LOXAHATCHEE RIVER WATER QUALITY AND BIOLOGICAL MONITORING

TASK 4: FINAL REPORT
ASSESSMENT OF 2009-2010 LOXAHATCHEE RIVER WATER QUALITY

In Partial Fulfillment of Agreement No. 4600001907

For the Period

October 2009 through September 2010

Respectfully Submitted by

Bud Howard, Lorene Bachman, Susan Noel, David Porter, Jerry Metz, Helen Johnson, Abbey Wilkison, Albrey Arrington, Ph.D.

Loxahatchee River District

December 2010

Contents

List of Figures

List of Tables

Executive Summary

This report presents water quality data collected under the Loxahatchee River District's (LRD) RiverKeeper water quality monitoring program. This monitoring program evaluates 29 water quality parameters at 39 sites throughout the Loxahatchee River watershed and estuary. Fifteen sites are sampled every month, and the remaining sites are sampled bi-monthly (every other month). The purpose of this program is to identify long-term trends, assess compliance with established water quality targets, and establish baseline conditions prior to the modifications of freshwater inflows resulting from the Comprehensive Everglades Restoration Project (CERP) and the Northwest Fork Restoration Plan.

This report provides a simplified characterization and overview of water quality conditions in the Loxahatchee River for the reporting period October 2009 through September 2010, with historical comparisons. A stoplight analysis (green/good, yellow/caution, red/poor) evaluating several key parameters to compare the 2010 water quality data to the established Target Period of 1998-2002 indicated generally good water quality throughout the watershed. These findings are encouraging because flows into the river were higher than previous years, particularly during the dry season. While increased base flows into the river are beneficial, protecting freshwater dependent species in downstream segments of the river from saltwater intrusion, increased flows may lead to increased nutrient loading to the system. The results presented here suggest that increased flows in 2010 did not increase nitrogen and phosphorus concentrations to detrimental levels, e.g., observed concentrations did not exceed EPA's newly published numeric nutrient criteria. On a less encouraging note, the sampling sites throughout the watershed continue to exhibit elevated chlorophyll and low dissolved oxygen values relative to the targets and FDEP criteria. While two river segments scored a "yellow/caution" level, our assessment of all sampling sites indicates elevated chlorophyll throughout the watershed. Further investigation into the causes and potential consequences of these findings is needed. Lastly, several sites in the watershed have consistently scored poorly for more than three key parameters. Targeted projects should be developed and implemented to improve water quality at these sites.

Introduction

Since 1971 the Loxahatchee River District (LRD) has been fulfilling its mission to preserve and protect the Loxahatchee River through an innovative wastewater treatment and reuse program and an active water quality monitoring program. LRD staff have monitored water quality in the surface waters of the Loxahatchee River and associated waters (see Figure 1) in an effort to document the condition and ecological health of the river and to determine the location and extent of water quality issues that need to be addressed. Over these past 35 years, the Loxahatchee River District has contributed significantly to the understanding of the ecology of this river (see http://www.loxahatcheeriver.org/reports.php). While numerous reports have been written regarding the Loxahatchee River, perhaps none are as comprehensive as the *Restoration Plan for the Northwest Fork of the Loxahatchee River* (SFWMD 2006). This document characterizes the watershed, discusses various restoration alternatives, and identifies the preferred restoration flow scenario. In particular, Table 10-1 of the restoration plan includes the water quality targets for the marine (salinity >30 ppt), polyhaline (salinity 18 – 30 ppt), meso/oligohaline (salinity 5 – 18 / 0.5 - 5 ppt), wild and scenic (salinity <5 ppt), and freshwater tributary (salinity <5 ppt) zones of the Loxahatchee River. These water quality targets (i.e., non-degradation standards) were established by LRD and SFWMD scientists using bi-monthly water quality data collected by LRD over the five year period 1998-2002. Using this model, we have expanded the numbers of sites within each of the above categories and added supplemental river segment or analysis group categories for Freshwater Canals, and Brackish Tributaries. Figure 2 and Table 1 illustrate water quality sampling sites, analysis group categories and sampling frequency.

Staff from the Loxahatchee River District's WildPine Ecological Laboratory collects and analyzes surface water samples for 29 parameters at 39 sites located in the Loxahatchee River, its major tributaries, and associated waters (Figure 1). Fifteen sites are sampled every month, and the remaining sites are sampled bi-monthly (every other month). This water quality monitoring program, entitled "RiverKeeper", was developed to identify long-term trends, and assess compliance with the established water quality targets. Furthermore, on-going results from our water quality monitoring program are used to establish baseline conditions prior to modification of freshwater inflows resulting from the Comprehensive Everglades Restoration Project and the Northwest Fork Restoration Plan (CERP 2001; SFWMD 2006).

The purpose of this report is to provide a simplified characterization and overview of the water quality conditions in Loxahatchee River. We assess and summarize the water quality throughout the watershed at three levels: first, a high-level "stoplight" approach by river segment; second, a temporal and spatial assessment by river segment; and third, annual comparisons of individual sampling sites relative to target levels.

Study Area

The Loxahatchee River estuary encompasses approximately 400 ha and drains a watershed of approximately 700 km^2 located in northeastern Palm Beach County and southeastern Martin County, Florida, USA (Figure 1). Freshwater discharges into the estuary from the North Fork, the Northwest Fork, and the Southwest Fork of the Loxahatchee River. The hydrology of the basin has been substantially altered by flood control efforts since the 1950s. Historically (pre-1950), most surface water runoff reaching the estuary originated in Loxahatchee and Hungryland Sloughs and flowed gradually to the Northwest Fork. In the 1930s the Lainhart Dam, a small fixed-weir dam, was constructed in the Northwest Fork at river mile 14.5 to reduce "over" drainage of upstream reaches of the Northwest Fork during dry seasons. In 1958 a major canal (C-18) and flood control structure (S-46) were constructed to divert flows from the Northwest Fork to the Southwest Fork, which increased the intensity and decreased the duration of storm-related discharge to the estuary. Furthermore, since 1947 Jupiter inlet, the eastern link to the ocean, was expanded through ongoing dredging projects. These hydraulic modifications promoted increased saltwater flows into the previously freshwater portions of Northwest Fork. Ongoing restoration efforts seek to increase base flows into the Northwest Fork, while not compromising the ecological integrity of downstream reaches (i.e., estuary) nor impairing valued ecosystem components of the estuary such as oysters and seagrasses (SFWMD 2006).

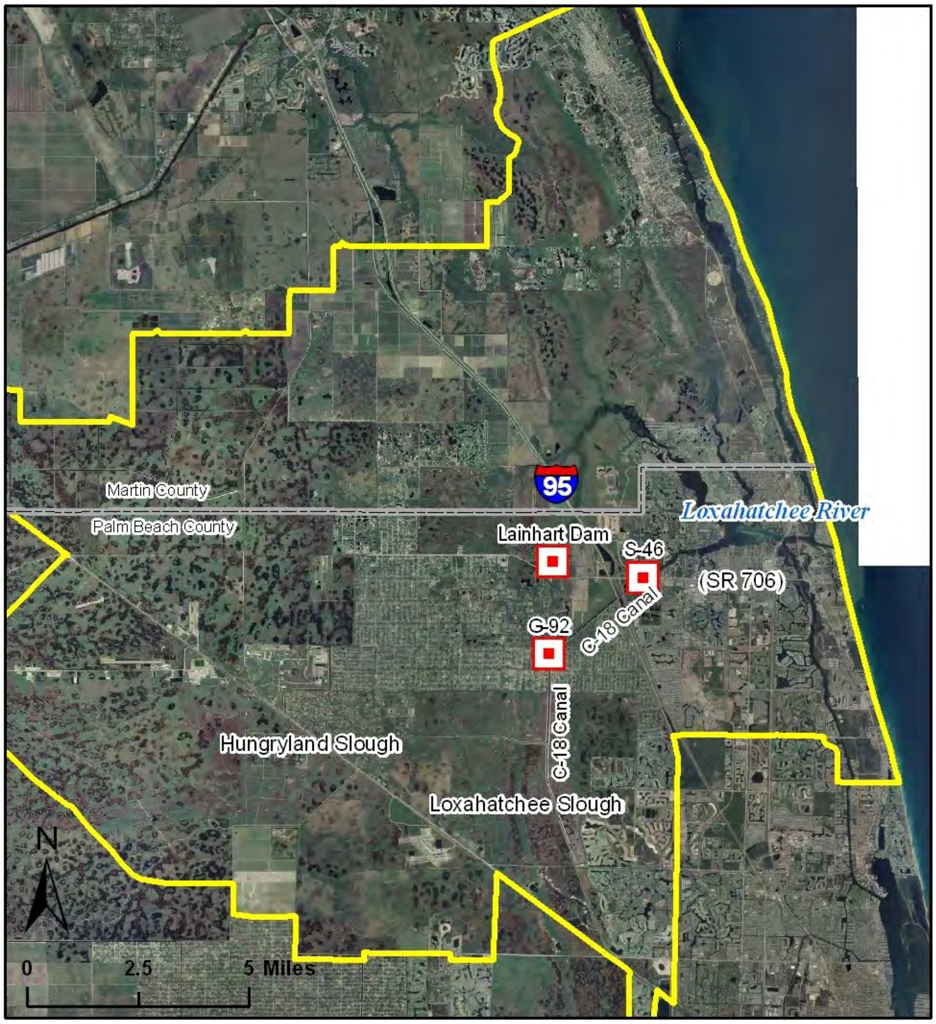


Figure 1. Loxahatchee River watershed and associated features.

Materials and Methods

LRD scientists collected water quality samples monthly or every other month at the stations identified in Table 1. At each station, physical water quality conditions (e.g., temperature, pH, conductivity, salinity, and dissolved oxygen) were evaluated using a multi-probe water quality instrument near the water surface (0.3 m depth). At stations 60 through 66, the river reach most likely to experience a halocline (salinity stratification), we also sampled at mid-depth and approximately 20 cm above the river bottom.

Nutrient, bacteriological, chlorophyll *a*, turbidity, total suspended solids, and water color samples were processed following Standard Methods by the Loxahatchee River District's

WildPine Laboratory. The WildPine Laboratory has been certified (#E56026) under the National Environmental Laboratory Accreditation Program (NELAC) since 2000. Prior to 2000, the WildPine lab was a state certified laboratory. Analysis methods and detection limits are summarized in Appendix C. Photosynthetically active radiation (PAR) was assessed by simultaneously logging at least three replicates of PAR using three LI-COR spherical sensors (4 π) fixed at 20 cm, 50 cm, and 100 cm below the water surface. Appendix E contains a complete list of parameters for each station.

A key distinction in this report and analysis is the removal of problematic nitrogen data (Total Kjeldahl Nitrogen (TKN), total nitrogen, organic nitrogen) collected prior to January 1, 2005. Prior to 2005 the WildPine laboratory employed a laboratory analysis technique for nitrogen that used mercury. Unfortunately, we discovered that saline waters caused interference in the results. These problems were remedied in 2005 though the use of an analysis technique utilizing copper. As a precaution to eliminate spurious results we removed the nitrogen data for all samples collected prior to 2005 where salinity was greater than 10 ppt. While it is regrettable that these data are lost, it is fortunate that we identified and remedied the analytical issue.

For consistency in analyses we summarized “annual” data collected from October 1 through September 30. For example, the data group named “2010” included all data from October 1, 2009 and September 30, 2010; the 5-year target period group from 1998 – 2002 included all data collected from October 1, 1997 and September 30, 2002.

For our first data visualization tool we used a ‘stoplight’ approach to provide a simplified, integrated assessment of annual observed water quality conditions for key nutrient measures including Total Nitrogen, Total Phosphorus, and Chlorophyll *a* as measured by the annual geometric mean. We compared the annual geometric mean relative to target water quality values (1998-2002) for each of the seven river reaches: marine, polyhaline, mesohaline, wild and scenic, freshwater tributaries, brackish tributaries, and freshwater canals. We utilize the geometric mean for consistency with DEP and EPA analytical approaches, and it is the more appropriate measure of central tendency for skewed data. Analytical results for each river reach were divided into three categories (red, yellow, and green), which can be interpreted similar to the colors in a traffic signal. Appendix A presents the decision rules and data. But in general terms we evaluated the annual geometric mean relative to the 75^{th} and 90^{th} percentiles from the data collected during the target period 1998-2002. Green indicates good or acceptable conditions – no degradation is occurring. Yellow indicates caution should be observed – degradation may or may not be occurring (i.e., there may be cause for concern). Red indicates degradation likely is occurring, and resource managers should seek to identify the source of the problem and determine what actions might be employed to remedy the observed degradation in water quality.

Next, we provide a more comprehensive and thorough temporal and spatial assessment using box and whisker plots to compare water quality conditions for all parameters among the following periods: the target period (1998-2002), the subsequent 5 year period (2003-2007), and then annually 2008 through 2010.

With the recent publication of the Environmental Protection Agency's (EPA) Water Quality Standards for the State of Florida's Lakes and Flowing Waters, we provide an assessment of the water quality at all freshwater sampling sites throughout the Loxahatchee River watershed relative to EPA's Numeric Nutrient Criteria instream protection values for streams in Florida's Peninsula region. To compliment the comparisons to the nutrient criteria, we provide comparisons for the non-freshwater segments to the 1998-2002 target period using the stoplight method described above. These comparisons provide a more detailed stoplight assessment of annual water quality conditions for each sampling site for total nitrogen, total phosphorus, chlorophyll a, dissolved oxygen, and fecal coliform bacteria. Lastly, we present maps showing all sampling sites symbolized by the 2010 stoplight scores developed from the previously described comparisons to the numeric nutrient criteria, or the 1998-2002 target period.

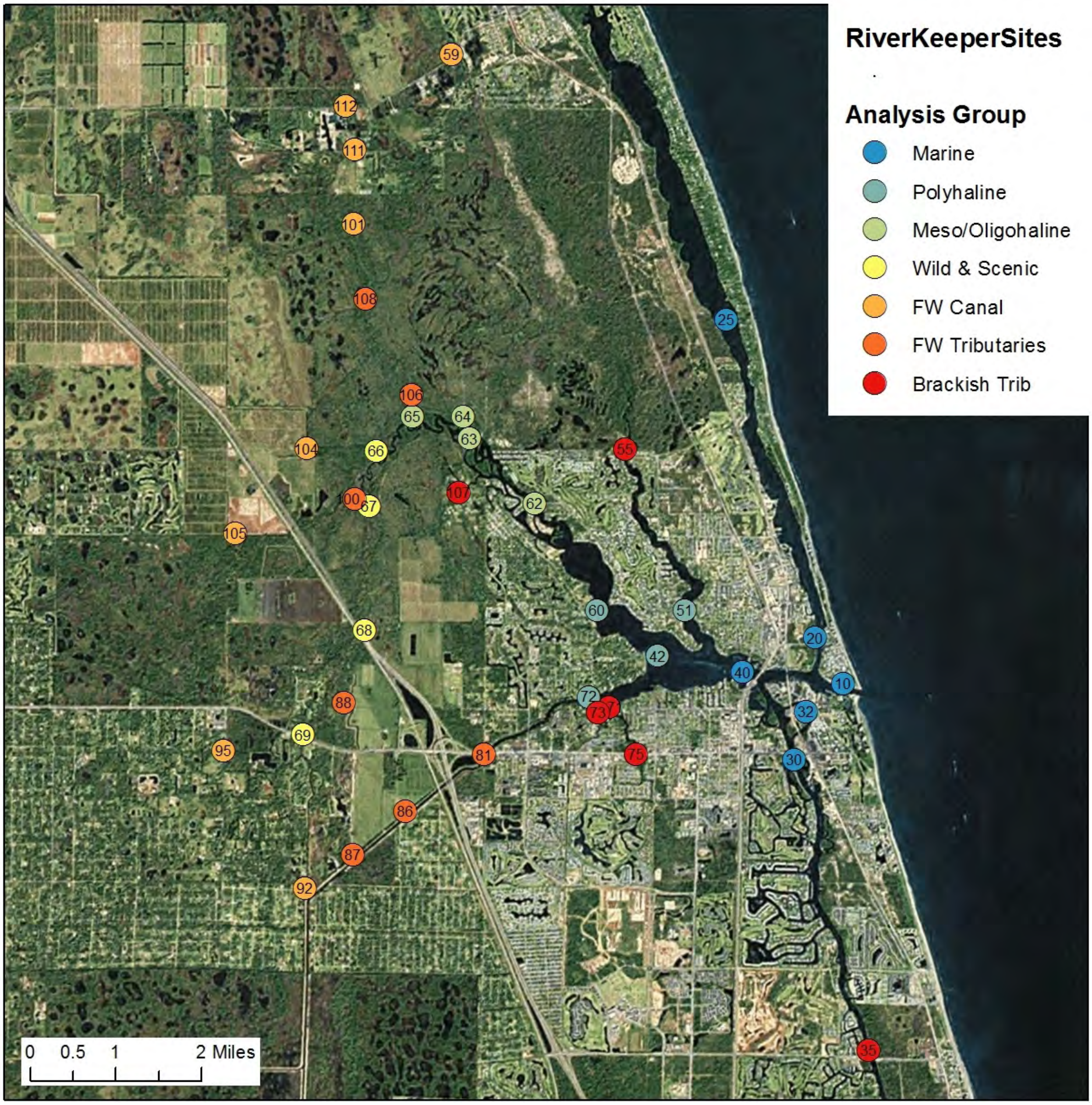


Figure 2. Loxahatchee River District's water quality monitoring stations in the Loxahatchee River and associated waters, color coded by river segment/analysis group.

Table 1. RiverKeeper sampling sites.

Station	Analysis Group	Restoration Plan Zone+	Sampling Frequency++	Northing*	Easting*	Latitude**	Longitude**
10	Marine	Marine	Monthly	950,408	957,903	26 56.7206	-80 04.4293
20	Marine	Marine	BM	953,238	956,193	26 57.1897	-80 04.7404
25	Marine		BM	972,837	950,720	27 00.4308	-80 05.7224
30	Marine	Marine	BM	945,745	954,896	26 55.9546	-80 04.9892
32	Marine		BM	948,686	955,606	26 56.4391	-80 04.8546
35	Brackish Trib		BM	927,816	959,468	26 52.9901	-80 04.1717
40	Marine		Monthly	951,108	951,709	26 56.8435	-80 05.5690
42	Polyhaline		BM	952,109	946,497	26 57.0148	-80 06.5275
51	Polyhaline	Polyhaline	BM	954,927	948,122	26 57.4780	-80 06.2246
55	Brackish Trib		BM	964,841	944,439	26 59.1185	-80 06.8901
59	FW Canal		BM	989,168	933,755	27 03.1456	-80 08.8280
60	Polyhaline	Polyhaline	Monthly	954,920	942,739	26 57.4831	-80 07.2160
62	Meso/Oligohaline	Meso/Oligohaline	Monthly	961,525	938,899	26 58.5776	-80 07.9148
63	Meso/Oligohaline	Meso/Oligohaline	BM	965,503	934,848	26 59.2387	-80 08.6561
64	Meso/Oligohaline	Meso/Oligohaline	BM	966,884	934,503	26 59.4670	-80 08.7179
65	Meso/Oligohaline		Monthly	966,873	931,330	26 59.4687	-80 09.3025
66	Wild & Scenic		BM	964,747	929,142	26 59.1202	-80 09.7082
67	Wild & Scenic	Wild & Scenic	Monthly	961,353	928,662	26 58.5606	-80 09.8008
68	Wild & Scenic	Wild & Scenic	BM	953,689	928,384	26 57.2960	-80 09.8613
69	Wild & Scenic	Wild & Scenic	Monthly	947,259	924,583	26 56.2389	-80 10.5691
71	Brackish Trib		BM	948,947	943,456	26 56.4965	-80 07.0916
72	Polyhaline	Polyhaline	Monthly	949,554	942,258	26 56.5981	-80 07.3114
73	Brackish Trib		BM	948,621	942,812	26 56.4434	-80 07.2106
75	Brackish Trib		BM	946,078	945,127	26 56.0211	-80 06.7876
81	FW Tributaries	FW Tributaries	BM	946,035	935,787	26 56.0246	-80 08.5075
86	FW Tributaries		BM	942,562	930,899	26 55.4568	-80 09.4118
87	FW Tributaries		BM	939,867	927,701	26 55.0155	-80 10.0039
88	FW Tributaries		BM	949,254	927,103	26 56.5654	-80 10.1026
92	FW Canal		BM	937,810	924,731	26 54.6793	-80 10.5531
95	FW Canal	FW Tributaries	Monthly	946,288	919,695	26 56.0839	-80 11.4703
100	FW Tributaries	FW Tributaries	Monthly	961,807	927,804	26 58.6365	-80 09.9583
101	FW Canal		BM	978,724	927,740	27 01.4285	-80 09.9494
104	FW Canal		BM	964,884	924,842	26 59.1475	-80 10.5002
105	FW Canal		BM	959,657	920,431	26 58.2895	-80 11.3190
106	FW Tributaries		BM	968,197	931,290	26 59.6873	-80 09.3082
107	Brackish Trib		BM	962,186	934,199	26 58.6920	-80 08.7798
108	FW Tributaries		BM	974,119	928,465	27 00.6677	-80 09.8215
111	FW Canal		BM	983,296	927,764	27 02.1831	-80 09.9395
112	FW Canal		BM	985,981	927,200	27 02.6268	-80 10.0401

Notes:

+ From Restoration Plan, (SFWMD, 2006)

++ BM - Bi-Monthly (Every other month)

* State Plane, Florida East, Ft

** WGS 1984, Degrees - Decimal Minutes

Results & Discussion

During the period October 2009 through September 2010 we collected and analyzed 374 water quality samples for 29 parameters resulting in over 6,000 analytical results. Because water quality is closely related to the hydrologic conditions in the region, we first provide an assessment of rainfall and resulting river flows. Water managers have established minimum flow criteria that are designed to provide sufficient flows to protect the river's freshwater ecosystems from saltwater intrusion migrating up the river.

