Trend	Increasing
SB	Dissolved Oxygen (mg/l)	Surface	No_Trend	Increasing

5.2 Power Analysis

The ability to detect a trend in a given water quality parameter is a function of the magnitude of the trend, the sampling intensity, the statistical certainty (alpha level) and the unexplained variability in the measurement as well as the length of the period of record tested. To estimate the power of the current sampling design to detect trends in water quality, we used a method accepted by the South Florida Water Management District for optimization of their water quality monitoring network (Rust 2005). This method is constructed based on a parametric statistical modeling techniques and then utilizes the 5000 iterations of the seasonal Kendall Tau test for trend (Reckhow et al., 1993) based on a simulated dataset constructed from the parametric model.

Briefly, a timeseries of empirical water quality data was modeled using a parametric covariance pattern model. This method is constructed based on a parametric statistical modeling techniques and therefore uses natural log transformation of the response parameter to conform to the parametric model assumption of normal error distribution. A simulation data pool was constructed using the prediction timeseries equation and random natural variability was added to the time series using the error covariance matrix. Five thousand iterations of the seasonal Kendall Tau test for trend (Reckhow et al., 1993) were then performed by randomly subsampling a timeseries from the data pool to test alternative sampling frequency scenarios against the current sampling regime. For example, comparisons were made for a specific geographic sampling unit (e.g., E1) based on the current design (n=8), a bi-monthly design (n=6), a quarterly design (n=4), a design that samples 10 times per year, and a monthly design (n=12). These alternative sampling frequency scenarios were run for each geographic reporting unit sampled under the probabilistic design. These sampling intensities were also tested under various temporal assessment scales. For example, the results reported in Task 1a were based on 11 years of sampling between 2003 and 2013. We varied the length of the simulation timeseries from 10 to 25 years in 5 year increments (e.g. 10 years or 25 years) to assess the power of the design as a function of time as well as sampling intensity.

Again, for each temporal and sampling frequency scenario, a simulated (modeled) timeseries for a particular water quality parameter of interest was constructed from the data pool based on an assumed sampling intensity (e.g., bimonthly) and a seasonal Kendall Tau test was performed. This was repeated 5000 times. The results were then pooled and the power of each design to detect a trend in the water quality parameter of interest was computed by calculating the proportion of times that the test resulted in a statistically significant slope estimate. Four water quality parameters were included in the assessment: chlorophyll *a* (μg/l); dissolved oxygen (DO) (mg/l); total nitrogen (mg/l) and total phosphorus (mg/l).

To synthesize the results of the comparisons, box and whisker plots of the distribution of the percent change in the magnitude that could be detected with statistical confidence were constructed for each parameter. The box and whisker plots depict the percent change in two ways; as a function of the number of samples taken per year, and as a function of the length of the timeseries tested. For example, Figure 5-4-1 depicts the results for the chlorophyll power analysis. Each separate colored boxplot represents an annual sampling intensity tested. These box and whisker plots are grouped for each temporal assessment category (x axis). The results suggest a nonlinear decrease in the power of the test as a function of both decreasing sampling intensity and time. Under the current design scheme, the power of the KT test to detect changes in chlorophyll is approximately 60% as a median value for the ten year interval but the power increases by the 25 year interval to be able to detect a change as small as 36% as a median value. The boxplots tend to be elongated for the upper quartiles and the mean tends to be higher than the median value indicating that the power of the test is strata dependent (results were grouped across strata in these plots) with some strata resulting in disproportionally lower power than others with the minimum detectable change as high as 100% (i.e., concentrations would need to double) in some cases to be statistically significant.

