WATER QUALITY DATA ANALYSIS REPORT FOR THE CHARLOTTE HARBOR NATIONAL ESTUARY PROGRAM

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The Charlotte Harbor National Estuary Program is a partnership of citizens, elected officials, resource managers and commercial and recreational resource users working to improve the water quality and ecological integrity of the greater Charlotte Harbor watershed. A cooperative decision-making process is used within the program to address diverse resource management concerns in the 4,400 square mile study area. Many of these partners also financially support the Program, which, in turn, affords the Program opportunities to fund projects such as this. The entities that have financially supported the program include the following:

The U.S. Environmental Protection Agency Southwest Florida Water Management District, South Florida Water Management District, Florida Department of Environmental Protection, Florida Coastal Zone Management Program, Peace River/Manasota Region Water Supply Authority, Polk, Sarasota, Manatee, Lee, Charlotte and Hardee Counties, the cities of Sanibel, Cape Coral, Fort Myers, Punta Gorda, Venice and Fort Myers Beach, and the Southwest Florida Regional Planning Council.

EXECUTIVE SUMMARY

This report provides an extensive data compilation and analysis of water quality trends including rainfall, streamflow and surface water quality data collected throughout the Charlotte Harbor National Estuary Program (CHNEP) study area. The purpose of the report is to compile data for this extensive area, describe time series trends of these important indicators of environmental condition and report that information in an easily accessible format that can be effectively used by natural resource managers to characterize water quality conditions over an expansive area of southwest Florida. The analyses presented within incorporate the preponderance of data collected over the last century in basins that maintain an active monitoring program. For rainfall and streamflow these records may date back to 1940's while for water quality, the initial collection dates for routine monitoring programs tended to be in the early 1990's.

The core analytical technique employed for this project was the seasonal Kendall Tau test for trend (SKT: Reckhow et al. 1993). The SKT was performed for each station and parameter that met the inclusion criteria for the study (at least 5 years of routine monthly sampling with some data collected after 2005). Included in this core testing procedure were techniques to account for seasonality, autocorrelation and multiple comparisons in an effort to ensure that the reported statistical outcomes were valid, reliable and robust. These procedures are detailed in section 2 of this report. In addition to the core testing procedure, several additional analyses were conducted to supplement the SKT on the period of record data. For example, a comparison was made for the probabilistic data collected as part of the Coastal Charlotte Harbor Monitoring Network between the results of the SKT and a potentially more explanatory hierarchical parametric time series model. For long term stations with more than 20 years of routine data collection, an analysis was conducted to determine if shorter term trends were evident within the longer time series of data. Finally, some recommendations were made for improving future efforts to correlate water quality trends with anthropogenic changes in the watershed.

The results of the rainfall analyses indicated that over the long term period of record there were no apparent trends in rainfall. In other words, rainfall varied seasonally in a predictable way but there was insufficient evidence to suggest that rainfall was either declining or increasing at the basin level over time. The results of the stream flow trend analyses indicated that statistically significant trends were prevalent for certain stream flow parameters in many of the rivers and streams throughout the CHNEP study area. Stream flow changes have occurred in terms of magnitude of flows as well as timing and volume of flows as described by the 32 aspects of the Index of Hydrologic Alteration (IHA). For example, the annual 1 day and 30 day flow maxima in the Estero Bay and Cape Coral area appeared to be increasing, coincident with decreases in the number of low flow pulses. From these results, it may be concluded that changes to stream flow have been occurring at statistically significant rates for many streams over the period of record. Many of the strongest IHA stream flow changes were observed to occur in the Cape Coral peninsula area and the Estero Bay watershed, and these locations were also locations where changes in water quality were detected. However, these results are not a direct causative expression of relationships between stream flow and water quality as these trends can represent differing periods of record. Other potential sources of surface water quality declines include changes in pollutant loading from non-point sources in the watershed, point sources, and or atmospheric deposition.

Reporting of surface water quality trends was divided into three regions; the Myakka River region, the Peace River region, and the Southern Coast region that includes Charlotte Harbor Proper, the Caloosahatchee River and Estero Bay. The results of the surface water quality status and trends analyses indicated that there have been both areas of stable or improving water quality as well as areas of declining water quality in many of the basins in the CHNEP study area. In the Myakka River region trends were mostly stable in the estuarine segments with isolated improving trends in total phosphorus and color. There were a few degrading trends in chlorophyll in the Lower Myakka River basin that were correlated with small increases over time in total kjeldahl nitrogen and increases in bottom salinity. Dissolved oxygen concentrations were largely stable throughout the region. In the Peace River Region, there were several stations with increasing salinity and pH trends in the Coastal Lower Peace sub-basin. Despite some degrading trends in total kjeldahl nitrogen and total nitrogen, chlorophyll trends were mostly stable; however, some degrading trends in dissolved oxygen concentration were noted. Otherwise water quality throughout the Peace River Region where mostly stable over time. The exception was in the Peace at Zolpho Springs sub-basin where there were a majority of the chlorophyll a and total nitrogen trends were found to be degrading. These stations were located in one particular area within the sub-basin and may warrant further investigation. The Southern Coast Region includes many of the estuarine segments within Charlotte Harbor as well as the Caloosahatchee River and the Estero Bay watershed. In the estuary, most parameters were stable over time; however, there were a few improving trends including the light attenuation parameter Kd that was found to be improving in the upper segments of Charlotte Harbor including East Wall, West Wall, And the tidal portions of the Peace and Myakka Rivers. This corresponded with improvements in total kjeldahl nitrogen and total nitrogen trends in the same area. However, small degrading trends were also noted such as total suspended solids in Bokeelia, Pine Island Sound, San Carlos Bay and Matlacha Pass. In the watershed sub-basins, there was consistent evidence of improving trends in chlorophyll a throughout the region and very few degrading trends. This occurred despite increasing trends in nitrogen for many of the same stations. Trends in total phosphorus depended largely on which side of the Caloosahatchee River the station was located with improving trends south of the river and degrading trends north of the river. There were also some stations with increasing copper and chromium concentrations isolated to within the Tidal Caloosahatchee sub-basin.

An important addition to water quality monitoring in the CHNEP boundaries was the incorporation of a probabilistic sampling design for estuarine water quality. These data collections began between 2001 and 2003 and continue throughout the estuarine segments of the CHNEP to date. The data collected has been a valuable asset in supporting water quality targets protective of important natural resources in CHNEP estuaries. Due to the nature of the sampling design, these data required additional analysis to ensure that the SKT method remained a valid estimator of time series trends. Results suggested that there was good agreement between the results of the SKT and the parametric modeling efforts with over 70% of the results identical. The SKT method was more powerful in most cases where there was disagreement between model outcomes but both methods appeared adequate to provide inference on the segment level water quality timeseries trends in the CHNEP estuarine segments.

Together these results present a great deal of information regarding the recent trends in water quality in the CHNEP basin supporting the aims of the CCMP. The results presented within, along with the tools developed for this project, provide valuable information to scientist and managers to support science-based decision making to identify areas where water quality conditions have improved throughout the region and identify areas where actions may be necessary to ameliorate further declines in water quality as well as identify potential areas for restoration activities. The results of this project aid the CHNEP in promoting the effective long-term management of estuaries whose ecological integrity is potentially at risk due to pollution, development or overuse.

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The authors wish to acknowledge the following individuals and groups who contributed to the guidance and resources needed to complete this report: Judy Ott, CHNEP Senior Scientist and Project Manager; Lisa Beever, CHNEP Director; The staff of the CHNEP; The CHNEP Technical Advisory Committee and the Water Quality subcommittee and all the CHNEP partners who provided data and support for this project including: the Southwest Florida Water Management District, South Florida Water Management District Peace River/Manasota Region Water Supply Authority, Polk, Sarasota, Manatee, Lee, Charlotte, and Hardee counties, the cities of Sanibel, Cape Coral, Fort Myers, Punta Gorda, Venice and Fort Myers Beach, and the finally, the Charlotte Harbor Aquatic Preserve.

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1.0 Introduction

The Charlotte Harbor National Estuary Program (CHNEP) has developed a Comprehensive Conservation and Management Plan (CCMP) (CHNEP, 2000) to address important environmental goals for the study area. These goals were translated into quantifiable objectives in the most recent CCMP update (CHNEP 2008).

The Goals of the Charlotte Harbor National Estuary Program are:

1. Improve the environmental integrity of the Charlotte Harbor study area.
2. Preserve, restore, and enhance seagrass beds, coastal wetlands, barrier beaches, and functionally related uplands.
3. Reduce point and non-point sources of pollution to attain desired uses of the estuary.
4. Provide the proper fresh water inflow to the estuary to ensure a balanced and productive ecosystem.
5. Develop and implement a strategy for public participation and education.
6. Develop and implement a formal Charlotte Harbor management plan with a specified structure and process for achieving goals for the estuary.

In support of these program goals, the water quality status and trends project was initiated to provide the information needed to:

- prioritize areas of the estuary for improvements (CHNEP Goal 1),
- identify conditions that threaten habitats or provide opportunities for habitat enhancement (CHNEP Goal 2),
- identify water quality responses to sources of pollution in support of source reduction efforts (CHNEP Goal 3),
- identify impacts to freshwater inflows and salinity regimes (CHNEP Goal 4),
- provide background scientific results for incorporation into public education materials (CHNEP Goal 5), and
- provide a statistical framework for future monitoring of the effectiveness of management actions associated with CHNEP Goal 6.

Evaluations of water quality status and trends are an important element of the NEP review and evaluation process, and are conducted on a regular basis throughout the implementation of the CCMP (EPA, 1991).

Specific Objectives of this Project

In order to address the goals of this project, the CHNEP identified a series of specific objectives to be completed as follows:

Objective 1 Compile initial data sets for surface water quality, hydrology, and rainfall.

Objective 2 Survey regional experts to identify potential data sources that were not captured in Objective 1.

Objective 3 Review the data and identify the datasets that meet the project criteria for availability, documentation of metadata, and quality control.

Objective 4 Prepare datasets that meet the project criteria and will be used in the analysis of water quality status and trends.

Objective 5 Conduct analyses of temporal water quality trends within the study area.

Objective 6 Supplement trends analyses with additional analysis to provide additional context to trends results.

Objective 7 Prepare a final report, an ArcGIS geodatabase, and datasets summarizing the project results.

The final report is produced using Adobe PDF® software and organized in a hierarchical fashion, linked to a series of digital bookmarks, and cross referenced with summary tables to detailed graphical output to allow for easy review of summary information as well as intensely detailed station and parameter level output for each trend test result.

Project Scope and Geographic Extent

The geographic extent of the project study area comprises the entire boundary of the Charlotte Harbor Estuary Program. The results are organized in a hierarchical fashion ranging from study area-wide discussions (regional maps of flow, rainfall, and surface water quality) to presentations of individual sampled values for specific stations (statistical detail digital appendices). The geographic extent of the project study area is provided in Figure 1-1.

The water quality parameters defined for this project were identified by the CHNEP, and they are presented in Table 1-1.

The analyses for this report include:

- comprehensive flow trend analyses (Chapter 3);
- rainfall trend analyses (Chapter 4);
- surface water quality trend analyses (Chapter 5);
- probabilistic data trend comparisons (Chapter 6), and
- summary and recommendations (Chapter 7).

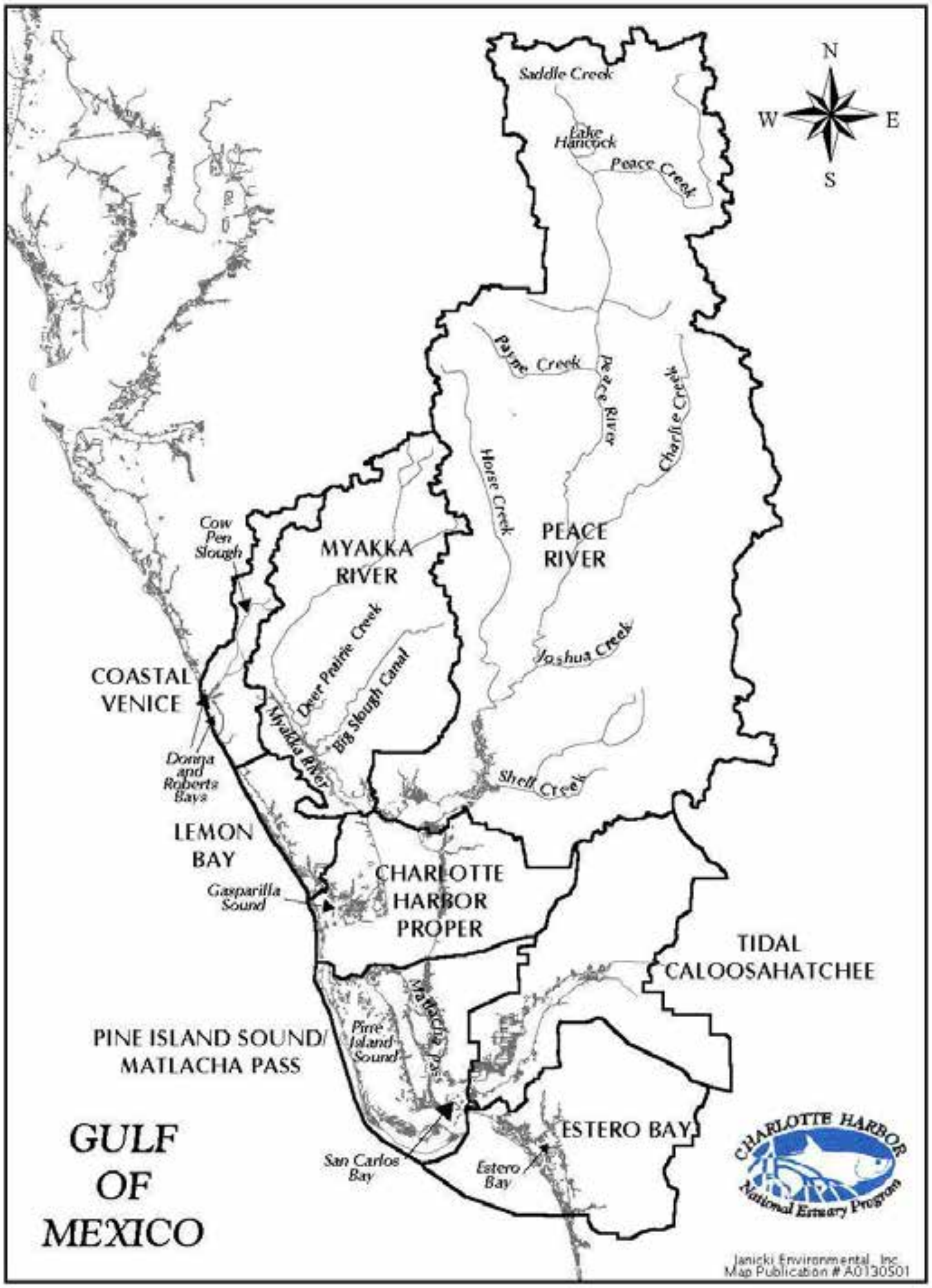

Figure 1-1. The project study area.

Table 1-1. Water quality parameters identified for trend analysis in fresh and estuarine waters.

Marine/Estuarine Core Constituents	Freshwater Core Constituents
Chlorophyll-*a* (corrected for phaeophytin)	Chlorophyll-*a* (corrected for phaeophytin)
Total ammonia nitrogen	Total ammonia nitrogen
Total nitrate + nitrite nitrogen	Total nitrate + nitrite nitrogen
TKN (as needed to calculate TN)	TKN (as needed to calculate TN)
Total Nitrogen	Total Nitrogen
	Unionized Ammonia
Total Phosphorous	Total Phosphorous
Orthophosphate	Orthophosphate
Dissolved Oxygen	Dissolved Oxygen
Biochemical Oxygen Demand $_5$	Biochemical Oxygen Demand $_5$
Total coliform bacteria	Total coliform bacteria
Fecal coliform bacteria	Fecal coliform bacteria
Enterococci bacteria	Enterococci bacteria
Specific conductance	Specific conductance
	Chlorides
	Sulfides
	Total Dissolved Solids
Copper	Copper
Lead	Lead
Iron	Iron
Colored Dissolved Organic Matter	Colored Dissolved Organic Matter
Turbidity	Turbidity
PAR (light attenuation, Kd)	
Secchi disk depth	Secchi disk depth
Total Suspended Solids	Total Suspended Solids
Dissolved Organic Carbon	Dissolved Organic Carbon
Salinity	
pH	pH
Temperature	Temperature
Streamflow IHA statistics and rainfall	
Monthly median discharge	Annual minimum (1,3,7,30,90 day)
Number of high pulses	Number of low pulses
Mean duration of high pulses	
Basin average interpolated monthly rainfall	

2.0 Methods

Here were three principal tasks associated with this report for which methods are described: data compilation; core trend testing, and supplemental analysis. The methods associated with each of these separate tasks are detailed in separate appendices associated with this section. Below is a concise description of the methodologies used to complete each phase of the project with references to literature and detailed appendices that complement each section.

2.1 Data Compilation:

This goal of the data compilation effort was to provide a comprehensive inventory of data from active monitoring programs with the CHNEP boundaries. These agencies are listed in Table 2.1. Individual data providers were contacted and data requests were made to each identified incorporate in an effort to update the database through 2011 as available. If the data provider referenced downloading data from the FDEP STORET database, STORET was used as the data source. STORET was also used to fill in any data gaps. A master data template was constructed and each individual data providers data were transformed to match the master template format.

Duplicate values and equipment blanks were not included in the data compilation effort. Values coded as below the detection limit were set to the detection limit. Quality assurance codes were used to screen the data as described by FDEP methods (**Appendix 2.1**). Once the individual provider data files were screened and transformed into the master template, summary statistics were generated that characterized the sampling frequency at each station and the distribution of values for each parameter of interest. Any obvious outliers such as negative values, or values generally outside the accepted range of values were set to missing.

Table 2-1. Data sources for CHNEP status and trends update.

Region	Collection Agency	Contact
Cape Coral/Matlacha Pass/Tidal Caloosahatchee	Cape Coral	Kraig Hankins Cape Coral
Coastal Charlotte Harbor	Charlotte Harbor Volunteer Monitoring Network (CHEVWQMN)	Melinda Brown Charlotte Harbor Aquatic Preserve
Coastal Charlotte Harbor	Florida Wildlife Research Institute (FWRI)	Tim MacDonald FWRI
Coastal Charlotte Harbor	Coastal Charlotte Harbor Monitoring Network (CCHMN)	Inter-Agency
Lee County	Lee County Fixed Station and CCHMN Network data	Keith Kibbey Lee County
Manatee County	Manatee County	Greg Blanchard/STORET
National Weather Service (Rainfall data)	NWS	http://water.weather.gov/precip/
Polk County	Polk County	STORET
Peace/Myakka	SWFWMD/DEP	Catherine Wolden/ Kate Muldoon
Rookery Bay	FIU / SERC	Joe Boyer
Sarasota County	Mote Marine Lab	Jon Perry
United States Geological Service (WQ data)	USGS	STORET
United States Geological Service (Streamflow data)	USGS	http://waterdata.usgs.gov/fl/nwis/

2.2 Kendall Tau Trend Test

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. 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 data 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. This sample page (and each page of the detailed output) was indexed with a display number that is unique for the particular appendix. The location of the display number on this page is indicated by label 1 (annotated labels are circled, and are not part of the actual outputs). The display numbers may be electronically searched in the PDF documents, are linked to electronic bookmarks, and are indexed to the digital page slider bar in the PDF files.

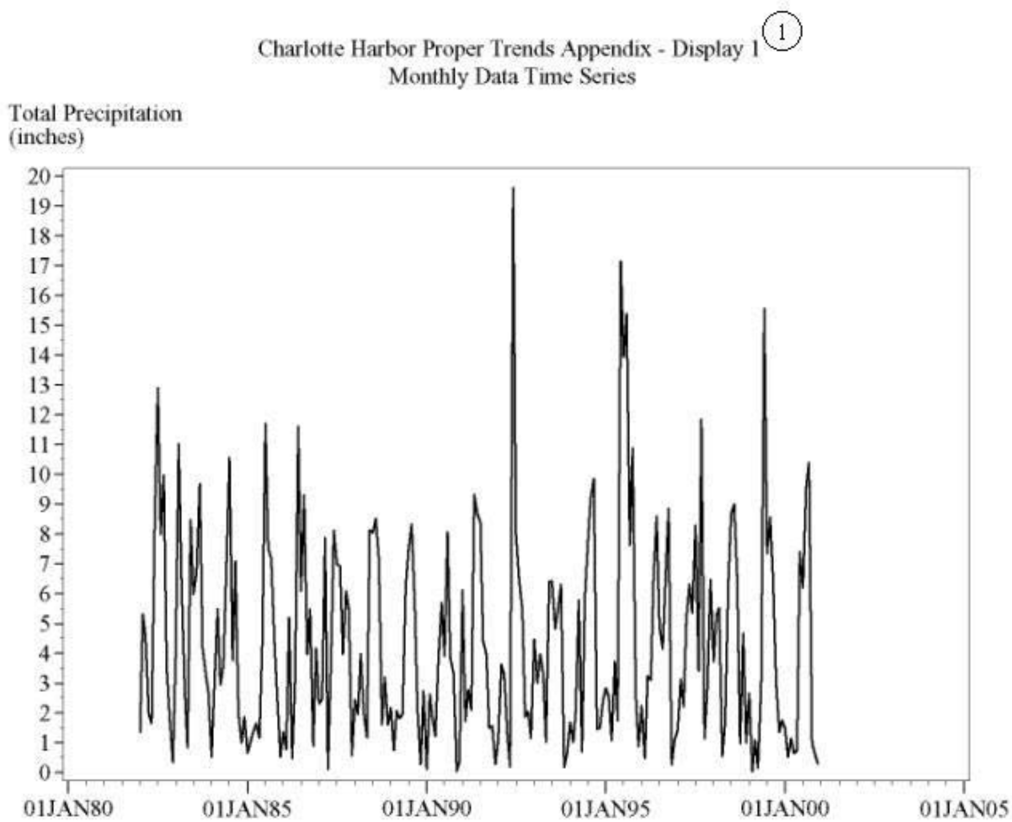

Figure 2-1. **Sample trend results output for step 1.**

In the second step of the trend analysis, the time series data are averaged to monthly values, and a complete set of univariate statistics is calculated to present the seasonality of the data on a monthly intra-annual basis. This figure provides a valuable overall view of the seasonality of the data.

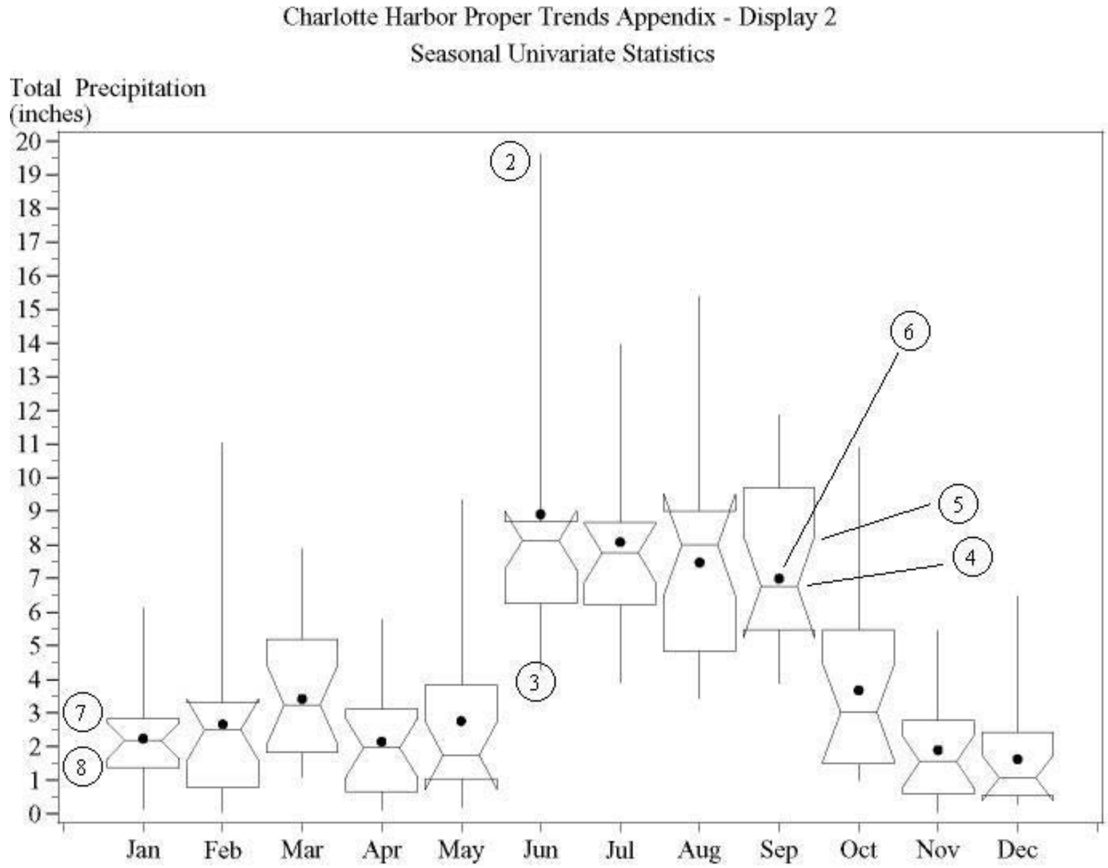

Figure 2-2. **Sample seasonal univariate results output for step 2.**

Figure 2-2 presents an example page from the results of the second step. The annotated labels indicate the following features: 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. If the confidence limits around the medians for any pair of months 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 monthly value, the previous month's value, two months prior, etc., until correlation statistics have been calculated for all previous months up to 15 months prior. A table of these values is provided in the output (Display 3 not shown).

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-month lag values to be negatively correlated and the 12-month lag values to be positively

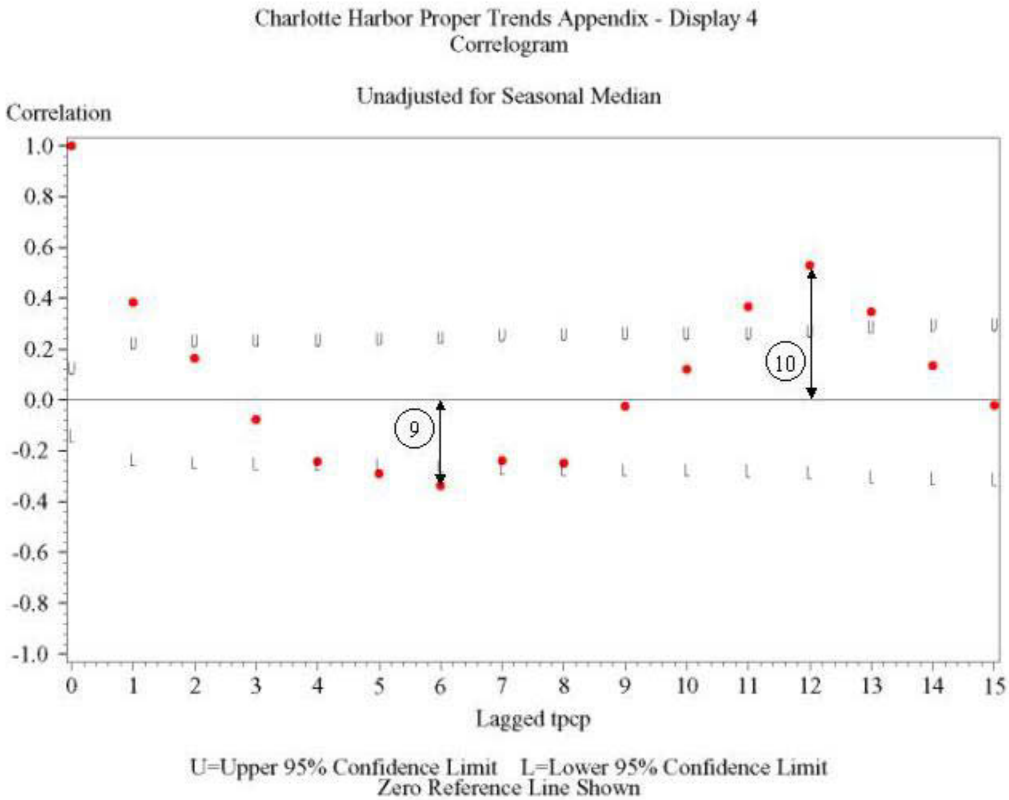

Figure 2-3. Sample seasonality test information output for step 4.

correlated. The objective test measures the proportional distance between the zero line and the lower 95% confidence limit for the 6-month lag correlation (label 9), and the proportional distance between the zero reference line and the upper 95% confidence limit for the 12-month 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 monthly 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 in the appendices 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).

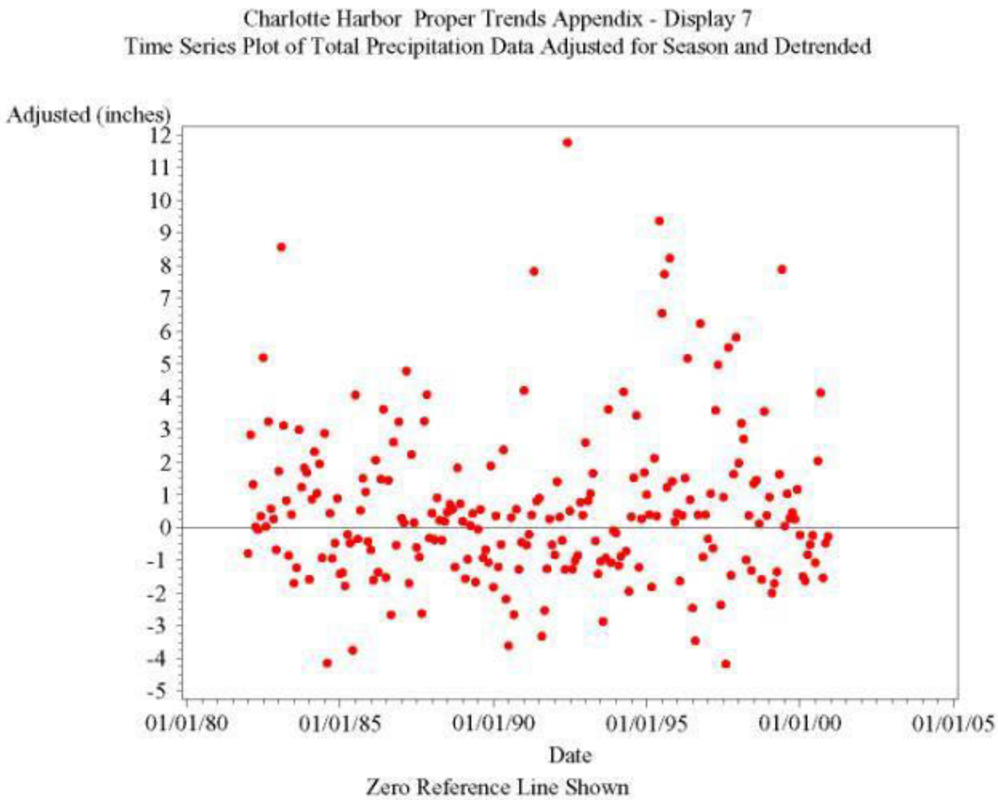

Figure 2-4. An example of the season adjusted and de-trended data.

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-month lag (label 11) or the 2-month 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 from the pages of output and tabulated in a summary table of trend test results. For the surface water quality trend tests, these tabulated summaries are indexed to the detailed pages of outputs through the display numbers.

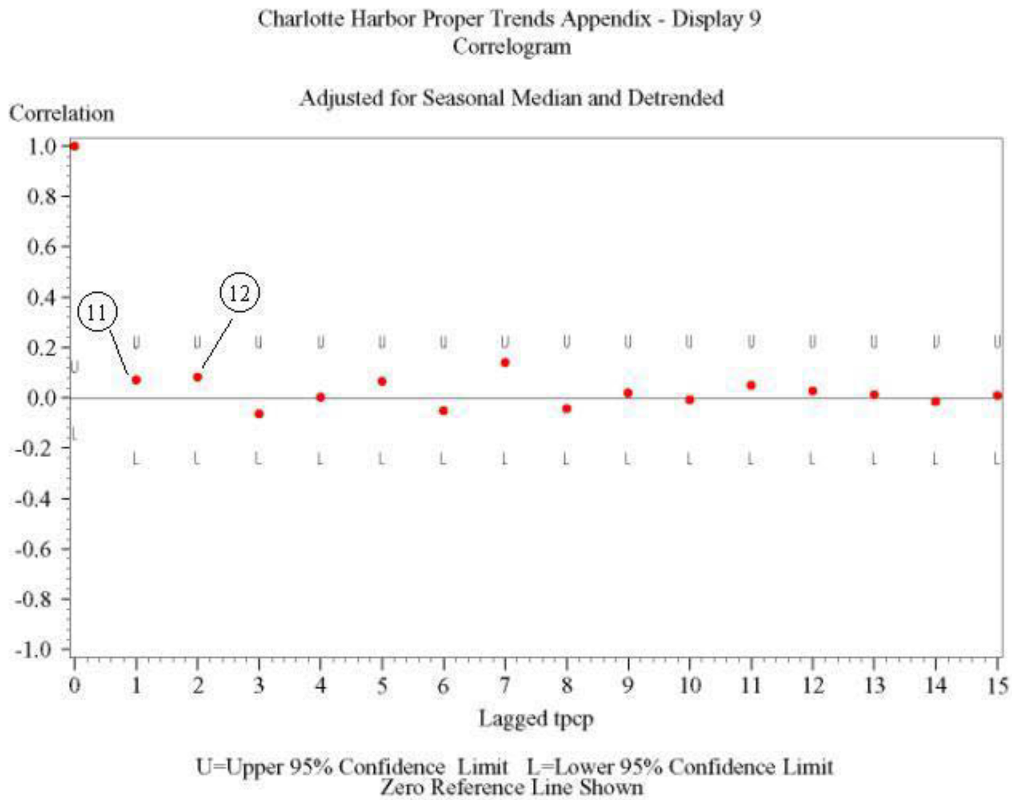

Figure 2-5. Sample autocorrelation test figure.

Due to the large number of station/parameter combinations tested, an adjustment was made to the p values when reporting significant 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. Details of the testing procedures can be found in **Appendix 2-2**.

Inverse distance weighting was used to interpolate the rainfall data in order to provide an estimate of rainfall to each basin center within the CHNEP boundary. The trend test was then conducted on the monthly sum of the weighted average. For stream flow, the non-seasonal form of the Kendall Tau test was applied to the Index of Hydrologic Alteration (IHA) metrics for complete periods of record. A non-seasonal approach was applied because the IHA method already synthesizes seasonal metrics, and provides information for each year of the time series. The IHA provides a method for assessing hydrologic alterations in the watershed by examining a comprehensive suite of hydrologic metrics that may have been altered by human activities (Richter et al., 1996). A summary of the IHA parameters is provided from Richter and others in the following table.

Table 2-2. The suite of IHA metrics from Richter et al. (1996).

Table 1. Summary of hydrologic parameters used in the Indicators of Hydrologic Alteration and their characteristics.

IHA statistics group	*Regime characteristics*	*Hydrologic parameters*
Group 1: Magnitude of monthy water conditions	Magnitude Timing	Mean value for each calendar month
Group 2: Magnitude and duration of annual extreme water conditons	Magnitude Duration	Annual minima 1-day means Annual maxima 1-day means Annual minima 3-day means Annual maxima 3-day means Annual minima 7-day means Annual maxima 7-day means Annual minima 30-day means Annual maxima 30-day means Annual minima 90-day means Annual maxima 90-day means
Group 3: Timing of annual extreme water conditions	Timing	Julian date of each annual 1 day maximum Julian date of each annual 1 day minimum
Group 4: Frequency and duration of high and low pulses	Magnitude Frequency Duration	No. of high pulses each year No. of low pulses each year Mean duration of high pulses within each year Mean duration of low pulses within each year
Group 5: Rate and frequency of water condition changes	Frequency Rate of change	Means of all positive differences between consecutive daily means Means of all negative differences between consecutive daily values No. of rises No. of falls

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In the first step of the stream flow analyses, IHA metrics were calculated for each year for each gage. Note that only verified flow data were used in the development of the IHA statistics. Therefore, the period of record for trend tests using the IHA method ended in 2010 rather than 2011. In the second step of the stream flow analyses, trend tests were conducted on each of the individual IHA metrics for each gage, and a complete set of plots was compiled into appendices. An example plot for one of the metrics is provided in Figure 2-6. In this plot, the vertical reference lines represent the period of record for which the water quality data were tested for trends for the same basin.

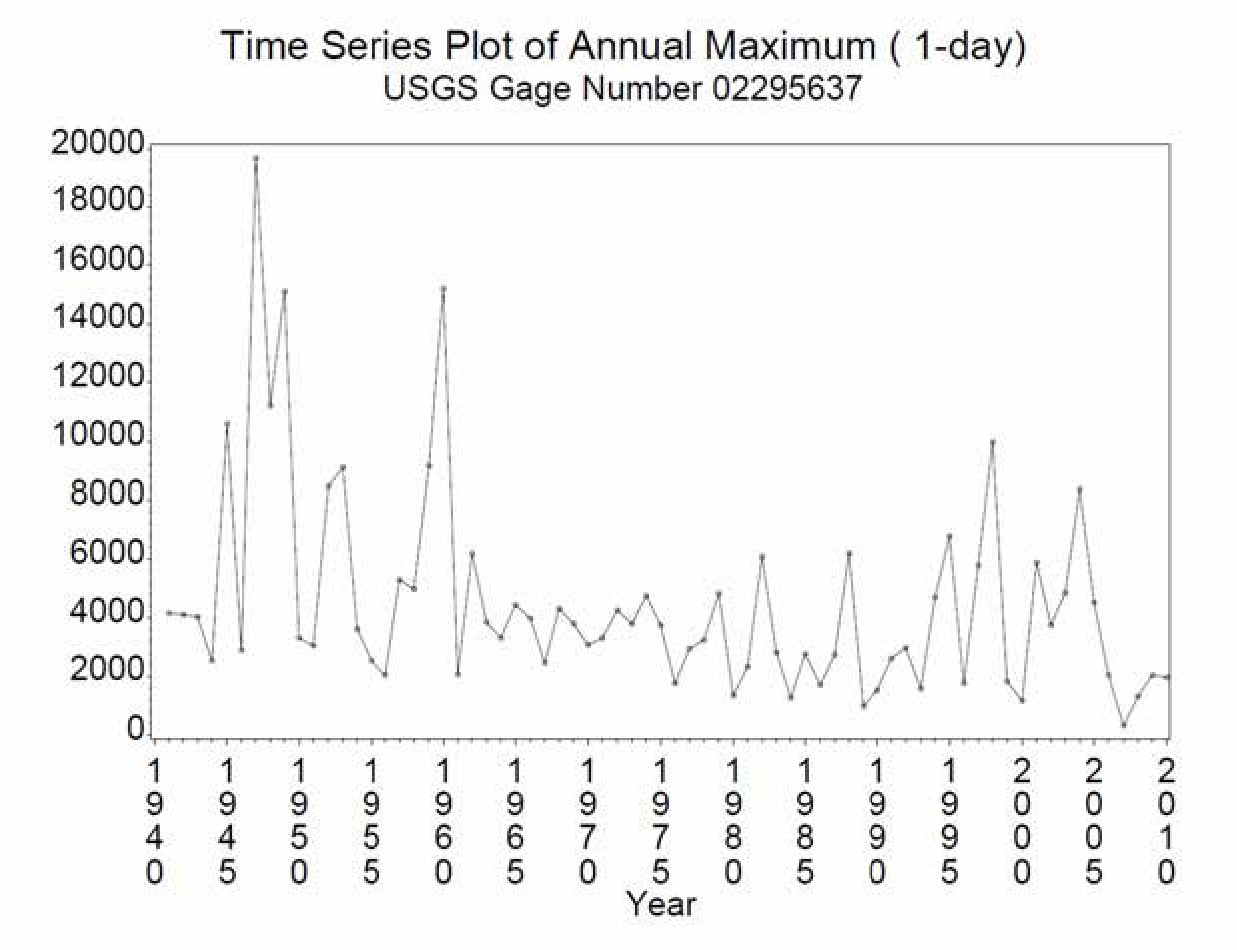


Figure 2-6. Example plot of an IHA metric for a stream flow gage (actual report output).

In the final step of the flow trend testing, the IHA parameters are tested for trends and compiled by gage into summary tables.

IHA Parameter Trend Summary

Name=Peace River At Zolfo Springs USGS Gage=02295637

IHA Parameter	Trend Direction	Significant Trend?	Rate of Change (% of Median/Year)	Relative Change	Trend Period
Mean Duration of High Pulses	Decreasing	Yes	Small	1%	1941-2010
Number of High Pulses(>75th Percentile)		No			1941-2010
Mean Duration of Low Pulses	Increasing	Yes	Small	2%	1941-2010
Number of Low Pulses (<25th Percentile)		No			1941-2010
Annual Maximum (1-day)	Decreasing	Yes	Small	1%	1941-2010
Annual Maximum (30-day)		No			1941-2010
Annual Maximum (3-day)	Decreasing	Yes	Small	1%	1941-2010
Annual Maximum (7-day)	Decreasing	Yes	Small	1%	1941-2010
Annual Maximum (90-day)		No			1941-2010
Median Jan Flow		No			1941-2010
Median Oct Flow		No			1941-2010
Median Nov Flow	Decreasing	Yes	Small	1%	1941-2010
Median Dec Flow	Decreasing	Yes	Small	1%	1941-2010
Median Feb Flow		No			1941-2010
Median Mar Flow		No			1941-2010
Median Apr Flow		No			1941-2010
Median May Flow	Decreasing	Yes	Small	1%	1941-2010
Median Jun Flow		No			1941-2010
Median Jul Flow		No			1941-2010
Median Aug Flow		No			1941-2010
Median Sep Flow		No			1941-2010
Annual Minimum (1-day)	Decreasing	Yes	Small	2%	1941-2010
Annual Minimum (30-day)	Decreasing	Yes	Small	1%	1941-2010
Annual Minimum (3-day)	Decreasing	Yes	Small	2%	1941-2010
Annual Minimum (7-day)	Decreasing	Yes	Small	2%	1941-2010
Annual Minimum (90-day)	Decreasing	Yes	Small	1%	1941-2010
Average Fall	Increasing	Yes	Small	1%	1941-2010
Average Rise	Decreasing	Yes	Small	1%	1941-2010
Number of Falls		No			1941-2010
Number of Rises		No			1941-2010

Figure 2-7. Example IHA trend test summary table.

Flow Duration Curves

Flow duration curves were also constructed for each gage, and compared across three relevant periods of record: the stream flow gage period of record through December 2011, the water quality trend analysis period of record (1975) through December 2011, and the CHNEP (1995-2011) period of record. An example plot is provided in Figure 2-8.

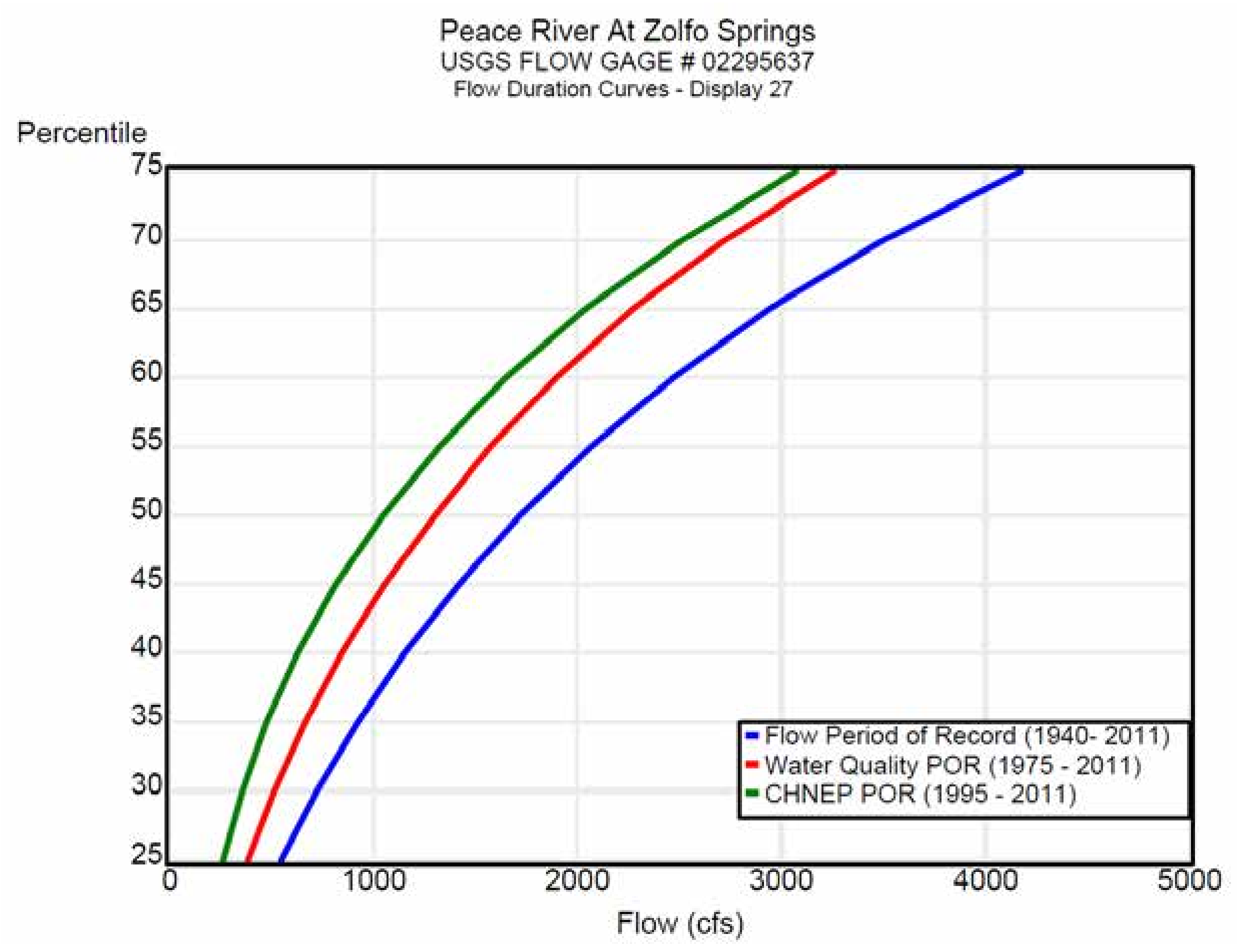


Figure 2-8. **Example flow duration curves constructed from three relevant periods of record.**

The complete surface water quality dataset was assessed to determine suitability for trend and status analysis. If the data met the requirements of the data compilation phase of the project, then the core statistical SKT test was performed for the period or record for each station, sample level and parameter. Trend tests were conducted for surface and bottom values separately as requested by the CHNEP TAC subcommittee. The seasonal Kendall Tau methods were applied as previously described for the rainfall analyses. The detailed trend results were then summarized in the results section. A comprehensive set of maps and tables is provided in the water quality results section of this document, and statistical detail pages are provided in interactive PDF files in the report CD. The display range presented in the example indicates which pages of the detailed results correspond to each trend test.

Parameter	Sampling Level	Collecting Agency	Station	Seasonal	Serial Correlation	Trend Direction	Rate of Change (% of Median/Year)	Trend Period
NH3_MGL	Surface	Lee County	10MIGR50	Y	N	Increasing	0.00	1990-2011
NO23_MGL	Surface	Lee County	10MIGR50	Y	Y	No Trend	0.00	1990-2011
NO2_MGL	Surface	Lee County	10MIGR50	N	Y	No Trend	0.00	1990-2011
NO3_MGL	Surface	Lee County	10MIGR50	Y	Y	No Trend	0.00	1990-2011
PB_UGL	Surface	Lee County	10MIGR50	N	N	No Trend	0.00	1991-2011
PH	Surface	Lee County	10MIGR50	N	Y	No Trend	0.00	1990-2011
PO4_MGL	Surface	Lee County	10MIGR50	N	N	Increasing	0.00	1990-2011
TEMP_C	Surface	Lee County	10MIGR50	Y	N	Decreasing	-0.08	1990-2011
TKN_MGL	Surface	Lee County	10MIGR50	N	N	Increasing	0.14	1990-2011
TN_MGL	Surface	Lee County	10MIGR50	N	N	Increasing	0.15	1990-2011
TOC_MGL	Surface	Lee County	10MIGR50	Y	Y	No Trend	-0.33	2002-2011
TPO4_MGL	Surface	Lee County	10MIGR50	N	N	No Trend	0.00	1990-2011
TP_MGL	Surface	Lee County	10MIGR50	N	N	No Trend	0.00	1990-2011
TSS_MGL	Surface	Lee County	10MIGR50	N	Y	Decreasing	-0.60	1990-2011
BOD_MGL	Surface	Lee County	10MIGR60	Y	N	Increasing	0.03	1990-2011
CHLAC_UGL	Surface	Lee County	10MIGR60	Y	N	No Trend	-0.08	1997-2011
CL_MGL	Surface	Lee County	10MIGR60	Y	Y	No Trend	-1.51	1990-2011
COLOR	Surface	Lee County	10MIGR60	Y	Y	Decreasing	-2.55	2000-2011
COND	Surface	Lee County	10MIGR60	Y	Y	No Trend	-2.94	1990-2011
CR_UGL	Surface	Lee County	10MIGR60	Y	Y	No Trend	-0.05	2002-2011
CU_UGL	Surface	Lee County	10MIGR60	Y	Y	No Trend	0.13	1994-2011
DO_MGL	Surface	Lee County	10MIGR60	Y	Y	No Trend	0.03	1990-2011
DSI_MGL	Surface	Lee County	10MIGR60	Y	Y	No Trend	-0.10	2000-2011
NH3_MGL	Surface	Lee County	10MIGR60	N	N	No Trend	0.00	1990-2011
NO23_MGL	Surface	Lee County	10MIGR60	N	Y	No Trend	0.00	1990-2011
NO2_MGL	Surface	Lee County	10MIGR60	N	Y	No Trend	0.00	1990-2011
NO3_MGL	Surface	Lee County	10MIGR60	N	Y	No Trend	0.00	1990-2011
PB_UGL	Surface	Lee County	10MIGR60	N	N	No Trend	0.00	1991-2011
PH	Surface	Lee County	10MIGR60	N	Y	No Trend	-0.07	1990-2011

Figure 2-9. Example page from surface water quality trend summary table.

3.0 Stream Flow Analysis Results

The following chapter summarizes the results of the comprehensive stream flow trend analysis. Summary maps and tables are found at the end of this chapter for each basin and station within the CHNEP study area. Detailed time series plots for each metric evaluated can be found in **Appendix 3.1**. The results of the stream flow trend analyses indicated that many stream gages measured significant changes in instream characteristics over the period of record. Flow duration curves suggested that depending on the time period evaluated, the distribution for a particular statistic could be substantially different. Detailed plots of flow duration curves corresponding to the three relevant periods of record for the report are provided in **Appendix 3.2**. It is also important to note that some of these gages are located on actively managed water conveyances, while others are located on relatively more free-running reaches.

Index of Hydrologic Alteration Results

The IHA tables summarize results for each IHA statistic for each gage station within each CHNEP basin including annual statistics representing the magnitude, frequency and duration of specific flow characteristics. The trend period rate of change, relative change (i.e. relative to the median value over the period of record assessed) and significance level for each basin and station are provided in the tables while these results are summarized by IHA statistic across all stations in the maps provided at the end of this chapter. Figure 3-1 provides a reference map of the CHNEP basins. The CHNEP study area is further divided by regions within the study area as represented by shading in the background in the trend maps. Results of trend testing suggest that many alterations to the hydrology have occurred in the Upper Peace River, the Myakka River, the Tidal Caloosahatchee, and tributaries of the Estero Bay watershed. Consistently decreasing trends were observed for many of the flow statistics within the Upper Peace River. Base flows in the Myakka River near Sarasota appeared to be increasing as evidenced by increasing trends in several of the annual minima statistics. Joshua Creek and Imperial River exhibited similar results to the Myakka River with respect to increases in minima statistics over time. However, many of the other gages exhibited no trends indicating stable conditions over the period of record examined. Shorter periods of record were less likely to result in significant trend results.

Frequency and Duration of High and Low Pulses

The number and mean duration of high pulses were found to be declining in the upper Peace River basins but were otherwise stable throughout the watershed. Trends in the mean duration of low pulses were variable throughout the watershed with decreases at four stations in the Estero Bay, Joshua Creek, and Lower Myakka basins but increases in the duration of low pulses in the Upper Peace River basins.

Rate and Frequency of Water Condition Changes

The average fall (descending limbs of hydrographs) was found to be increasing in the upper Peace River basins, but decreasing in the more controlled hydrology of the Tidal Caloosahatchee and Matlacha Pass watersheds. These types of changes would be consistent with changes in land use practices and urbanizing watershed effects, but the data from these analyses alone are not sufficient to attribute causation. It is sufficient for this report to note that areas where water quality conditions were observed to be changing over the long-term were geographically coincident with long-term changes in the rate and frequency of flow changes.

Median Monthly Flows (Magnitude)

Coincident with the frequency and duration of high and low pulses, the median monthly flows were found to be decreasing for several months in the Upper Peace River basins. These trends occurred principally in the November and December as well as in April and May. In the Myakka River basin, the opposite trends were evident in Joshua Creek and, to a lesser extent, in the Lower Myakka with increasing trends in winter and spring flows in those basins over the period of record. There were few trends in median flows in the summer months other than in the Peace at Bartow basin.

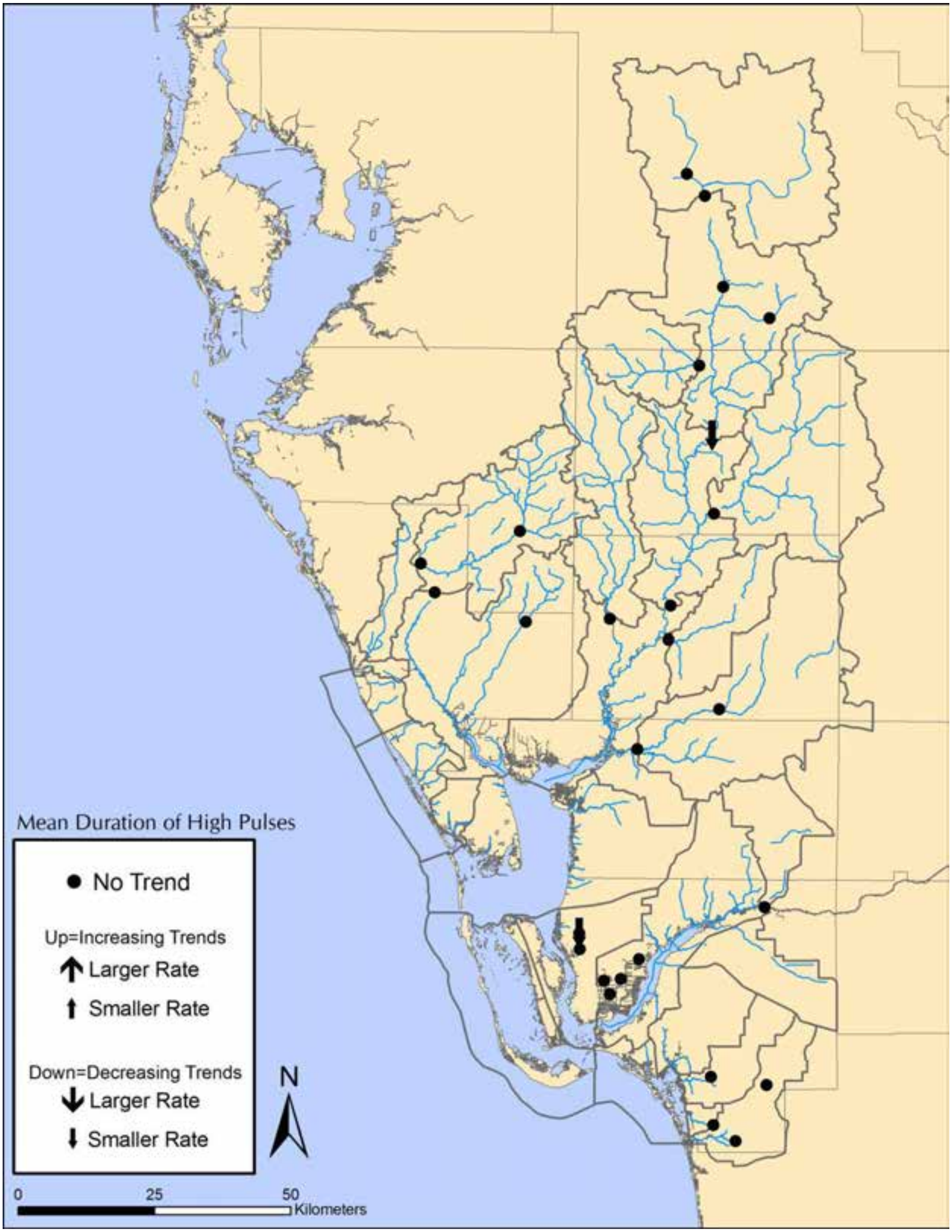
Magnitude and Duration of Annual Extreme Durations

The annual minima for 1-day, 3-day, 7-day, 30-day and 90-day periods were generally found to be decreasing in the Peace River and Tidal Caloosahatchee basins but increasing in Imperial River, Joshua Creek and the Myakka River basins. However, statistics representing different aspects of the annual maxima were stable over time in most basins except the Peace River at Bartow where the annual maxima exhibit decreasing trends.

Conclusion

Stream flow changes have occurred in terms of the magnitude of flows as well as timing and volume of flows as described by the 32 aspects of the Index of Hydrologic Alteration (IHA). From these results, it may be concluded that changes to stream flow have been occurring at statistically significant rates for many streams over the period of record. Many of the strongest IHA stream flow changes were observed for gages in the Upper Peace River Basins which is consistent with the extent of current knowledge of the area. Increases in the minima statistics in the Myakka River have been widely reported as influenced by historical agricultural water use practices and there have been significant efforts at ameliorating those effects in recent years. Likewise, reduced flows in the Upper Peace River basin in an active area of research and restoration. The trends in Joshua Creek are similar to Myakka River and may be worthy of further investigation. It is important to note that these stream flow gages include different periods of record and therefore the trends are not necessarily coincident with the water quality period of record in these basins.

Figure 3-1. Study area and basin reference map for the IHA trend characterization map series.


Mean Duration of High Pulses
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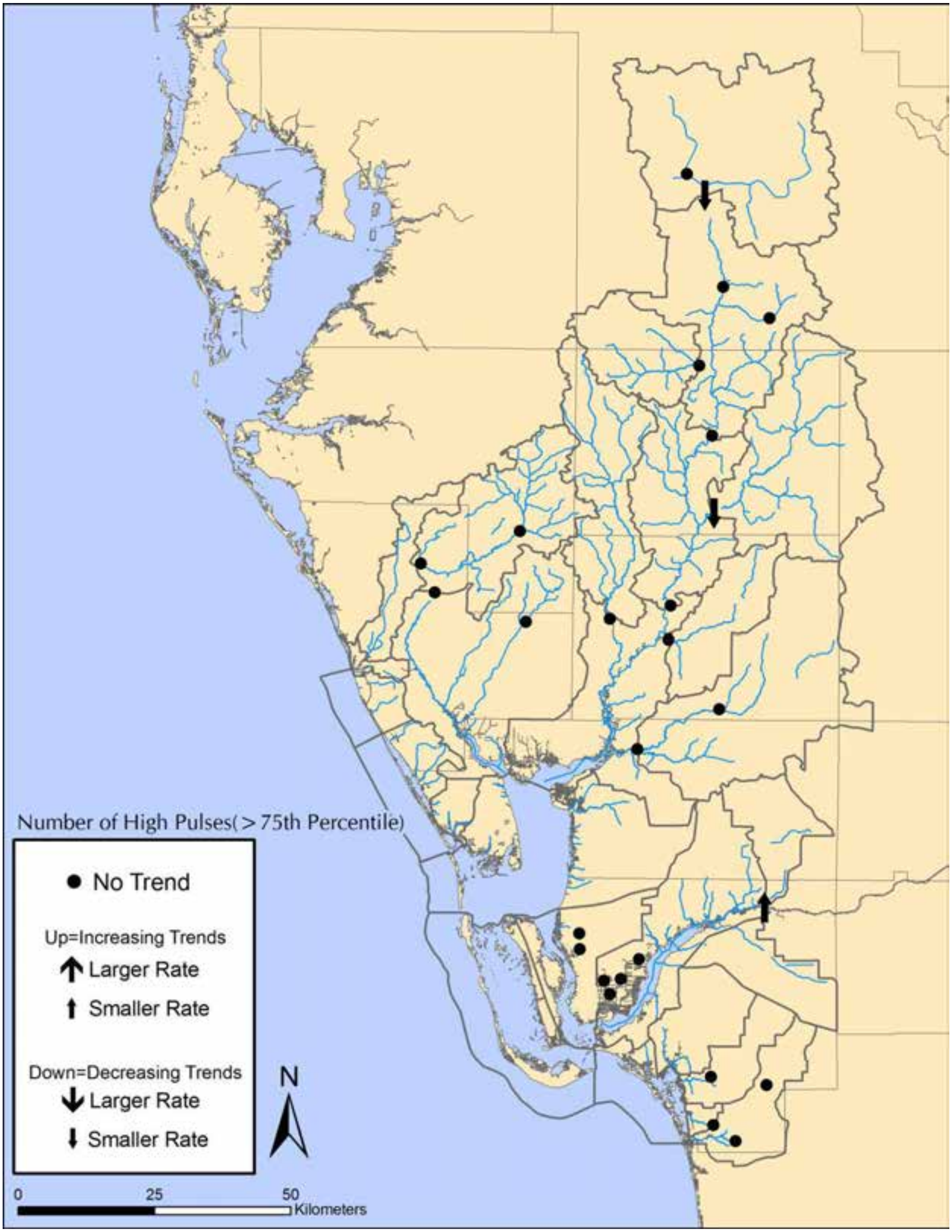
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Number of High Pulses(>75th Percentile)
No Trend
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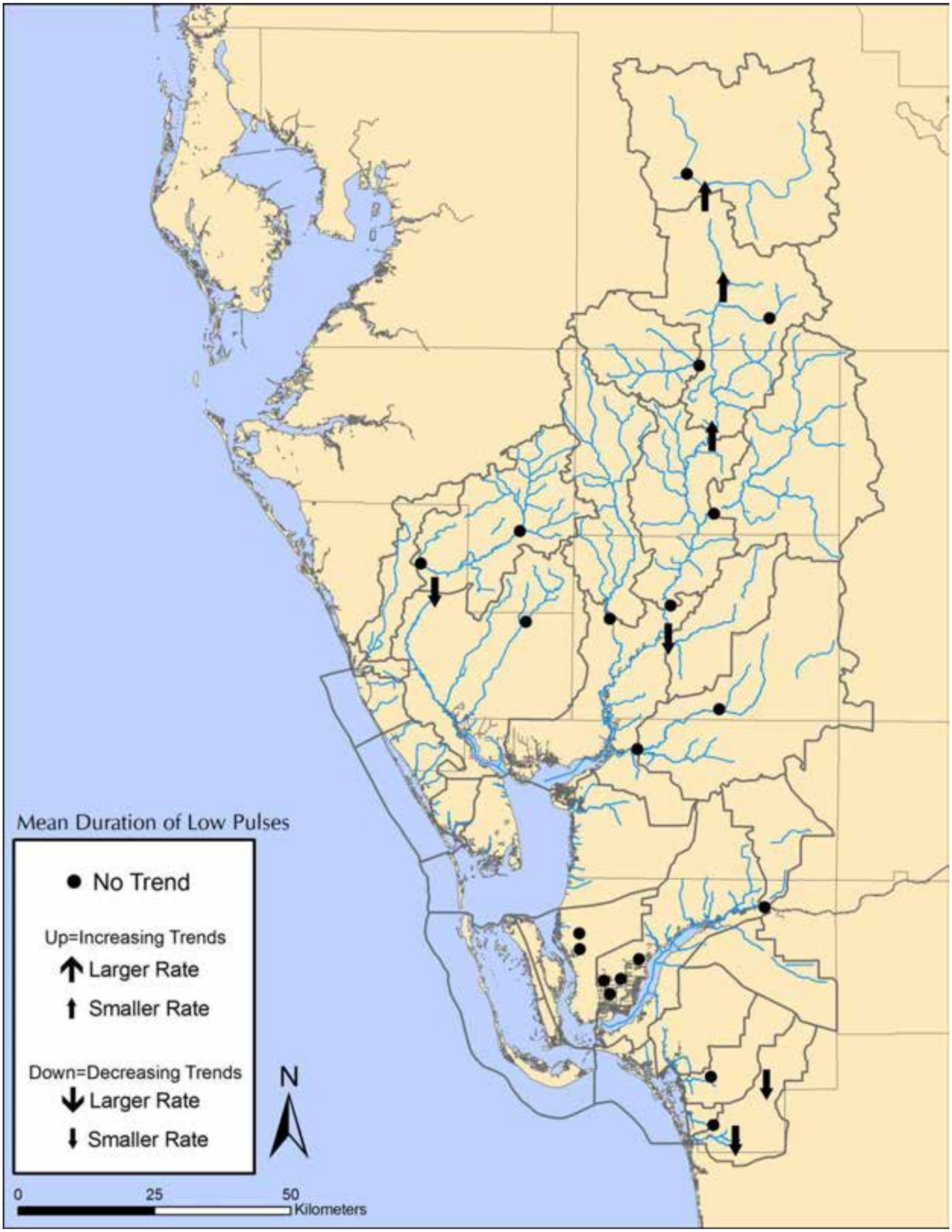
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers



Mean Duration of Low Pulses
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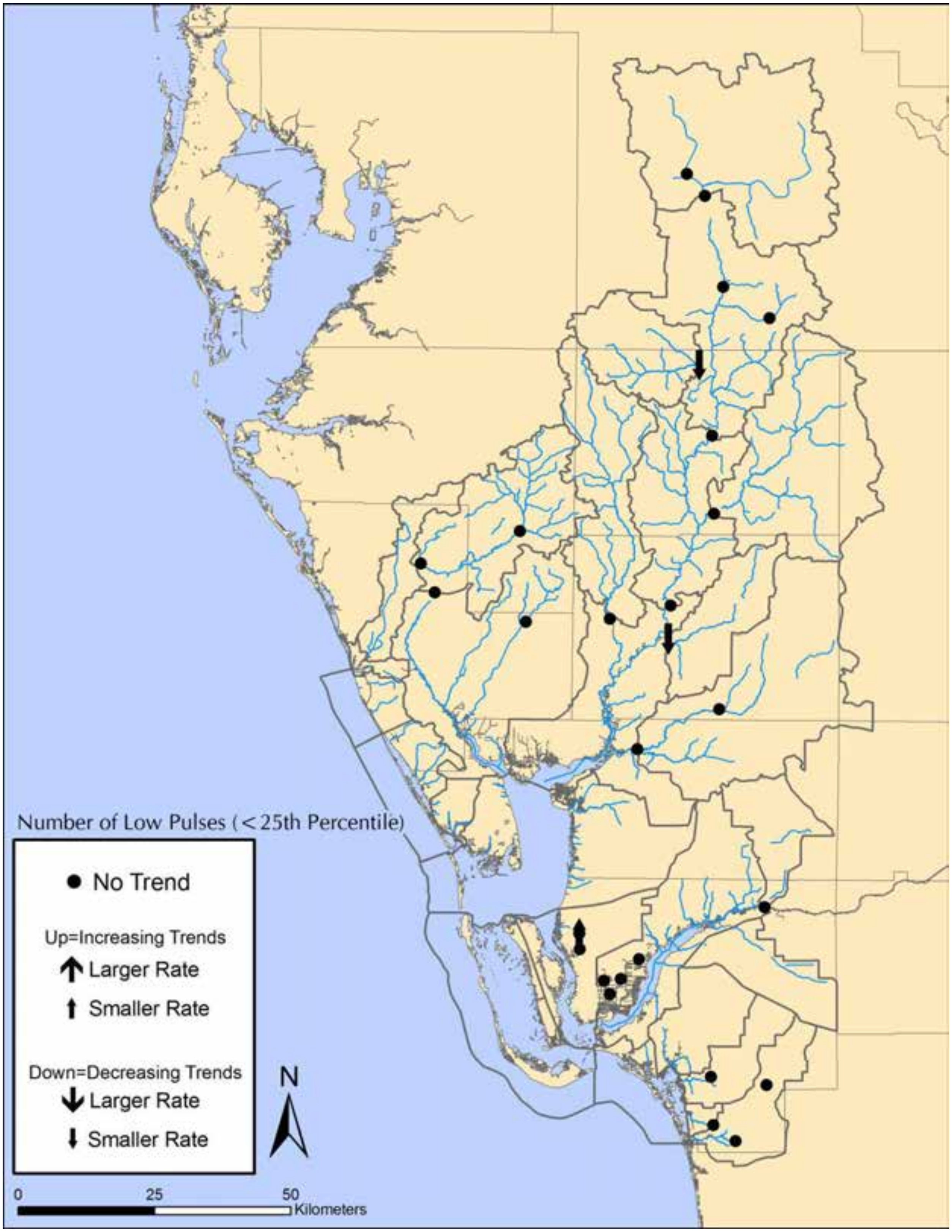
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Number of Low Pulses (<25th Percentile)
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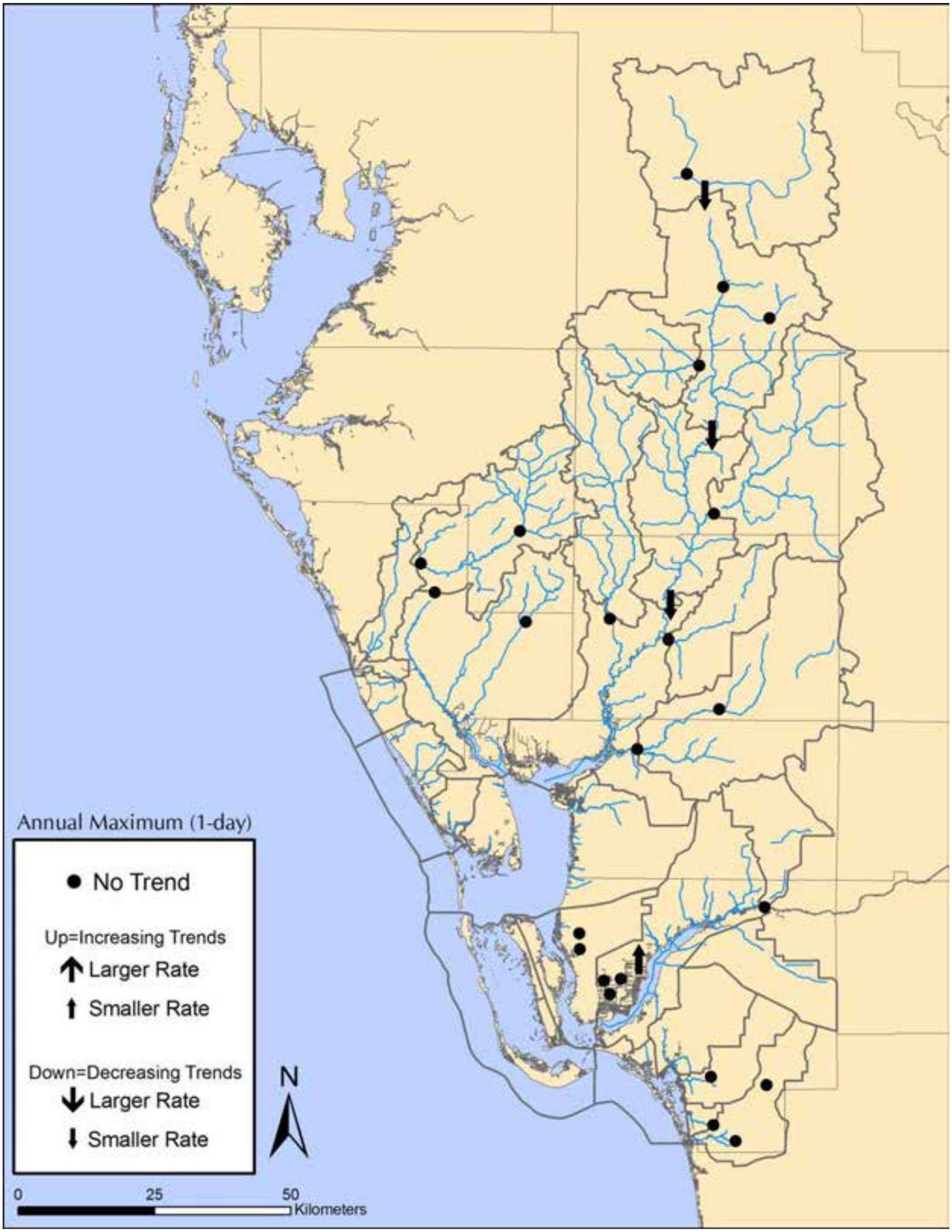
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Annual Maximum (1-day)
No Trend
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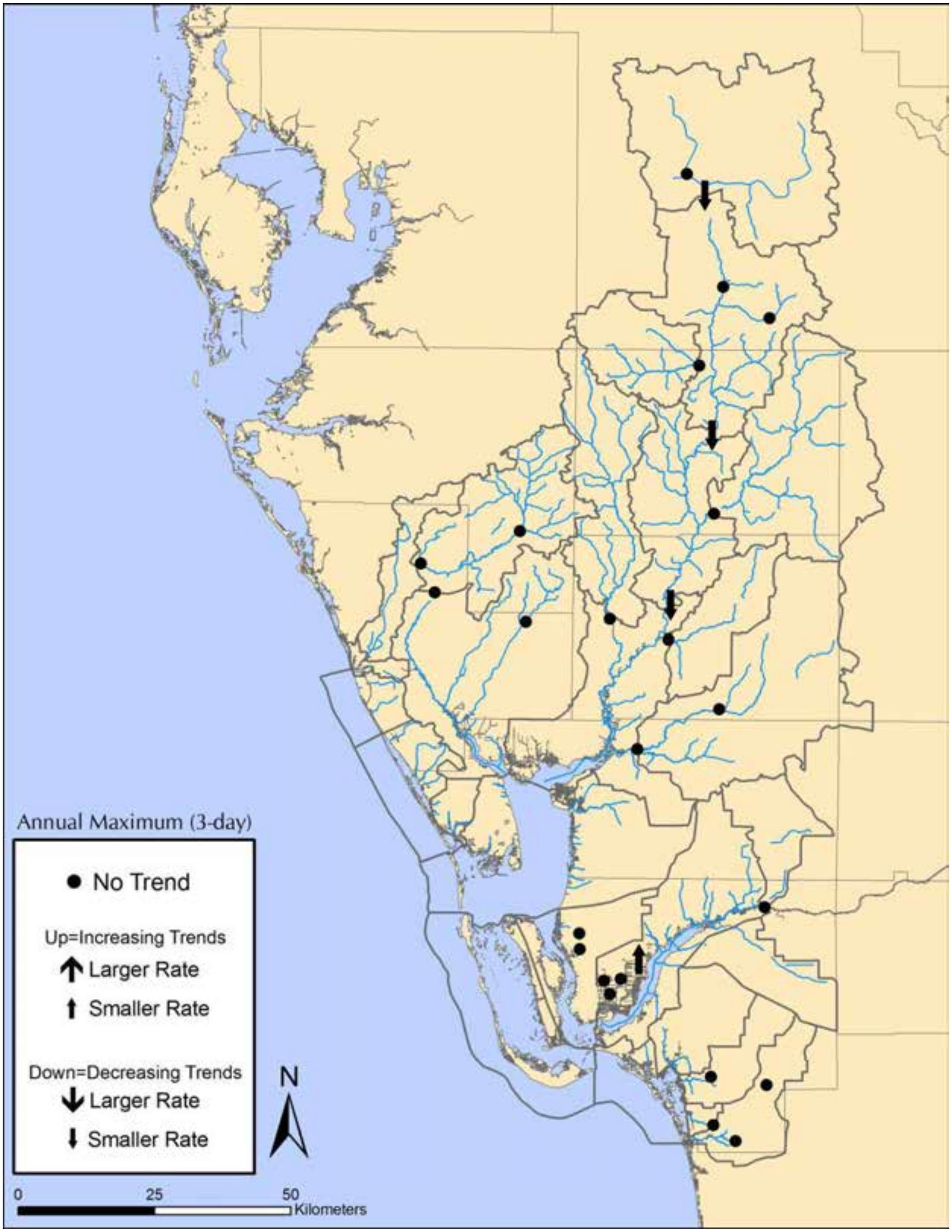
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Annual Maximum (3-day)
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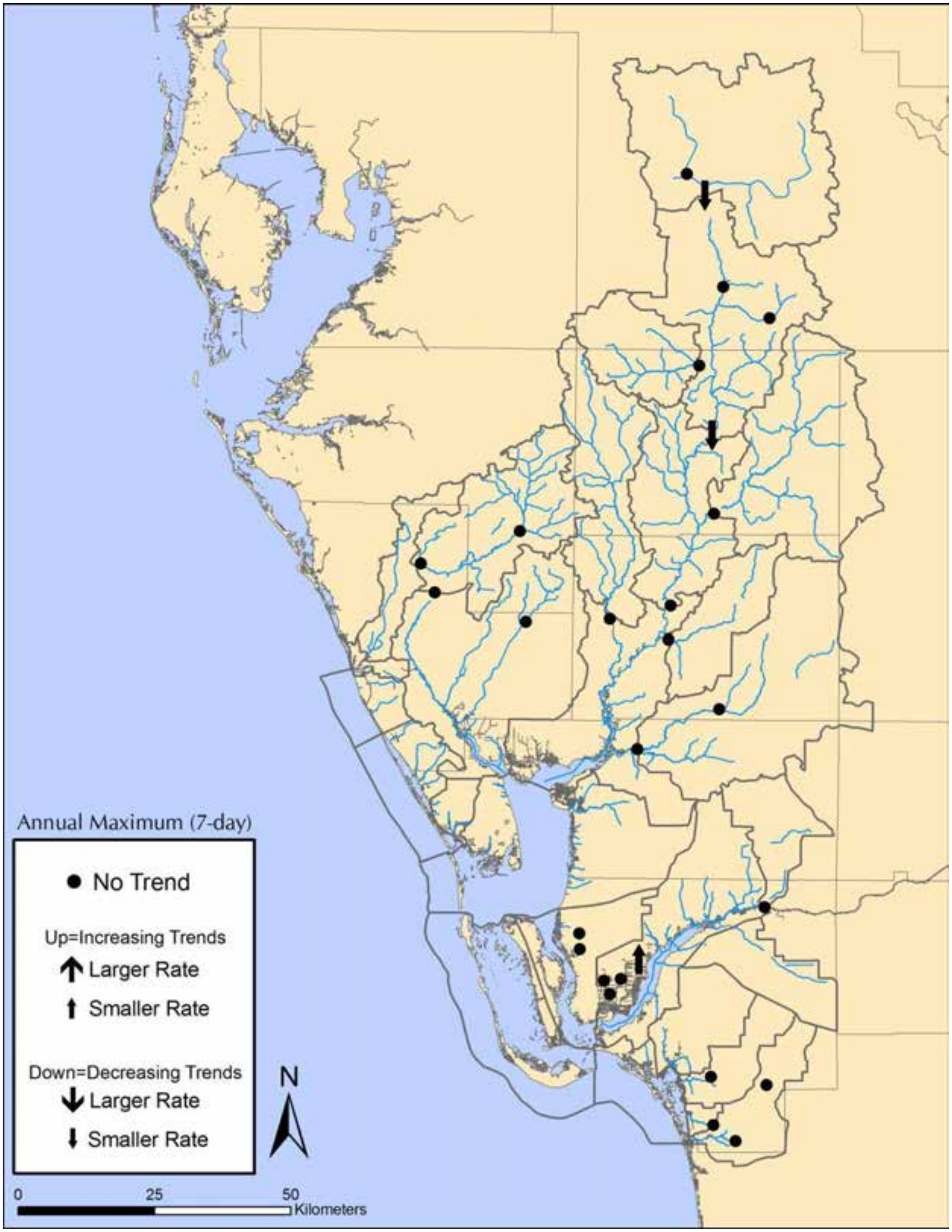
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Annual Maximum (7-day)
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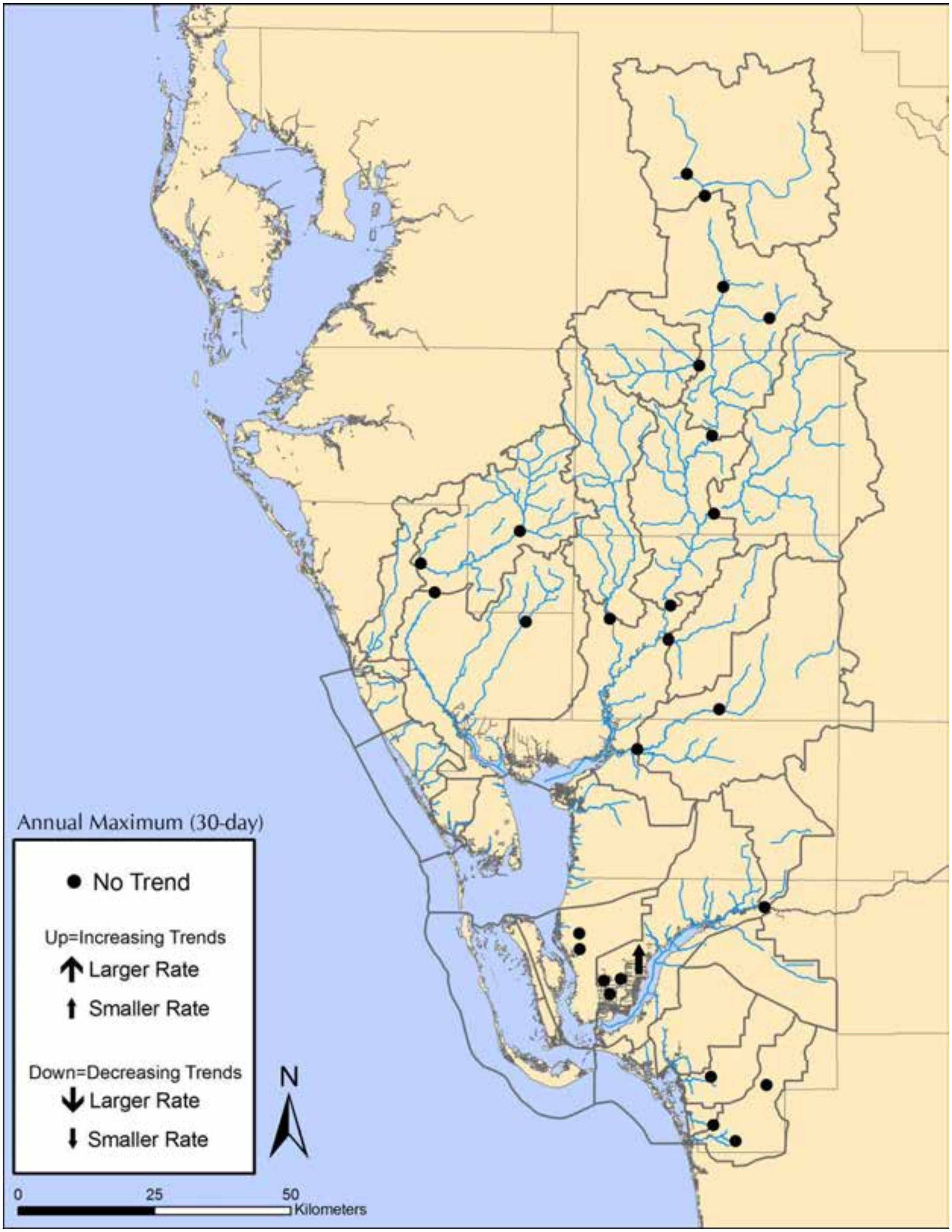
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Annual Maximum (30-day)
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Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
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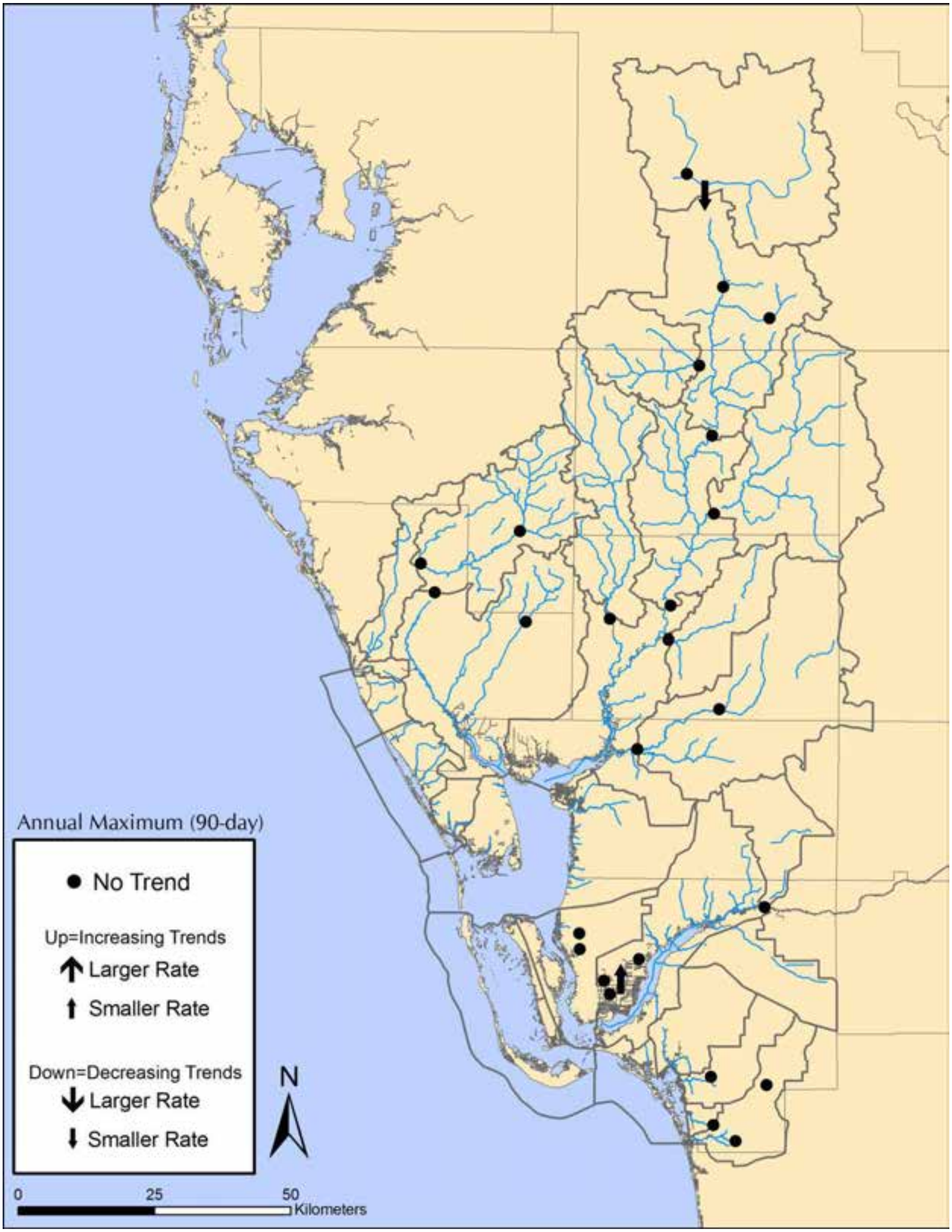
25
50
Kilometers


Annual Maximum (90-day)
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Down=Decreasing Trends
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Smaller Rate
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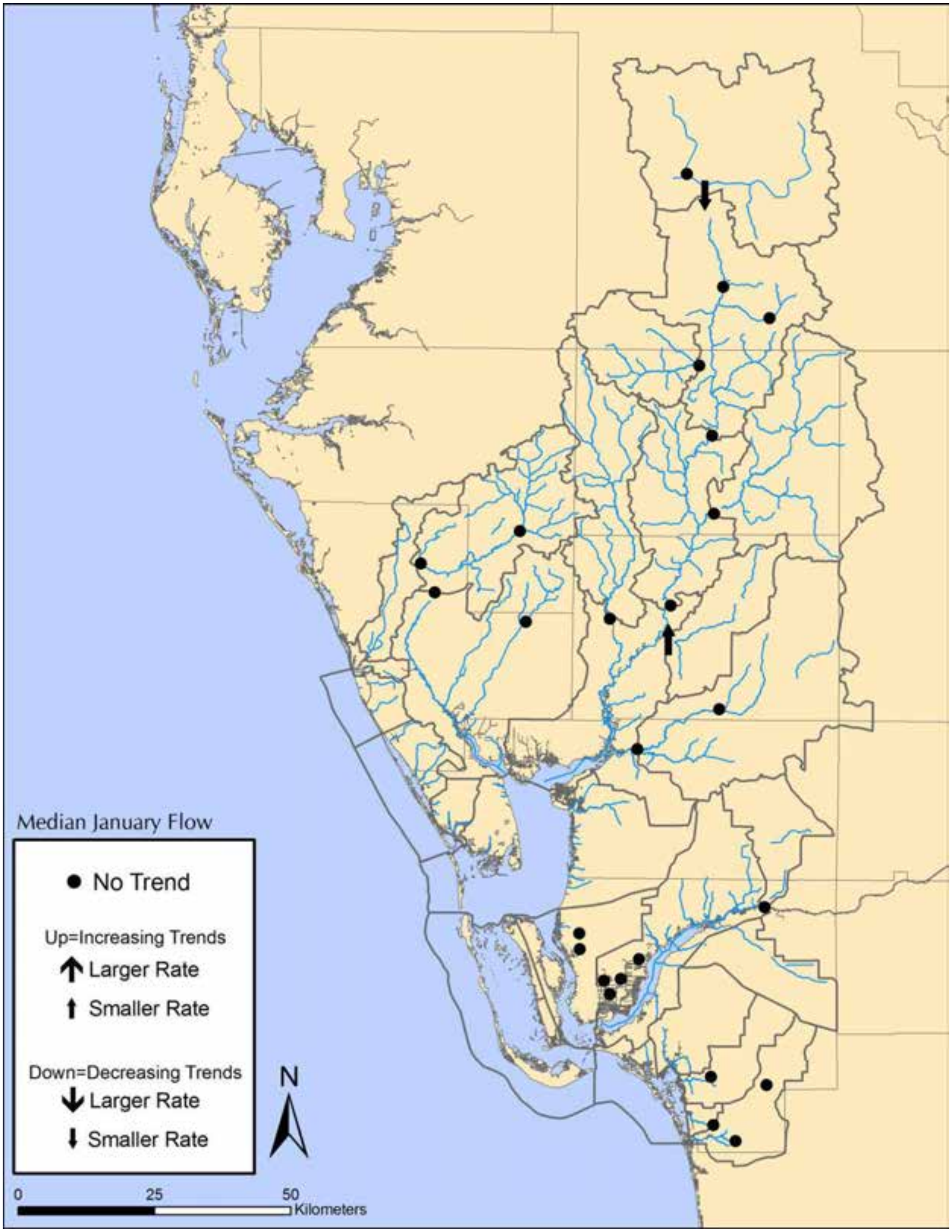
25
50
Kilometers


Median January Flow
No Trend
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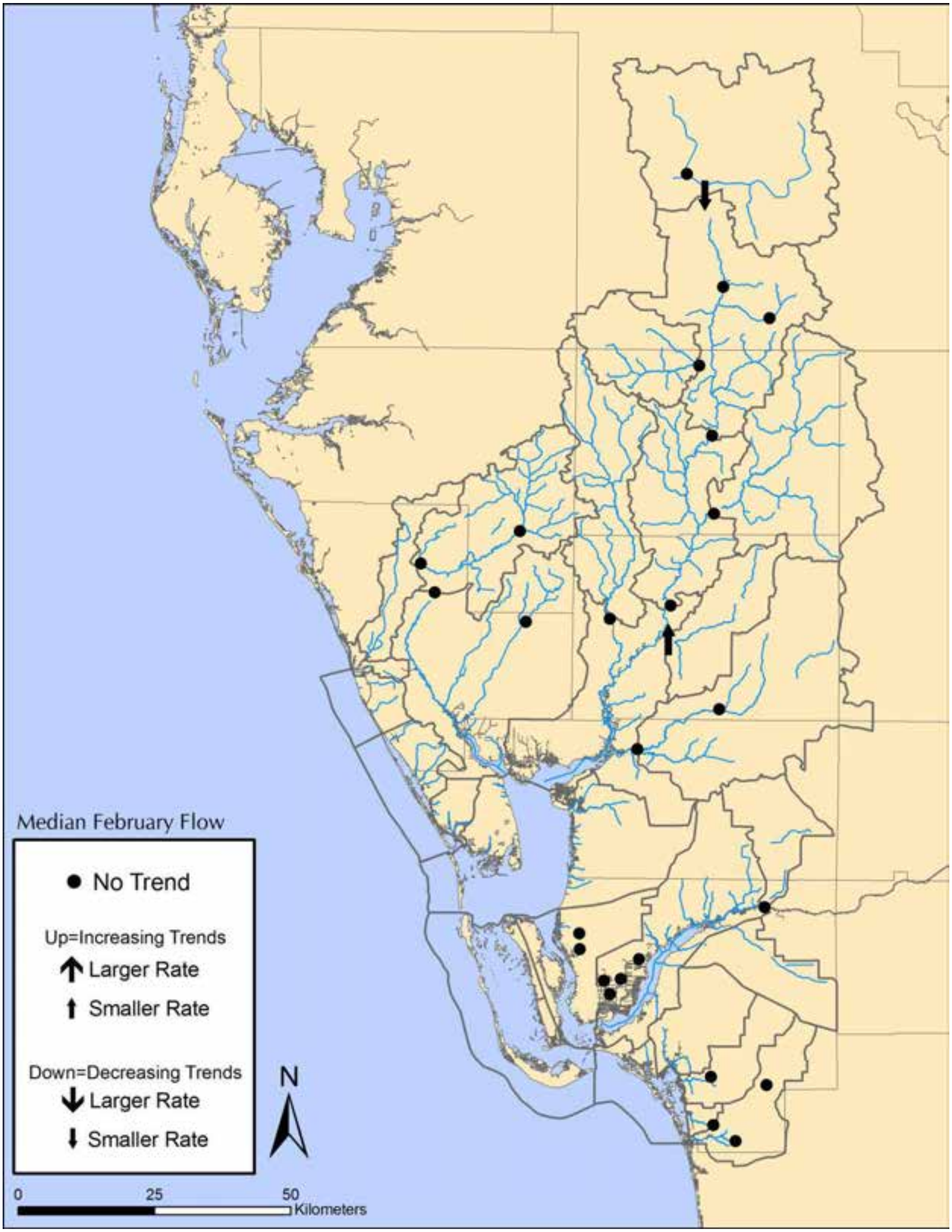
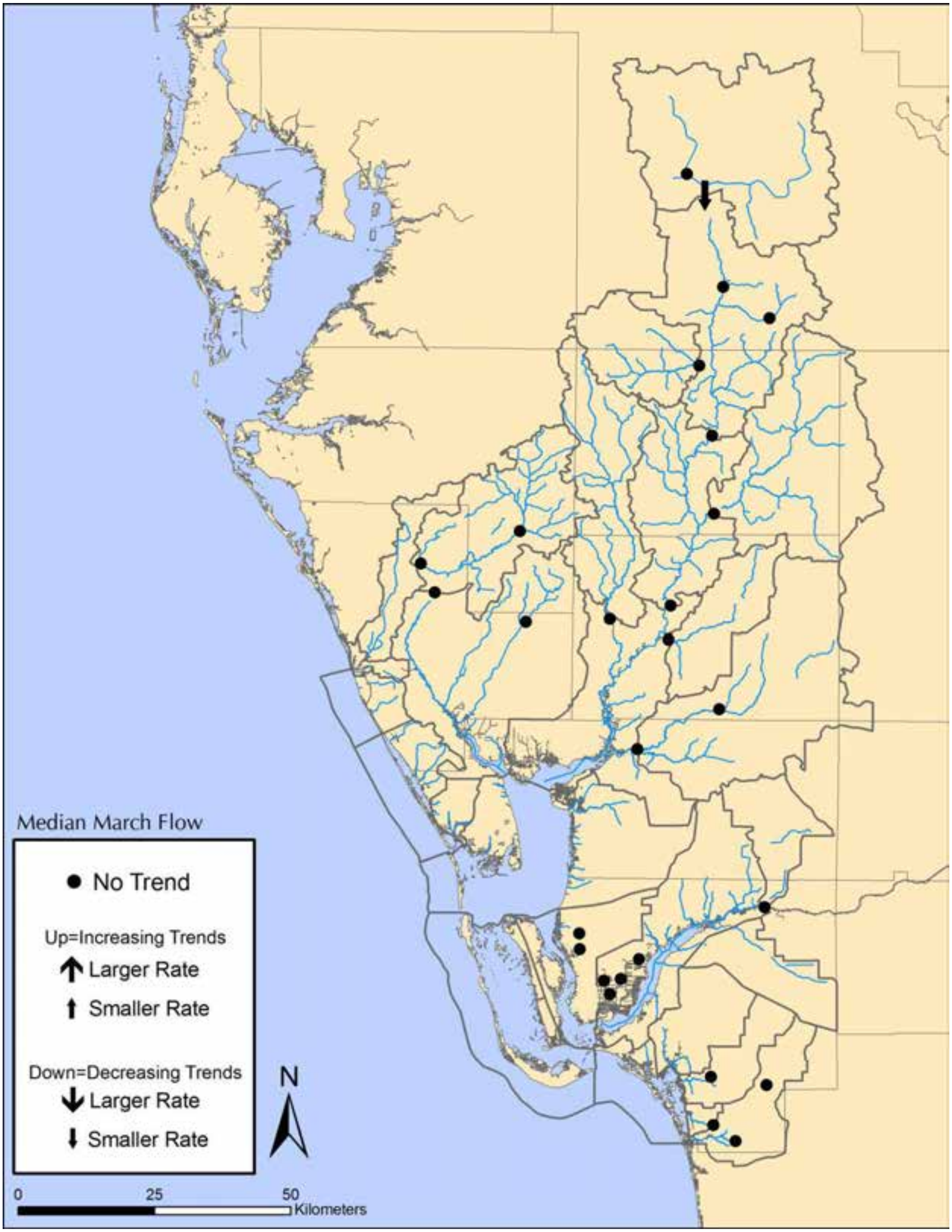
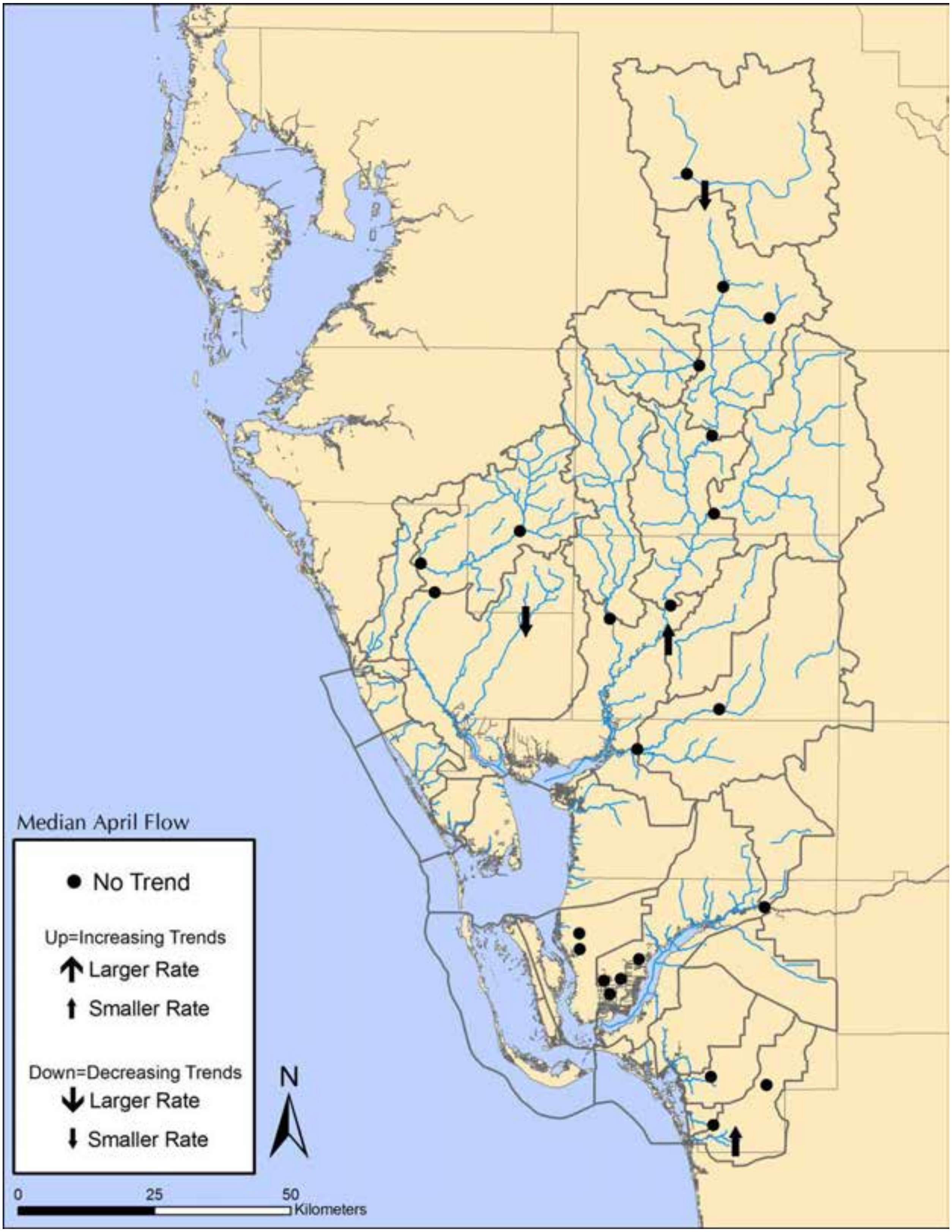
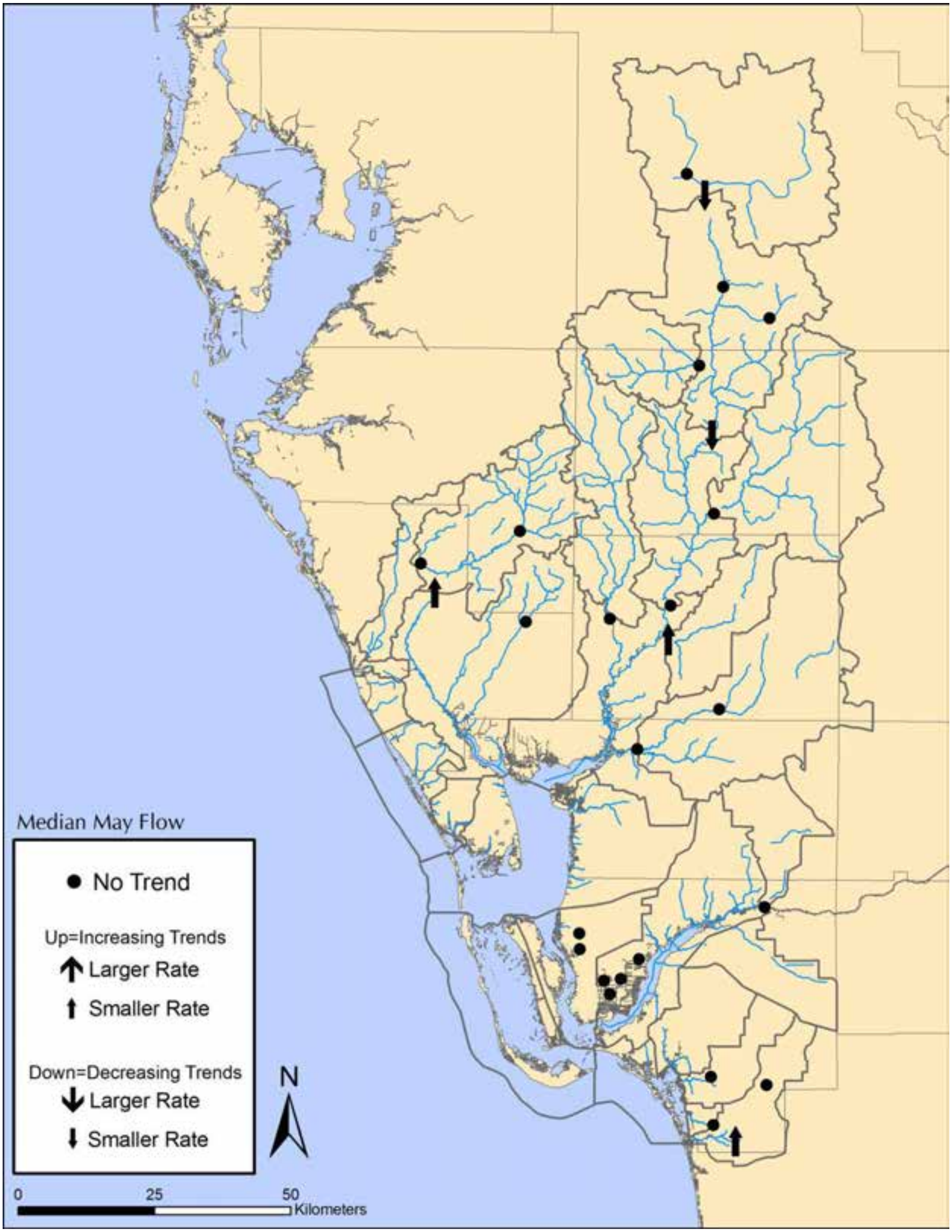
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Median February Flow
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers



Median March Flow
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Median April Flow
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Median May Flow
No Trend
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Down=Decreasing Trends
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Smaller Rate
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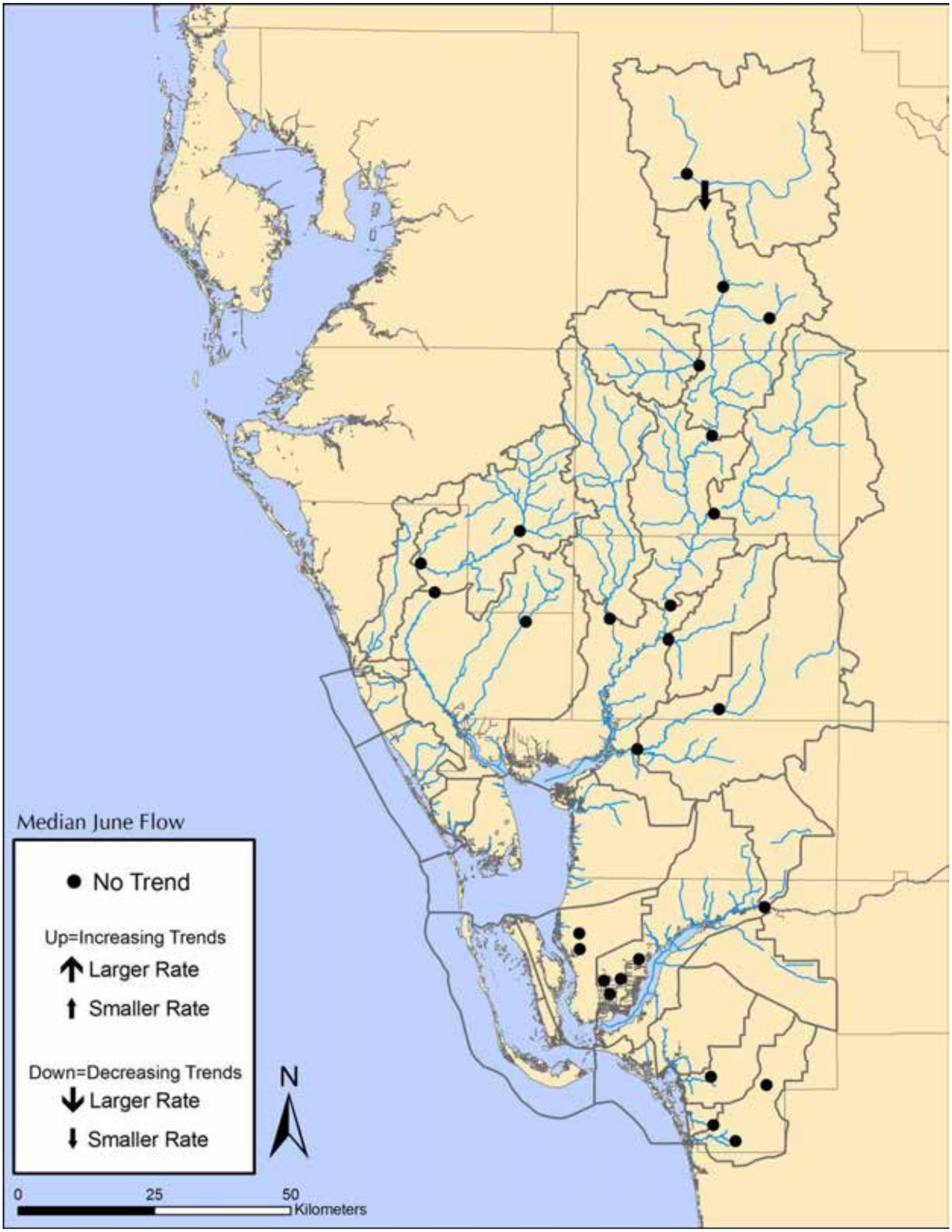
25
50
Kilometers


Median June Flow
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Down=Decreasing Trends
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Smaller Rate
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25
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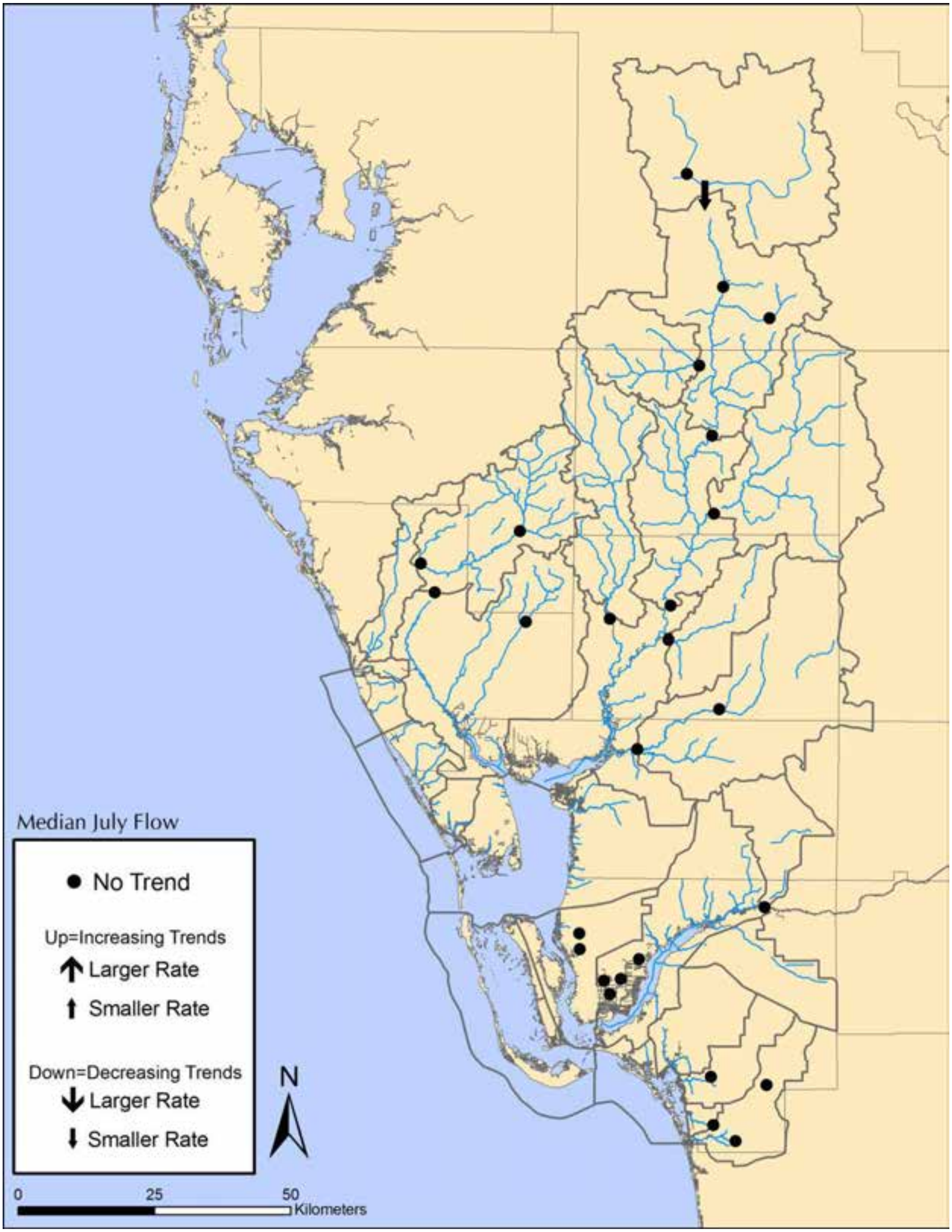
Kilometers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Down=Decreasing Trends
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Smaller Rate
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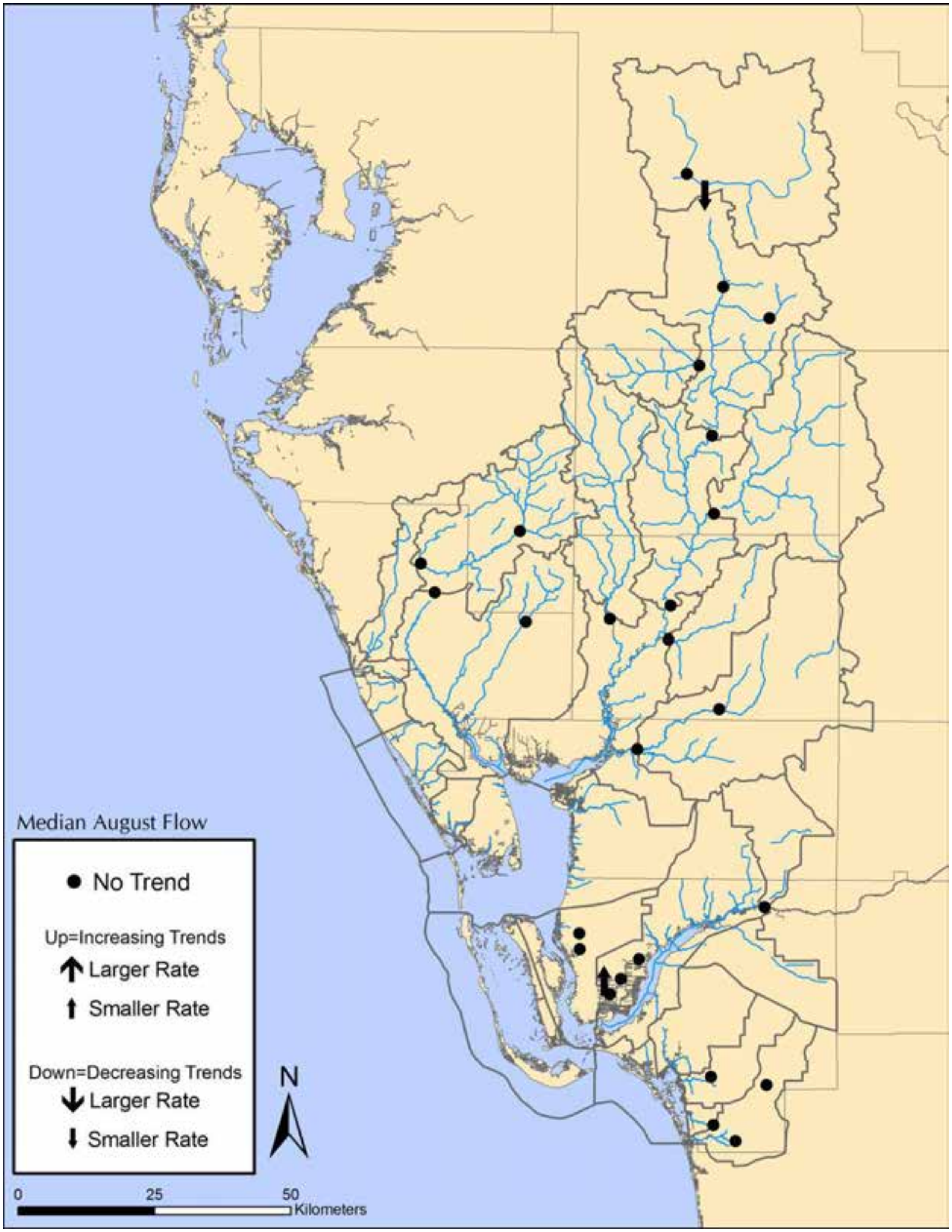
Kilometers


Median August Flow
No Trend
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Smaller Rate
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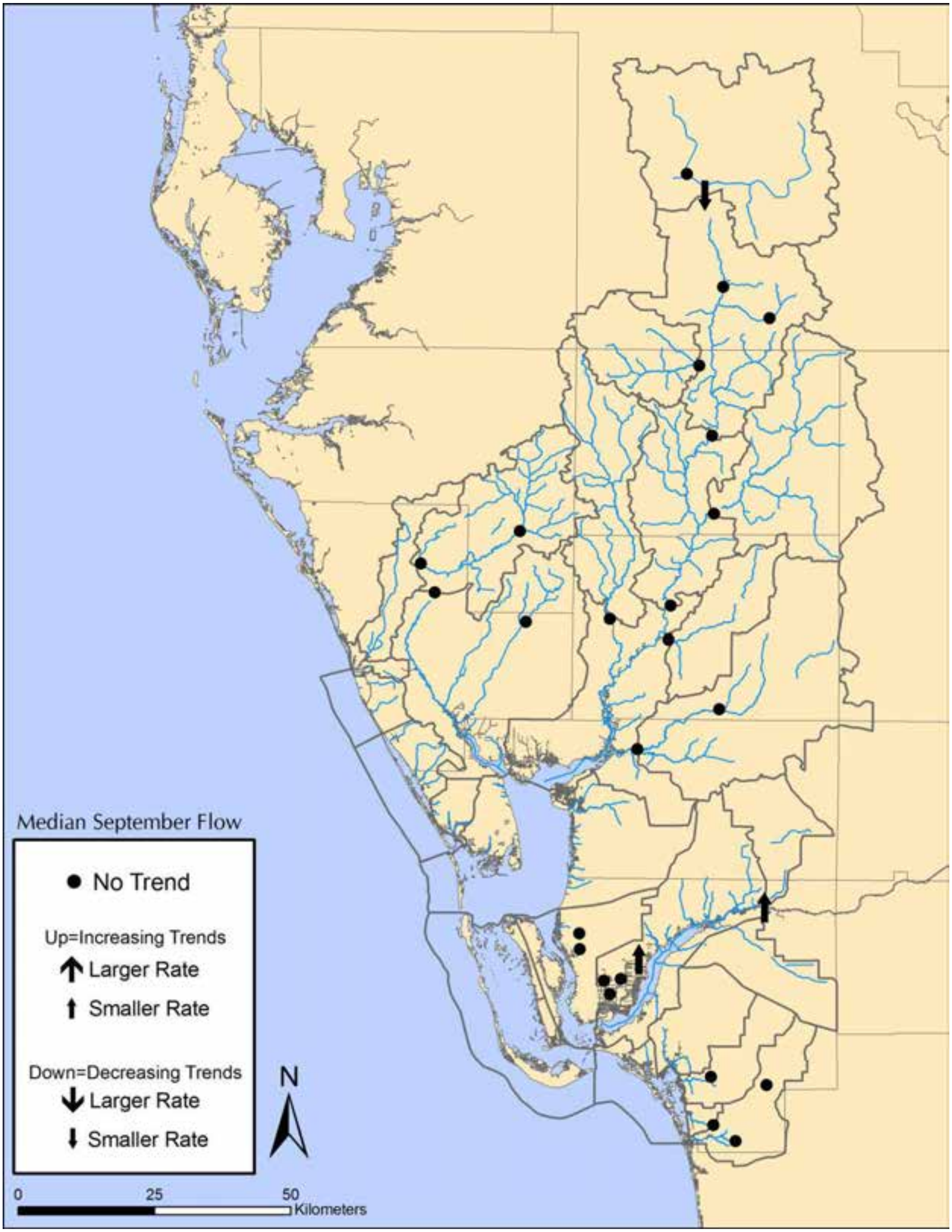
25
50
Kilometers


Median September Flow
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25
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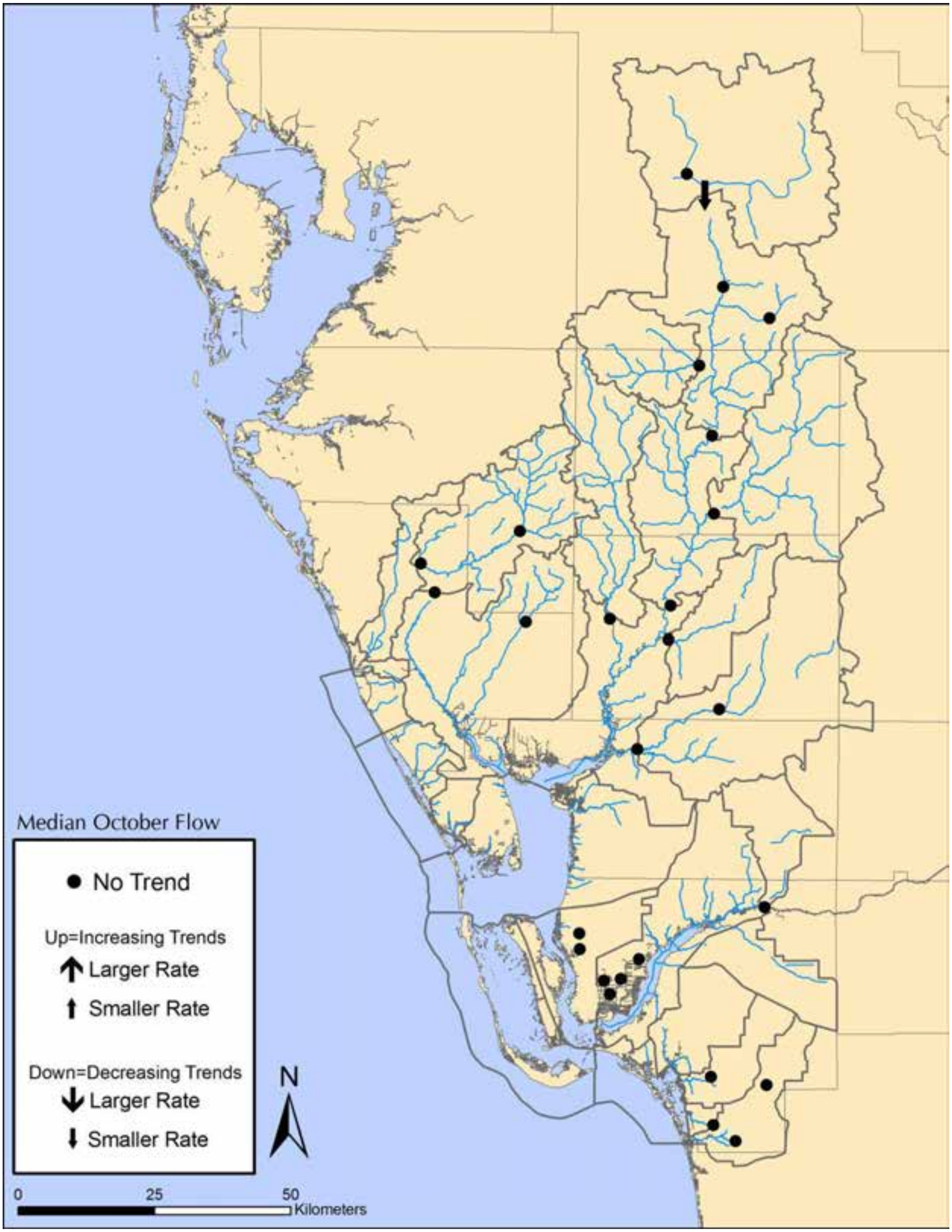
Kilometers


Median October Flow
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Smaller Rate
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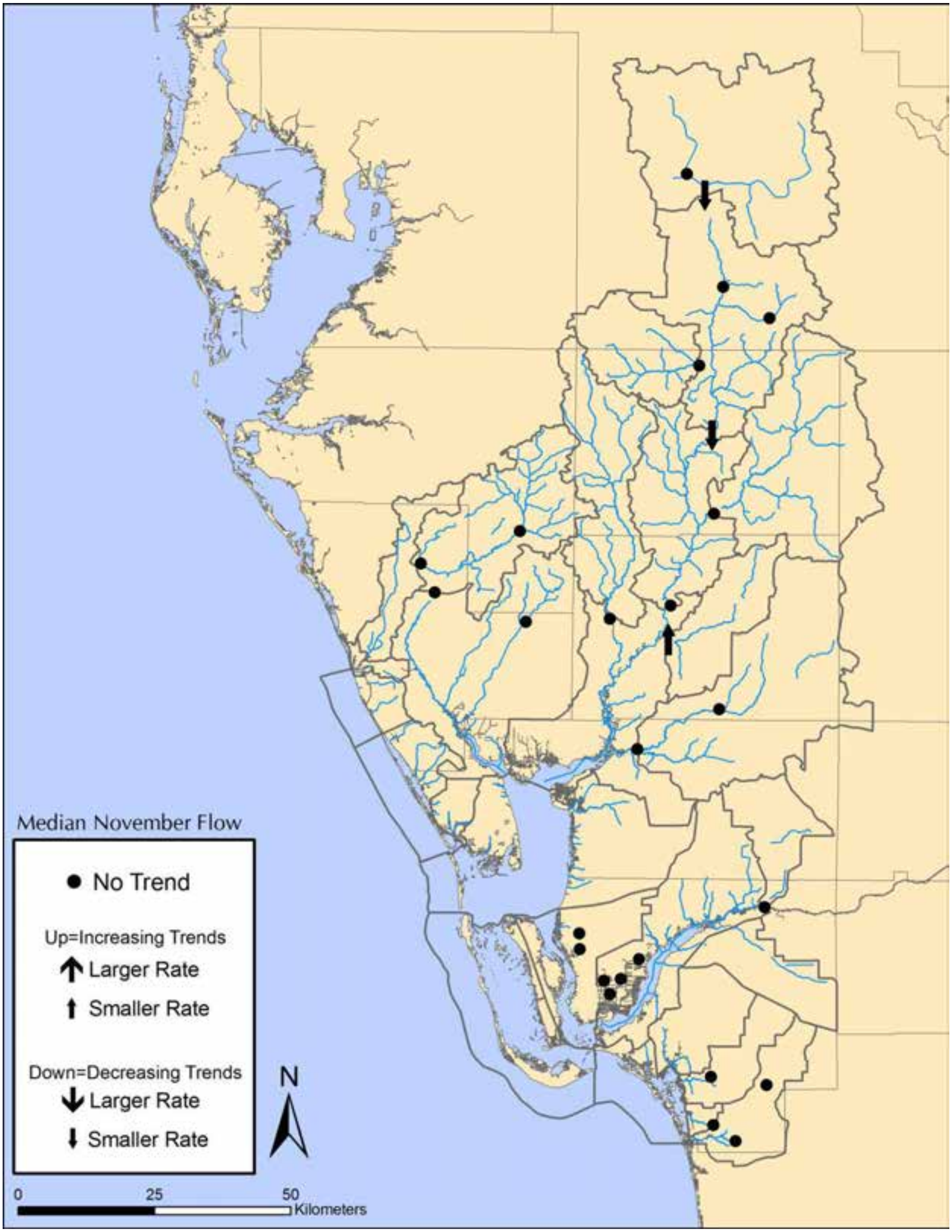
0
25
50
Kilometers


Median November Flow
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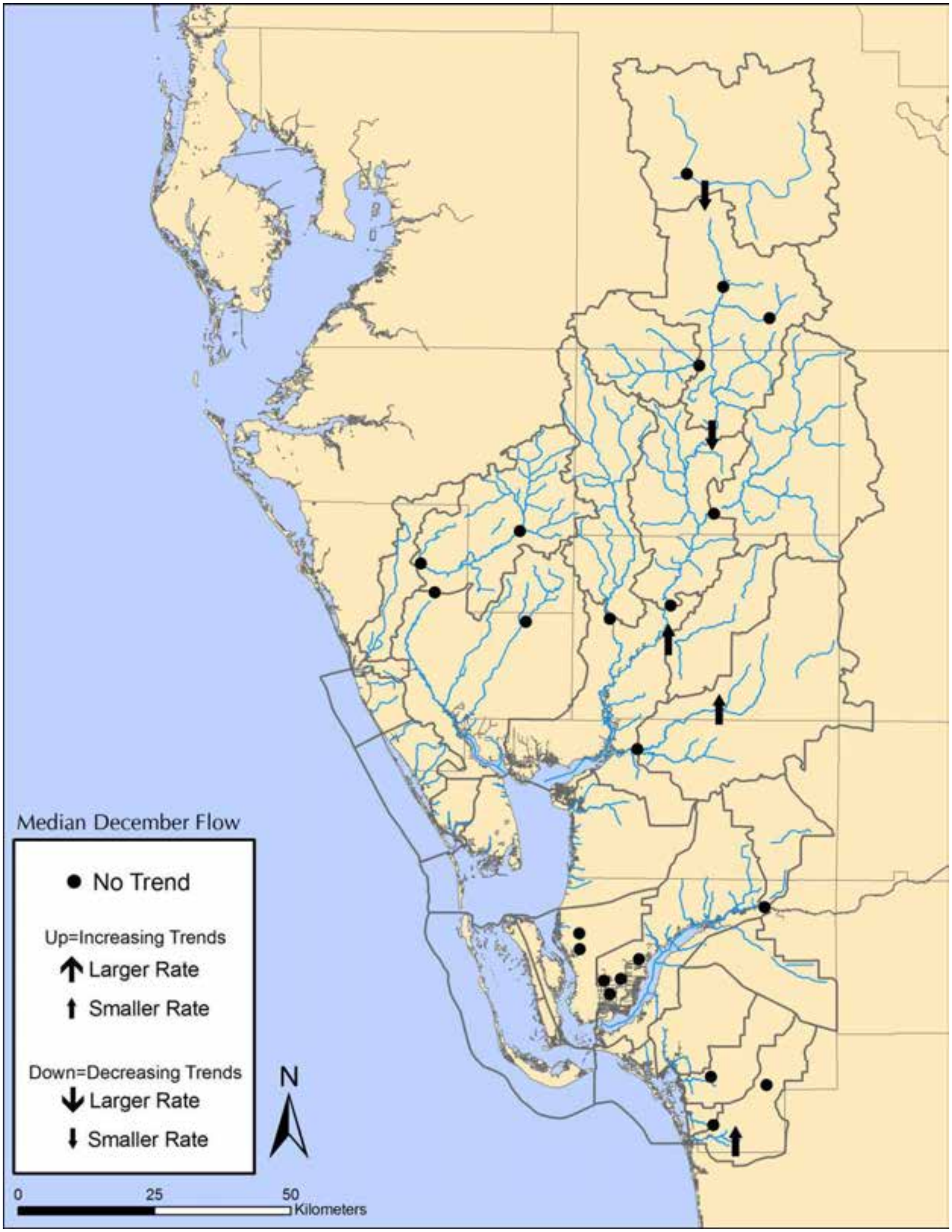
N
0
25
50
Kilometers


Median December Flow
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0
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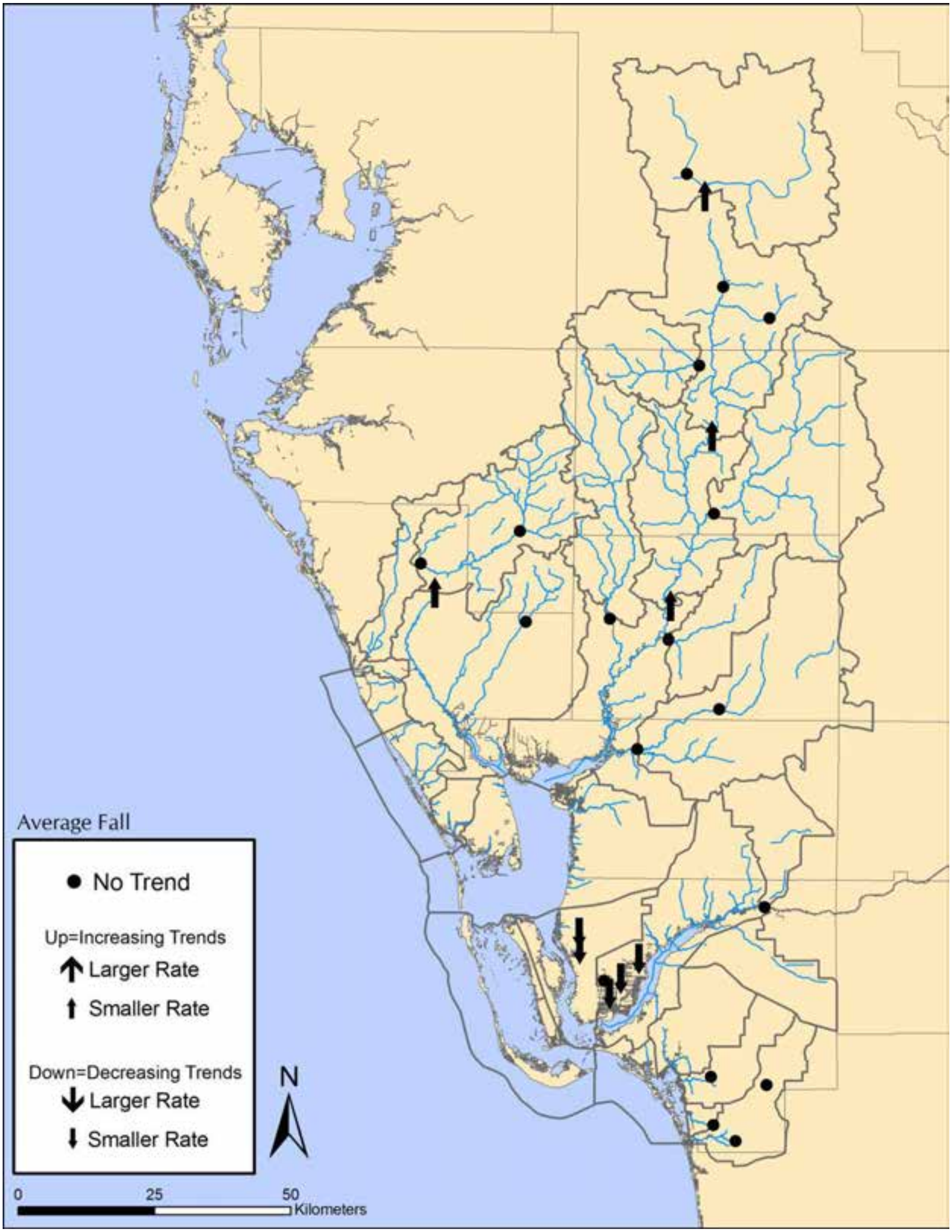
50
Kilometers



Average Fall
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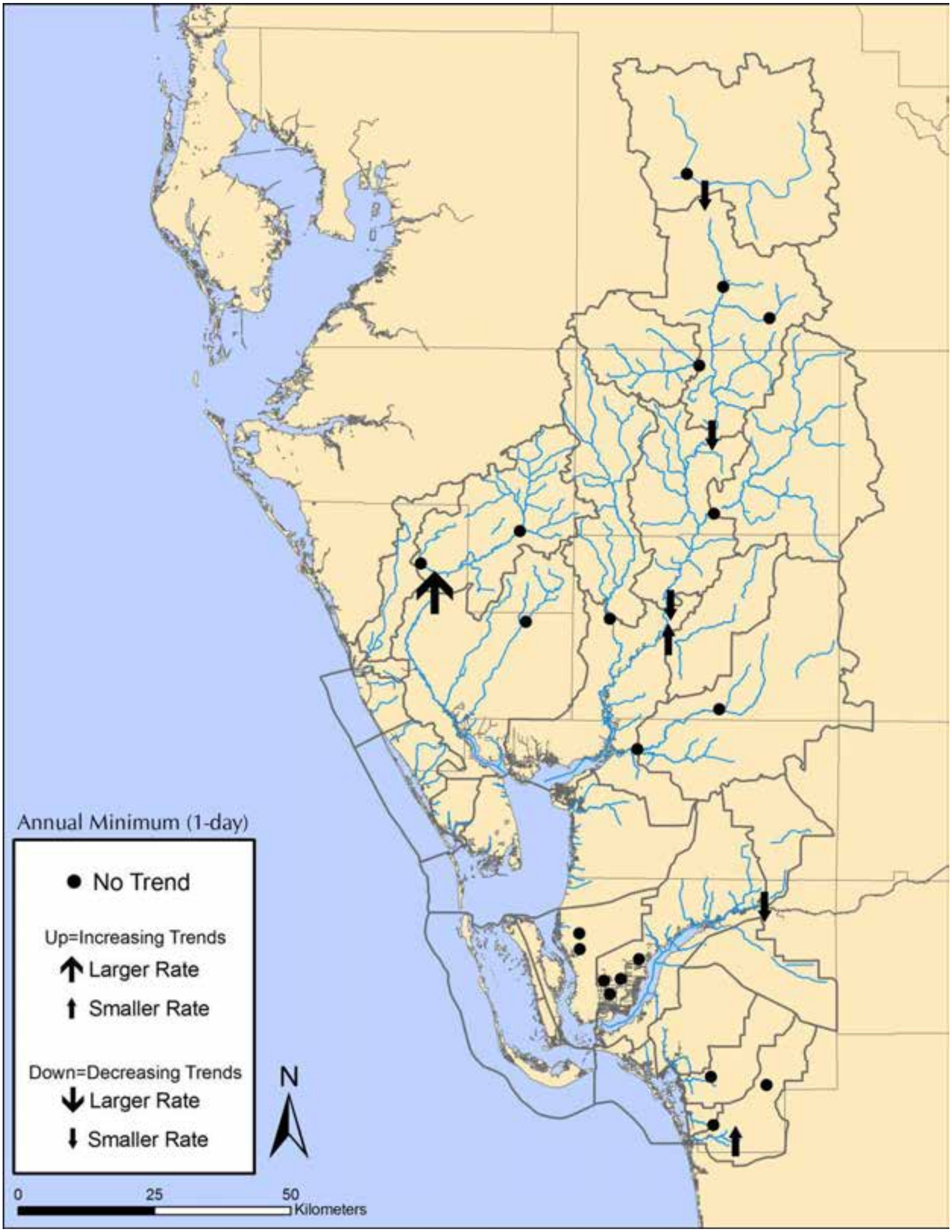
Smaller Rate
N
0
25
50
Kilometers