Rainfall and River Flows

Total annual rainfall for the period October 1 through September 30 was highest observed since 2003. The increased rainfall and effective flood control management resulted in moderate but consistent river flows measured at Lainhart Dam. In 2010 we recorded 70 inches of rain at LRD's treatment plant in Jupiter, compared to 60, 59, and 64 inches for the same period (October-September) in 2009, 2008 and 2007 (Table 2). Annual average daily flows at Lainhart Dam during the same period were also moderate at 89 cfs in 2010 compared to 77, 106, and 80 cfs for 2009, 2008 and 2007 (SFWMD-DBHYDRO). Daily flows over Lainhart Dam were less than 35 cfs, the minimum target flow established in the Restoration Plan, for only 11 total days in 2010 compared to 45, 48, and 162 days during 2009, 2008 and 2007 (SFWMD-DBHYDRO). Figure 3 illustrates the daily rainfall and elevated flows in 2010, with fewer low-flow conditions compared to 2008 and 2009. The increased rainfall during the 2009/2010 dry season, and sound water management operations, resulted in the first time the Minimum Flows and Levels (MFL) criteria were not violated in the Northwest Fork of the Loxahatchee River since 1997.

Table 2. Summary of annual rainfall and river flows measured at Lainhart Dam. Lainhart flow data from SFWMD-DBHYDRO.

Year (Oct 1 – Sept 30)	Annual Average Rainfall LRD Treatment Plan (in.)	Annual Average Daily Flow at Lainhart Dam (cfs)	Number of days where Lainhart flow < 35 cfs
2010	70.0	89.1	11
2009	60.1	76.7	45
2008	59.4	105.8	48
2007	64.4	80.0	162
2006	56.7	89.4	143
2005	44.8	109.9	77
2004	63.9	79.3	143
2003	56.2	72.4	103

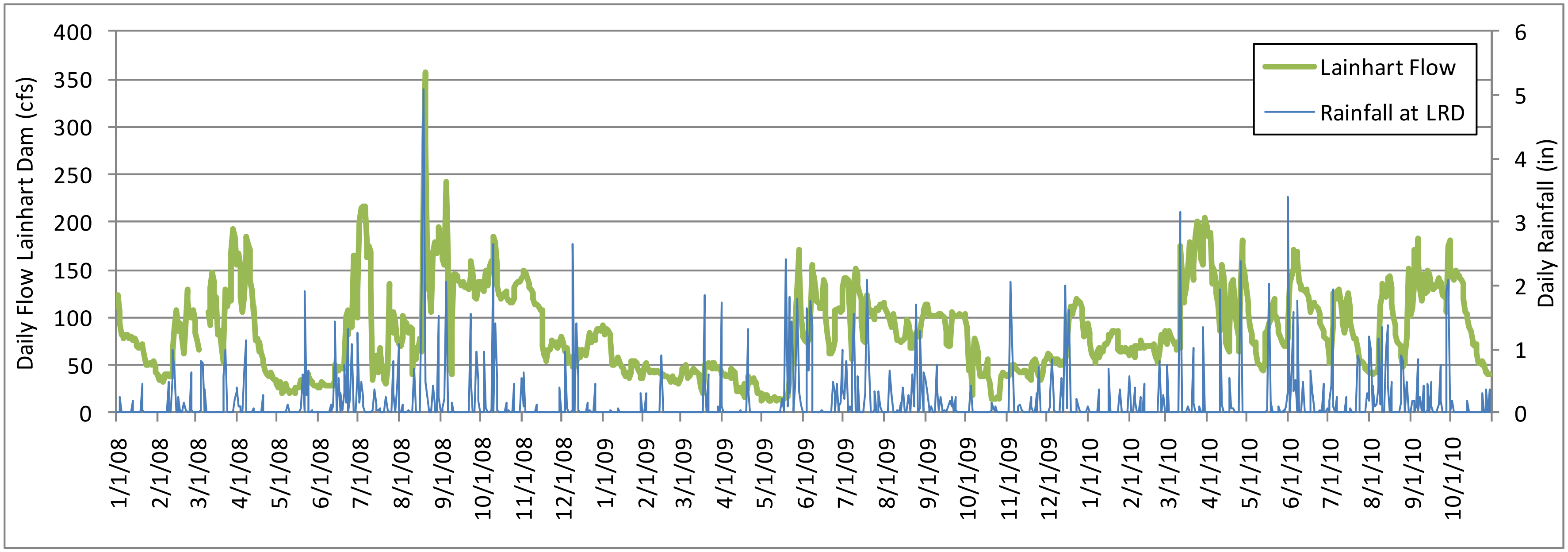


Figure 3. Plot of daily flow at Lainhart Dam and daily rainfall at LRD for the period of January 2008 through October 2010.

Stoplight Assessment

When compared against the water quality targets (i.e., non-degradation standards), water quality in the Loxahatchee River for 2010 (the period October 2009 through September 2010) scored "green/good" at all segments for total nitrogen and total phosphorus (Table 3). Two river segments (meso/oligohaline and brackish tributaries) showed elevated chlorophyll *a* values and suggest possible impairment of these waters (i.e. 'yellow'), relative to the 1998-2002 target values. A cursory review of Chlorophyll *a* over time suggests a trend of increasing concentrations relative to the 1998-2002 target period. However, more detailed analysis of these data are needed to determine if these are definite trends, or artifacts due to changes in sampling frequency (monthly prior to 2007 vs. bi-monthly since 2007), variations in duration of the reference period, or some other cause. The marine and polyhaline segments continue to show the greatest overall health. Semi-diurnal tides flush these downstream sites twice a day with relatively high quality (e.g., low nutrient concentrations) sea water flowing from the Atlantic Ocean in through the Jupiter Inlet.

In order to provide a historical perspective on water quality throughout the watershed, we also provide the annual stoplight scores back to 2003 (Table 3). Using these scoring thresholds, the river appears relatively healthy. Increased nutrient levels and the subsequent 'yellow' scores during the years labeled 2005 and 2006 (Oct. – Sept.) correspond with the heavy tropical storm activity during that period. Chlorophyll *a* values in the meso/oligohaline and brackish tributary segments are more frequently higher than the target values than the other segments. The temporal and spatial assessment sections (discussed below) provide additional detail into these observations. These data are somewhat perplexing. The observed increase in chlorophyll *a* appears to have occurred without an increase in either nitrogen or phosphorous. It is conceivable that the observed increase in chlorophyll a is due to an increase in availability of some other limiting nutrient. Presently, we do not have sufficient data to evaluate this hypothesis.

Table 3. A 'stoplight' assessment of water quality for Total Nitrogen, Total Phosphorus, and Chlorophyll *a* among the seven reaches of the Loxahatchee River for each period October through September relative to the target levels of 1998-2002. See Appendix A for decision rules and data.

Total Nitrogen

	Marine	Polyhaline	Meso/Oligo haline	Wild & Scenic	FW Tributaries	Brackish Tributaries	FW Canals
2003	🟢	🟢	🟡	🟢	🟢	🟡	🟢
2004	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2005	🟢	🟢	🔴	🟡	🟡	🟢	🟡
2006	🟢	🟢	🟢	🟡	🟡	🟢	🟡
2007	🟢	🟢	🟢	🟢	🟢	🟢	🟡
2008	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2009	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2010	🟢	🟢	🟢	🟢	🟢	🟢	🟢

Total Phosphorus

	Marine	Polyhaline	Meso/Oligo haline	Wild & Scenic	FW Tributaries	Brackish Tributaries	FW Canals
2003	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2004	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2005	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2006	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2007	🟢	🟢	🟢	🟡	🟢	🟢	🟢
2008	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2009	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2010	🟢	🟢	🟢	🟢	🟢	🟢	🟢

Chlorophyll *a*

	Marine	Polyhaline	Meso/Oligo haline	Wild & Scenic	FW Tributaries	Brackish Tributaries	FW Canals
2003	🟢	🟢	🟡	🟢	🟢	🟢	🟡
2004	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2005	🟢	🟡	🟡	🟢	🟢	🔴	🟢
2006	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2007	🟢	🟢	🟢	🟢	🟢	🟢	🟢
2008	🟢	🟢	🟡	🟢	🟢	🟡	🟢
2009	🟢	🟢	🔴	🟡	🟢	🟢	🟢
2010	🟢	🟢	🟡	🟢	🟢	🟡	🟢

Temporal Assessment

In addition to the previous stoplight assessment, in Appendix B we present water quality results using box and whisker plots for each parameter. These plots facilitate comparisons of water quality for all parameters among five temporal periods: the target period (1998-2002), five years following the target period (2003-2007), then 2008, 2009, and 2010 (October – September for all). The following provides a brief summary of noteworthy results from 2010, relative to the target period (1998-2002) for each parameter.

Alkalinity values measured in 2010 were above the target values in the polyhaline and brackish tributary segments. Chlorophyll *a* values from 2010 in the oligo/mesohaline were higher relative to the target period, but down from last year's high. Median chlorophyll values in the brackish tributaries reached a new high, and are well above the target values. Conductivity and salinity values in 2010 were notably lower than the targets in the important, saline sensitive meso/oligohaline and wild & scenic segments. These lower salinities are likely a result of the favorable river flows and higher annual rainfall during the dry season. Median dissolved oxygen values in 2010 in the wild & scenic segment were slightly lower than the target period and similar to 2008. In contrast, the median dissolved oxygen was higher than historical observations in the freshwater canal segments. Median fecal coliform values were highest in the brackish tributaries, while all other segments were similar to previous observations. Percent light transmission readings in 2010 were higher than previous years, meeting or exceeding median target periods nearly all river segments. An important observation is that despite heavier flows into the river, nitrogen related values (nitrate + nitrite, TKN, total nitrogen, organic nitrogen, and ammonia) are generally similar to previous years, and in-line with target values. Note that comparisons of nitrogen related values (TKN, total nitrogen, and organic nitrogen) in the marine segments, prior to 2005, are based on substantially reduced sample sizes because of data removal (see methods section for details). Median pH values in 2010 were elevated relative to the target period in the marine, polyhaline and brackish tributary segments. Despite record cold water temperatures during January and February 2010, the cooler temperatures are not reflected in the median or low range of the RiverKeeper sampling relative to the target period. This finding reinforces the benefits of higher high frequency sampling using instrumentation because the timing of monthly or bi-monthly sample might not capture significant events. Similar to the 2010 nitrogen-related parameters, phosphorus values (orthophosphorus and total phosphorus) also did not show substantial increases relative to the target period despite higher river flows and rainfall. While individual sites (see discussion below) show higher values, the combination of sites that comprise an analysis segment appear to be relatively healthy and similar to the target period values. Total suspended sediment and turbidity values in 2010 were lower in nearly all segments relative to the target periods and previous observations.

Assessment of Individual Sampling Sites

In order to provide an increased level of detail, we evaluated annual water quality at individual sampling sites throughout the watershed for five key parameters (total nitrogen, total phosphorus, chlorophyll *a*, dissolved oxygen and fecal coliform bacteria). This analysis provides additional insight into the water quality at specific sampling sites that comprise a river segment analysis group described above. We computed the annual geometric mean for the five key parameters. We compared the annual geometric mean of total nitrogen and total phosphorus relative to EPA's numeric nutrient criteria for freshwater streams in Florida for the stations within the wild & scenic, freshwater tributaries and freshwater canal river segments. For the other segments (marine, polyhaline, meso/oligohaline, and brackish tributaries) we compared the annual geometric mean to the 1998-2002 target for the respective river segment. For the chlorophyll *a* we compared the station geometric mean relative to the 1998-2002 river segment targets. Observed dissolved oxygen concentrations were compared to FDEP's Class III surface water criteria. Lastly, for the fecal coliform bacteria, we compared the annual geometric mean relative to EPA and FDEP's thresholds for recreational waters.

Total nitrogen values in 2010 were elevated (greater than 75% of the numeric nutrient criteria limit) at the majority of sampling stations within Kitching Creek (Table 4 and figure in Appendix C). Station 59, a canal tributary in the northern part of the watershed, exceeded the numeric nutrient criteria value of 1.54 mg/l. All other stations were below the 1998-2002 target or the numeric nutrient criteria.

Total phosphorus values were elevated at several sampling stations within the meso/oligohaline and brackish tributary segments. Two sampling sites (88 and 104) exceeded the numeric nutrient criteria for phosphorus (Table 5 and Appendix C).

Chlorophyll *a* values were elevated at more stations (17 total) than any other parameter, and were distributed throughout the various river segments (Table 6 and Appendix C). Seven of the stations measured values greater than the 90th percentile of the target period for the respective segment. Clearly, chlorophyll *a* is a parameter that needs to be monitored closely and further evaluated to gain a better understanding of the causes driving the increasing concentrations.

Observed dissolved oxygen values relative to FDEP's Class III surface water criteria were moderately low for fourteen stations and below the criteria at five stations (Table 7, Appendix C). We scored the annual geometric mean for each station 'green/good' for dissolved oxygen values that exceeded the 5 mg/l criteria; 'yellow/caution' for values less than 5 mg/l, but greater 3 mg/l, the lower limit for agricultural water supplies, and 'red/poor' for values less than 3 mg/l. All of the stations in the Wild & Scenic segment scored 'yellow/caution', but the dissolved oxygen values are not surprising considering the connectivity between the river channel and the floodplain swamp. Similarly low dissolved oxygen values in the meso/oligohaline stations may be attributed to the significant groundwater inputs into this segment of the river documented in studies by the U.S. Geological Survey. While the dissolved oxygen values for these segments are concerning relative to FDEP criteria, the values are generally comparable to the 1998-2002 targets using the previously described stoplight criteria. The freshwater canals, tributaries, and brackish tributaries each have stations that score yellow/caution, or red and do not meet the state's criteria for dissolved oxygen. While these stations have historically experienced low oxygen levels because of the nature of the sites (e.g., stagnant ditches, canals, etc.), they do not meet FDEP's critera.

Fecal coliform bacteria counts were high at two stations (107 and 73), and moderately high at two stations (106 and 75) (Table 8, Appendix C). The Loxahatchee River District has invested significant effort in converting existing development from the use of on-site wastewater treatment systems (i.e., septic systems) to the regional sanitary sewer. Nonetheless, the homes surrounding station 107 continue to rely on septic systems for their wastewater treatment.

In Figure 4 we provide a synthesis of these data in a spatial plot. When considering all five parameters, station 88, a freshwater tributary/ditch that flows into the northwest fork, station 75 at Jones Creek, a brackish tributary into the southwest fork, and station 107 a brackish tributary into the northwest fork are the most degraded sampling sites in the watershed. Station 88 is a surface water outfall that delivers water from a fallow agriculture area to the floodplain of the Northwest Fork just upstream of Masten Dam. During the dry season this site (i.e., culvert) is dry. During the wet season low flows are observed as this site following rainfall events. Station 75 is in Jones Creek, a drainage tributary for an extensive urban area of Jupiter. The Town of Jupiter, in partnership with the Loxahatchee River Preservation Initiative (LRPI), continues work a variety of stormwater improvement projects that may improve water quality within this sub-basin. Station 107 is in a tributary of the Northwest Fork referred to as Ketter Creek. This tributary provides drainage to an older residential community that relies on septic systems for wastewater treatment as well as a new development on former agriculture fields. These three sampling sites clearly present opportunities for restoration that would further improve surface water quality within the Loxahatchee River watershed.

Table 4. Summary of annual geometric mean for **total nitrogen** by sample station, color coded by numeric nutrient criteria for Florida streams, or 1998-2002 target values, Loxahatchee River, Florida.

Total Nitrogen (mg/l)

Freshwater Segments Color Coded by EPA's Numeric Nutrient Criteria for Florida Streams

River Analysis Zone	Site	1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Wild & Scenic	66	1.07	1.27	0.98	1.33	1.49	1.09	0.88	0.98	0.74
	67	0.93	1.07	1.00	1.22	1.34	1.10	0.97	1.05	0.85
	68	0.97	1.01	1.03	1.38	1.37	1.37	0.96	1.02	0.91
	69	0.88	1.09	0.97	1.37	1.30	1.11	0.99	1.05	0.93
FW Tributaries	81	0.90	1.02	0.96	1.34	1.18	1.29	0.91	1.10	0.87
	86							0.64	1.06	0.89
	87							0.62	1.11	0.87
	88							1.30	1.45	1.17
	100	1.07	1.14	0.95	1.45	1.32	1.09	0.98	1.02	0.89
	106	1.18	1.44	0.98	1.48	1.91	1.09	1.15	1.04	1.24
	108					2.14	1.34	0.94	1.34	1.22
FW Canal	59	1.20	1.05	1.47	1.60	2.05	1.95	1.42	2.24	1.89
	92	0.97	0.92	0.98	1.44	1.32	1.37	1.01	1.18	0.90
	95	0.85	0.95	0.87	1.52	1.27	1.48	0.88	1.10	0.93
	101	1.23	1.38	1.11	1.95	2.10	2.02	1.19	1.62	1.52
	104	1.37	1.77	1.26	1.93	1.42	1.14	0.99	1.13	1.08
	105	1.11	1.14	0.97	1.51	1.52	1.09	0.88	1.02	1.05
	111		1.23	1.15	1.54	1.86	1.65	0.87	1.79	1.50
	112		1.23	1.65	1.42	2.08	1.81	1.38	1.38	1.41

* Color Code - Yellow: >1.16 (75% of NNC Limit) and <1.54 (NNC Limit); Red: >1.54 (NNC Limit)

Color Coded By Loxahatchee River District Targets from 1998 - 2002

River Analysis Zone	Site	1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Marine	10		0.85		0.60	0.45	0.15	0.16	0.12	0.16
	20		0.78		0.59	0.28	0.17	0.18	0.16	0.15
	25		0.82		0.73	0.37	0.12	0.12	0.16	0.11
	30		0.95		0.68	0.47	0.18	0.22	0.18	0.21
	32				0.67	0.54	0.17	0.17	0.12	0.19
	40	1.44	0.63		0.69	0.38	0.20	0.19	0.11	0.11
	* Thresholds not available because of limited data (see methods)									
Brackish Trib	35		1.17		0.65	0.42	0.22	0.33	0.18	0.16
	55	1.26	1.46	1.75	1.41	0.65	0.75	0.37	0.47	0.45
	71	1.23	2.40	1.24	1.14	0.63	0.39	0.56	0.27	0.38
	73	1.28	2.47	0.81	0.79	0.71	0.65	0.66	0.49	0.58
	75						0.49	0.62	0.58	0.82
	107	1.20	1.62	1.20	2.26	1.81	0.60	1.01	0.99	0.91
	* Color Code - Yellow (>1.46 and <1.79); Red >1.79									
Polyhaline	42			1.62	0.78	0.57	0.37	0.36	0.18	0.25
	51	0.54	1.86		0.78	0.50	0.30	0.30	0.23	0.15
	60	1.77	1.06	2.09	1.25	0.76	0.35	0.55	0.54	0.30
	72	1.41	2.49	0.86	1.22	0.78	0.55	0.56	0.40	0.49
	* Color Code - Yellow (>1.95 and <2.32); Red >2.32									
Meso/Oligohaline	62	1.46	1.78	2.18	2.73	0.97	0.62	0.77	0.58	0.72
	63	1.33	1.83	1.15	2.01	1.49	0.52	1.29	0.77	0.91
	64	1.26	2.16	1.07	1.86	1.69	0.69	1.18	0.84	0.87
	65	1.13	1.68	0.99	1.43	1.64	0.98	0.93	0.94	0.89
	* Color Code - Yellow (>1.54 and <1.91); Red >1.91									

Table 5. Summary of annual geometric mean for **total phosphorus** by sample station, color coded by numeric nutrient criteria for Florida streams, or 1998-2002 target values, Loxahatchee River, Florida.