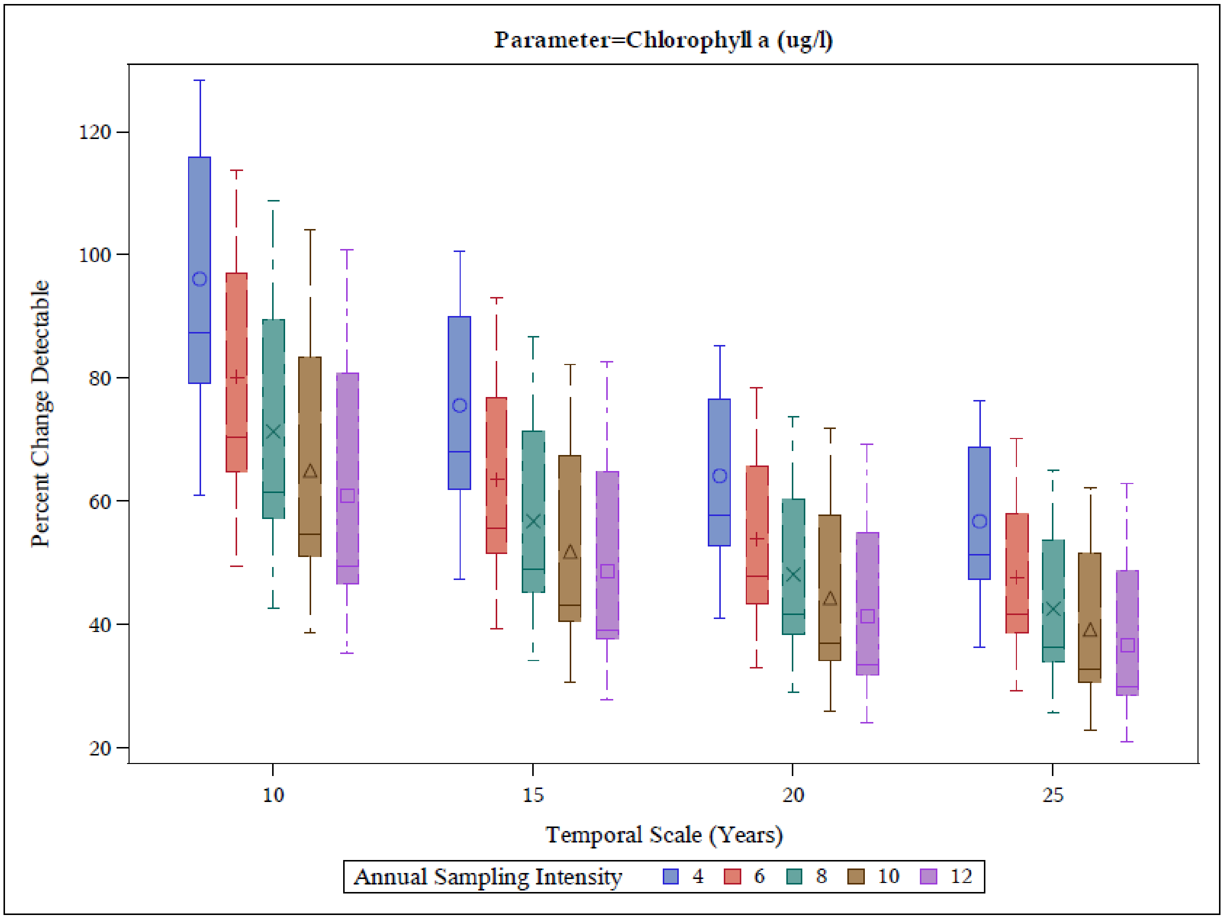

Figure 5-4-1. Results of the power analysis for chlorophyll *a* (μg/l).

Dissolved oxygen data tended to have much higher power to detect trends relative to chlorophyll with the average percent change detectable of about 20% at the current sampling intensity at the 10 year time interval (Figure 5-4-2). Outlier observations show up in the dissolved oxygen results for each temporal scale indicating for some stations, a near 50% change in DO would be necessary to be statistically significant.