Annual Minimum (1-day)
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Larger Rate
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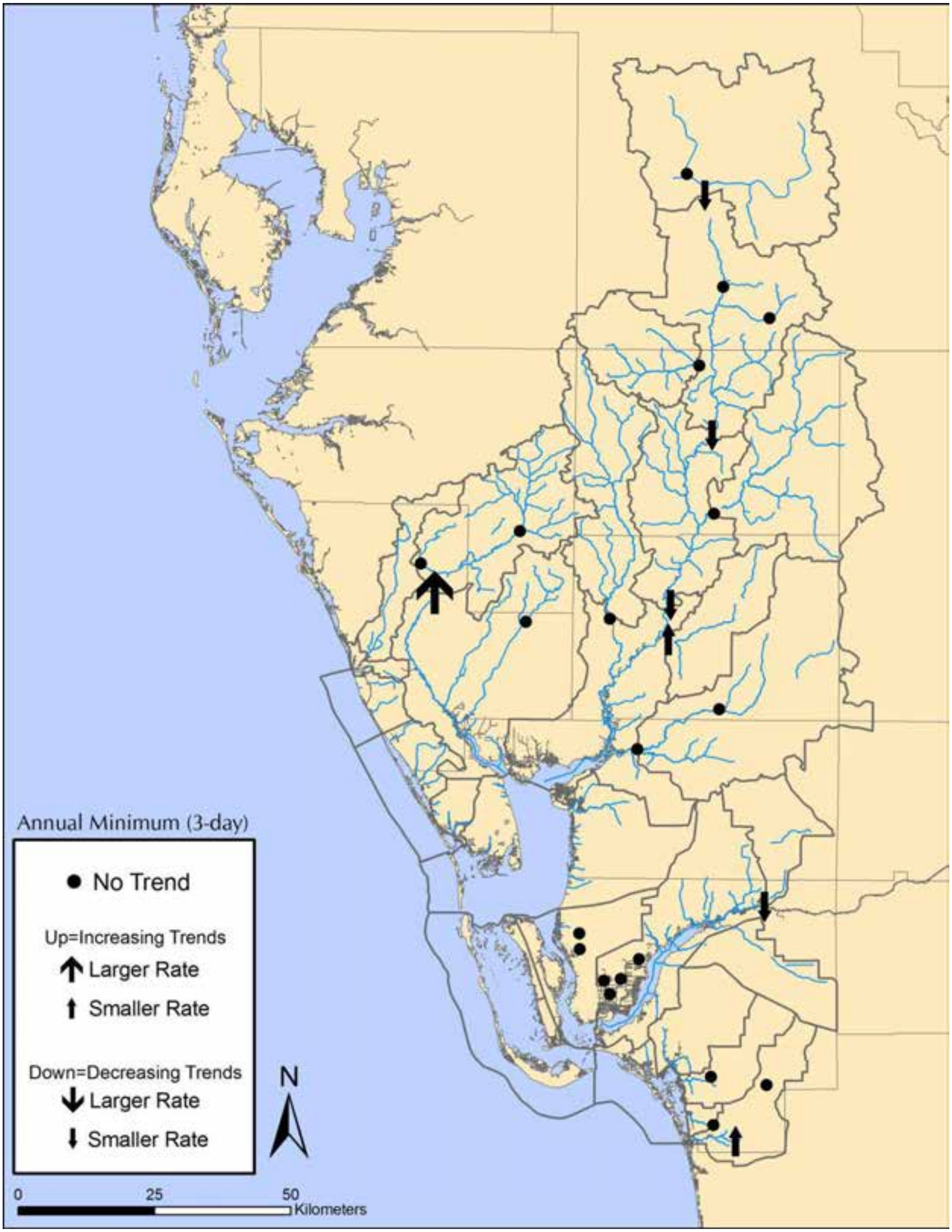
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Annual Minimum (3-day)
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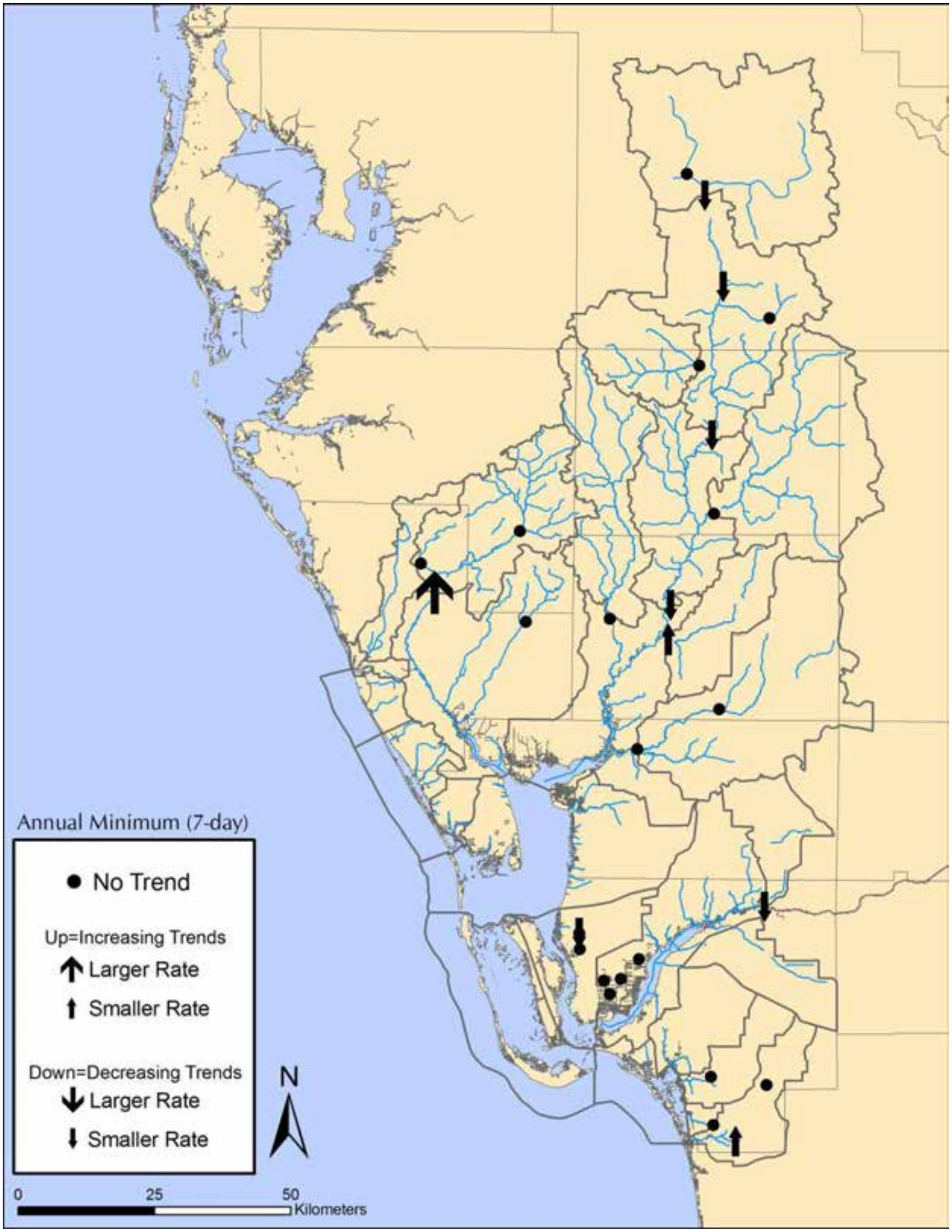
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Annual Minimum (7-day)
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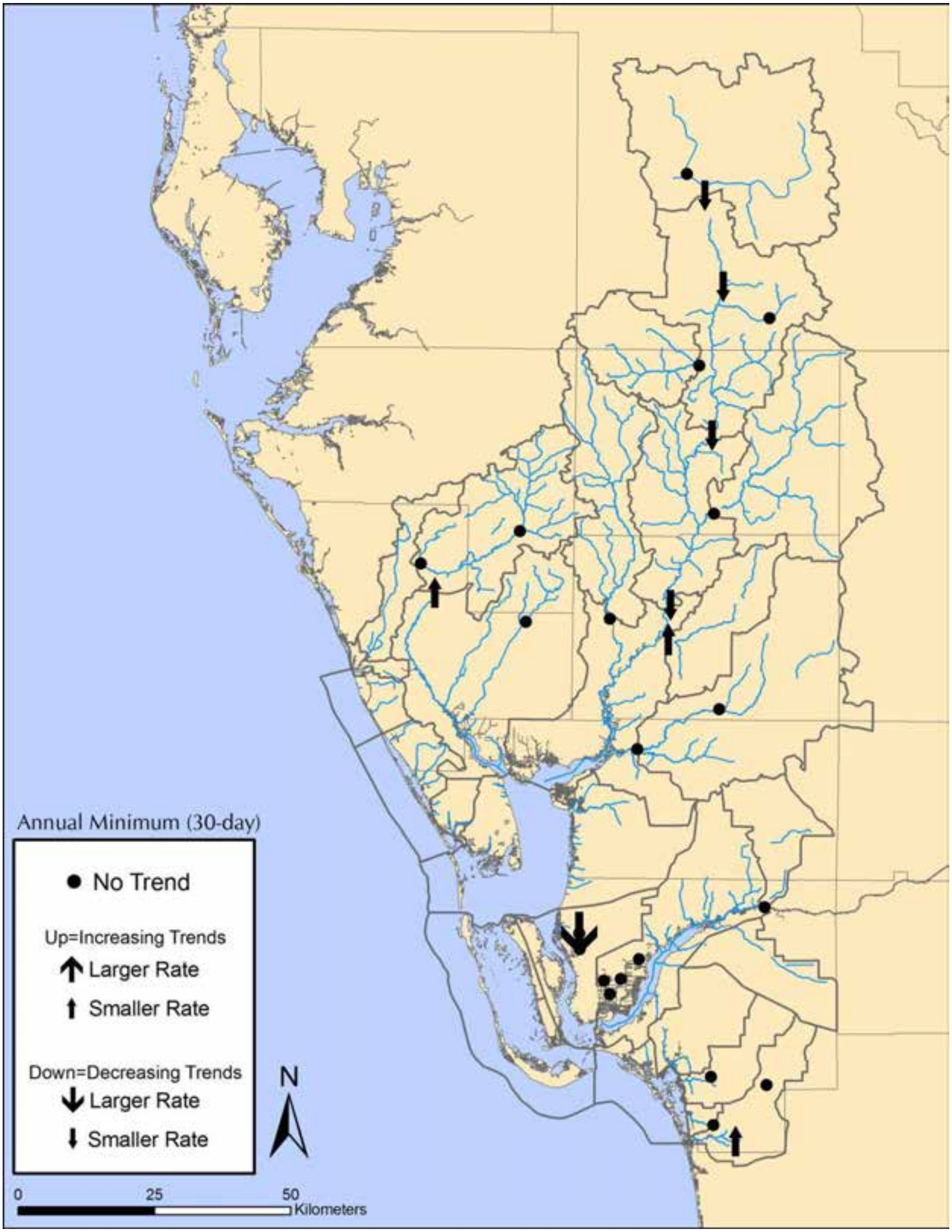
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Annual Minimum (30-day)
No Trend
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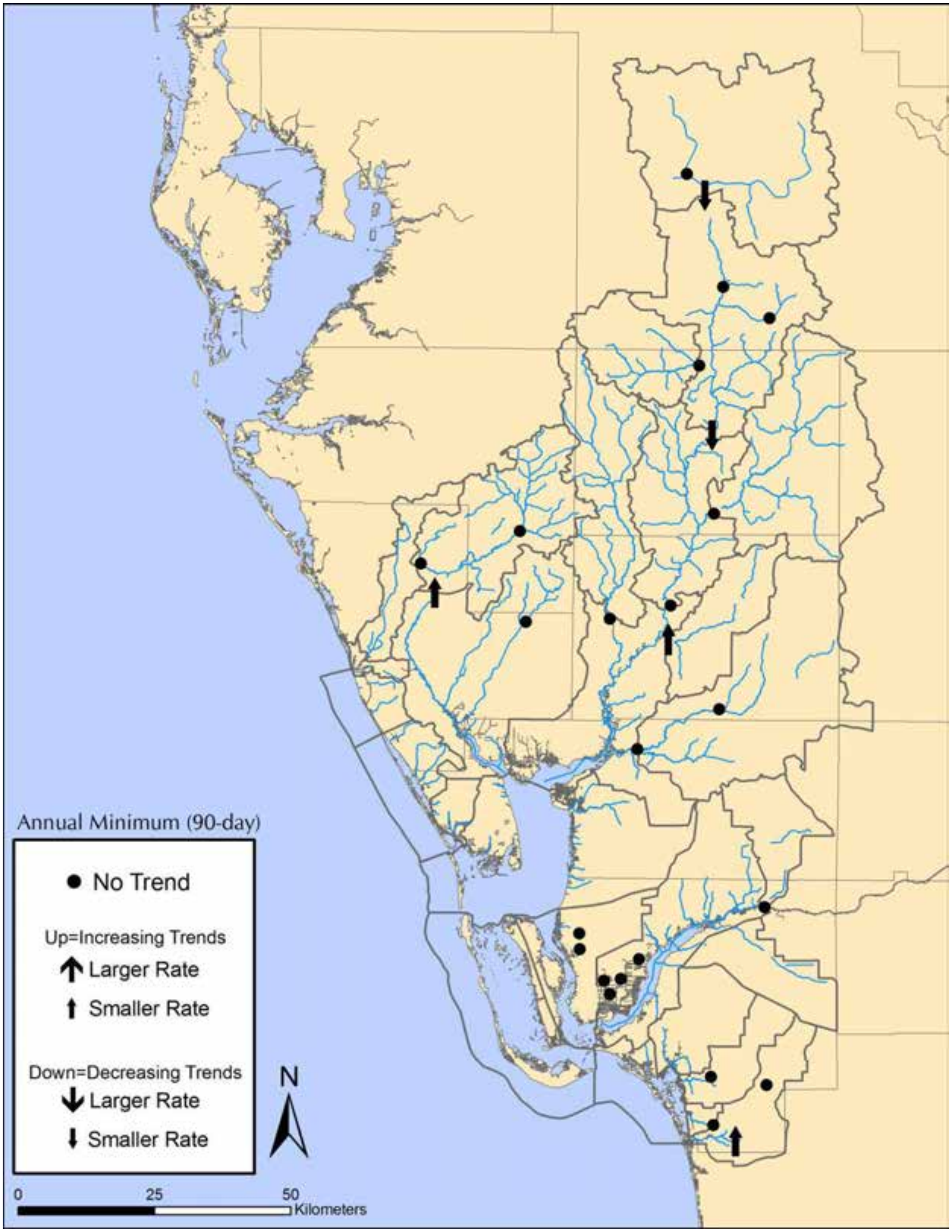
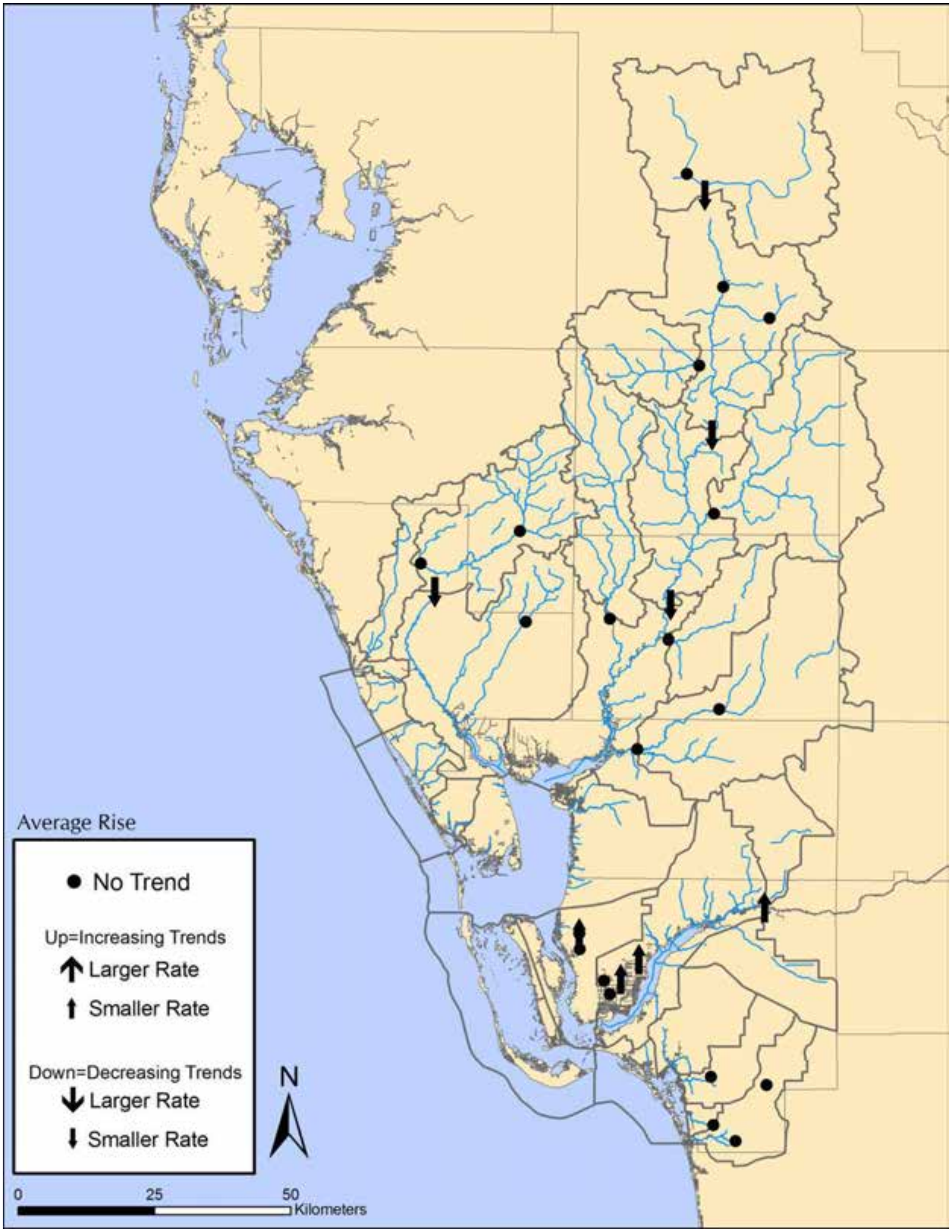
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Annual Minimum (90-day)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Average Rise
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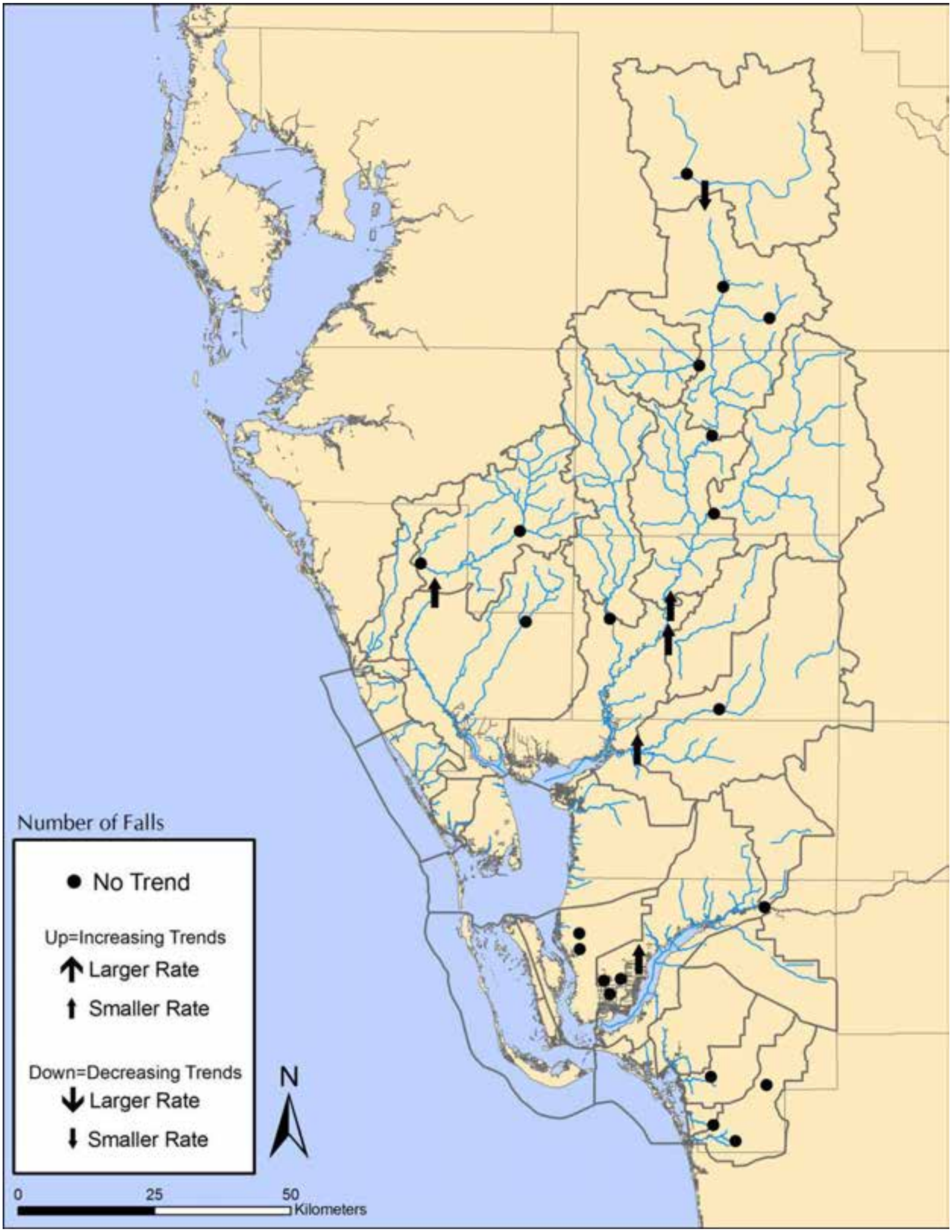
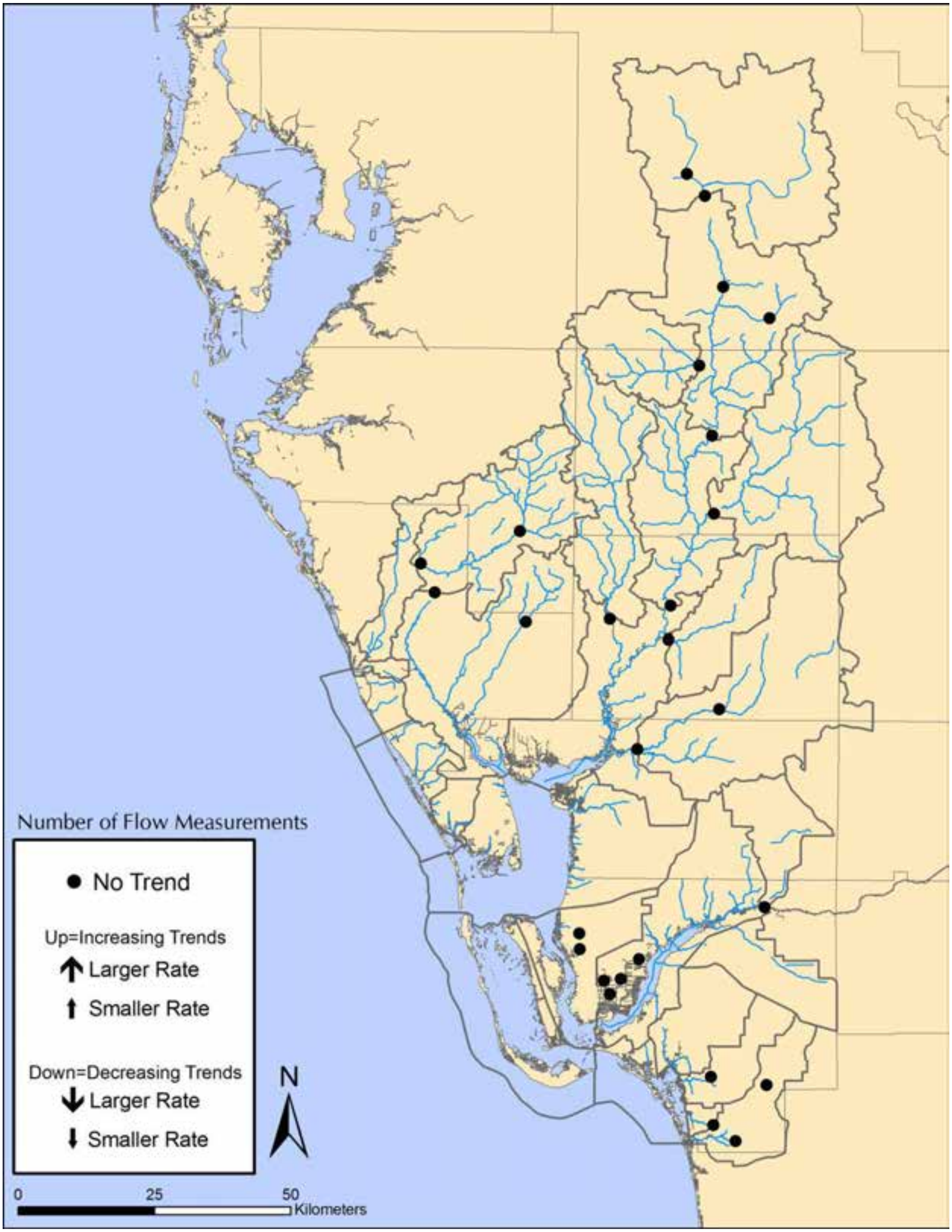
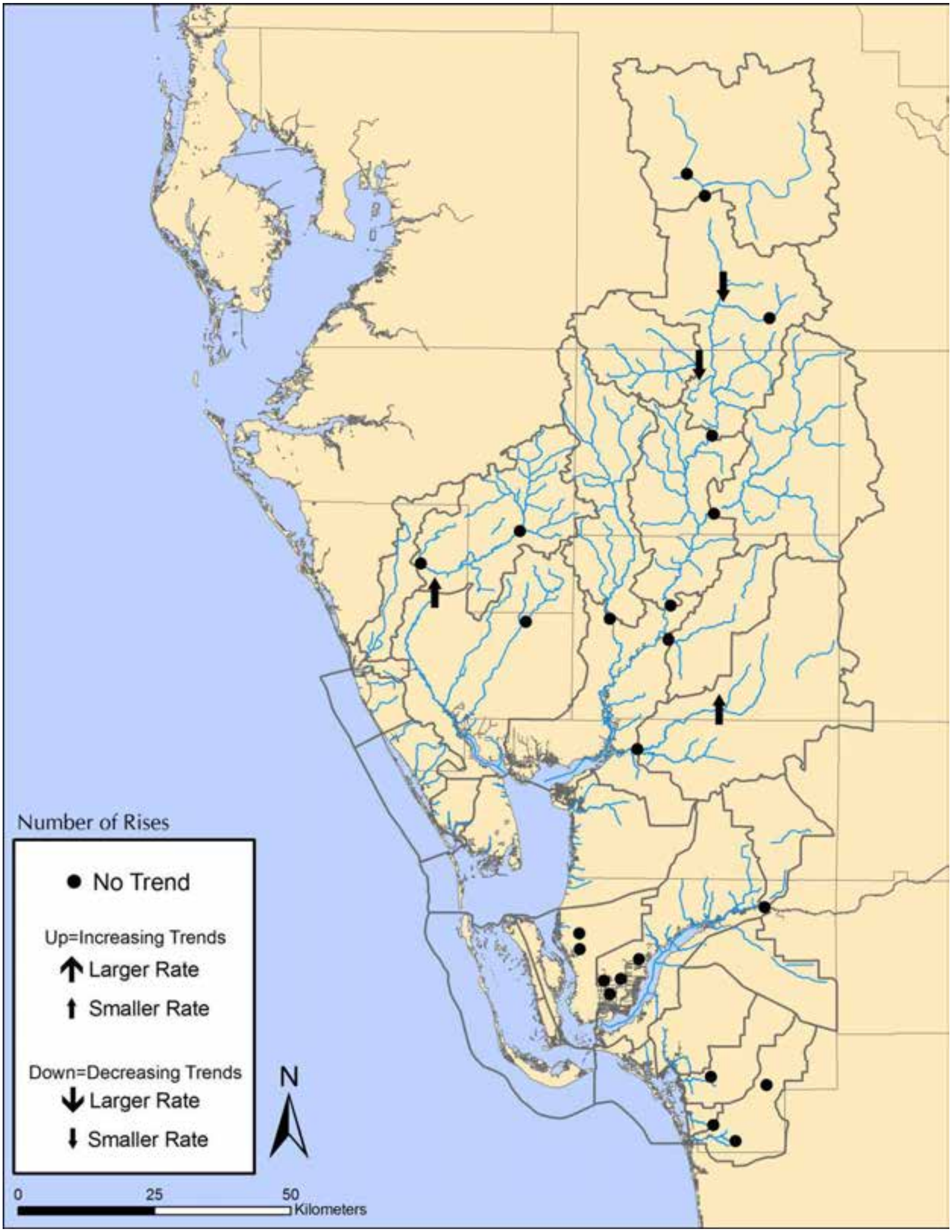
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Number of Falls
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers


Number of Flow Measurements
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers



Number of Rises
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
N
0
25
50
Kilometers

IHA Parameter Trend Summary

Name=Aries Canal At Cape Coral USGS Gage=02293240

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1990-2010
Number of High Pulses(>75th Percentile)		No			1990-2010
Mean Duration of Low Pulses		No			1990-2010
Number of Low Pulses (<25th Percentile)		No			1990-2010
Annual Maximum (1-day)		No			1990-2010
Annual Maximum (30-day)		No			1990-2010
Annual Maximum (3-day)		No			1990-2010
Annual Maximum (7-day)		No			1990-2010
Annual Maximum (90-day)		No			1990-2010
Median Jan Flow		No			1990-2010
Median Oct Flow		No			1990-2010
Median Nov Flow		No			1990-2010
Median Dec Flow		No			1990-2010
Median Feb Flow		No			1990-2010
Median Mar Flow		No			1990-2010
Median Apr Flow		No			1990-2010
Median May Flow		No			1990-2010
Median Jun Flow		No			1990-2010
Median Jul Flow		No			1990-2010
Median Aug Flow	Increasing	Yes	Small	6%	1990-2010
Median Sep Flow		No			1990-2010
Annual Minimum (1-day)		No			1990-2010
Annual Minimum (30-day)		No			1990-2010
Annual Minimum (3-day)		No			1990-2010
Annual Minimum (7-day)		No			1990-2010
Annual Minimum (90-day)		No			1990-2010
Average Fall		No			1990-2010
Average Rise		No			1990-2010
Number of Falls		No			1990-2010
Number of Rises		No			1990-2010

IHA Parameter Trend Summary

Name=Big Slough Canal Near Myakka City USGS Gage=02299410

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1981-2010
Number of High Pulses(>75th Percentile)		No			1981-2010
Mean Duration of Low Pulses		No			1981-2010
Number of Low Pulses (<25th Percentile)		No			1981-2010
Annual Maximum (1-day)		No			1981-2010
Annual Maximum (30-day)		No			1981-2010
Annual Maximum (3-day)		No			1981-2010
Annual Maximum (7-day)		No			1981-2010
Annual Maximum (90-day)		No			1981-2010
Median Jan Flow		No			1981-2010
Median Oct Flow		No			1981-2010
Median Nov Flow		No			1981-2010
Median Dec Flow		No			1981-2010
Median Feb Flow		No			1981-2010
Median Mar Flow		No			1981-2010
Median Apr Flow	Decreasing	Yes	Small	-8%	1981-2010
Median May Flow		No			1981-2010
Median Jun Flow		No			1981-2010
Median Jul Flow		No			1981-2010
Median Aug Flow		No			1981-2010
Median Sep Flow		No			1981-2010
Annual Minimum (1-day)		No			1981-2010
Annual Minimum (30-day)		No			1981-2010
Annual Minimum (3-day)		No			1981-2010
Annual Minimum (7-day)		No			1981-2010
Annual Minimum (90-day)		No			1981-2010
Average Fall		No			1981-2010
Average Rise		No			1981-2010
Number of Falls		No			1981-2010
Number of Rises		No			1981-2010

IHA Parameter Trend Summary

Name=Bowlegs Creek Near Fort Meade USGS Gage=02295013

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1965-2010
Number of High Pulses(>75th Percentile)		No			1965-2010
Mean Duration of Low Pulses		No			1965-2010
Number of Low Pulses (<25th Percentile)		No			1965-2010
Annual Maximum (1-day)		No			1965-2010
Annual Maximum (30-day)		No			1965-2010
Annual Maximum (3-day)		No			1965-2010
Annual Maximum (7-day)		No			1965-2010
Annual Maximum (90-day)		No			1965-2010
Median Jan Flow		No			1965-2010
Median Oct Flow		No			1965-2010
Median Nov Flow		No			1965-2010
Median Dec Flow		No			1965-2010
Median Feb Flow		No			1965-2010
Median Mar Flow		No			1965-2010
Median Apr Flow		No			1965-2010
Median May Flow		No			1965-2010
Median Jun Flow		No			1965-2010
Median Jul Flow		No			1965-2010
Median Aug Flow		No			1965-2010
Median Sep Flow		No			1965-2010
Annual Minimum (1-day)		No			1965-2010
Annual Minimum (30-day)		No			1965-2010
Annual Minimum (3-day)		No			1965-2010
Annual Minimum (7-day)		No			1965-2010
Annual Minimum (90-day)		No			1965-2010
Average Fall		No			1965-2010
Average Rise		No			1965-2010
Number of Falls		No			1965-2010
Number of Rises		No			1965-2010

IHA Parameter Trend Summary

Name=Caloosahatchee River At S-79 Nr.Olga USGS Gage=02292900

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1967-2010
Number of High Pulses(>75th Percentile)	Increasing	Yes	Small	2%	1967-2010
Mean Duration of Low Pulses		No			1967-2010
Number of Low Pulses (<25th Percentile)		No			1967-2010
Annual Maximum (1-day)		No			1967-2010
Annual Maximum (30-day)		No			1967-2010
Annual Maximum (3-day)		No			1967-2010
Annual Maximum (7-day)		No			1967-2010
Annual Maximum (90-day)		No			1967-2010
Median Jan Flow		No			1967-2010
Median Oct Flow		No			1967-2010
Median Nov Flow		No			1967-2010
Median Dec Flow		No			1967-2010
Median Feb Flow		No			1967-2010
Median Mar Flow		No			1967-2010
Median Apr Flow		No			1967-2010
Median May Flow		No			1967-2010
Median Jun Flow		No			1967-2010
Median Jul Flow		No			1967-2010
Median Aug Flow		No			1967-2010
Median Sep Flow	Increasing	Yes	Small	4%	1967-2010
Annual Minimum (1-day)	Decreasing	Yes	Small	-5%	1967-2010
Annual Minimum (30-day)		No			1967-2010
Annual Minimum (3-day)	Decreasing	Yes	Small	-4%	1967-2010
Annual Minimum (7-day)	Decreasing	Yes	Small	-3%	1967-2010
Annual Minimum (90-day)		No			1967-2010
Average Fall		No			1967-2010
Average Rise	Increasing	Yes	Small	2%	1967-2010
Number of Falls		No			1967-2010
Number of Rises		No			1967-2010

IHA Parameter Trend Summary

Name=Charlie Creek Near Gardner USGS Gage=02296500

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1951-2010
Number of High Pulses(>75th Percentile)	Decreasing	Yes	Small	-1%	1951-2010
Mean Duration of Low Pulses		No			1951-2010
Number of Low Pulses (<25th Percentile)		No			1951-2010
Annual Maximum (1-day)		No			1951-2010
Annual Maximum (30-day)		No			1951-2010
Annual Maximum (3-day)		No			1951-2010
Annual Maximum (7-day)		No			1951-2010
Annual Maximum (90-day)		No			1951-2010
Median Jan Flow		No			1951-2010
Median Oct Flow		No			1951-2010
Median Nov Flow		No			1951-2010
Median Dec Flow		No			1951-2010
Median Feb Flow		No			1951-2010
Median Mar Flow		No			1951-2010
Median Apr Flow		No			1951-2010
Median May Flow		No			1951-2010
Median Jun Flow		No			1951-2010
Median Jul Flow		No			1951-2010
Median Aug Flow		No			1951-2010
Median Sep Flow		No			1951-2010
Annual Minimum (1-day)		No			1951-2010
Annual Minimum (30-day)		No			1951-2010
Annual Minimum (3-day)		No			1951-2010
Annual Minimum (7-day)		No			1951-2010
Annual Minimum (90-day)		No			1951-2010
Average Fall		No			1951-2010
Average Rise		No			1951-2010
Number of Falls		No			1951-2010
Number of Rises		No			1951-2010

IHA Parameter Trend Summary

Name=Courtney Canal At Cape Coral USGS Gage=02293243

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1987-2010
Number of High Pulses(>75th Percentile)		No			1987-2010
Mean Duration of Low Pulses		No			1987-2010
Number of Low Pulses (<25th Percentile)		No			1987-2010
Annual Maximum (1-day)		No			1987-2010
Annual Maximum (30-day)		No			1987-2010
Annual Maximum (3-day)		No			1987-2010
Annual Maximum (7-day)		No			1987-2010
Annual Maximum (90-day)		No			1987-2010
Median Jan Flow		No			1987-2010
Median Oct Flow		No			1987-2010
Median Nov Flow		No			1987-2010
Median Dec Flow		No			1987-2010
Median Feb Flow		No			1987-2010
Median Mar Flow		No			1987-2010
Median Apr Flow		No			1987-2010
Median May Flow		No			1987-2010
Median Jun Flow		No			1987-2010
Median Jul Flow		No			1987-2010
Median Aug Flow		No			1987-2010
Median Sep Flow		No			1987-2010
Annual Minimum (1-day)		No			1987-2010
Annual Minimum (30-day)		No			1987-2010
Annual Minimum (3-day)		No			1987-2010
Annual Minimum (7-day)		No			1987-2010
Annual Minimum (90-day)		No			1987-2010
Average Fall	Decreasing	Yes	Small	4%	1987-2010
Average Rise		No			1987-2010
Number of Falls		No			1987-2010
Number of Rises		No			1987-2010

IHA Parameter Trend Summary

Name=Hermosa Canal At Cape Coral USGS Gage=02293347

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses	Decreasing	Yes	Small	-4%	1988-2010
Number of High Pulses(>75th Percentile)		No			1988-2010
Mean Duration of Low Pulses		No			1988-2010
Number of Low Pulses (<25th Percentile)	Increasing	Yes	Small	10%	1988-2010
Annual Maximum (1-day)		No			1988-2010
Annual Maximum (30-day)		No			1988-2010
Annual Maximum (3-day)		No			1988-2010
Annual Maximum (7-day)		No			1988-2010
Annual Maximum (90-day)		No			1988-2010
Median Jan Flow		No			1988-2010
Median Oct Flow		No			1988-2010
Median Nov Flow		No			1988-2010
Median Dec Flow		No			1988-2010
Median Feb Flow		No			1988-2010
Median Mar Flow		No			1988-2010
Median Apr Flow		No			1988-2010
Median May Flow		No			1988-2010
Median Jun Flow		No			1988-2010
Median Jul Flow		No			1988-2010
Median Aug Flow		No			1988-2010
Median Sep Flow		No			1988-2010
Annual Minimum (1-day)		No			1988-2010
Annual Minimum (30-day)	Decreasing	Yes	Large		1988-2010
Annual Minimum (3-day)		No			1988-2010
Annual Minimum (7-day)	Decreasing	Yes	Small	.%	1988-2010
Annual Minimum (90-day)		No			1988-2010
Average Fall	Decreasing	Yes	Small	9%	1988-2010
Average Rise	Increasing	Yes	Small	6%	1988-2010
Number of Falls		No			1988-2010
Number of Rises		No			1988-2010

IHA Parameter Trend Summary

Name=Horse Creek Near Arcadia USGS Gage=02297310

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1951-2010
Number of High Pulses(>75th Percentile)		No			1951-2010
Mean Duration of Low Pulses		No			1951-2010
Number of Low Pulses (<25th Percentile)		No			1951-2010
Annual Maximum (1-day)		No			1951-2010
Annual Maximum (30-day)		No			1951-2010
Annual Maximum (3-day)		No			1951-2010
Annual Maximum (7-day)		No			1951-2010
Annual Maximum (90-day)		No			1951-2010
Median Jan Flow		No			1951-2010
Median Oct Flow		No			1951-2010
Median Nov Flow		No			1951-2010
Median Dec Flow		No			1951-2010
Median Feb Flow		No			1951-2010
Median Mar Flow		No			1951-2010
Median Apr Flow		No			1951-2010
Median May Flow		No			1951-2010
Median Jun Flow		No			1951-2010
Median Jul Flow		No			1951-2010
Median Aug Flow		No			1951-2010
Median Sep Flow		No			1951-2010
Annual Minimum (1-day)		No			1951-2010
Annual Minimum (30-day)		No			1951-2010
Annual Minimum (3-day)		No			1951-2010
Annual Minimum (7-day)		No			1951-2010
Annual Minimum (90-day)		No			1951-2010
Average Fall		No			1951-2010
Average Rise		No			1951-2010
Number of Falls		No			1951-2010
Number of Rises		No			1951-2010

IHA Parameter Trend Summary

Name=Horseshoe Canal At Cape Coral USGS Gage=02293346

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1988-2010
Number of High Pulses(>75th Percentile)		No			1988-2010
Mean Duration of Low Pulses		No			1988-2010
Number of Low Pulses (<25th Percentile)		No			1988-2010
Annual Maximum (1-day)		No			1988-2010
Annual Maximum (30-day)		No			1988-2010
Annual Maximum (3-day)		No			1988-2010
Annual Maximum (7-day)		No			1988-2010
Annual Maximum (90-day)		No			1988-2010
Median Jan Flow		No			1988-2010
Median Oct Flow		No			1988-2010
Median Nov Flow		No			1988-2010
Median Dec Flow		No			1988-2010
Median Feb Flow		No			1988-2010
Median Mar Flow		No			1988-2010
Median Apr Flow		No			1988-2010
Median May Flow		No			1988-2010
Median Jun Flow		No			1988-2010
Median Jul Flow		No			1988-2010
Median Aug Flow		No			1988-2010
Median Sep Flow		No			1988-2010
Annual Minimum (1-day)		No			1988-2010
Annual Minimum (30-day)		No			1988-2010
Annual Minimum (3-day)		No			1988-2010
Annual Minimum (7-day)		No			1988-2010
Annual Minimum (90-day)		No			1988-2010
Average Fall	Decreasing	Yes	Small	4%	1988-2010
Average Rise		No			1988-2010
Number of Falls		No			1988-2010
Number of Rises		No			1988-2010

IHA Parameter Trend Summary

Name=Howard Creek Near Sarasota USGS Gage=02298760

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1984-2010
Number of High Pulses(>75th Percentile)		No			1984-2010
Mean Duration of Low Pulses		No			1984-2010
Number of Low Pulses (<25th Percentile)		No			1984-2010
Annual Maximum (1-day)		No			1984-2010
Annual Maximum (30-day)		No			1984-2010
Annual Maximum (3-day)		No			1984-2010
Annual Maximum (7-day)		No			1984-2010
Annual Maximum (90-day)		No			1984-2010
Median Jan Flow		No			1984-2010
Median Oct Flow		No			1984-2010
Median Nov Flow		No			1984-2010
Median Dec Flow		No			1984-2010
Median Feb Flow		No			1984-2010
Median Mar Flow		No			1984-2010
Median Apr Flow		No			1984-2010
Median May Flow		No			1984-2010
Median Jun Flow		No			1984-2010
Median Jul Flow		No			1984-2010
Median Aug Flow		No			1984-2010
Median Sep Flow		No			1984-2010
Annual Minimum (1-day)		No			1984-2010
Annual Minimum (30-day)		No			1984-2010
Annual Minimum (3-day)		No			1984-2010
Annual Minimum (7-day)		No			1984-2010
Annual Minimum (90-day)		No			1984-2010
Average Fall		No			1984-2010
Average Rise		No			1984-2010
Number of Falls		No			1984-2010
Number of Rises		No			1984-2010

IHA Parameter Trend Summary

Name=Imperial River Near Bonita Springs USGS Gage=02291500

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1941-2010
Number of High Pulses(>75th Percentile)		No			1941-2010
Mean Duration of Low Pulses	Decreasing	Yes	Small	-6%	1941-2010
Number of Low Pulses (<25th Percentile)		No			1941-2010
Annual Maximum (1-day)		No			1941-2010
Annual Maximum (30-day)		No			1941-2010
Annual Maximum (3-day)		No			1941-2010
Annual Maximum (7-day)		No			1941-2010
Annual Maximum (90-day)		No			1941-2010
Median Jan Flow		No			1941-2010
Median Oct Flow		No			1941-2010
Median Nov Flow		No			1941-2010
Median Dec Flow	Increasing	Yes	Small	2%	1941-2010
Median Feb Flow		No			1941-2010
Median Mar Flow		No			1941-2010
Median Apr Flow	Increasing	Yes	Small	2%	1941-2010
Median May Flow	Increasing	Yes	Small	2%	1941-2010
Median Jun Flow		No			1941-2010
Median Jul Flow		No			1941-2010
Median Aug Flow		No			1941-2010
Median Sep Flow		No			1941-2010
Annual Minimum (1-day)	Increasing	Yes	Small	2%	1941-2010
Annual Minimum (30-day)	Increasing	Yes	Small	2%	1941-2010
Annual Minimum (3-day)	Increasing	Yes	Small	2%	1941-2010
Annual Minimum (7-day)	Increasing	Yes	Small	2%	1941-2010
Annual Minimum (90-day)	Increasing	Yes	Small	2%	1941-2010
Average Fall		No			1941-2010
Average Rise		No			1941-2010
Number of Falls		No			1941-2010
Number of Rises		No			1941-2010

IHA Parameter Trend Summary

Name=Joshua Creek At Nocatee USGS Gage=02297100

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1951-2010
Number of High Pulses(>75th Percentile)		No			1951-2010
Mean Duration of Low Pulses	Decreasing	Yes	Small	-3%	1951-2010
Number of Low Pulses (<25th Percentile)	Decreasing	Yes	Small	-2%	1951-2010
Annual Maximum (1-day)		No			1951-2010
Annual Maximum (30-day)		No			1951-2010
Annual Maximum (3-day)		No			1951-2010
Annual Maximum (7-day)		No			1951-2010
Annual Maximum (90-day)		No			1951-2010
Median Jan Flow	Increasing	Yes	Small	2%	1951-2010
Median Oct Flow		No			1951-2010
Median Nov Flow	Increasing	Yes	Small	1%	1951-2010
Median Dec Flow	Increasing	Yes	Small	2%	1951-2010
Median Feb Flow	Increasing	Yes	Small	2%	1951-2010
Median Mar Flow		No			1951-2010
Median Apr Flow	Increasing	Yes	Small	2%	1951-2010
Median May Flow	Increasing	Yes	Small	3%	1951-2010
Median Jun Flow		No			1951-2010
Median Jul Flow		No			1951-2010
Median Aug Flow		No			1951-2010
Median Sep Flow		No			1951-2010
Annual Minimum (1-day)	Increasing	Yes	Small	6%	1951-2010
Annual Minimum (30-day)	Increasing	Yes	Small	5%	1951-2010
Annual Minimum (3-day)	Increasing	Yes	Small	6%	1951-2010
Annual Minimum (7-day)	Increasing	Yes	Small	6%	1951-2010
Annual Minimum (90-day)	Increasing	Yes	Small	2%	1951-2010
Average Fall		No			1951-2010
Average Rise		No			1951-2010
Number of Falls	Increasing	Yes	Small	0%	1951-2010
Number of Rises		No			1951-2010

IHA Parameter Trend Summary

Name=Meade Canal At Cape Coral USGS Gage=02293214

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1987-2010
Number of High Pulses(>75th Percentile)		No			1987-2010
Mean Duration of Low Pulses		No			1987-2010
Number of Low Pulses (<25th Percentile)		No			1987-2010
Annual Maximum (1-day)	Increasing	Yes	Small	4%	1987-2010
Annual Maximum (30-day)	Increasing	Yes	Small	4%	1987-2010
Annual Maximum (3-day)	Increasing	Yes	Small	4%	1987-2010
Annual Maximum (7-day)	Increasing	Yes	Small	5%	1987-2010
Annual Maximum (90-day)		No			1987-2010
Median Jan Flow		No			1987-2010
Median Oct Flow		No			1987-2010
Median Nov Flow		No			1987-2010
Median Dec Flow		No			1987-2010
Median Feb Flow		No			1987-2010
Median Mar Flow		No			1987-2010
Median Apr Flow		No			1987-2010
Median May Flow		No			1987-2010
Median Jun Flow		No			1987-2010
Median Jul Flow		No			1987-2010
Median Aug Flow		No			1987-2010
Median Sep Flow	Increasing	Yes	Small	5%	1987-2010
Annual Minimum (1-day)		No			1987-2010
Annual Minimum (30-day)		No			1987-2010
Annual Minimum (3-day)		No			1987-2010
Annual Minimum (7-day)		No			1987-2010
Annual Minimum (90-day)		No			1987-2010
Average Fall	Decreasing	Yes	Small	4%	1987-2010
Average Rise	Increasing	Yes	Small	4%	1987-2010
Number of Falls	Increasing	Yes	Small	2%	1987-2010
Number of Rises		No			1987-2010

IHA Parameter Trend Summary

Name=Myakka River At Myakka City USGS Gage=02298608

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1964-2010
Number of High Pulses(>75th Percentile)		No			1964-2010
Mean Duration of Low Pulses		No			1964-2010
Number of Low Pulses (<25th Percentile)		No			1964-2010
Annual Maximum (1-day)		No			1964-2010
Annual Maximum (30-day)		No			1964-2010
Annual Maximum (3-day)		No			1964-2010
Annual Maximum (7-day)		No			1964-2010
Annual Maximum (90-day)		No			1964-2010
Median Jan Flow		No			1964-2010
Median Oct Flow		No			1964-2010
Median Nov Flow		No			1964-2010
Median Dec Flow		No			1964-2010
Median Feb Flow		No			1964-2010
Median Mar Flow		No			1964-2010
Median Apr Flow		No			1964-2010
Median May Flow		No			1964-2010
Median Jun Flow		No			1964-2010
Median Jul Flow		No			1964-2010
Median Aug Flow		No			1964-2010
Median Sep Flow		No			1964-2010
Annual Minimum (1-day)		No			1964-2010
Annual Minimum (30-day)		No			1964-2010
Annual Minimum (3-day)		No			1964-2010
Annual Minimum (7-day)		No			1964-2010
Annual Minimum (90-day)		No			1964-2010
Average Fall		No			1964-2010
Average Rise		No			1964-2010
Number of Falls		No			1964-2010
Number of Rises		No			1964-2010

IHA Parameter Trend Summary

Name=Myakka River Near Sarasota USGS Gage=02298830

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1941-2010
Number of High Pulses(>75th Percentile)		No			1941-2010
Mean Duration of Low Pulses	Decreasing	Yes	Small	-1%	1941-2010
Number of Low Pulses (<25th Percentile)		No			1941-2010
Annual Maximum (1-day)		No			1941-2010
Annual Maximum (30-day)		No			1941-2010
Annual Maximum (3-day)		No			1941-2010
Annual Maximum (7-day)		No			1941-2010
Annual Maximum (90-day)		No			1941-2010
Median Jan Flow		No			1941-2010
Median Oct Flow		No			1941-2010
Median Nov Flow		No			1941-2010
Median Dec Flow		No			1941-2010
Median Feb Flow		No			1941-2010
Median Mar Flow		No			1941-2010
Median Apr Flow		No			1941-2010
Median May Flow	Increasing	Yes	Small	3%	1941-2010
Median Jun Flow		No			1941-2010
Median Jul Flow		No			1941-2010
Median Aug Flow		No			1941-2010
Median Sep Flow		No			1941-2010
Annual Minimum (1-day)	Increasing	Yes	Large	21%	1941-2010
Annual Minimum (30-day)	Increasing	Yes	Small	7%	1941-2010
Annual Minimum (3-day)	Increasing	Yes	Large	16%	1941-2010
Annual Minimum (7-day)	Increasing	Yes	Large	13%	1941-2010
Annual Minimum (90-day)	Increasing	Yes	Small	2%	1941-2010
Average Fall	Increasing	Yes	Small	-1%	1941-2010
Average Rise	Decreasing	Yes	Small	-1%	1941-2010
Number of Falls	Increasing	Yes	Small	0%	1941-2010
Number of Rises	Increasing	Yes	Small	0%	1941-2010

IHA Parameter Trend Summary

Name=North Branch Estero River At Estero USGS Gage=02291580

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1988-2010
Number of High Pulses(>75th Percentile)		No			1988-2010
Mean Duration of Low Pulses		No			1988-2010
Number of Low Pulses (<25th Percentile)		No			1988-2010
Annual Maximum (1-day)		No			1988-2010
Annual Maximum (30-day)		No			1988-2010
Annual Maximum (3-day)		No			1988-2010
Annual Maximum (7-day)		No			1988-2010
Annual Maximum (90-day)		No			1988-2010
Median Jan Flow		No			1988-2010
Median Oct Flow		No			1988-2010
Median Nov Flow		No			1988-2010
Median Dec Flow		No			1988-2010
Median Feb Flow		No			1988-2010
Median Mar Flow		No			1988-2010
Median Apr Flow		No			1988-2010
Median May Flow		No			1988-2010
Median Jun Flow		No			1988-2010
Median Jul Flow		No			1988-2010
Median Aug Flow		No			1988-2010
Median Sep Flow		No			1988-2010
Annual Minimum (1-day)		No			1988-2010
Annual Minimum (30-day)		No			1988-2010
Annual Minimum (3-day)		No			1988-2010
Annual Minimum (7-day)		No			1988-2010
Annual Minimum (90-day)		No			1988-2010
Average Fall		No			1988-2010
Average Rise		No			1988-2010
Number of Falls		No			1988-2010
Number of Rises		No			1988-2010

IHA Parameter Trend Summary

Name=Payne Creek Near Bowling Green USGS Gage=02295420

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1964-2010
Number of High Pulses(>75th Percentile)		No			1964-2010
Mean Duration of Low Pulses		No			1964-2010
Number of Low Pulses (<25th Percentile)	Decreasing	Yes	Small	-2%	1964-2010
Annual Maximum (1-day)		No			1964-2010
Annual Maximum (30-day)		No			1964-2010
Annual Maximum (3-day)		No			1964-2010
Annual Maximum (7-day)		No			1964-2010
Annual Maximum (90-day)		No			1964-2010
Median Jan Flow		No			1964-2010
Median Oct Flow		No			1964-2010
Median Nov Flow		No			1964-2010
Median Dec Flow		No			1964-2010
Median Feb Flow		No			1964-2010
Median Mar Flow		No			1964-2010
Median Apr Flow		No			1964-2010
Median May Flow		No			1964-2010
Median Jun Flow		No			1964-2010
Median Jul Flow		No			1964-2010
Median Aug Flow		No			1964-2010
Median Sep Flow		No			1964-2010
Annual Minimum (1-day)		No			1964-2010
Annual Minimum (30-day)		No			1964-2010
Annual Minimum (3-day)		No			1964-2010
Annual Minimum (7-day)		No			1964-2010
Annual Minimum (90-day)		No			1964-2010
Average Fall		No			1964-2010
Average Rise		No			1964-2010
Number of Falls		No			1964-2010
Number of Rises	Decreasing	Yes	Small	-1%	1964-2010

IHA Parameter Trend Summary

Name=Peace River At Arcadia USGS Gage=02296750

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1941-2010
Number of High Pulses(>75th Percentile)		No			1941-2010
Mean Duration of Low Pulses		No			1941-2010
Number of Low Pulses (<25th Percentile)		No			1941-2010
Annual Maximum (1-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Maximum (30-day)		No			1941-2010
Annual Maximum (3-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Maximum (7-day)		No			1941-2010
Annual Maximum (90-day)		No			1941-2010
Median Jan Flow		No			1941-2010
Median Oct Flow		No			1941-2010
Median Nov Flow		No			1941-2010
Median Dec Flow		No			1941-2010
Median Feb Flow		No			1941-2010
Median Mar Flow		No			1941-2010
Median Apr Flow		No			1941-2010
Median May Flow		No			1941-2010
Median Jun Flow		No			1941-2010
Median Jul Flow		No			1941-2010
Median Aug Flow		No			1941-2010
Median Sep Flow		No			1941-2010
Annual Minimum (1-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Minimum (30-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Minimum (3-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Minimum (7-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Minimum (90-day)		No			1941-2010
Average Fall	Increasing	Yes	Small	-1%	1941-2010
Average Rise	Decreasing	Yes	Small	-1%	1941-2010
Number of Falls	Increasing	Yes	Small	0%	1941-2010
Number of Rises		No			1941-2010

IHA Parameter Trend Summary

Name=Peace River At Bartow USGS Gage=02294650

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1941-2010
Number of High Pulses(>75th Percentile)	Decreasing	Yes	Small	-1%	1941-2010
Mean Duration of Low Pulses	Increasing	Yes	Small	3%	1941-2010
Number of Low Pulses (<25th Percentile)		No			1941-2010
Annual Maximum (1-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Maximum (30-day)		No			1941-2010
Annual Maximum (3-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Maximum (7-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Maximum (90-day)	Decreasing	Yes	Small	-1%	1941-2010
Median Jan Flow	Decreasing	Yes	Small	-2%	1941-2010
Median Oct Flow	Decreasing	Yes	Small	-2%	1941-2010
Median Nov Flow	Decreasing	Yes	Small	-2%	1941-2010
Median Dec Flow	Decreasing	Yes	Small	-2%	1941-2010
Median Feb Flow	Decreasing	Yes	Small	-2%	1941-2010
Median Mar Flow	Decreasing	Yes	Small	-2%	1941-2010
Median Apr Flow	Decreasing	Yes	Small	-2%	1941-2010
Median May Flow	Decreasing	Yes	Small	-3%	1941-2010
Median Jun Flow	Decreasing	Yes	Small	-2%	1941-2010
Median Jul Flow	Decreasing	Yes	Small	-2%	1941-2010
Median Aug Flow	Decreasing	Yes	Small	-1%	1941-2010
Median Sep Flow	Decreasing	Yes	Small	-2%	1941-2010
Annual Minimum (1-day)	Decreasing	Yes	Small	-3%	1941-2010
Annual Minimum (30-day)	Decreasing	Yes	Small	-3%	1941-2010
Annual Minimum (3-day)	Decreasing	Yes	Small	-3%	1941-2010
Annual Minimum (7-day)	Decreasing	Yes	Small	-3%	1941-2010
Annual Minimum (90-day)	Decreasing	Yes	Small	-2%	1941-2010
Average Fall	Increasing	Yes	Small	-1%	1941-2010
Average Rise	Decreasing	Yes	Small	-1%	1941-2010
Number of Falls	Decreasing	Yes	Small	0%	1941-2010
Number of Rises		No			1941-2010

IHA Parameter Trend Summary

Name=Peace River At Fort Meade USGS Gage=02294898

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1975-2010
Number of High Pulses(>75th Percentile)		No			1975-2010
Mean Duration of Low Pulses	Increasing	Yes	Small	6%	1975-2010
Number of Low Pulses (<25th Percentile)		No			1975-2010
Annual Maximum (1-day)		No			1975-2010
Annual Maximum (30-day)		No			1975-2010
Annual Maximum (3-day)		No			1975-2010
Annual Maximum (7-day)		No			1975-2010
Annual Maximum (90-day)		No			1975-2010
Median Jan Flow		No			1975-2010
Median Oct Flow		No			1975-2010
Median Nov Flow		No			1975-2010
Median Dec Flow		No			1975-2010
Median Feb Flow		No			1975-2010
Median Mar Flow		No			1975-2010
Median Apr Flow		No			1975-2010
Median May Flow		No			1975-2010
Median Jun Flow		No			1975-2010
Median Jul Flow		No			1975-2010
Median Aug Flow		No			1975-2010
Median Sep Flow		No			1975-2010
Annual Minimum (1-day)		No			1975-2010
Annual Minimum (30-day)	Decreasing	Yes	Small	-4%	1975-2010
Annual Minimum (3-day)		No			1975-2010
Annual Minimum (7-day)	Decreasing	Yes	Small	-5%	1975-2010
Annual Minimum (90-day)		No			1975-2010
Average Fall		No			1975-2010
Average Rise		No			1975-2010
Number of Falls		No			1975-2010
Number of Rises	Decreasing	Yes	Small	-2%	1975-2010

IHA Parameter Trend Summary

Name=Peace River At Zolfo Springs USGS Gage=02295637

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses	Decreasing	Yes	Small	-1%	1941-2010
Number of High Pulses(>75th Percentile)		No			1941-2010
Mean Duration of Low Pulses	Increasing	Yes	Small	2%	1941-2010
Number of Low Pulses (<25th Percentile)		No			1941-2010
Annual Maximum (1-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Maximum (30-day)		No			1941-2010
Annual Maximum (3-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Maximum (7-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Maximum (90-day)		No			1941-2010
Median Jan Flow		No			1941-2010
Median Oct Flow		No			1941-2010
Median Nov Flow	Decreasing	Yes	Small	-1%	1941-2010
Median Dec Flow	Decreasing	Yes	Small	-1%	1941-2010
Median Feb Flow		No			1941-2010
Median Mar Flow		No			1941-2010
Median Apr Flow		No			1941-2010
Median May Flow	Decreasing	Yes	Small	-1%	1941-2010
Median Jun Flow		No			1941-2010
Median Jul Flow		No			1941-2010
Median Aug Flow		No			1941-2010
Median Sep Flow		No			1941-2010
Annual Minimum (1-day)	Decreasing	Yes	Small	-2%	1941-2010
Annual Minimum (30-day)	Decreasing	Yes	Small	-1%	1941-2010
Annual Minimum (3-day)	Decreasing	Yes	Small	-2%	1941-2010
Annual Minimum (7-day)	Decreasing	Yes	Small	-2%	1941-2010
Annual Minimum (90-day)	Decreasing	Yes	Small	-1%	1941-2010
Average Fall	Increasing	Yes	Small	-1%	1941-2010
Average Rise	Decreasing	Yes	Small	-1%	1941-2010
Number of Falls		No			1941-2010
Number of Rises		No			1941-2010

IHA Parameter Trend Summary

Name=Prairie Creek Near Fort Ogden USGS Gage=02298123

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1964-2010
Number of High Pulses(>75th Percentile)		No			1964-2010
Mean Duration of Low Pulses		No			1964-2010
Number of Low Pulses (<25th Percentile)		No			1964-2010
Annual Maximum (1-day)		No			1964-2010
Annual Maximum (30-day)		No			1964-2010
Annual Maximum (3-day)		No			1964-2010
Annual Maximum (7-day)		No			1964-2010
Annual Maximum (90-day)		No			1964-2010
Median Jan Flow		No			1964-2010
Median Oct Flow		No			1964-2010
Median Nov Flow		No			1964-2010
Median Dec Flow	Increasing	Yes	Small	3%	1964-2010
Median Feb Flow		No			1964-2010
Median Mar Flow		No			1964-2010
Median Apr Flow		No			1964-2010
Median May Flow		No			1964-2010
Median Jun Flow		No			1964-2010
Median Jul Flow		No			1964-2010
Median Aug Flow		No			1964-2010
Median Sep Flow		No			1964-2010
Annual Minimum (1-day)		No			1964-2010
Annual Minimum (30-day)		No			1964-2010
Annual Minimum (3-day)		No			1964-2010
Annual Minimum (7-day)		No			1964-2010
Annual Minimum (90-day)		No			1964-2010
Average Fall		No			1964-2010
Average Rise		No			1964-2010
Number of Falls		No			1964-2010
Number of Rises	Increasing	Yes	Small	0%	1964-2010

IHA Parameter Trend Summary

Name=Saddle Creek At Structure P-11 Near Bartow USGS Gage=02294491

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1964-2010
Number of High Pulses(>75th Percentile)		No			1964-2010
Mean Duration of Low Pulses		No			1964-2010
Number of Low Pulses (<25th Percentile)		No			1964-2010
Annual Maximum (1-day)		No			1964-2010
Annual Maximum (30-day)		No			1964-2010
Annual Maximum (3-day)		No			1964-2010
Annual Maximum (7-day)		No			1964-2010
Annual Maximum (90-day)		No			1964-2010
Median Jan Flow		No			1964-2010
Median Oct Flow		No			1964-2010
Median Nov Flow		No			1964-2010
Median Dec Flow		No			1964-2010
Median Feb Flow		No			1964-2010
Median Mar Flow		No			1964-2010
Median Apr Flow		No			1964-2010
Median May Flow		No			1964-2010
Median Jun Flow		No			1964-2010
Median Jul Flow		No			1964-2010
Median Aug Flow		No			1964-2010
Median Sep Flow		No			1964-2010
Annual Minimum (1-day)		No			1964-2010
Annual Minimum (30-day)		No			1964-2010
Annual Minimum (3-day)		No			1964-2010
Annual Minimum (7-day)		No			1964-2010
Annual Minimum (90-day)		No			1964-2010
Average Fall		No			1964-2010
Average Rise		No			1964-2010
Number of Falls		No			1964-2010
Number of Rises		No			1964-2010

IHA Parameter Trend Summary

Name=San Carlos Canal At Cape Coral USGS Gage=02293241

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1987-2010
Number of High Pulses(>75th Percentile)		No			1987-2010
Mean Duration of Low Pulses		No			1987-2010
Number of Low Pulses (<25th Percentile)		No			1987-2010
Annual Maximum (1-day)		No			1987-2010
Annual Maximum (30-day)		No			1987-2010
Annual Maximum (3-day)		No			1987-2010
Annual Maximum (7-day)		No			1987-2010
Annual Maximum (90-day)	Increasing	Yes	Small	3%	1987-2010
Median Jan Flow		No			1987-2010
Median Oct Flow		No			1987-2010
Median Nov Flow		No			1987-2010
Median Dec Flow		No			1987-2010
Median Feb Flow		No			1987-2010
Median Mar Flow		No			1987-2010
Median Apr Flow		No			1987-2010
Median May Flow		No			1987-2010
Median Jun Flow		No			1987-2010
Median Jul Flow		No			1987-2010
Median Aug Flow		No			1987-2010
Median Sep Flow		No			1987-2010
Annual Minimum (1-day)		No			1987-2010
Annual Minimum (30-day)		No			1987-2010
Annual Minimum (3-day)		No			1987-2010
Annual Minimum (7-day)		No			1987-2010
Annual Minimum (90-day)		No			1987-2010
Average Fall	Decreasing	Yes	Small	3%	1987-2010
Average Rise	Increasing	Yes	Small	3%	1987-2010
Number of Falls		No			1987-2010
Number of Rises		No			1987-2010

IHA Parameter Trend Summary

Name=Shadroe Canal At Cape Coral USGS Gage=02293345

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1988-2010
Number of High Pulses(>75th Percentile)		No			1988-2010
Mean Duration of Low Pulses		No			1988-2010
Number of Low Pulses (<25th Percentile)		No			1988-2010
Annual Maximum (1-day)		No			1988-2010
Annual Maximum (30-day)		No			1988-2010
Annual Maximum (3-day)		No			1988-2010
Annual Maximum (7-day)		No			1988-2010
Annual Maximum (90-day)		No			1988-2010
Median Jan Flow		No			1988-2010
Median Oct Flow		No			1988-2010
Median Nov Flow		No			1988-2010
Median Dec Flow		No			1988-2010
Median Feb Flow		No			1988-2010
Median Mar Flow		No			1988-2010
Median Apr Flow		No			1988-2010
Median May Flow		No			1988-2010
Median Jun Flow		No			1988-2010
Median Jul Flow		No			1988-2010
Median Aug Flow		No			1988-2010
Median Sep Flow		No			1988-2010
Annual Minimum (1-day)		No			1988-2010
Annual Minimum (30-day)		No			1988-2010
Annual Minimum (3-day)		No			1988-2010
Annual Minimum (7-day)		No			1988-2010
Annual Minimum (90-day)		No			1988-2010
Average Fall	Decreasing	Yes	Small	4%	1988-2010
Average Rise		No			1988-2010
Number of Falls		No			1988-2010
Number of Rises		No			1988-2010

IHA Parameter Trend Summary

Name=Shell Creek Near Punta Gorda USGS Gage=02298202

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1965-2010
Number of High Pulses(>75th Percentile)		No			1965-2010
Mean Duration of Low Pulses		No			1965-2010
Number of Low Pulses (<25th Percentile)		No			1965-2010
Annual Maximum (1-day)		No			1965-2010
Annual Maximum (30-day)		No			1965-2010
Annual Maximum (3-day)		No			1965-2010
Annual Maximum (7-day)		No			1965-2010
Annual Maximum (90-day)		No			1965-2010
Median Jan Flow		No			1965-2010
Median Oct Flow		No			1965-2010
Median Nov Flow		No			1965-2010
Median Dec Flow		No			1965-2010
Median Feb Flow		No			1965-2010
Median Mar Flow		No			1965-2010
Median Apr Flow		No			1965-2010
Median May Flow		No			1965-2010
Median Jun Flow		No			1965-2010
Median Jul Flow		No			1965-2010
Median Aug Flow		No			1965-2010
Median Sep Flow		No			1965-2010
Annual Minimum (1-day)		No			1965-2010
Annual Minimum (30-day)		No			1965-2010
Annual Minimum (3-day)		No			1965-2010
Annual Minimum (7-day)		No			1965-2010
Annual Minimum (90-day)		No			1965-2010
Average Fall		No			1965-2010
Average Rise		No			1965-2010
Number of Falls	Increasing	Yes	Small	1%	1965-2010
Number of Rises		No			1965-2010

IHA Parameter Trend Summary

Name=South Branch Estero River At Estero USGS Gage=02291597

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1988-2010
Number of High Pulses(>75th Percentile)		No			1988-2010
Mean Duration of Low Pulses	Decreasing	Yes	Small	-6%	1988-2010
Number of Low Pulses (<25th Percentile)		No			1988-2010
Annual Maximum (1-day)		No			1988-2010
Annual Maximum (30-day)		No			1988-2010
Annual Maximum (3-day)		No			1988-2010
Annual Maximum (7-day)		No			1988-2010
Annual Maximum (90-day)		No			1988-2010
Median Jan Flow		No			1988-2010
Median Oct Flow		No			1988-2010
Median Nov Flow		No			1988-2010
Median Dec Flow		No			1988-2010
Median Feb Flow		No			1988-2010
Median Mar Flow		No			1988-2010
Median Apr Flow		No			1988-2010
Median May Flow		No			1988-2010
Median Jun Flow		No			1988-2010
Median Jul Flow		No			1988-2010
Median Aug Flow		No			1988-2010
Median Sep Flow		No			1988-2010
Annual Minimum (1-day)		No			1988-2010
Annual Minimum (30-day)		No			1988-2010
Annual Minimum (3-day)		No			1988-2010
Annual Minimum (7-day)		No			1988-2010
Annual Minimum (90-day)		No			1988-2010
Average Fall		No			1988-2010
Average Rise		No			1988-2010
Number of Falls		No			1988-2010
Number of Rises		No			1988-2010

IHA Parameter Trend Summary

Name=Spring Creek Headwater Near Bonita Springs USGS Gage=02291524

IHA Parameter	Trend Direction	Significant Trend?	Relative Change	Rate of Change (% of Median/Year)	Trend Period
Mean Duration of High Pulses		No			1988-2010
Number of High Pulses(>75th Percentile)		No			1988-2010
Mean Duration of Low Pulses		No			1988-2010
Number of Low Pulses (<25th Percentile)		No			1988-2010
Annual Maximum (1-day)		No			1988-2010
Annual Maximum (30-day)		No			1988-2010
Annual Maximum (3-day)		No			1988-2010
Annual Maximum (7-day)		No			1988-2010
Annual Maximum (90-day)		No			1988-2010
Median Jan Flow		No			1988-2010
Median Oct Flow		No			1988-2010
Median Nov Flow		No			1988-2010
Median Dec Flow		No			1988-2010
Median Feb Flow		No			1988-2010
Median Mar Flow		No			1988-2010
Median Apr Flow		No			1988-2010
Median May Flow		No			1988-2010
Median Jun Flow		No			1988-2010
Median Jul Flow		No			1988-2010
Median Aug Flow		No			1988-2010
Median Sep Flow		No			1988-2010
Annual Minimum (1-day)		No			1988-2010
Annual Minimum (30-day)		No			1988-2010
Annual Minimum (3-day)		No			1988-2010
Annual Minimum (7-day)		No			1988-2010
Annual Minimum (90-day)		No			1988-2010
Average Fall		No			1988-2010
Average Rise		No			1988-2010
Number of Falls		No			1988-2010
Number of Rises		No			1988-2010

4.0 Rainfall Analysis Results

Data providers for rainfall included long term records provided by the National Weather Service dating back to the 1940's and data collected by the Southwest Florida Water Management District and Lee County collected from the mid 1990's through 2011. As expected, there were clear seasonal patterns to the rainfall distributions. The intra-annual variability in rainfall exhibited typical wet season/dry season patterns for southwest Florida. For example, total rainfall amounts in Charlotte Harbor Proper (Figure 4-1) varied predictably within each year following an expected Florida wet season/dry season pattern. Rainfall for this basin follows the typical cycle with median rainfall of less than 2 inches per month for the winter and spring dry season to a median of over 7 inches per month during the summer wet season.