Total Phosphorus (mg/l)

Freshwater Segments Color Coded by EPA's Numeric Nutrient Criteria for Florida Streams

River Analysis Zone	Site	1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Wild & Scenic	66	0.055	0.058	0.061	0.059	0.062	0.072	0.051	0.061	0.056
	67	0.043	0.046	0.048	0.045	0.049	0.080	0.060	0.051	0.044
	68	0.040	0.042	0.040	0.036	0.042	0.080	0.046	0.053	0.047
	69	0.033	0.032	0.030	0.033	0.032	0.054	0.043	0.041	0.038
FW Tributaries	81	0.028	0.037	0.016	0.025	0.026	0.029	0.026	0.024	0.027
	86							0.027	0.040	0.027
	87							0.038	0.028	0.034
	88							0.350	0.587	0.492
	100	0.059	0.058	0.045	0.065	0.060	0.070	0.058	0.058	0.065
	106	0.068	0.077	0.081	0.052	0.088	0.081	0.086	0.085	0.069
	108					0.105	0.087	0.063	0.089	0.068
FW Canal	59	0.060	0.040	0.076	0.054	0.101	0.070	0.080	0.223	0.076
	92	0.031	0.031	0.027	0.031	0.033	0.057	0.039	0.040	0.040
	95	0.038	0.042	0.043	0.050	0.041	0.088	0.074	0.069	0.057
	101	0.067	0.058	0.038	0.064	0.090	0.086	0.051	0.078	0.068
	104	0.085	0.094	0.095	0.105	0.121	0.080	0.107	0.108	0.144
	105	0.058	0.061	0.059	0.057	0.075	0.085	0.035	0.055	0.064
	111		0.053	0.041	0.033	0.052	0.054	0.036	0.102	0.055
	112		0.031	0.057	0.021	0.067	0.037	0.050	0.067	0.040

* Color Code - Yellow: >0.09 (75% of NNC Limit) and <0.12 (NNC Limit); Red: >0.12 (NNC Limit)

Color Coded By Loxahatchee River District Targets from 1998 - 2002

River Analysis Zone	Site	1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Marine	10	0.017	0.012	0.012	0.043	0.013	0.009	0.016	0.014	0.014
	20	0.013	0.008	0.010	0.034	0.010	0.004	0.008	0.011	0.008
	25	0.019	0.014	0.012	0.022	0.022	0.013	0.015	0.013	0.012
	30	0.030	0.022	0.027	0.031	0.033	0.024	0.021	0.022	0.027
	32				0.029	0.029	0.019	0.020	0.022	0.023
	40	0.022	0.015	0.013	0.031	0.023	0.008	0.019	0.013	0.015

* Color Code - Yellow (>0.033 and <0.043); Red >0.043

River Analysis Zone	Site	1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Brackish Trib	35	0.034	0.029	0.029	0.032	0.030	0.022	0.026	0.024	0.023
	55	0.042	0.037	0.049	0.042	0.045	0.043	0.039	0.040	0.040
	71	0.048	0.041	0.052	0.044	0.047	0.031	0.046	0.034	0.044
	73	0.055	0.049	0.066	0.052	0.049	0.040	0.065	0.048	0.047
	75						0.067	0.079	0.074	0.088
	107	0.208	0.179	0.232	0.115	0.091	0.107	0.101	0.110	0.118

* Color Code - Yellow (>0.080 and <0.150); Red >0.150

River Analysis Zone	Site	1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Meso/Oligohaline	62	0.049	0.045	0.062	0.050	0.051	0.056	0.057	0.048	0.052
	63	0.054	0.055	0.062	0.059	0.059	0.062	0.064	0.058	0.069
	64	0.053	0.062	0.065	0.057	0.065	0.064	0.064	0.062	0.066
	65	0.056	0.064	0.066	0.055	0.068	0.072	0.063	0.061	0.066

* Color Code - Yellow (>0.066 and <0.081); Red >0.081

River Analysis Zone	Site	1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Polyhaline	42			0.031	0.028	0.025	0.021	0.024	0.018	0.026
	51	0.027	0.020	0.026	0.030	0.028	0.016	0.023	0.023	0.024
	60	0.037	0.030	0.035	0.038	0.041	0.056	0.038	0.031	0.037
	72	0.041	0.032	0.042	0.043	0.037	0.031	0.038	0.030	0.035

* Color Code - Yellow (>0.044 and <0.070); Red >0.070

Table 6. Summary of annual geometric mean for **chlorophyll *a*** by sample station, color coded by 1998-2002 target values, Loxahatchee River, Florida.

Clorophyll *a*

Color Coded By Loxahatchee River District Targets from 1998 - 2002

Zone	Site	1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Marine	10	1.9	2.3	2.3	3.3	0.9	1.0	2.4	1.6	2.0
	20	1.5	1.8	1.9	2.9	0.9	0.5	3.4	1.2	1.1
	25	2.8	4.0	3.4	4.7	2.5	1.7	3.7	1.8	2.2
	30	4.4	6.0	8.9	6.3	4.6	5.4	8.4	5.6	7.9
	32				4.7	4.3	4.9	7.3	5.5	5.7
	40	2.6	3.5	2.7	4.1	2.0	2.2	3.9	2.4	2.6
	* Color Code - Yellow (>4.2 and <6.9); Red >6.9									
Polyhaline	42			4.5	7.2	3.0	5.6	6.8	4.4	7.1
	51	3.7	5.6	10.3	7.7	3.2	4.2	6.0	5.0	5.4
	60	4.2	6.8	4.0	10.6	5.8	4.9	7.4	8.4	7.3
	72	9.9	15.7	13.4	17.0	6.5	13.3	12.8	11.7	14.8
	* Color Code - Yellow (>9.3 and <14.5); Red >14.5									
Meso/Oligo haline	62	4.1	6.9	6.2	7.6	6.9	5.6	8.8	9.4	8.1
	63	4.2	8.8	4.6	7.6	5.3	5.6	8.9	8.7	7.9
	64	4.0	10.3	3.8	7.6	4.0	3.2	8.1	7.0	8.5
	65	3.7	7.5	4.5	5.3	3.1	4.7	5.6	8.5	5.6
	* Color Code - Yellow (>5.8 and <8.3); Red >8.3									
Wild & Scenic	66	3.5	3.8	3.6	4.6	3.0	4.1	1.9	5.4	3.2
	67	2.2	1.2	1.3	4.0	1.6	3.7	3.5	3.8	2.3
	68	1.8	1.3	1.1	3.2	1.5	2.8	4.1	3.2	3.0
	69	2.6	3.7	2.8	5.2	2.1	5.7	7.1	9.6	8.6
	* Color Code - Yellow (>4.4 and <8.3); Red >8.3									
FW Tributaries	81	5.0	10.5	3.8	6.4	2.4	12.5	6.9	7.0	9.0
	86							10.0	12.4	12.2
	87							11.2	10.3	12.6
	88							49.5	48.2	19.5
	100	2.8	3.2	2.3	3.7	1.4	4.0	2.7	3.1	2.9
	106	4.4	6.7	9.9	4.0	5.2	4.0	10.4	7.3	5.5
	108					5.2	3.3	7.5	4.6	3.5
	* Color Code - Yellow (>8.0 and <12.8); Red >12.8									
Brackish Trib	35	3.4	3.8	7.5	8.0	4.5	5.5	8.5	6.0	7.9
	55	5.6	8.4	4.6	13.8	5.0	11.2	5.3	10.1	8.7
	71	7.3	9.6	9.9	16.2	6.2	10.5	12.3	11.3	12.6
	73	8.4	16.9	14.2	22.0	5.8	11.1	17.8	12.6	15.2
	75							16.0	11.6	20.1
	107	3.6	5.4	4.4	14.4	5.7	5.0	4.0	4.0	7.0
	* Color Code - Yellow (>8.9 and <13.7); Red >13.7									
FW Canal	59	6.3	13.3	2.5	6.0	15.7	6.8	10.1	14.5	11.9
	92	4.5	10.1	3.6	8.4	3.4	9.1	7.3	10.9	11.0
	95	3.1	4.5	3.8	6.4	2.0	10.0	8.4	11.0	7.8
	101	10.6	27.3	10.8	13.5	8.3	13.9	7.1	9.8	21.6
	104	11.3	11.7	9.7	21.1	7.7	3.4	17.3	20.0	12.8
	105	3.5	3.6	2.4	4.5	2.3	1.2	2.7	4.0	4.4
	111		19.1	9.0	7.1	5.2	9.4	7.3	12.1	9.6
	112		16.2	12.3	6.6	8.5	7.0	9.8	7.0	5.5
	* Color Code - Yellow (>11.0 and <26.5); Red >26.5									

Table 7. Summary of annual geometric mean for **dissolved oxygen** by sample station, color coded by FDEP's criteria for surface waters of the State of Florida, Loxahatchee River, Florida.

Dissolved Oxygen (mg/l)

Color Coded By FDEP Criteria for Class III Florida Waters

Zone	Site	1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Marine	10	6.49	6.33	6.13	6.64	6.32	6.62	6.51	6.72	6.96
	20	6.66	6.63	6.41	6.61	6.18	6.56	6.64	6.79	7.06
	25	6.62	6.33	6.07	6.44	6.32	6.24	6.41	6.59	6.59
	30	6.00	5.96	5.80	6.44	5.41	5.88	5.96	6.06	6.22
	32				6.14	5.34	5.89	5.93	5.94	6.20
	40	6.65	6.53	6.36	6.62	6.45	6.65	6.54	6.85	7.09
Polyhaline	42			6.50	6.51	6.08	6.04	5.86	6.27	6.62
	51	6.25	5.91	5.80	6.27	6.16	5.92	6.35	6.28	6.85
	60	6.20	5.86	6.27	6.34	5.78	5.61	6.04	6.22	6.28
	72	6.16	5.31	5.48	6.31	6.06	5.22	5.95	5.93	5.30
Meso/Oligo haline	62	5.40	5.12	4.86	5.71	5.04	4.61	5.26	5.48	5.57
	63	5.14	4.73	3.56	5.23	4.23	4.10	4.65	4.60	4.64
	64	5.22	4.75	3.21	5.17	4.11	4.46	4.92	4.54	4.82
	65	4.99	3.81	2.91	5.60	3.15	3.50	5.00	3.46	4.75
Wild & Scenic	66	5.63	5.46	4.88	6.05	4.39	4.27	4.97	4.86	4.85
	67	5.67	5.40	4.55	4.91	3.93	4.10	4.57	4.61	4.95
	68	5.75	5.64	6.67	4.70	4.45	4.17	4.52	4.78	4.87
	69	4.41	4.08	5.00	3.99	4.05	3.25	4.02	4.19	3.81
FW Tributaries	81	6.73	6.42	6.00	5.40	6.09	5.49	5.46	6.79	5.88
	86							6.44	6.58	6.37
	87							6.90	6.18	6.24
	88							1.16	0.69	1.60
	100	6.17	6.24	5.91	6.15	4.88	5.23	5.71	5.39	5.17
	106	3.68	3.53	4.66	3.98	4.59	4.30	4.03	3.52	4.27
	108					3.92	2.75	3.21	3.83	4.82
Brackish Trib	35	5.61	5.50	5.81	6.03	5.82	5.72	5.70	6.01	5.93
	55	4.94	3.51	3.67	5.30	4.22	4.27	4.22	4.22	4.98
	71	5.28	4.64	4.18	5.76	5.59	5.70	4.68	5.52	5.69
	73	4.86	4.30	3.75	5.36	4.99	5.50	4.40	4.95	5.94
	75						3.01	2.91	2.72	2.95
	107	4.40	2.90	5.07	4.37	4.00	3.99	4.58	4.12	3.40
FW Canal	59	0.50	0.53	0.49	1.35	1.79	0.88	0.36	0.36	2.77
	92	5.26	4.55	5.16	4.21	4.52	2.80	4.60	4.38	4.37
	95	5.30	4.73	4.29	4.39	4.73	3.32	4.15	4.59	4.51
	101	0.74	0.58	1.77	2.28	2.12	1.01	1.09	2.36	2.67
	104	6.33	4.77	6.72	5.96	5.54	4.84	5.29	6.45	6.49
	105	4.69	3.12	5.68	4.91	4.91	3.40	3.83	4.00	5.42
	111		2.18	1.86	1.78	1.33	1.39	1.19	1.43	2.81
	112		0.81	1.32	3.08	2.31	2.81	1.18	3.14	4.05

* Color Code - Yellow (> 3.0 and < 5.0); Red < 3.0

Table 8. Summary of annual geometric mean for **fecal coliform bacteria** by sample station, color coded by EPA and FDEP's criteria for recreational waters.

Fecal Coliform (cfu 100/ml)

Color Coded By EPA and FDEP Criteria for Recreational Waters

Zone	Site	1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Marine	10	4	1	5	5	5	2	8	2	2
	20	3	6	5	8	3	2	2	1	1
	25	3	3	2	6	2	2	2	1	1
	30	13	17	15	10	12	6	19	7	8
	32				41	13	15	43	17	19
	40	5	6	6	10	10	3	11	1	3
Polyhaline	42			61	10	36	9	49	8	30
	51	12	6	11	14	17	8	33	5	9
	60	40	20	30	18	15	17	53	14	31
	72	53	59	57	145	52	97	197	67	121
Meso/Oligo haline	62	73	66	40	142	46	61	149	51	90
	63	117	115	188	120	115	76	276	63	127
	64	129	132	121	102	92	91	187	79	156
	65	164	131	235	145	88	118	217	160	166
Wild & Scenic	66	174	149	214	91	97	193	103	144	109
	67	154	168	191	52	54	136	114	109	91
	68	209	152	167	94	62	147	141	42	72
	69	36	36	53	38	50	44	75	26	44
FW Tributaries	81	87	137	152	90	94	134	143	76	38
	86							30	21	19
	87							23	8	7
	88							80	67	45
	100	148	80	105	132	47	119	93	90	59
	106	193	185	323	129	173	312	193	357	245
	108					261	189	134	240	64
Brackish Trib	35	41	14	13	19	14	8	14	9	9
	55	135	137	130	139	57	115	303	92	123
	71	84	68	139	125	136	50	158	97	150
	73	145	202	346	513	194	254	922	441	520
	75						110	327	214	331
	107	544	1262	1207	745	633	295	815	919	455
FW Canal	59	42	104	115	49	49	170	53	105	22
	92	29	25	35	40	72	86	28	31	31
	95	112	81	112	211	326	107	270	81	196
	101	27	15	90	26	35	240	57	42	113
	104	131	215	179	106	87	86	84	40	90
	105	44	35	31	96	26	54	39	20	26
	111		43	88	38	37	49	77	158	27
	112		66	406	59	58	94	66	80	55

* Color Code - Yellow (>200 and <400); Red >400 based on FDEP and EPA thresholds for recreational waters

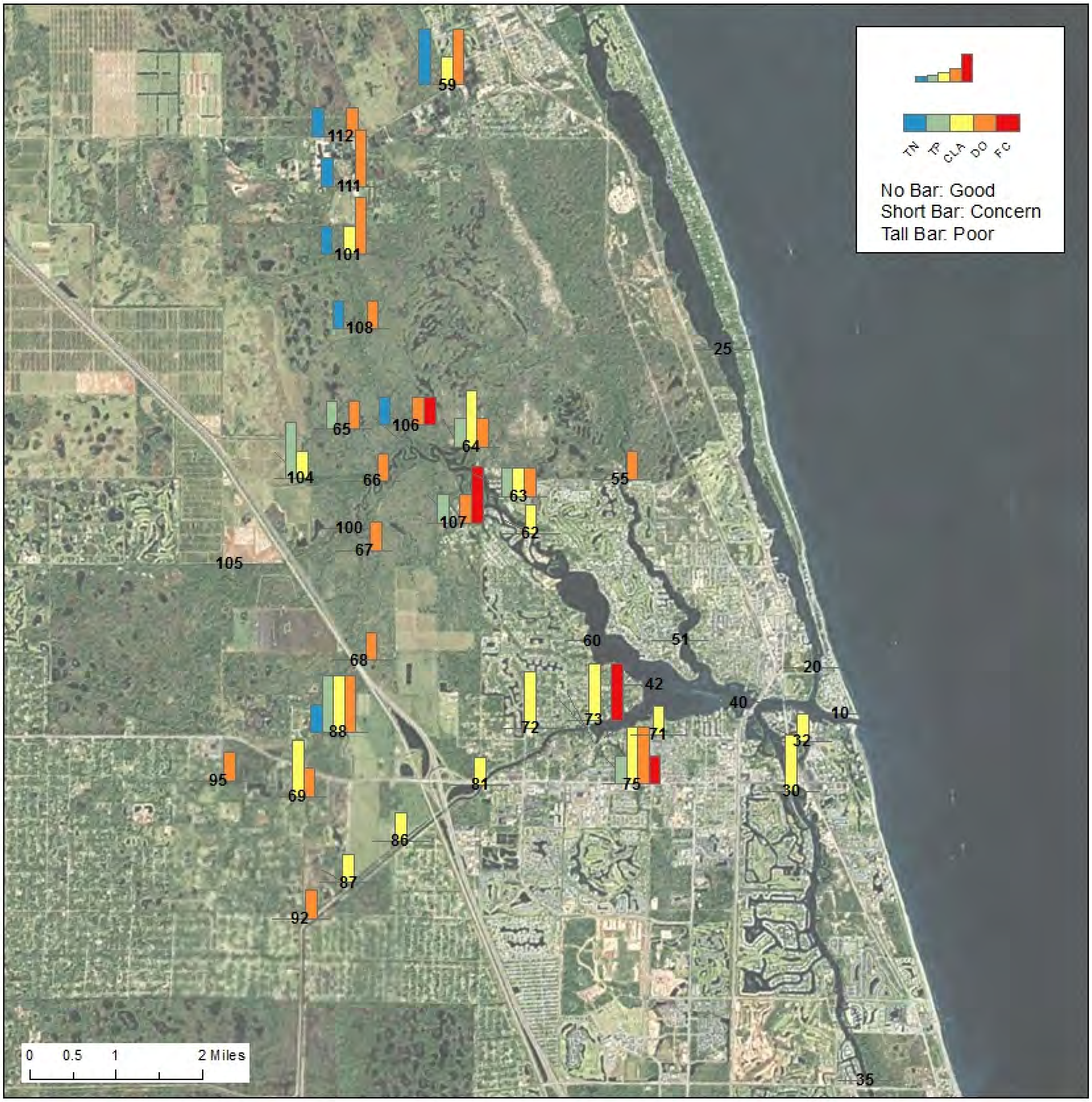


Figure 4. Synthesis of 2010 water quality stoplight scoring by sampling site for total phosphorus (TP), total nitrogen (TN), chlorophyll a (CLA), dissolved oxygen (DO), and fecal coliform (FC), Loxahatchee River, Florida. Bar height corresponds to stoplight score relative to reference period or numeric nutrient critera. No bar is equivalent to green/good, short bar equivalent to yellow/concern; and tall bar equivalent to red/poor. See text for details on scoring.

Conclusions

In conclusion, water quality in the Loxahatchee River during 2010 was generally good. These findings are encouraging because the river experienced greater base flows than observed over the past several years. In fact, during the 2009/2010 dry season, river flows measured at Lainhart Dam fell below the 35 cfs target for only 11 days total, and it was the first year since 1997 that the MFL was not violated. Higher than usual rainfall, particularly during the dry season, and improved water management within the basin were key contributors to improved flows.

Despite the increased flows, total nitrogen and phosphorus values were generally below target values established by EPA's numeric nutrient criteria, and the 1998-2002 targets established by LRD. Elevated chlorophyll *a* concentrations, particularly in the meso/oligohaline and brackish water tributaries continue to present values higher than the 1998-2002 targets. Further investigation into the causes and potential consequences of the elevated chlorophyll *a* concentrations is needed.

