Chapter 2A: Status of Water Quality in the Everglades Protection Area

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SUMMARY

The focus of this chapter is to provide an update to the 2001 Consolidated Report. It provides a review of the water quality status for each EPA region during the past water year (i.e., May 1, 2000 through April 30, 2001). An analysis of the water quality parameters not meeting the water quality criteria specified in Section 62-302.530, F.A.C., and a discussion of any temporal or spatial trends observed for the parameters identified as concerns or potential concerns, is also provided. Annual excursion rates were summarized in a manner consistent with methods employed in the 1999 Interim and previous Consolidated Reports, with parameters not meeting existing standards being classified into two categories based on excursion frequencies. This chapter also provides a discussion of the factors contributing to excursions from applicable water quality criteria and an evaluation of the natural background condition where existing standards are not appropriate. The results of the evaluation detailed in this chapter are summarized below.

- Hydrologically, WY2001 was dominated by a persistent and severe drought. In addition to the drought, releases from Lake Okeechobee during the drawdown and a tropical disturbance in October 2000 were major hydrologic events during the water year. These conditions very likely influenced the frequency of excursions for certain parameters during the year.
- The percentage of TP measurements between 10 and 50 µg/L increased dramatically from WY2000 levels. This increase resulted from decreases in both the percentage of samples at or below 10 µg/L and samples greater than 50 µg/L. The percent of sample levels at or below 10 µg/L decreased particularly within WCA-3 outflows (28-percent decrease) and Park inflows (27-percent decrease) compared to the WY2000 level of 45 percent. Additionally, there was a 24-percent decline in the frequency of TP concentrations greater than 50 µg/L in WCA-2 inflow waters compared to WY2001 levels. Many of the observed changes in the TP concentrations are probably related to the drought conditions experienced during WY2001.

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- Water Year 2001 TN concentrations fell within the range of previous periods.
- Dissolved oxygen (DO) was placed in the Category of Concern for all EPA regions and classes due to ubiquitous concentrations below the current 5.0 mg/L criterion. However, an SSAC has been proposed by the Department to recognize the naturally low DO regime characteristic of macrophyte dominated wetlands such as the Everglades. Application of the proposed SSAC to the DO data collected during WY2001 resulted in a reduction in the number of monitoring stations at which DO was identified as being a Concern from 121 to 24. Most of the remaining 24 sites can be shown to be influenced by either nutrient enrichment or groundwater infiltration and are accurately describe as below marsh background levels defined in the SSAC.
- As was the case in previous years, alkalinity was classified as a Concern for the interior of the Refuge due to an excursion rate of 14.7 percent. The low alkalinity levels in the interior portions of the Refuge result from natural hydrologic pattern and should not be considered in violation of the current criterion. In contrast to other portions of the Everglades, the interior of the Refuge is a soft-water system that receives most of its hydrologic load from rainfall instead of canal inflows.
- Similar to alkalinity, pH was classified as a Concern in the interior of the Refuge due to frequent values below the lower limit of the state criterion. The low pH levels within the Refuge are associated with low alkalinity levels and the fact that the hydrologic budget for this area is driven by rainfall. Since they depict natural background conditions, the low pH levels within the Refuge are not considered as violations of the current standard. Additionally, two pH values above 8.5 were observed at a Refuge inflow site, resulting in pH being categorized as a Potential Concern for this area.
- Conductivity was categorized as a parameter of Concern for Refuge inflows. Additionally, conductivity was categorized as a Potential Concern for the Refuge rim canal, interior and outflows, WCA-2 inflows, and interior, and WCA-3 inflows. Similar to previous years all the conductivity excursions occurred in close proximity to at either water control structures or canals and are likely associated with the pumping or seepage of high ionic strength groundwater into the surface water in the canals. Groundwater can be introduced to the surface water through the normal operation and morphology of the water conveyance system and as the result of agricultural activities in the EAA. The importance of each of these factors in contributing to the observed conductivity excursions is unclear and warrants further evaluation.
- Un-ionized ammonia was placed in the Potential Concern category for the Refuge inflow, rim canal and outflow, WCA2 inflow, interior, and outflow, WCA-3 inflow, and Park interior. A substantial number of excursions (5 of the 12) were reported at various sites, during the month of April 2000. A review of the associated data indicates that these were probably the result of high dissolved ammonia levels at these sites during the month of April 2000. Overall, WY2001 excursion rates for un-ionized ammonia are within the historical range, but have increased since last water year. The increased un-ionized ammonia levels during WY2001 may be related to the dry conditions associated with the extended drought experienced through much of the year. Next water year's data should be

reviewed to determine whether excursion rates show a continued increase and pervasiveness throughout the system.