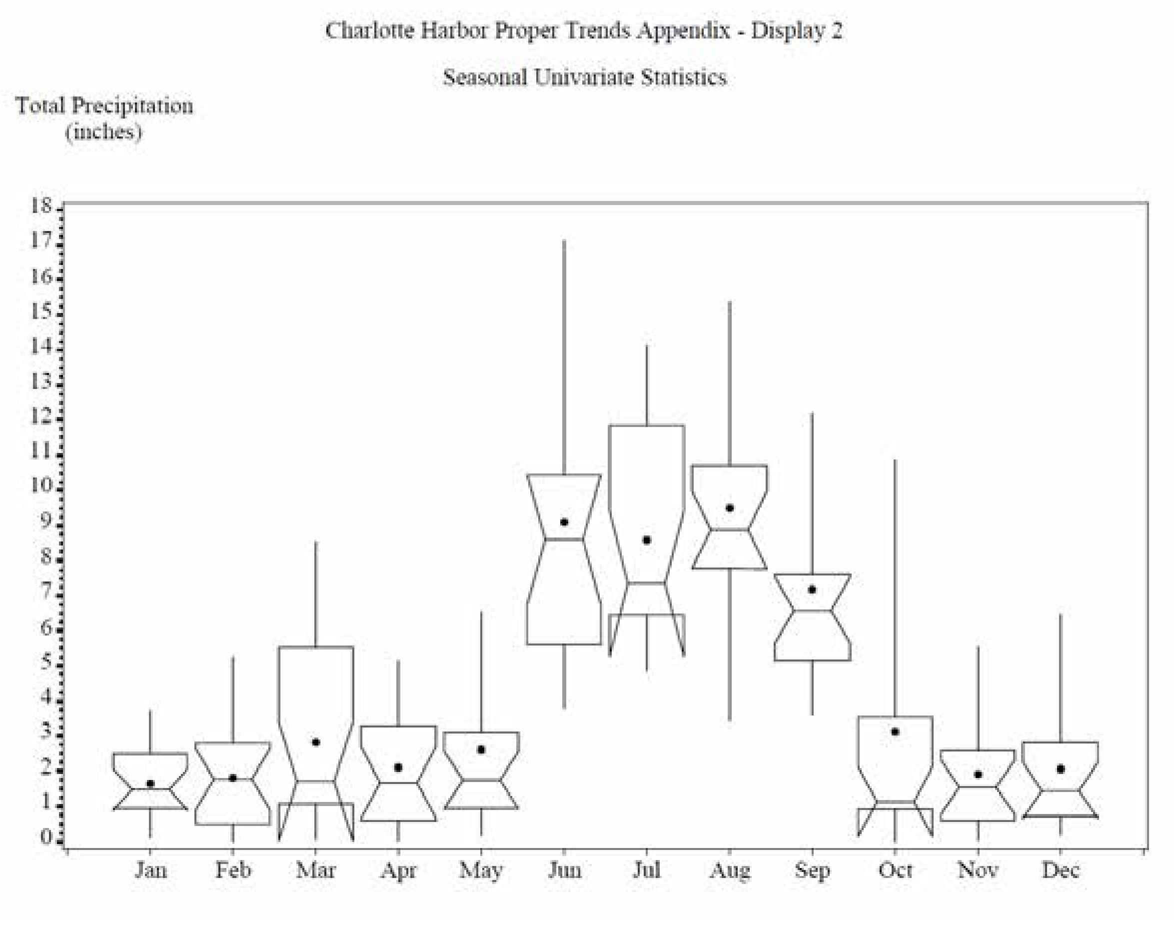


Figure 4-1. **Example intra-annual variation in rainfall for the distribution of monthly total rainfall for the Charlotte Harbor Proper basin over the specific rainfall data period of record for this basin.**

Due to the extended period of rainfall record with some gages dating back to the 1930's a trend stability test was conducted by analyzing rainfall data within 10 year moving windows to see if there were periods of time within the longer timeseries when rainfall trends were evident. The results suggested that during the period around 1960 there was a consistent declining trend in rainfall across all basins within the CHNEP (Table 4-1). To remove the effects of this historic anomaly in the rainfall record the period of record for further analysis became 1961.

Table 4-1. **Results of 10 year moving window analysis for rainfall. A -1 (shaded) indicates a decreasing trend, +1 indicates an increasing trend and 0 indicates no trend over the window period. The window is slide 5 years for each iteration and the year header represents the middle of that 10 year analysis period.**

Basin	1935	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Charlie Creek	0	0	0	-1	0	-1	0	0	0	0	0	0	0	0	0
Charlotte Harbor Proper	0	0	0	-1	0	-1	0	0	0	0	-1	0	0	0	0
Coastal Estero	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0
Coastal Lower Peace	0	0	0	-1	0	-1	0	0	0	0	-1	0	0	0	0
Coastal Venice	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	-1
Cow Pen Slough	0	0	0	0	0	-1	0	0	0	0	-1	0	0	0	-1
Dona & Roberts Bays	0	0	0	0	0	-1	0	0	0	0	-1	0	0	0	-1
Estero River	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	-1
Gasparilla Sound	0	0	0	-1	0	-1	0	0	0	0	-1	0	0	0	0
Hendry Creek & Six Mile	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	-1
Horse Creek	0	0	0	0	0	-1	0	0	0	0	0	0	-1	0	0
Imperial River	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0
Joshua Creek	0	0	0	0	0	-1	0	0	0	0	-1	0	-1	0	0
Lemon Bay	0	0	0	0	0	-1	0	0	0	0	-1	0	0	0	-1
Lower Myakka	0	0	0	-1	0	-1	0	0	0	0	-1	0	0	0	0
Matlacha Pass	0	0	0	-1	0	-1	0	0	0	0	0	0	0	0	-1
Orange River	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	-1
Payne Creek	0	0	0	0	0	-1	0	0	0	0	0	0	-1	0	0
Peace at Arcadia	1	0	0	0	0	-1	0	0	0	0	-1	0	-1	0	0
Peace at Bartow	0	0	0	-1	0	-1	0	0	0	0	0	0	-1	0	0
Peace at Zolpho Springs	0	0	0	-1	0	-1	0	0	0	0	0	0	-1	0	0
Pine Island Sound	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0
Shell Creek	0	0	0	-1	0	-1	0	0	0	0	-1	0	-1	0	0
Spring Creek	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0
Telegraph Swamp	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0
Tidal Caloosahatchee	0	0	0	-1	0	-1	0	0	0	0	0	0	0	0	0
Upper Myakka	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	-1

Despite some short term decreasing trends in several basins in some years between 1980 and 2010, after accounting for seasonality and applying the False Discovery Rate correction for multiple comparisons there were no significant trends detected in the long term rainfall patterns. Without applying the False Discovery Rate correction, the Peace River Region suggested very minor decreasing trends in rainfall including the Peace River at Arcadia, Peace River at Bartow, and Peace River at Zolpho Springs. These trends were due to decreases in rainfall in the 1990's. The slope of these trends suggested a loss of rainfall on the order to 1 inch every 100 years; however, it is important to remember that after including corrections for multiple comparisons none of these trends met the criteria for significance for the long term record. Detailed statistical results for rainfall trend testing for each basin for the rainfall data period of record are presented in the "POR Rainfall Trends" in **Appendix 4.1**.

Conclusions Regarding Rainfall Variation

The results of the rainfall analyses indicated that, over the long term period of record, there were no significant trends in rainfall. Rainfall varied largely from year to year, and in a relatively predictable fashion within each year. Shorter term trends in rainfall were evident and these trends were likely artifacts of more short term variations in rainfall associated with either El Nino / La Nina phases, or multi-decadal oscillations in the weather governing climatological patterns. Based on these observations, it is unlikely that any trends observed in the surface water quality data for the basins of the Charlotte Harbor study area can be attributed to changes in rainfall alone.

5.0 Surface Water Quality Analysis Results

The results of the surface water quality trends analyses indicated a substantial number of trends throughout the CHNEP study area. The section below provides details of these results for each of the three regions defined by the CHNEP including the Peace River region, the Myakka River region and the Southern Coast region.

Trend Report Organization

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 regional summarizations of results to results for individual stations, sample levels (i.e., surface or bottom) and water quality constituent of interest. At the beginning of each basin summary paragraph the basin header is hyperlinked. Clicking on the hyperlink will take the reader to a table containing a tabular summary of the seasonal Kendall Tau trend test results for each station, parameter and sample level. Finally, at the end of these tables there is a link-table to the appendices which provides individual station results including a very large number of pages ("displays") of detailed statistical results and data plots for each station, parameter and sample level. These displays present summary plots of individual sample values over time, tests of significance and autocorrelation and final trend results as described in Chapter 2.

The following water quality discussion details significant water quality trends by basin within each region for the period of record of water quality data collection. A geographic reference map is provided in Figure 5-1 to orient the reader to the basin locations discussed in this section. Geographic reference maps are also provided for three regions in which water quality trends are mapped in Figures 5-2, 5-3, and 5-4. The results of the water quality trend analysis for the period of record are summarized by region and basin with short paragraphs describing general results for parameters of interest. The overwhelming majority of results are for surface waters with typically only in situ physical chemistry parameters sampled in bottom waters. At the end of regional summary, maps showing trend results are presented by region and parameter. Following the maps are detailed parameter tables summarizing the trend results for each basin and sampling type (i.e. fixed or random sampling).

Terminology

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 the rate of change for "large trends." These are relative terms, and the precise rates of change are presented for each station in the statistical detail appendices. The terms “large” and “small” do not imply either ecological significance or the lack of ecological significance. Further, we differentiate trends based on the trend direction. The term “declining trend” is meant to signify declining water quality condition rather than decreasing in magnitude whereas “improving trend” is meant to signify improving water quality rather than increasing in magnitude. For most parameters increases in concentration equate to declining water quality but for some parameters (e.g., dissolved oxygen) increases are related to improving conditions. Therefore, on the maps, the color green indicates improving trends while red indicates declining trend. Lastly, the terms “surface waters” or “surface” to trends from samples collected at or within 1 meter of the water surface while bottom waters refer to samples collected near the bottom.

Land Use

Land use descriptions are provided for each basin within the CHNEP study area. Land use categories were combined from Florida land use land cover classification system (FLUCCS) codes accompanying the 1999 - 2000 land use data provided by the South and Southwest Florida Water Management Districts. These land use coverages were combined by CHNEP staff to incorporate the CHNEP study area since the area encompasses portions of both districts boundaries. This combined coverage was used to describe general land use for each basin examined for this report.

Figure 5-1 A geographic features reference map showing the basins of the study area.

Figure 5-2. A geographic features reference map presenting the basins of the Myakka River region.

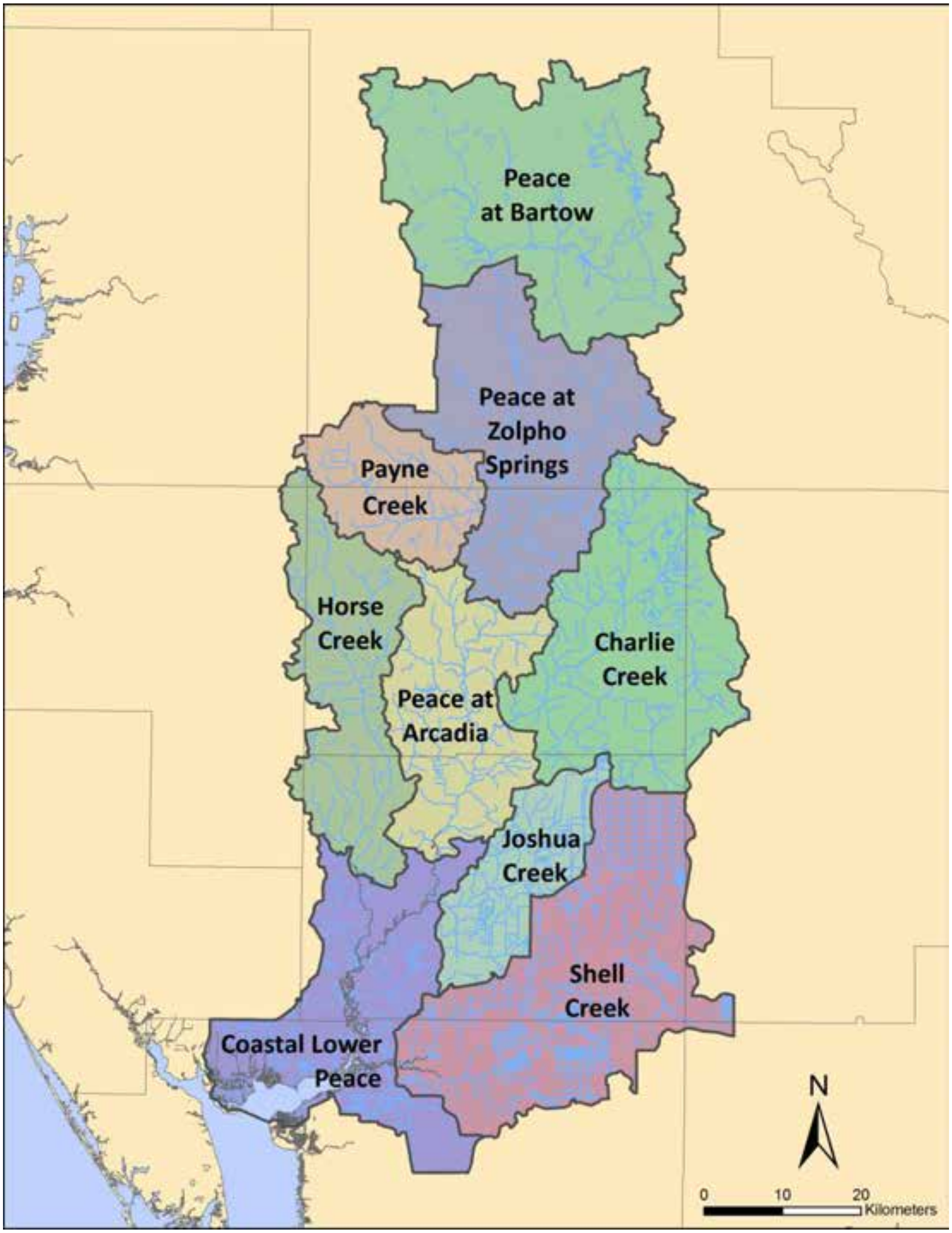


Figure 5-3. Geographic features reference map presenting the basins of the Peace River region.

Figure 5-4. Geographic features reference map presenting the basins of the Southern Coast region.

5.1 Myakka River Region

5.1.1 Upper Myakka

The Upper Myakka River watershed is a large drainage basin that discharges water from extensive wetlands and streams including Ogleby Creek, Owen Creek, the Tatum Sawgrass, Upper Myakka Lake and the Flatford Swamp (Figure 6-2). The land cover in the Upper Myakka River Basin was reported to be primarily rangelands (20%) and pasture (38%). Other important land covers included upland forests (11%), forested freshwater wetlands (12%) such as those associated with the Flatford Swamp, and non-forested freshwater wetlands (8%).

Water Quality Trends

Improving trends for two species of nitrogen (NO23 and NO3) were found at two stations in the Upper Myakka River watershed. Improving trends in total nitrogen, chlorophyll and dissolved oxygen were also observed in at least a single station. However, declining trends in chloride, fluoride, and biological oxygen demand were also observed at single stations within the Upper Myakka watershed. Otherwise, parameters within the Upper Myakka, including phosphorus species, were stable over the period of record.

5.1.2 Lower Myakka

The Lower Myakka Basin includes the wider portions of the Myakka River at its confluence with Charlotte Harbor Proper (Figure 6-2). This is a relatively high tidal energy, estuarine environment. The land use for the Lower Myakka River Basin was reported to be primarily range lands (33%), pasture (12%), upland forests (24%), and freshwater wetlands (21%). In addition, there was reported to be close to 1% of the basin area comprised of saltwater wetlands.

Water Quality Trends

In the Lower Myakka watershed, small increasing trends were found including several stations recording increasing chlorophyll concentrations and total kjeldahl nitrogen concentrations reflecting declining conditions with respect to those parameters. Coincident to those declining trends were increasing trends in conductivity at 3 stations over the period of record. However, no stations were found to have large declining trends and overall the majority of stations exhibited stable trends over time.

5.1.3 Dona & Roberts Bays

Dona and Roberts Bays are very small estuaries that receive pollutant and freshwater loads from the much larger Cow Pen Slough drainage basin to the north and east (Figure 6-2). These bays are located in a relatively urban developed coastal portion of the study area.

Landuse in this basin is reported to be residential development (25%), upland forests (12%), pasturelands (3%) and freshwater wetlands (3%).

Water Quality Trends

The Dona and Roberts Bays data were collected by Sarasota County and were included in the estuarine portion of the analysis by averaging across the 5 strata sampled monthly within this stratum as was done for the remaining estuarine segments of the CHNEP. Small declining trends in chlorophyll a were observed in Dona and Roberts Bays despite improving trends in total phosphorus concentrations. All other parameters were stable over the period of record (2003-2011).

5.1.4 Coastal Venice

The Coastal Venice basin represents a relatively narrow watershed that discharges to an even narrower inland waterway between the barrier island system and the coast of the City of Venice mainland (Figure 6-2). The land use for the Coastal Venice Basin was reported to be primarily residential (36%), upland forests (10%), urban (8%) and freshwater wetlands (6%).

Water Quality Trends

A single improving trends in total phosphorus was reported in Coastal Venice while all other parameters were stable over the period of record (1998-2011).

5.1.5 Lemon Bay

Lemon Bay is a very small, narrow barrier island-protected stretch of estuary that extends from Gasparilla Sound north to the Coastal Venice basin (Figure 6-2). Lemon Bay receives freshwater from several small tributaries, Buck, Coral, Alligator, Forked, Gottfried, Rock and Oyster Creeks. Water circulation within this embayment is restricted to passes in the barrier islands and flow parallel to the barrier islands. The length of the bay is traversed by the Intra-coastal Waterway. The land use of the Lemon Bay basin was reported to be primarily residential (24%), freshwater wetlands (9%), pasturelands (9%) and saltwater wetlands (2%). The bay itself was reported to encompass 14% of the basin surface area for this narrow basin.

Water Quality Trends

No large increasing or decreasing trends were found. Total phosphorus trends were improving over the period of record in both upper and lower Lemon Bay. Biological oxygen demand also improved in Upper Lemon Bay while total organic carbon and color trends improved in Lower Lemon Bay. However, in Lower Lemon Bay small declining trends in chlorophyll a, ammonia, salinity and conductivity were observed.

5.1.6 Gasparilla Sound

Gasparilla Sound is a mangrove dominated portion of Charlotte Harbor located between the Lemon Bay to the north and the Boca Grande barrier island system to the south. This basin is a relatively small embayment adjacent to the open estuary of Charlotte Harbor Proper and Boca Grande Pass (Figure 6-2). Land use is reported to be urban (22%), residential (14%), saltwater wetlands (10%) and upland forests (9%)

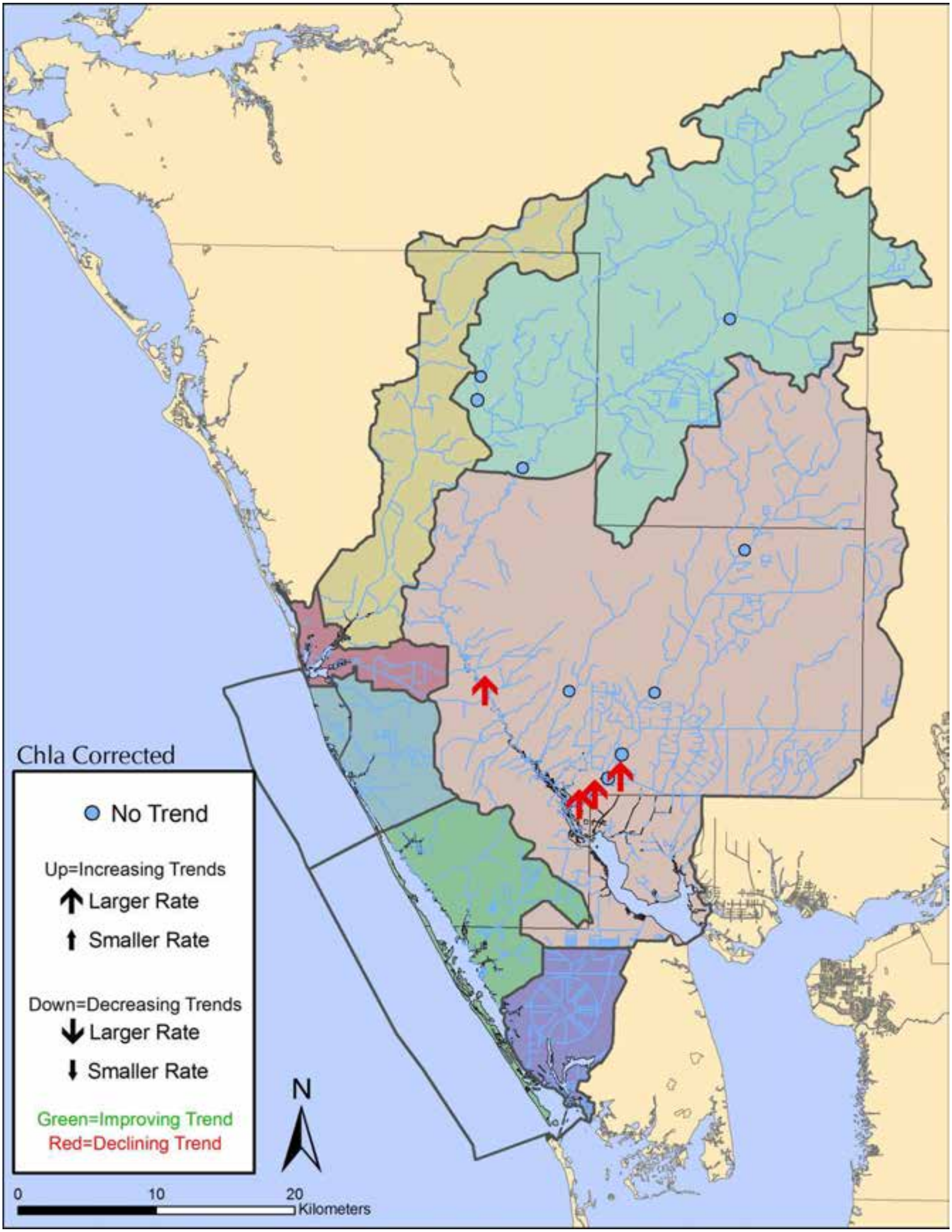
Water Quality Trends

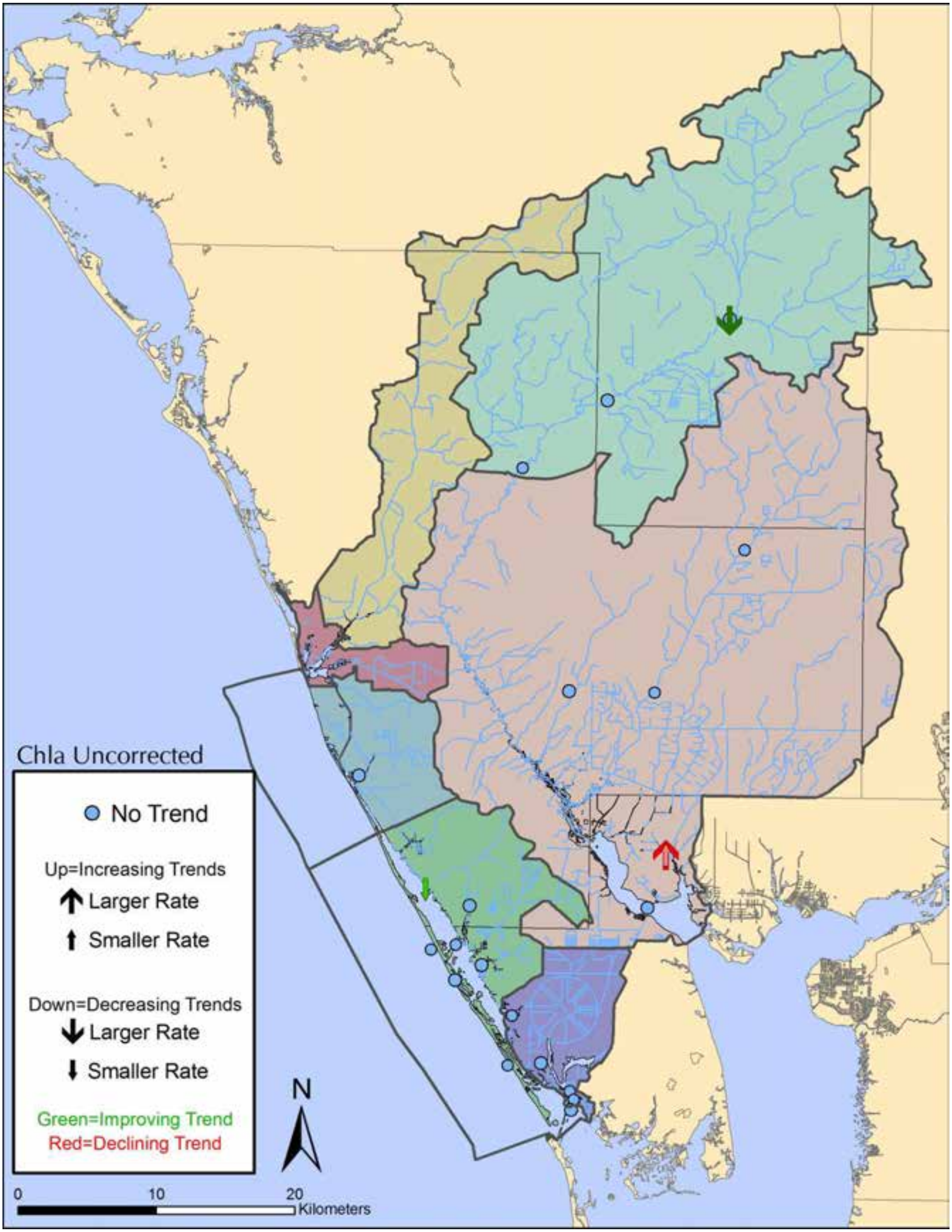
Trend test results were mixed for fixed stations in Gasparilla Sound. Total Nitrogen concentrations increased at one station and decreased at another station. Total kjeldahl nitrogen increased at a single station and dissolved oxygen concentrations declined. However, chlorophyll a concentrations were stable across stations. Salinity and pH concentrations decreased over the period of record.


Ammonium Unionized
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

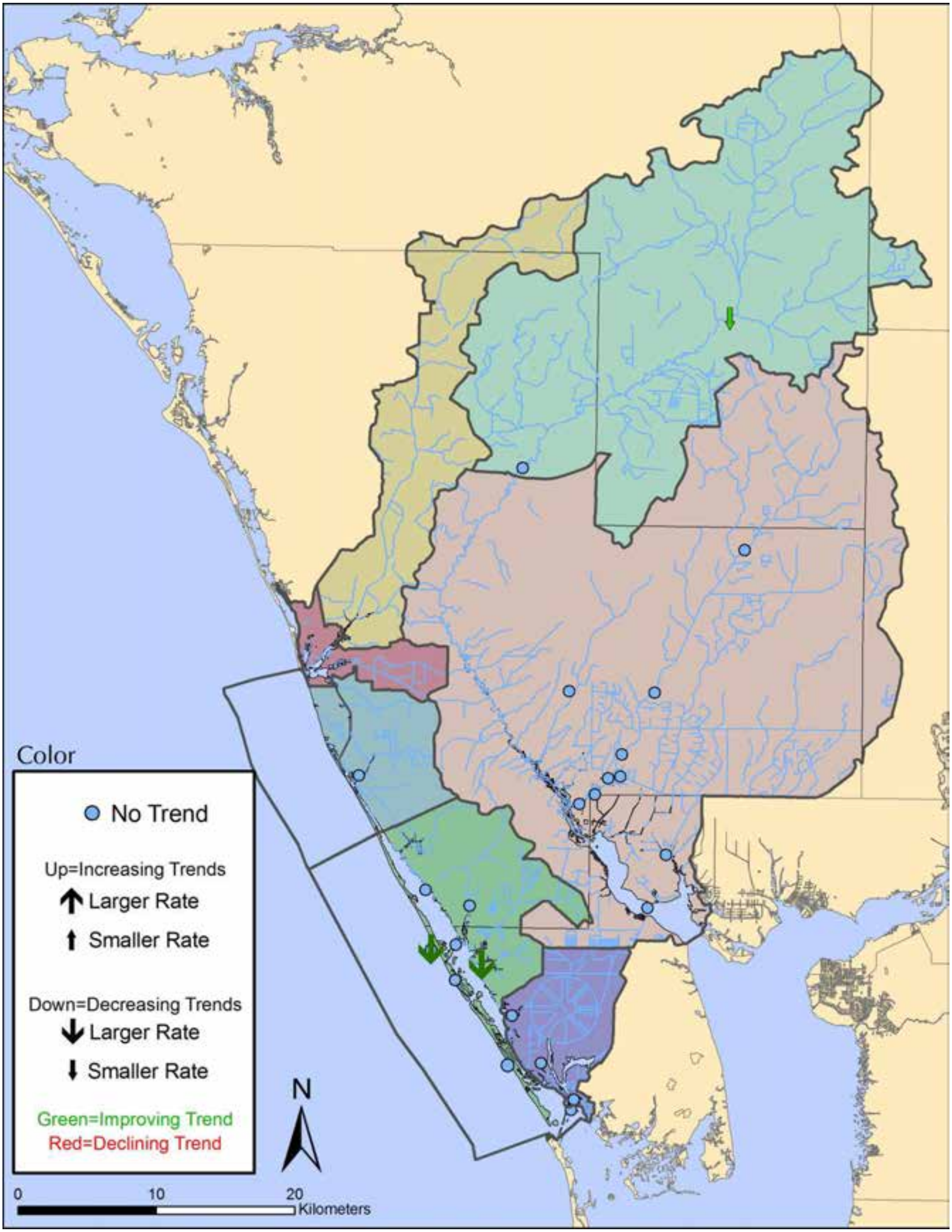

BOD 5-Day
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Calcium
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

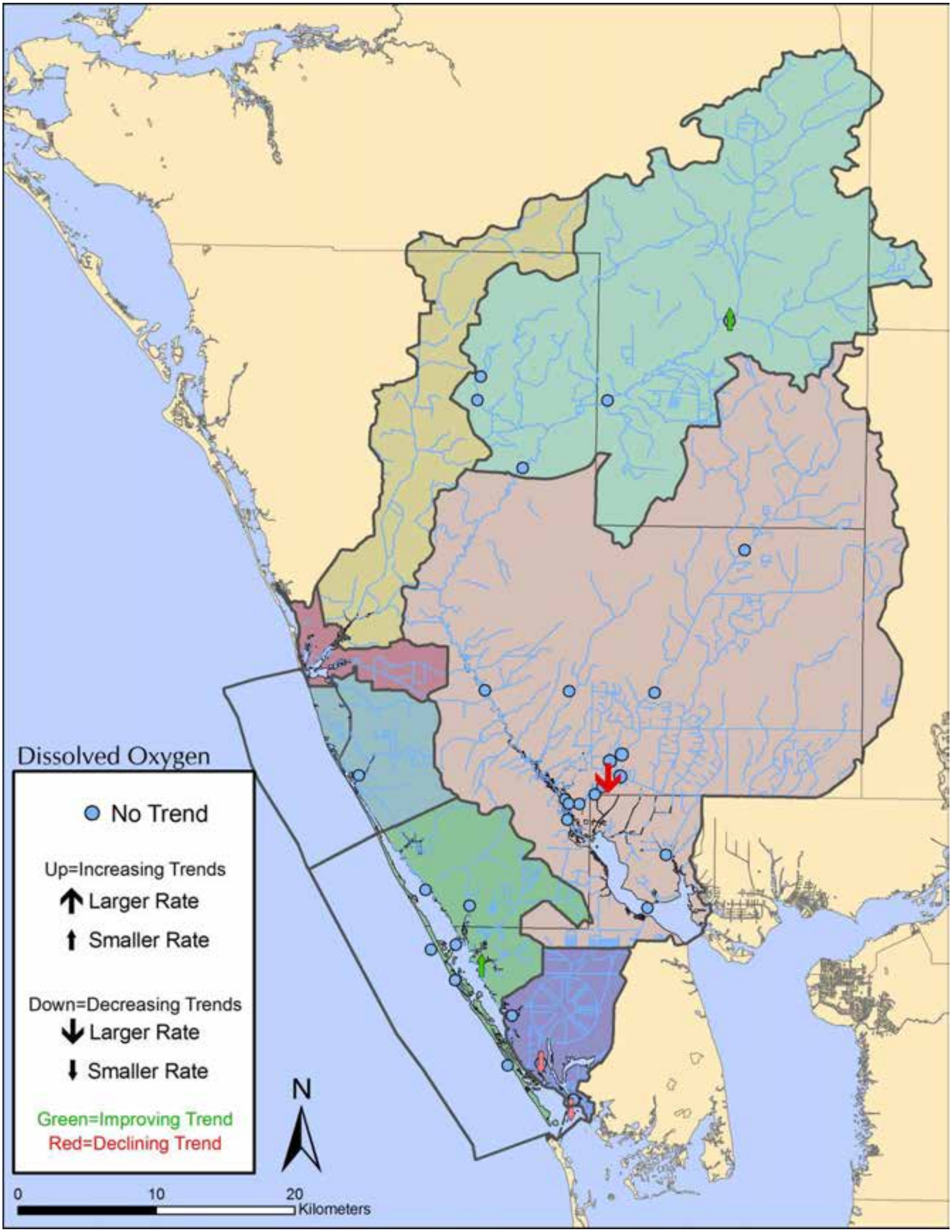

Chla Corrected
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Chla Uncorrected
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Chloride
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Color
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Conductivity
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers



Dissolved Oxygen
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

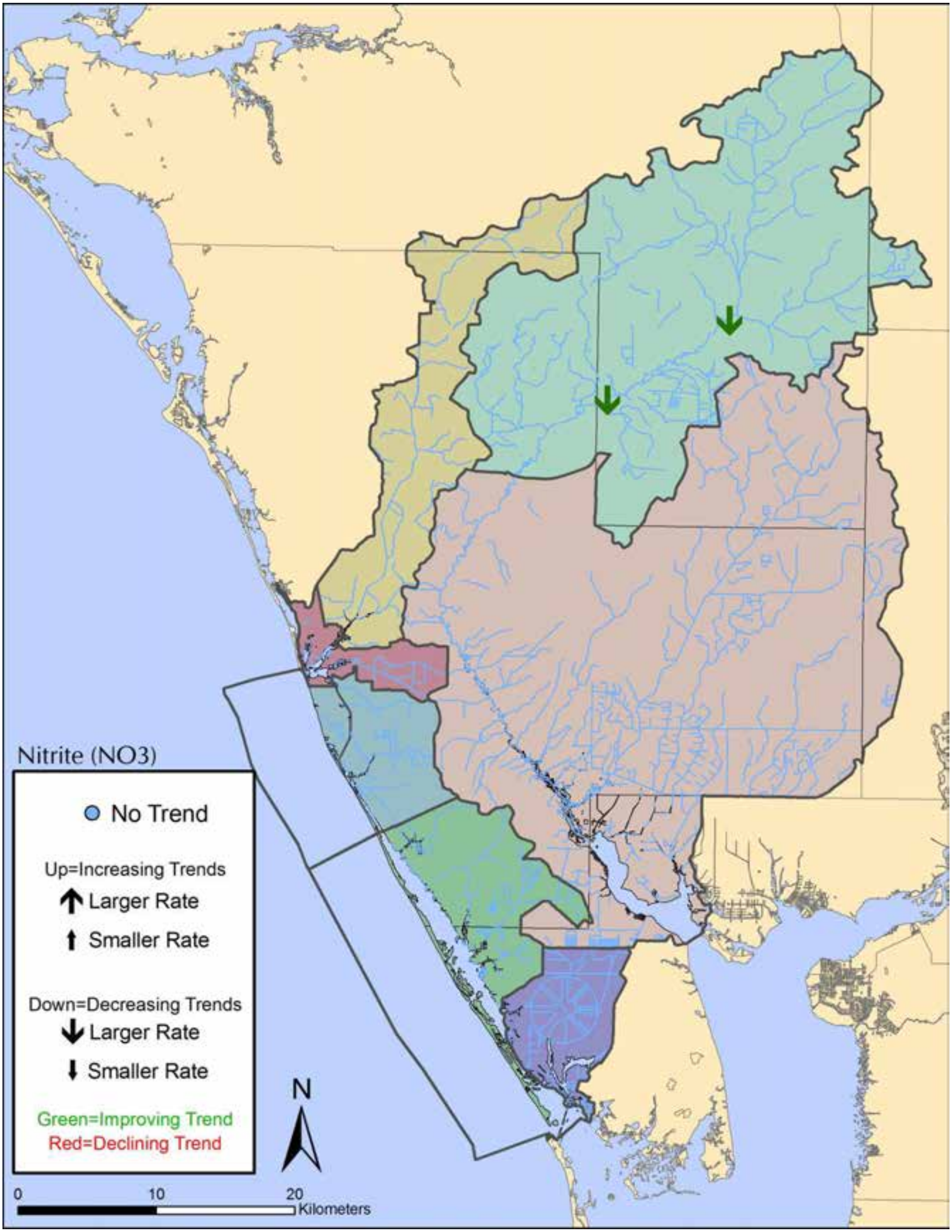

Enterococci
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

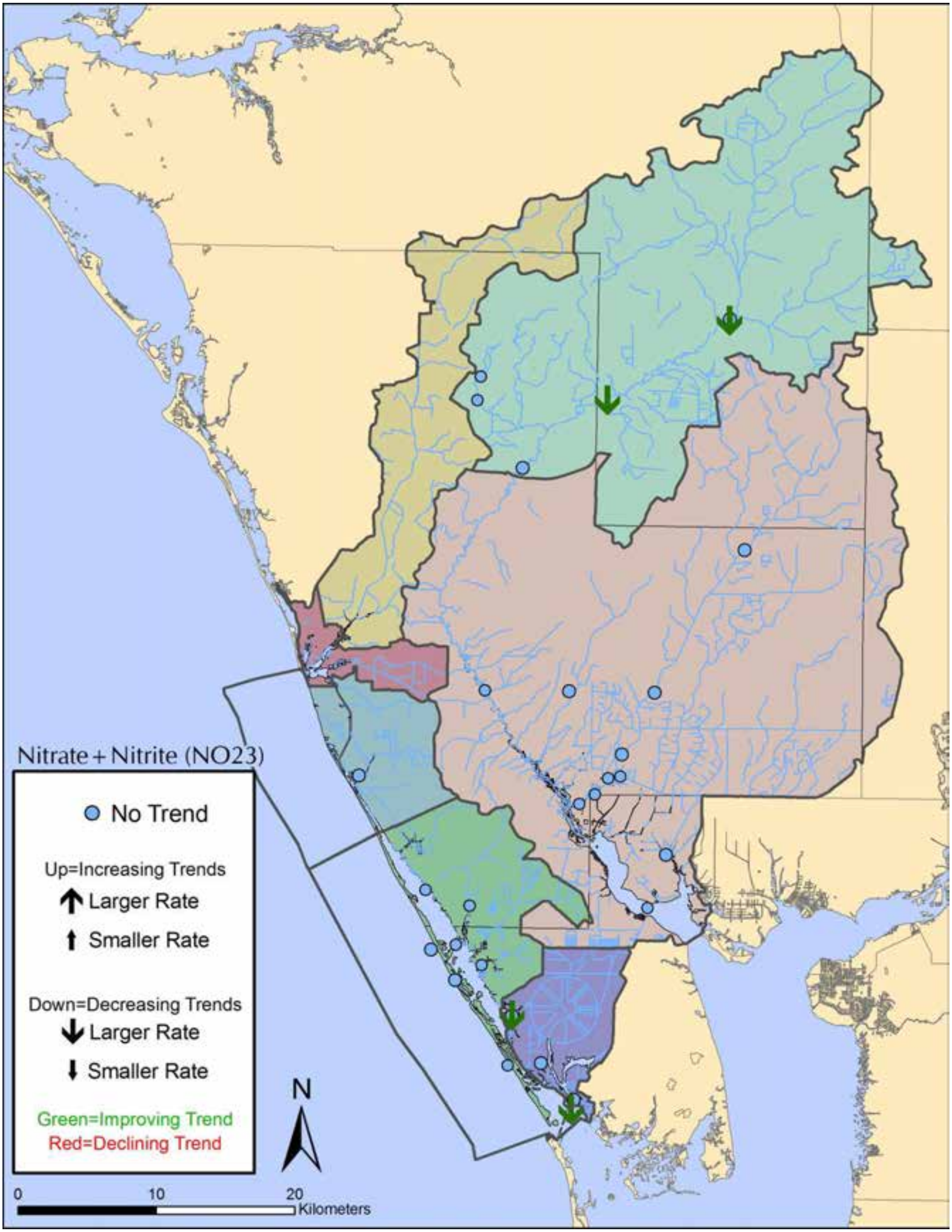

Fecal Coliform
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Fluoride
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Ammonia (NH3)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Nitrate (NO2)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Nitrite (NO3)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers



Nitrate + Nitrite (NO23)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

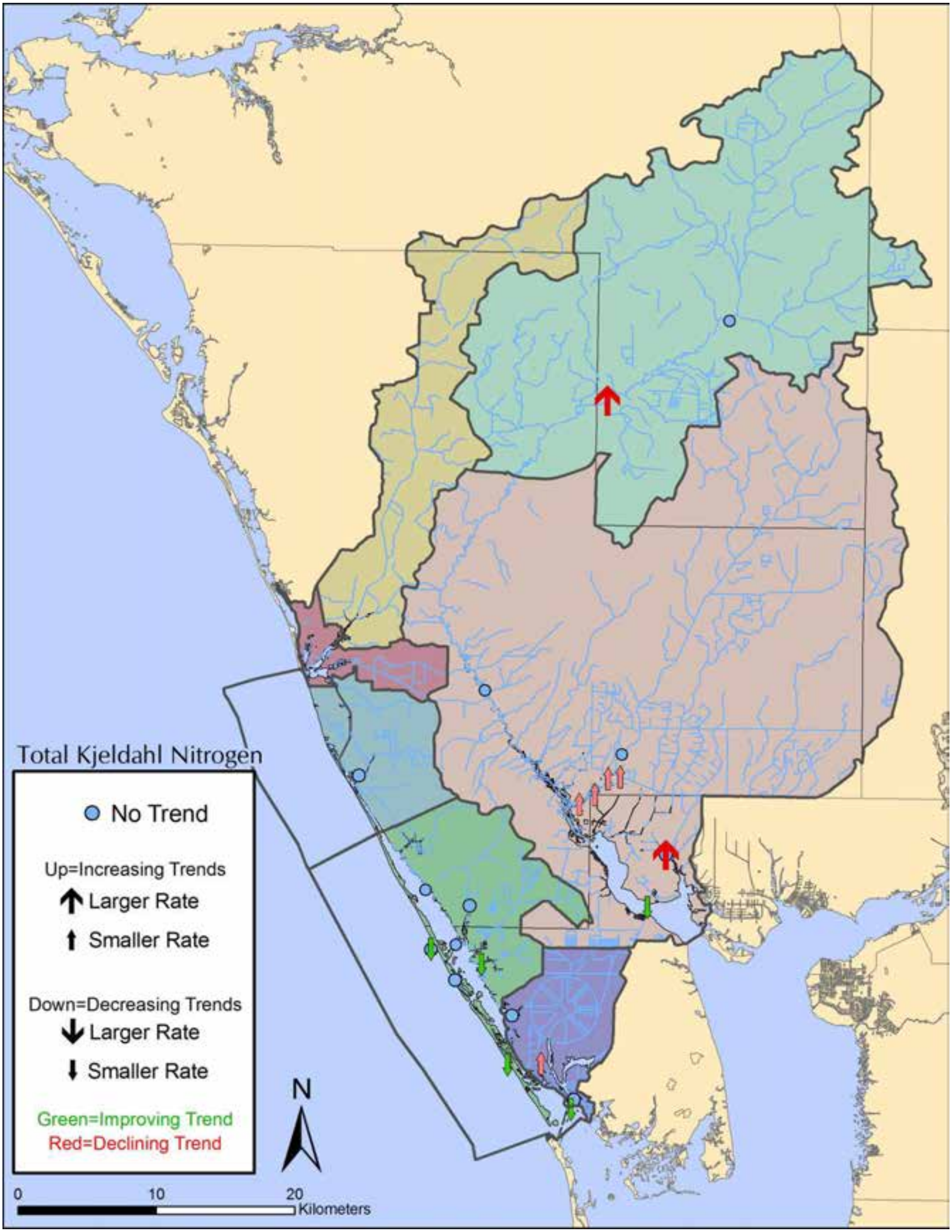

Orthophosphate
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

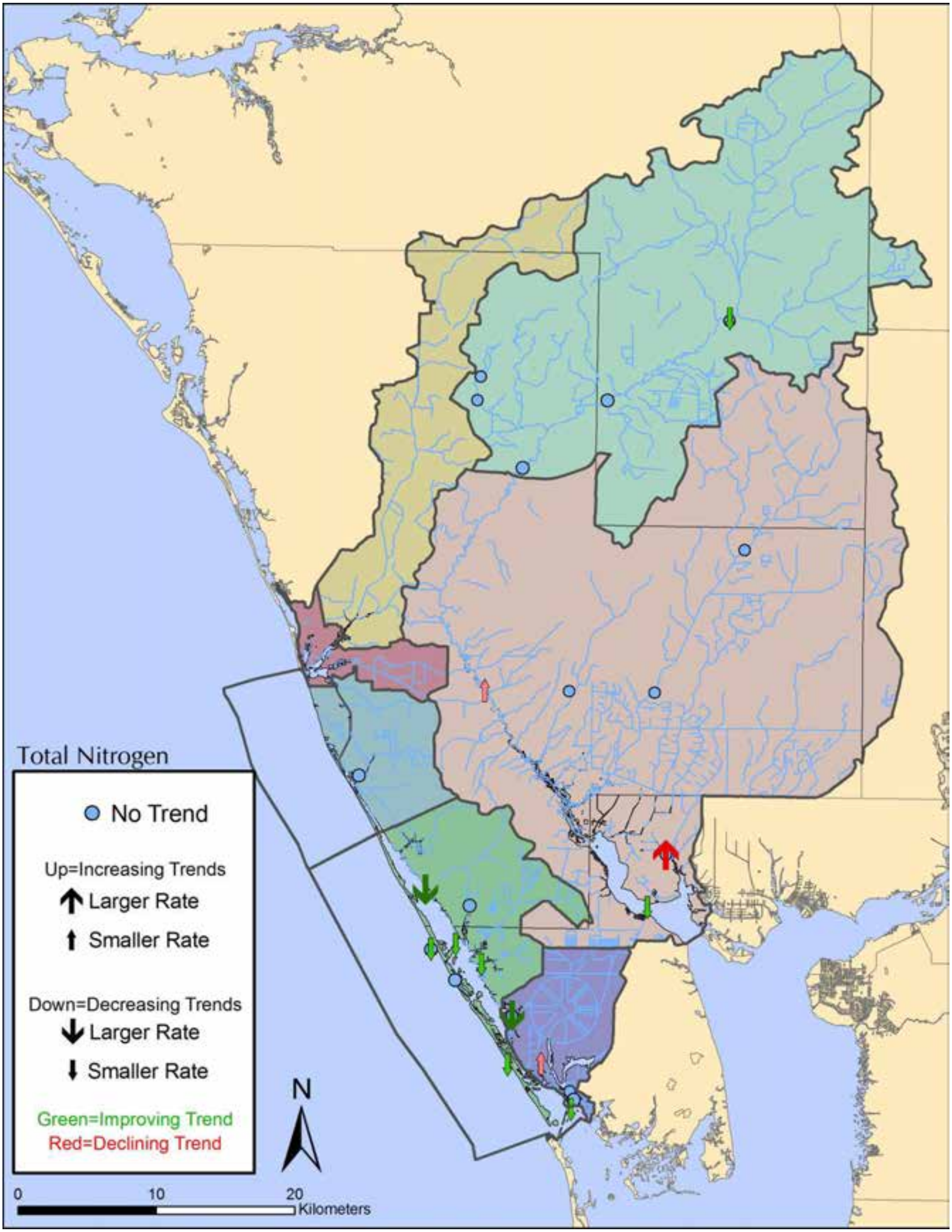

pH
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Salinity
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Secchi
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Temperature
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Kjeldahl Nitrogen
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Nitrogen
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Organic Carbon
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Orthophosphate
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
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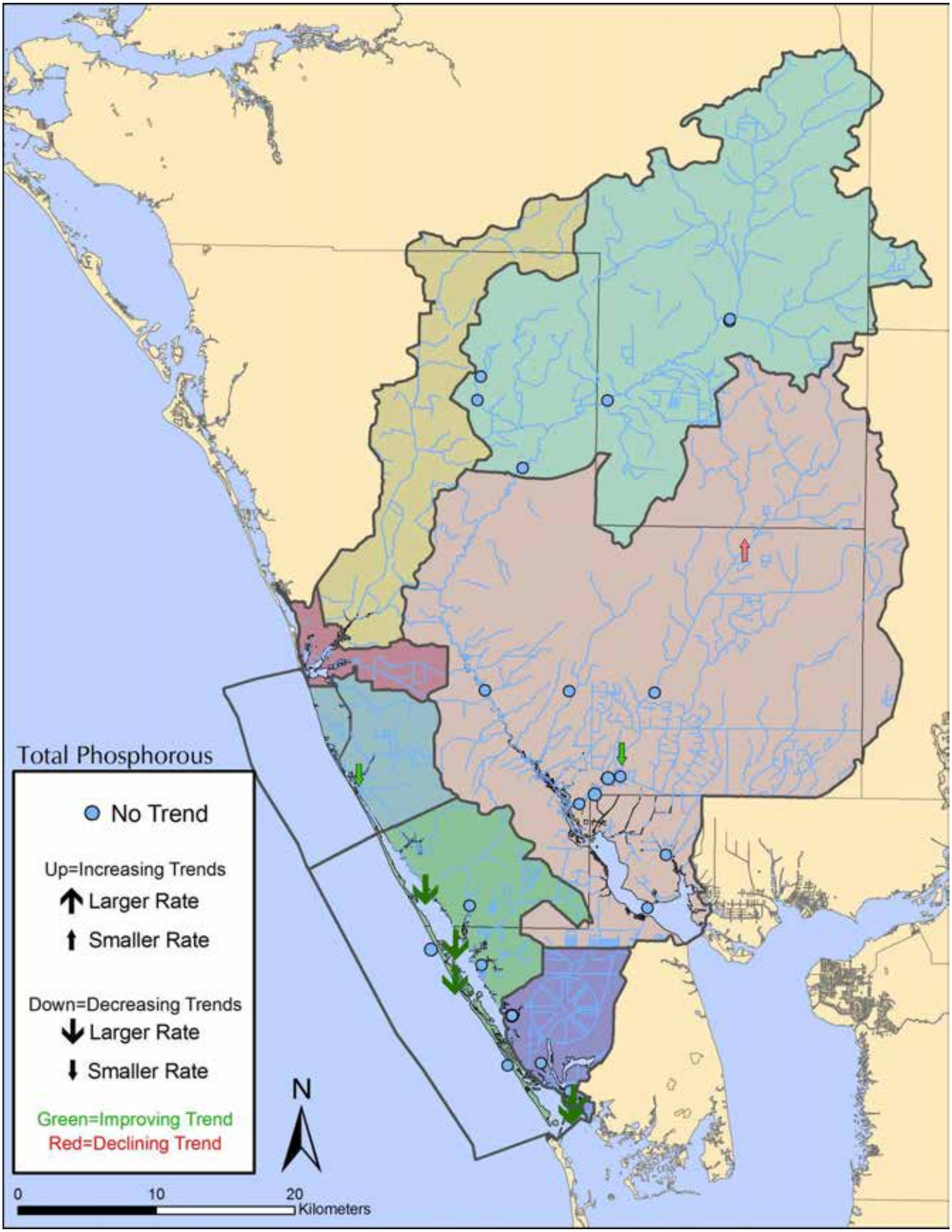
Kilometers


Total Phosphorous
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Suspended Solids
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Turbidity
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

Trend Summary for CHNEP Basin - Coastal Venice
Data From Fixed Stations

		Trend Results		
		Decreasing		Stable
		(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level			
Chlorophyll a Uncorrected (ug/L)	Surface	0	0	1
Color (PCU)	Surface	0	0	1
Dissolved Oxygen (mg/L)	Surface	0	0	1
Fecal Coliform	Surface	1	0	1
Total Kjeldahl Nitrogen (mg/L)	Surface	0	0	1
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	0	0	1
PH (SU)	Surface	0	0	1
Salinity (ppt)	Surface	0	0	1
Secchi Disk (m)	Surface	0	0	1
Temperature (C)	Surface	0	0	1
Total Nitrogen (mg/L)	Surface	0	0	1
Total Phosphorus (mg/L)	Surface	0	1	0

Trend Summary for CHNEP Basin - Dona and Roberts Bays
Data From Random Stations

		Trend Results		
		Decreasing	Increasing	Stable
		(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level			
Ammonia as N Total (mg/l)	Surface	0	0	1
BOD 5-Day (mg/L)	Surface	0	0	1
Chlorophyll a Corrected (ug/l)	Surface	0	1	0
Color (PCU)	Surface	0	0	1
Dissolved Oxygen (mg/l)	Bottom	0	0	1
	Surface	0	0	1
Light Attenuation Coefficient (1/m)	Surface	0	0	1
Nitrate+Nitrite as Nitrogen (mg/L)	Surface	0	0	1
Orthophosphate (as P)(mg/l)	Surface	0	0	1
PH (SU)	Bottom	0	0	1
	Surface	0	0	1
Salinity (ppt)	Bottom	0	0	1
	Surface	0	0	1
Specific Conductance (uS/cm)	Bottom	0	0	1
	Surface	0	0	1
Temperature (C)	Bottom	0	0	1
	Surface	0	0	1
Total Nitrogen (mg/L)	Surface	0	0	1
Total Organic Carbon (mg/l)	Surface	0	0	1
Total Phosphorous (mg/l)	Surface	1	0	0
Turbidity (NTU)	Surface	0	0	1

Trend Summary for CHNEP Basin - Gasparilla Sound
Data From Fixed Stations

		Trend Results			
		Decreasing		Increasing	Stable
		(>10%/Year)	(<=10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level				
Chlorophyll a Uncorrected (ug/L)	Surface	0	0	0	5
Color (PCU)	Surface	0	0	0	4
Dissolved Oxygen (mg/L)	Surface	0	1	0	4
Fecal Coliform	Surface	0	0	0	3
Total Kjeldahl Nitrogen (mg/L)	Surface	0	0	1	3
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	1	0	0	3
PH (SU)	Surface	0	1	0	4
Salinity (ppt)	Surface	2	0	0	3
Secchi Disk (m)	Surface	0	0	0	4
Temperature (C)	Surface	0	0	0	5
Total Nitrogen (mg/L)	Surface	1	0	1	3
Total Phosphorus (mg/L)	Surface	1	0	0	4

Trend Summary for CHNEP Basin - Lemon Bay
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Chlorophyll a Uncorrected (ug/L)	Surface	0	1	0	0	8
Color (PCU)	Surface	2	0	0	0	7
Dissolved Oxygen (mg/L)	Surface	0	1	0	1	7
Enterococci (cfu)	Surface	0	0	1	0	1
Fecal Coliform	Surface	1	0	1	1	10
Total Kjeldahl Nitrogen (mg/L)	Surface	0	4	0	0	5
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	1	0	0	0	8
PH (SU)	Surface	0	4	0	0	5
Salinity (ppt)	Surface	0	0	0	1	8
Secchi Disk (m)	Surface	0	2	1	1	5
Temperature (C)	Surface	0	0	0	0	9
Total Nitrogen (mg/L)	Surface	1	5	0	0	3
Total Phosphorus (mg/L)	Surface	4	0	0	0	5

Trend Summary for CHNEP Basin - Lower Lemon Bay
Data From Random Stations

		Trend Results			
		Decreasing	Increasing		Stable
		(>10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level				
Ammonia as N Total (mg/l)	Surface	0	1	0	0
Chlorophyll a Corrected (ug/l)	Surface	0	0	1	0
Color (PCU)	Surface	1	0	0	0
Dissolved Oxygen (mg/l)	Surface	0	0	0	1
Light Attenuation Coefficient (1/m)	Surface	0	0	0	1
PH (SU)	Surface	0	0	0	1
Salinity (ppt)	Surface	0	0	1	0
Specific Conductance (uS/cm)	Surface	0	0	1	0
Temperature (C)	Surface	0	0	0	1
Total Kjeldahl Nitrogen (mg/l)	Surface	0	0	0	1
Total Nitrogen (mg/L)	Surface	0	0	0	1
Total Organic Carbon (mg/l)	Surface	1	0	0	0
Total Phosphorous (mg/l)	Surface	1	0	0	0
Total Suspended Solids (mg/l)	Surface	0	0	0	1
Turbidity (NTU)	Surface	0	0	0	1

Trend Summary for CHNEP Basin - Upper Lemon Bay
Data From Random Stations

		Trend Results		
		Decreasing	Increasing	Stable
		(<=10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level			
Ammonia as N Total (mg/l)	Surface	0	0	1
BOD 5-Day (mg/L)	Surface	1	0	0
Chlorophyll a Corrected (ug/l)	Surface	0	0	1
Color (PCU)	Surface	0	0	1
Dissolved Oxygen (mg/l)	Bottom	0	0	1
	Surface	0	0	1
Light Attenuation Coefficient (1/m)	Surface	0	0	1
Nitrate+Nitrite as Nitrogen (mg/L)	Surface	0	0	1
Orthophosphate (as P)(mg/l)	Surface	0	0	1
PH (SU)	Bottom	0	0	1
	Surface	0	0	1
Salinity (ppt)	Bottom	0	1	0
	Surface	0	0	1
Specific Conductance (uS/cm)	Bottom	0	1	0
	Surface	0	0	1
Temperature (C)	Bottom	0	0	1
	Surface	0	0	1
Total Kjeldahl Nitrogen (mg/l)	Surface	0	0	1
Total Nitrogen (mg/L)	Surface	0	0	1
Total Phosphorous (mg/l)	Surface	1	0	0
Total Suspended Solids (mg/l)	Surface	0	0	1
Turbidity (NTU)	Surface	0	0	1

Trend Summary for CHNEP Basin - Lower Myakka
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Ammonium Unionized (mg/L)	Surface	0	0	0	0	1
Calcium (mg/L)	Surface	0	0	0	0	4
Chlorophyll a Corrected (ug/L)	Surface	0	0	4	0	5
Chlorophyll a Uncorrected (ug/L)	Surface	0	0	1	1	4
Chloride (mg/L)	Surface	0	0	0	1	3
Color (PCU)	Surface	0	0	0	0	11
Conductivity (uS/cm)	Surface	0	0	1	2	5
Dissolved Oxygen (mg/L)	Bottom	1	1	0	0	8
	Surface	1	0	0	0	16
Enterococci (cfu)	Surface	0	0	0	0	1
Fecal Coliform	Surface	0	0	0	0	9
Fluoride (mg/l)	Surface	0	0	0	0	4
Total Kjeldahl Nitrogen (mg/L)	Surface	0	1	1	4	3
NH3 Ammonia (mg/L)	Surface	0	1	1	0	7
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	0	0	0	0	12
Nitrite (mg/L)	Surface	0	0	0	0	3
Orthophosphate (as P)(mg/L)	Surface	0	0	0	0	5
PH (SU)	Bottom	0	1	0	0	9
	Surface	0	2	0	1	14
Salinity (ppt)	Bottom	0	0	0	2	8
	Surface	0	0	0	1	12
Secchi Disk (m)	Surface	0	1	1	0	4
Total Organic Carbon (mg/L)	Surface	0	0	0	0	4
Total Suspended Solids (mg/L)	Surface	0	0	0	0	5
Temperature (C)	Bottom	0	0	0	0	10
	Surface	0	1	0	0	16
Total Nitrogen (mg/L)	Surface	0	1	1	1	4
Total Phosphorus (mg/L)	Surface	0	1	0	1	10
Turbidity (NTU)	Surface	0	0	0	0	5

Trend Summary for CHNEP Basin - Upper Myakka
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Ammonium Unionized (mg/L)	Surface	0	0	0	0	4
BOD 5-Day (mg/L)	Surface	0	0	1	0	1
Calcium (mg/L)	Surface	0	0	0	0	4
Chlorophyll a Corrected (ug/L)	Surface	0	0	0	0	4
Chlorophyll a Uncorrected (ug/L)	Surface	1	0	0	0	3
Chloride (mg/L)	Surface	0	0	0	1	3
Color (PCU)	Surface	0	1	0	0	1
Conductivity (uS/cm)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	2
Dissolved Oxygen (mg/L)	Bottom	0	0	0	0	1
	Surface	0	0	0	1	5
Fluoride (mg/l)	Surface	0	0	0	1	5
Total Kjeldahl Nitrogen (mg/L)	Surface	0	0	1	0	1
NH3 Ammonia (mg/L)	Surface	0	1	0	1	4
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	2	0	0	0	4
Nitrate (mg/L)	Surface	2	0	0	0	0
Nitrite (mg/L)	Surface	0	0	0	0	3
PH (SU)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	6
Salinity (ppt)	Surface	0	0	0	0	4
Secchi Disk (m)	Surface	0	1	0	0	2
Total Orthophosphate (mg/L)	Surface	0	0	0	0	2
Total Organic Carbon (mg/L)	Surface	0	0	0	0	4
Temperature (C)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	6
Total Nitrogen (mg/L)	Surface	0	1	0	0	5
Total Phosphorus (mg/L)	Surface	0	0	0	0	6

5.2 Peace River Region

5.2.1 Peace at Bartow

The Peace River at Bartow basin includes the most upstream headwater sections of the Peace River (Figure 6-3) including Lake Hancock and the Winter Haven Chain of Lakes. Land use region was reported to be primarily pastureland (13%), freshwater wetlands (10%), agriculture (9%), and residential (15%).

Water Quality Trends

There were an impressive number of decreasing trends in both total phosphorus (15) and total nitrogen (9) in the Peace at Bartow region indicating improving water quality conditions in several areas of northern Polk County. These trends include decreases at stations in Arietta, Elbert, Jessie, Haines, Buckeye and Banana lakes and several trends were considered large with rates of change greater than 10 percent of the median value per year. While increasing trends also existed for these parameters within the basin (6 and 4 respectively), these trends were small in magnitude (i.e. less than 10% of the median per year) and restricted to a small number of locations including lake Dexter. Most of the other parameters were stable over time other than three improving trends in chlorophyll a in Lake Shipp. It should be noted that the period of record did vary ending among the many stations within this basin between 2008 and 2011 based on sampling agency and location.

5.2.2 Peace at Zolpho Springs

The Peace River at Zolpho Springs Basin is located between the upstream Peace River at Bartow Basin and the downstream Peace River at Arcadia basin (Figure 6-3). This basin also receives direct discharge through the confluence of Payne Creek with the Peace River mainstem. Land use in the Peace River at Zolpho Springs Basin was reported to be primarily freshwater wetlands (12%), Agriculture (10%), Pastureland (10%), and upland forests (4%).

Water Quality Trends

There were a substantial number (15) of increasing trends in total nitrogen in this basin primarily associated with stations located in a very specific area just south of Bartow near Gaskins Road. Increasing trends in chlorophyll a concentrations were concomitant with the trends in total nitrogen in most stations. These stations were not directly associated with the Peace River but rather appear to be retention ponds associated with a mobile home park and associated industrial holding ponds and their connection to the Peace River is unclear. The period of record for these trends generally included the time period between 1991 and 2011. Fewer increasing trends were observed for trends in total phosphorus and there were few trends observed for other parameters at these stations.

5.2.3 Peace at Arcadia

The Peace River at Arcadia basin includes all of the lands below the Peace River at Zolpho Springs stream flow gage that discharge to the stream flow gage at the town of Arcadia (Figure 6-3). This basin is located upstream of the confluences of Horse Creek and Joshua Creek, and it receives discharge from the confluence of Charlie Creek into the Peace River mainstem. The land use in the Peace at Arcadia basin was reported to be primarily freshwater wetlands (19%), pasturelands (16%) and agriculture (15%).

Water Quality Trends

No large increasing or decreasing trends were found for the Peace River at Arcadia, and there were few trends of significance overall within the basin. The exception was three small increasing trends in total phosphorus within the basin between 1997 and 2009. Most other parameters were stable over the period of record.

5.2.4 Coastal Lower Peace

The Coastal Lower Peace Basin includes the wider portions of the Peace River at its confluence with Charlotte Harbor Proper (Figure 6-3). This is a relatively high tidal energy, estuarine environment. The land use in the Coastal Lower Peace Basin was reported to be primarily residential (22%), freshwater wetlands (14%), and agriculture (6%).

Water Quality Trends

Water quality stations in the Coastal Lower Peace basin include data collected in the Lower Peace River and adjacent tributaries including Shell Creek. The collection agencies include the City of Punta Gorda, The Peace River Manasota Water Supply Authority, the Southwest Florida Water Management District and the Charlotte Harbor Volunteer Monitoring network.

There were a substantial number (7) of stations with improving trends in total nitrogen and total kjeldahl nitrogen in the Coastal Lower Peace primarily reported by the Shell Creek HBMP program for the period of record between 1991 and 2011. Interestingly, dissolved oxygen concentrations decreased significantly at many of these same stations which may be explained by significantly increasing trends in salinity, pH and dissolved silica concentrations. Chlorophyll a concentrations were mostly stable though there were two stations with decreasing trends and one station with an increasing trend.

5.2.5 Horse Creek

The Horse Creek Basin is a relatively large basin that discharges freshwater into the Coastal Lower Peace Basin downstream of the stream flow gage at Arcadia (Figure 6-3). Land use in the Horse Creek Basin was reported to be pastureland (38%) and freshwater wetlands (17%) upland forests (11%), and agriculture (9%).