This report provides a historical assessment of water quality for five key parameters by river segment and by individual sampling station, relative to EPA's numeric nutrient criteria and the 1998-2002 targets. Fortunately, the vast majority of sampling sites in the Loxahatchee River watershed meet the numeric nutrient criteria for nitrogen and phosphorus. In general, many of the parameters with elevated concentrations correspond with significant weather events observed in 2004 and 2005. Elevated chlorophyll *a* and low dissolved oxygen levels were observed at a variety of sampling sites throughout the watershed. We cannot identify a straightforward explanation for the elevated chlorophyll values. While there are some logical explanations for the lower dissolved oxygen observations, the water quality does not consistently meet FDEP's criteria for Class III waters. Three sampling sites present consistently poor water quality and these sub-basins should be targeted for restoration work to improve water quality.

We believe the RiverKeeper water quality monitoring project continues to be an excellent and efficient approach to monitor water quality in the Loxahatchee River watershed. Because of LRD's long standing commitment to assess water quality in the Loxahatchee River watershed, we have an excellent historical record against which present water quality conditions can be compared. As restoration efforts continue to move forward in the watershed, we will continue to assess current water quality conditions and compare them against EPA's numeric nutrient criteria, established target conditions (1998-2002) and the pre-restoration conditions, thereby providing a comprehensive measure of project success. Such across-time comparisons are invaluable when trying to adaptively manage our valuable resources. Finally, it should be noted that while much work has been done in the Loxahatchee River Watershed (e.g., the numerous LRPI projects) there continue to be water quality issues that need to be addressed.

Recommendations for future work:

1. Continue the RiverKeeper monitoring project to assess long- and short-term trends in water quality in the Loxahatchee River. These data provide essential information for adaptive management of restoration activities.
2. Further assess causes and potential consequences of elevated chlorophyll *a* concentrations observed at various sites throughout the watershed.
3. Where water quality concerns are identified, resource managers should identify the source of the degradation, and develop and implement projects to remedy the source of water quality degradation.
4. The RiverKeeper data should be used to the greatest extent possible by the Department of Environmental Protection under their efforts to assess Total Maximum Daily Loads (TMDL) for the Loxahatchee River and tributaries.

Literature Cited

Comprehensive Everglades Restoration Plan (CERP). 2001. Baseline Report for the Comprehensive Everglades Restoration Plan. South Florida Water Management District, West Palm Beach, Florida.

ESRI. 2009. ArcGIS Desktop Resource Help.

South Florida Water Management District (SFWMD). 2006. Restoration Plan for the Northwest Fork of the Loxahatchee River. South Florida Water Management District, West Palm Beach, Florida.

South Florida Water Management District (SFWMD) - DBHYDRO. 2010. South Florida Water Management District's hydrometeorologic, water quality, and hydrogeologic data retrieval system at www.sfwmd.gov. South Florida Water Management District, West Palm Beach, Florida.

Appendix A - Stoplight Decision Rules & Data. Decision rules and data used in the 'stoplight' assessment. Because we assumed the observed conditions during the target period (1998-2002) represent non-degradation conditions, we therefore scored conditions equal to or better than those conditions as green (good). Conditions marginally worse than the target conditions (i.e., between the 75th and 90th percentile) were scored yellow (caution). Observed conditions significantly worse than the target conditions (i.e., falling above of the 90th percentile) were scored as red (cause for concern). Scoring criteria is generally based on FDEP's proposed approach for Numeric Nutrient Criteria Development in Marine Waters. Assessment is based on the annual geometric mean (GM) value (utilized by EPA and FDEP) for the parameter and period being assessed. Total nitrogen values prior to 2005 have smaller sample sizes to due to data removal because of interference in analysis method. See methods section for additional information.

< 75th Percentile Target Value	≥ 75th Percentile and < 90th Percentile Target Value	≥90th Percentile Target Value

Total Nitrogen (mg/l)

		1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Marine	N	1	5	0	30	30	44	48	48	48
	GM	1.44	0.80		0.66	0.41	0.16	0.17	0.13	0.15
	75th	N/A								
	90th	N/A								
Polyhaline	N	8	3	3	20	22	32	36	36	36
	GM	1.40	1.70	1.43	0.98	0.65	0.40	0.47	0.35	0.30
	75th	1.95								
	90th	2.32								
Meso/Oligo haline	N	84	20	18	23	24	32	35	36	36
	GM	1.26	1.87	1.15	1.92	1.42	0.70	0.96	0.76	0.83
	75th	1.54								
	90th	1.91								
Wild & Scenic	N	120	24	24	24	24	32	36	36	36
	GM	0.96	1.10	0.99	1.32	1.38	1.15	0.96	1.03	0.87
	75th	1.26								
	90th	1.56								
FW Tributaries	N	87	17	18	18	23	28	43	44	47
	GM	1.04	1.17	0.96	1.42	1.57	1.18	0.89	1.11	0.99
	75th	1.29								
	90th	1.69								
Brackish Tributaries	N	28	11	9	26	29	31	36	36	37
	GM	1.22	1.66	1.26	1.16	0.75	0.48	0.55	0.43	0.49
	75th	1.46								
	90th	1.79								
FW Canals	N	179	48	44	47	46	45	50	49	57
	GM	1.11	1.18	1.15	1.61	1.66	1.47	1.03	1.31	1.14
	75th	1.37								
	90th	1.77								

Appendix A continued

Total Phosphorus (mg/l)

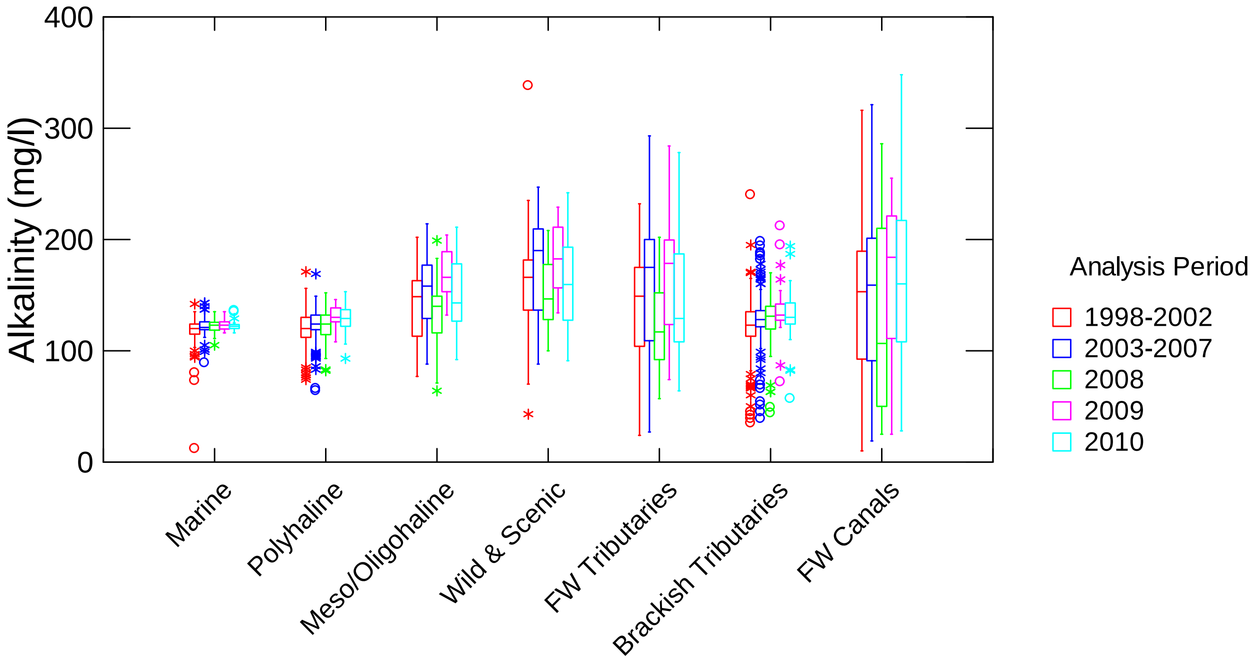
		1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Marine	N	149	30	30	35	36	44	48	48	48
	GM	0.019	0.014	0.014	0.031	0.020	0.010	0.016	0.015	0.015
	75th	0.033								
	90th	0.043								
Polyhaline	N	90	18	21	24	24	32	36	36	36
	GM	0.035	0.027	0.033	0.034	0.032	0.030	0.032	0.027	0.032
	75th	0.044								
	90th	0.070								
Meso/Oligo haline	N	119	24	24	24	24	32	36	36	36
	GM	0.053	0.056	0.064	0.055	0.060	0.063	0.061	0.056	0.061
	75th	0.066								
	90th	0.081								
Wild & Scenic	N	120	24	24	24	24	32	36	36	36
	GM	0.042	0.044	0.043	0.042	0.045	0.069	0.050	0.049	0.044
	75th	0.056								
	90th	0.089								
FW Tributaries	N	89	18	18	18	23	28	43	44	47
	GM	0.048	0.055	0.039	0.044	0.060	0.063	0.053	0.055	0.060
	75th	0.079								
	90th	0.101								
Brackish Tributaries	N	148	30	30	30	30	31	36	36	37
	GM	0.059	0.052	0.065	0.051	0.049	0.042	0.054	0.048	0.053
	75th	0.080								
	90th	0.150								
FW Canals	N	179	48	45	47	46	45	50	49	57
	GM	0.053	0.048	0.051	0.047	0.067	0.069	0.057	0.076	0.058
	75th	0.085								
	90th	0.134								

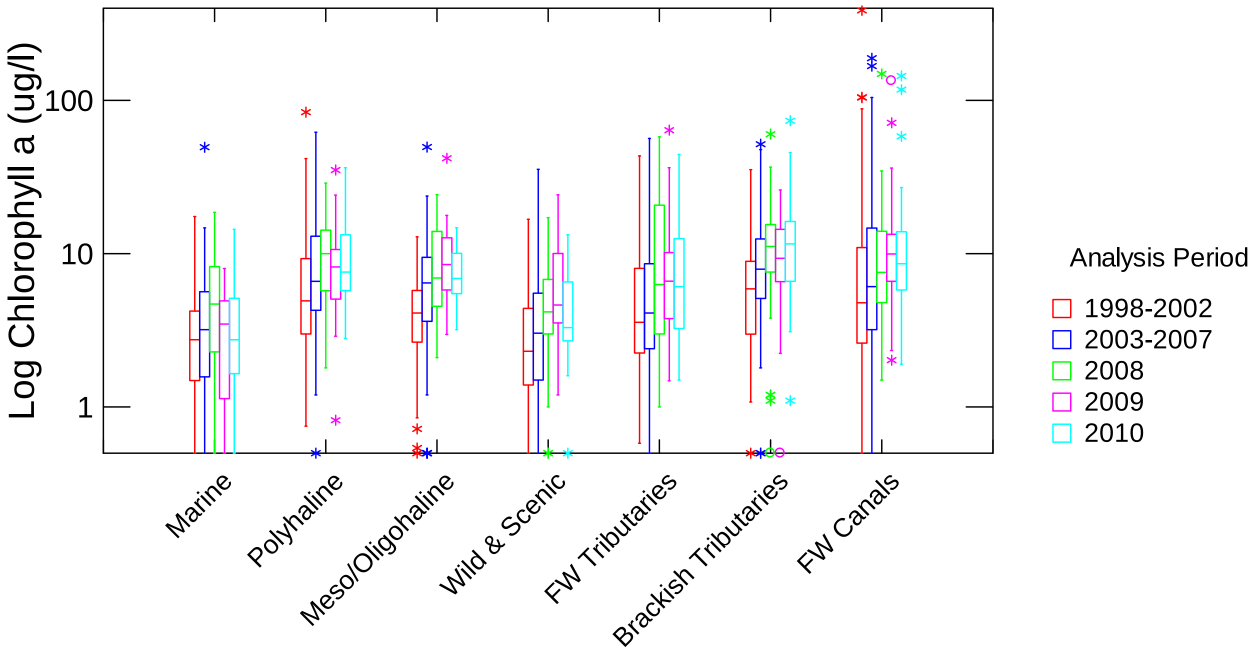
Appendix A continued

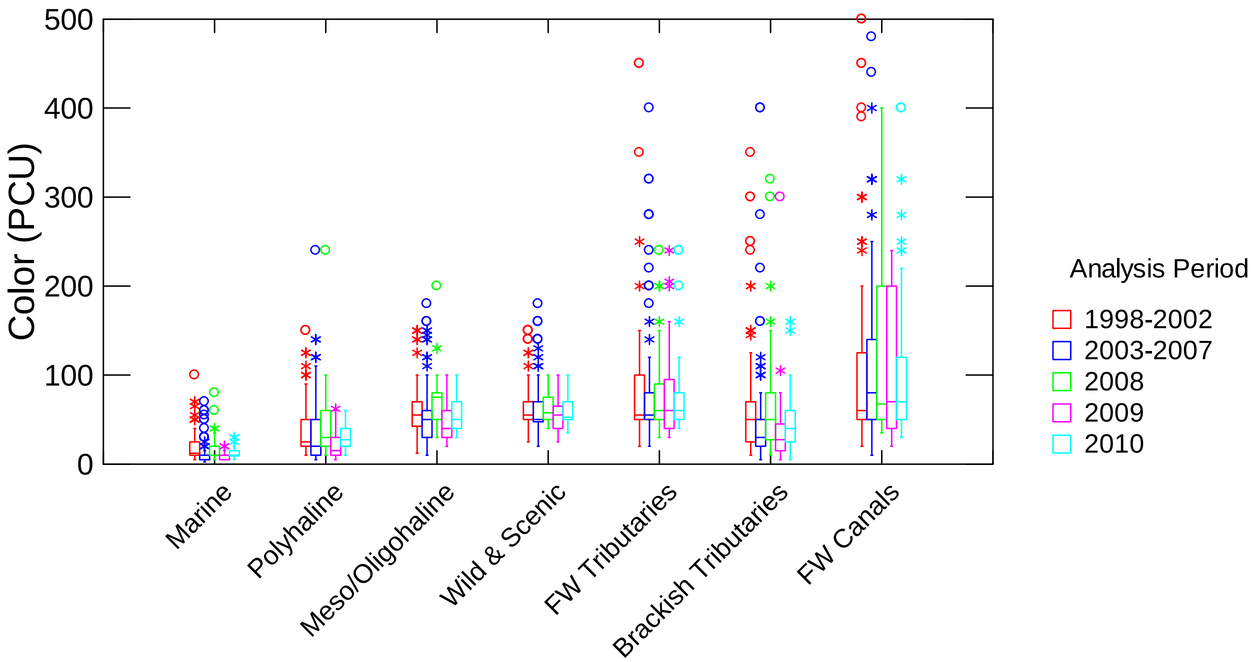
Chlorophyll *a* (µg/l)

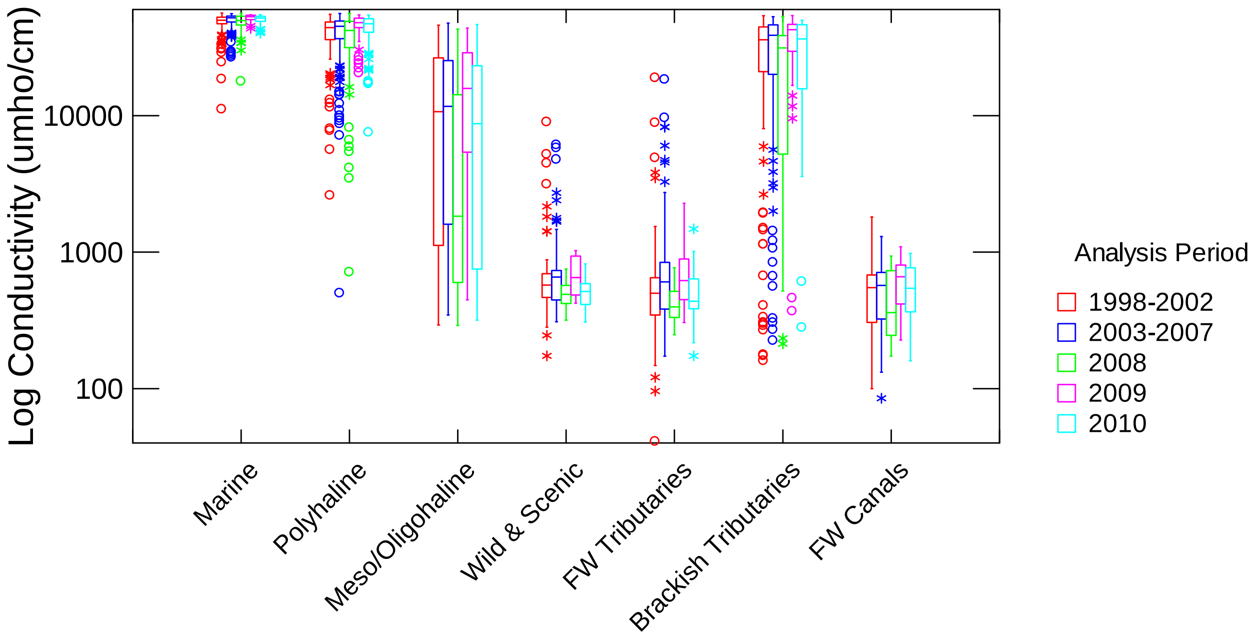
		1998-2002	2003	2004	2005	2006	2007	2008	2009	2010
Marine	N	146	29	30	35	36	38	48	48	48
	GM	2.5	3.3	3.3	4.2	2.0	1.8	4.0	2.4	2.7
	75th	4.2								
	90th	6.9								
Polyhaline	N	89	17	21	22	24	28	35	36	36
	GM	5.4	8.5	7.5	9.9	4.3	6.7	8.5	7.7	8.8
	75th	9.3								
	90th	14.5								
Meso/Oligo haline	N	120	24	24	24	24	28	32	36	36
	GM	4.0	8.3	4.7	6.9	4.6	4.8	7.5	8.5	7.2
	75th	5.8								
	90th	8.3								
Wild & Scenic	N	120	24	24	24	24	28	34	36	36
	GM	2.4	2.2	1.9	4.2	2.0	4.1	4.2	5.3	3.9
	75th	4.4								
	90th	8.3								
FW Tributaries	N	88	18	18	18	23	24	40	44	47
	GM	3.9	6.0	4.4	4.6	3.0	4.9	7.4	6.6	6.6
	75th	8.0								
	90th	12.8								
Brackish Tributaries	N	148	30	30	27	29	25	36	36	37
	GM	5.4	7.7	7.3	13.8	5.4	8.2	9.2	8.5	11.0
	75th	8.9								
	90th	13.7								
FW Canals	N	176	47	45	47	46	36	46	49	57
	GM	5.8	11.3	5.5	8.1	5.3	5.9	7.9	10.2	9.3
	75th	11.0								
	90th	26.5								

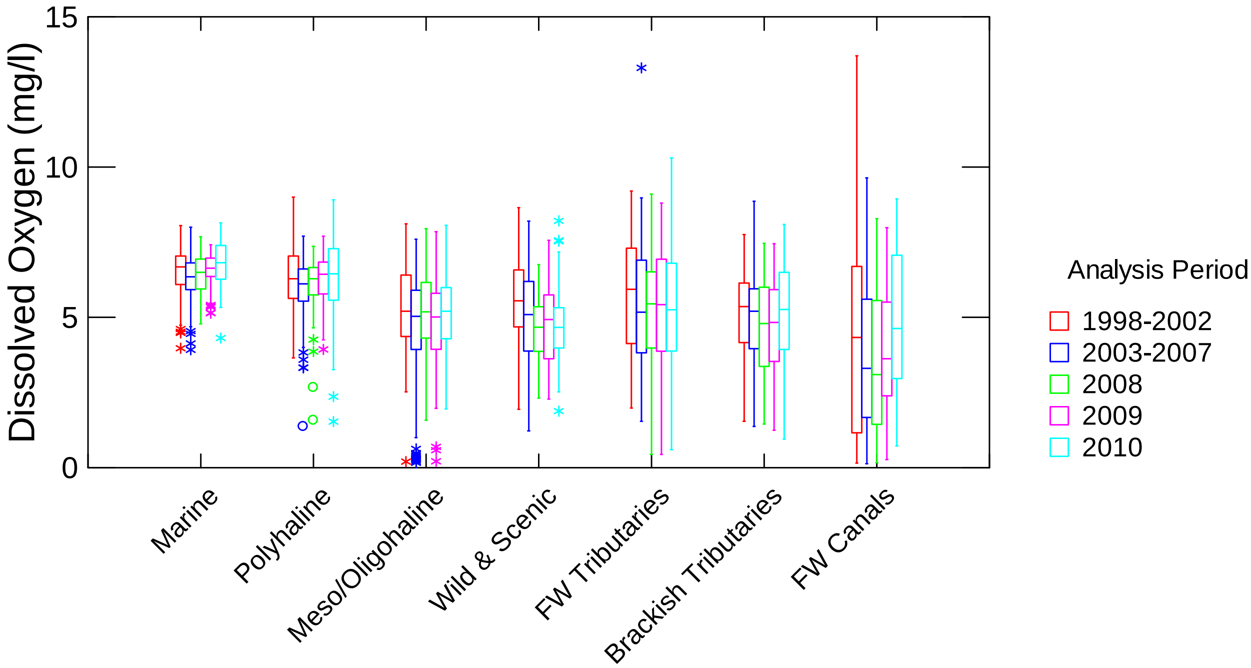
Appendix B – Box & Whisker Plots. Box and whisker plots of Loxahatchee River District's RiverKeeper data for the period October 1997 through September 2010. See Figure 2 for a map of sample site locations. In these box plots, the center horizontal line marks the median of the sample. The length of each box shows the range within which the central 50% of the values fall, with the box edges at the first and third quartiles. The whiskers show the range of observed values that fall within inner fences (1.5*interquartile range). Because the whiskers extend to observed values and the fences need not correspond to observed values, the whiskers do not necessarily extend all the way to the inner fences. Values between the inner and outer fences (3*interquartile range) are plotted with asterisks. Values beyond the outer fences, called far outside values, are plotted with empty circles (SYSTAT, 2009).