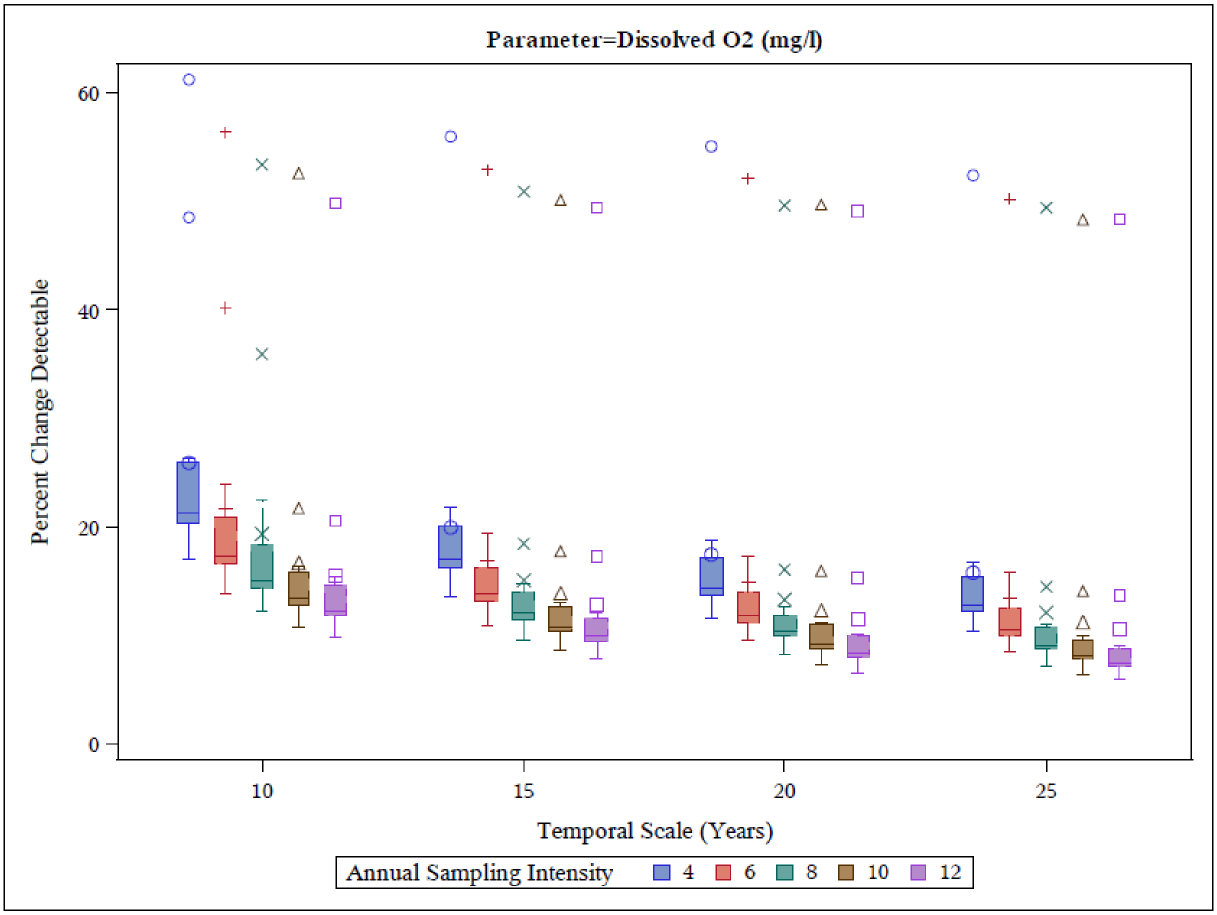

Figure 5-4-2. Results of power analysis for dissolved oxygen.

For total nitrogen, the median percent change under the current sampling intensity was 35% at the ten year interval but the mean percent change detectable was ca. 50% (Figure 5-4-3) and for some stations, a 150% increase in total nitrogen was necessary to be declared statistically significant.

Figure 5-4-3. Results of power analysis for total nitrogen (mg/l).

For total phosphorus, the percent change was ca. 50% under the current sampling intensity at a 10 year temporal sampling assessment. However, as with total nitrogen, some strata have very low power to detect change expressed as a percentage Figure 5-4-4. For total phosphorus this results was due to the preponderance of detection limit values reported for TP in Strata W1.