Water Quality Trends

There are few water quality stations in this basin that met the criteria for conducting trend tests. Most parameters were found to be stable over the period of record (1997-2009). Small increasing trends were found for conductivity at one station each, as shown in the results presented at the end of this section. A single, small, decreasing trend in NO23 was also observed in the Horse Creek basin. Otherwise all trends were stable over time.

5.2.6 Joshua Creek

The Joshua Creek Basin is a relatively small basin that discharges freshwater into the Coastal Lower Peace Basin downstream of the stream flow gage at Arcadia (Figure 6-2). Land use in the Joshua Creek Basin was reported to be primarily agriculture (15%), freshwater wetlands (9%) pasture (8%), and upland forests (5%).

Water Quality Trends

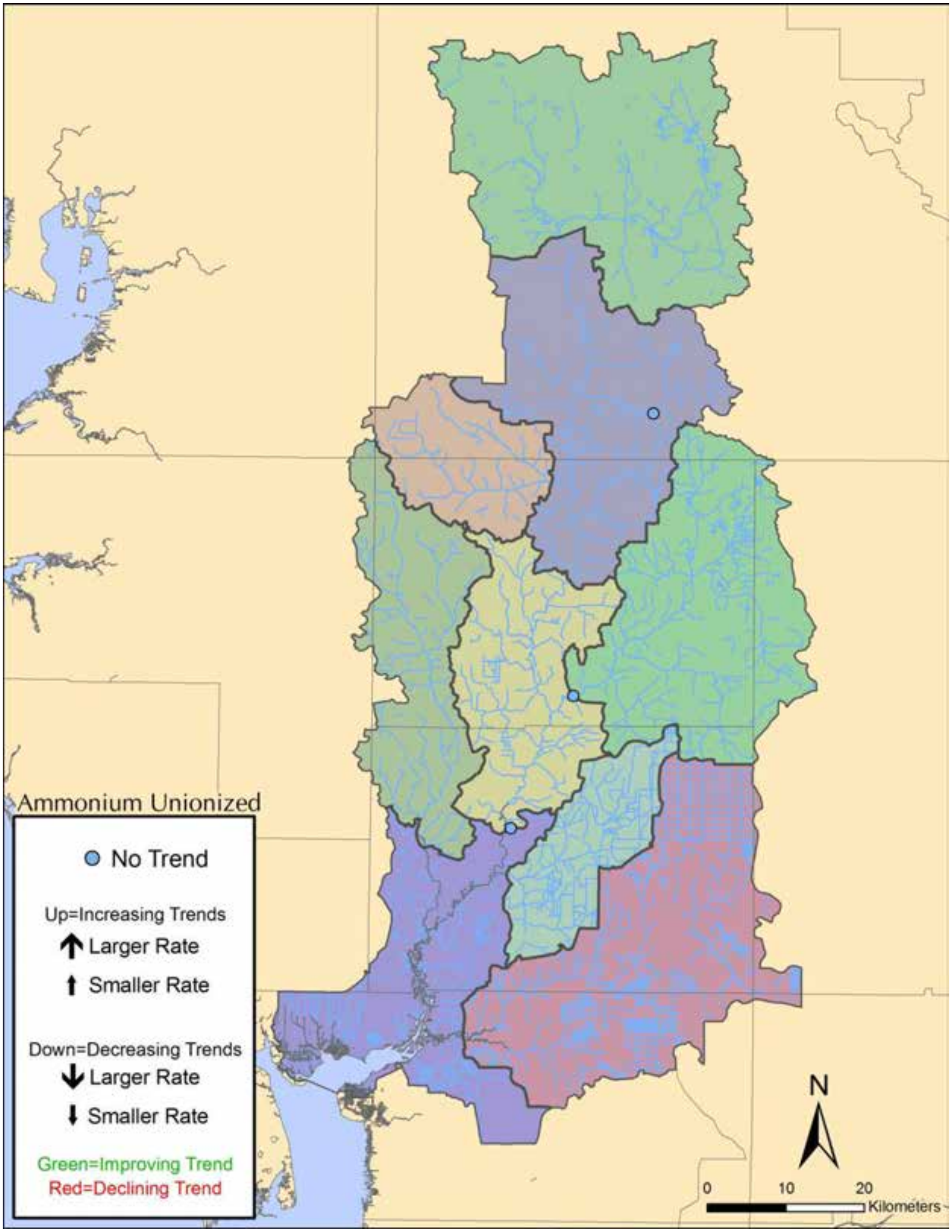
Joshua Creek results were very similar to Horse Creek with a single increasing conductivity trend, and a single decreasing trend in total nitrogen and NO23. A small increasing trend in total phosphorus was also observed. As in Horse Creek there were few stations within this basin that met the criteria for trend testing.

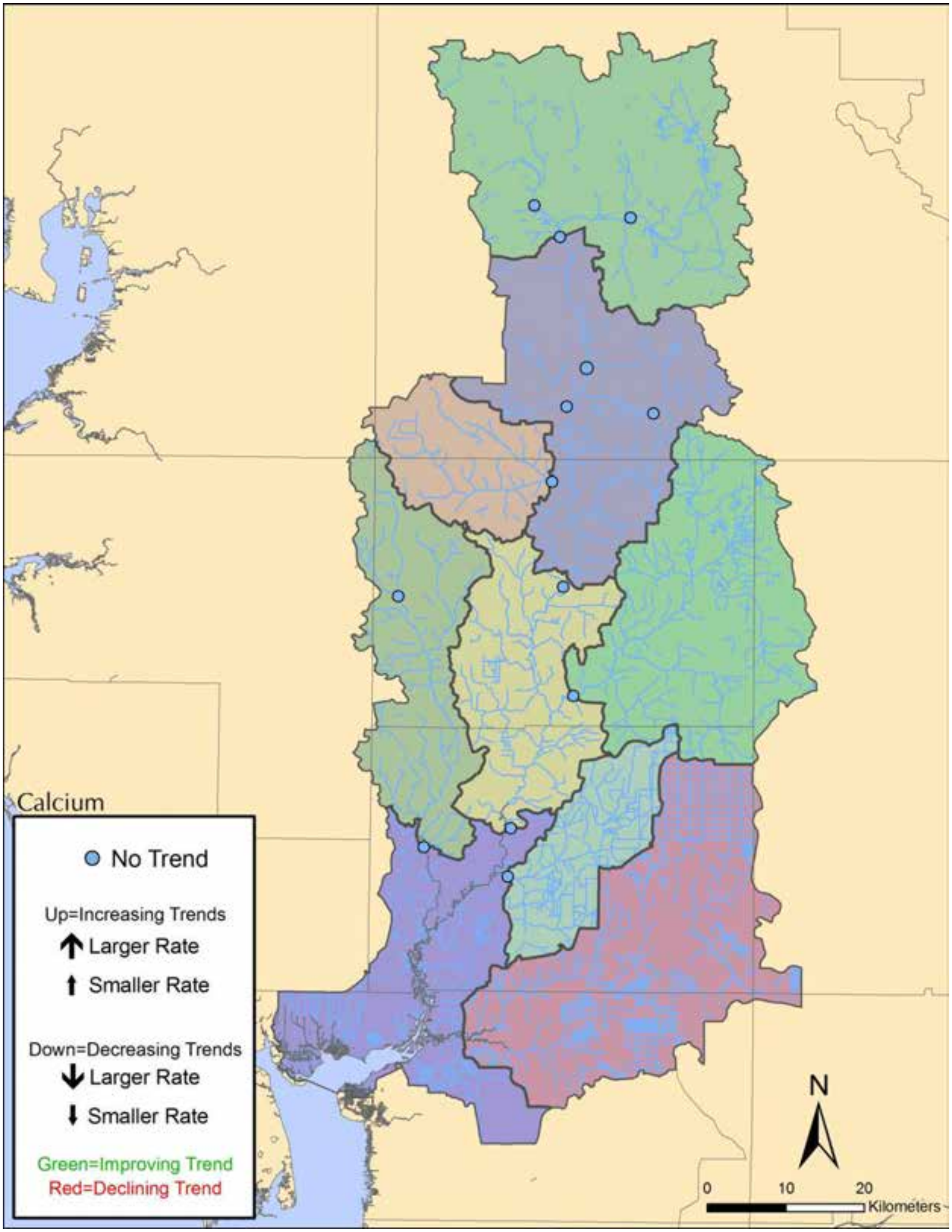
5.2.7 Shell Creek

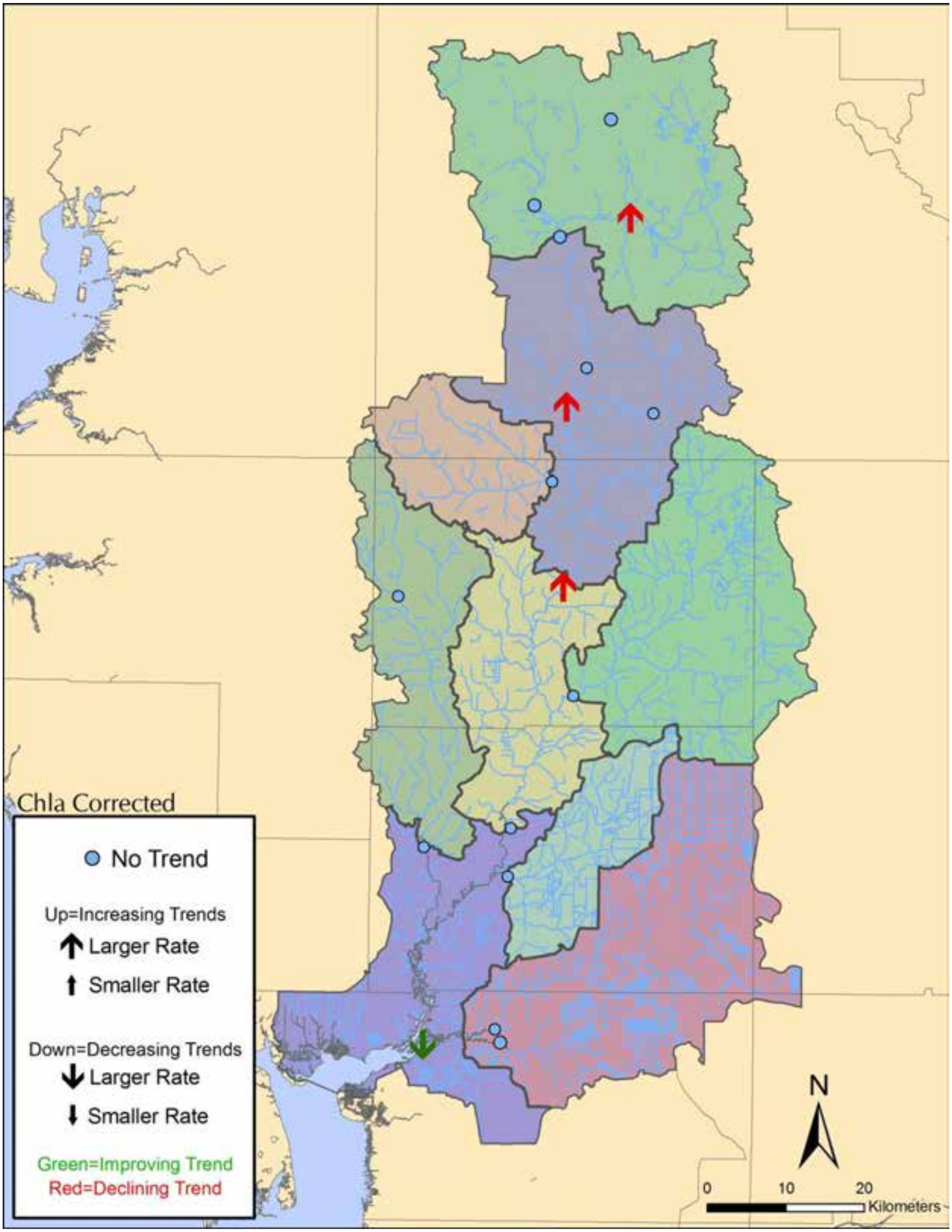
The Shell Creek Basin includes the those areas east of the Coastal Lower Peace basin that include the Shell Creek and Prairie Creek tributaries east of the Punta Gorda Reservoir. The basin stretches Northeast towards Desoto and Highlands County. The land use in the Shell Creek basin was reported to be primarily pasture (38%), freshwater wetlands (15%), agriculture (10%) and upland forests (6%).

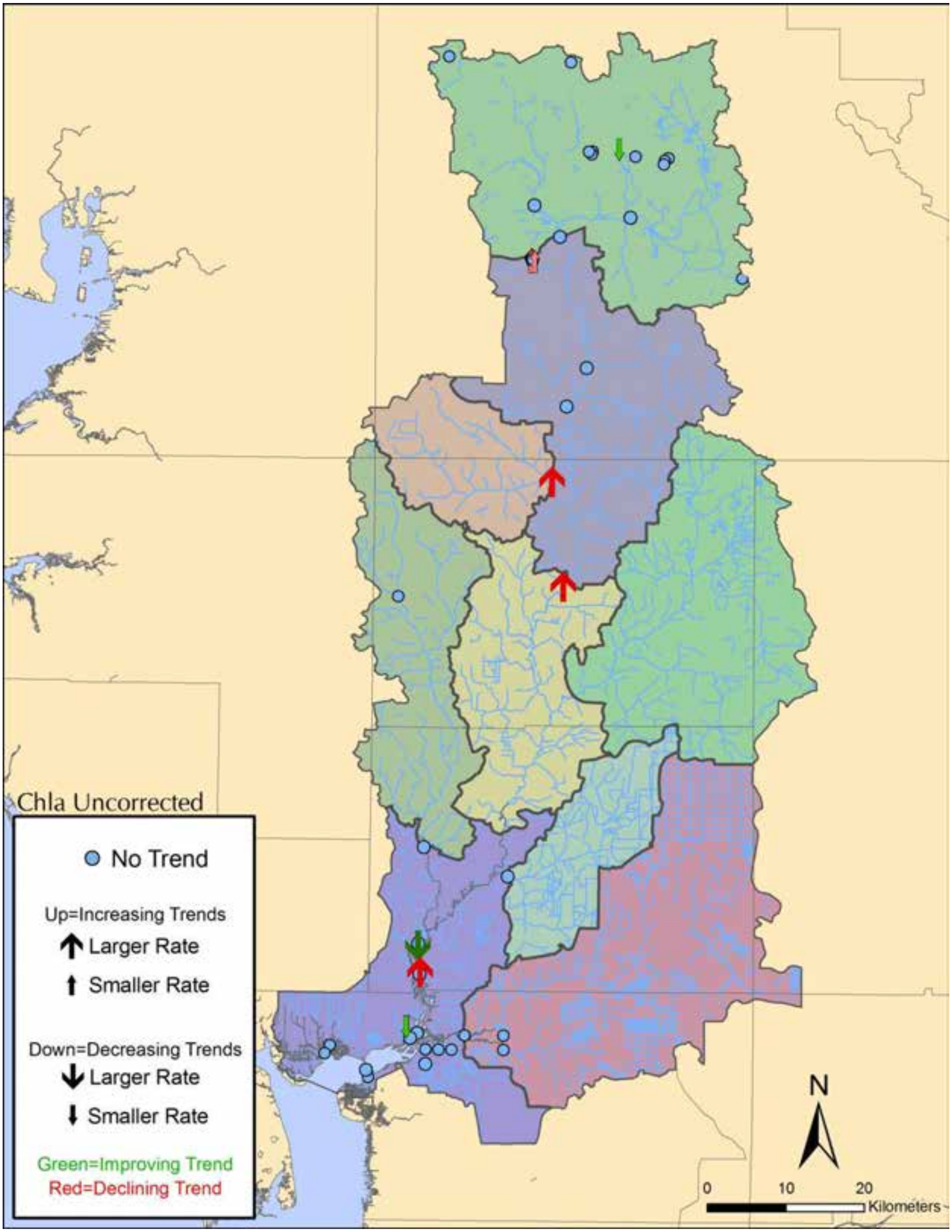
Water Quality Trends

There were two decreasing trends in total nitrogen and four decreasing trends in total kjeldahl nitrogen within the Shell Creek basin. Two increasing trends were observed for total phosphorus and four increasing trends for dissolved silica were also observed.


Ammonium Unionized
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Calcium
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Chla Corrected
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Chla Uncorrected
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
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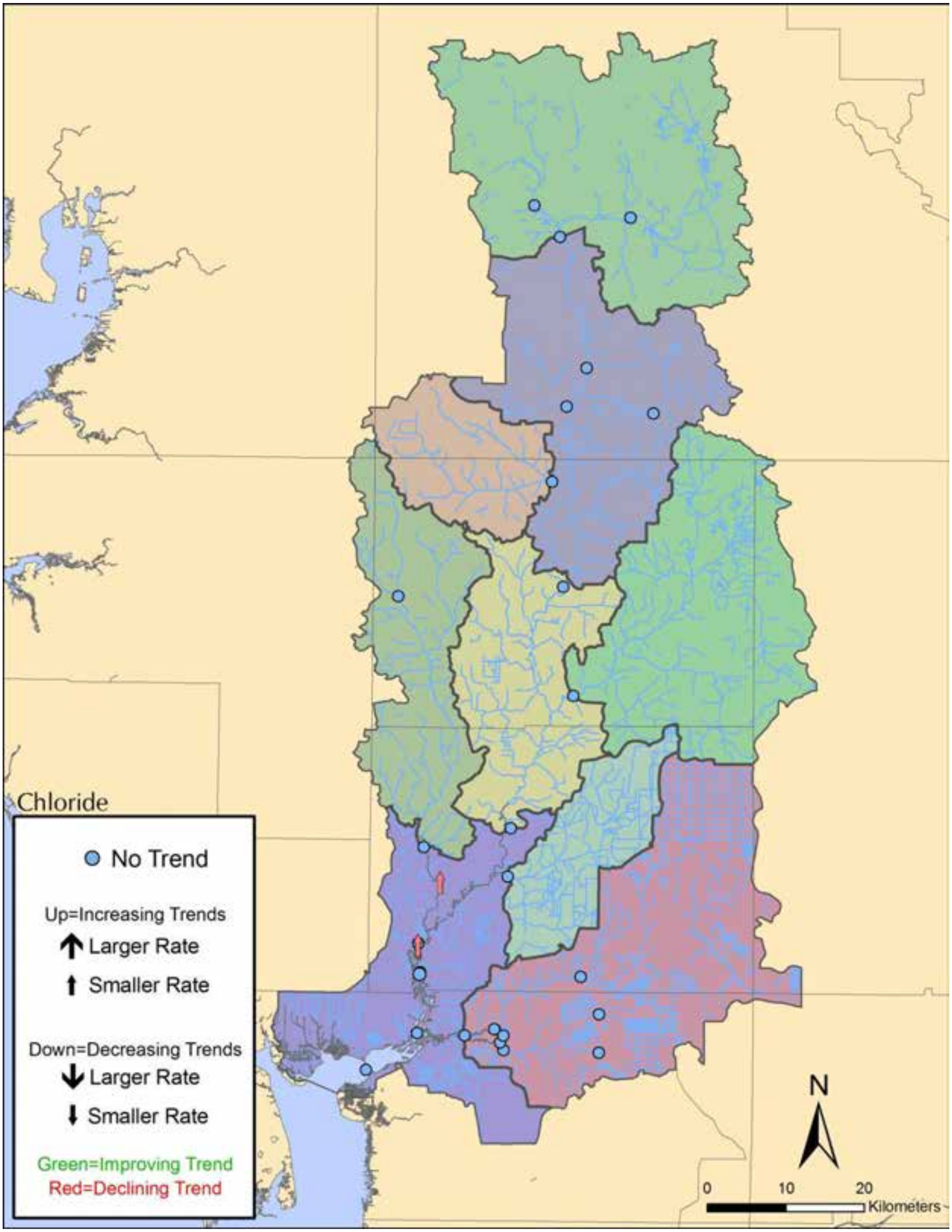
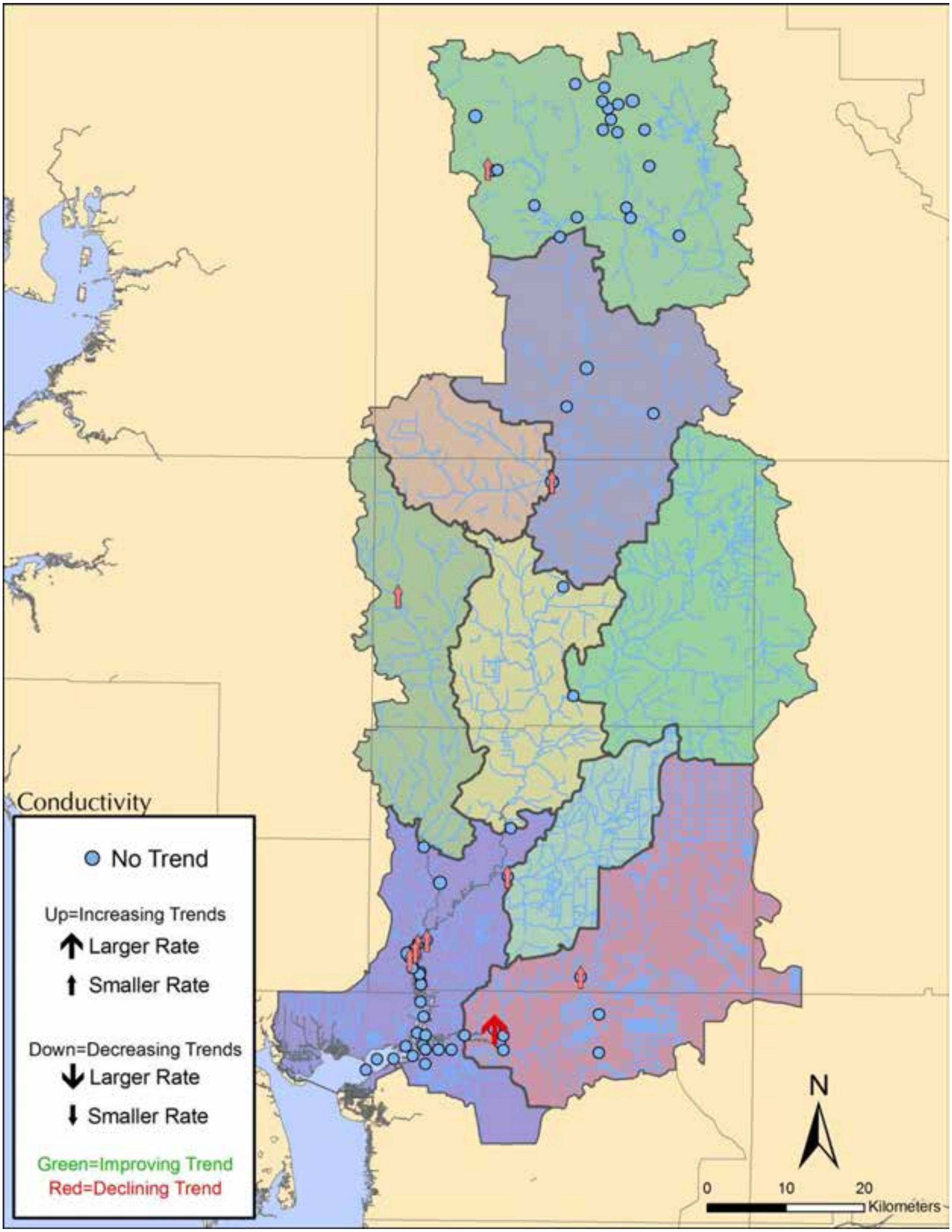
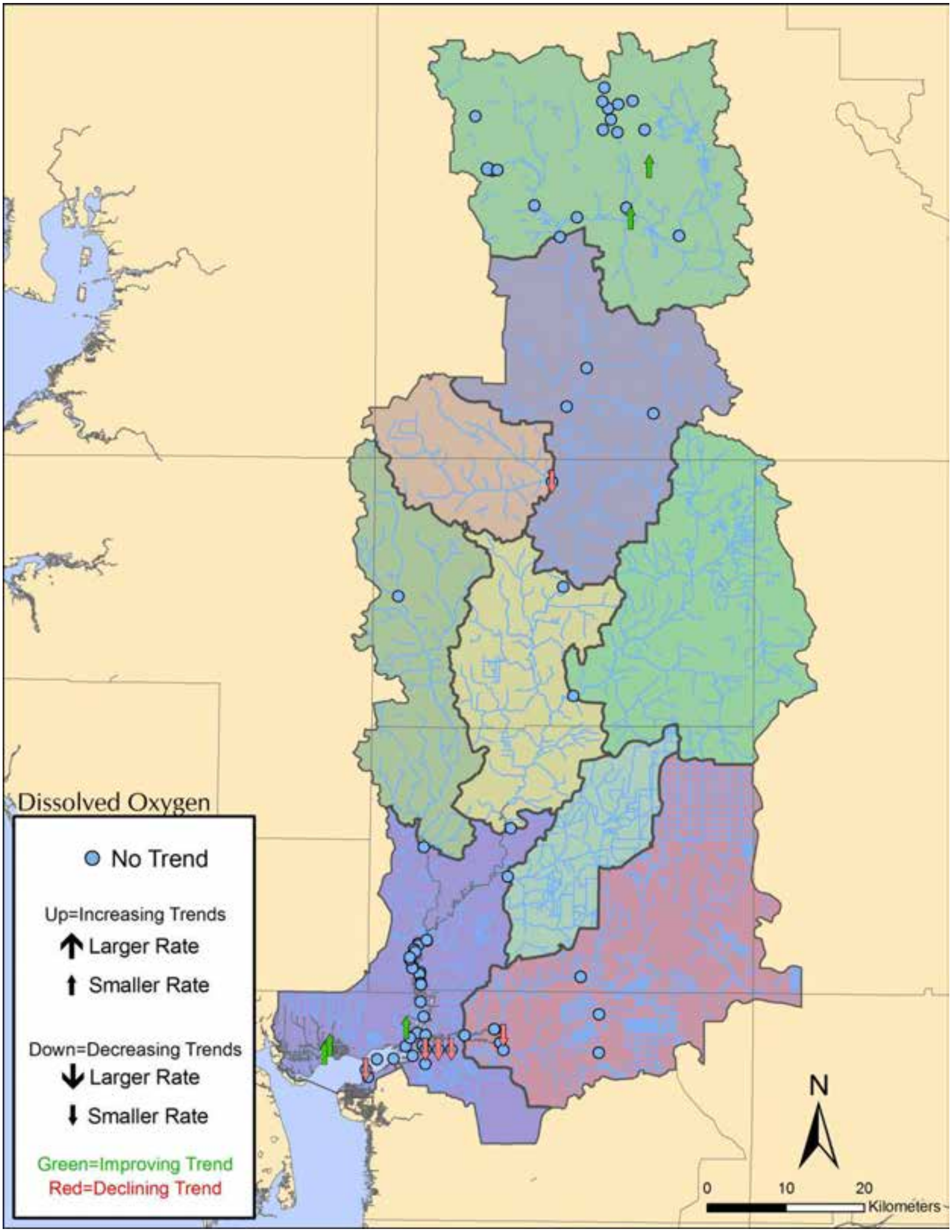
N
0
10
20
Kilometers


Chloride
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Conductivity
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Dissolved Oxygen
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
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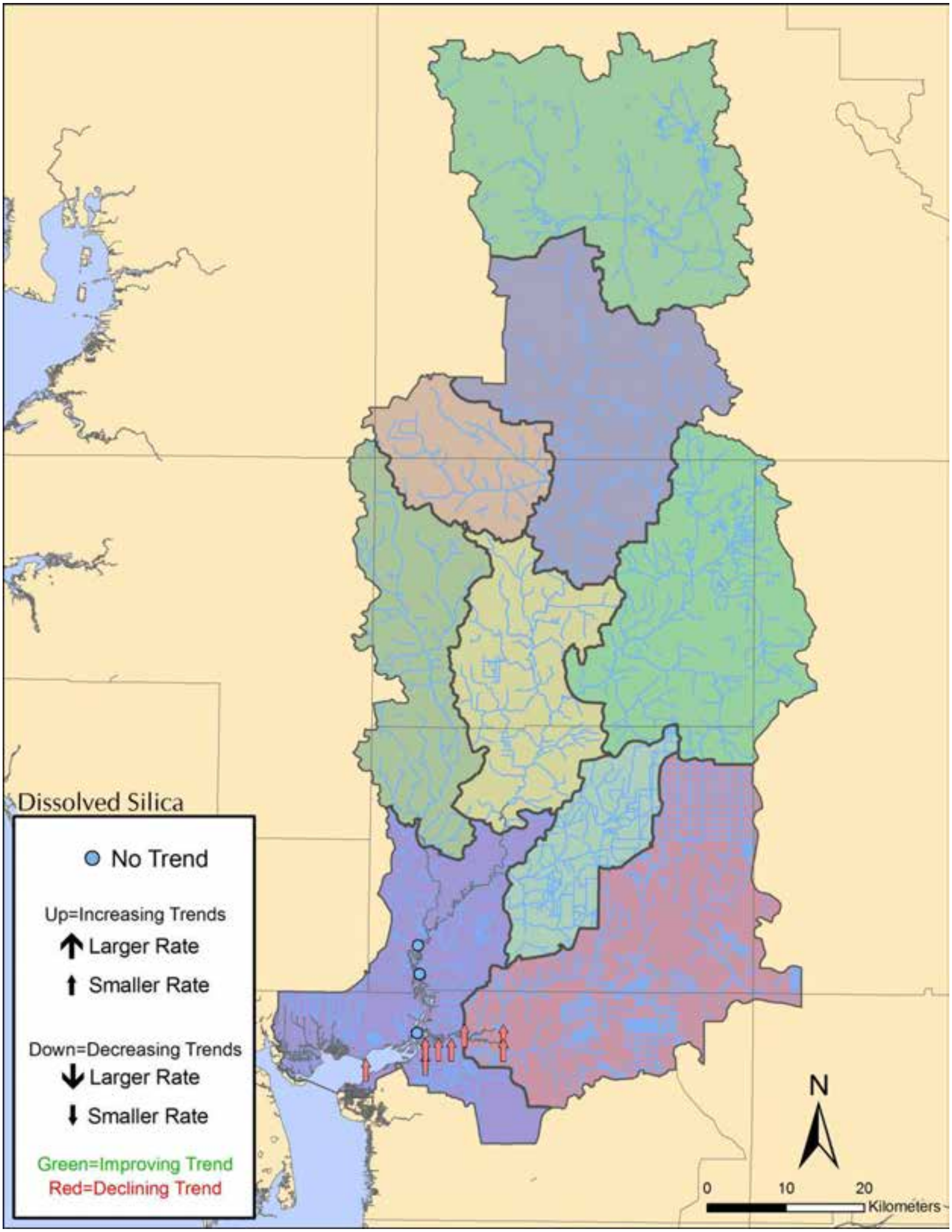
N
0
10
20
Kilometers


Dissolved Silica
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
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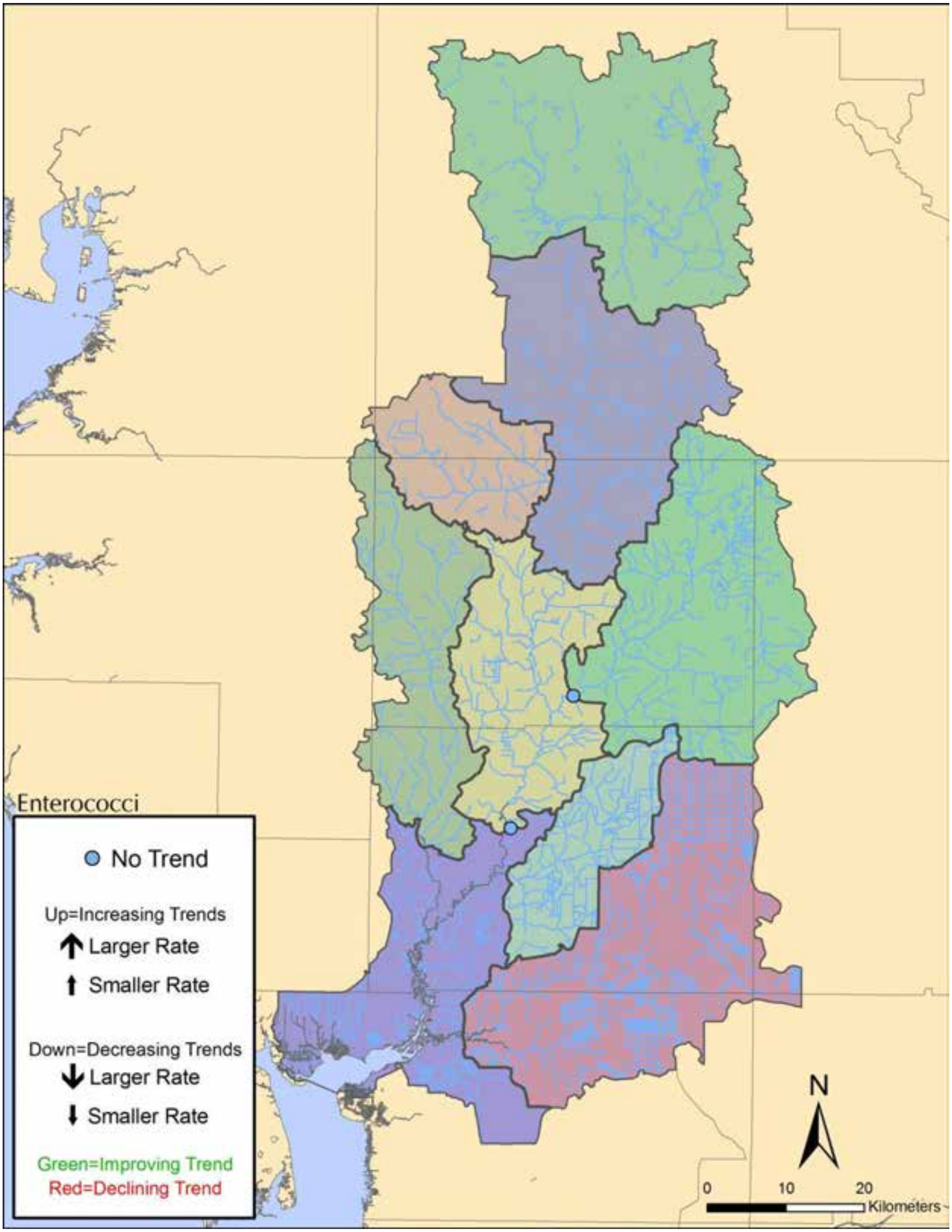
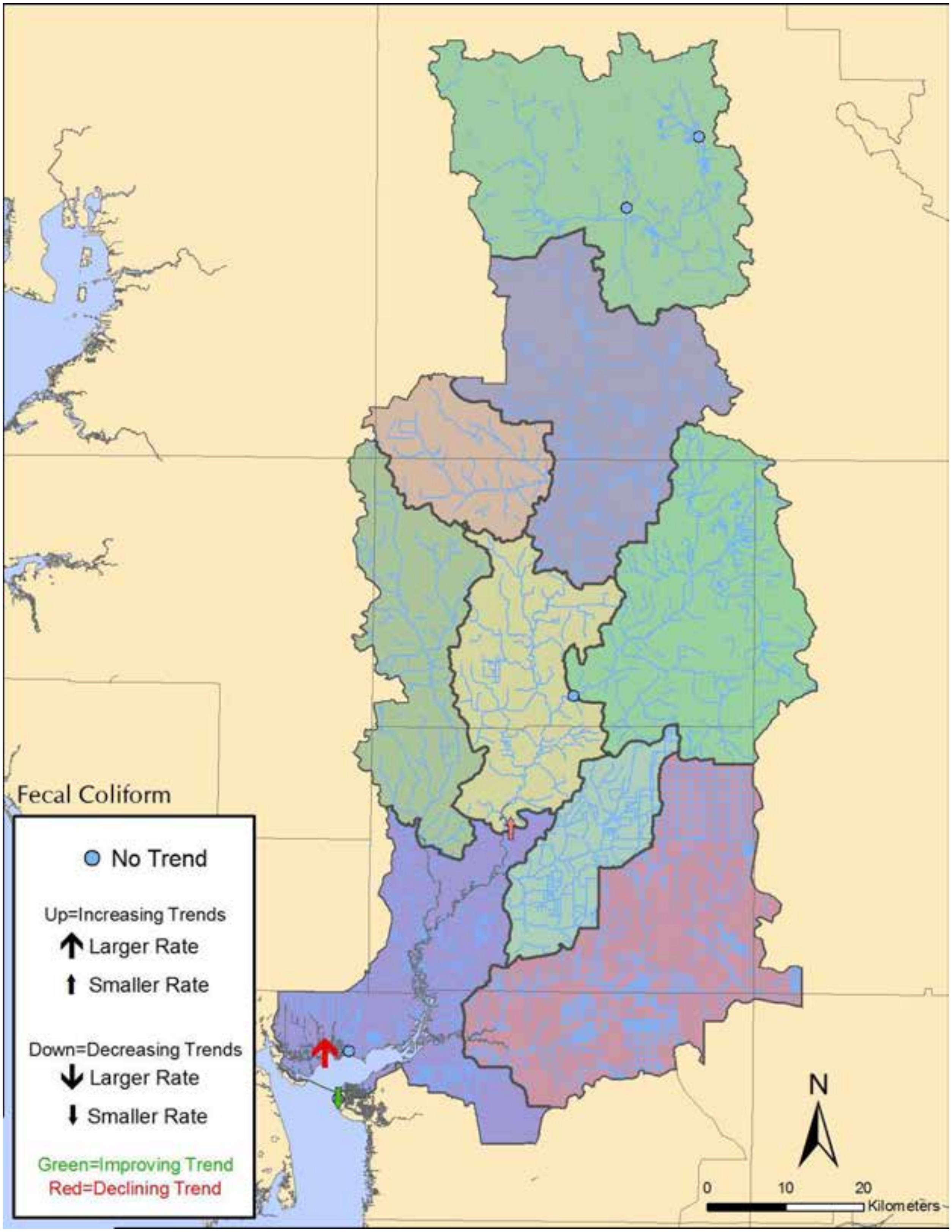
N
0
10
20
Kilometers


Enterococci
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Fecal Coliform
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
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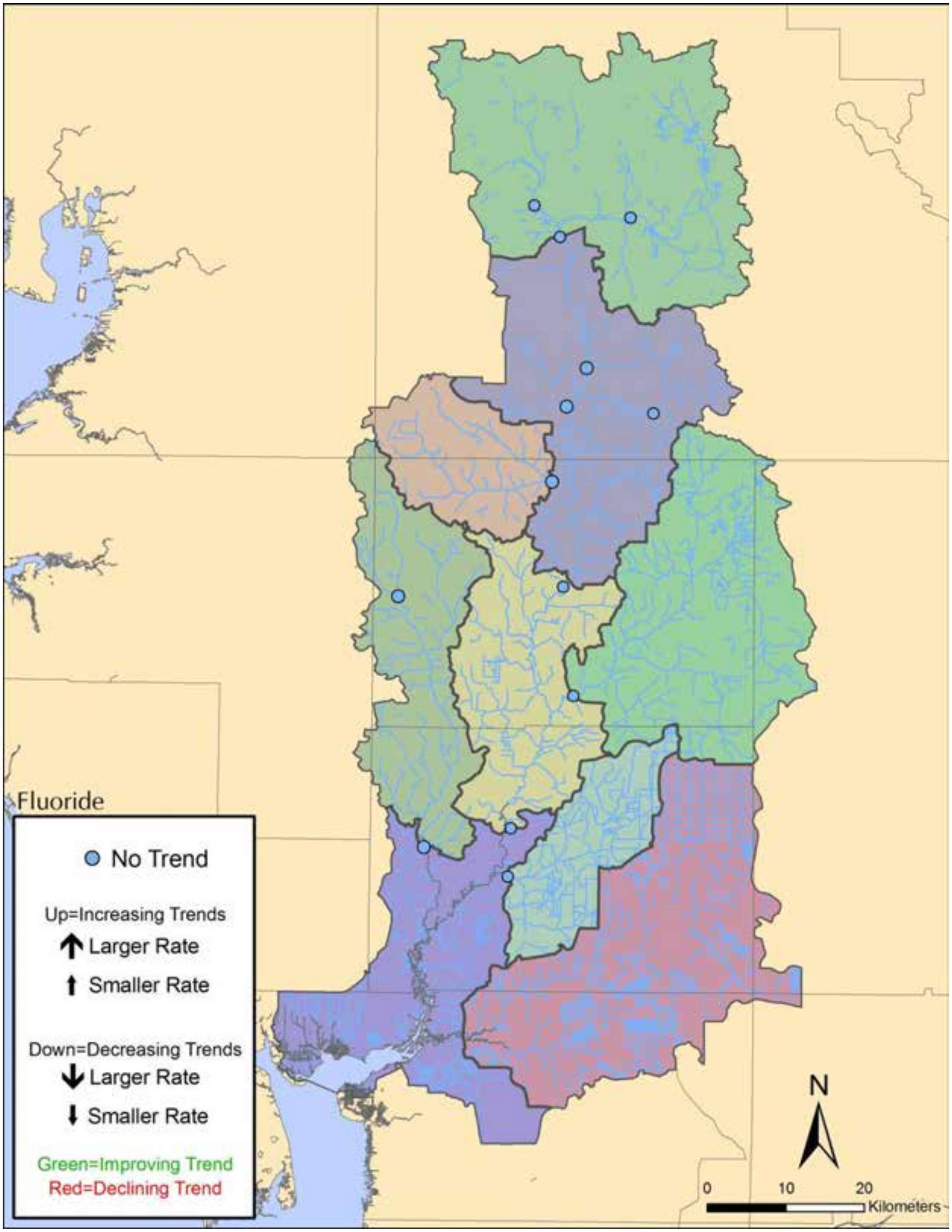
N
0
10
20
Kilometers


Fluoride
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
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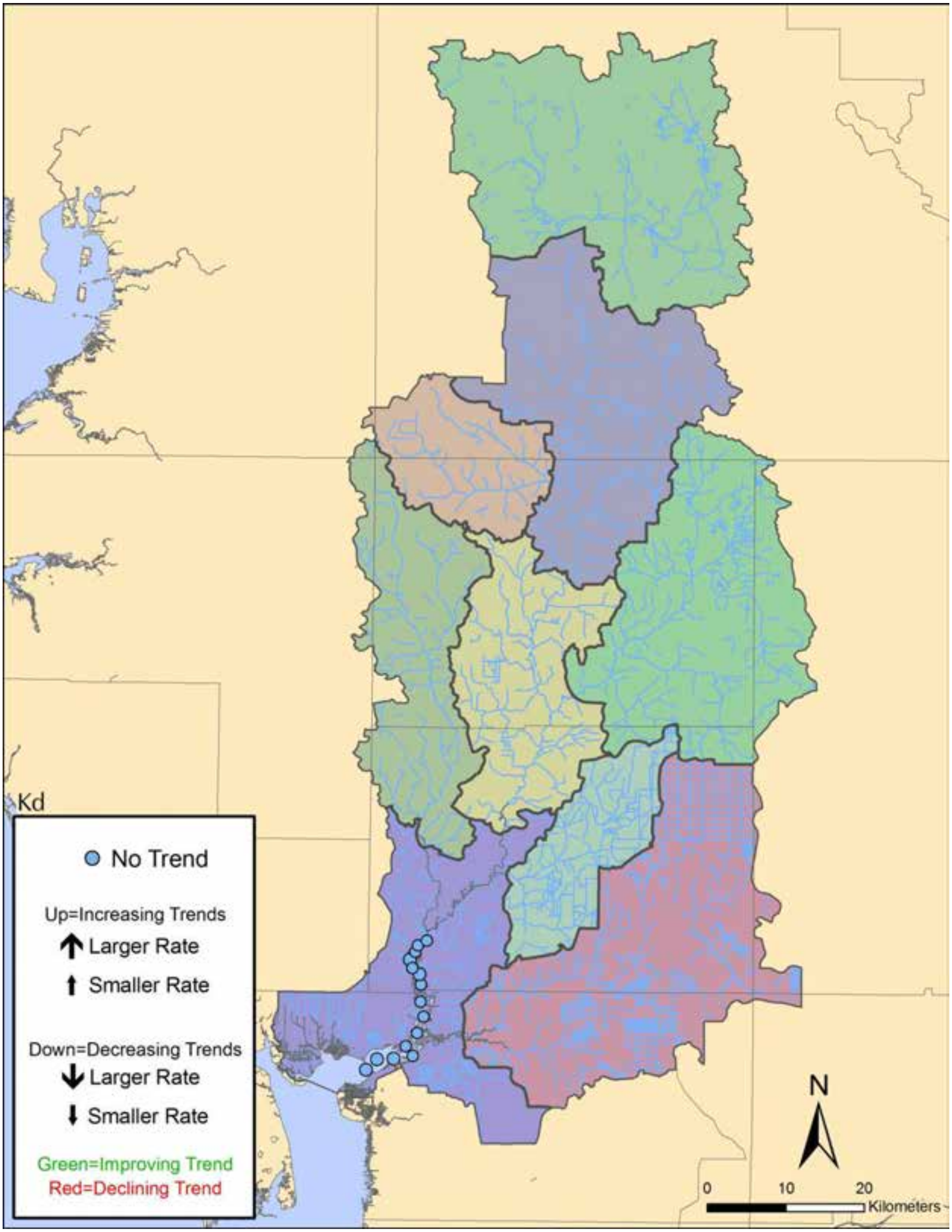
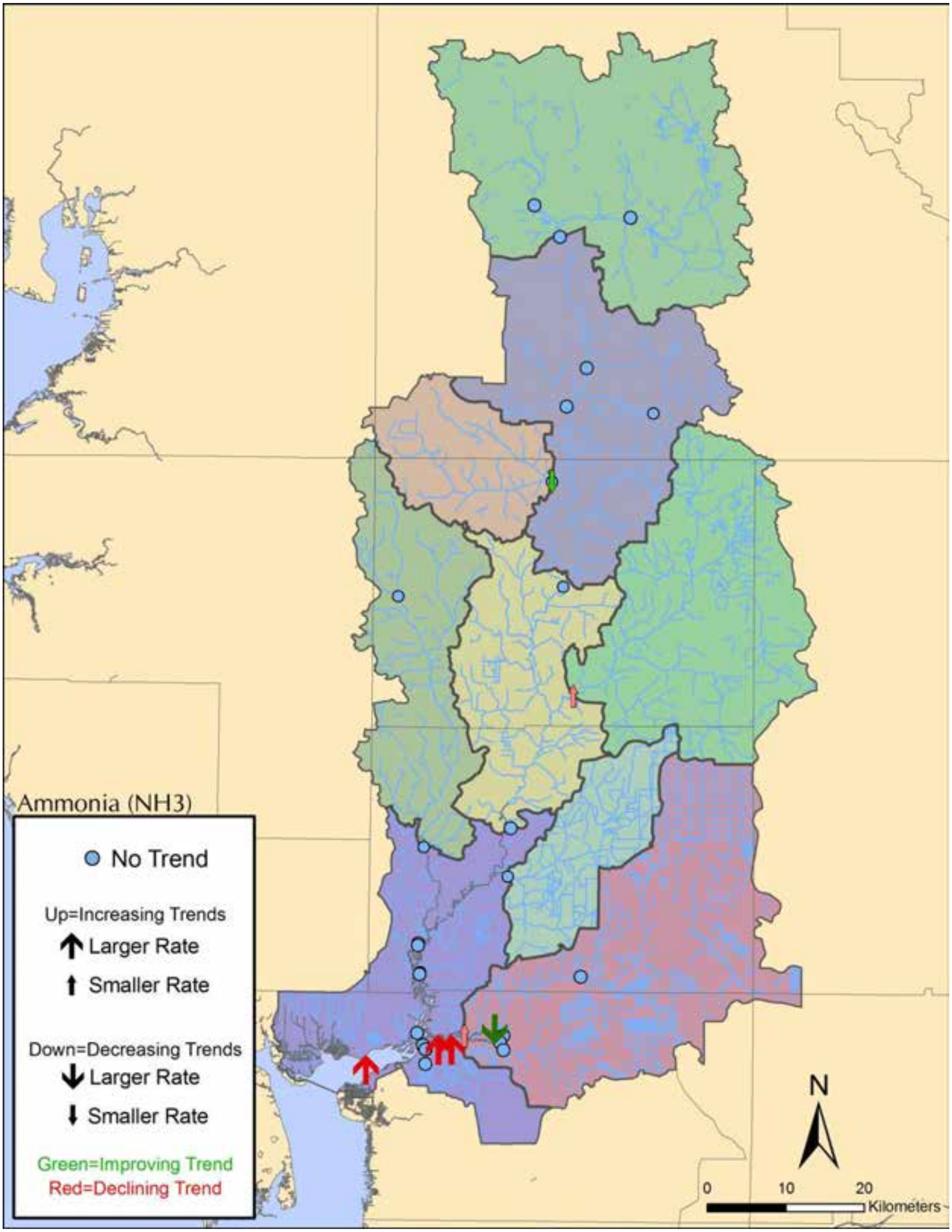
0
10
20
Kilometers


Kd
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Ammonia (NH3)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
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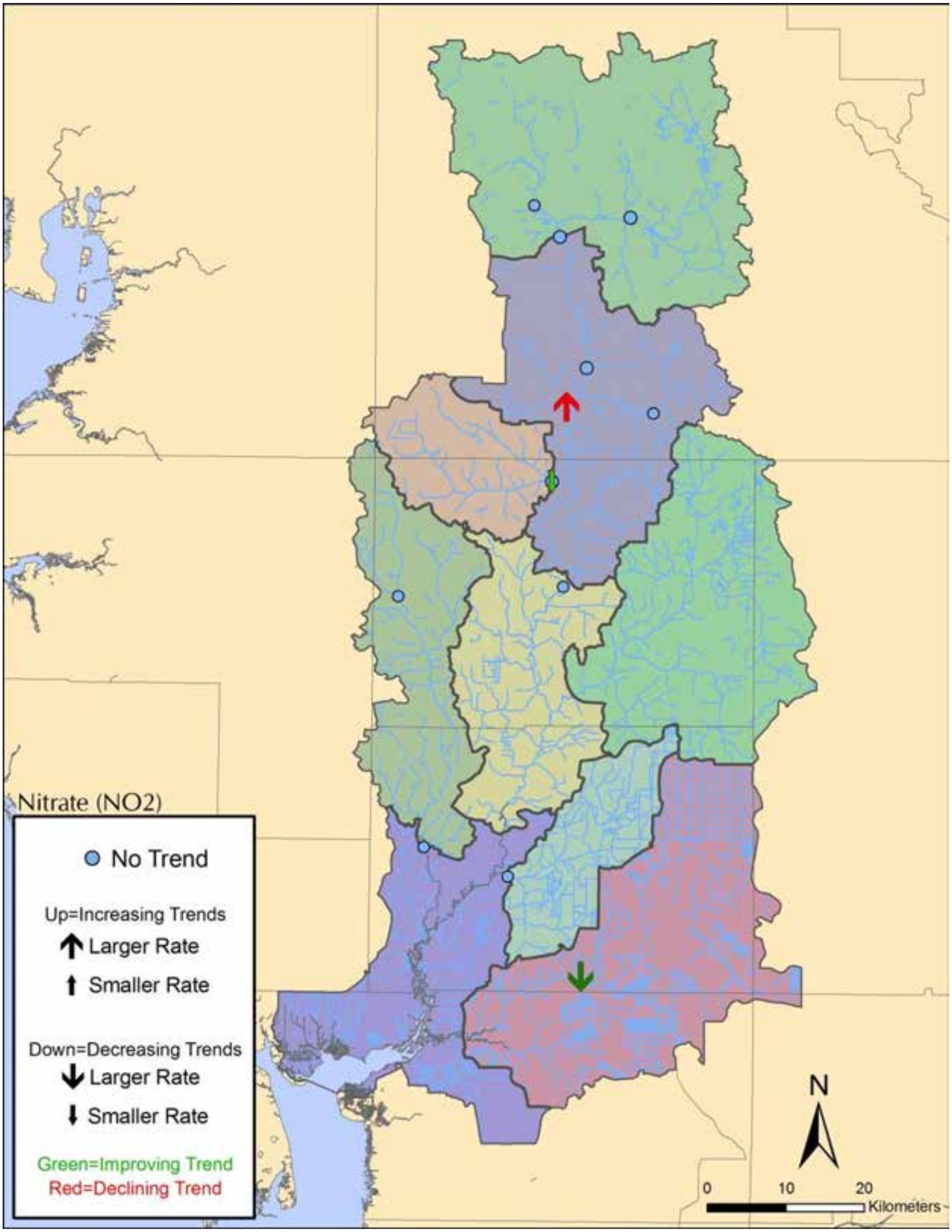
N
0
10
20
Kilometers


Nitrate (NO2)
No Trend
Up=Increasing Trends
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Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
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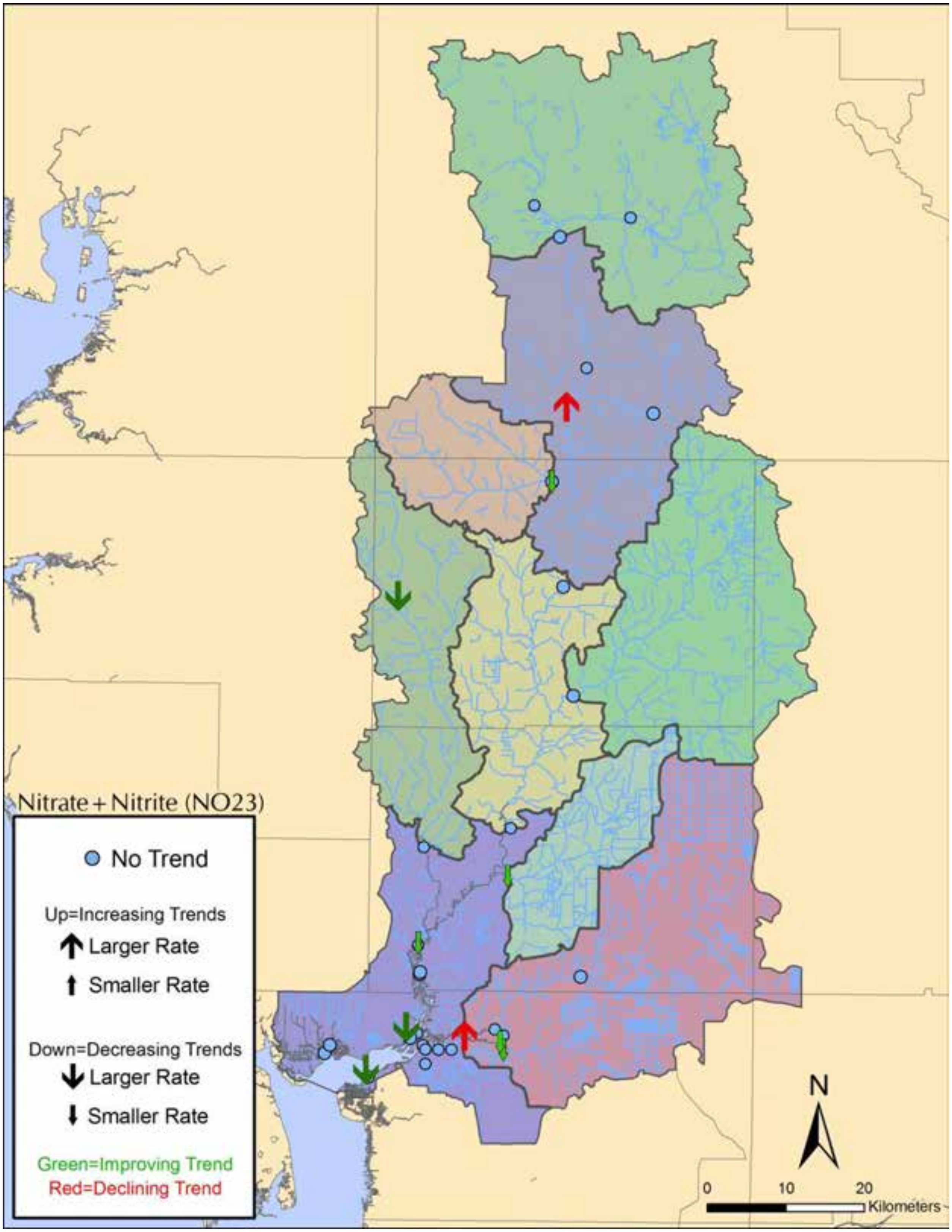
N
0
10
20
Kilometers



Nitrate + Nitrite (NO23)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
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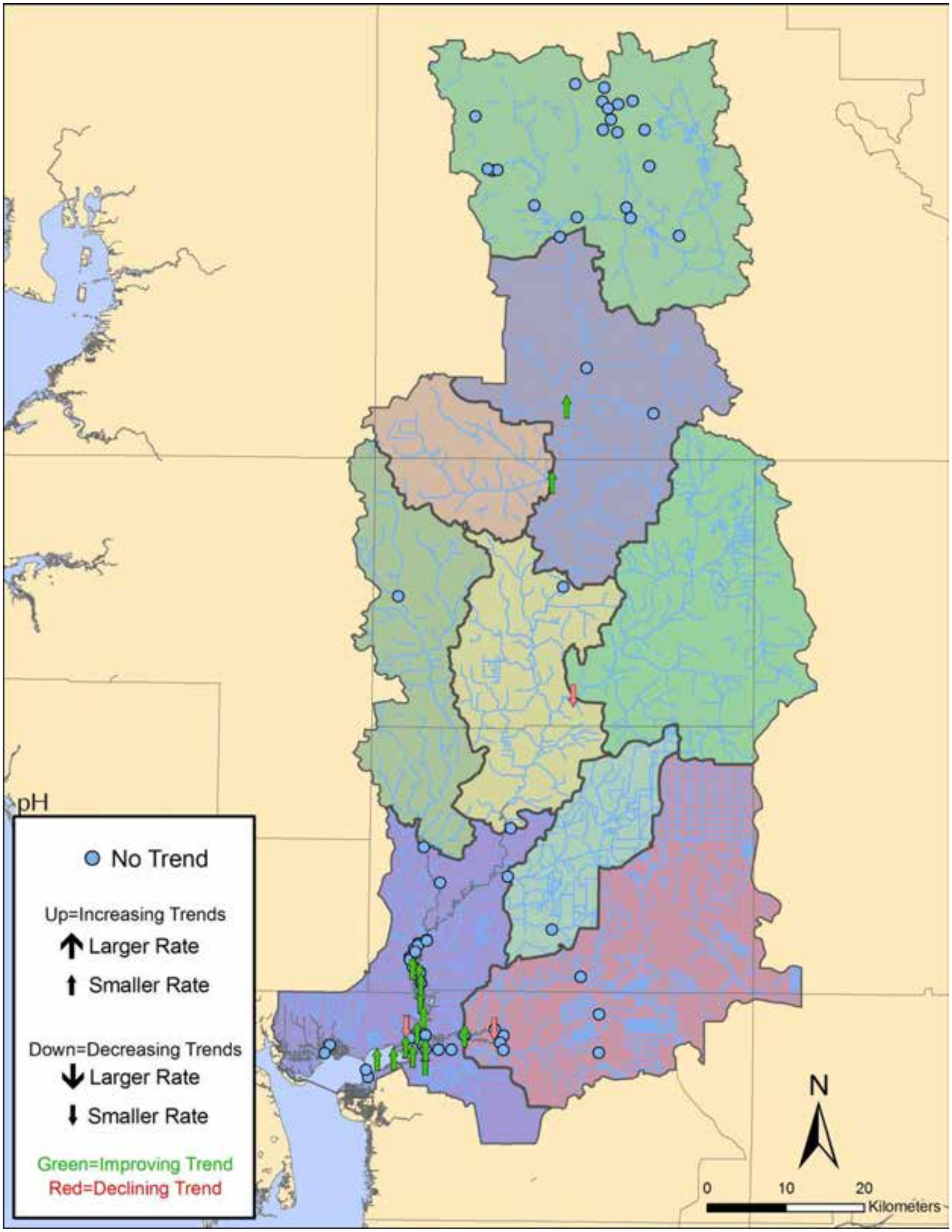
0
10
20
Kilometers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Up=Increasing Trends
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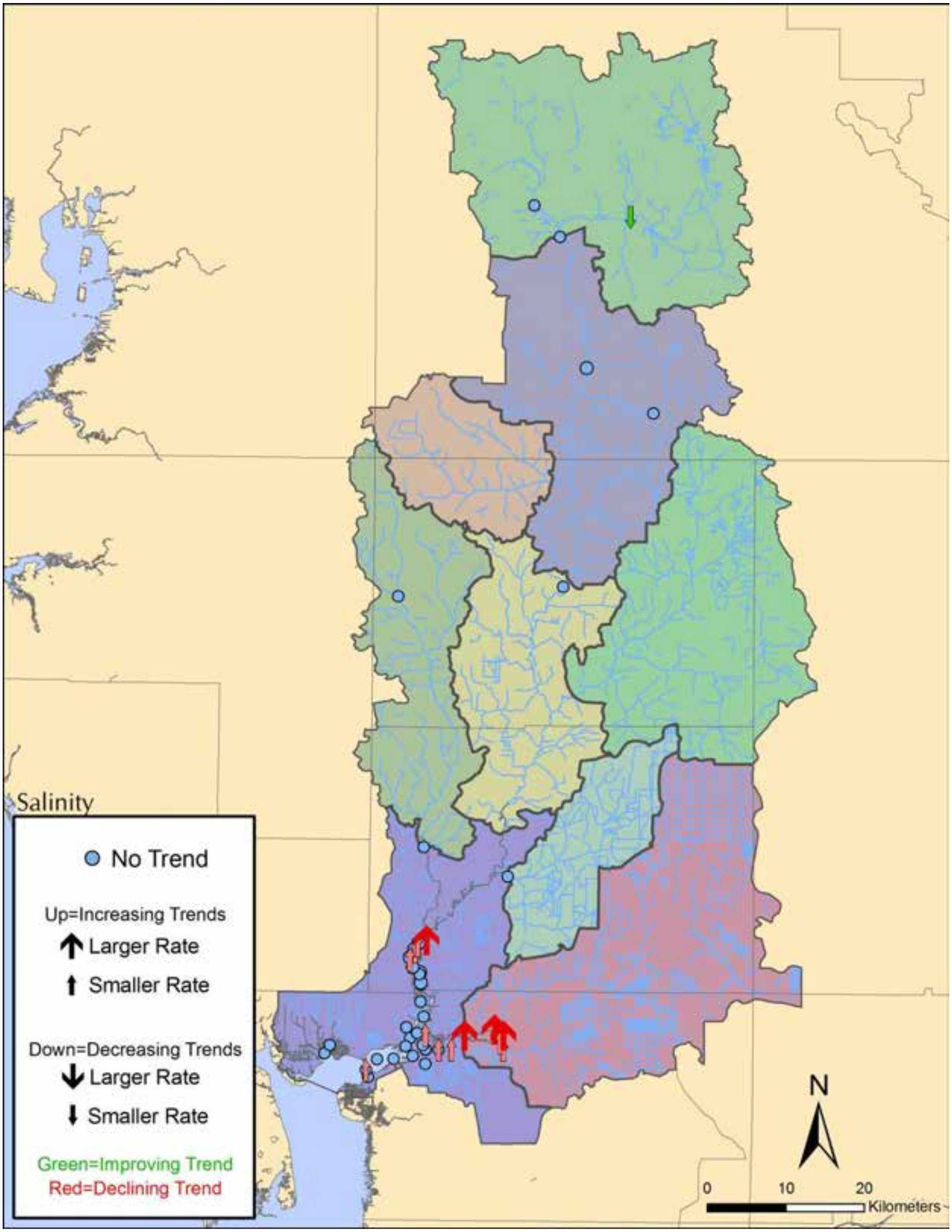
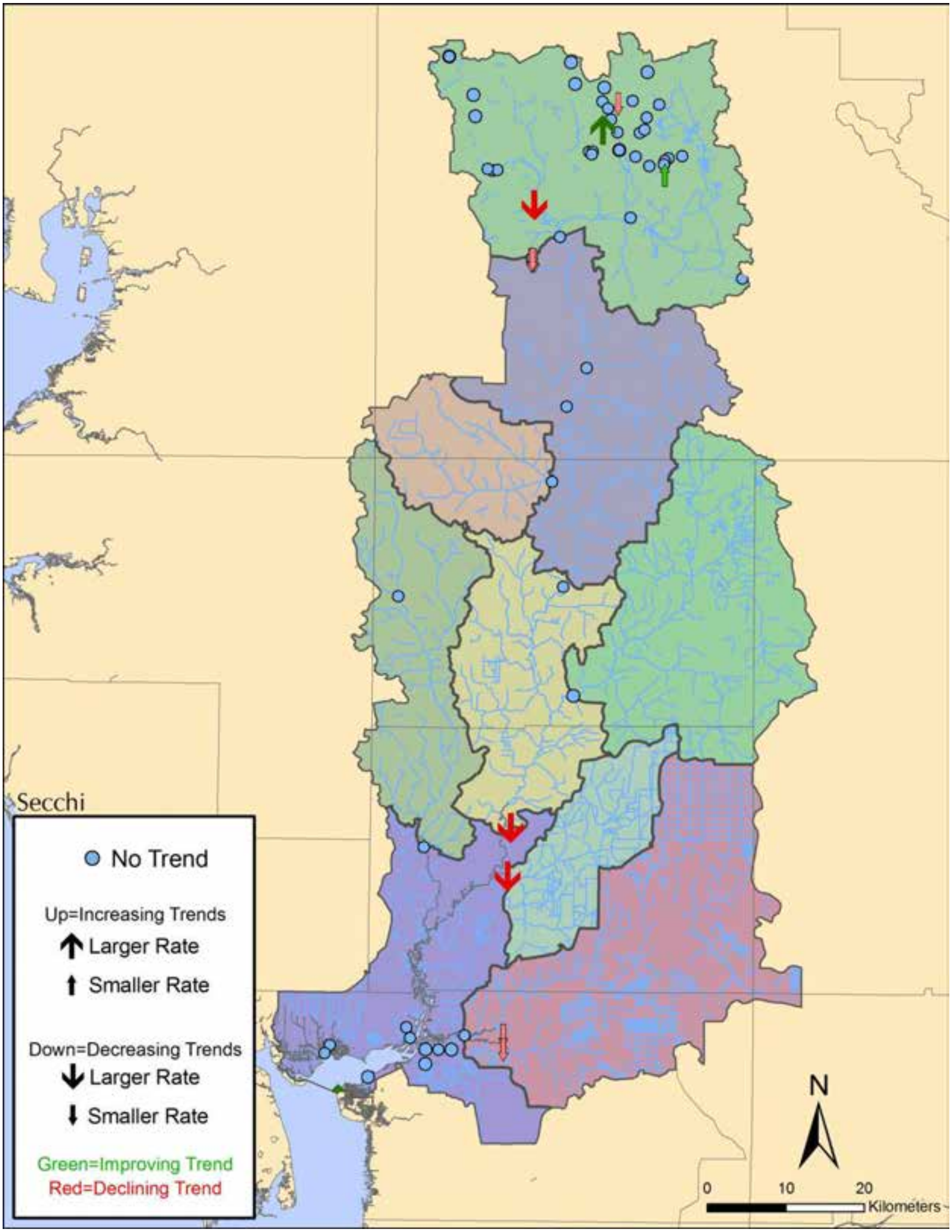
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Salinity
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Secchi
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
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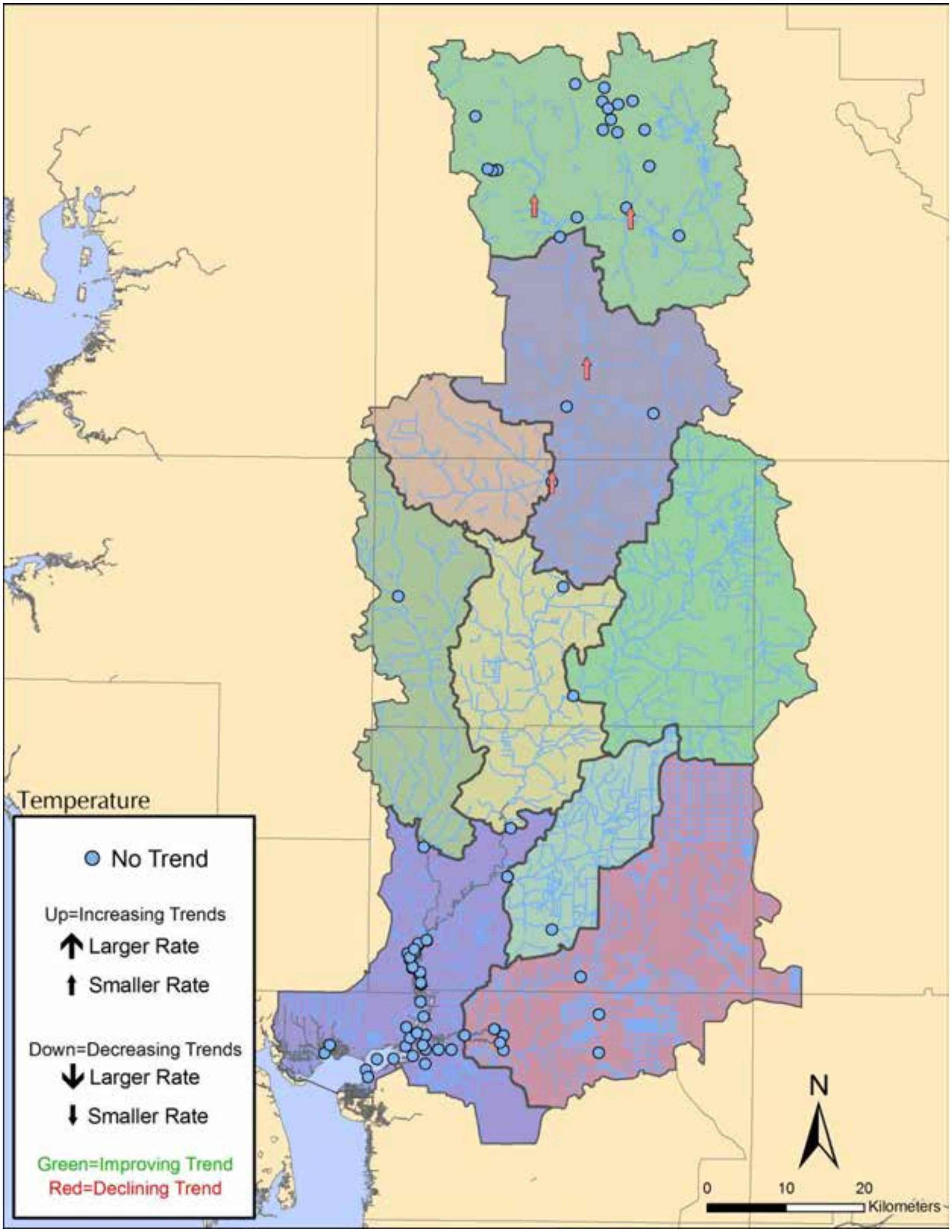
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Temperature
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Larger Rate
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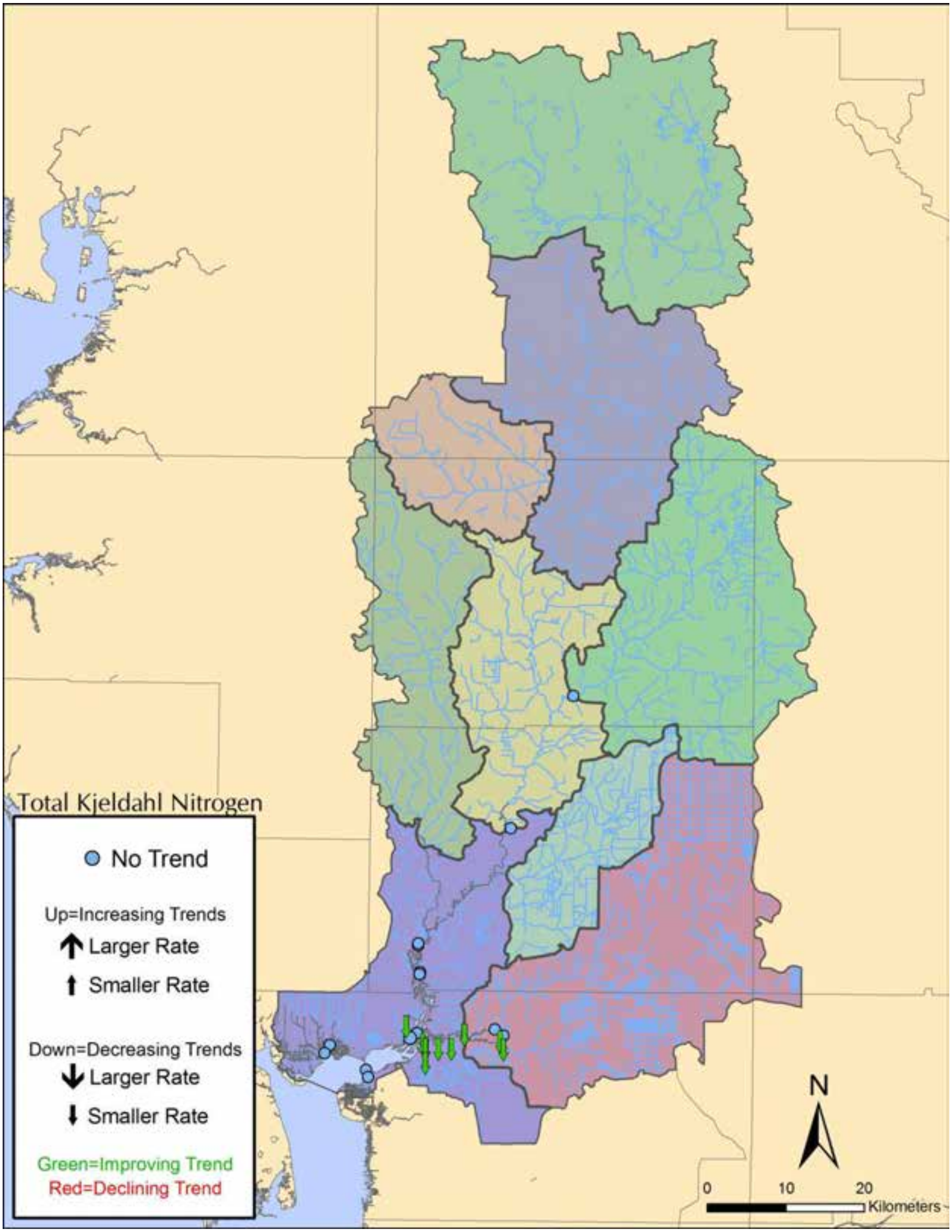
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Kjeldahl Nitrogen
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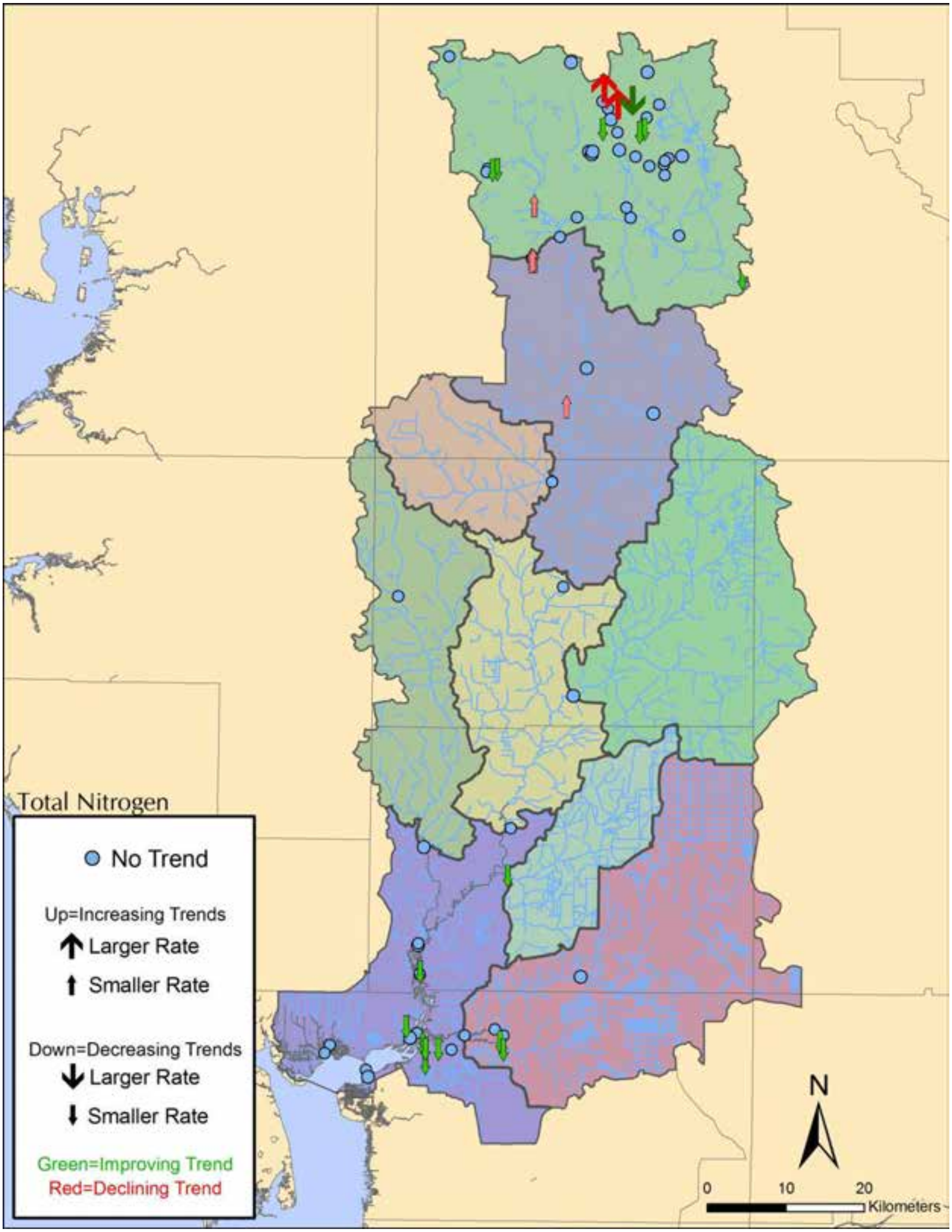
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Nitrogen
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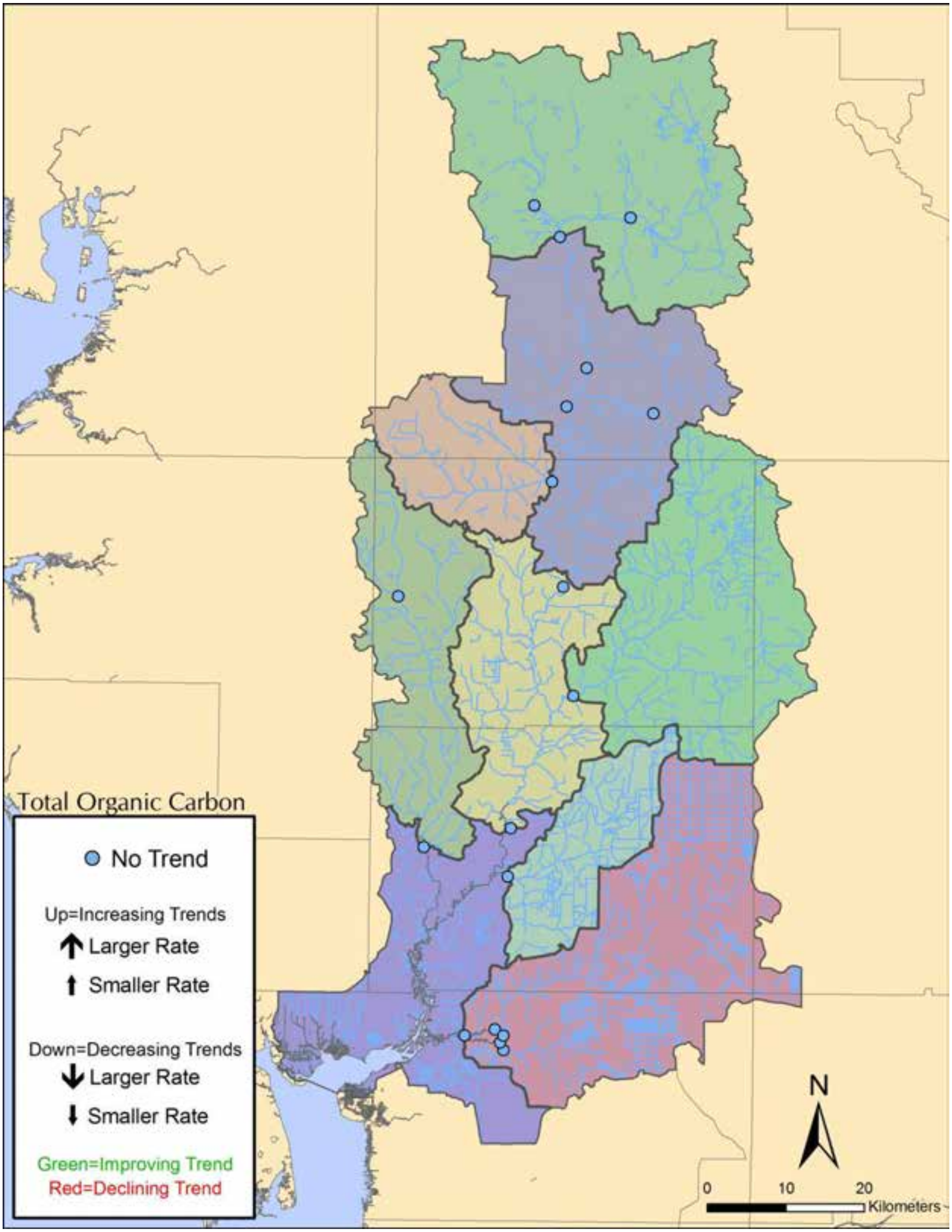
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers



Total Organic Carbon
No Trend
Up=Increasing Trends
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Larger Rate
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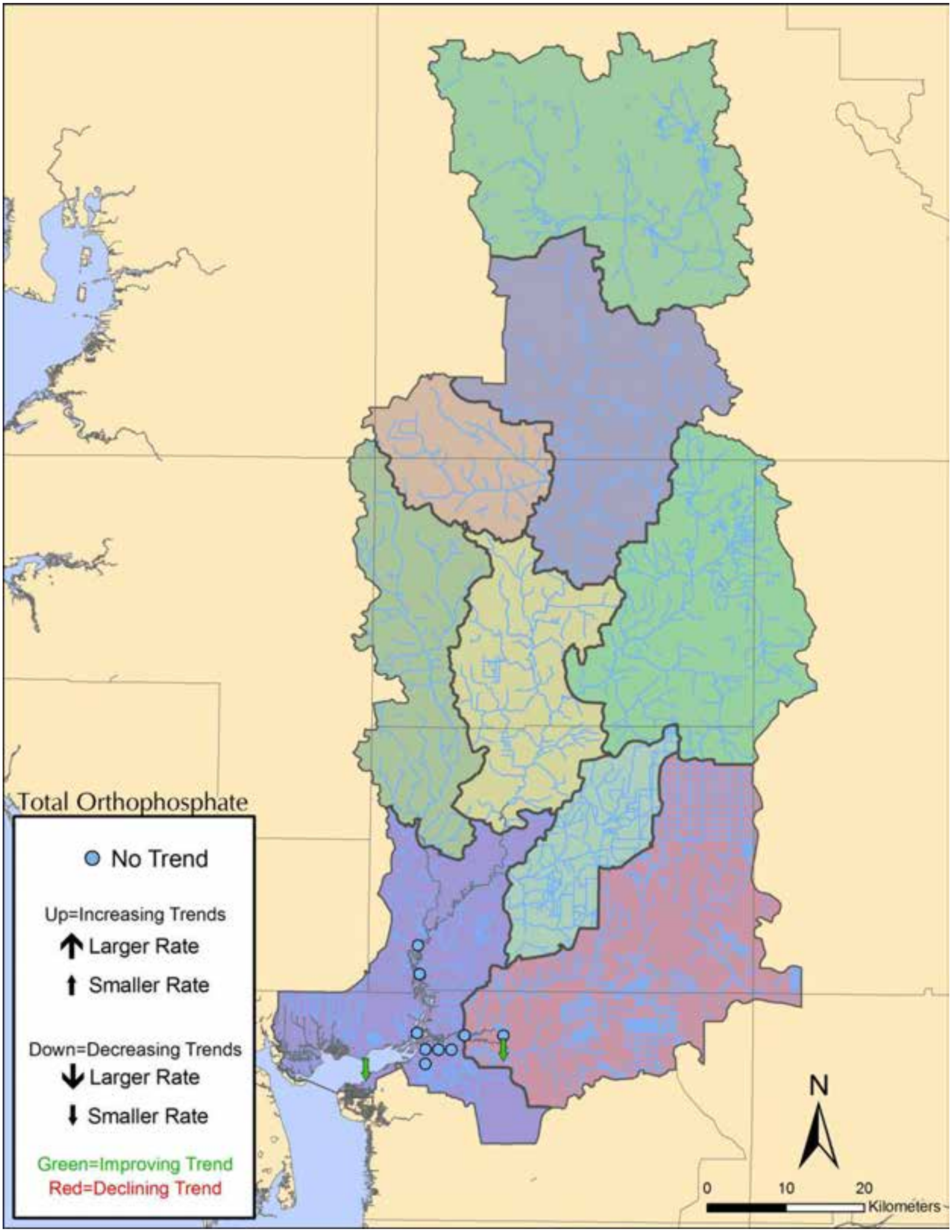
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers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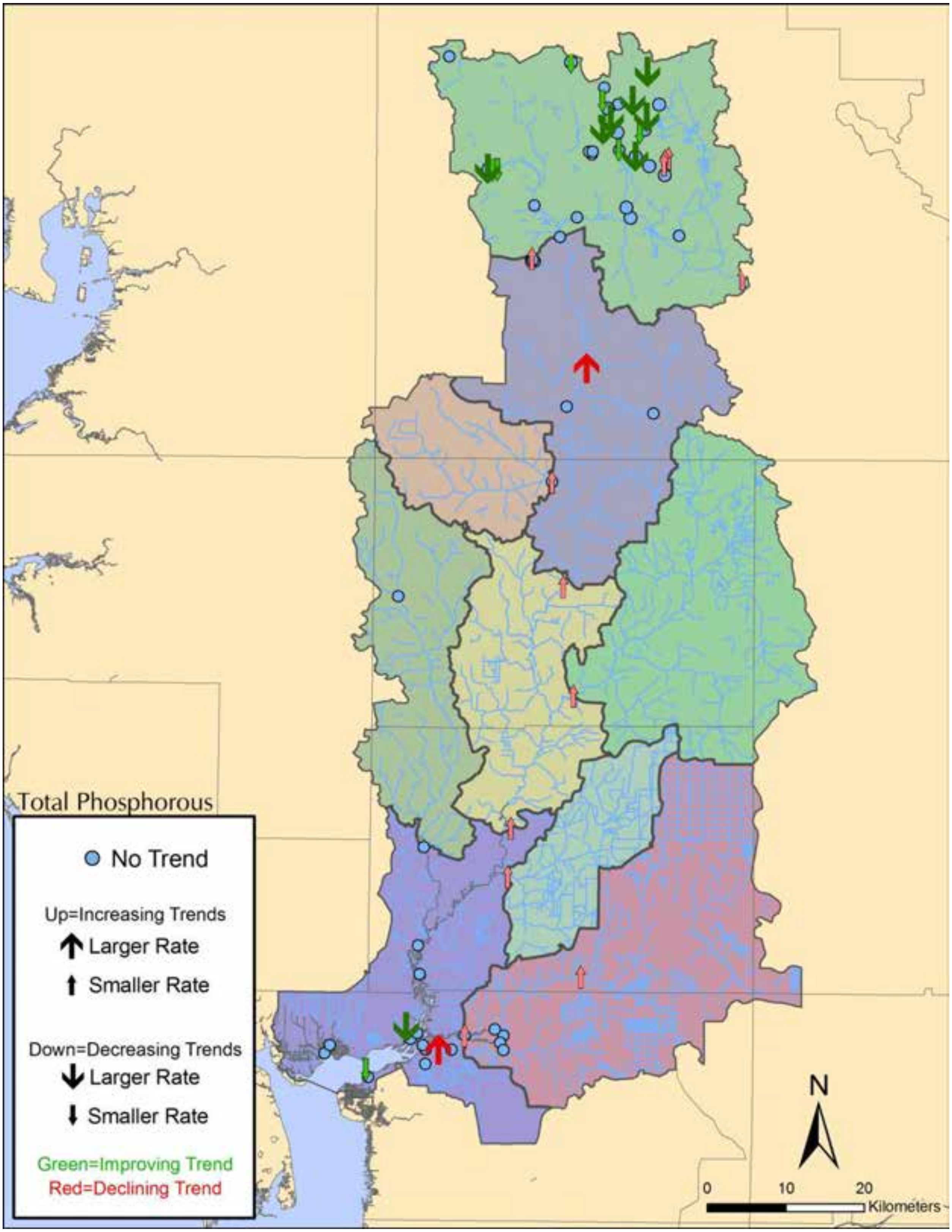
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers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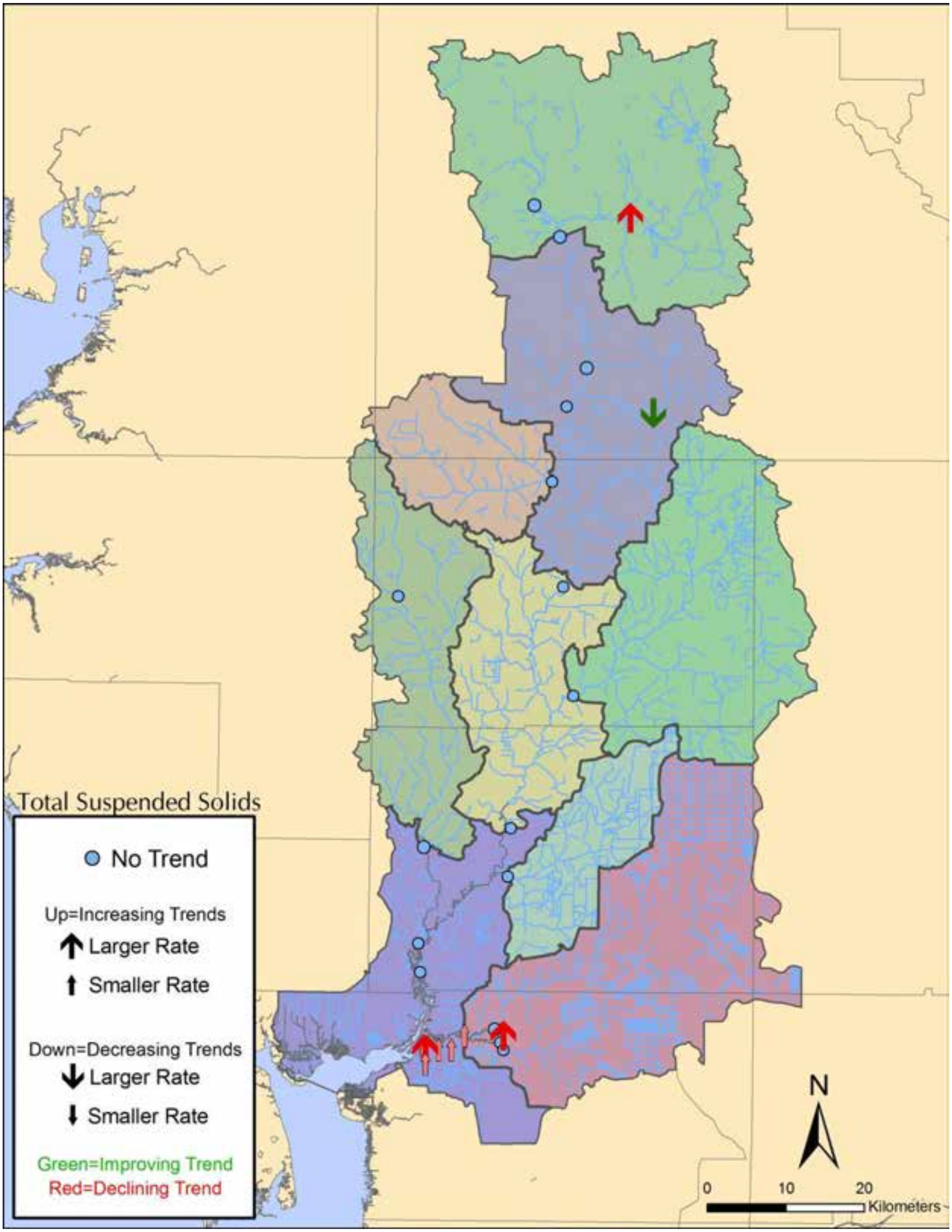
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers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Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

Trend Summary for CHNEP Basin - Coastal Lower Peace
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Chlorophyll a Corrected (ug/L)	Surface	1	0	0	0	0
Chlorophyll a Uncorrected (ug/L)	Bottom	0	0	0	0	4
	Surface	1	1	1	0	13
Chloride (mg/L)	Bottom	0	0	0	1	3
	Surface	0	0	0	2	5
Color (PCU)	Bottom	0	0	0	0	4
	Surface	0	0	0	0	17
Conductivity (uS/cm)	Bottom	0	0	0	3	25
	Surface	0	0	0	4	34
Dissolved Oxygen (mg/L)	Bottom	0	3	0	0	25
	Surface	0	6	0	3	32
Dissolved Silica (mg/L)	Bottom	0	0	0	0	4
	Surface	0	0	0	6	3
Fecal Coliform	Surface	1	0	1	0	2
Kd (1/m)	Bottom	0	0	0	0	15
	Surface	0	0	0	0	15
Total Kjeldahl Nitrogen (mg/L)	Bottom	0	0	0	0	4
	Surface	0	7	0	0	10
NH3 Ammonia (mg/L)	Bottom	0	0	4	0	0
	Surface	0	0	3	0	9
Nitrate+Nitrate as Nitrogen (mg/L)	Bottom	2	0	0	0	2
	Surface	2	1	0	0	14
PH (SU)	Bottom	0	0	0	20	8
	Surface	0	1	0	15	26
Salinity (ppt)	Bottom	0	0	0	9	19
	Surface	0	0	1	10	30
Secchi Disk (m)	Surface	0	0	0	0	10
Total Orthophosphate (mg/L)	Bottom	0	1	0	0	3
	Surface	0	1	0	0	8
Temperature (C)	Bottom	0	0	0	0	28
	Surface	0	0	0	0	42
Total Nitrogen (mg/L)	Bottom	0	0	0	0	4
	Surface	0	7	0	0	10

(Continued)

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Total Phosphorus (mg/L)	Bottom	0	1	0	0	3
	Surface	1	1	1	0	12

Trend Summary for CHNEP Basin - Horse Creek
Data From Fixed Stations

		Trend Results		
		Decreasing	Increasing	Stable
		(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level			
Calcium (mg/L)	Surface	0	0	2
Chlorophyll a Corrected (ug/L)	Surface	0	0	2
Chlorophyll a Uncorrected (ug/L)	Surface	0	0	2
Chloride (mg/L)	Surface	0	0	2
Color (PCU)	Surface	0	0	2
Conductivity (uS/cm)	Surface	0	1	1
Dissolved Oxygen (mg/L)	Surface	0	0	2
Fluoride (mg/l)	Surface	0	0	2
NH3 Ammonia (mg/L)	Surface	0	0	2
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	1	0	1
Nitrite (mg/L)	Surface	0	0	2
PH (SU)	Surface	0	0	2
Salinity (ppt)	Surface	0	0	2
Secchi Disk (m)	Surface	0	0	2
Total Organic Carbon (mg/L)	Surface	0	0	2
Temperature (C)	Surface	0	0	2
Total Nitrogen (mg/L)	Surface	0	0	2
Total Phosphorus (mg/L)	Surface	0	0	2

Trend Summary for CHNEP Basin - Joshua Creek
Data From Fixed Stations

		Trend Results			
		Decreasing		Increasing	Stable
		(>10%/Year)	(<=10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level				
Calcium (mg/L)	Surface	0	0	0	1
Chlorophyll a Corrected (ug/L)	Surface	0	0	0	1
Chlorophyll a Uncorrected (ug/L)	Surface	0	0	0	1
Chloride (mg/L)	Surface	0	0	0	1
Color (PCU)	Surface	0	0	0	1
Conductivity (uS/cm)	Surface	0	0	1	1
Dissolved Oxygen (mg/L)	Surface	0	0	0	1
Fluoride (mg/l)	Surface	0	0	0	1
NH3 Ammonia (mg/L)	Surface	0	0	0	1
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	0	1	0	0
Nitrite (mg/L)	Surface	0	0	0	1
PH (SU)	Surface	0	0	0	2
Salinity (ppt)	Surface	0	0	0	1
Secchi Disk (m)	Surface	1	0	0	0
Total Organic Carbon (mg/L)	Surface	0	0	0	1
Temperature (C)	Surface	0	0	0	3
Total Nitrogen (mg/L)	Surface	0	1	0	0
Total Phosphorus (mg/L)	Surface	0	0	1	0

Trend Summary for CHNEP Basin - Peace at Arcadia
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Ammonium Unionized (mg/L)	Surface	0	0	0	0	2
Calcium (mg/L)	Surface	0	0	0	0	3
Chlorophyll a Corrected (ug/L)	Surface	0	0	1	0	2
Chlorophyll a Uncorrected (ug/L)	Surface	0	0	1	0	0
Chloride (mg/L)	Surface	0	0	0	0	3
Color (PCU)	Surface	0	0	0	0	3
Conductivity (uS/cm)	Surface	0	0	0	0	3
Dissolved Oxygen (mg/L)	Surface	0	0	0	0	3
Enterococci (cfu)	Surface	0	0	0	0	2
Fecal Coliform	Surface	0	0	0	1	1
Fluoride (mg/l)	Surface	0	0	0	0	3
Total Kjeldahl Nitrogen (mg/L)	Surface	0	0	0	0	2
NH3 Ammonia (mg/L)	Surface	0	0	0	1	2
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	0	0	0	0	3
Nitrite (mg/L)	Surface	0	0	0	0	1
PH (SU)	Surface	0	1	0	0	2
Salinity (ppt)	Surface	0	0	0	0	1
Secchi Disk (m)	Surface	1	0	0	0	2
Total Organic Carbon (mg/L)	Surface	0	0	0	0	3
Temperature (C)	Surface	0	0	0	0	3
Total Nitrogen (mg/L)	Surface	0	0	0	0	3
Total Phosphorus (mg/L)	Surface	0	0	0	3	0

Trend Summary for CHNEP Basin - Peace at Bartow
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Calcium (mg/L)	Surface	0	0	0	0	3
Chlorophyll a Corrected (ug/L)	Surface	0	0	1	0	3
Chlorophyll a Uncorrected (ug/L)	Surface	0	3	0	0	21
Chloride (mg/L)	Surface	0	0	0	0	3
Color (PCU)	Surface	0	0	0	0	3
Conductivity (uS/cm)	Bottom	0	0	0	0	2
	Surface	0	0	0	2	21
Dissolved Oxygen (mg/L)	Bottom	0	0	0	0	2
	Surface	0	0	0	2	20
Fecal Coliform	Surface	0	0	0	0	2
Fluoride (mg/l)	Surface	0	0	0	0	3
NH3 Ammonia (mg/L)	Surface	0	0	0	0	3
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	0	0	0	0	3
Nitrite (mg/L)	Surface	0	0	0	0	3
PH (SU)	Bottom	0	0	0	0	2
	Surface	0	0	0	0	23
Salinity (ppt)	Surface	0	1	0	0	2
Secchi Disk (m)	Bottom	0	0	0	0	1
	Surface	1	1	1	1	45
Total Organic Carbon (mg/L)	Surface	0	0	0	0	3
Temperature (C)	Bottom	0	0	0	0	2
	Surface	0	0	0	2	21
Total Nitrogen (mg/L)	Surface	1	8	2	2	36
Total Phosphorus (mg/L)	Surface	8	7	0	6	26

Trend Summary for CHNEP Basin - Peace at Zolpho Springs
Data From Fixed Stations

		Trend Results			
		Decreasing	Increasing		Stable
		(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level				
Ammonium Unionized (mg/L)	Surface	0	0	0	1
Calcium (mg/L)	Surface	0	0	0	4
Chlorophyll a Corrected (ug/L)	Surface	0	1	0	3
Chlorophyll a Uncorrected (ug/L)	Surface	0	1	12	8
Chloride (mg/L)	Surface	0	0	0	4
Color (PCU)	Surface	0	0	1	3
Conductivity (uS/cm)	Surface	0	0	1	4
Dissolved Oxygen (mg/L)	Surface	1	0	0	4
Fluoride (mg/l)	Surface	0	0	0	4
NH3 Ammonia (mg/L)	Surface	1	0	0	4
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	1	1	0	3
Nitrite (mg/L)	Surface	1	1	0	3
PH (SU)	Surface	0	0	3	2
Salinity (ppt)	Surface	0	0	0	2
Secchi Disk (m)	Surface	15	0	0	6
Total Organic Carbon (mg/L)	Surface	0	0	0	4
Temperature (C)	Surface	0	0	2	3
Total Nitrogen (mg/L)	Surface	0	0	16	7
Total Phosphorus (mg/L)	Surface	0	1	4	18

5.3 Southern Coast Region

5.3.1 Charlotte Harbor Proper

The Charlotte Harbor Proper basin and the mainstem of the Harbor are the geographic focus of Charlotte Harbor Estuary Program (Figures 6-1 and 6-4) and the embayment into which two of the three major rivers (Peace River and Myakka River) in the study area flow. The harbor is a relatively shallow, sandy, 270 square mile estuary that exchanges water with the Gulf through Boca Grande Pass. The shorelines support a mix of natural mangroves and developed urban areas. The land use for the Charlotte Harbor Proper basin was reported as primarily upland forests (14%), wetlands (14%), saltwater wetlands (8%), and rural pasturelands (4%). The Charlotte Harbor Proper basin includes both fixed station data as well as monthly probabilistic water quality data collected as part of the Coastal Charlotte Harbor Monitoring Network (CCHMN).

Water Quality Trends

Most parameters had stable trends over time in Charlotte Harbor Proper. There were two improving trends in total nitrogen and three improving trends in total phosphorus within the basin. There were no degrading trends for either parameter in the basin. Chlorophyll, color and dissolved silica were found to be decreasing over time at two fixed stations in the basin. Other than two small increasing trends in biological oxygen demand, there were only single station increasing trends for suspended solids, and ammonia.

The Charlotte Harbor Proper basin includes the CCHMN strata of East Wall, West Wall, Cape Haze and Bokeelia. Results of trend analysis using these data suggested that in East and West Wall, total nitrogen, total kjeldahl nitrogen, NO23 and the light attenuation coefficient Kd were improving over time. In East Wall total phosphorus and total organic carbon were also improving. The only increasing trend was for pH in East Wall. All other parameters were stable over the period of record. Trend results for Cape Haze and Bokeelia, the two strata closer to the Boca Grande inlet, were less consistent with only total phosphorus in agreement with consistently improving trends in both segments. However, increasing ammonia, chlorophyll a, and turbidity concentrations were found in Cape Haze while these trends were stable in Bokeelia. Conversely, biological oxygen demand, conductivity, total organic carbon and total suspended solids were increasing in Bokeelia but not in Cape Haze.

5.3.2 Tidal Caloosahatchee River

The tidal portion of the Caloosahatchee River downstream of the Franklin Lock and Dam water control structure, excluding the Orange River and Telegraph Swamp basins, is defined as the Tidal Caloosahatchee River basin for the CHNEP (Figure 6-5). The tidal portion of the river mainstem is completely encompassed by this basin, as the Franklin Lock maintains a freshwater river system upstream of the control structure. The Tidal

Caloosahatchee River Basin is very urbanized. Land uses were reported to be primarily single-family residential (18%), medium density residential (13%), multifamily residential (2%), rangelands (6%), pasture (25%), upland forests (11%), and freshwater wetlands (14%).

Water Quality Trends

This basin has perhaps the largest number of fixed station locations of any CHNEP basin. Over 60 individual stations qualified for trend tests including data collected by Cape Coral, Lee County, the South Florida Water Management District, the Charlotte Harbor Volunteer Monitoring Network, and the Coastal Charlotte Harbor Monitoring Network.

There was a relatively large number (18 of 60) station in the basin with decreasing chlorophyll a concentrations over the period of record and no increasing trends in chlorophyll at any fixed station. This result is somewhat perplexing given the results of trend tests for total nitrogen and total phosphorus (and their constituents which were widely reported to be increasing throughout the basin including many trends with a relatively large magnitude rate of change. Several decreasing trends in temperature, total suspended solids, and color were observed which may partly explain the reduced chlorophyll a concentrations in spite of the increased nutrient trends. Salinity was principally stable throughout the basin though there were 8 increasing trends in conductivity. This basin is one of the few that has sufficient data on metal for trend testing and 7 of the 41 stations with data available showed increasing trends in copper concentration and no decreasing trends. Lead concentrations were mostly stable over time though one increasing and one decreasing trend was observed.

Results from CCHMN sampling in the Tidal Caloosahatchee resulted in only decreasing trends indicating improving conditions for chlorophyll a, nitrate, and NO23 concentrations but degrading dissolved oxygen concentrations over the period of record (2003-2011).

5.3.3 Telegraph Swamp

Telegraph swamp is a small basin northeast of the Tidal Caloosahatchee above the Franklin Lock. There is limited data available from this basin with few water quality stations located within the boundary as defined by CHNEP. Land use is primarily upland forests (24%), mixed wetlands (15%), pastureland (12%) and freshwater wetlands (5%).

Water Quality Trends

Of the five stations with sufficient data for trend testing, total nitrogen and total kjeldahl nitrogen were observed to be significantly increasing at 2 and 3 stations respectively. Chlorophyll concentrations were found to be decreasing at three stations while conductivity was found to be increasing at a single station. There was also a single station with increasing total phosphorus concentrations in Telegraph Swamp.

5.3.4 Orange River

The Orange River is a major tributary to the Caloosahatchee River, and it has its confluence with the Caloosahatchee downstream of the Franklin Lock in an estuarine, tidal portion of the river (Figure 6-5). The Orange River Basin is relatively developed with urban land uses, and it was reported to have land uses of primarily single-family residential (33%), medium density residential (2%), and high density residential (5%). Other important land uses were reported to include rangeland (31%), pasture (11%), and upland forests (9%). Interestingly, despite the basin name, less than 1% of the basin area is currently developed as citrus groves.

Water Quality Trends

Trend test results for Orange River were similar to that of the Tidal Caloosahatchee with respect to a relatively large number on increasing total nitrogen trends, but declining chlorophyll a concentrations. However, total phosphorus concentrations were found to be significantly improving at many (9 of 15) stations in the basin.

The Orange River basin also contained some data on metals and results suggest that copper, and chromium were increasing at several stations in the basin while lead was decreasing at two of the 11 stations with sufficient data. There were no increasing lead concentrations in the basin.

5.3.5 Matlacha Pass

Matlacha Pass is a narrow estuarine, barrier island-dominated bay located between Pine Island and Cape Coral (Figure 6-4). The pass is characterized by extensive seagrass meadows and relatively moderately developed mangrove shorelines of Pine Island. Significant freshwater and pollutant loading is provided by the Caloosahatchee River to the south and runoff from the Cape Coral peninsula. Land use is primarily saltwater wetlands (16%), urban (13%), upland forests (7%), and residential (5%).

Water Quality Trends

Water quality monitoring was conducted by Cape Coral, Lee County, The Charlotte Harbor Volunteer Monitoring Network, and by Florida International University through 2008 when that program was discontinued. Trends results were very mixed among the generally 21 stations with sufficient data for analysis with no clear patterns exhibited among parameters. For example, there were 6 increasing and 6 decreasing trends in total phosphorus and two decreasing and three increasing trends in total nitrogen. Biological oxygen demand was increasing at 6 of 15 stations. Chlorophyll was decreasing at 6 of 21 stations but increasing at two stations. Dissolved oxygen was decreasing at four stations and increasing at four stations. Total suspended solids exhibited increasing trends at five of eight stations. Other fixed station results were mostly stable over the time period. Data collected from the probabilistic CCHMN design between 2003 and 2011 suggested that total kjeldahl nitrogen, total suspended solids, turbidity, and pH all exhibited small, but statistically significant increasing trends in the estuary over the period of record but chlorophyll and dissolved oxygen concentrations were stable of the same period.

5.3.6 Estero Bay Trends

Estero Bay is an important regional estuary, which the State of Florida has designated as an "Outstanding Florida Water" (OFW) (Figure 6-5) and was Florida's first designated Aquatic Preserve 40 years ago. Over 300 square miles of watershed discharge to 15 square miles of estuarine habitat characterized by seagrass meadows, oyster bars, and sandy substrates. Its proximity to the popular recreational and development area of Fort Myers Beach and Bonita Beach influences both the surface water quality and environmental management decisions related to the surface water quality in the bay.

The land use for the Estero Bay basin was reported to be primarily mixed wetlands (11%), upland forests (12%) pastureland ((8%) and residential (4%).

Several important tributaries discharge into Estero Bay (Named Coastal Estero in the CHNEP Basin coverage). These tributaries include the Estero River, Hendry Creek and Six Mile Canal, Imperial River, and Spring Creek. The water quality for stations in each of these tributaries is discussed separately in the sections following this Estero Bay section of this report.

Water Quality Trends

Water quality monitoring conducted in the Coastal Estero basin includes data collected by Lee County, The Charlotte Harbor Volunteer Monitoring Network, the CCHMN, and Florida International University until that program was discontinued in 2008. There were several parameters associated with the fixed station sample collections with consistently decreasing trends including; total phosphorus (16 of 24 stations), total organic carbon (10 of 18 stations), color (12 of 20 stations, and chlorophyll (5 of 14 stations). Total nitrogen concentrations exhibited decreasing trends at 3 of 24 stations. Despite significant improvements for these parameters there were some degrading trends as evidenced by increasing biological oxygen demand and total suspended solids concentrations (8 of 14 stations each). Otherwise, trends were mostly stable throughout the basin.

Data collected from the CCHMN between 2003 and 2001 suggested that trends in basin wide averages generally supported findings from the fixed station results with decreasing trends in total nitrogen, total phosphorus, and color and increasing trends in total suspended solids and biological oxygen demand. However, a small degrading trend in dissolved oxygen resulted from trend tests on the probabilistic data.

5.3.7 Estero River

The Estero River system connects with Estero Bay near the point where Estero Bay is widest with respect to the barrier island system. Land use is primarily residential (12%), upland forest (12%), mixed wetlands (8%) and pastureland (3%).

Water Quality Trends

Water quality monitoring in the Estero River basin is principally conducted by Lee County using fixed station sampling. Generally 5 stations had sufficient data for trend testing within the basin with a period of record between 1992 and 2011. Total nitrogen concentrations, and the associated constituents that make up total nitrogen were found to be significantly increasing at the majority of these stations. Total phosphorus concentrations were stable at 3 stations, increasing at 1 station and decreasing at one station though dissolved orthophosphate concentrations increased at 3 of 5 stations. Dissolved silica and chloride concentrations increased at 2 of 4 stations. Dissolved oxygen concentrations were mostly stable with one decreasing trend. Copper and lead concentrations were stable at all stations sampled.

5.3.8 Hendry Creek & Six Mile

Hendry Creek discharges to Estero Bay from the northwestern portion of the Estero Bay watershed (Figure 6-5). Land use is primarily saltwater wetlands (15%), residential (11%), upland forests (9%), and mixed wetlands (2%).

Water Quality Trends

Water quality monitoring in the Hendry Creek basin is principally conducted by Lee County using fixed station sampling. Generally 30 stations within the basin had sufficient data for trend testing and though the period of record among these stations was variable, many stations had data dating back to 1990. Total nitrogen trends increased at 13 of 31 stations and no stations had decreasing trends in total nitrogen. The increases in total nitrogen seem principally due to increased concentrations of total kjeldahl nitrogen rather than the associated inorganic forms of nitrogen. Biological oxygen demand also increased at 12 of the 31 stations and dissolved silica increased at 6 stations. Despite these increasing trends in nitrogen and biological oxygen demand, chlorophyll a concentrations improved at 14 of the 31 stations. Total phosphorus also exhibited improving trends at 13 of those 31 stations though there were 4 stations with increasing trends for total phosphorus. Decreased trends in color were also observed at 11 stations within the basin. The remaining parameters had mixed results such as dissolved oxygen which decreased at 6 stations but increased at 5 stations within the basin.

5.3.9 Imperial River

The Imperial River it is a relatively small coastal waterway that discharges to the most southern portion of Estero Bay near the point where Estero Bay has a large degree of surface water exchange with the Gulf of Mexico. The size of the basin significantly increases during the rainy season and expands beyond the CHNEP-defined boundaries. Land use is primarily agriculture (23%), residential (18%), upland forests (16%), and mixed wetlands (5%).

Water Quality Trends

Water quality monitoring in the Imperial River basin is principally conducted by Lee County using fixed station sampling. Generally 7 stations had sufficient data for trend testing within the basin with a period of record either between 1992 and 2011 or beginning in the early 2000's through 2011. Three of 7 stations in the Imperial River exhibited increasing trends in total nitrogen and dissolved silica. Five of 7 stations exhibited increased trends in total kjeldahl nitrogen. Biological oxygen demand increased at 2 of 7 stations while other parameters exhibited stable trends over the period of record of had only a single increasing or decreasing trend.

5.3.10 Spring Creek

Spring Creek is a relatively small coastal waterway that discharges to the most southern portion of Estero Bay near the point where Estero Bay has a large degree of surface water exchange with the Gulf of Mexico (Figure 6-5). Land use is primarily residential (17%), upland forests (12%), agriculture (7%) and mixed wetlands (7%).

Water Quality Trends

Water quality monitoring in the Spring Creek basin is principally conducted by Lee County using fixed station sampling. Generally 7 stations had sufficient data for trend testing within the basin with a period of record either between 1992 and 2011 or beginning in the early 2000's through 2011. Five of the 7 stations in Spring Creek exhibited increasing trends in total nitrogen and total kjeldahl nitrogen. Three of seven station exhibited increasing trends in dissolved silica. Five of 7 stations exhibited increased trends in Biological oxygen demand. However, despite these degrading trends, chlorophyll concentrations decreasing at 4 of 7 stations and total phosphorus also decreased at 3 of 7 stations. Dissolved oxygen decreased at 3 stations, pH decreased at two stations and conductivity increased at 2 stations. Copper increased at 3 of the 7 stations while lead decreased at a single station in the basin. Other parameters including color and temperature were stable over the period of record.

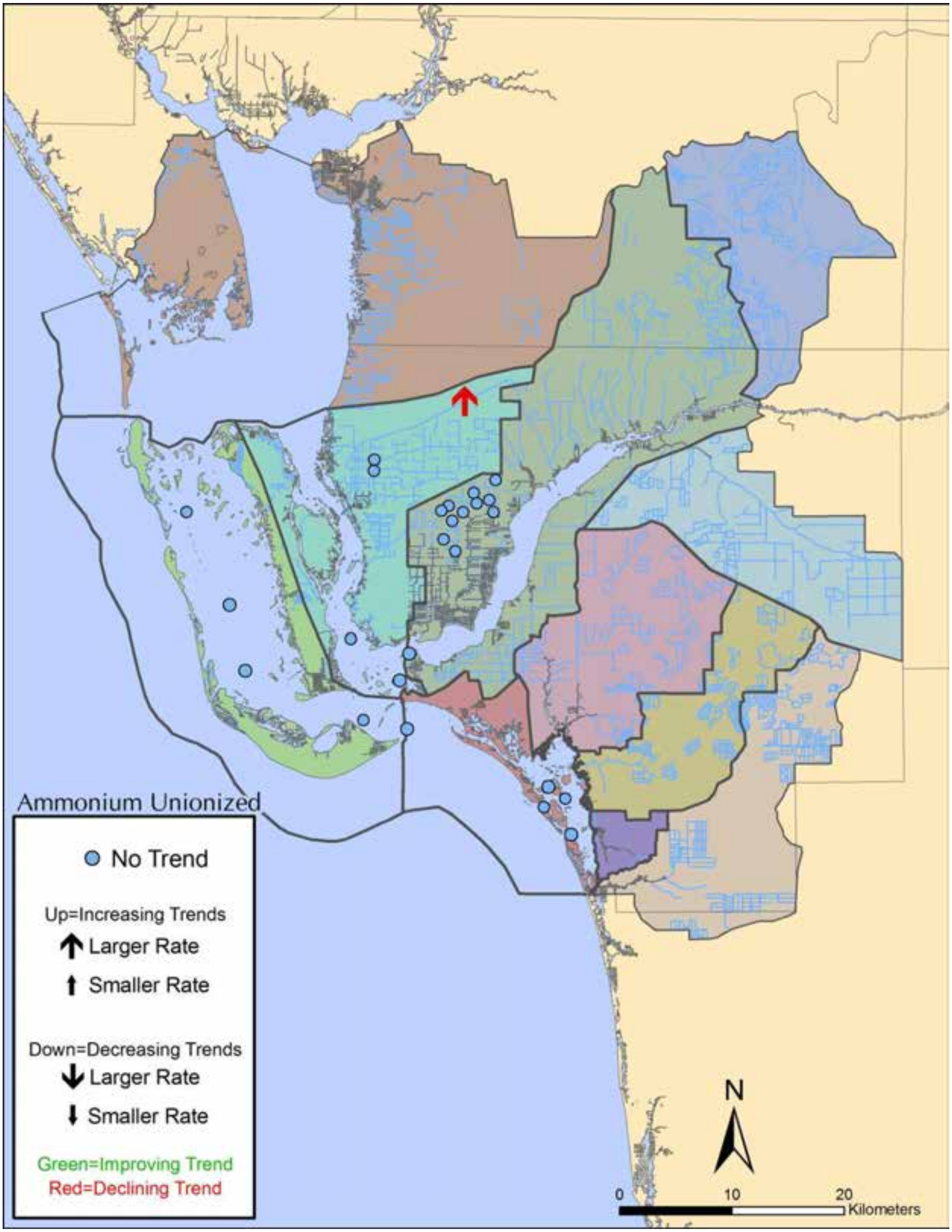
5.3.11 Pine Island Sound

Pine Island Sound is a large estuarine, barrier island-dominated bay located between Pine Island, Cayo Costa, Captiva, and Sanibel Islands (Figure 6-4). The Sound is characterized by extensive seagrass meadows, and relatively moderately developed mangrove shorelines. Significant freshwater and pollutant loading is provided by the Caloosahatchee River to the south and runoff from the Cape Coral peninsula. Land use is primarily saltwater wetlands (14%), residential (5%) and upland forests (2%).

Water Quality Trends

Water quality monitoring in the Pine Island Sound is conducted by Lee County, the Charlotte Harbor Volunteer Water Quality Monitoring Network, the CCHMN and Florida International University though that program ended in 2008. Generally, 17 stations had sufficient data for testing trends. Total nitrogen trends were found to be decreasing at 7 of 17 stations and total phosphorus trends were found to be decreasing at 11 of 17 stations indicating improving conditions for the parameters over the period of record. Chlorophyll concentrations were also improving at 7 of 17 stations and trends in color were significant decreasing at 5 of 13 stations. Dissolved oxygen concentrations increased at 6 of 17 stations. However, biological oxygen demand and total suspended solids increased at 3 of the 5 stations with adequate data for testing. Trends for most other parameters were stale of the period of record or exhibit a single increasing or decreasing trend.

Data from the probabilistic data collected efforts of the CCHMN between 2003 and 2011 generally supported the findings of the fixed station trends with decreasing trends in total nitrogen, total phosphorus, color, chlorophyll and ammonia. Increasing trends in total suspended solids, and turbidity were likewise consistent with the fixed station results. Additionally, a small increasing trend in salinity was noted for Pine Island Sound.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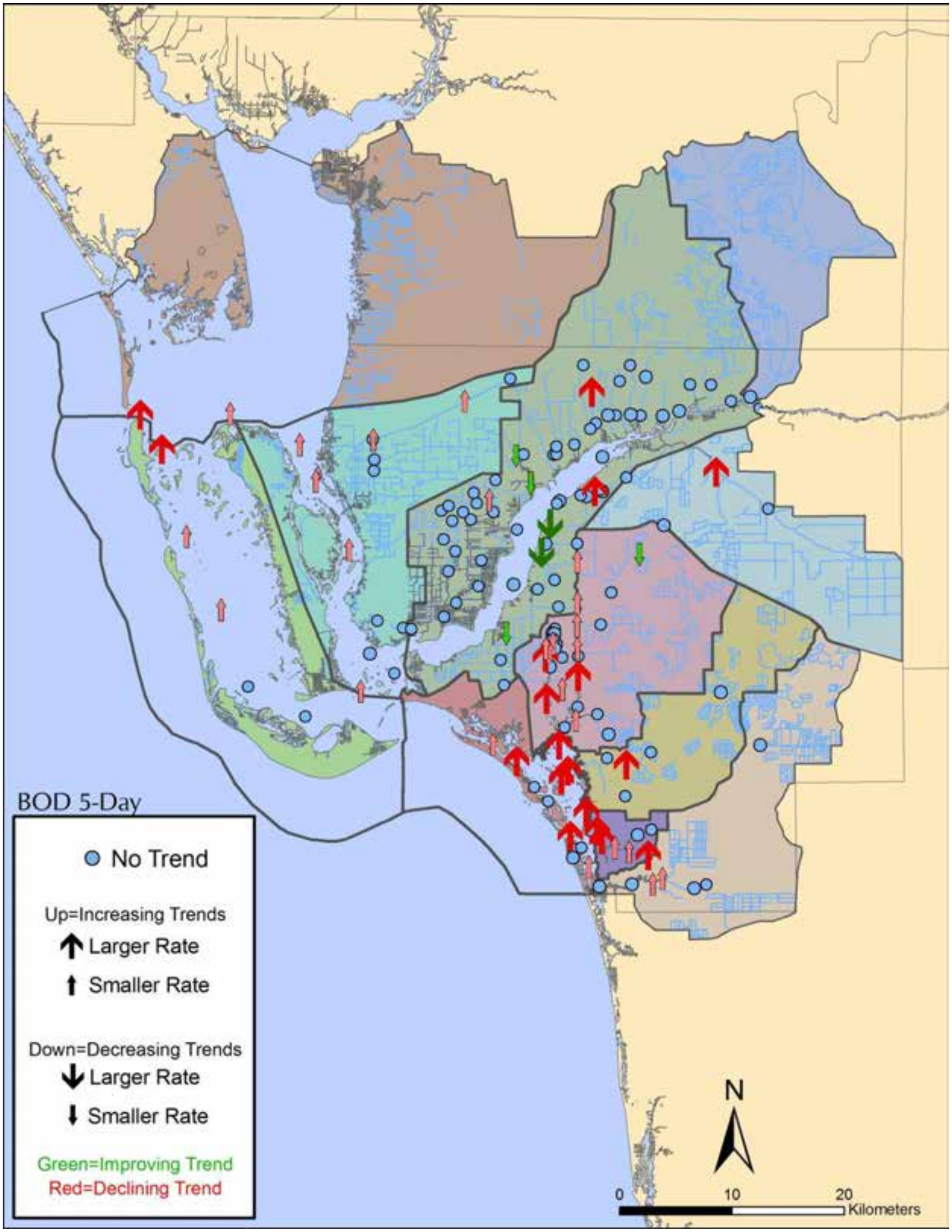
10
20
Kilometers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Smaller Rate
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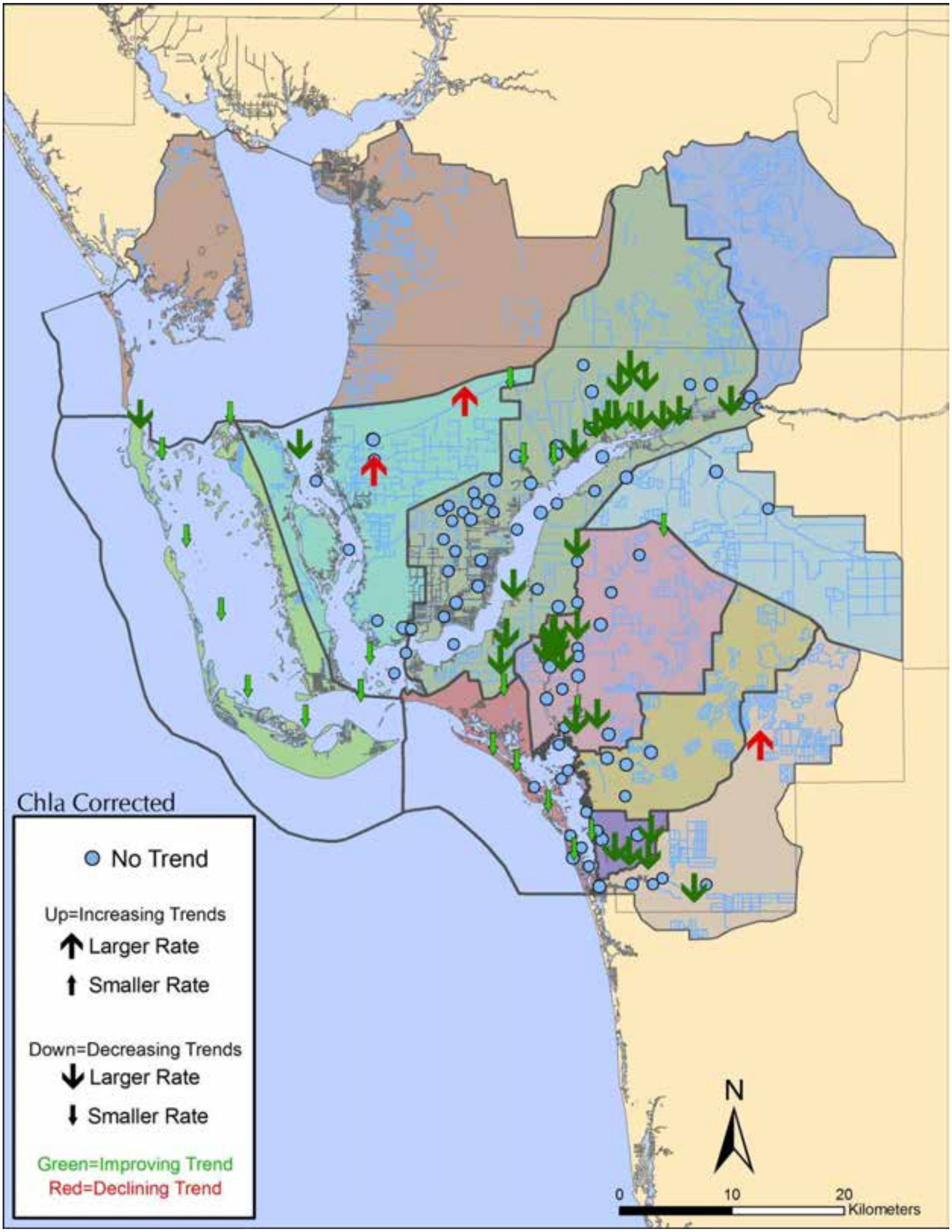
Kilometers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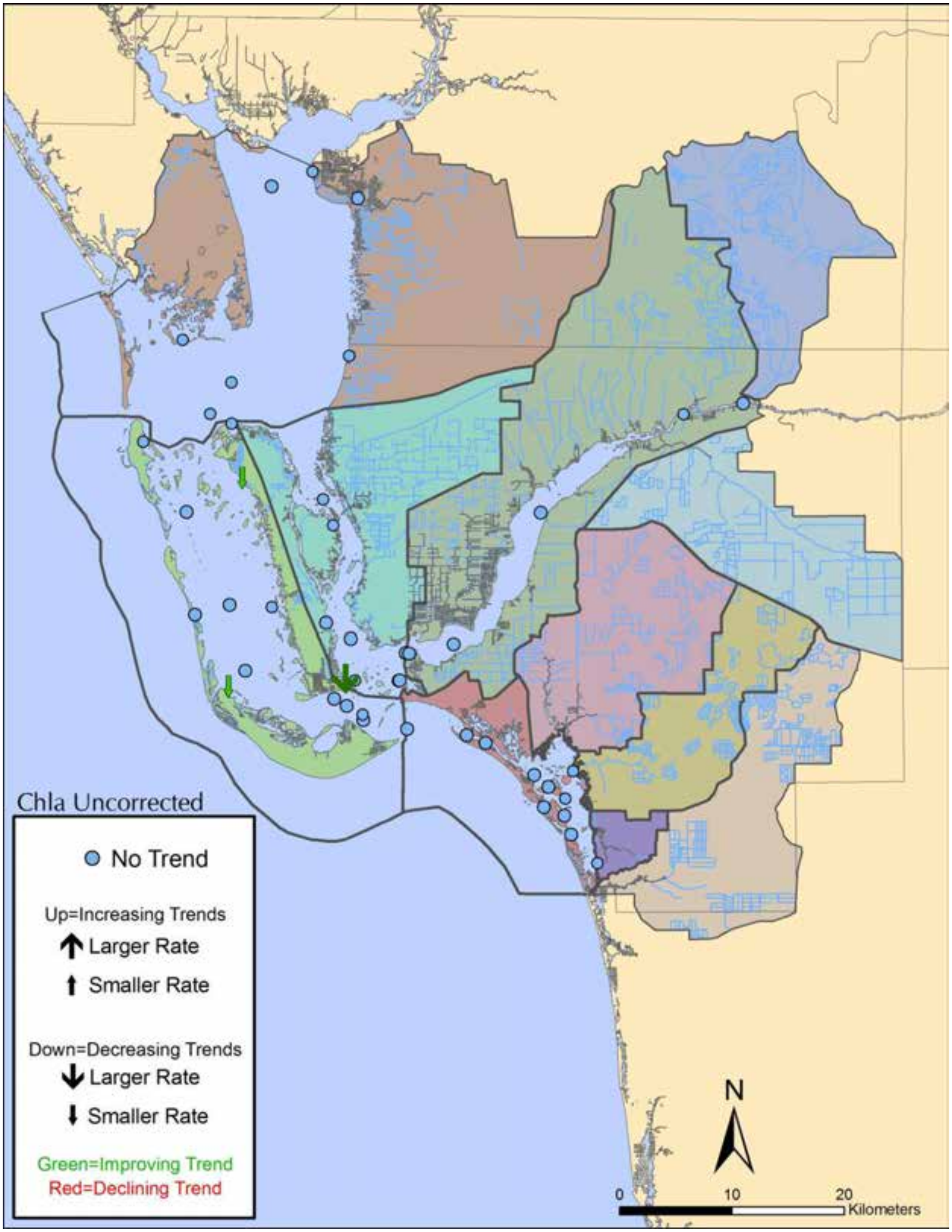
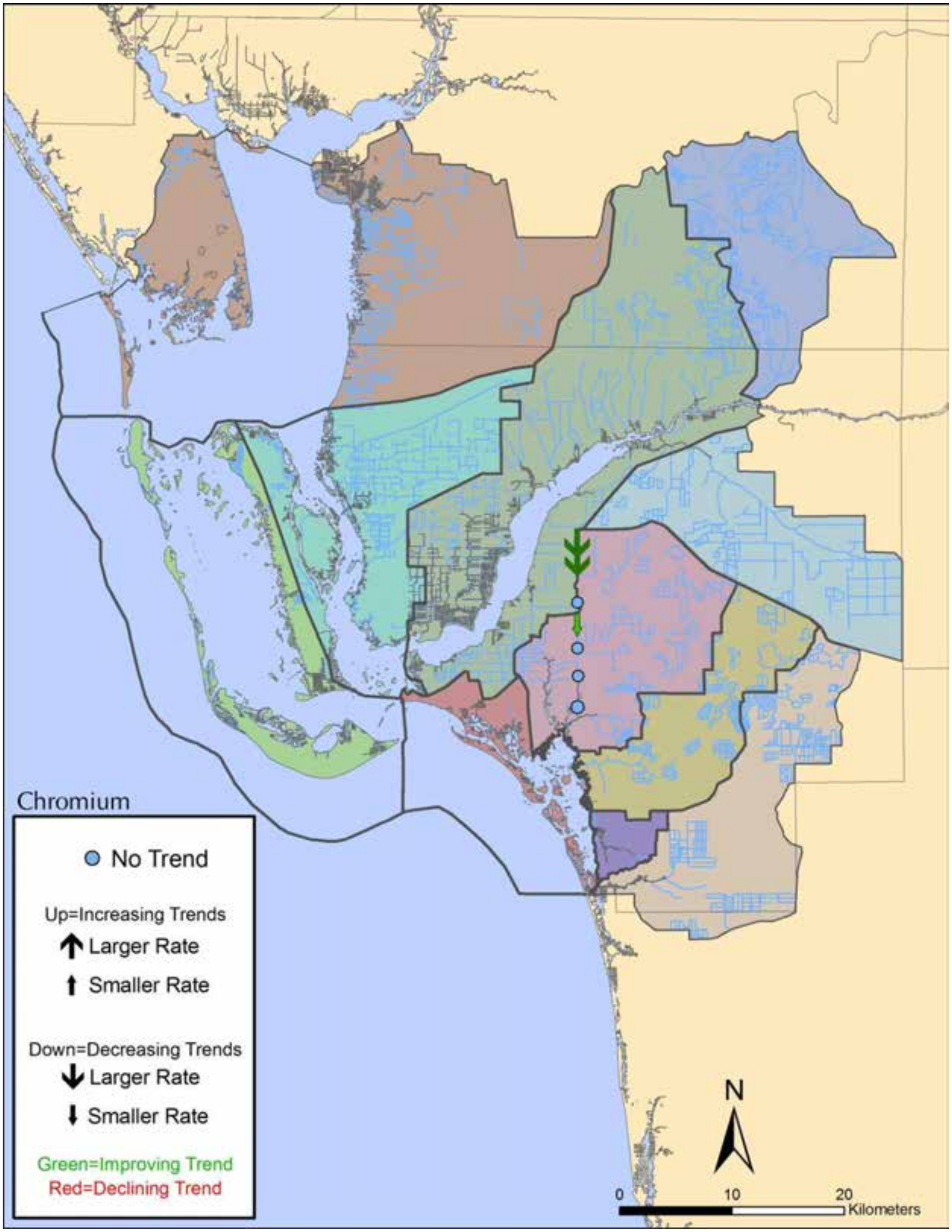
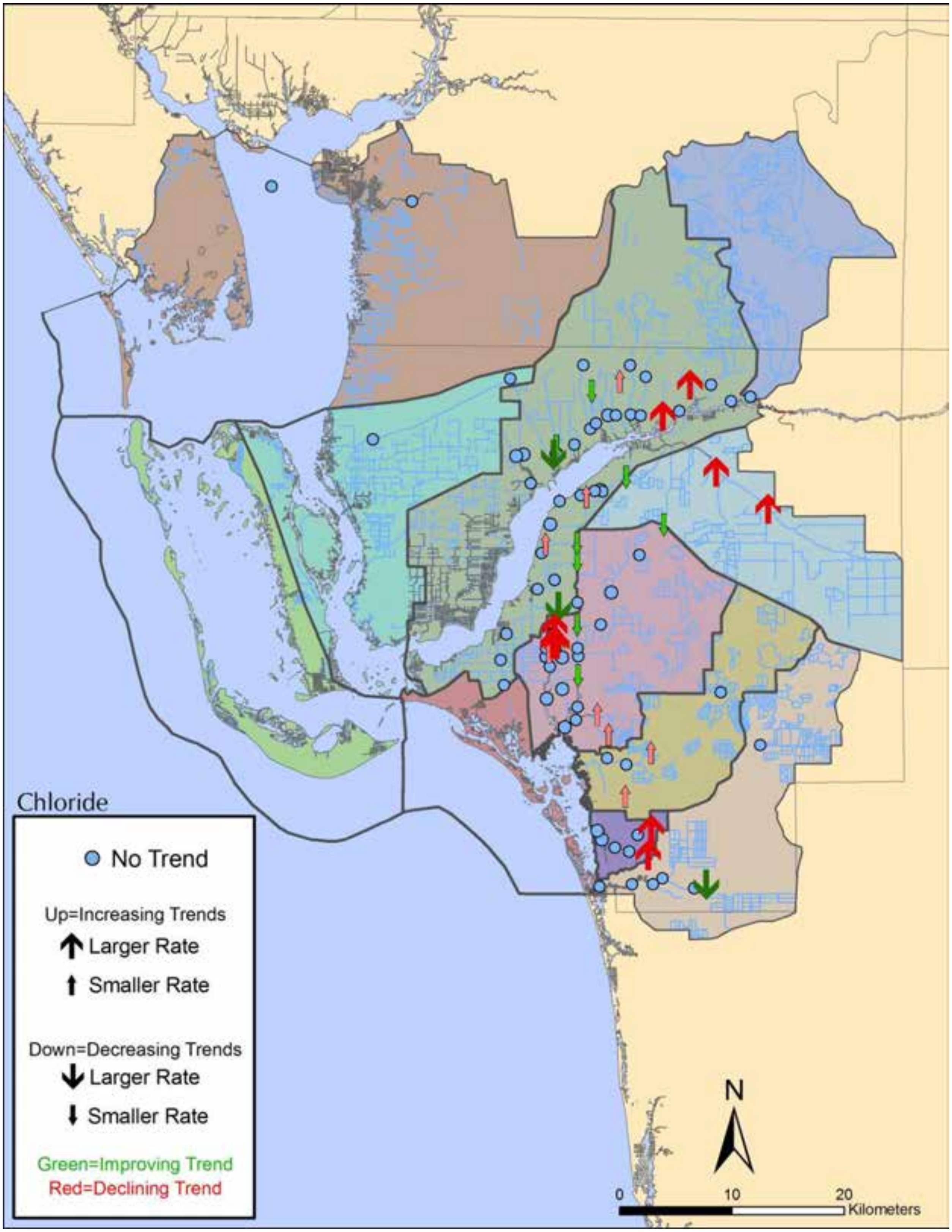
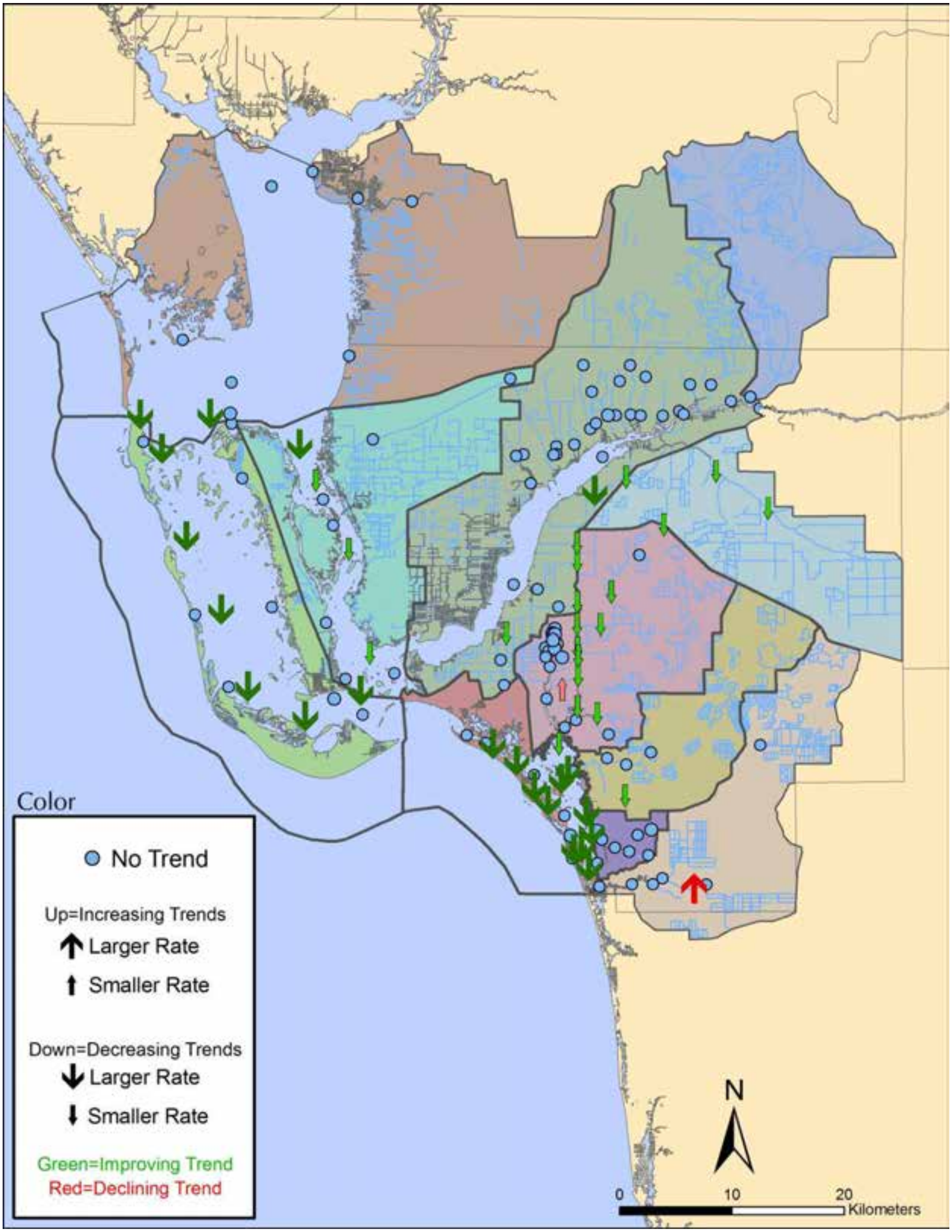
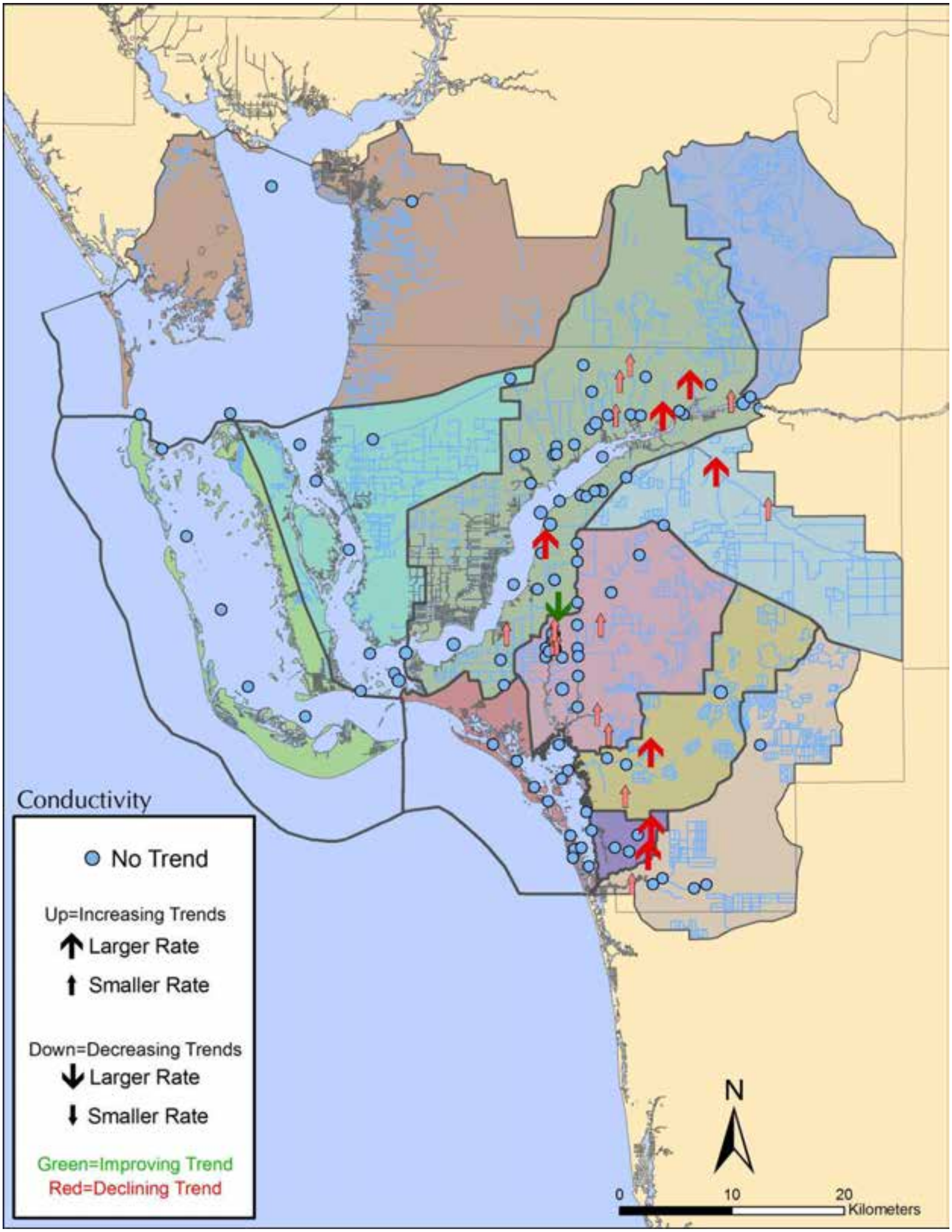
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