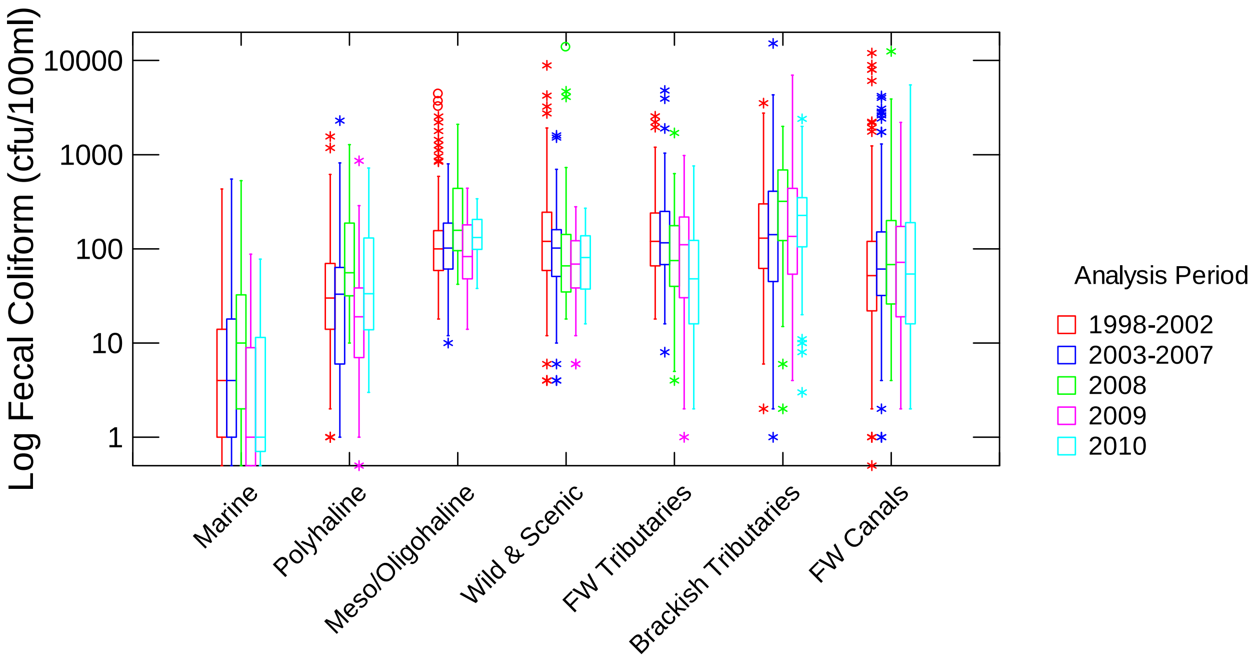


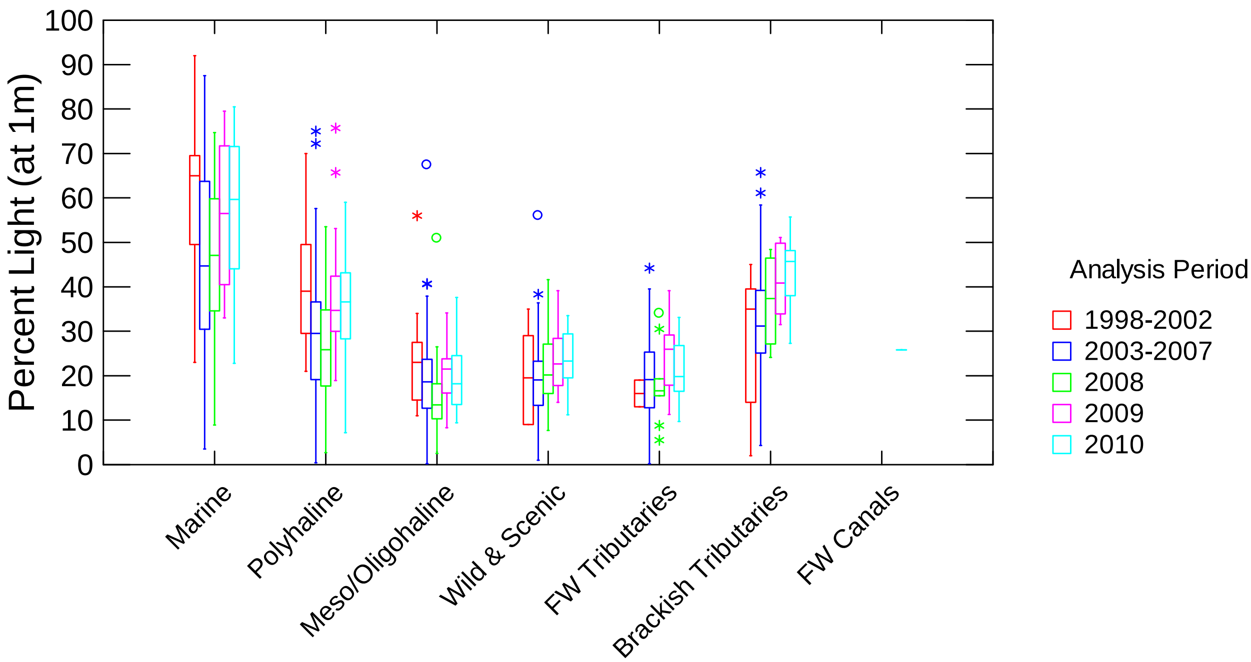

Log Chlorophyll a (ug/l)
100
10
1
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

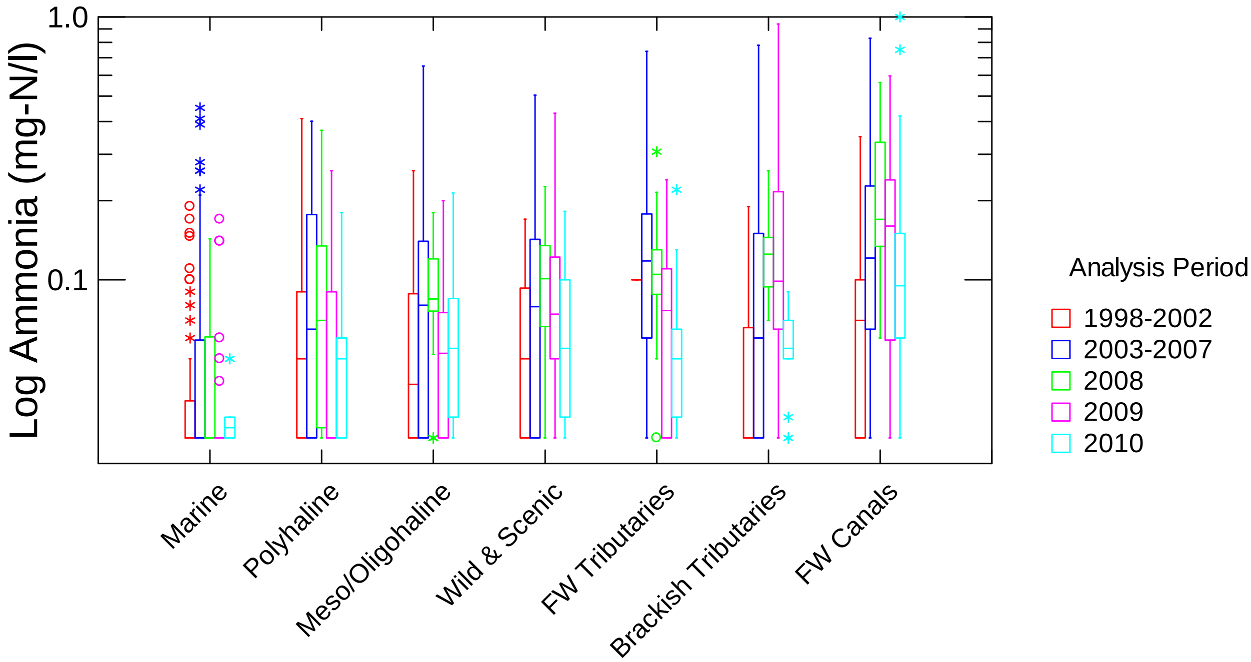

Color (PCU)
500
400
300
200
100
0
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

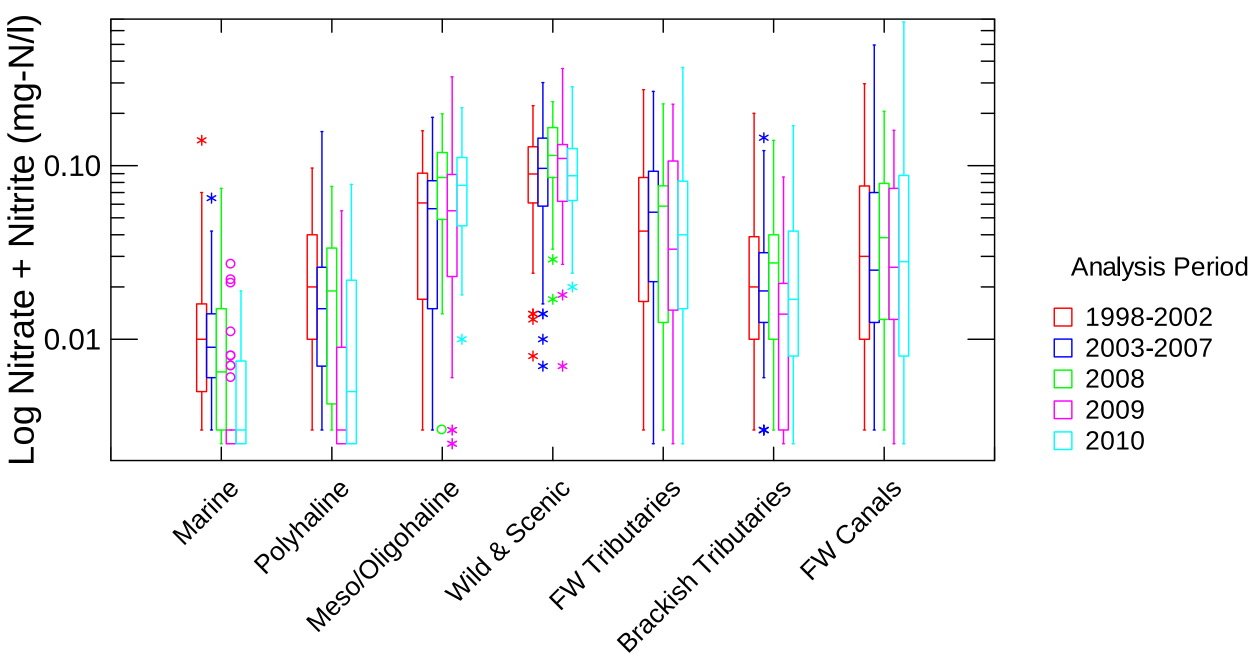

Log Conductivity (umho/cm)
10000
1000
100
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

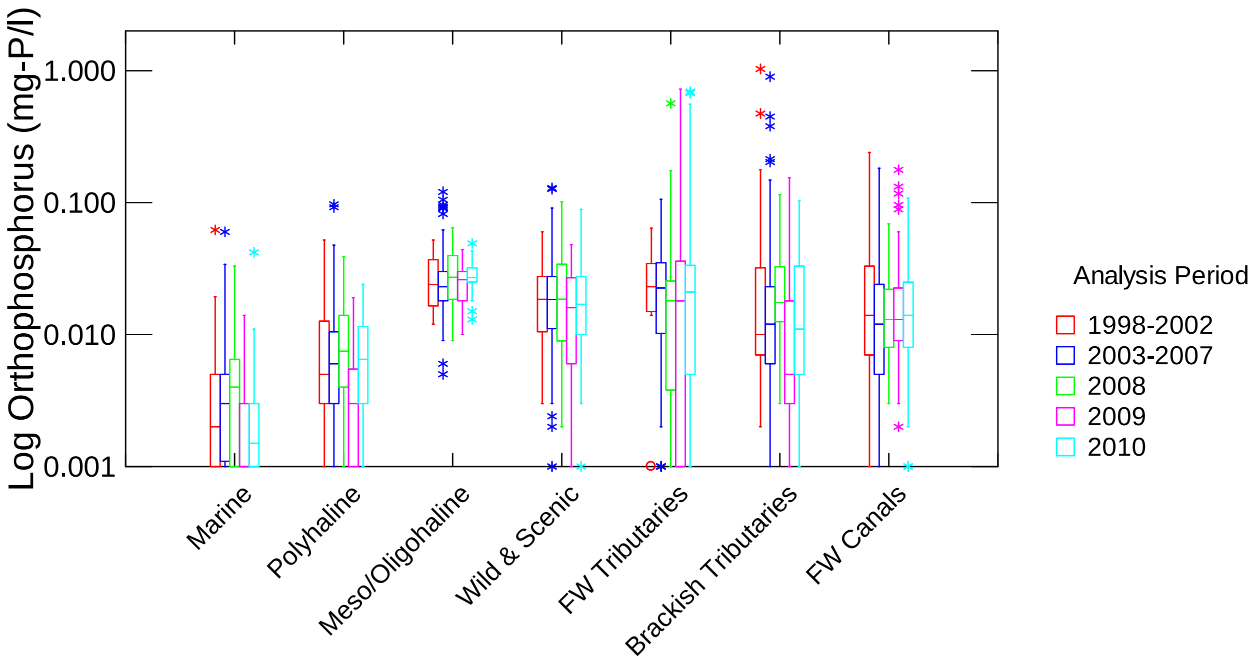

Dissolved Oxygen (mg/l)
15
10
5
0
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

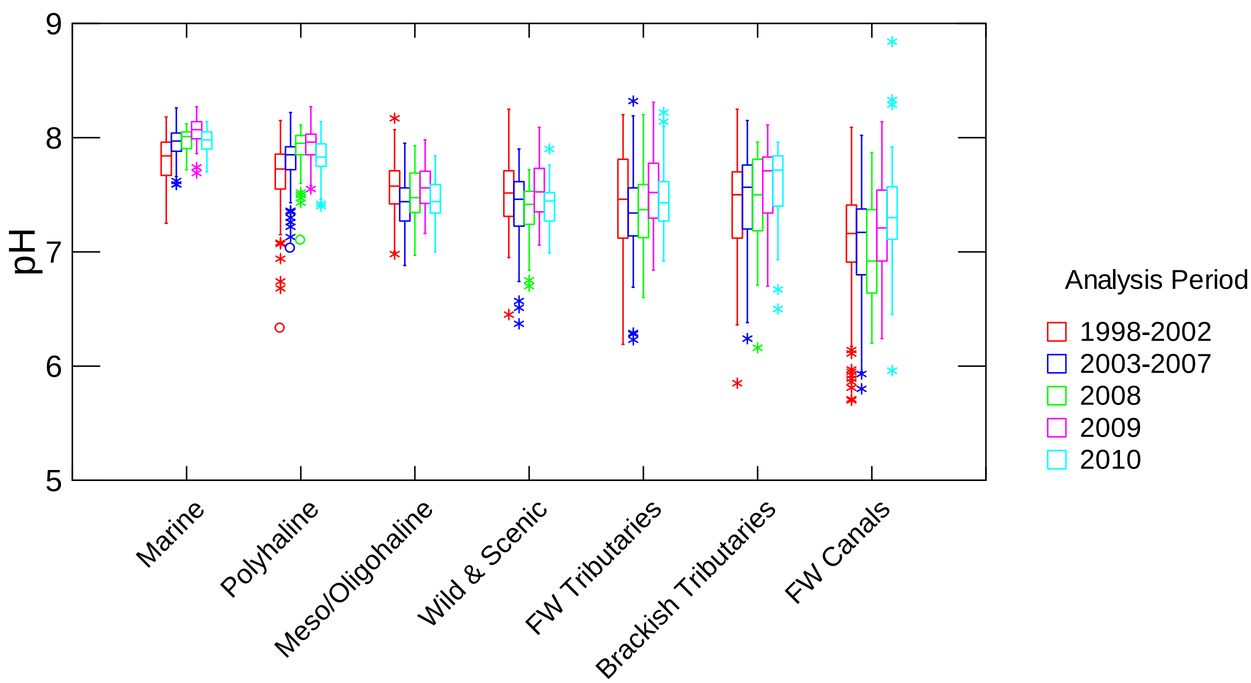

Log Fecal Coliform (cfu/100ml)
10000
1000
100
10
1
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

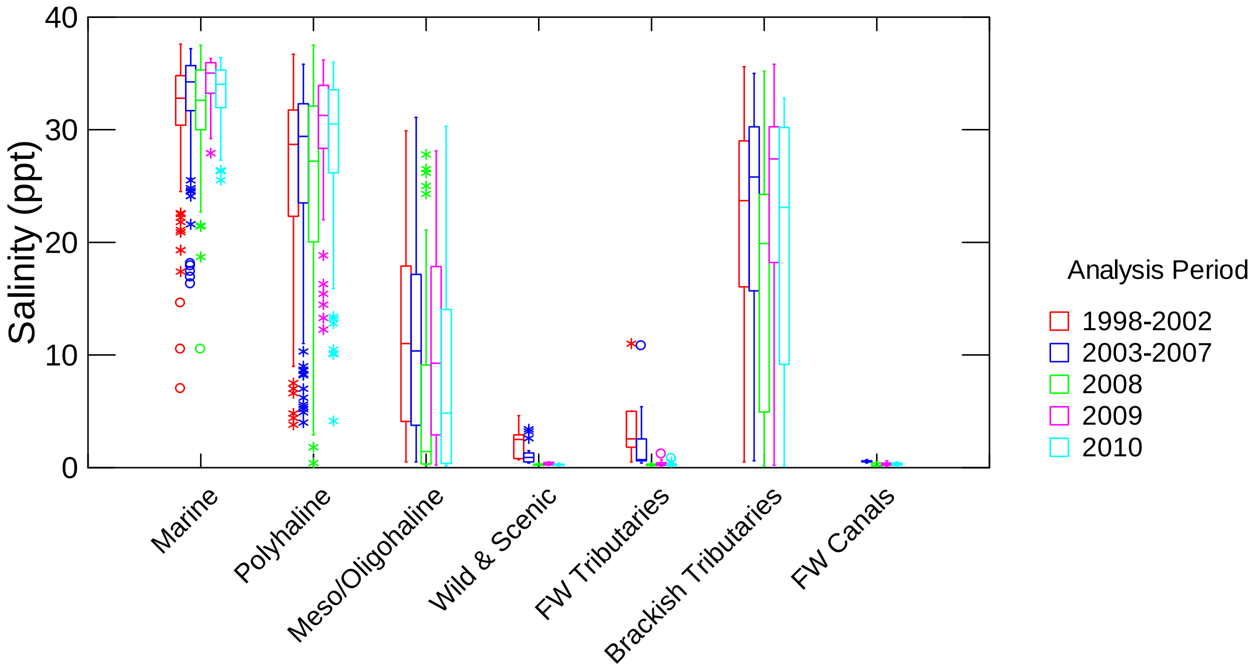

Percent Light (at 1m)
100
90
80
70
60
50
40
30
20
10
0
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