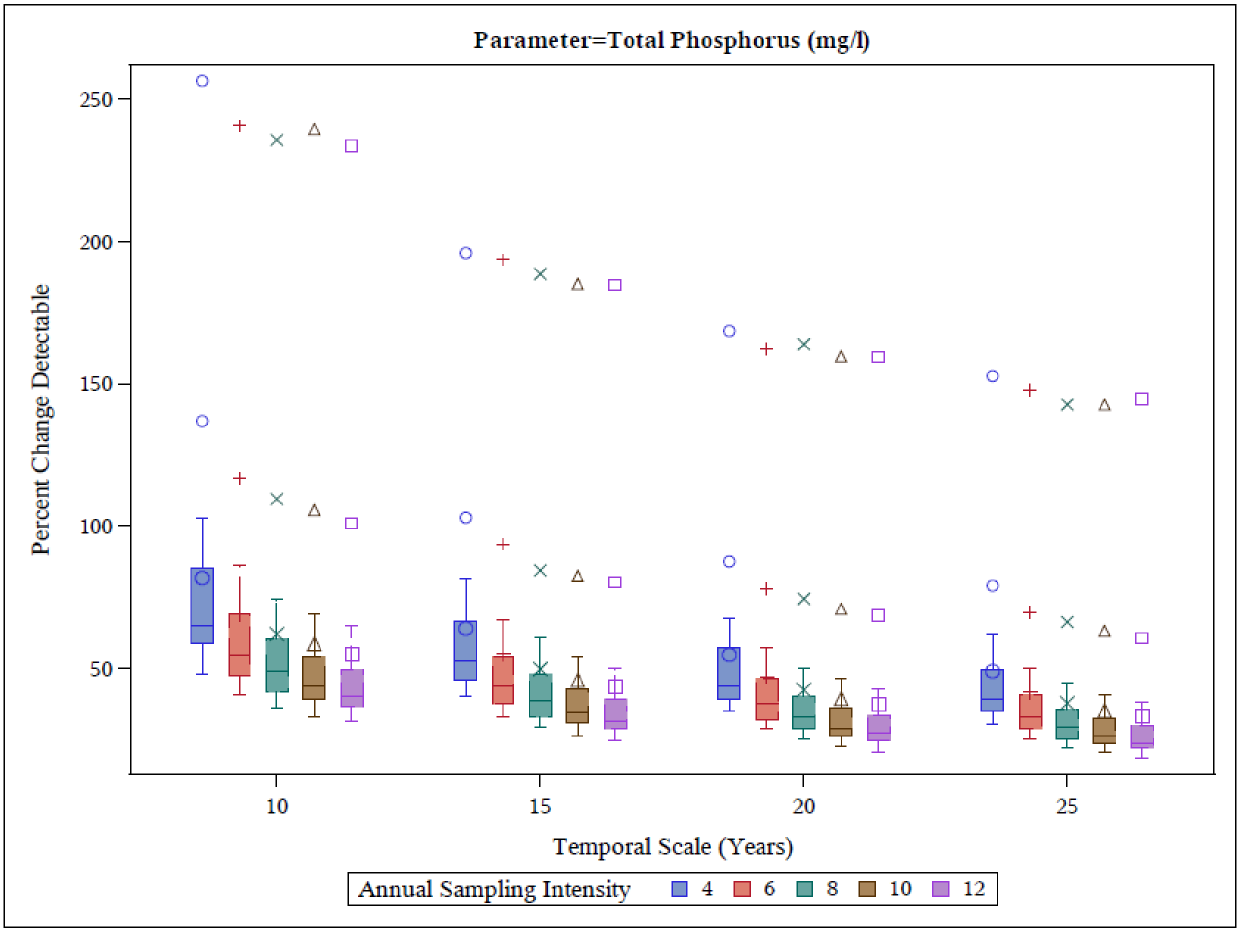

Figure 5-4-4. Results of power analysis for total phosphorus (mg/l).

The detailed results including the minimum, median, mean, and maximum percent change detectable for each parameter, sampling intensity, and temporal assessment scale is provided in Appendix B.

In summary, the current sampling program has sufficient power to detect a reasonable percent change in a parameter of interest at a ten year interval in most strata though the results were strata specific. There was some convergence issues with the mixed modeling procedure used to generate the sampling data pool to conduct the power analysis in some cases. These cases tended to be where the serial correlation could not effectively stabilize. These strata included strata RB for total nitrogen, W1 for total phosphorus, SA and W2 for DO and E1 and W5 for chlorophyll. Further, the procedure does not allow for missing data and therefore may have resulted in somewhat more robust estimates of the power of the test when translating these results to stations with a higher proportion of missing data. Despite these issues, the power analysis provides an expectation for the power of the sampling program to detect changes in important indicators of water quality at a reasonable time interval and illustrates the benefits of maintaining a long term program where compounding gains in the power of the monitoring program are achieved to accomplish objectives related to the ability to detect trends in water quality over time. The question of whether it is more efficient to increase sampling intensity or wait a longer period of time to increase the power or the test is a management decision based on available resources and constraints; however, because of multiyear oscillations in weather patterns such as droughts, and ENSO events, testing the results over a longer temporal assessment scale is beneficial to avoid reporting of results that are affected by these short term oscillations as the trend tests used only test for a monotonic trend in the timeseries and are not generally considered explanatory models. The ability to develop more explanatory models is described in the next section of this report.