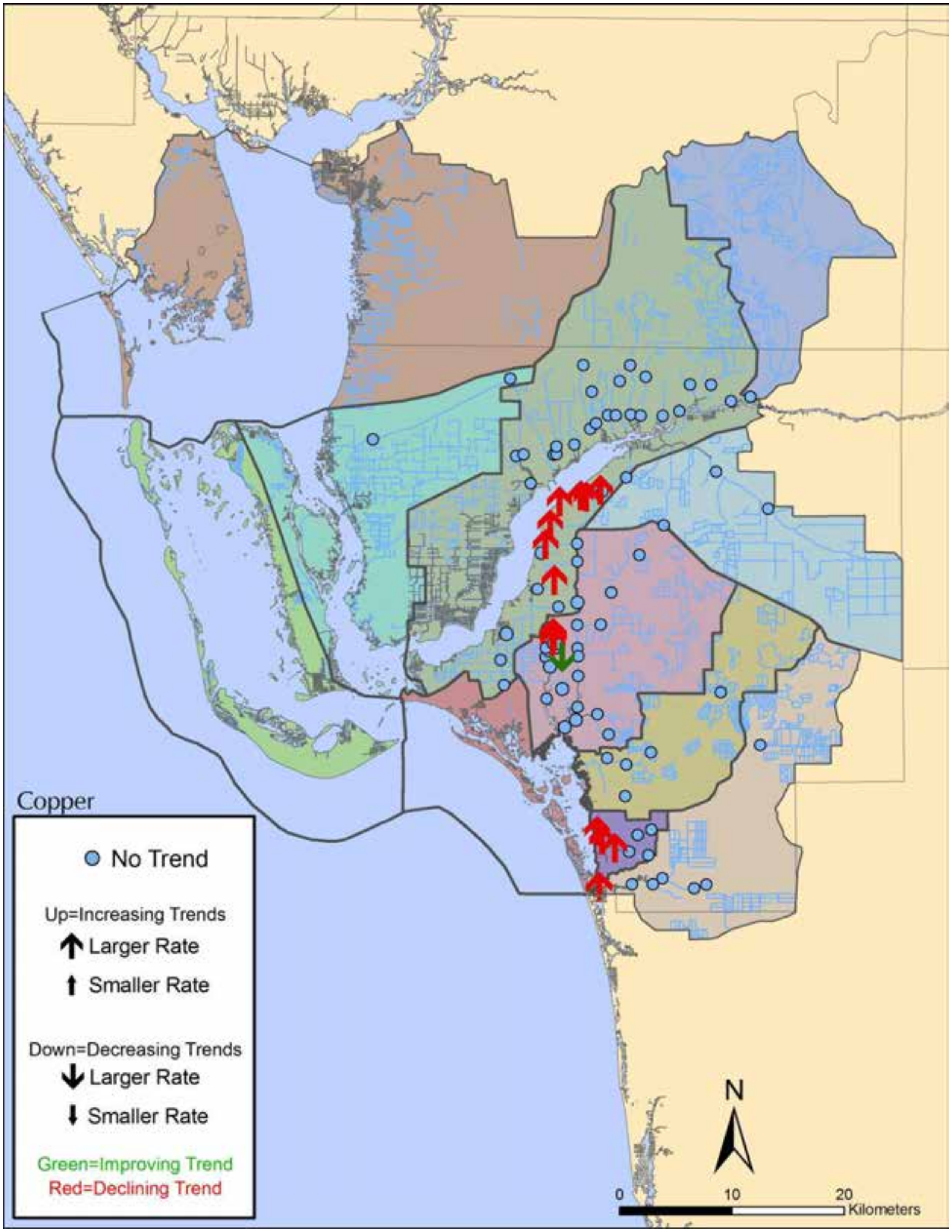

Chla Uncorrected
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

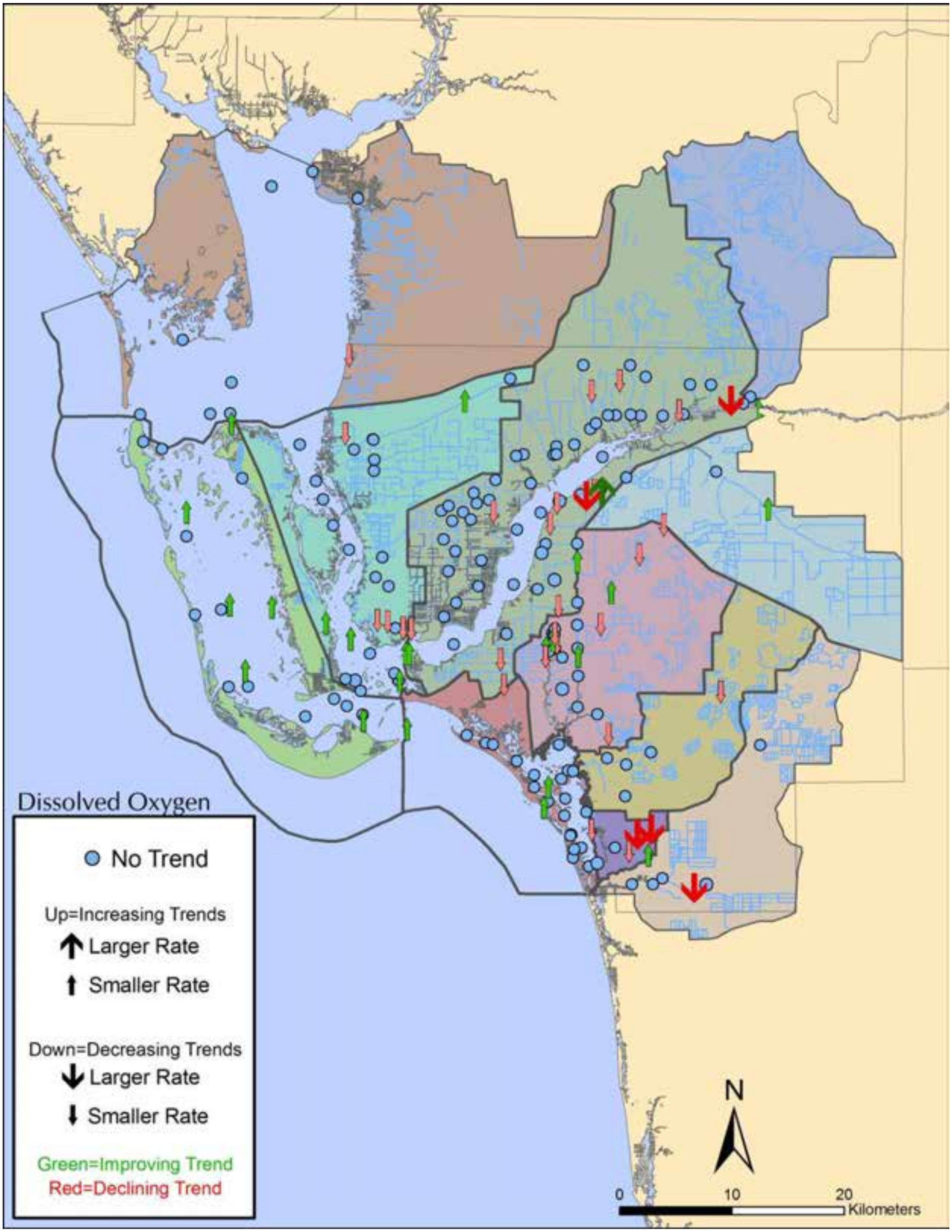

Chromium
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

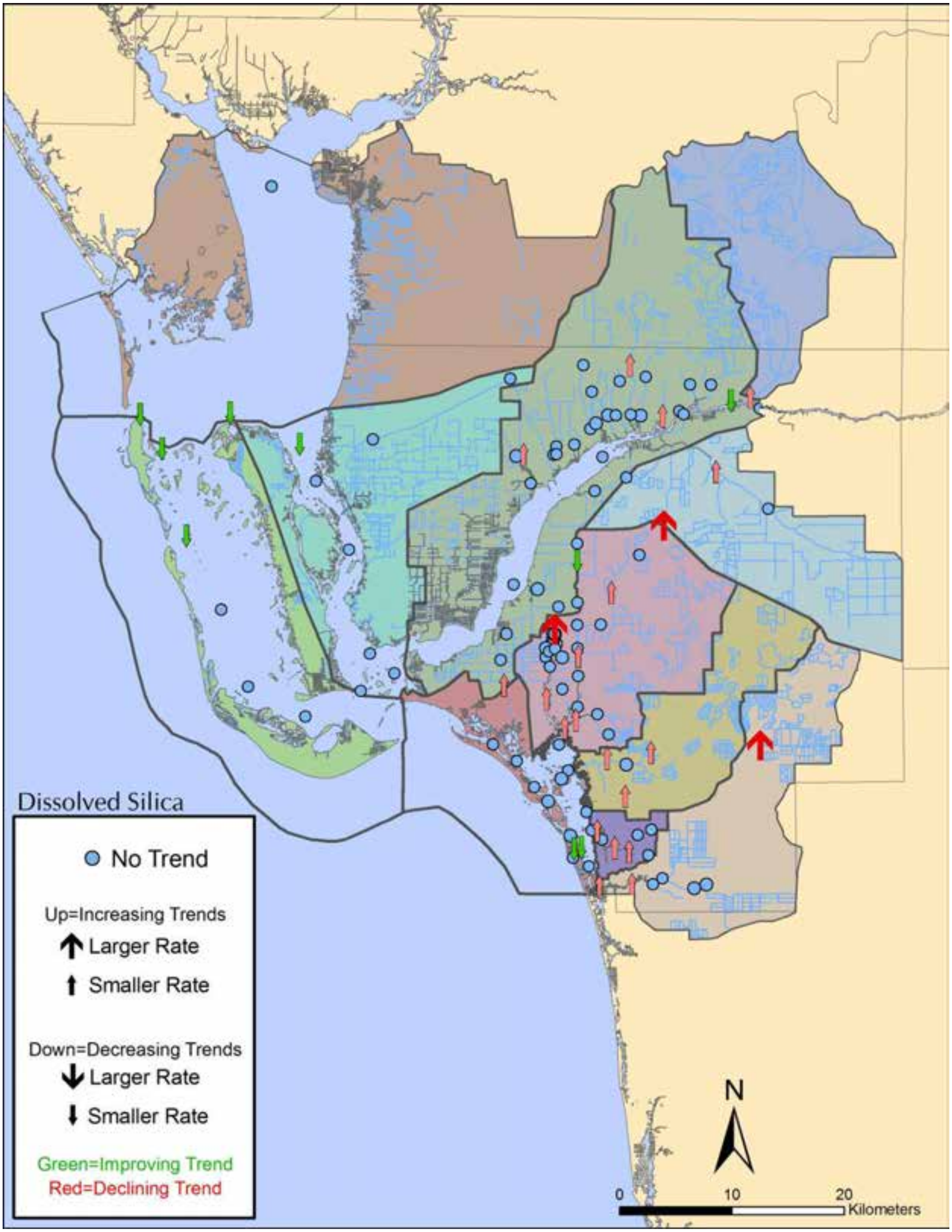

Chloride
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

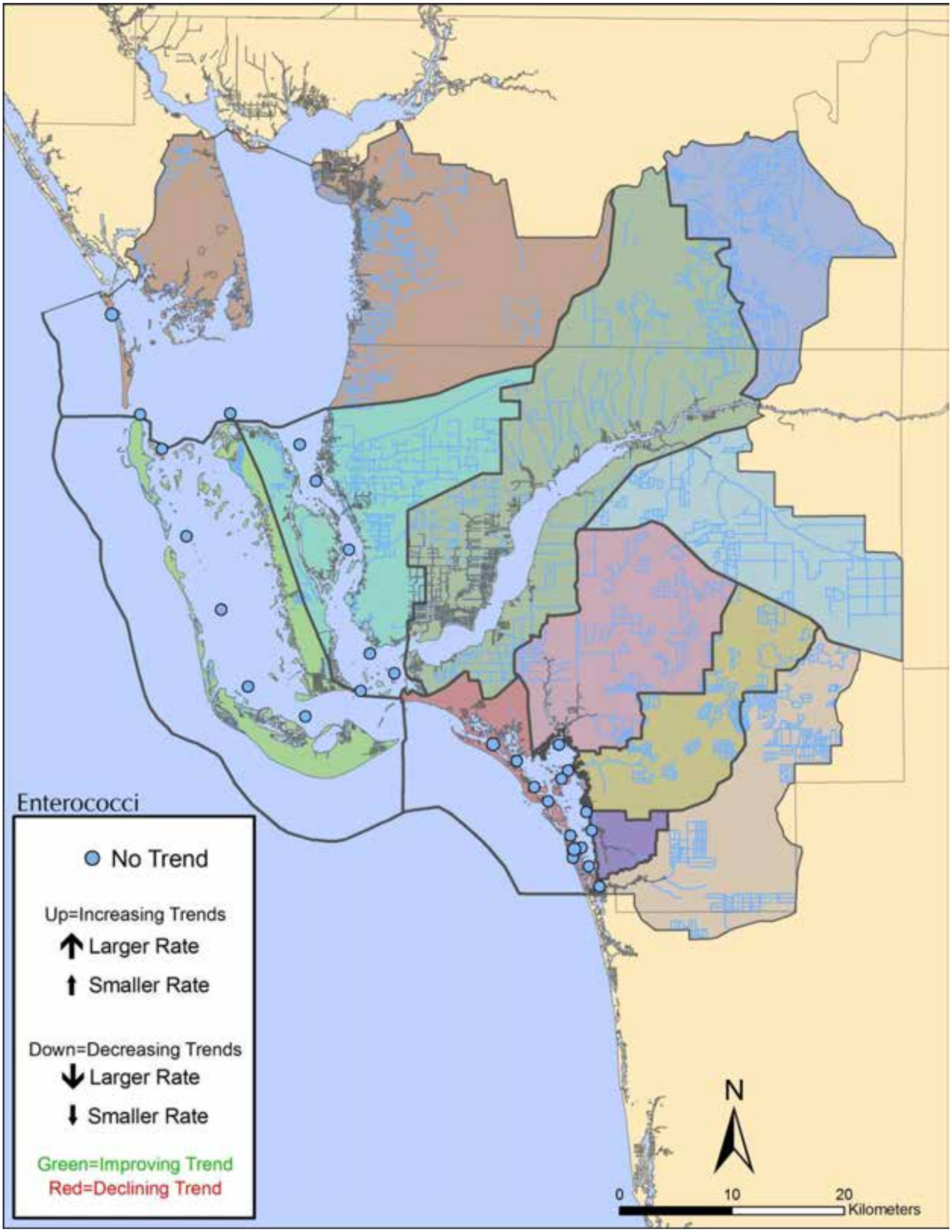

Color
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

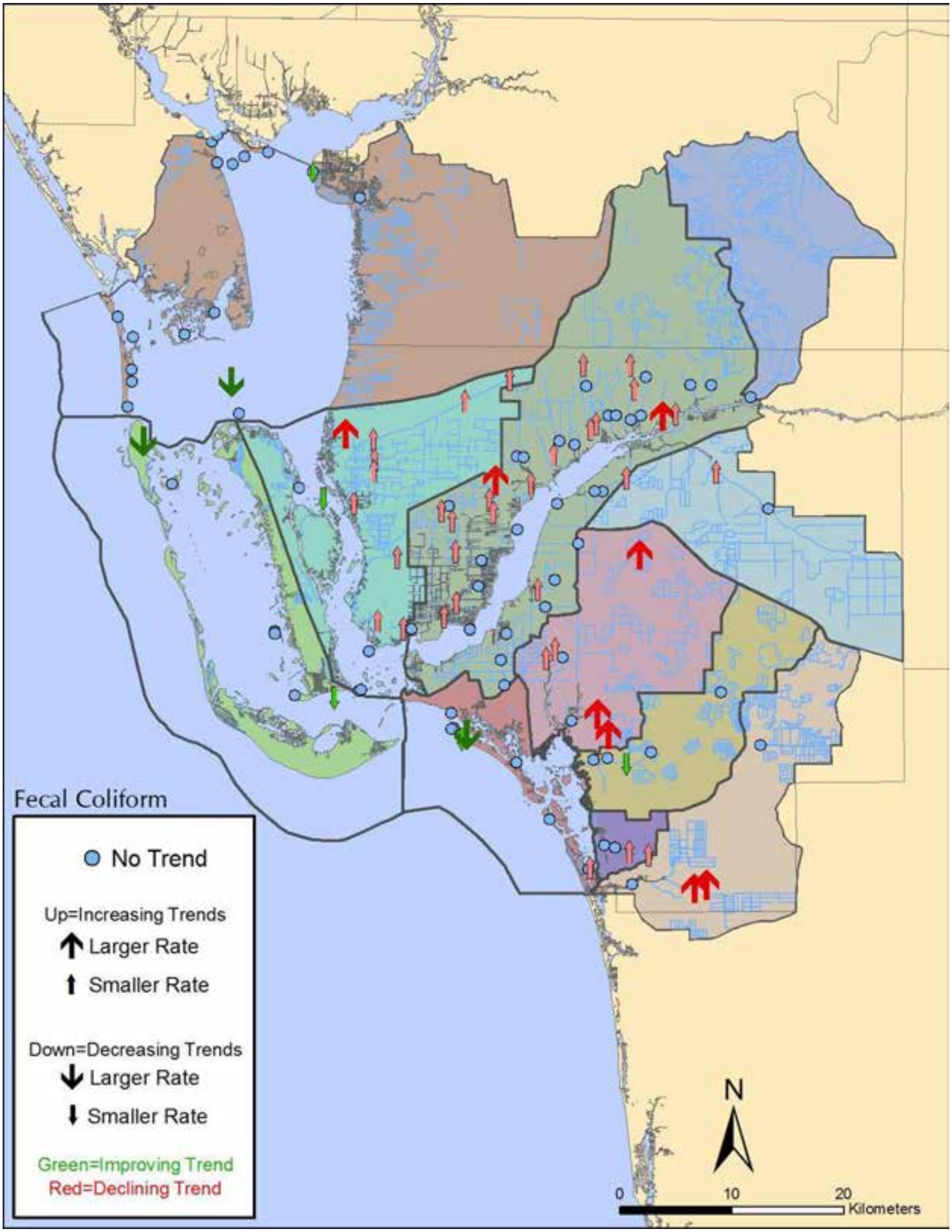

Conductivity
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Copper
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

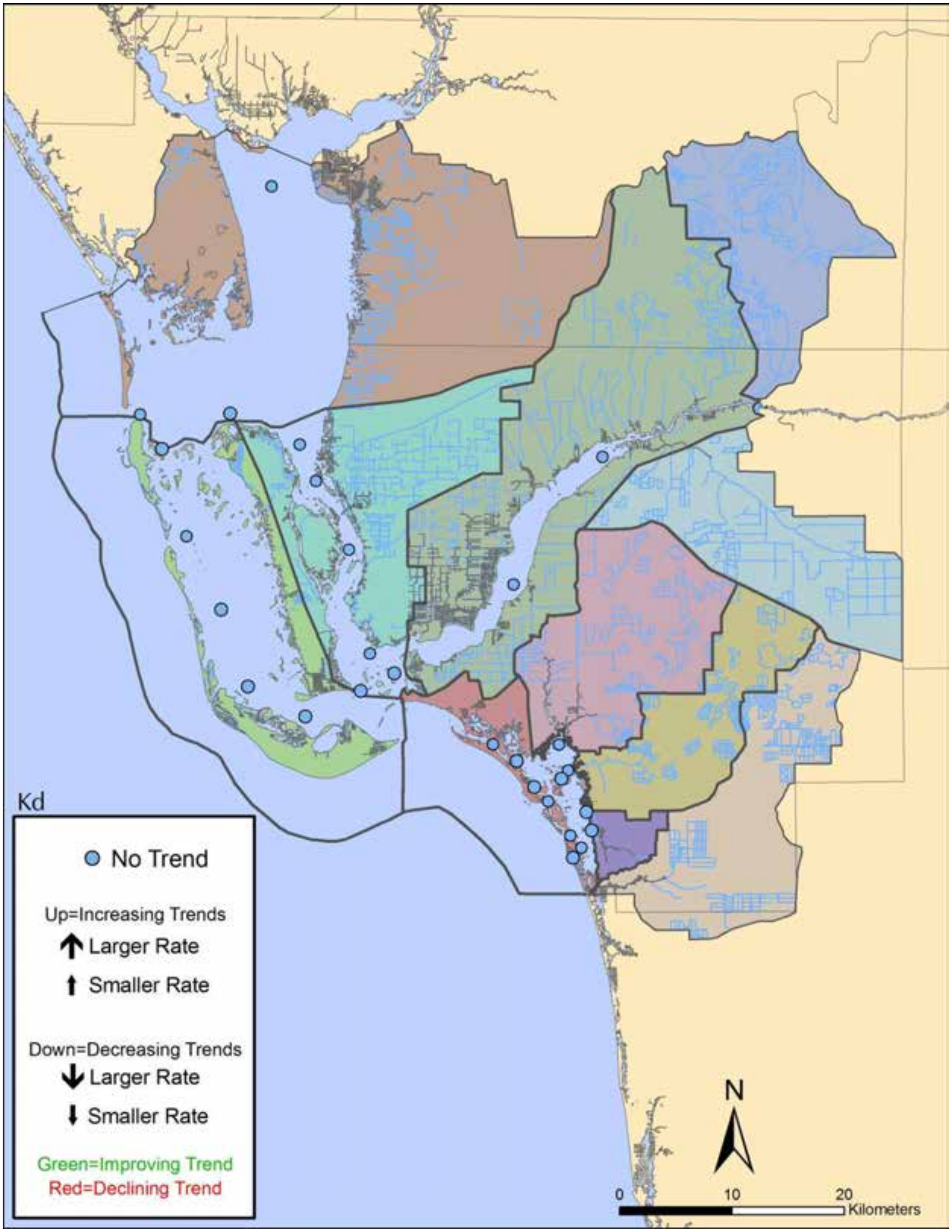

Dissolved Oxygen
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

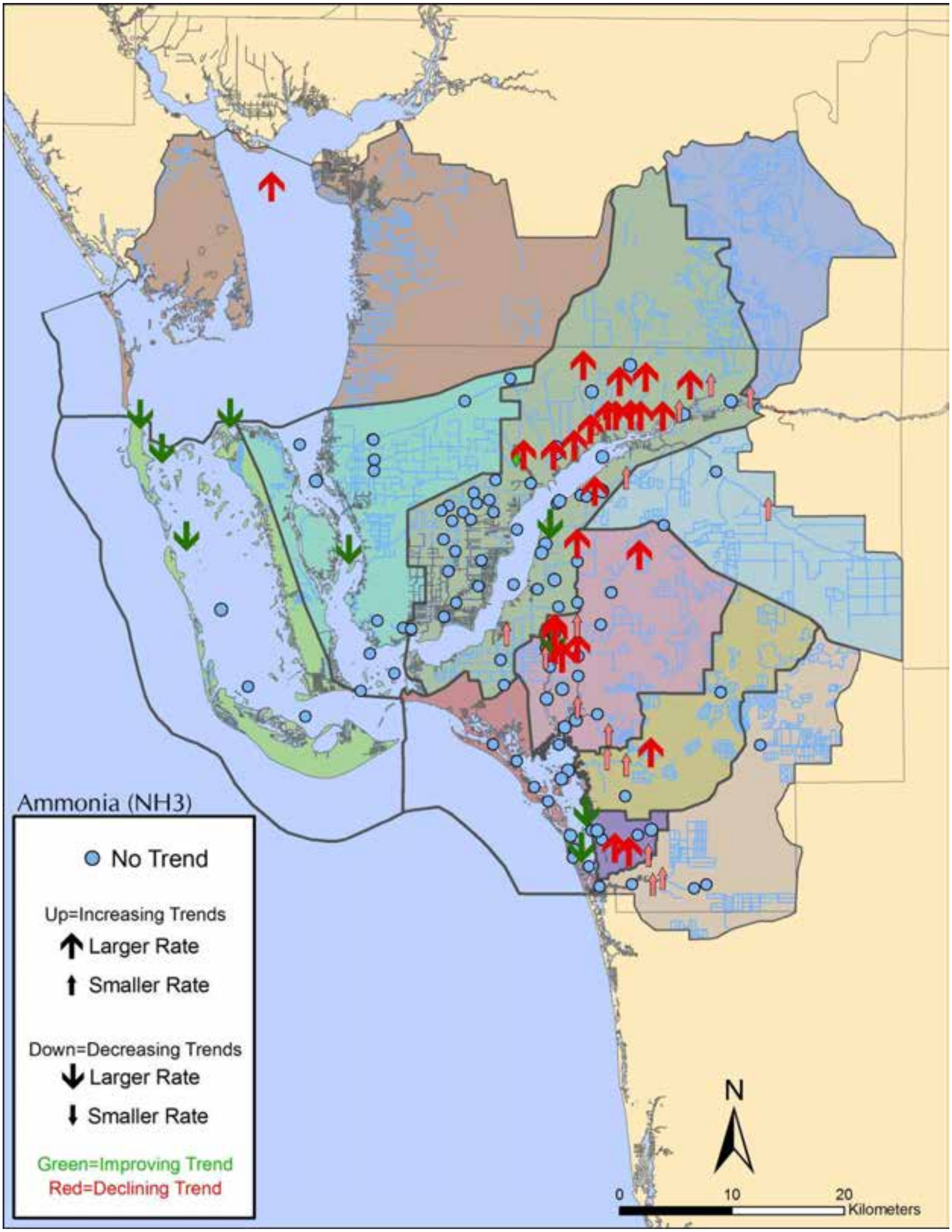

Dissolved Silica
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

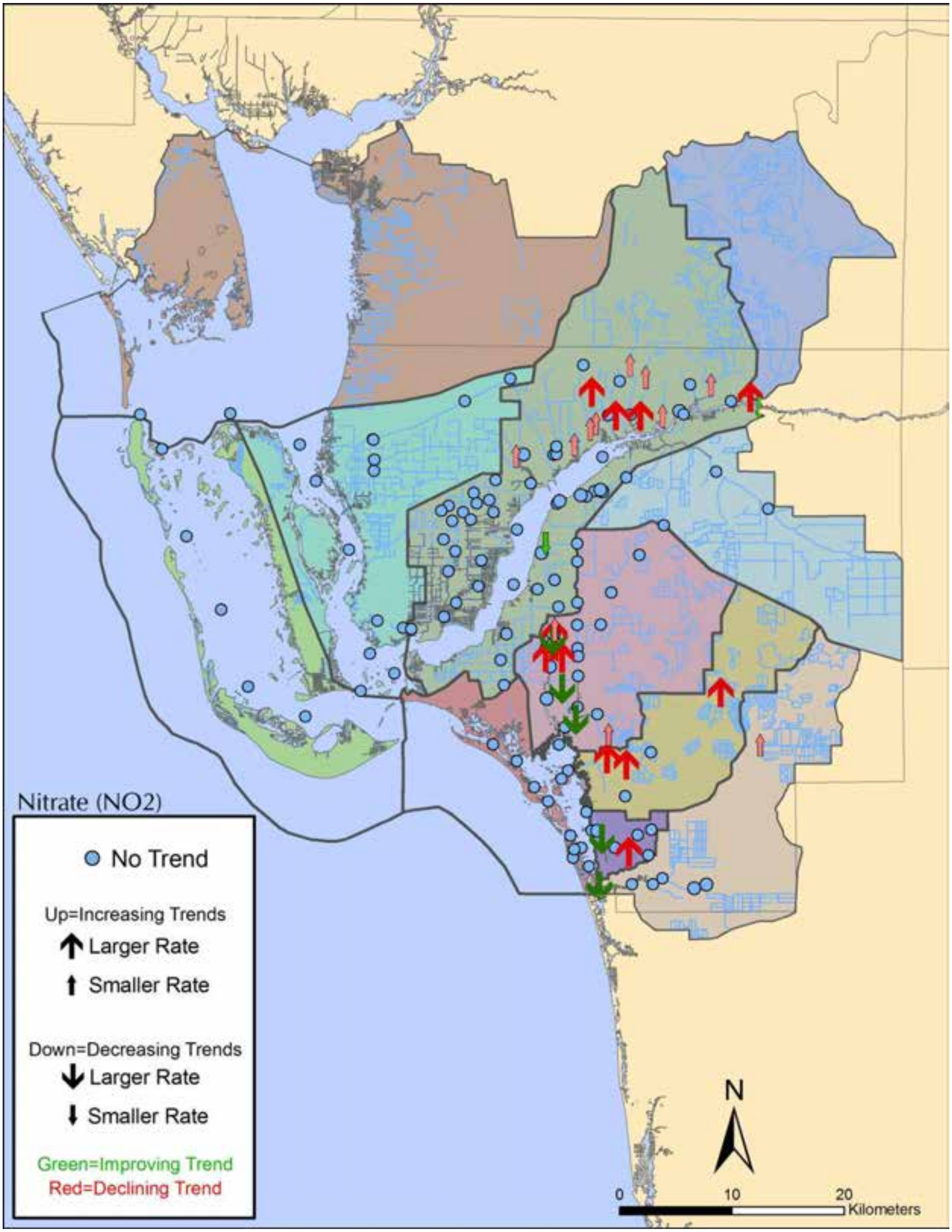

Enterococci
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

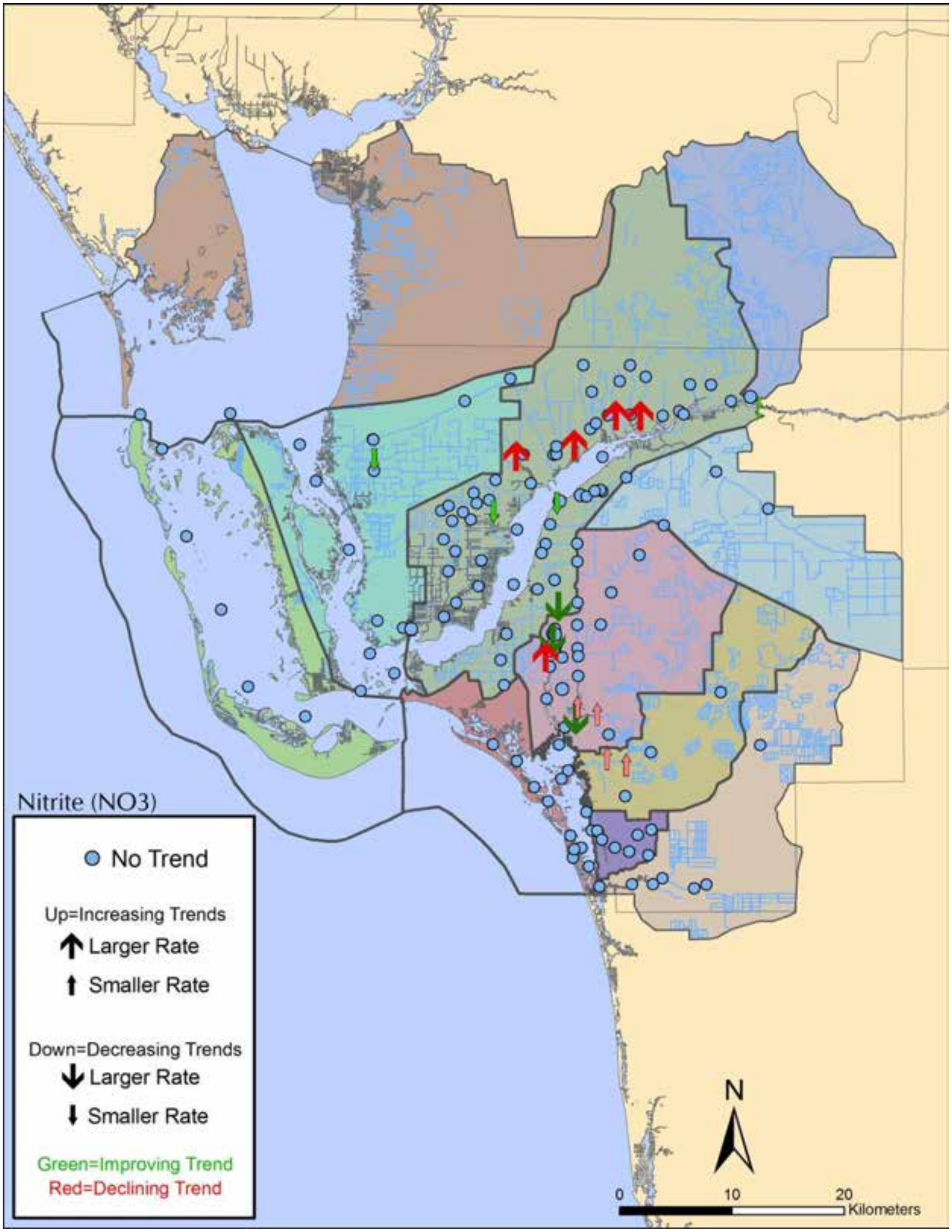


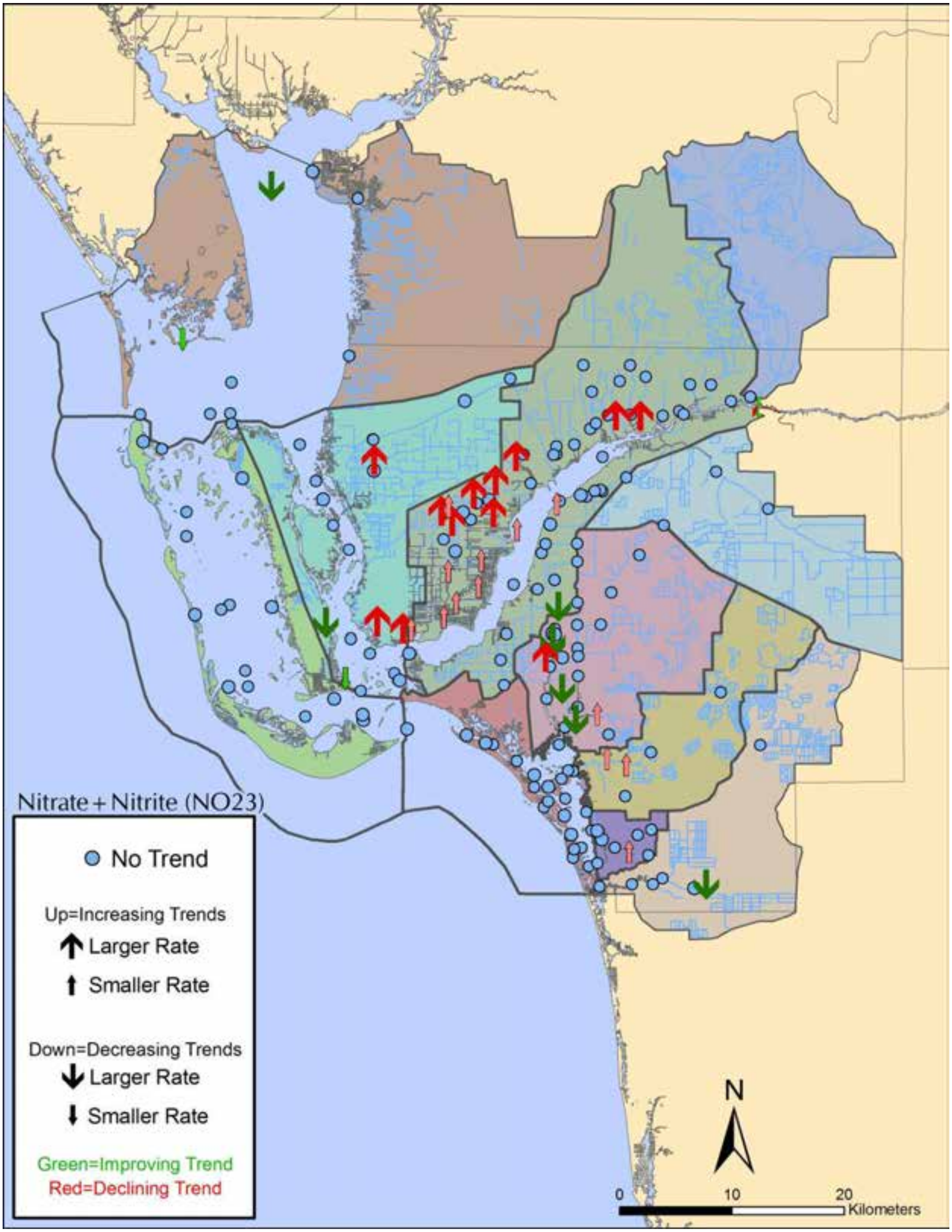
Fecal Coliform
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