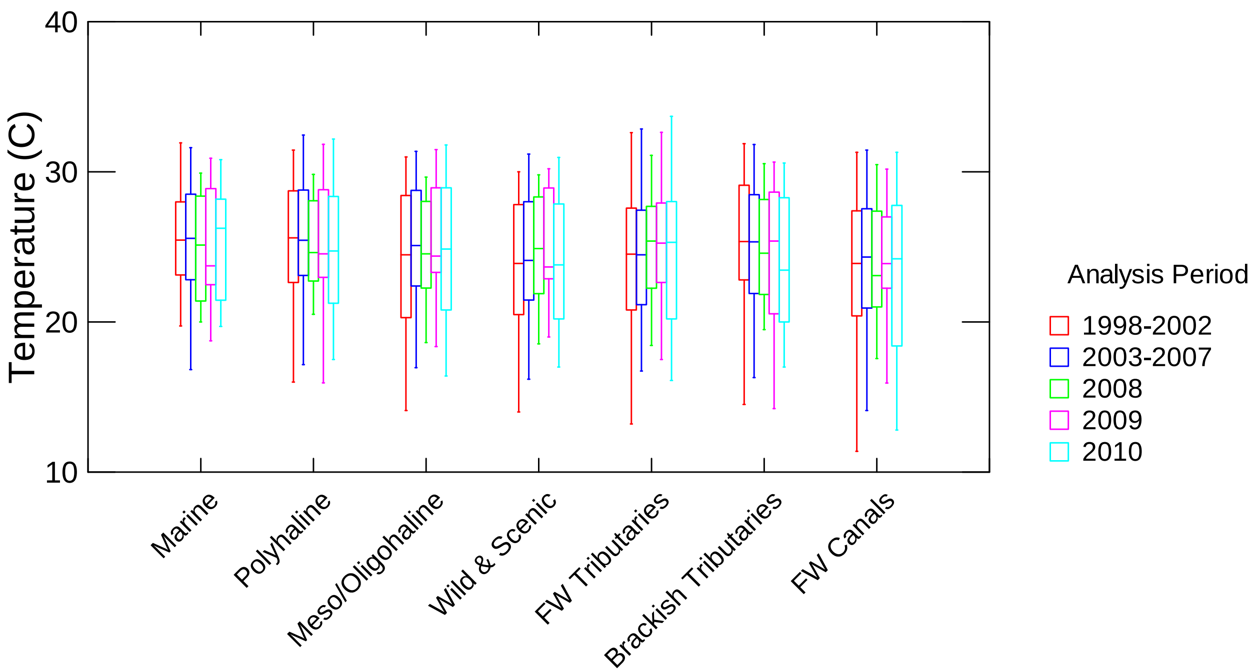

1.0
0.1
Log Ammonia (mg-N/l)
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

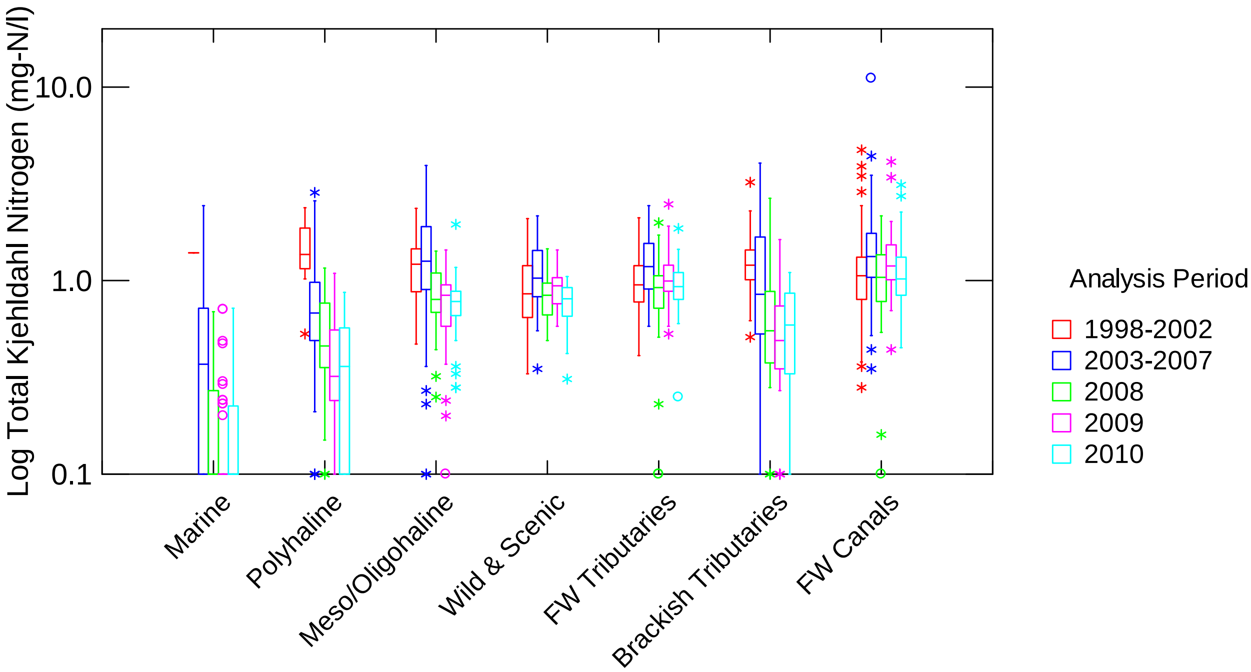

0.10
0.01
Log Nitrate + Nitrite (mg-N/l)
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

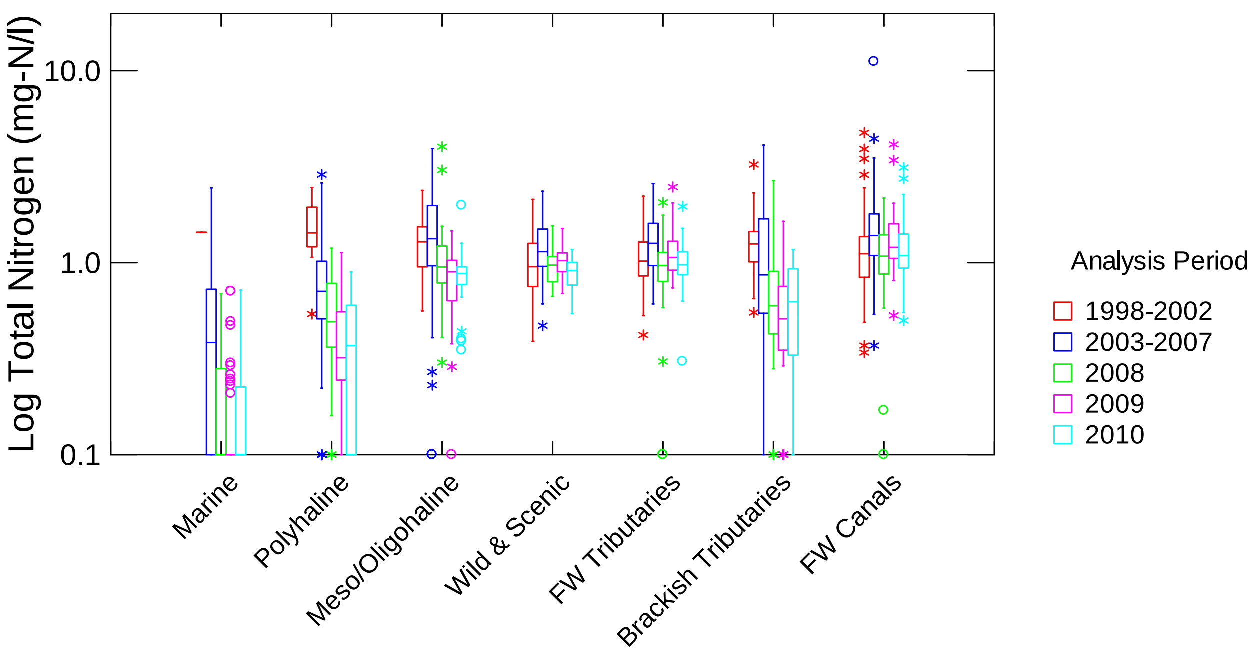

Log Orthophosphorus (mg-P/l)
1.000
0.100
0.010
0.001
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

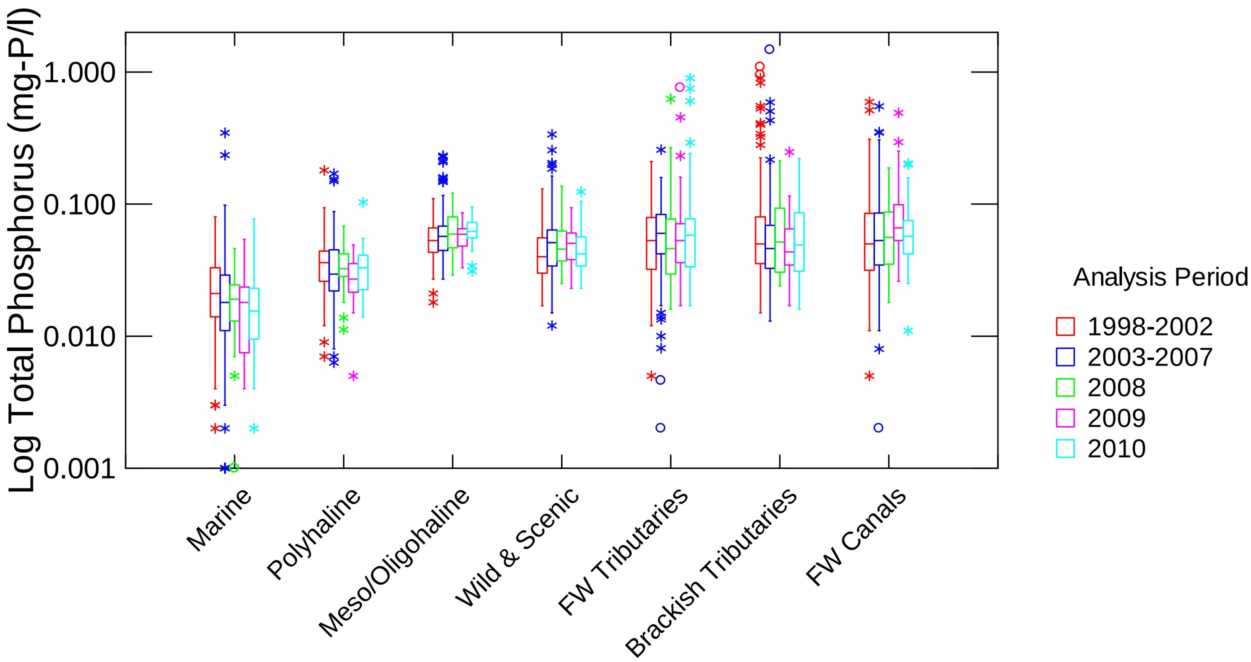

pH
9
8
7
6
5
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

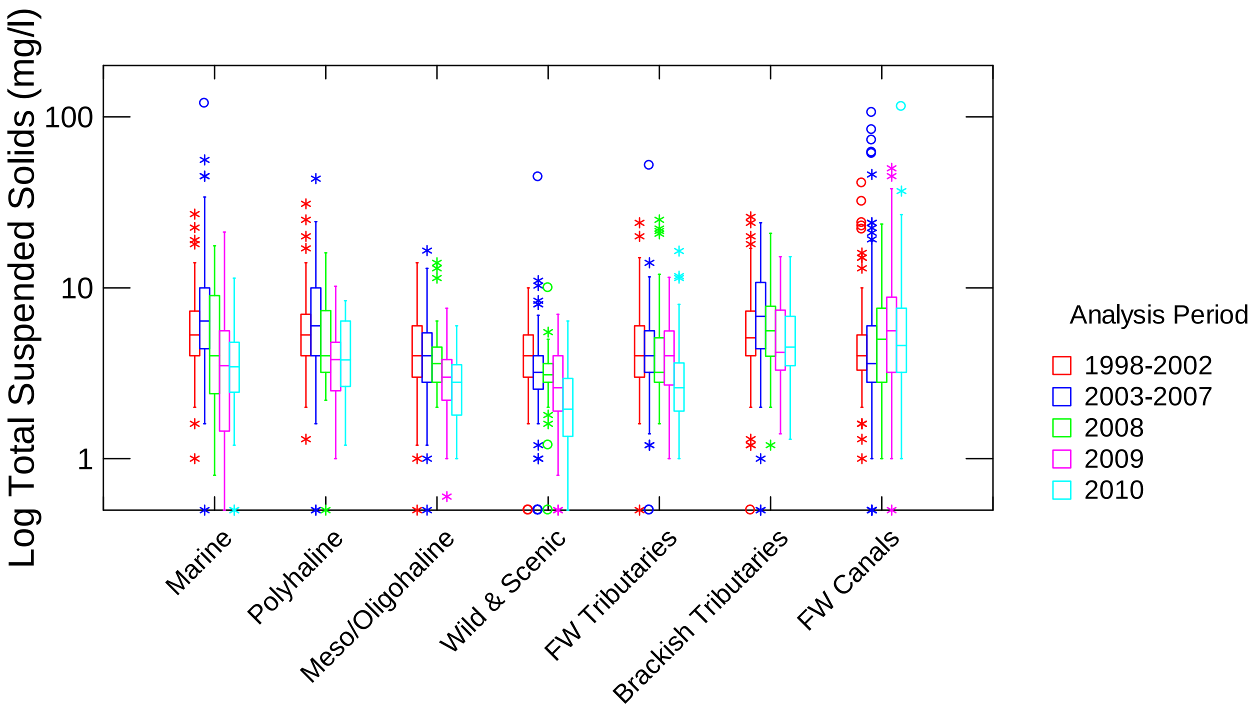

40
30
20
10
0
Salinity (ppt)
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

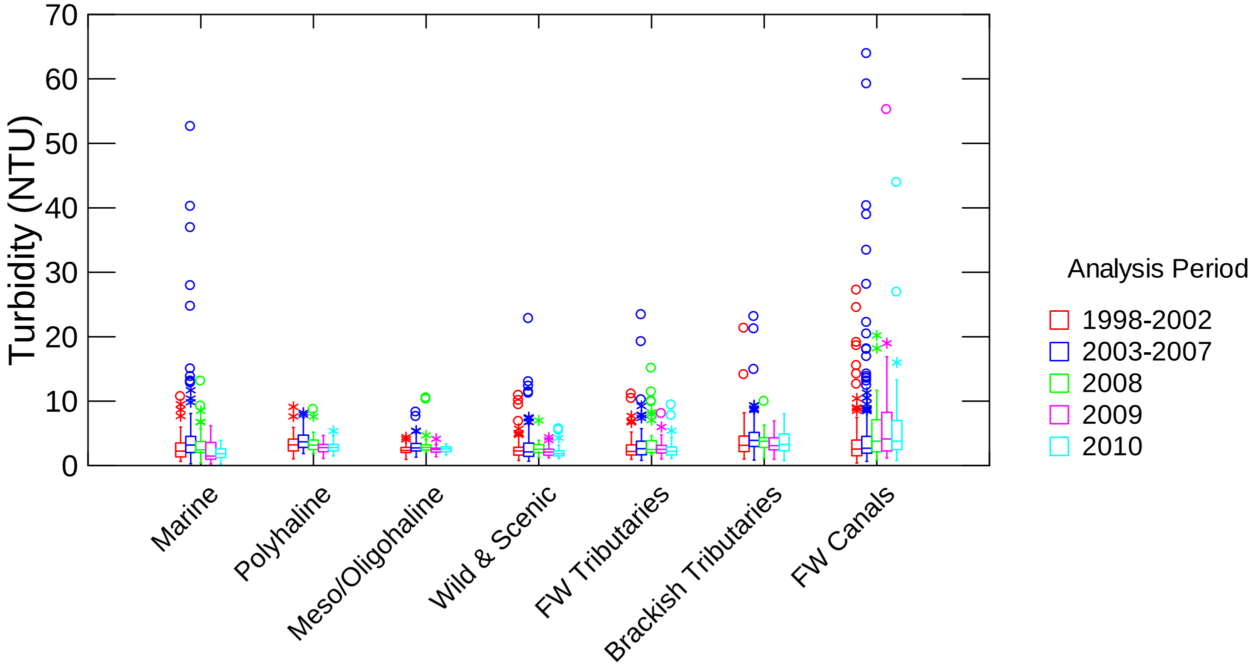

40
30
20
10
Temperature (C)
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010


Log Total Kjehldahl Nitrogen (mg-N/l)
10.0
1.0
0.1
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010


Log Total Nitrogen (mg-N/l)
10.0
1.0
0.1
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

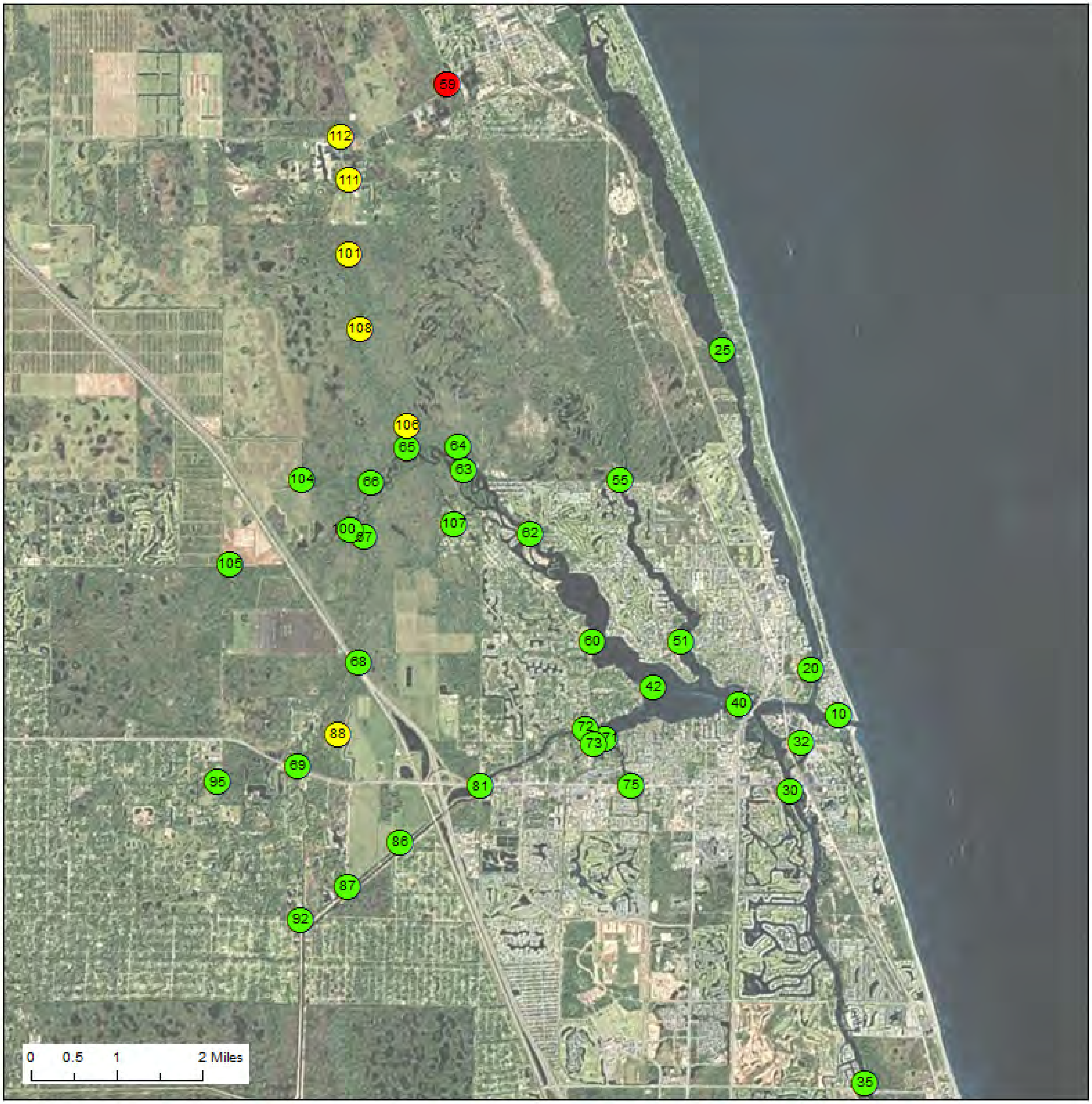

Log Total Phosphorus (mg-P/l)
1.000
0.100
0.010
0.001
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010


Log Total Suspended Solids (mg/l)
100
10
1
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