5.3 Adding explanatory variables

A principal advantage of using the parametric models is that they allow for additional explanatory factors to be included in the models. Adding an explanatory factor can account for a potential confounding factor in the relationship between the magnitude of a particular parameter and time. This is especially true for short timeseries that could be influenced by meteorological oscillations resulting in drought and/or flood conditions that affect water quality responses. The Florida Department of Environmental Protection (FDEP 2013) has proposed to use timeseries analysis as weight of evidence in assigning impairment to waterbodies even if they may be currently attaining water quality standards and has described the need to account for confounding factors in the evaluation of timeseries trends. The FDEP did not sufficiently detail the methodology they propose to perform this test and this task is an initial effort to conduct such analysis.

The methods described above for conducting the parametric timeseries analysis were used to evaluate the potential for meteorological factors to affect the timeseries trend for the parameters used in the analysis above. Importantly the analysis above includes variance components that account for seasonality and autocorrelation in the statistical result, two factors not mentioned by FDEP that can significantly inflate the type I error (i.e., the probability of falsely declaring a trend as statistically significant) associated with the statistical outcome.

As part of a separate task for this work assignment (Task 5), a hydrologic index was developed to characterize rainfall and hydrologic conditions relative to their expected, long term monthly values. This index is very similar to standard methods used to characterize drought conditions such as the Standardized Precipitation Index, Palmer Drought Severity Scores (Guttman 1998), and even the El Nino Southern Oscillation (ENSO). These indices use a methodology that describes deviations from expected conditions in terms of “Departure from Normal”. We developed a similar index for Pinellas County based on the same concept that we refer to in this report as the “Pinellas County Precipitation Index (PCPI)” . The PCPI uses long term rainfall records from Tarpon Springs (Coopid = 8824), Clearwater Beach (Coopid = 1632), St. Petersburg Clearwater Airport (Coopid =12873) and Albert Whitted Airport in St Petersburg (Coopid 7886). The monthly rainfall summations for each station were cubic root transformed to help normalize the distribution and then the long term monthly average rainfall was calculated for each station. An index was developed for each station by standardizing a particular month’s value to the long term average:

That is:

$$\text{PCPI\_Tarpon} = \frac{x_{mi} - \mu_m}{\sigma_m}$$

Where:

x_{m_i} = monthly rain at Tarpon Springs for month *i*

μ_m = the long term monthly mean value for Tarpon Springs

σ_m = standard deviation of the monthly mean values

The individual station PCPI's were then averaged to represent an average index for the County. The average was used to create three parameters representing the month's particular value, the sum of the month and the previous month and the, 3 month cumulative sum. These cumulative totals represent antecedent conditions that can be tested in the timeseries modeling. An example plot of the index and the cumulative departures are provided in Figure 5-4-5 for the entire period of record. In Figure 5-4-6, the same data are plotted for only the 2003-2013 time period. In these plots negative values represent drier than normal conditions and positive values represent wetter than normal conditions. Horizontal reference lines at 1 and -1 represent deviations of a magnitude that have occurred approximately 15 percent of the time over the historical record.