- Iron was categorized as a Concern and Potential Concern for the interior of the Park and inflows to the Refuge, respectively. Given the infrequent excursions, low concentrations and absence of anthropogenic sources, it is unlikely that iron represents a significant threat to designated uses of the water body. It is believed that the infrequent values above 1.0 mg/L represent a combination of the natural variability and disturbance of sediments resulting in samples that are not representative of the true conditions in the southern Everglades.
- Turbidity was categorized as a Concern for the Refuge rim canal. Additionally, turbidity was classified as a Potential Concern for the inflows and interiors of the Refuge and WCA-3, respectively. Similar to previous years, all WY2001 excursions were associated with water control structures or canals.
- A single silver value of 0.07 mg/L at ENR012, the STA-1W outflow structure, exceeded the Class III criterion and resulted in silver being categorized as a Concern for Refuge inflows.
- Diazinon continued a recent trend and was classified as a Concern in WCA-2 because of an exceedance, originating from the North Springs Improvement District.
- Pesticide excursions were notably absent from the EAA and C-111 basin and may be associated with better BMP performance or lower influences from agricultural areas resulting from the extended drought.

PURPOSE

The primary purpose of Chapter 2A is to provide an overview of the status of water quality in the Everglades Protection Area (EPA) for Water Year 2001 (WY2001) (i.e., May 1, 2000 through April 30, 2001). It builds on water quality analyses previously presented in past Interim and Consolidated Reports. The chapter is presented as an update to the 2001 Everglades Consolidated Report. More specifically, the chapter and its appendices will achieve the following:

1. Summarize areas and times where water quality criteria are not being met and indicate trends in excursions over space and time
2. Discuss factors contributing to excursions from water quality criteria and provide an evaluation of natural background conditions where existing standards are not appropriate
3. Summarize total phosphorus and total nitrogen concentrations in the EPA and indicate spatial and temporal trends
4. Provide an update concerning the status of an alternative criterion for dissolved oxygen in Everglades marsh waters
5. Review all pesticide and priority pollutant data currently available.

METHODS

An approach similar to the regional synoptic approach used in the 2001 Everglades Consolidated Report was applied to the WY2001 data to provide an overview of the status of compliance with water quality criteria in the EPA. The consolidation of water quality data on a regional basis provides for analysis over time, but limits spatial analyses within each region. However, spatial analyses can be made between regions because the majority of inflow and pollutants enter the northern one-third of the EPA and the net water flow is from north to south.

WATER QUALITY DATA SOURCES

The large majority of the water quality data evaluated in this chapter was retrieved from the South Florida Water Management District's (SFWMD's or District's) DBHYDRO database. Before water quality data are entered into the database, the SFWMD follows strict Quality Assurance/Quality Control (QA/QC) procedures approved by the Florida Department of Environmental Protection (FDEP or Department) for both data collection and analytical methods (**Appendix 8B-1f**). These methods are documented in the SFWMD Comprehensive Quality Assurance Plan #870166G (SFWMD, 1999), which is annually reviewed, updated and approved by the Department. Contract laboratories used by the SFWMD must also have their comprehensive QA/QC plans approved by the Department. Water quality data from the nutrient gradient sampling stations monitored by the Everglades Systems Research Division in the northern part of Water Conservation Area 2A (WCA-2A) and the southwestern part Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) were obtained from the Everglades Research Database.

EVERGLADES PROTECTION AREA WATER QUALITY SAMPLING STATIONS

Everglades sampling stations used in this report are classified as Class III waters of the state (Section 62-302.400, F.A.C.). Class III water quality criteria were established to protect recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife (Section 62-302.400, F.A.C.). Additionally, the Arthur R. Marshall Loxahatchee Wildlife Refuge and Everglades National Park are classified as Outstanding Florida Waters and Outstanding National Resource Waters, respectively (Section 62-302.700, F.A.C.). Beyond the requirements of Class III water quality criteria, no degradation of water quality, other than that allowed in Rule 62-4.242(2) and (3), F.A.C., is to be permitted in Outstanding Florida Waters and Outstanding National Resource Waters (Section 62-302.700, F.A.C.).

Water quality sampling stations (n=111) in each region of the EPA were classified as inflow, interior, or outflow sites, to provide a more detailed analysis of each region for compliance with Class III water quality criteria and to assist in the evaluation of potential causes for observed excursions (**Figure 2A-1**). There are several interior structures that convey water between EPA regions. Based on the current classification system, it was necessary to classify these structures conveying water from one region to another within the EPA as inflow stations. Thus, the S-10 structures were added as inflow sites to WCA-2, the S-11 structures as inflow sites to WCA-3, and the S-12 structures and S-333 as inflow sites to Everglades National Park (Park). The interior sites of each region consist of marsh and canal stations in addition to structures that convey water within the area. In contrast to the other regions, the Refuge has four components for analysis (inflow sites, rim canal sites, outflow sites and interior marsh sites) to account for inflows being conveyed in rim canals that border the east and west refuge levees and discharge into outflow structures in the south levee. Most of the water entering the Refuge through the S-5A and S-6 structures bypasses the marsh by the L-7 rim canal and is discharged to WCA-2A through the S-10 structures. The location and classification of stations used in this report are shown in **Figures 2A-2** through **2A-5**.