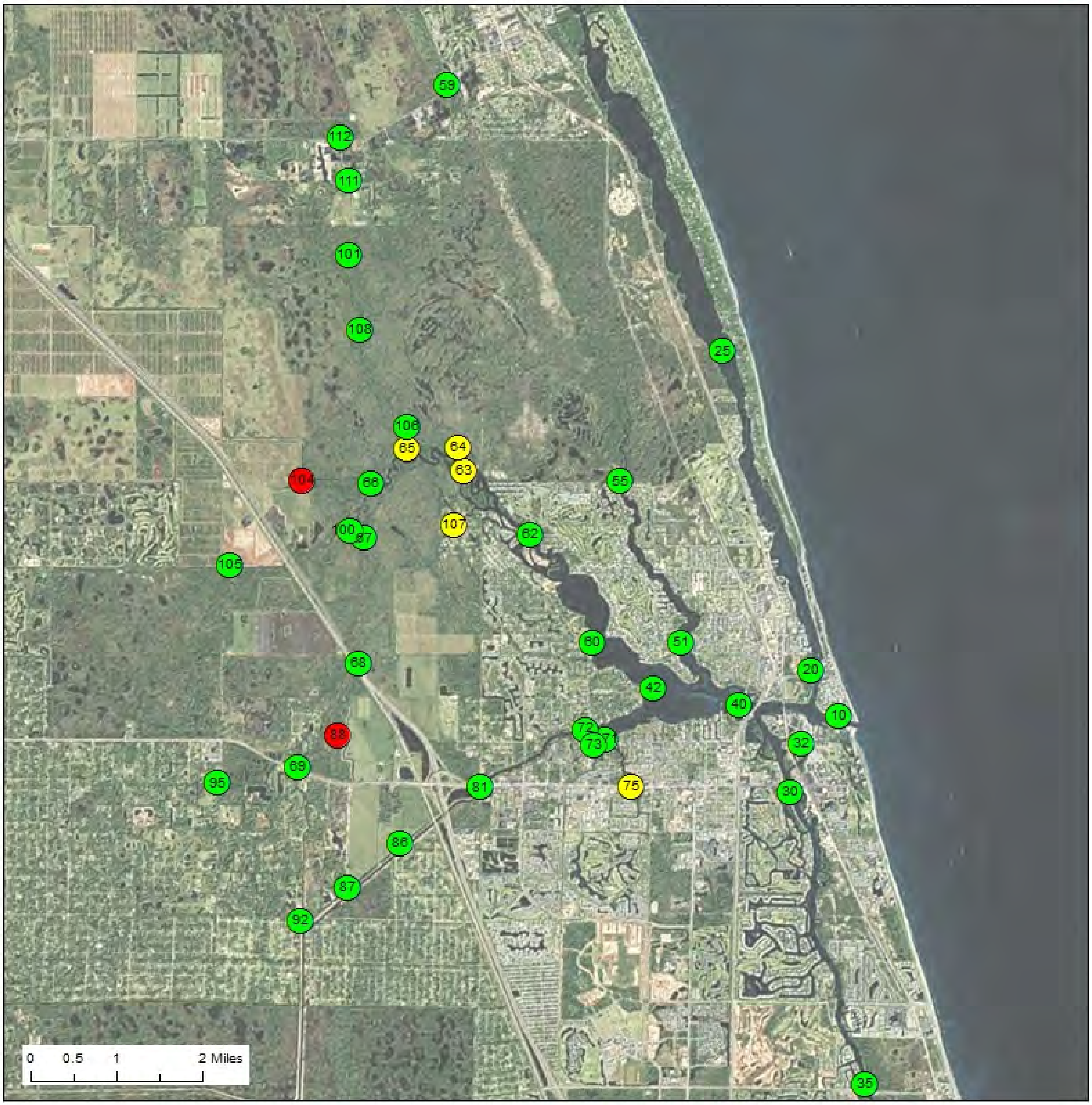

Turbidity (NTU)
0
10
20
30
40
50
60
70
Marine
Polyhaline
Meso/Oligohaline
Wild & Scenic
FW Tributaries
Brackish Tributaries
FW Canals
Analysis Period
1998-2002
2003-2007
2008
2009
2010

Appendix C – Spatial Plots. Spatial plots of select water quality parameters from the Loxahatchee River District's RiverKeeper data for the period October 2009 through September 2010.

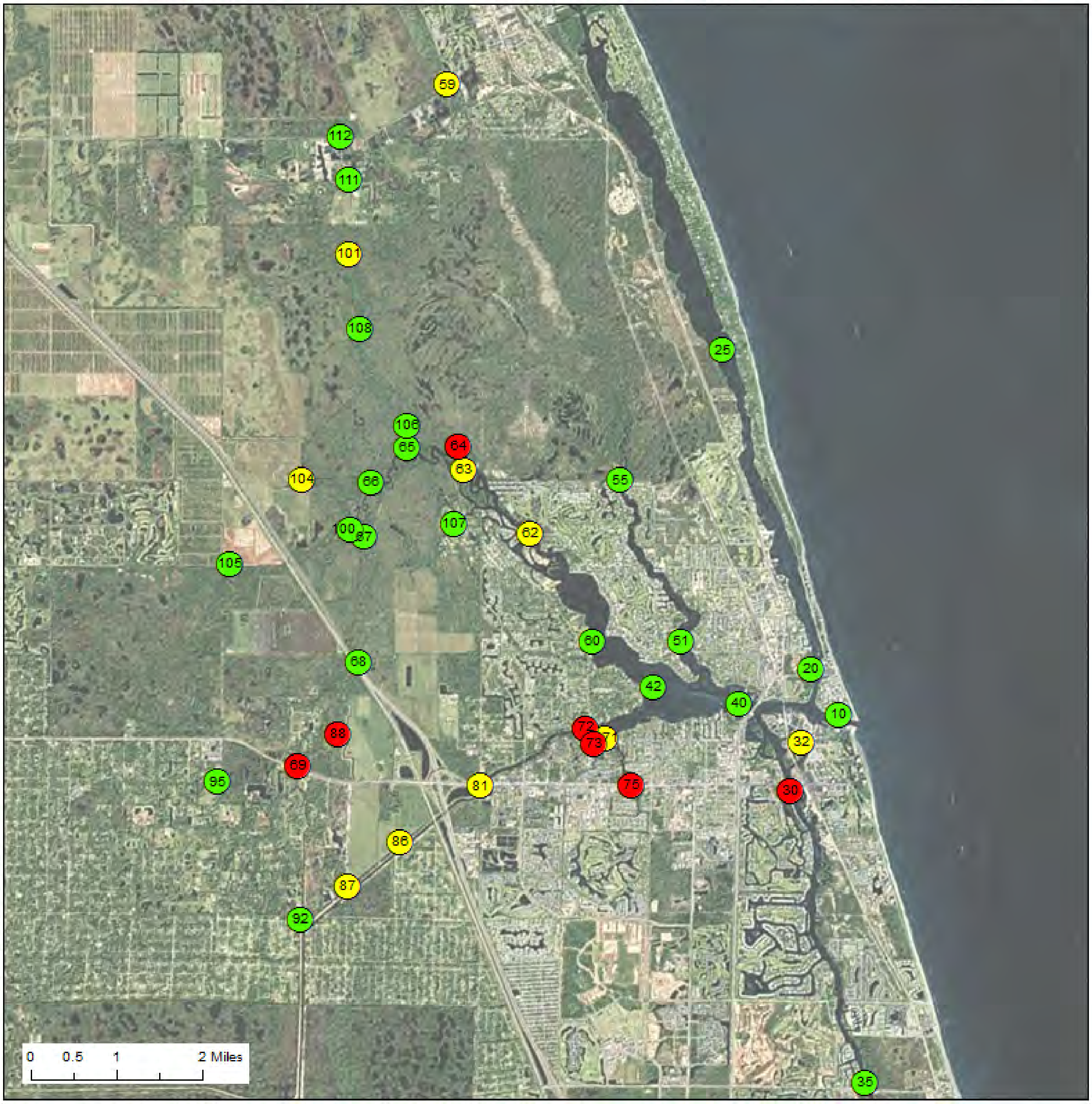
2010 water quality stoplight scoring by sampling site for total nitrogen (TN), Loxahatchee River, Florida. See text for details on scoring.



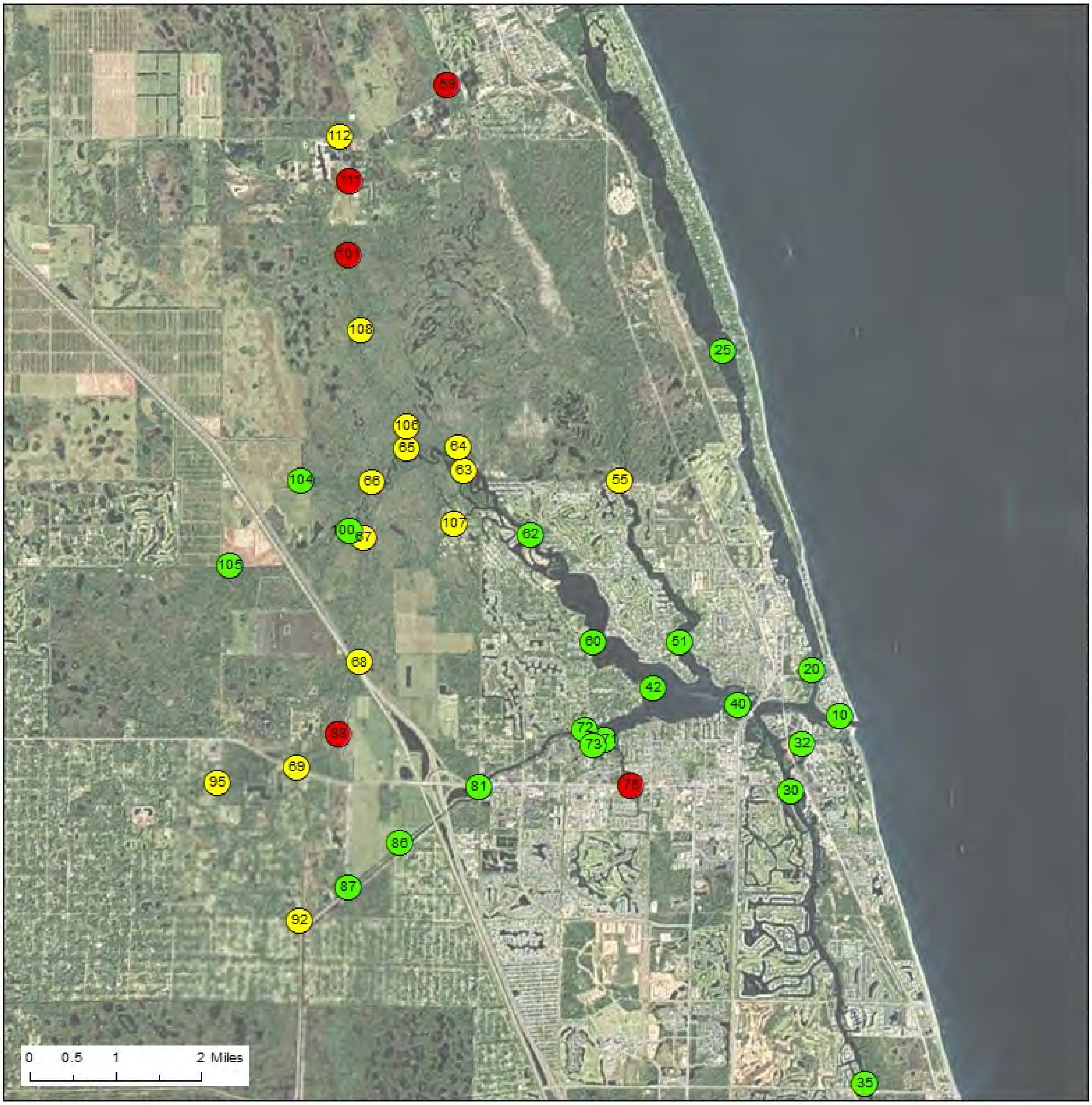
2010 water quality stoplight scoring by sampling site for total phosphorus (TP), Loxahatchee River, Florida. See text for details on scoring.



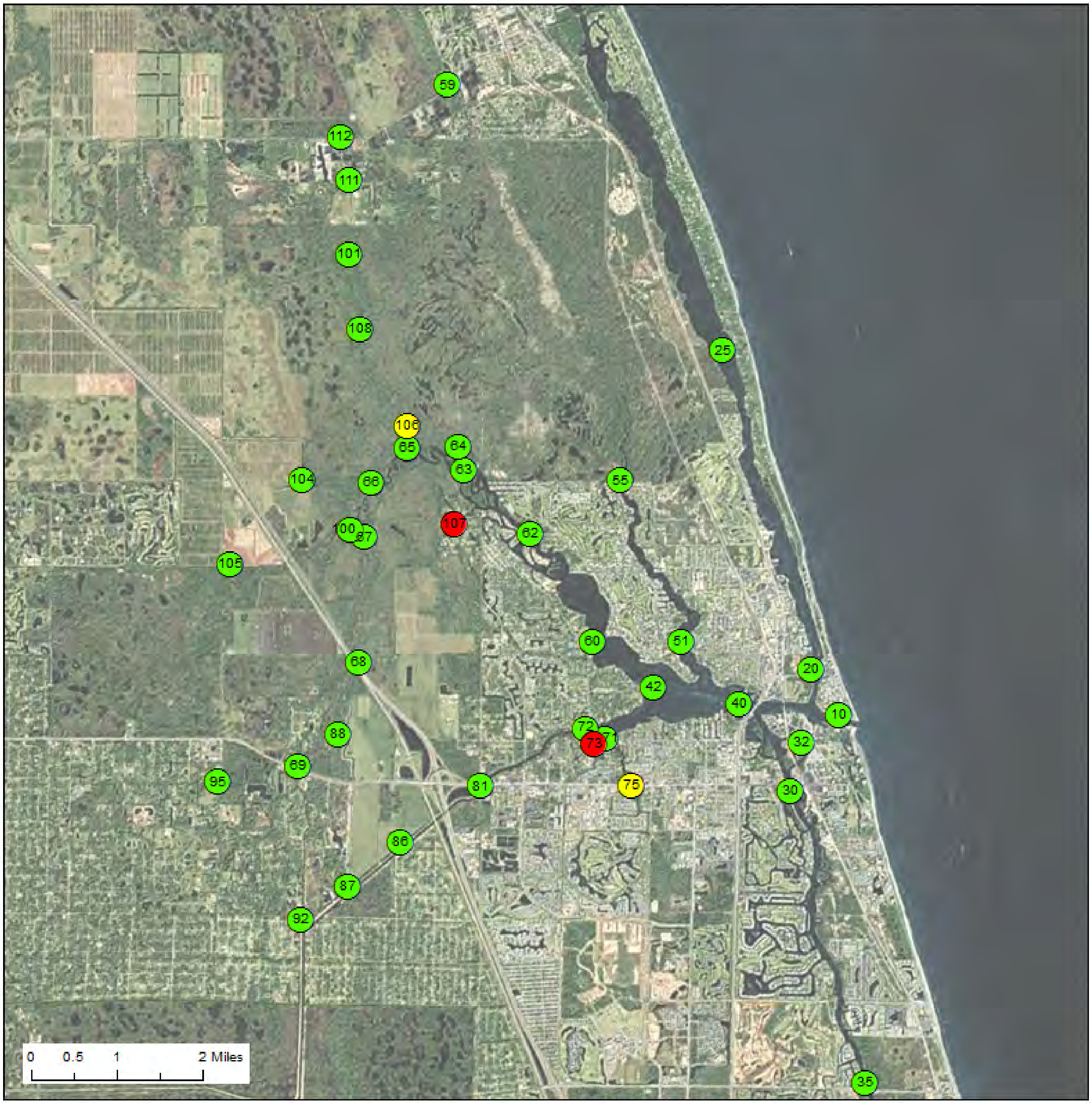
2010 water quality stoplight scoring by sampling site for cholorphyll a (CLA), Loxahatchee River, Florida. See text for details on scoring.



2010 water quality stoplight scoring by sampling site for dissolved oxygen (DO), Loxahatchee River, Florida. See text for details on scoring.



2010 water quality stoplight scoring by sampling site for fecal coliform bacteria (FC), Loxahatchee River, Florida. See text for details on scoring.



Appendix D – Analysis Methods & Calibration Criteria

LOXAHATCHEE RIVER DISTRICT WILDPINE LAB				E56026					
TABLE OF CALIBRATION ACCEPTANCE CRITERIA FOR LAB ACTIVITIES									
Effective Date: 4/24/03 Rev. 8 on January 2010									
							[HISTORICAL VALUES]		
PARAMETER/ METHOD	BLANK (mg/L)	LOQ (mg/L)	# OF INITIAL STDS	INITIAL CALIB CORR COEF OR % R	2ND STD % R	CONTINUING CALIB (LCS) % R	PRECISION OF DUPS % RPD	ACCURACY OF SPIKES % R	HOLD TIMES/ PRES
Fecal Coliform	1 pre-1 post +	1 cfu/	N/A	N/A	N/A	N/A	[0 - 50]	N/A	6 hours
SM9222D	every 10 samp	100 mLs					every 10 samples		on ice
MF	less than LOQ						or matrix set		
Total Coliform	1 pre-1 post +	1 cfu/	N/A	N/A	N/A	N/A	[0 - 50]	N/A	6 hours
SM9222B	every 10 samp	100 mLs					every 10 samples		on ice
MF	less than LOQ						or matrix set		
Ammonia-N low	1 pre- +	0.05	6 to	>/= 0.995	90 - 110	80 - 120	[0 - 30]	[80 - 120]	28 days
SM4500-NH3 C (18th ed)	every 10 samples		bracket		one prior	LCS in dup every	very 10 sample	very 10 sample	w/H2SO4
Color, Nessler's	less than LOQ		samples		to sample analysi	10 samples + end	or matrix set	or matrix set	
Ammonia-N high	1 pre- +	0.2	3 to	>/= 0.995	90 - 110	80 - 120	[0 - 10]	[85-115]	28 days
SM4500-NH3 C	every10 samples		bracket		one prior	LCS in dup every	very 10 sample	very 10 sample	w/H2SO4
Titrimetric	less than LOQ		samples		to sample analysi	10 samples + end	or matrix set	or matrix set	
TKN	1 pre- +	0.2	6 to	>/= 0.995	90 - 110	90 - 110	[0 - 20]	90 - 110	28 days
EPA 351.2	every 10 samples		bracket		one prior	LCS in dup every	very 10 sample	very 10 sample	w/H2SO4
Block, FIA	less than LOQ		samples		to sample analysi	10 samples + end	or matrix set	or matrix set	
Nitrate+Nitrate-N low	1 pre- +	0.005	6 to	>/= 0.995	90 - 110	90 -110	[0 - 20]	90 -110	48 hours
EPA 353.2	every 10 samples		bracket		one prior	LCS in dup every	very 10 sample	very 10 sample	no acid
Cd Reduc, FIA	less than LOQ		samples		to sample analysi	10 samples + end	or matrix set	or matrix set	filter
Nitrate+Nitrate-N high	1 pre- +	0.02	6 to	>/= 0.995	90 - 110	90 -110	[0 - 14]	90 -110	28 days
EPA 353.2	every 10 samples		bracket		one prior	LCS in dup every	very 10 sample	very 10 sample	w/H2SO4
Cd Reduc, FIA	less than LOQ		samples		to sample analysi	10 samples + end	or matrix set	or matrix set	filter
Ortho-Phosphate	1 pre- +	0.003	6 to	>/= 0.995	90 - 110	80 -120	[0 - 20]	[90 - 110]	48 hours
SM4500-P F	every 10 samples		bracket	98 -102	one prior	LCS in dup every	very 10 sample	very 10 sample	no acid
FIA	less than LOQ		samples	published	o sample analysi	10 samples + end	or matrix set	or matrix set	filter
Ortho-Phosphate	1 pre- +	0.003	6 to	>/= 0.995	90 - 110	80 -120	[0 - 20]	[90 - 110]	48 hours
SM4500-P E	every 10 samples		bracket	98 -102	one prior	LCS in dup every	very 10 sample	very 10 sample	no acid
Color, Ascorbic	less than LOQ		samples	published	o sample analysi	10 samples + end	or matrix set	or matrix set	filter
Total Phosphorus low	1 pre- +	0.002	6 to	>/= 0.995	90 - 110	80 -120	[0 - 10]	[85 - 115]	28 days
SM4500-P E	every 10 samples		bracket	98 -102	one prior	LCS in dup every	very 10 sample	very 10 sample	w/H2SO4
Color, Ascorbic	less than LOQ		samples	published	o sample analysi	10 samples + end	or matrix set	or matrix set	
Total Phosphorus high	1 pre- +	0.005	6 to	>/= 0.995	90 - 110	80 -120	[0 - 20]	[85 - 115]	28 days
SM4500-P E	every 10 samples		bracket	98 -102	one prior	LCS in dup every	very 10 sample	very 10 sample	w/H2SO4
Color, Ascorbic	less than LOQ		samples	published	o sample analysi	10 samples + end	or matrix set	or matrix set	
BOD	1 dil. H20-	2.0	2 GGA	75 - 125	75 - 125	75 - 125	[0 - 30]	[70 - 130]	48 hours
SM5210B	1 seed Bk	published			one prior	every 10 samples	very 10 sample	very 10 sample	on ice
5 day, 20 C	every 10 samples				to sample analysi	or at end	or matrix set	or matrix set	
NOTE: Must meet 2.0 mg/L minimum DO depletion (initial minus final) and 1.0 mg/L residual (final) DO for each test bottle.									
CBOD	1 dil. H20-	2.0	2 GGA	75 - 125	75 - 125	75 - 125	[0 - 30]	[70 - 130]	48 hours
SM5210B	1 seed Bk	published		published	one prior	every 10 samples	very 10 sample	very 10 sample	on ice
5 day, 20 C	every 10 samples			in method	o sample analysi	or at end	or matrix set	or matrix set	
NOTE: Must meet 2.0 mg/L minimum DO depletion (initial minus final) and 1.0 mg/L residual (final) DO for each test bottle.									
Alkalinity	1 pre- +	1	min of 2	>/= 0.995	90 - 110	80 -120	[0 - 5]	[85 - 115]	14 days
SM2320B	every 10 samples		bracket		one prior	every 10 samples	very 10 sample	very 10 sample	on ice
Titrimetric, pH 4.5	less than LOQ		samples		to sample analysi	or at end	or matrix set	or matrix set	
Chloride	1 pre- +	2	min of 2	>/= 0.995	90 - 110	80 -120	[0 - 4]	[80 - 120]	28 days
SM4500Cl- B	every 10 samples		bracket		one prior	every 10 samples	very 10 sample	very 10 sample	on ice
Argentometric	less than LOQ		samples		to sample analysi	or at end	or matrix set	or matrix set	
Conductivity	1 pre- +	2	min of 2	95-105	95-105	95-105	[0 - 2]	N/A	28 days
EPA 120.1	every 10 samp	umhos/cm	to bracket		one prior	every 10 samples	very 10 samples		on ice
Lab Meter	less than LOQ		samples		to sample analysi	or at end	or matrix set		
TDS	1 pre- +	10	1	[93 - 103]	[93 - 103]	N/A	[0 - 6]	N/A	7 days
SM2540C	every 10 samples						every 10 samples		on ice
Gravimetric, 180 C	less than LOQ						or matrix set		
NOTE: Dried to constant w eight-- w hen w eight change is less than 0.005 gm.									
NOTE: Choose sample size to yield less than 200 mg residue.									
TSS	1 pre- +	1	1	[80 - 120]	[80 - 120]	N/A	[0 - 45]	N/A	7 days
SM2540D	every 10 samples						every 10 samples		on ice
Gravimetric, 104 C	less than LOQ						or matrix set		
NOTE: Dried to constant w eight-- w hen w eight change is less than 0.005 gm.									
NOTE: Choose sample size to yield betw een 2.5 & 200 mg residue and complete filtration time w ithin 10 min.									
Sulfate	1 pre- +	5	12	>/= 0.995	90 - 110	90 -110	[0 - 20]	90 -110	28 days
EPA 375.2	every 10 samples		to bracket		one prior	LCS in dup every	very 10 sample	very 10 sample	on ice
Color, MTB, FIA	less than LOQ		samples		to sample analys	10 samples or end	or matrix set	or matrix set	
Turbidity	1 DI H2O	0.1 NTU	4 formazin	95 - 105	95 - 105	95 - 105	[0 - 5]	N/A	48 hours
EPA 180.1	every 20 samples		quarterly		2 gelex stds to	1 gelex every 10	very 10 samples		on ice
Turbidimeter	less than LOQ				bracket analysis	samples or at end	or matrix set		
pH	N/A	N/A	2 or 3 to	95 - 105	+/- 0.2 units	+/- 0.2 units	0 - 5	N/A	analyze
EPA 150.1			bracket	% efficiency					immediately
Lab Meters			samples	of electrode					
DO			1 initial	+/- 0.5 mg/L		95 - 105			analyze
EPA 360.1	N/A	N/A	Water	With chart	N/A	1 end Water	N/A	N/A	immediately
Field & Lab meters			Sat air			Sat air			
Chlorophyll a	1 pre	1	1	N/A	none	N/A	0 - 30	N/A	21 days
									filter/freeze
Color	1 pre	5	1	N/A	none	N/A	0 - 5	N/A	48 hours
									filter/on ice