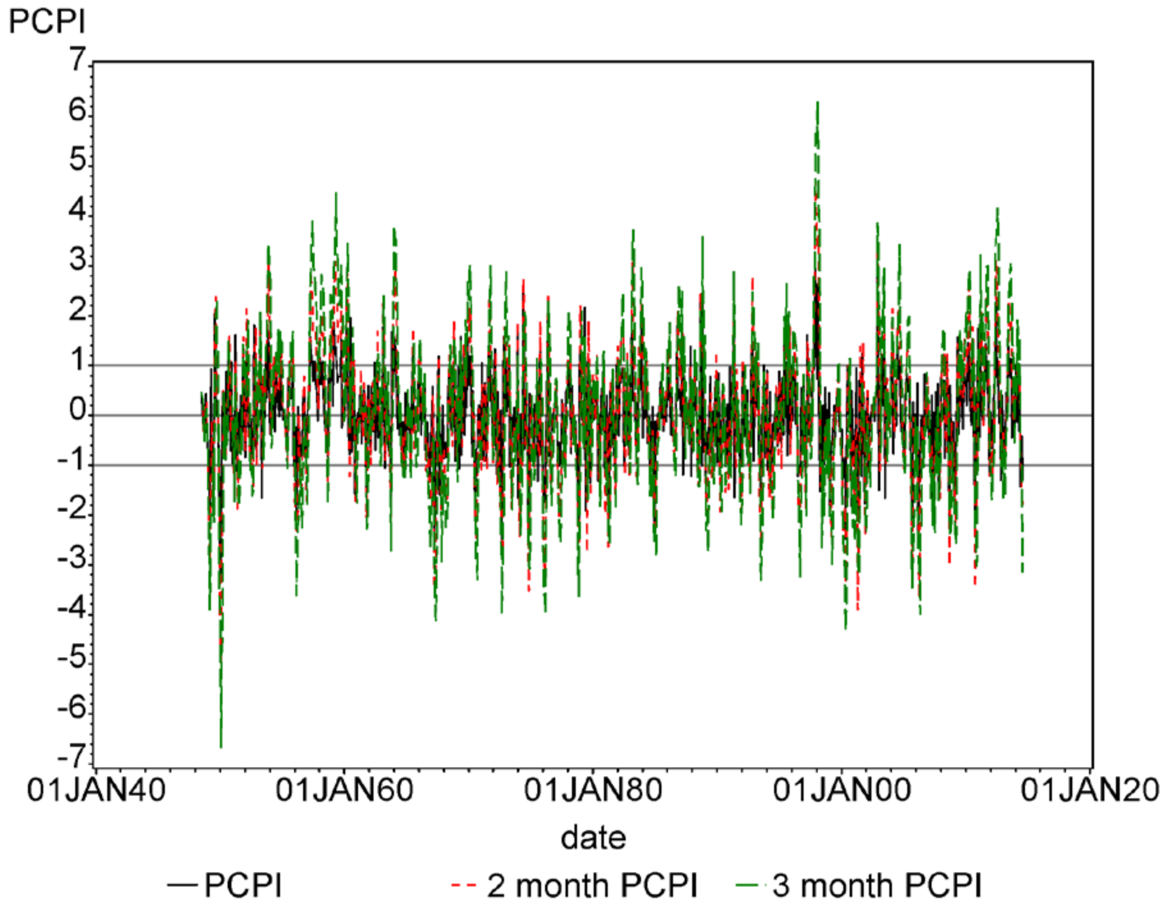

Figure 5-4-5. Pinellas County Precipitation Index for the long term period of record.