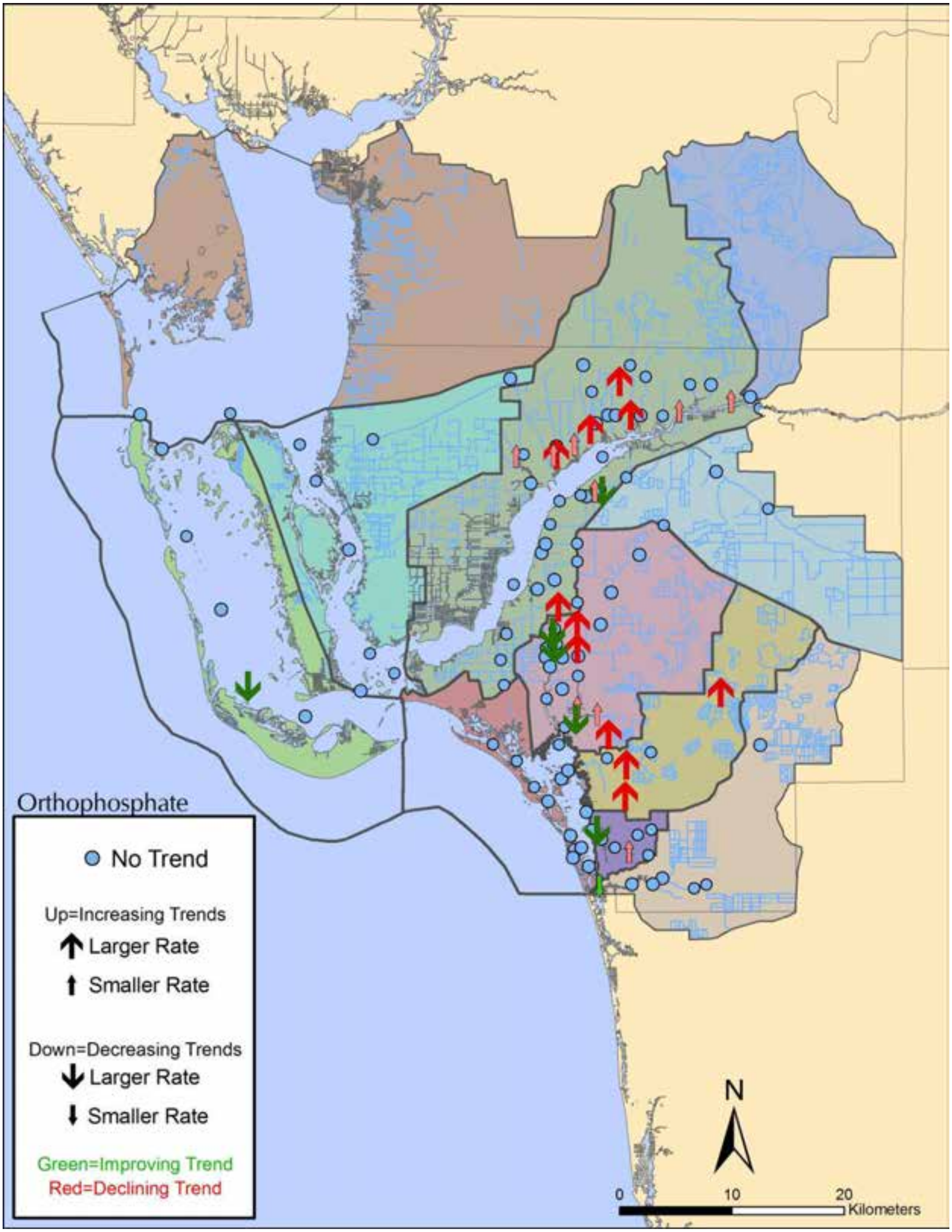

Kd
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

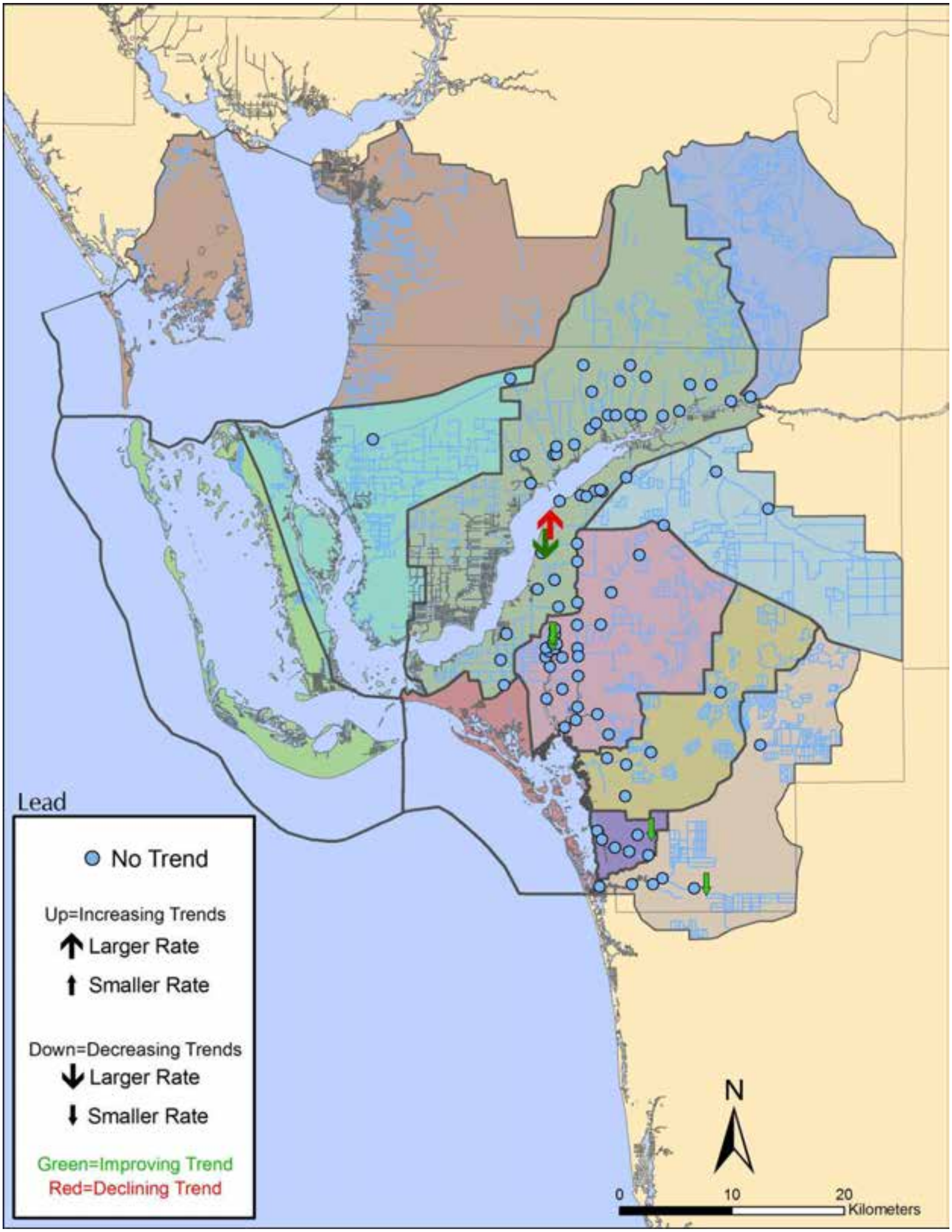

Ammonia (NH3)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

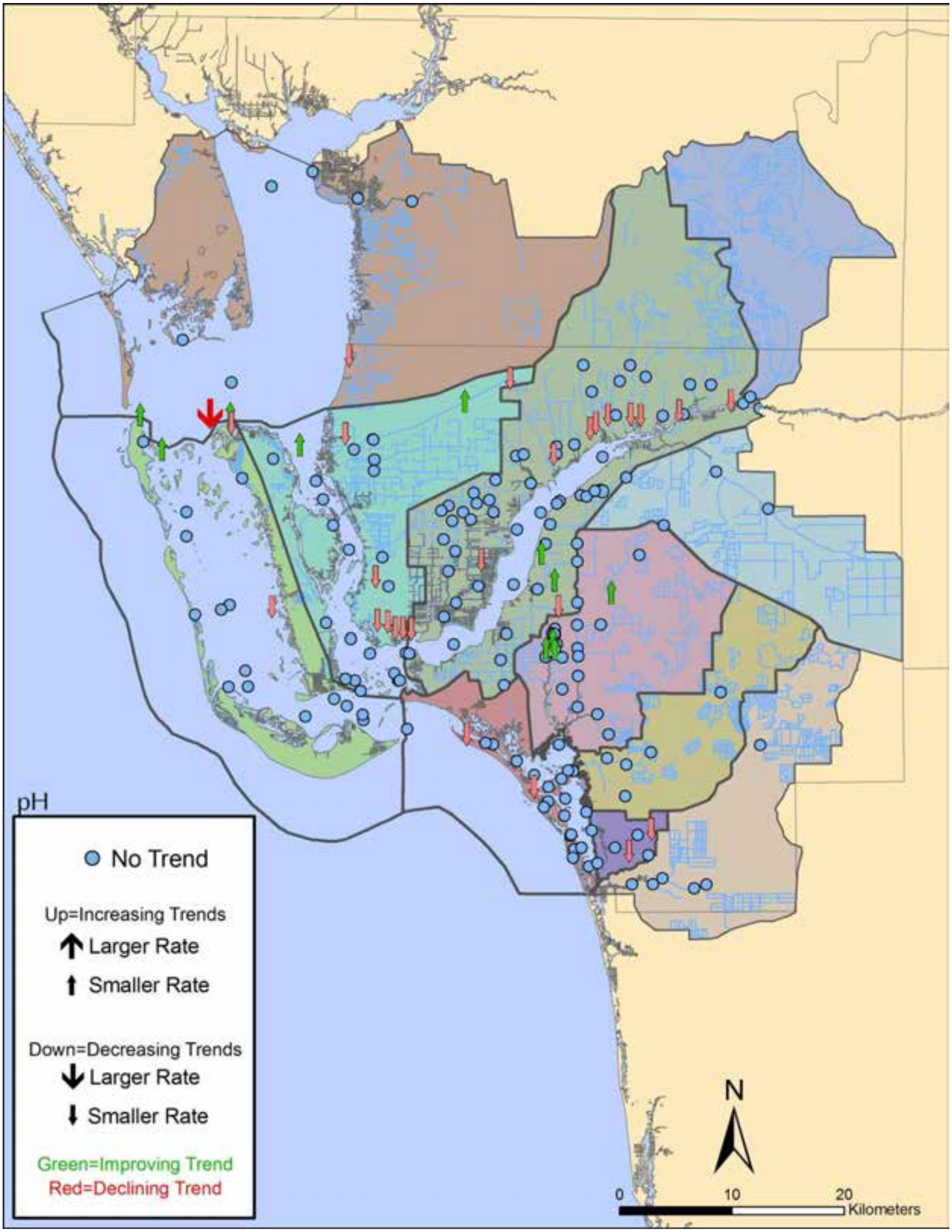

Nitrate (NO2)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

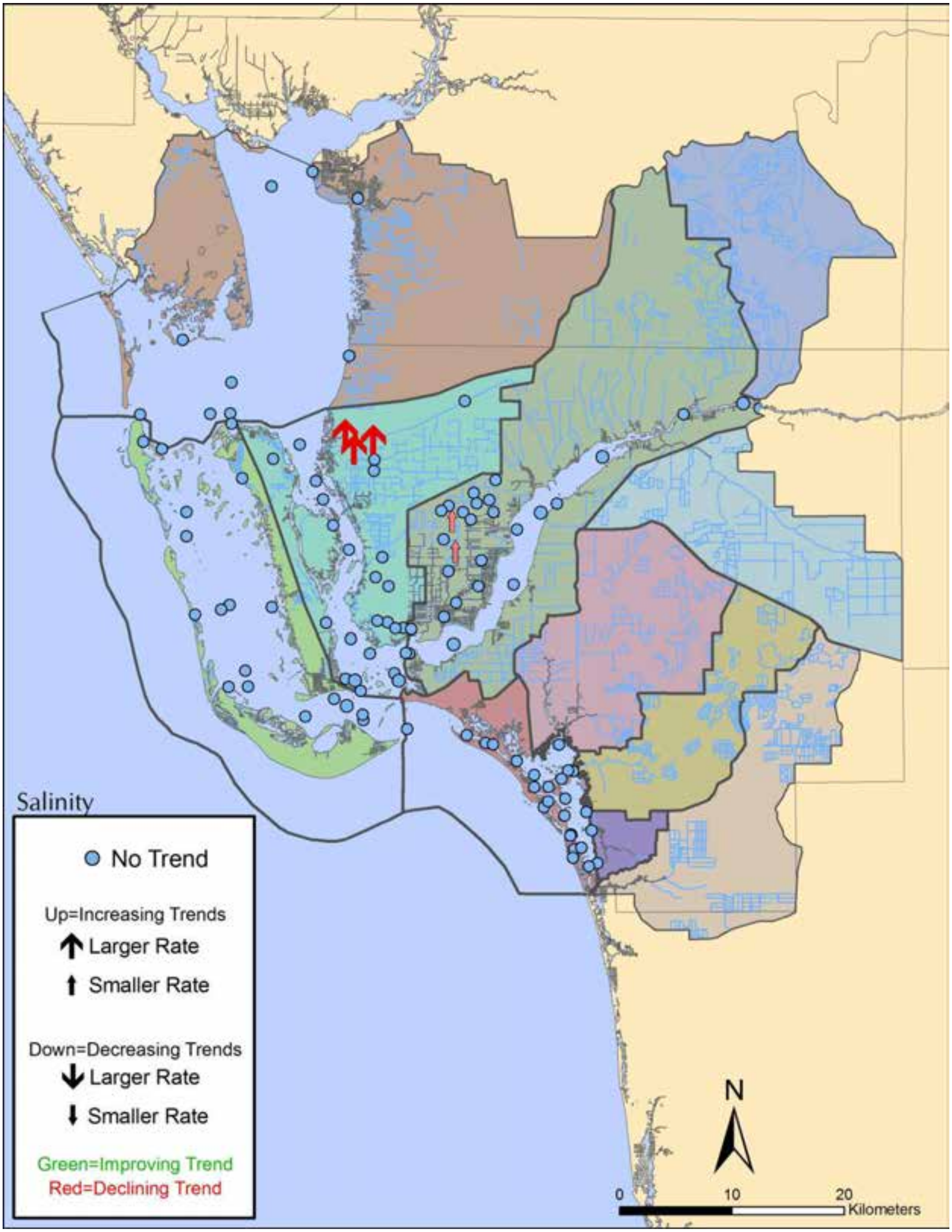

Nitrite (NO3)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

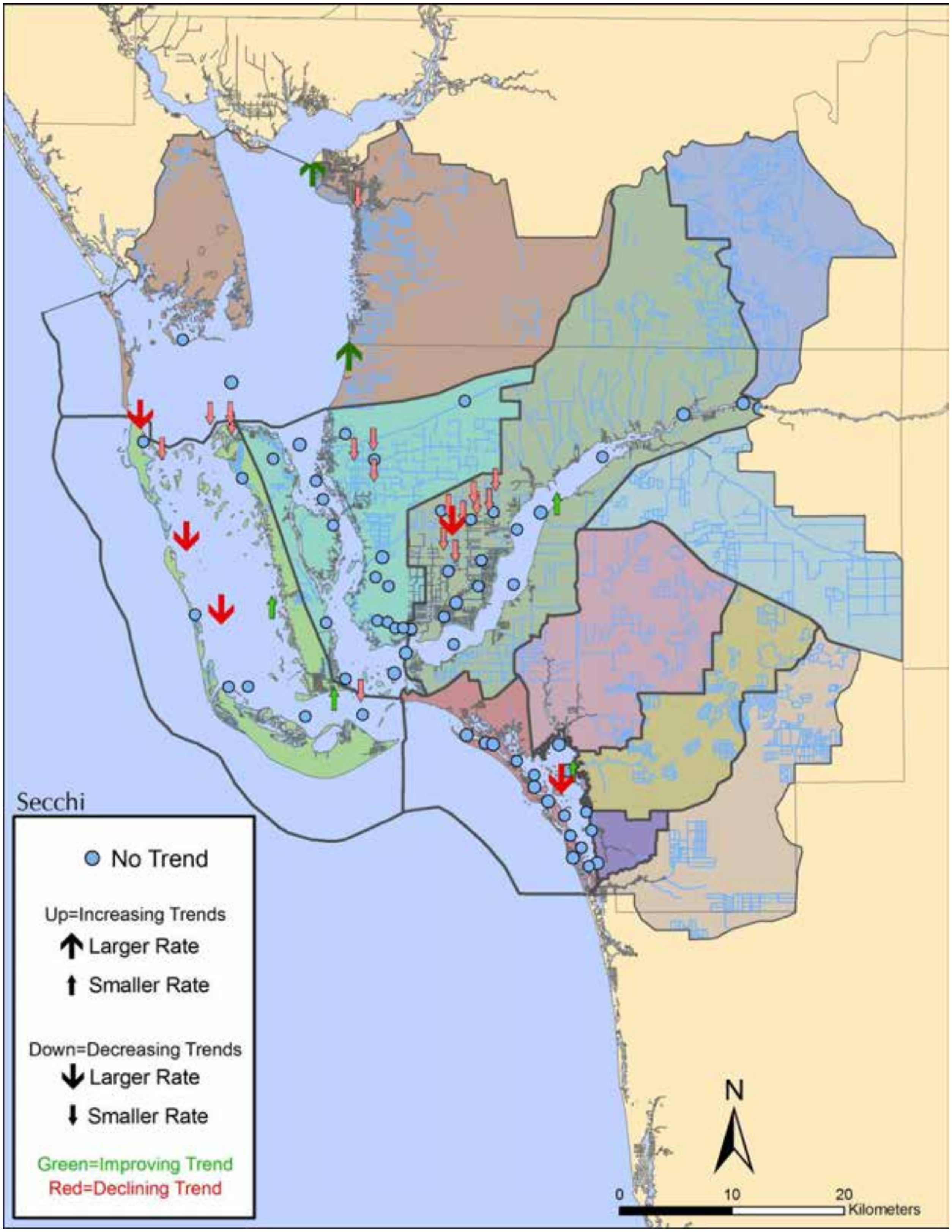

Nitrate + Nitrite (NO23)
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

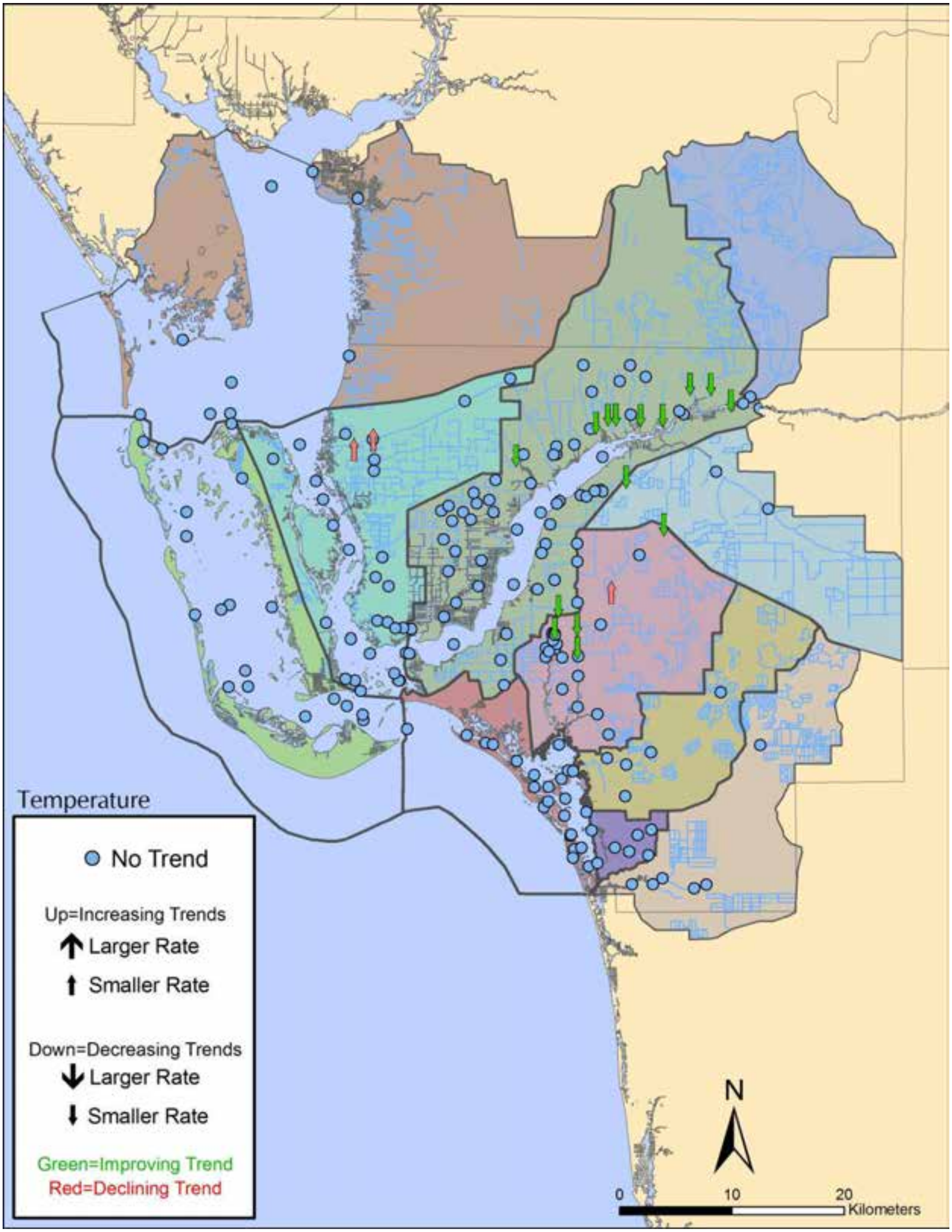

Orthophosphate
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

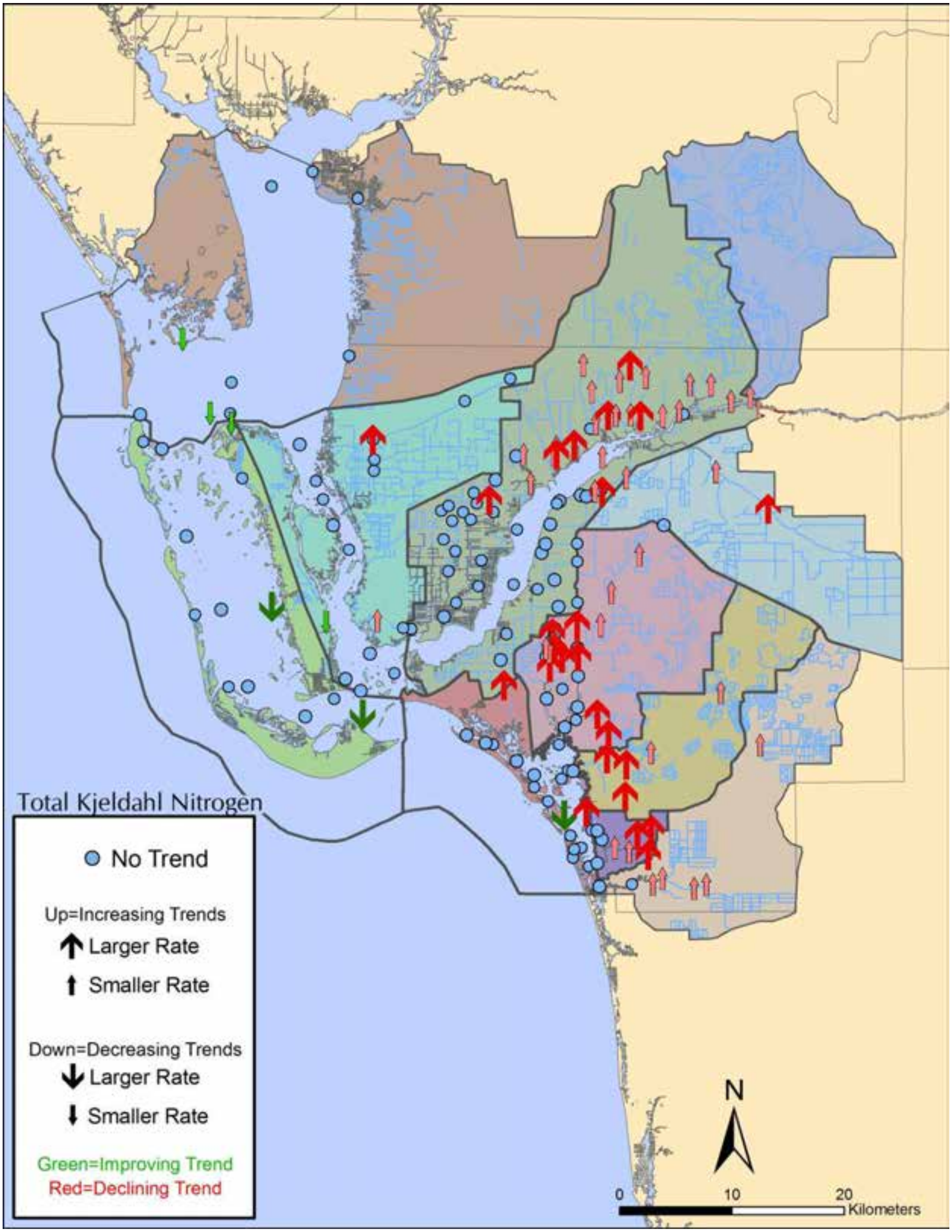

Lead
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


pH
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

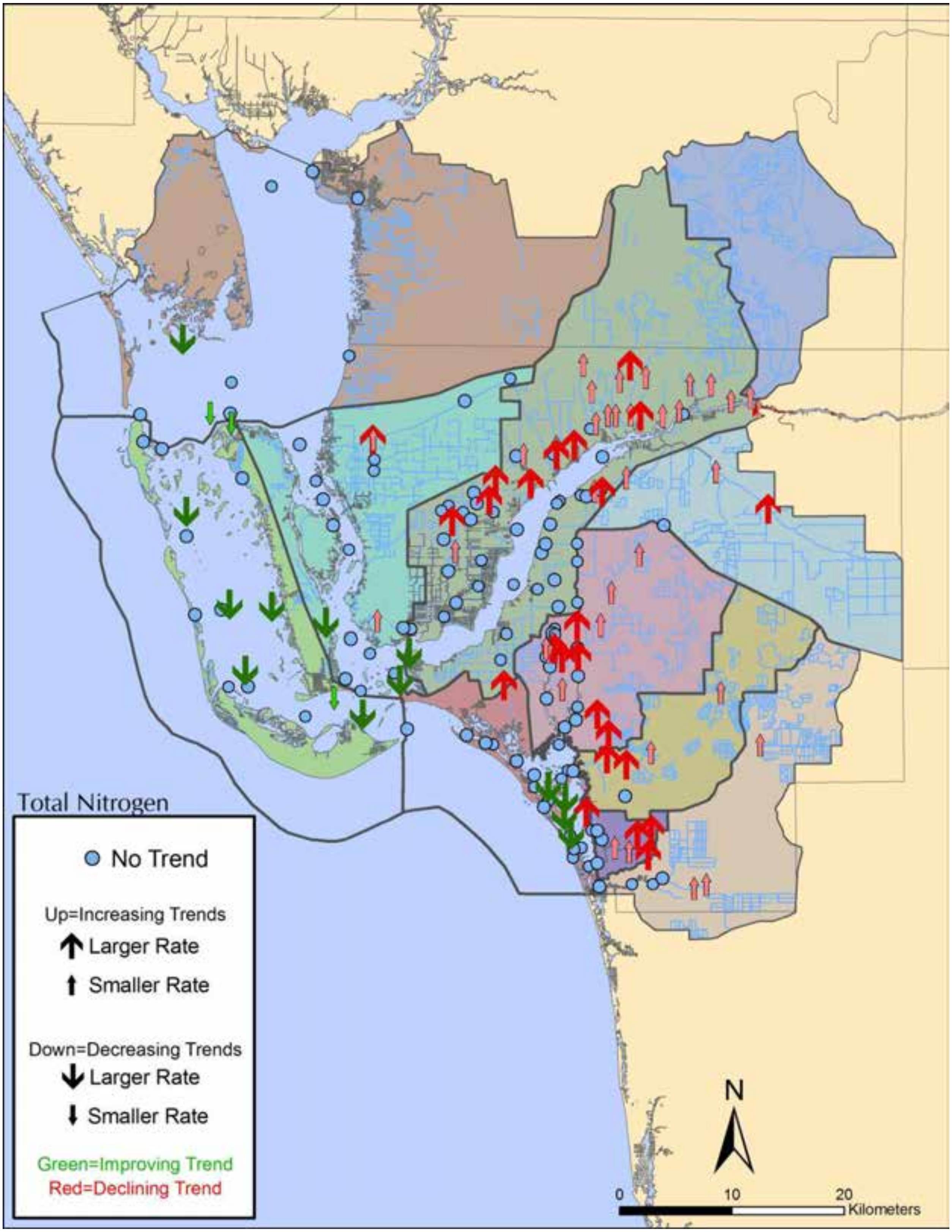

Salinity
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

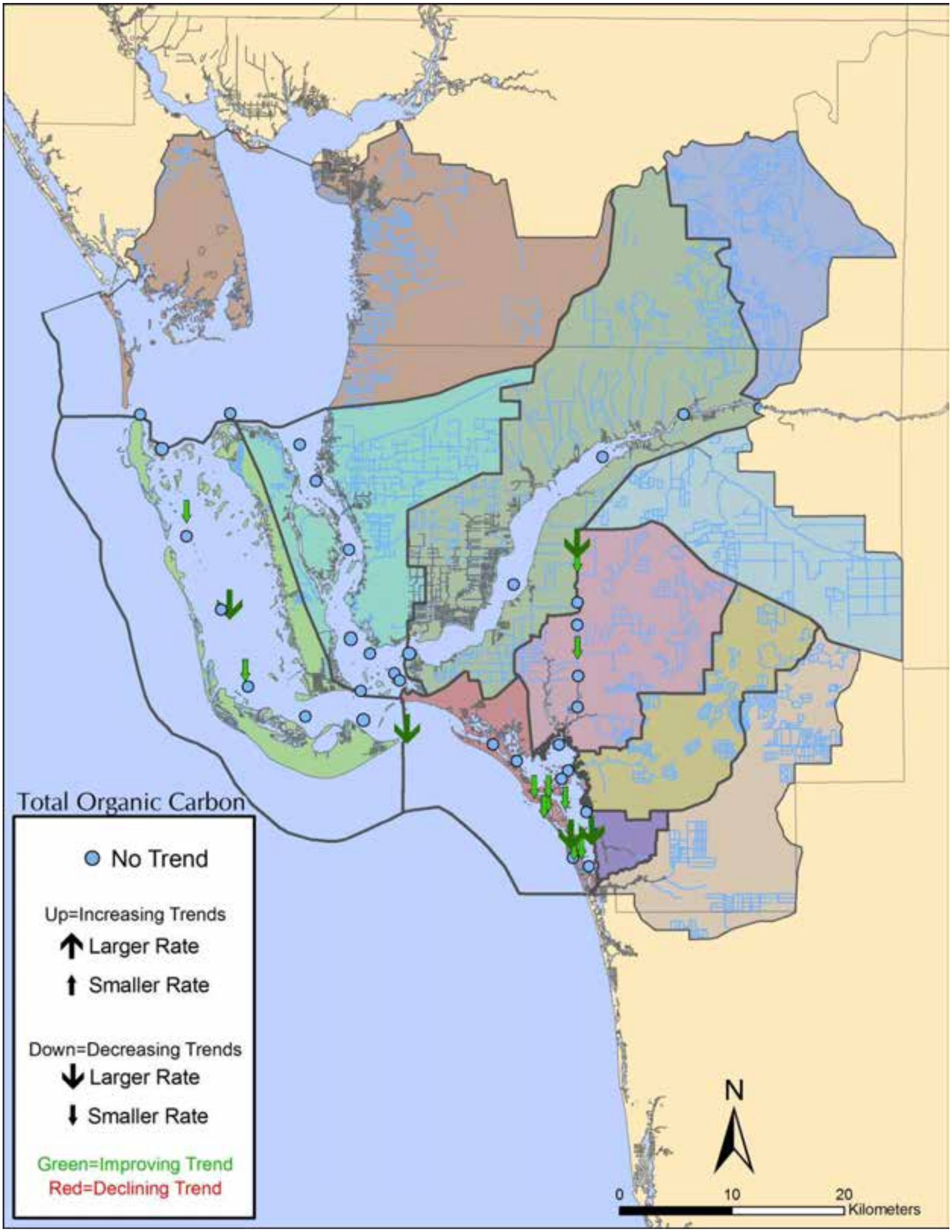

Secchi
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

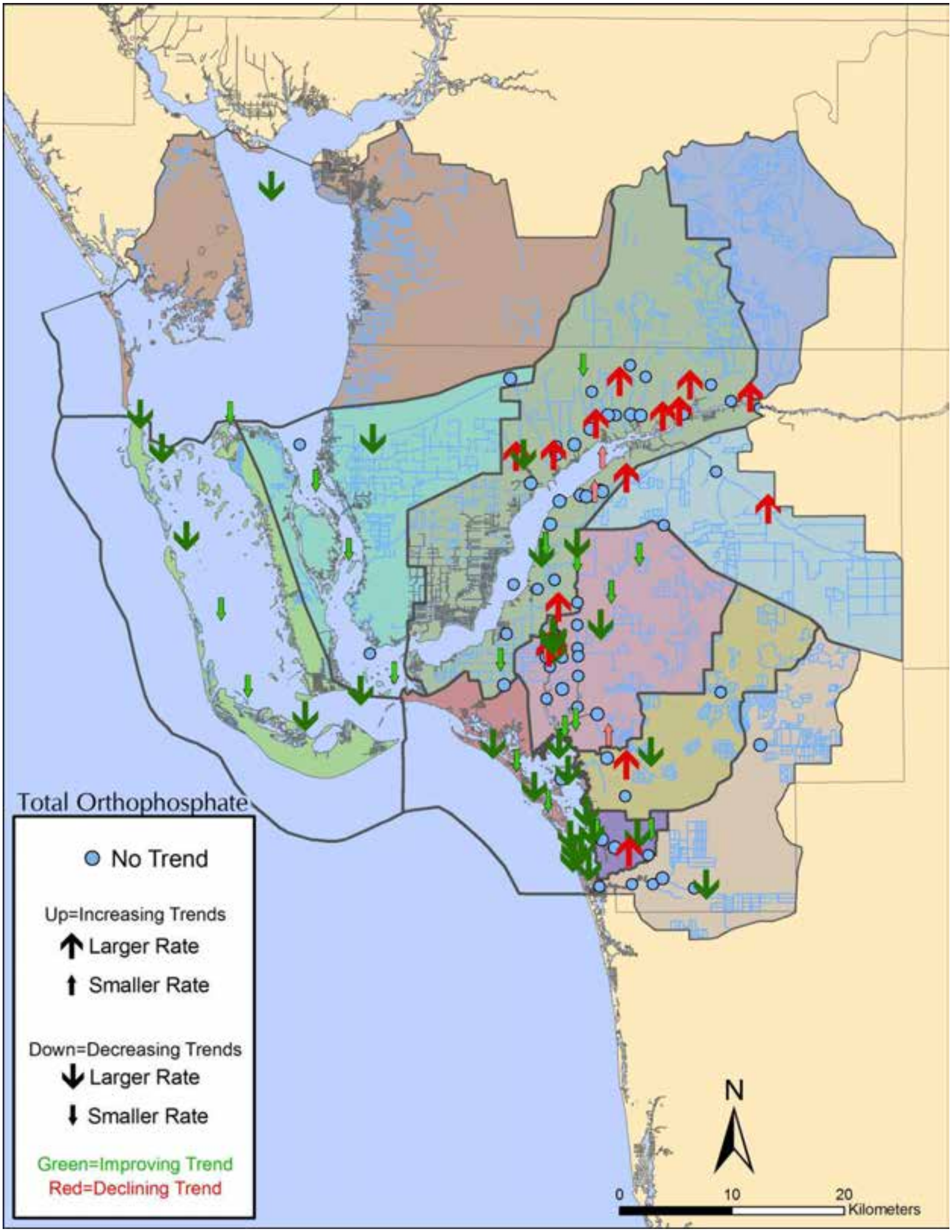

Temperature
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

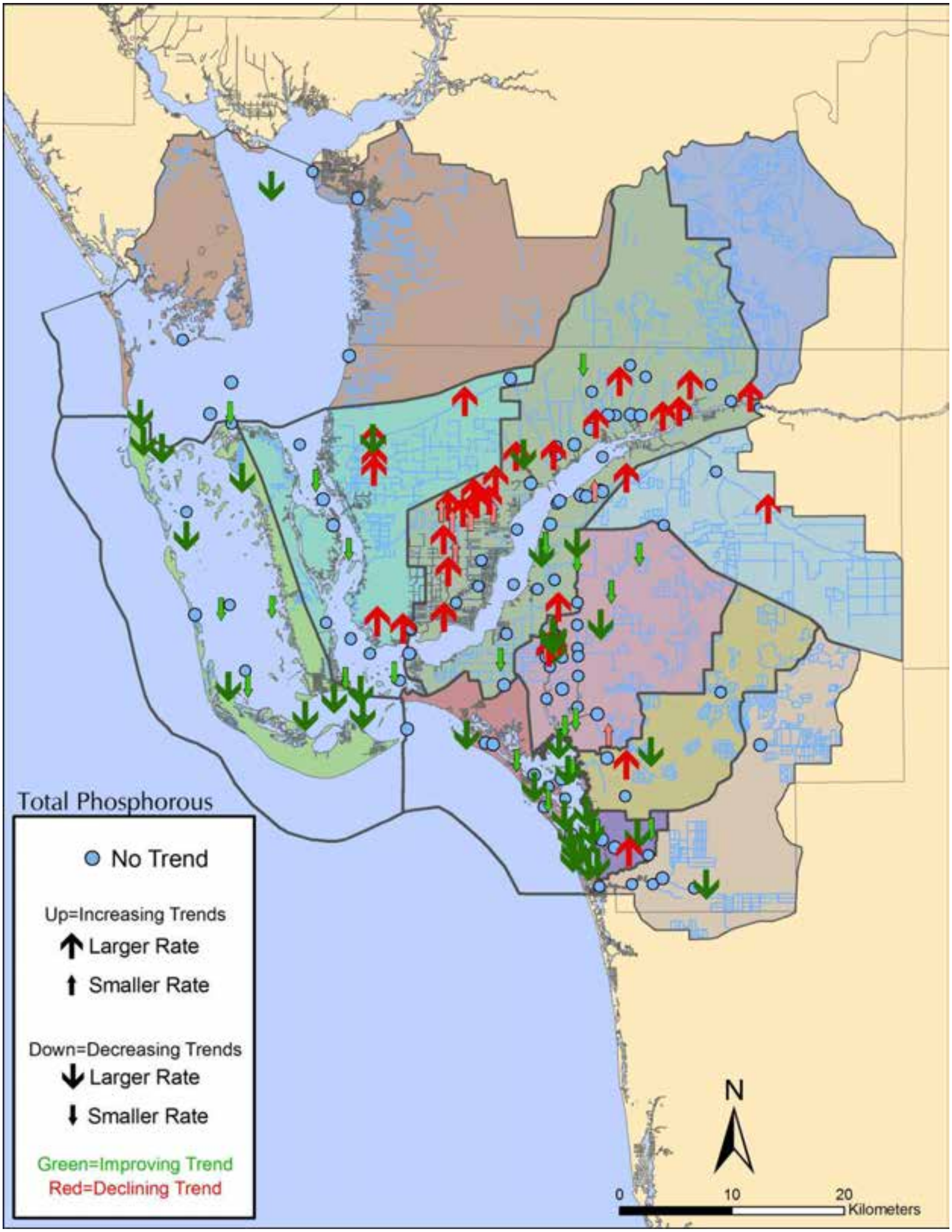


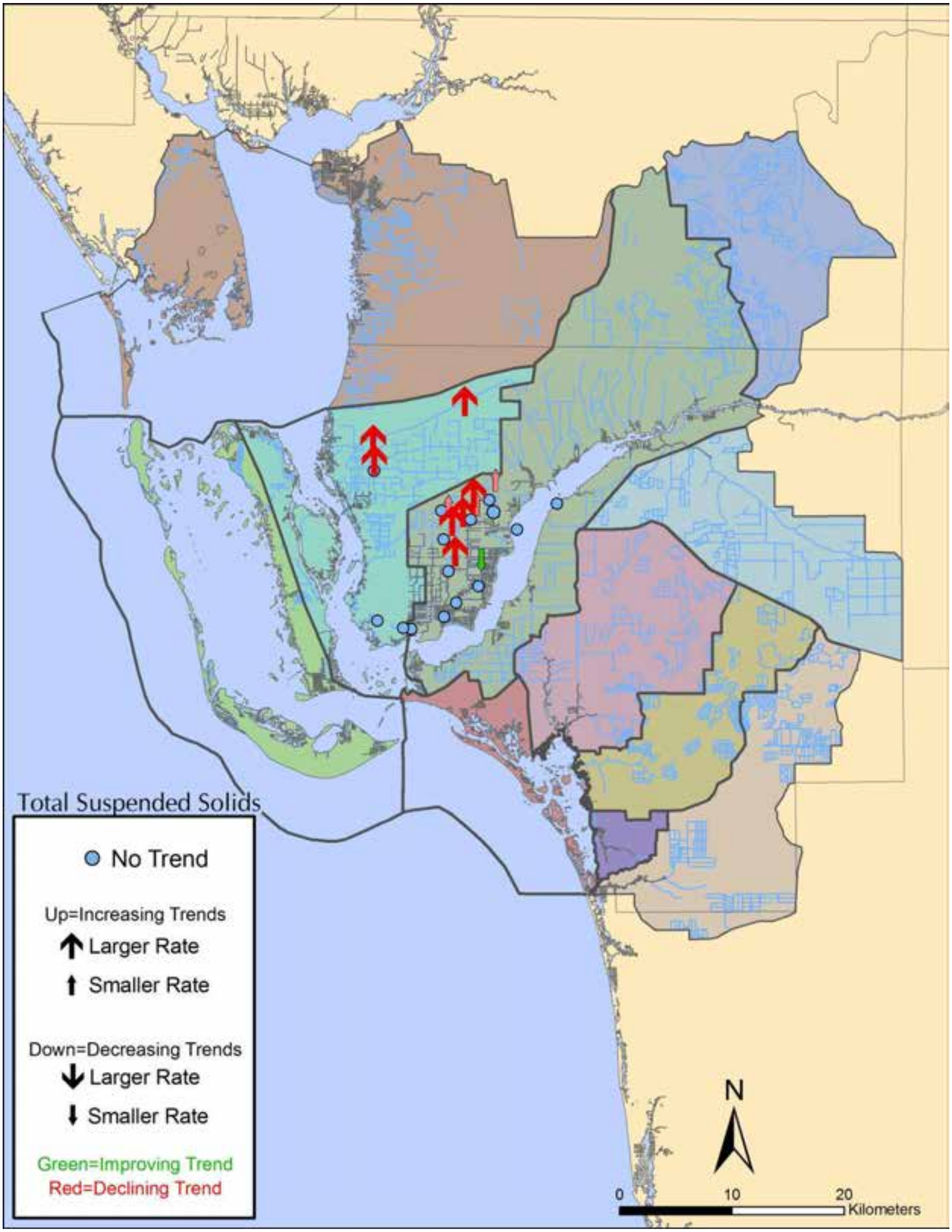
Total Kjeldahl Nitrogen
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Nitrogen
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Organic Carbon
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Orthophosphate
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers


Total Phosphorous
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers



Total Suspended Solids
No Trend
Up=Increasing Trends
Larger Rate
Smaller Rate
Down=Decreasing Trends
Larger Rate
Smaller Rate
Green=Improving Trend
Red=Declining Trend
N
0
10
20
Kilometers

Trend Summary for CHNEP Basin - Charlotte Harbor Proper
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
BOD 5-Day (mg/L)	Surface	0	0	1	1	0
Chlorophyll a Corrected (ug/L)	Surface	1	1	0	0	0
Chlorophyll a Uncorrected (ug/L)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	7
Chloride (mg/L)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	2
Color (PCU)	Bottom	0	0	0	0	1
	Surface	2	0	0	0	8
Conductivity (uS/cm)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	4
Dissolved Oxygen (mg/L)	Bottom	0	0	0	0	1
	Surface	0	1	0	0	8
Dissolved Silica (mg/L)	Bottom	0	0	0	0	1
	Surface	0	2	0	0	1
Enterococci (cfu)	Surface	0	0	0	0	3
Fecal Coliform	Surface	0	2	0	0	16
Kd (1/m)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	3
Total Kjeldahl Nitrogen (mg/L)	Bottom	0	0	0	0	1
	Surface	0	2	0	0	7
NH3 Ammonia (mg/L)	Bottom	0	0	1	0	0
	Surface	2	0	1	0	0
Nitrate+Nitrate as Nitrogen (mg/L)	Bottom	1	0	0	0	0
	Surface	1	1	0	0	7
Nitrate (mg/L)	Surface	0	0	0	0	2
Nitrite (mg/L)	Surface	0	0	0	0	2
Orthophosphate (as P)(mg/L)	Surface	0	0	0	0	2
PH (SU)	Bottom	0	0	0	1	0
	Surface	1	1	0	2	6
Salinity (ppt)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	9
Secchi Disk (m)	Surface	1	3	2	0	2

(Continued)

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Total Orthophosphate (mg/L)	Bottom	0	0	0	0	1
	Surface	2	1	0	0	0
Total Organic Carbon (mg/L)	Surface	0	0	0	0	2
Total Suspended Solids (mg/L)	Surface	0	0	1	0	1
Temperature (C)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	9
Total Nitrogen (mg/L)	Bottom	0	0	0	0	1
	Surface	1	1	0	0	7
Total Phosphorus (mg/L)	Bottom	0	0	0	0	1
	Surface	2	1	0	0	6

Trend Summary for CHNEP Basin - Bokeelia
Data From Random Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Ammonia as N Total (mg/l)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
BOD 5-Day (mg/L)	Bottom	0	0	1	0	0
	Surface	0	0	0	1	0
Chlorophyll a Corrected (ug/l)	Bottom	0	1	0	0	0
	Surface	0	0	0	0	1
Color (PCU)	Bottom	0	0	0	0	1
	Surface	0	1	0	0	0
Dissolved Oxygen (mg/l)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Dissolved Silica (mg/L)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Light Attenuation Coefficient (1/m)	Surface	0	0	0	0	1
Nitrate+Nitrite as Nitrogen (mg/L)	Bottom	0	1	0	0	0
	Surface	0	0	0	0	2
Nitrite (mg/l)	Bottom	0	1	0	0	0
	Surface	0	0	0	0	1
Orthophosphate (as P)(mg/l)	Surface	1	0	0	0	0
PH (SU)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Salinity (ppt)	Bottom	0	0	0	1	0
	Surface	0	0	0	0	1
Specific Conductance (uS/cm)	Bottom	0	0	0	1	0
	Surface	0	0	0	1	0
Temperature (C)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Total Kjeldahl Nitrogen (mg/l)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Total Nitrogen (mg/L)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Total Organic Carbon (mg/l)	Bottom	0	0	1	0	0
	Surface	0	0	1	0	0

(Continued)

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Total Phosphorous (mg/l)	Bottom	0	1	0	0	0
	Surface	1	0	0	0	0
Total Suspended Solids (mg/l)	Bottom	0	0	0	0	1
	Surface	0	0	0	1	0
Turbidity (NTU)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1

Trend Summary for CHNEP Basin - Cape Haze
Data From Random Stations

		Trend Results			
		Decreasing		Increasing	Stable
		(>10%/Year)	(<=10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level				
Ammonia as N Total (mg/l)	Surface	0	0	1	0
Chlorophyll a Corrected (ug/l)	Surface	0	0	1	0
Color (PCU)	Surface	0	0	0	1
Dissolved Oxygen (mg/l)	Surface	0	0	0	1
Light Attenuation Coefficient (1/m)	Surface	0	0	0	1
Nitrate+Nitrite as Nitrogen (mg/L)	Surface	1	0	0	0
PH (SU)	Surface	0	0	0	1
Salinity (ppt)	Surface	0	0	0	1
Specific Conductance (uS/cm)	Surface	0	0	0	1
Temperature (C)	Surface	0	0	0	1
Total Kjeldahl Nitrogen (mg/l)	Surface	0	0	0	1
Total Nitrogen (mg/L)	Surface	0	0	0	1
Total Organic Carbon (mg/l)	Surface	0	1	0	0
Total Phosphorous (mg/l)	Surface	0	1	0	0
Total Suspended Solids (mg/l)	Surface	0	0	0	1
Turbidity (NTU)	Surface	0	0	1	0

Trend Summary for CHNEP Basin - East Wall
Data From Random Stations

Parameter	Sample Level	Trend Results: Decreasing (>10%/Year)	Decreasing (<=10%/Year)	Increasing (>10%/Year)	Increasing (<=10%/Year)	Stable: No Change
Ammonia as N Total (mg/l)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Chlorophyll a Corrected (ug/l)	Bottom	0	0	1	0	0
	Surface	0	0	0	0	1
Color (PCU)	Bottom	0	1	0	0	0
	Surface	0	0	0	0	1
Dissolved Oxygen (mg/l)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Light Attenuation Coefficient (1/m)	Surface	1	0	0	0	0
Nitrate+Nitrite as Nitrogen (mg/L)	Surface	1	0	0	0	0
PH (SU)	Bottom	0	0	0	0	1
	Surface	0	0	0	1	0
Salinity (ppt)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Specific Conductance (uS/cm)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Temperature (C)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Total Kjeldahl Nitrogen (mg/l)	Bottom	0	0	0	0	1
	Surface	0	1	0	0	0
Total Nitrogen (mg/L)	Bottom	0	1	0	0	0
	Surface	0	1	0	0	0
Total Organic Carbon (mg/l)	Bottom	0	1	0	0	0
	Surface	0	1	0	0	0
Total Phosphorous (mg/l)	Bottom	0	0	0	0	1
	Surface	0	1	0	0	0
Total Suspended Solids (mg/l)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1
Turbidity (NTU)	Bottom	0	0	0	0	1
	Surface	0	0	0	0	1

Trend Summary for CHNEP Basin - West Wall
Data From Random Stations

		Trend Results			
		Decreasing		Increasing	Stable
		(>10%/Year)	(<=10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level				
Ammonia as N Total (mg/l)	Bottom	0	0	1	0
	Surface	0	0	0	1
Chlorophyll a Corrected (ug/l)	Bottom	0	0	0	1
	Surface	0	0	0	1
Color (PCU)	Bottom	0	0	0	1
	Surface	0	0	0	1
Dissolved Oxygen (mg/l)	Bottom	0	0	0	1
	Surface	0	0	0	1
Light Attenuation Coefficient (1/m)	Surface	1	0	0	0
Nitrate+Nitrite as Nitrogen (mg/L)	Surface	1	0	0	0
PH (SU)	Bottom	0	0	0	1
	Surface	0	0	0	1
Salinity (ppt)	Bottom	0	0	0	1
	Surface	0	0	0	1
Specific Conductance (uS/cm)	Bottom	0	0	0	1
	Surface	0	0	0	1
Temperature (C)	Bottom	0	0	0	1
	Surface	0	0	0	1
Total Kjeldahl Nitrogen (mg/l)	Bottom	0	1	0	0
	Surface	0	1	0	0
Total Nitrogen (mg/L)	Bottom	0	1	0	0
	Surface	0	1	0	0
Total Organic Carbon (mg/l)	Bottom	0	1	0	0
	Surface	0	0	0	1
Total Phosphorous (mg/l)	Bottom	0	0	0	1
	Surface	0	0	0	1
Total Suspended Solids (mg/l)	Bottom	0	0	0	1
	Surface	0	0	0	1
Turbidity (NTU)	Bottom	0	0	0	1
	Surface	0	0	0	1

Trend Summary for CHNEP Basin - Tidal Caloosahatchee
Data From Random Stations

		Trend Results		
		Decreasing		Stable
		(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level			
Ammonia as N Total (mg/l)	Surface	0	0	1
BOD 5-Day (mg/L)	Surface	0	0	1
Chlorophyll a Corrected (ug/l)	Surface	1	0	0
Color (PCU)	Surface	0	0	1
Dissolved Oxygen (mg/l)	Surface	0	1	0
Dissolved Silica (mg/L)	Surface	0	0	1
Light Attenuation Coefficient (1/m)	Surface	0	0	1
Nitrate+Nitrite as Nitrogen (mg/L)	Surface	0	1	1
Nitrite (mg/l)	Surface	1	0	0
Orthophosphate (as P)(mg/l)	Surface	0	0	1
PH (SU)	Surface	0	0	1
Salinity (ppt)	Surface	0	0	1
Specific Conductance (uS/cm)	Surface	0	0	1
Temperature (C)	Surface	0	0	1
Total Kjeldahl Nitrogen (mg/l)	Surface	0	0	1
Total Nitrogen (mg/L)	Surface	0	0	1
Total Organic Carbon (mg/l)	Surface	0	0	1
Total Phosphorous (mg/l)	Surface	0	0	1
Total Suspended Solids (mg/l)	Surface	0	0	1
Turbidity (NTU)	Surface	0	1	0

Trend Summary for CHNEP Basin - Telegraph Swamp
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
BOD 5-Day (mg/L)	Surface	0	0	0	0	5
Chlorophyll a Corrected (ug/L)	Surface	3	0	0	0	2
Chloride (mg/L)	Surface	0	0	0	1	4
Color (PCU)	Surface	0	1	0	0	4
Conductivity (uS/cm)	Surface	0	0	0	2	3
Copper(ug/L)	Surface	0	0	1	0	4
Dissolved Oxygen (mg/L)	Surface	0	0	0	0	5
Dissolved Silica (mg/L)	Surface	0	0	0	2	3
Fecal Coliform	Surface	0	0	0	0	1
Total Kjeldahl Nitrogen (mg/L)	Surface	0	0	1	2	2
Lead (ug/L)	Surface	0	1	0	0	4
NH3 Ammonia (mg/L)	Surface	1	0	0	1	3
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	0	0	0	0	5
Nitrate (mg/L)	Surface	0	0	0	0	5
Nitrite (mg/L)	Surface	0	0	1	0	4
Orthophosphate (as P)(mg/L)	Surface	0	0	1	0	4
PH (SU)	Surface	0	0	0	0	5
Total Orthophosphate (mg/L)	Surface	0	0	1	0	4
Total Suspended Solids (mg/L)	Surface	1	0	0	0	4
Temperature (C)	Surface	0	0	0	0	5
Total Nitrogen (mg/L)	Surface	0	0	1	1	3
Total Phosphorus (mg/L)	Surface	0	0	1	0	4

Trend Summary for CHNEP Basin - Orange River
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
BOD 5-Day (mg/L)	Surface	0	0	1	0	12
Chlorophyll a Corrected (ug/L)	Surface	3	1	0	0	8
Chlorophyll a Uncorrected (ug/L)	Surface	0	0	0	0	1
Chloride (mg/L)	Surface	1	1	3	0	9
Chromium (ug/L)	Surface	0	0	3	1	2
Color (PCU)	Surface	0	4	3	0	6
Conductivity (uS/cm)	Surface	0	0	4	1	10
Copper(ug/L)	Surface	0	0	6	0	7
Dissolved Oxygen (mg/L)	Surface	1	1	0	1	12
Dissolved Silica (mg/L)	Surface	0	0	1	1	10
Fecal Coliform	Surface	0	0	0	1	1
Total Kjeldahl Nitrogen (mg/L)	Surface	1	0	8	2	4
Lead (ug/L)	Surface	2	0	0	0	11
NH3 Ammonia (mg/L)	Surface	0	1	1	1	11
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	1	0	0	0	14
Nitrate (mg/L)	Surface	0	0	0	0	14
Nitrite (mg/L)	Surface	3	0	0	1	10
Orthophosphate (as P)(mg/L)	Surface	0	0	0	0	14
PH (SU)	Surface	0	5	0	0	11
Salinity (ppt)	Surface	0	0	0	0	1
Secchi Disk (m)	Surface	0	0	1	0	0
Total Orthophosphate (mg/L)	Surface	8	1	1	0	4
Total Organic Carbon (mg/L)	Surface	0	0	0	0	7
Total Suspended Solids (mg/L)	Surface	0	0	0	0	13
Temperature (C)	Surface	0	1	0	0	14
Total Nitrogen (mg/L)	Surface	1	0	8	2	4
Total Phosphorus (mg/L)	Surface	8	1	1	0	5

Trend Summary for CHNEP Basin - Matlacha Pass
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Ammonium Unionized (mg/L)	Bottom	0	0	0	0	3
	Surface	0	0	1	0	4
BOD 5-Day (mg/L)	Bottom	0	0	1	4	1
	Surface	0	0	0	6	9
Chlorophyll a Corrected (ug/L)	Surface	2	3	2	0	8
Chlorophyll a Uncorrected (ug/L)	Surface	1	0	0	0	5
Chloride (mg/L)	Surface	0	0	0	0	2
Color (PCU)	Surface	2	3	0	0	8
Conductivity (uS/cm)	Surface	0	0	0	0	9
Copper(ug/L)	Surface	0	0	0	0	2
Dissolved Oxygen (mg/L)	Bottom	1	3	0	2	9
	Surface	0	4	0	4	20
Dissolved Silica (mg/L)	Surface	0	1	0	0	8
Enterococci (cfu)	Surface	0	0	0	0	6
Fecal Coliform	Surface	0	1	1	7	4
Kd (1/m)	Surface	0	0	0	0	6
Total Kjeldahl Nitrogen (mg/L)	Bottom	0	0	0	0	6
	Surface	0	1	2	1	15
Lead (ug/L)	Surface	0	0	0	0	2
NH3 Ammonia (mg/L)	Bottom	0	0	0	0	6
	Surface	1	0	0	0	14
Nitrate+Nitrate as Nitrogen (mg/L)	Bottom	0	0	2	0	4
	Surface	1	1	3	0	16
Nitrate (mg/L)	Bottom	1	2	0	0	3
	Surface	0	1	0	0	14
Nitrite (mg/L)	Bottom	0	0	0	0	6
	Surface	0	0	0	0	15
Orthophosphate (as P)(mg/L)	Surface	0	0	0	0	9
PH (SU)	Bottom	0	8	0	1	4
	Surface	0	7	0	2	20

(Continued)

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Salinity (ppt)	Bottom	0	0	2	0	13
	Surface	0	0	3	0	24
Secchi Disk (m)	Surface	0	4	0	0	18
Total Orthophosphate (mg/L)	Surface	2	3	0	0	4
Total Organic Carbon (mg/L)	Surface	0	0	0	0	9
Total Suspended Solids (mg/L)	Surface	1	0	2	3	3
Temperature (C)	Bottom	0	0	0	1	14
	Surface	0	0	0	2	27
Total Nitrogen (mg/L)	Bottom	0	0	2	1	3
	Surface	2	0	1	2	16
Total Phosphorus (mg/L)	Bottom	0	0	4	2	0
	Surface	2	4	6	0	9

Trend Summary for CHNEP Basin - Matlacha Pass
Data From Random Stations

		Trend Results	
		Increasing	Stable
		(<=10%/Year)	No Change
Parameter	Sample Level		
Ammonia as N Total (mg/l)	Surface	0	1
Chlorophyll a Corrected (ug/l)	Surface	0	1
Color (PCU)	Surface	0	1
Dissolved Orthophosphate (mg/L)	Surface	0	1
Dissolved Oxygen (mg/l)	Surface	0	1
Light Attenuation Coefficient (1/m)	Surface	0	1
Nitrite (mg/l)	Surface	0	1
Orthophosphate (as P)(mg/l)	Surface	0	1
PH (SU)	Surface	1	0
Salinity (ppt)	Surface	0	1
Specific Conductance (uS/cm)	Surface	0	1
Temperature (C)	Surface	0	1
Total Kjeldahl Nitrogen (mg/l)	Surface	1	0
Total Nitrogen (mg/L)	Surface	0	1
Total Organic Carbon (mg/l)	Surface	0	1
Total Phosphorous (mg/l)	Surface	0	1
Total Suspended Solids (mg/l)	Surface	1	0
Turbidity (NTU)	Surface	1	0

Trend Summary for CHNEP Basin - Coastal Estero
Data From Fixed Stations

Parameter	Sample Level	Trend Results: Decreasing (>10%/Year)	Decreasing (<=10%/Year)	Increasing (>10%/Year)	Increasing (<=10%/Year)	Stable: No Change
Ammonium Unionized (mg/L)	Surface	0	0	0	0	4
BOD 5-Day (mg/L)	Surface	0	0	6	2	6
Chlorophyll a Corrected (ug/L)	Surface	0	5	0	0	9
Chlorophyll a Uncorrected (ug/L)	Surface	0	0	0	0	10
Color (PCU)	Surface	11	1	0	0	8
Conductivity (uS/cm)	Surface	0	0	0	0	14
Dissolved Oxygen (mg/L)	Bottom	0	0	0	1	3
	Surface	0	1	0	3	20
Dissolved Silica (mg/L)	Surface	0	2	0	0	12
Enterococci (cfu)	Surface	0	0	0	0	14
Fecal Coliform	Surface	1	1	0	1	6
Kd (1/m)	Surface	0	0	0	0	12
Total Kjeldahl Nitrogen (mg/L)	Surface	1	0	1	0	18
NH3 Ammonia (mg/L)	Surface	2	0	0	0	12
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	0	0	0	0	24
Nitrate (mg/L)	Surface	0	0	0	0	14
Nitrite (mg/L)	Surface	0	0	0	0	14
Orthophosphate (as P)(mg/L)	Surface	0	0	0	0	14
PH (SU)	Surface	0	2	0	0	22
Salinity (ppt)	Bottom	0	0	0	0	4
	Surface	0	0	0	0	24
Secchi Disk (m)	Surface	1	0	0	1	17
Total Orthophosphate (mg/L)	Surface	11	2	0	0	1
Total Organic Carbon (mg/L)	Surface	2	8	0	0	8
Total Suspended Solids (mg/L)	Surface	0	0	8	0	6
Temperature (C)	Bottom	0	0	0	0	4
	Surface	0	0	0	0	24
Total Nitrogen (mg/L)	Surface	3	0	1	0	20
Total Phosphorus (mg/L)	Surface	13	3	0	0	8

Trend Summary for CHNEP Basin - Estero Bay
Data From Random Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Ammonia as N Total (mg/l)	Surface	1	0	0	0	0
BOD 5-Day (mg/L)	Surface	0	0	0	1	0
Chlorophyll a Corrected (ug/l)	Surface	0	0	0	0	1
Color (PCU)	Surface	0	1	0	0	0
Dissolved Oxygen (mg/l)	Surface	0	1	0	0	0
Dissolved Silica (mg/L)	Surface	0	0	0	0	1
Light Attenuation Coefficient (1/m)	Surface	0	0	0	0	1
Nitrate+Nitrite as Nitrogen (mg/L)	Surface	2	0	0	0	0
Nitrite (mg/l)	Surface	0	0	0	0	1
Orthophosphate (as P)(mg/l)	Surface	1	0	0	0	0
PH (SU)	Surface	0	0	0	0	1
Salinity (ppt)	Surface	0	0	0	0	1
Specific Conductance (uS/cm)	Surface	0	0	0	1	0
Temperature (C)	Surface	0	0	0	0	1
Total Kjeldahl Nitrogen (mg/l)	Surface	0	1	0	0	0
Total Nitrogen (mg/L)	Surface	0	1	0	0	0
Total Organic Carbon (mg/l)	Surface	0	0	0	0	1
Total Phosphorous (mg/l)	Surface	0	1	0	0	0
Total Suspended Solids (mg/l)	Surface	0	0	0	1	0
Turbidity (NTU)	Surface	0	0	1	0	0

Trend Summary for CHNEP Basin - Estero River
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
BOD 5-Day (mg/L)	Surface	0	0	1	0	4
Chlorophyll a Corrected (ug/L)	Surface	0	0	0	0	4
Chloride (mg/L)	Surface	0	0	0	2	3
Color (PCU)	Surface	0	1	0	0	3
Conductivity (uS/cm)	Surface	0	0	1	1	3
Copper(ug/L)	Surface	0	0	0	0	5
Dissolved Oxygen (mg/L)	Surface	0	1	0	0	4
Dissolved Silica (mg/L)	Surface	0	0	0	3	1
Fecal Coliform	Surface	0	1	0	0	4
Total Kjeldahl Nitrogen (mg/L)	Surface	0	0	3	2	0
Lead (ug/L)	Surface	0	0	0	0	5
NH3 Ammonia (mg/L)	Surface	0	0	1	2	2
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	0	0	0	2	3
Nitrate (mg/L)	Surface	0	0	0	2	3
Nitrite (mg/L)	Surface	0	0	3	0	2
Orthophosphate (as P)(mg/L)	Surface	0	0	3	0	2
PH (SU)	Surface	0	0	0	0	5
Total Orthophosphate (mg/L)	Surface	1	0	1	0	3
Total Suspended Solids (mg/L)	Surface	2	2	0	0	1
Temperature (C)	Surface	0	0	0	0	5
Total Nitrogen (mg/L)	Surface	0	0	2	2	1
Total Phosphorus (mg/L)	Surface	1	0	1	0	3

Trend Summary for CHNEP Basin - Hendry Creek - Six Mile
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
BOD 5-Day (mg/L)	Surface	0	1	3	9	18
Chlorophyll a Corrected (ug/L)	Surface	12	2	0	0	17
Chloride (mg/L)	Surface	0	4	3	3	21
Chromium (ug/L)	Surface	2	1	0	0	4
Color (PCU)	Surface	0	11	0	1	19
Conductivity (uS/cm)	Surface	0	0	0	7	20
Copper(ug/L)	Surface	1	0	3	0	27
Dissolved Oxygen (mg/L)	Surface	0	6	0	5	16
Dissolved Silica (mg/L)	Surface	0	1	1	5	24
Fecal Coliform	Surface	0	0	3	2	3
Total Kjeldahl Nitrogen (mg/L)	Surface	0	0	8	7	16
Lead (ug/L)	Surface	0	3	0	0	28
NH3 Ammonia (mg/L)	Surface	1	0	7	5	18
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	4	0	1	1	25
Nitrate (mg/L)	Surface	2	0	1	2	26
Nitrite (mg/L)	Surface	3	0	3	2	23
Orthophosphate (as P)(mg/L)	Surface	3	2	3	2	21
PH (SU)	Surface	0	0	0	4	23
Total Orthophosphate (mg/L)	Surface	6	7	2	2	14
Total Organic Carbon (mg/L)	Surface	1	2	0	0	4
Total Suspended Solids (mg/L)	Surface	4	0	4	0	23
Temperature (C)	Surface	0	3	0	1	23
Total Nitrogen (mg/L)	Surface	0	0	6	7	18
Total Phosphorus (mg/L)	Surface	6	7	2	2	14

Trend Summary for CHNEP Basin - Imperial River
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
BOD 5-Day (mg/L)	Surface	0	0	0	2	5
Chlorophyll a Corrected (ug/L)	Surface	1	0	1	0	5
Chloride (mg/L)	Surface	1	0	0	0	6
Color (PCU)	Surface	0	0	1	0	6
Conductivity (uS/cm)	Surface	0	0	0	1	5
Copper(ug/L)	Surface	0	0	1	0	6
Dissolved Oxygen (mg/L)	Surface	1	0	0	0	5
Dissolved Silica (mg/L)	Surface	0	0	1	2	4
Enterococci (cfu)	Surface	0	0	0	0	1
Fecal Coliform	Surface	0	0	2	0	2
Total Kjeldahl Nitrogen (mg/L)	Surface	0	0	0	5	2
Lead (ug/L)	Surface	0	1	0	0	6
NH3 Ammonia (mg/L)	Surface	0	0	0	2	5
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	1	0	0	0	6
Nitrate (mg/L)	Surface	0	0	0	0	7
Nitrite (mg/L)	Surface	1	0	0	1	5
Orthophosphate (as P)(mg/L)	Surface	0	1	0	0	6
PH (SU)	Surface	0	0	0	0	6
Total Orthophosphate (mg/L)	Surface	1	0	0	0	6
Total Suspended Solids (mg/L)	Surface	0	0	1	0	6
Temperature (C)	Surface	0	0	0	0	6
Total Nitrogen (mg/L)	Surface	0	0	0	3	4
Total Phosphorus (mg/L)	Surface	1	0	0	0	6

Trend Summary for CHNEP Basin - Spring Creek
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
BOD 5-Day (mg/L)	Surface	0	0	3	2	2
Chlorophyll a Corrected (ug/L)	Surface	4	0	0	0	3
Chloride (mg/L)	Surface	0	0	2	0	5
Color (PCU)	Surface	0	0	0	0	7
Conductivity (uS/cm)	Surface	0	0	2	0	3
Copper(ug/L)	Surface	0	0	3	0	4
Dissolved Oxygen (mg/L)	Surface	2	1	0	1	1
Dissolved Silica (mg/L)	Surface	0	0	0	3	4
Fecal Coliform	Surface	0	0	0	2	2
Total Kjeldahl Nitrogen (mg/L)	Surface	0	0	3	2	2
Lead (ug/L)	Surface	0	1	0	0	6
NH3 Ammonia (mg/L)	Surface	0	0	2	1	4
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	0	0	0	1	6
Nitrate (mg/L)	Surface	0	0	0	0	7
Nitrite (mg/L)	Surface	1	0	1	0	5
Orthophosphate (as P)(mg/L)	Surface	1	0	0	1	5
PH (SU)	Surface	0	2	0	0	3
Total Orthophosphate (mg/L)	Surface	1	2	1	0	3
Total Suspended Solids (mg/L)	Surface	0	0	2	0	5
Temperature (C)	Surface	0	0	0	0	5
Total Nitrogen (mg/L)	Surface	0	0	3	2	2
Total Phosphorus (mg/L)	Surface	1	2	1	0	3

Trend Summary for CHNEP Basin - Pine Island Sound
Data From Fixed Stations

		Trend Results				
		Decreasing		Increasing		Stable
		(>10%/Year)	(<=10%/Year)	(>10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level					
Ammonium Unionized (mg/L)	Surface	0	0	0	0	4
BOD 5-Day (mg/L)	Surface	0	0	1	2	2
Chlorophyll a Corrected (ug/L)	Surface	0	5	0	0	0
Chlorophyll a Uncorrected (ug/L)	Surface	0	2	0	0	10
Color (PCU)	Surface	5	0	0	0	8
Conductivity (uS/cm)	Surface	0	0	0	0	5
Dissolved Oxygen (mg/L)	Bottom	0	0	0	2	2
	Surface	0	0	0	6	11
Dissolved Silica (mg/L)	Surface	0	2	0	0	3
Enterococci (cfu)	Surface	0	0	0	0	5
Fecal Coliform	Surface	2	1	0	0	8
Kd (1/m)	Surface	0	0	0	0	5
Total Kjeldahl Nitrogen (mg/L)	Surface	2	1	0	0	10
NH3 Ammonia (mg/L)	Surface	2	0	0	0	3
Nitrate+Nitrate as Nitrogen (mg/L)	Surface	0	0	0	0	17
Nitrate (mg/L)	Surface	0	0	0	0	5
Nitrite (mg/L)	Surface	0	0	0	0	5
Orthophosphate (as P)(mg/L)	Surface	1	0	0	0	4
PH (SU)	Surface	0	2	0	1	14
Salinity (ppt)	Bottom	0	0	0	0	4
	Surface	0	0	0	0	17
Secchi Disk (m)	Surface	2	2	0	2	7
Total Orthophosphate (mg/L)	Surface	3	2	0	0	0
Total Organic Carbon (mg/L)	Surface	1	2	0	0	6
Total Suspended Solids (mg/L)	Surface	0	0	3	0	2
Temperature (C)	Bottom	0	0	0	0	4
	Surface	0	0	0	0	17
Total Nitrogen (mg/L)	Surface	5	2	0	0	10
Total Phosphorus (mg/L)	Surface	8	3	0	0	6

Trend Summary for CHNEP Basin - Pine Island Sound
Data From Random Stations

		Trend Results			
		Decreasing		Increasing	Stable
		(>10%/Year)	(<=10%/Year)	(<=10%/Year)	No Change
Parameter	Sample Level				
Ammonia as N Total (mg/l)	Surface	1	0	0	0
BOD 5-Day (mg/L)	Surface	0	0	0	1
Chlorophyll a Corrected (ug/l)	Surface	0	1	0	0
Color (PCU)	Surface	1	0	0	0
Dissolved Oxygen (mg/l)	Surface	0	0	0	1
Dissolved Silica (mg/L)	Surface	0	0	0	1
Light Attenuation Coefficient (1/m)	Surface	0	0	0	1
Nitrate+Nitrite as Nitrogen (mg/L)	Surface	0	0	0	2
Nitrite (mg/l)	Surface	0	0	0	1
Orthophosphate (as P)(mg/l)	Surface	1	0	0	0
PH (SU)	Surface	0	0	0	1
Salinity (ppt)	Surface	0	0	1	0
Specific Conductance (uS/cm)	Surface	0	0	0	1
Temperature (C)	Surface	0	0	0	1
Total Kjeldahl Nitrogen (mg/l)	Surface	0	1	0	0
Total Nitrogen (mg/L)	Surface	0	1	0	0
Total Organic Carbon (mg/l)	Surface	0	1	0	0
Total Phosphorous (mg/l)	Surface	0	1	0	0
Total Suspended Solids (mg/l)	Surface	0	0	1	0
Turbidity (NTU)	Surface	0	0	1	0

6.0 Supplemental Analysis

This chapter describes supplemental analysis to augment the core trend testing results provided in the chapters above that may be considered by the CHNEP in proceeding with efforts to achieve its quantifiable objectives. The objectives of this analysis was to; compare the standard SKT methodology to parametric statistical models in estimating timeseries trends for data collected in the estuary using the CCHMN probabilistic monitoring design (Figure 6-1), and to estimate the effects of varying the length of the timeseries on the trend test result. The following sections describe the results of these supplemental analyses and provide insights into how these results may be used to inform future efforts to examine timeseries trends in water quality data throughout the CHNEP.

6.1 Comparing time series models

As stated previously, the Seasonal Kendall Tau test for trend is generally the gold standard for the analysis of fixed station water quality data as described in Reckhow et al. (1993). Application of the SKT to estuarine data collected using a probabilistic design, however, required developing the timeseries trend test on a summary statistic (the arithmetic average) of 5 samples collected within a particular CCHMN stratum on the same date. While this method is valid for the analysis of timeseries trends, it ignores the variability between stations within a stratum collected on the same date and may, in some instances result in reduced statistical power relative to parametric methods.

Rust (2005) developed a method to evaluate water quality timeseries data for the South Florida Water Management District that fits a parametric linear mixed effects timeseries model to water quality data. Briefly the procedure uses SAS Proc Mixed, to fit a mixed model to the natural log-transformed water quality data to produce a set of model parameters.

The mixed model fitted to the data is specified as follows.

$$Y_t = \alpha + \beta(t-t_0) + S_t + \varepsilon_1 + \varepsilon_2$$

where

Y_t = natural log-transformed water quality measurement at time t

α = average seasonally-adjusted water quality measurement value at time t_0

β = average change in water quality measurement per unit time;

t = time of sample collection;

t_0 = reference time point to give relevance to the α parameter

S_t = seasonal effect at time t that repeats itself on an annual cycle and averages to zero;

ε_1 = random error term (with mean zero and standard deviation σ_1) associated with temporal variability in true water quality measurement values; and

ε_2 = random error term (with mean zero and standard deviation σ_2) associated with sampling and chemical analysis variability.

The ε_2 error terms are assumed to be stochastically independent from sample to sample whereas the correlation between the ε_1 error terms at times t_1 and t_2 is assumed to be equal to

$$\rho^{|t_2 - t_1|}.$$

This allows for corrections to the denominator degrees of freedom due to autocorrelation.

For this exercise we used data collected by CCHMN between 2003 and 2011to test for differences between the two statistical methods in predicting timeseries trends. Data collected near the surface were used for comparison purposes and the parameters included all of the principal analytes monitored by the CCHMN. In total, 250 trend test comparisons were made. For this exercise no adjustment was made for multiple comparisons as it was not the intended to provide inference from the results but rather compare results across methods.

The parametric time series models were found to be a reliable approach to modeling the water quality time series data. For example, surface temperature was well modeled by the parametric models as evidence by the timeseries plot of predicted and observed timeseries (Figure 6-2). Because of the variance partitioning of the random effects components of the mixed models, it is not recommended to calculate the coefficient of determination statistic (R square) as with ordinary least squares regression models. However, these models do provide additional insights into the dynamics of the water quality data by including the seasonal component of the timeseries explicitly into the predictions.

The SKT and the parametric models were in good agreement regarding the trend direction, trend significance, and trend magnitude for the stratum average water quality timeseries. In every case the methods agreed on the trend direction. Seventy percent of the comparisons yielded identical results regarding trend significance (either no trend or a statistically significant trend). In 20% of the cases, the SKT yielded a significant result whereas the parametric model suggested no trend while in 10% of the cases the parametric model suggested as significant trend while the SKT suggested no trend.

The results of this analysis suggest that both the SKT and an appropriately derived parametric timeseries model are capable of producing similar results regarding inference of trend testing procedures. Because the SKT is less reliant on distribution assumptions of the data and specificity of the model form, and because the SKT tended to be more powerful in cases where only one test resulted in a significant trend test result. The detailed trend test results using the SKT are provided in **Appendix 6.1** while the detailed trend test results using the parametric time series model is provided in **Appendix 6.2**.

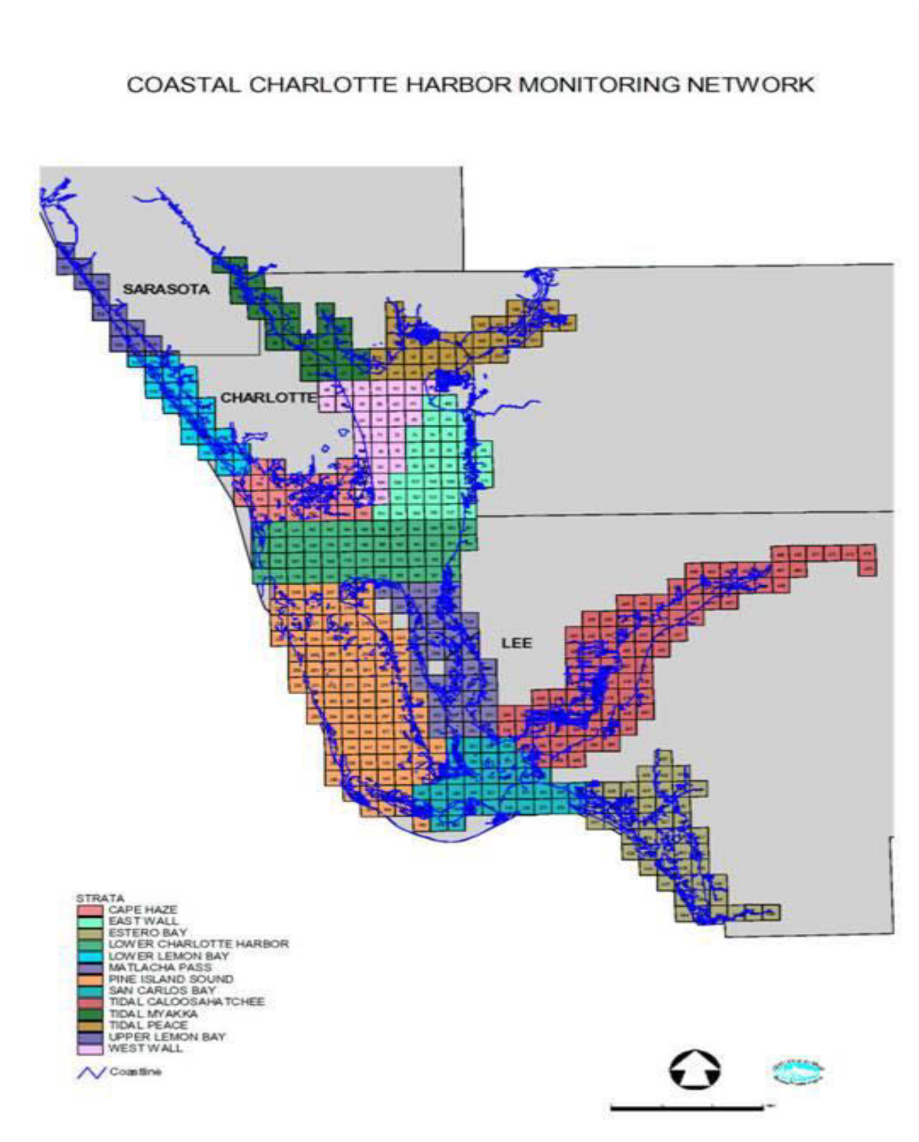


Figure 6-1. **The stratum used for probability based sampling by the Coastal Charlotte Harbor Water Quality Monitoring Network (CCHMN).**

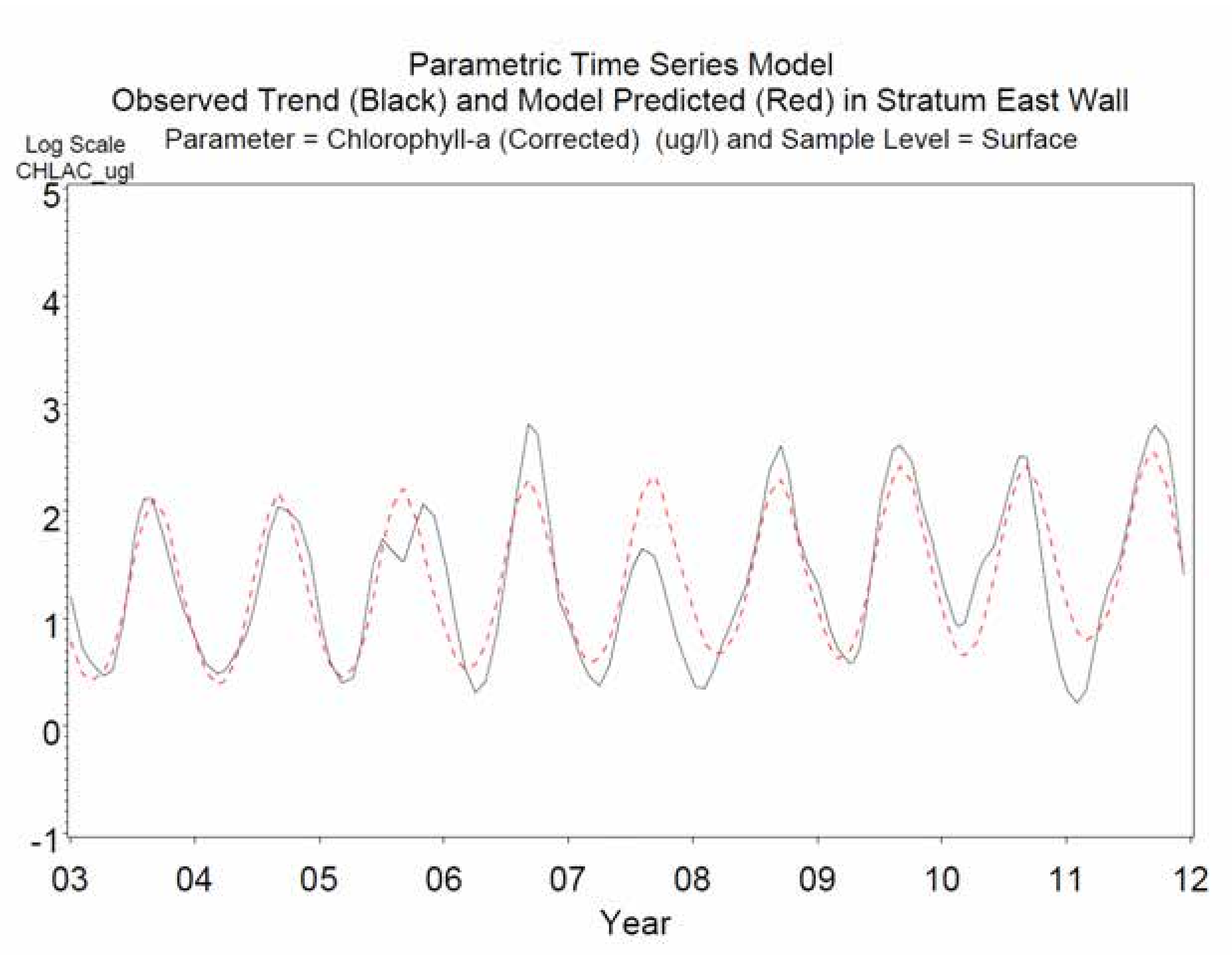


Figure 6-2. **Parametric timeseries model fit (broken line) to observed (solid line) surface corrected chlorophyll a in the East Wall stratum.**

6.2 Trend test stability

The objective of this effort was to examine the stability of the trend test in detecting long term trends in water quality constituents. The current minimum criterion for running time series trend analysis for a particular station parameter combination is a 5 year time window with continuous monthly sampling. This criterion was developed early in the initiation of the CHNEP when there were fewer fixed stations sampled and a shorter time period from which to conduct trend testing. From a management perspective the question is, is a 5 year time period the correct minimum and if not what is the correct time period minimum. To attempt to answer this question, a random sample of long term fixed stations with at least 15 years of data and a stable trend result from the core testing procedure in Chapter 5 (i.e., no trend was detected) were selected for analysis and 5 year trend tests using a 3 year moving window were conducted. Four parameters (total nitrogen, total phosphorus, chlorophyll a, and dissolved oxygen) were considered for this analysis. Optimally, if the long term trend was stable, then from a management perspective, none of the individual 5 year tests would be significant. If they were significant it would mean that making management decisions based on a 5 year trend may be an overreaction to a transient artifact in the timeseries that may be related to inter annual climatic cycles rather than an anthropogenic disturbance to water quality. It is important to keep in mind that:

- most of the trend test conducted as part of the core testing procedures was longer than 5 years;
- that the purpose of the trend tests as currently being used by the CHNEP is to provide a screening level assessment of trends in water quality that can then be targeted for further evaluation by resource managers, and
- that there is a balance in resource management that needs to be maintained between being proactive in protecting water quality while not over reacting to results that may not be anthropogenically derived.

The results of this analysis is provided in Table 6-1 and suggests that the 5 year minimum might be reconsidered as a minimum criteria if the desire is for the trend test results to provide basis for management action. Many of the stations with stable timeseries over the long term period of record contained individual five year periods with statistically significant increasing or decreasing trends. The Benjamini and Hochberg adjustment was also applied to this analysis to account for multiple comparisons. Significant trends (after adjustment for multiple comparisons) are denoted by a +1 for an increasing trend and a -1 for a decreasing trend. A value of zero indicates a stable trend.

The results of running the trend stability tests using a 10 year minimum and a 5 year moving window are provided in Table 6-2. These results also suggest that there are statistically significant short term trends in water quality embedded within many of the long term period of record stations with stable long term trends over a 15-20 year period of record. The implications of this are discussed in the next chapter on summary and recommendations.

Table 6-1. Results of trend stability test for stations with at least 15 years of data using a 5 year window and a three year shift.

		Five Year Interval						
Station	Parameter	1st	2nd	3rd	4th	5th	6th	7th
SIXMILE1	TN_MGL	0	0	0	0	0	0	0
SIXMILE1	TP_MGL	0	0	-1	1	0	0	0
10MIGR10	DO_MGL	0	0	0	1	0	0	
10MIGR10	TN_MGL	0	0	0	0	0	1	
10MIGR10	TP_MGL	0	0	0	0	0	-1	
20-9GR	DO_MGL	0	-1	0	1	0	0	
20-9GR	TN_MGL	0	0	0	0	0	0	
20-9GR	TP_MGL	0	-1	0	-1	0	0	
37-4GR	DO_MGL	0	0	-1	1	0	0	
37-4GR	TN_MGL	0	0	0	0	0	1	
37-4GR	TP_MGL	0	0	0	-1	0	0	
40-18GR	DO_MGL	-1	0	0	0	0	0	
47B-11GR	DO_MGL	-1	0	1	0	0	0	
47B-11GR	TN_MGL	0	0	0	0	0	1	
47B-11GR	TP_MGL	0	0	1	0	0	-1	
48-10GR	DO_MGL	-1	0	0	0	0	0	
48-10GR	TP_MGL	0	0	1	0	0	0	
EB-14	CHLAC_UGL	0	0	0	0	-1		
EB-14	DO_MGL	0	0	0	1	-1	0	
EB-14	TN_MGL	-1	0	1	1	-1	0	
EB-14	TP_MGL	0	0	0	-1	0	-1	
GATRGR60	DO_MGL	-1	0	0	1	0	-1	
GATRGR60	TN_MGL	0	0	0	0	0	1	
GATRGR60	TP_MGL	0	0	0	0	0	0	
IMPRGR30	DO_MGL	-1	0	0	0	0	0	
IMPRGR30	TN_MGL	0	0	0	0	0	1	
IMPRGR30	TP_MGL	0	0	1	0	0	-1	
PI-01	CHLAC_UGL	0	0	0	0			

Table 6-2. Results of trend stability test for stations with at least 15 years of data using a 10 year window with a 5 year shift.

		Ten Year Interval		
Station	Parameter	1st	2nd	3rd
SIXMILE1	TN_MGL	0	0	0
SIXMILE1	TP_MGL	0	0	0
10MIGR10	DO_MGL	0	1	0
10MIGR10	TN_MGL	0	0	0
10MIGR10	TP_MGL	0	1	-1
20-9GR	DO_MGL	-1	0	0
20-9GR	TN_MGL	0	0	1
20-9GR	TP_MGL	0	0	0
37-4GR	DO_MGL	-1	0	0
37-4GR	TN_MGL	0	0	1
37-4GR	TP_MGL	0	0	-1
40-18GR	DO_MGL	0	1	0
47B-11GR	DO_MGL	0	1	0
47B-11GR	TN_MGL	0	0	1
47B-11GR	TP_MGL	0	0	-1
48-10GR	DO_MGL	-1	1	0
48-10GR	TP_MGL	1	0	-1
EB-14	CHLAC_UGL	0	-1	
EB-14	DO_MGL	0	1	0
EB-14	TN_MGL	-1	1	0
EB-14	TP_MGL	0	0	-1
GATRGR60	DO_MGL	-1	1	0
GATRGR60	TN_MGL	0	0	0
GATRGR60	TP_MGL	0	0	-1
IMPRGR30	DO_MGL	-1	1	0
IMPRGR30	TN_MGL	0	1	1
IMPRGR30	TP_MGL	-1	0	0
PI-01	CHLAC_UGL	0	0	

7.0 Summary and Recommendations

This report has provided an extensive data compilation and analysis of water quality trends including rainfall, streamflow and surface water quality data collected throughout the Charlotte Harbor National Estuary Program (CHNEP) study area. The purpose of the report was to compile data for this extensive area, describe time series trends of these important indicators of environmental condition and report that information in an easily accessible format that can be effectively used by natural resource managers to characterize water quality conditions over an expansive area of southwest Florida. The analyses presented incorporate the preponderance of data collected over the last century in areas within the CHNEP boundaries with active monitoring programs.

The results of the rainfall analyses indicated that over the long term period of record there were no apparent trends in rainfall. In other words, rainfall varied seasonally in a predictable way but there was insufficient evidence to suggest that rainfall was either declining or increasing at the basin level over time. The results of the stream flow trend analyses indicated that statistically significant trends were prevalent for certain stream flow parameters in many of the rivers and streams throughout the CHNEP study area. Stream flow changes have occurred in terms of magnitude of flows as well as timing and volume of flows as described by the 32 aspects of the Index of Hydrologic Alteration (IHA). For example, the annual 1 day and 30 day flow maxima in the Estero Bay and Cape Coral area appeared to be increasing, coincident with decreases in the number of low flow pulses. From these results, it may be concluded that changes to stream flow have been occurring at statistically significant rates for many streams over the period of record. Many of the strongest IHA stream flow changes were observed to occur in the Cape Coral peninsula area and the Estero Bay watershed, and these locations were also locations where changes in water quality were detected. However, these results are not a direct causative expression of relationships between stream flow and water quality as these trends can represent differing periods of record. Other potential sources of surface water quality declines include changes in pollutant loading from non-point sources in the watershed, point sources, and or atmospheric deposition.

Reporting of surface water quality trends was divided into three regions; the Myakka River region, the Peace River region, and the Southern Coast region that includes Charlotte Harbor Proper, the Caloosahatchee River and Estero Bay. The results of the surface water quality status and trends analyses indicated that there have been both areas of stable or improving water quality as well as areas of declining water quality in many of the basins in the CHNEP study area. In the Myakka River region trends were mostly stable in the estuarine segments with isolated improving trends in total phosphorus and color. There were a few degrading trends in chlorophyll in the Lower Myakka River basin that were correlated with small increases over time in total kjeldahl nitrogen and increases in bottom salinity. Dissolved oxygen concentrations were largely stable throughout the region. In the Peace River Region, there were several stations with increasing salinity and pH trends in the Coastal Lower Peace sub-basin. Despite some degrading trends in total kjeldahl nitrogen and total nitrogen, chlorophyll trends were mostly stable; however, some degrading trends in dissolved oxygen concentration were noted. Otherwise water quality throughout the Peace River Region where mostly stable over time. The exception was in the Peace at Zolpho Springs sub-basin where there were a majority of the chlorophyll a and total nitrogen trends were found to be degrading. These stations were located in one particular area within the sub-basin and may warrant further investigation. The Southern Coast Region includes many of the estuarine segments within Charlotte Harbor as well as the Caloosahatchee River and the Estero Bay watershed. In the estuary, most parameters were stable over time; however, there were a few improving trends including the light attenuation parameter Kd that was found to be improving in the upper segments of Charlotte Harbor including East Wall, West Wall, And the tidal portions of the Peace and Myakka Rivers. This corresponded with improvements in total kjeldahl nitrogen and total nitrogen trends in the same area. However, small degrading trends were also noted such as total suspended solids in Bokeelia, Pine Island Sound, San Carlos Bay and Matlacha Pass. In the watershed sub-basins, there was consistent evidence of improving trends in chlorophyll a throughout the region and very few degrading trends. This occurred despite increasing trends in nitrogen for many of the same stations. Trends in total phosphorus depended largely on which side of the Caloosahatchee River the station was located with improving trends south of the river and degrading trends north of the river. There were also some stations with increasing copper and chromium concentrations isolated to within the Tidal Caloosahatchee sub-basin.

An important addition to water quality monitoring in the CHNEP boundaries was the incorporation of a probabilistic sampling design for estuarine water quality. These data collections began between 2001 and 2003 and continue throughout the estuarine segments of the CHNEP to date. The data collected has been a valuable asset in supporting water quality targets protective of important natural resources in CHNEP estuaries. Due to the nature of the sampling design, these data required additional analysis to ensure that the SKT method remained a valid estimator of time series trends. Results suggested that there was good agreement between the results of the SKT and the parametric modeling efforts with over 70% of the results identical. The SKT method was more powerful in most cases where there was disagreement between model outcomes but both methods appeared adequate to provide inference on the segment level water quality timeseries trends in the CHNEP estuarine segments.

Recommendations for future analysis include considering a longer time period as a minimum for invoking the trend testing procedure to avoid reporting significant results that may be due principally to interannual variation in climatic conditions such as El Nino. Alternatively, the effects of hydrologic variation on a particular water quality constituent might be factored out of the timeseries prior to analysis. Doing so, either prior to testing using the SKT or by including a term into the parametric models would help to remove variation in important drivers of water quality not directly related to anthropogenic activities (e.g., stream flow) on the water quality timeseries. More explanatory models would factor out other sources of natural variation such as temperature deviations (e.g., lower than average winter temperatures) on the water quality timeseries. However, in applying these techniques care should be taken to how variance is partitioned between these effects in the modeling framework. From a management perspective, the trend results provided within do not constitute direct inference with respect to the causes of reported trends. Rather, the trend results are used to investigate water quality trends over an expansive area and provide information to local resource managers on trend results over an expansive area of southwest Florida. Together these results present a great deal of information regarding trends in water quality in the CHNEP basin supporting the aims of the CCMP. The results presented within, along with the tools developed for this project, provide valuable information to scientist and managers to support science-based decision making to identify areas where water quality conditions have improved throughout the region and identify areas where actions may be necessary as well as identify potential areas for restoration activities. The results of this project aid the CHNEP in promoting the effective long-term management of estuaries whose ecological integrity is potentially at risk due to pollution, development or overuse.

8.0 References

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