Appendix E – Parameter & Station Listing

Parameters			*TOC*	*Ammonia*		
		Station		**Historical**	**Current**	
Date		10	*	*		
Time		20	*	*		
Sample Depth		25	*			
Tide Stage		30	*	*		
		32	*			
Alkalinity		40	*			
Ammonia		51	*			
Chlorophyll-a corrected		60	*	*	*	
Chlorophyll-a uncorrected		62	*	*	*	
Color		63	*			
Dissolved Oxygen		64	*	*		
Dissolved Oxygen % Saturation		65	*	*	*	
Fecal Coliforms		67	*	*	*	
Light % at 1 meter		68	*			
Light % at 2 meter		69	*	*	*	
Light Attenuation		72	*	*	*	
Nitrate+Nitrite		74			*	
Organic Nitrogen		75		*	*	
Orthophosphate		81	*	*	*	
pH		86	*	*	*	
Salinity		87	*	*	*	
Secchi Disk Depth		88	usually dry		*	
Specific Conductance		92			*	
Temperature						
Total Kjeldahl Nitrogen		95	*		*	
Total Nitrogen		100	*	*	*	
Total Organic Carbon		101		*		
Total Phosphorus		104	*			
Total Suspended Solids		105	*	*	*	
Turbidity		107		*	*	
		108	*			
		111	*		*	
		112	*		*	

Notes:

All the parameters listed are analyzed on all the samples except for TOC and Ammonia.

In 2009 several ammonia stations were discontinued at the marine stations
because occurance is rare; facilitated additional freshwater stations.

Appendix F – Quality Control Summary

Note: ‘I’, ‘P’ and ‘U’ qualifier codes *not* included

Site #	Date	Time	Analyte	Method	Code	Data Qualifier Issue
10	10/21/2009	1259	TKN	EPA351.2	J.3A+	Spike recovery above acceptable QC limits
10	10/21/2009	1259	TKN	EPA351.2	V	Analyte detected in the field blank
62	10/21/2009	1153	TKN	EPA351.2	J.3A+	Spike recovery above acceptable QC limits
62	10/21/2009	1153	TKN	EPA351.2	V	Analyte detected in the field blank
65	10/21/2009	1111	TKN	EPA351.2	J.3A+	Spike recovery above acceptable QC limits
65	10/21/2009	1111	TKN	EPA351.2	V	Analyte detected in the field blank
67	10/21/2009	1021	TKN	EPA351.2	J.3A+	Spike recovery above acceptable QC limits
67	10/21/2009	1021	TKN	EPA351.2	V	Analyte detected in the field blank
69	10/21/2009	915	TKN	EPA351.2	J.3A-	Spike recovery below acceptable QC limits
69	10/21/2009	915	TKN	EPA351.2	V	Analyte detected in the field blank
72	10/21/2009	1227	TKN	EPA351.2	J.3A-	Spike recovery below acceptable QC limits
72	10/21/2009	1227	TKN	EPA351.2	V	Analyte detected in the field blank
92	10/21/2009	930	NH3	SM4500NH3C 18th ed	J.3P	% RPD of duplicates outside acceptable QC limits
92	10/21/2009	930	ortho P	EPA365.2	J.3P	% RPD is outside acceptable QC limits
92	10/21/2009	930	TKN	EPA351.2	J.3A-	Spike recovery below acceptable QC limits
92	10/21/2009	930	TKN	EPA351.2	V	Analyte detected in the field blank
95	10/21/2009	1030	TKN	EPA351.2	J.3A-	Spike recovery below acceptable QC limits
95	10/21/2009	1030	TKN	EPA351.2	V	Analyte detected in the field blank
100	10/21/2009	1030	TKN	EPA351.2	V	Analyte detected in the field blank
101	11/9/2009	849	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
106	11/9/2009	813	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
106	11/9/2009	813	ortho P	EPA365.2	J.1+	% Recovery of standard is higher than acceptable QC limits
108	11/9/2009	837	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
108	11/9/2009	837	ortho P	EPA365.2	J.1+	% Recovery of standard is higher than acceptable QC limits
111	11/9/2009	903	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
112	11/9/2009	930	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
10	11/16/2009	1025	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
20	11/16/2009	1010	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
25	11/16/2009	940	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
30	11/16/2009	1118	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
32	11/16/2009	1105	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
35	11/16/2009	1135	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
40	11/16/2009	1045	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
42	11/17/2009	1007	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
51	11/17/2009	950	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
55	11/17/2009	931	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
71	11/17/2009	1040	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
72	11/17/2009	1020	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
73	11/17/2009	1031	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
74	11/17/2009	1140	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
74	11/17/2009	1140	TKN	EPA351.2	J.3A-	Spike recovery below acceptable QC limits
75	11/17/2009	1128	CHL A	SM10200-H	Q	Analyzed beyond acceptable hold time
67	11/24/2009	1000	TKN	EPA351.2	J.3A+	Spike recovery above acceptable QC limits
95	11/24/2009	1113	NH3	SM4500NH3C 18th ed	J.3A-	Spike recovery below acceptable QC limits
107	11/24/2009	909	Total P	EPA365.2	J.3A+	RPD of duplicates higher than acceptable QC limits
95	12/16/2009	1107	Fecal	SM9222D	B	Colony count higher than acceptable range
10	1/19/2010	1030	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
20	1/19/2010	1000	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
25	1/19/2010	937	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
30	1/19/2010	1137	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
32	1/19/2010	1120	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
35	1/19/2010	1150	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
40	1/19/2010	1053	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
42	1/20/2010	1000	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
51	1/20/2010	1045	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
55	1/20/2010	1025	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
59	1/20/2010	1103	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
71	1/20/2010	928	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
72	1/20/2010	949	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
72	1/20/2010	949	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
73	1/20/2010	938	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
73	1/20/2010	938	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
74	1/20/2010	1136	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
74	1/20/2010	1136	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
75	1/20/2010	913	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
75	1/20/2010	913	CHL A	SM10200-H	J.3P	RPD of duplicate outside acceptable QC limits
75	1/20/2010	913	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
101	1/20/2010	1023	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
101	1/20/2010	1023	TSS	SM2540D	Q	Sample analyzed beyond acceptable hold time
101	1/20/2010	1023	Turb	EPA180.1	Q	Sample analyzed beyond acceptable hold time
106	1/20/2010	937	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
108	1/20/2010	958	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
111	1/20/2010	1038	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
111	1/20/2010	1038	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank

Site #	Date	Time	Analyte	Method	Code	Data Qualifier Issue
112	1/20/2010	1053	Alk	SM2320B	Q	Samples analyzed beyond acceptable hold time
112	1/20/2010	1103	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
60	1/27/2010	1258	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
62	1/27/2010	1239	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
65	1/27/2010	1147	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
67	1/27/2010	1053	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
68	1/27/2010	947	TKN	EPA351.2	J.3P	RPD of duplicate outside acceptable QC limits
69	1/27/2010	1003	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
69	1/27/2010	1003	TKN	EPA351.2	J.3P	RPD of duplicate outside acceptable QC limits
81	1/27/2010	1338	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
81	1/27/2010	1338	TKN	EPA351.2	J.3P	RPD of duplicate outside acceptable QC limits
86	1/27/2010	1322	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
86	1/27/2010	1322	TKN	EPA351.2	J.3P	RPD of duplicate outside acceptable QC limits
87	1/27/2010	1315	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
87	1/27/2010	1315	TKN	EPA351.2	J.3P	RPD of duplicate outside acceptable QC limits
92	1/27/2010	1202	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
92	1/27/2010	1202	TKN	EPA351.2	J.3P	RPD of duplicate outside acceptable QC limits
95	1/27/2010	1214	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
95	1/27/2010	1214	TKN	EPA351.2	J.3P	RPD of duplicate outside acceptable QC limits
100	1/27/2010	1105	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
104	1/27/2010	1128	TKN	EPA351.2	J.3P	RPD of duplicate outside acceptable QC limits
105	1/27/2010	1038	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
105	1/27/2010	1038	TKN	EPA351.2	J.3P	RPD of duplicate outside acceptable QC limits
107	1/27/2010	925	NH3	SM4500NH3C 18th ed	V	Analyte detected in the method blank
107	1/27/2010	925	TKN	EPA351.2	J.3P	RPD of duplicate outside acceptable QC limits
69	2/16/2010	934	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
92	2/16/2010	1011	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
95	2/16/2010	1055	CHL A	SM10200-H	J.3P	RPD of duplicate outside acceptable QC limits
95	2/16/2010	1055	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
35	3/17/2010	1109	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
42	3/18/2010	1031	CHL A	SM10200-H	J.3P	RPD of duplicate outside acceptable QC limits
60	3/22/2010	1248	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
62	3/22/2010	1228	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
63	3/22/2010	1212	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
64	3/22/2010	1159	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
65	3/22/2010	1132	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
66	3/22/2010	1109	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
67	3/22/2010	1042	NH3	SM4500NH3C 18th ed	J.3P	RPD of duplicate outside acceptable QC limits
67	3/22/2010	1042	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
69	3/22/2010	1010	NO2+NO3	EPA353.2	J.3A+	Spike recovery is higher than acceptable QC limits
100	3/22/2010	1054	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
59	3/23/2010	905	CHL A	SM10200-H	J.3P	RPD of duplicate outside acceptable QC limits
59	3/23/2010	905	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
101	3/23/2010	825	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
106	3/23/2010	741	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
108	3/23/2010	803	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
111	3/23/2010	840	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
112	3/23/2010	855	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
62	4/15/2010	1145	NH3	SM4500NH3C 18th ed	J.3P	RPD of duplicate outside acceptable QC limits
62	4/15/2010	1145	NH3	SM4500NH3C 18th ed	J.3A+	Spike recovery is higher than acceptable QC limits
62	4/15/2010	1145	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
81	5/12/2010	1220	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
100	5/12/2010	1019	NH3	SM4500NH3C 18th ed	J.3P	RPD of duplicate outside acceptable QC limits
100	5/12/2010	1019	ortho P	SM4500-P E	J.3P	RPD of duplicate outside acceptable QC limits
101	5/13/2010	920	NO2+NO3	EPA353.2	J.3A-	Spike recovery is lower than acceptable QC limits
101	5/13/2010	920	ortho P	SM4500-P E	J.3P	RPD of duplicate outside acceptable QC limits
111	5/13/2010	945	NH3	SM4500NH3C 18th ed	J.1+	Standard higher than acceptable QC limits
112	5/13/2010	1020	NH3	SM4500NH3C 18th ed	J.1+	Standard higher than acceptable QC limits
40	5/18/2010	1104	TP	SM4500-P E	J.3P	RPD of duplicate outside acceptable QC limits
73	5/19/2010	1003	ortho P	SM4500-P E	J.1+	Standard higher than acceptable QC limits
75	5/19/2010	907	NH3	SM4500NH3C 18th ed	J.1+	Standard higher than acceptable QC limits
75	5/19/2010	907	ortho P	SM4500-P E	J.1+	Standard higher than acceptable QC limits
60	6/29/2010	1310	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
62	6/29/2010	1133	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
65	6/29/2010	1038	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
67	6/29/2010	950	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
69	6/29/2010	910	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
72	6/29/2010	1323	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
92	6/29/2010	936	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
95	6/29/2010	1028	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
100	6/29/2010	1000	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
10	7/7/2010	1030	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
20	7/7/2010	1015	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
25	7/7/2010	943	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time

Site #	Date	Time	Analyte	Method	Code	Data Qualifier Issue
30	7/7/2010	1125	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
32	7/7/2010	1110	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
35	7/7/2010	1140	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
40	7/7/2010	1052	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
42	7/8/2010	1129	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
51	7/8/2010	1056	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
55	7/8/2010	1030	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
71	7/8/2010	1239	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
72	7/8/2010	1151	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
73	7/8/2010	1205	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
74	7/8/2010	1323	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
75	7/8/2010	1224	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
60	7/12/2010	1221	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
60	7/12/2010	1221	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
62	7/12/2010	1205	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
62	7/12/2010	1205	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
63	7/12/2010	1147	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
63	7/12/2010	1147	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
64	7/12/2010	1134	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
64	7/12/2010	1134	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
65	7/12/2010	1113	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
65	7/12/2010	1113	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
66	7/12/2010	1055	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
66	7/12/2010	1055	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
67	7/12/2010	1030	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
67	7/12/2010	1030	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
68	7/12/2010	1004	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
68	7/12/2010	1004	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
69	7/12/2010	1023	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
69	7/12/2010	1023	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
81	7/12/2010	1309	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
81	7/12/2010	1309	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
86	7/12/2010	1219	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
86	7/12/2010	1219	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
87	7/12/2010	1211	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
87	7/12/2010	1211	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
88	7/12/2010	1258	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
88	7/12/2010	1258	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
92	7/12/2010	1127	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
92	7/12/2010	1127	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
95	7/12/2010	1139	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
95	7/12/2010	1139	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
100	7/12/2010	1040	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
100	7/12/2010	1040	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
104	7/12/2010	1103	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
104	7/12/2010	1103	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
105	7/12/2010	1035	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
105	7/12/2010	1035	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
107	7/12/2010	942	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
107	7/12/2010	942	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
101	7/20/2010	954	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
101	7/20/2010	954	NO2+NO3	EPA353.2	J.1-	% Recovery of end standard lower than acceptable QC limits
101	7/20/2010	954	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
101	7/20/2010	954	ortho P	SM4500-P F	V	Analyte detected in the method blank
106	7/20/2010	920	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
106	7/20/2010	920	NO2+NO3	EPA353.2	J.1-	% Recovery of end standard lower than acceptable QC limits
106	7/20/2010	920	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
106	7/20/2010	920	ortho P	SM4500-P F	V	Analyte detected in the method blank
108	7/20/2010	933	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
108	7/20/2010	933	NO2+NO3	EPA353.2	J.1-	% Recovery of end standard lower than acceptable QC limits
108	7/20/2010	933	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
108	7/20/2010	933	ortho P	SM4500-P F	V	Analyte detected in the method blank
111	7/20/2010	1006	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
111	7/20/2010	1006	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
111	7/20/2010	1006	ortho P	SM4500-P F	V	Analyte detected in the method blank
112	7/20/2010	1019	TKN	EPA351.2	J.3A-	Spike recovery is lower than acceptable QC limits
112	7/20/2010	1019	NO2+NO3	EPA353.2	J.1-	% Recovery of end standard lower than acceptable QC limits
112	7/20/2010	1019	Total P	SM4500-P E	Q	Sample analyzed beyond acceptable hold time
112	7/20/2010	1019	ortho P	SM4500-P F	V	Analyte detected in the method blank
72	8/25/2010	1210	TKN	EPA351.2	J.3A+	Spike recovery is higher than acceptable QC limits
60	9/8/2010	1131	TKN	EPA351.2	J.3PA+	Matrix duplicate & spike recoveries higher than acceptable QC limits
62	9/8/2010	1115	TKN	EPA351.2	J.3PA+	Matrix duplicate & spike recoveries higher than acceptable QC limits
63	9/8/2010	1059	TKN	EPA351.2	J.3PA+	Matrix duplicate & spike recoveries higher than acceptable QC limits
64	9/8/2010	1046	TKN	EPA351.2	J.3PA+	Matrix duplicate & spike recoveries higher than acceptable QC limits

Appendix F - Quality Control Summary

Site #	Date	Time	Analyte	Method	Code	Data Qualifier Issue
65	9/8/2010	1031	TKN	EPA351.2	J.3PA+	Matrix duplicate & spike recoveries higher than acceptable QC limits
66	9/8/2010	1009	TKN	EPA351.2	J.3PA+	Matrix duplicate & spike recoveries higher than acceptable QC limits
67	9/8/2010	946	TKN	EPA351.2	J.3PA+	Matrix duplicate & spike recoveries higher than acceptable QC limits
100	9/8/2010	957	TKN	EPA351.2	J.3PA+	Matrix duplicate & spike recoveries higher than acceptable QC limits
108	9/22/2010	914	Total P	SM4500-P E	J.3P	% RPD of matrix duplicate outside acceptable QC limits
72	9/23/2010	1026	TKN	EPA351.2	J.3A-	% Recovery of matrix spike is lower than acceptable QC limits