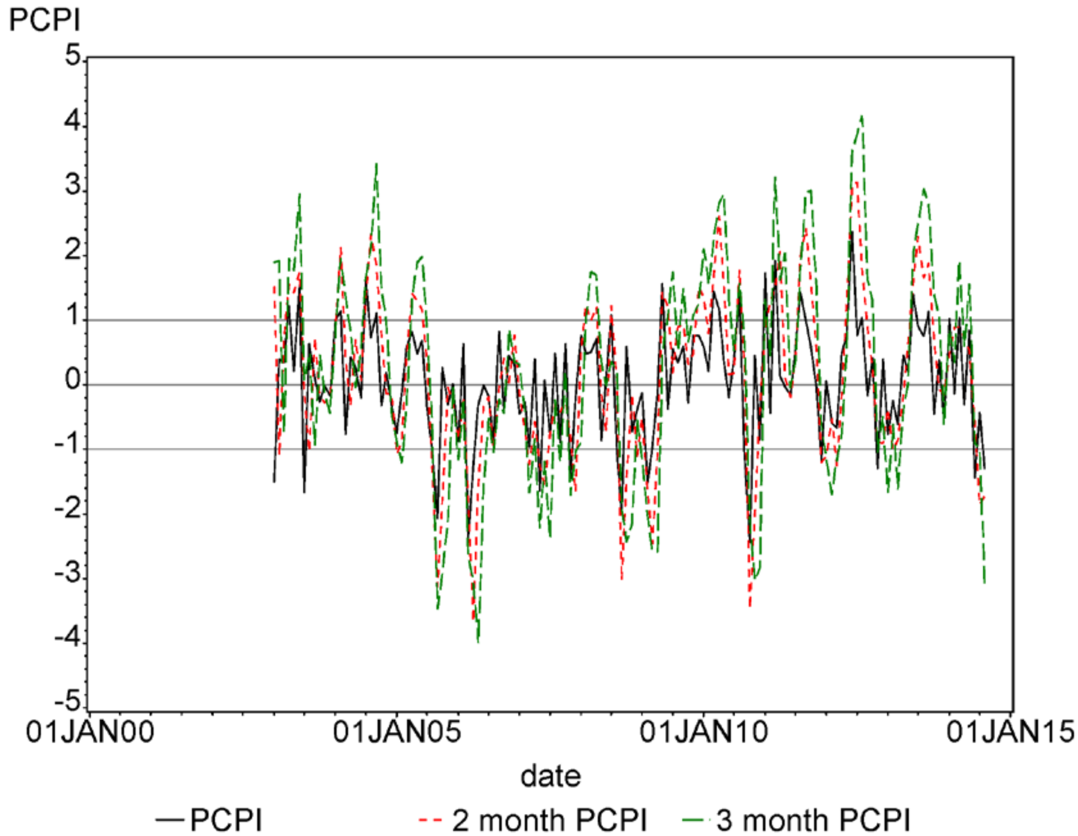

Figure 5-4-6. Pinellas County Precipitation Index between 2003 and 2014.

The PCPI parameters described above were used to assess the effects of variation in meteorological conditions on the trend test results. Out of the 80 tests conducted above, 10 of those tests resulted in a statistically significant effect due to the 3 month cumulative PCPI. Those stations included all four of the parameters tested. Four of those results were located in Lake Seminole and indicated that increased rainfall resulted in decreasing concentrations of Chlorophyll, TN, and TP in Stratum B and decreased TN in Stratum A (Table 5-4-3). Alternatively, in Strata E4 and E5 in Old Tampa Bay, increased rainfall resulted in increased chlorophyll concentrations.

Table 5-4-3. Strata with significant response to the 3 month cumulative PCPI .		
Strata	Parameter	PCPI Result
SA	Total Nitrogen (mg/l)	Decreasing
SB	Chlorophyll a (ug/l)	Decreasing
SB	Total Nitrogen (mg/l)	Decreasing
SB	Total Phosphorus (mg/l)	Decreasing
W2	Total Phosphorus (mg/l)	Decreasing
E4	Chlorophyll a (ug/l)	Increasing
E5	Chlorophyll a (ug/l)	Increasing
E7	Chlorophyll a (ug/l)	Increasing
W3	Dissolved Oxygen (mg/l)	Increasing
W4	Chlorophyll a (ug/l)	Increasing
W5	Total Nitrogen (mg/l)	Increasing

The inclusion of the PCPI only altered the trend test results in a single case where in Stratum E2, DO was found to be increasing once the PCPI was included in the model while both the parametric model without the PCPI term and the KT test results suggested no trend. However, the addition of the PCPI did, where significant, account for an approximately 5% reduction in the timeseries slope.

These results suggest that while climatological variation was a significant factor affecting water quality concentrations in several cases, its effect on the trend test results were minimal using the antecedent lags tested. Longer antecedent averages and testing the effects over a longer time series that had higher power to detect trends as demonstrated above would be beneficial to ensure that the relationships between antecedent rainfall conditions and variations in water quality were robust to forecast the effects of meteorological variation on water quality in these systems.

6 References

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Appendix A- Detailed Trend Results

Hyperlink

Appendix B – Trend Power Results

Appendix B. Results of timeseries power analysis across strata used in Pinellas County's probabilistic design. Statistics represent the % change detectable with statistical certainty under various potential alternative sampling frequencies and temporal scales. Higher numbers for these statistics represent lower power to detect.						
Parameter	Temporal Assessment Scale	Annual Sampling intensity	Minimum % Change	Median % Change	Average % Change	Maximum % Change
Chlorophyll a (ug/l)	10	4	61	87	96	128
Chlorophyll a (ug/l)	10	6	49	70	80	114
Chlorophyll a (ug/l)	10	8	43	61	71	109
Chlorophyll a (ug/l)	10	10	39	55	65	104
Chlorophyll a (ug/l)	10	12	35	49	61	101
Chlorophyll a (ug/l)	15	4	47	68	75	101
Chlorophyll a (ug/l)	15	6	39	56	64	93
Chlorophyll a (ug/l)	15	8	34	49	57	87
Chlorophyll a (ug/l)	15	10	31	43	52	82
Chlorophyll a (ug/l)	15	12	28	39	49	83
Chlorophyll a (ug/l)	20	4	41	58	64	85
Chlorophyll a (ug/l)	20	6	33	48	54	78
Chlorophyll a (ug/l)	20	8	29	42	48	74
Chlorophyll a (ug/l)	20	10	26	37	44	72
Chlorophyll a (ug/l)	20	12	24	34	41	69
Chlorophyll a (ug/l)	25	4	36	51	57	76
Chlorophyll a (ug/l)	25	6	29	42	48	70
Chlorophyll a (ug/l)	25	8	26	36	43	65
Chlorophyll a (ug/l)	25	10	23	33	39	62
Chlorophyll a (ug/l)	25	12	21	30	37	63
Dissolved O2 (mg/l)	10	4	17	21	26	61
Dissolved O2 (mg/l)	10	6	14	17	22	56
Dissolved O2 (mg/l)	10	8	12	15	19	53
Dissolved O2 (mg/l)	10	10	11	13	17	53
Dissolved O2 (mg/l)	10	12	10	12	15	50
Dissolved O2 (mg/l)	15	4	14	17	20	56
Dissolved O2 (mg/l)	15	6	11	14	17	53
Dissolved O2 (mg/l)	15	8	10	12	15	51
Dissolved O2 (mg/l)	15	10	9	11	14	50
Dissolved O2 (mg/l)	15	12	8	10	13	49
Dissolved O2 (mg/l)	20	4	12	14	18	55
Dissolved O2 (mg/l)	20	6	10	12	15	52
Dissolved O2 (mg/l)	20	8	8	10	13	50
Dissolved O2 (mg/l)	20	10	7	9	12	50
Dissolved O2 (mg/l)	20	12	7	8	12	49
Dissolved O2 (mg/l)	25	4	10	13	16	52
Dissolved O2 (mg/l)	25	6	9	11	14	50
Dissolved O2 (mg/l)	25	8	7	9	12	49
Dissolved O2 (mg/l)	25	10	7	8	11	48

Appendix B cont'd.						
Dissolved O2 (mg/l)	25	12	6	8	11	48
Total Nitrogen (mg/l)	10	4	35	49	63	158
Total Nitrogen (mg/l)	10	6	28	40	56	155
Total Nitrogen (mg/l)	10	8	25	35	52	154
Total Nitrogen (mg/l)	10	10	23	33	50	154
Total Nitrogen (mg/l)	10	12	21	31	48	153
Total Nitrogen (mg/l)	15	4	28	39	51	137
Total Nitrogen (mg/l)	15	6	23	32	46	136
Total Nitrogen (mg/l)	15	8	20	28	43	137
Total Nitrogen (mg/l)	15	10	18	26	41	135
Total Nitrogen (mg/l)	15	12	17	25	40	134
Total Nitrogen (mg/l)	20	4	24	32	44	121
Total Nitrogen (mg/l)	20	6	20	27	40	122
Total Nitrogen (mg/l)	20	8	16	24	37	119
Total Nitrogen (mg/l)	20	10	15	22	36	119
Total Nitrogen (mg/l)	20	12	14	21	34	119
Total Nitrogen (mg/l)	25	4	21	29	40	110
Total Nitrogen (mg/l)	25	6	17	24	36	111
Total Nitrogen (mg/l)	25	8	15	22	33	109
Total Nitrogen (mg/l)	25	10	13	20	32	108
Total Nitrogen (mg/l)	25	12	12	19	31	111
Total Phosphorus (mg/l)	10	4	48	65	82	256
Total Phosphorus (mg/l)	10	6	40	55	69	241
Total Phosphorus (mg/l)	10	8	36	49	62	236
Total Phosphorus (mg/l)	10	10	33	44	58	239
Total Phosphorus (mg/l)	10	12	31	40	55	234
Total Phosphorus (mg/l)	15	4	40	52	64	196
Total Phosphorus (mg/l)	15	6	33	44	55	193
Total Phosphorus (mg/l)	15	8	29	38	50	188
Total Phosphorus (mg/l)	15	10	26	34	46	185
Total Phosphorus (mg/l)	15	12	25	31	44	185
Total Phosphorus (mg/l)	20	4	35	44	55	169
Total Phosphorus (mg/l)	20	6	29	37	47	162
Total Phosphorus (mg/l)	20	8	25	33	42	164
Total Phosphorus (mg/l)	20	10	23	29	39	160
Total Phosphorus (mg/l)	20	12	21	27	37	159
Total Phosphorus (mg/l)	25	4	30	39	49	153
Total Phosphorus (mg/l)	25	6	25	33	42	148
Total Phosphorus (mg/l)	25	8	22	29	37	143
Total Phosphorus (mg/l)	25	10	20	26	35	143
Total Phosphorus (mg/l)	25	12	18	24	33	145