Although much of the data from the Non-ECP structures is used in the regional analysis of water quality conditions in the EPA, the Non-ECP structures are required by permit to be analyzed individually. This individual analysis of data collected at the Non-ECP structures, as well as all other permit required analyses and data presentations, are provided in Chapter 8 of this report to simplify and improve the readability of this chapter.

The current SFWMD Everglades monitoring programs are described in Germain (1998). Sampling frequency varies by site, depending on site classification, parameter group, and hydrologic conditions (water depth and flow). In general, inflow and outflow structures are monitored more frequently than interior marsh stations. Two examples will help illustrate the variation in sampling regimes. At the S-5A inflow structure to the Refuge nutrients and physical parameters (e.g., dissolved oxygen, conductivity, pH), pesticides, and trace metals are monitored weekly (when flowing), quarterly, and biannually, respectively. Monitoring at marsh stations within the Refuge is conducted on a monthly basis for most parameter groups. However, trace metals are monitored quarterly and pesticides are not routinely sampled. Due to low water conditions throughout much of WY2001, fewer samples were generally collected at interior marsh stations than in previous water years.

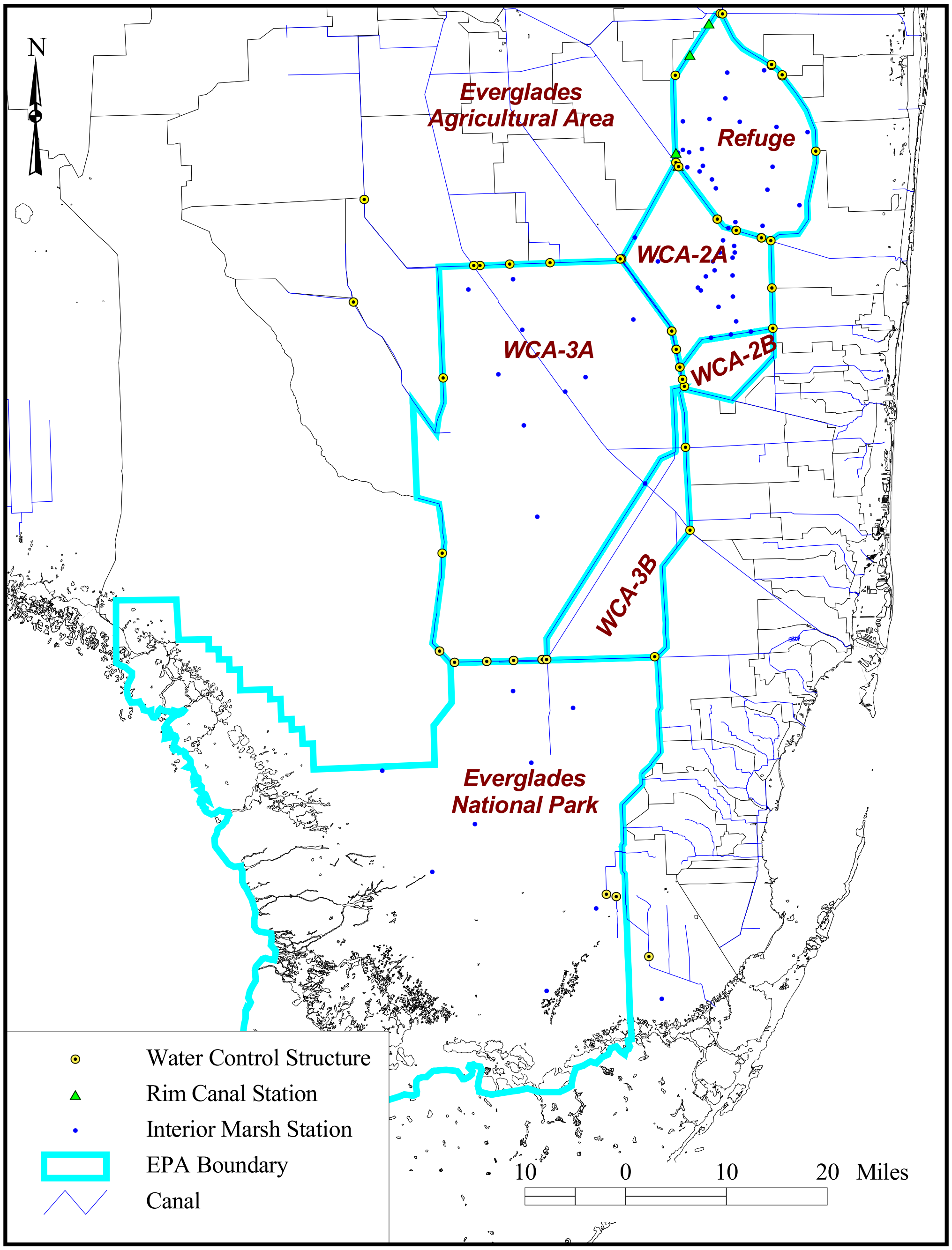

Figure 2A-1. Everglades Protection Area regions and water quality monitoring stations.

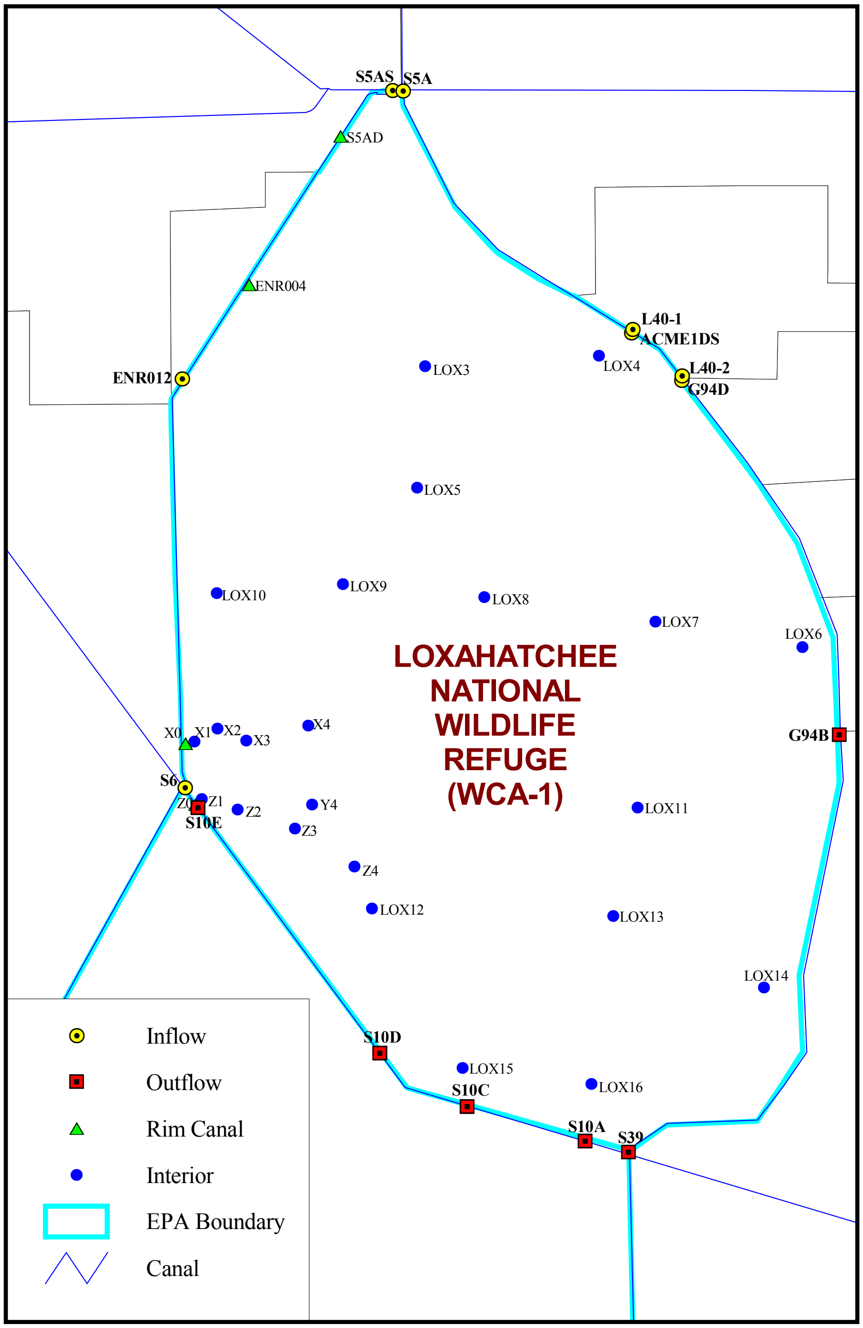

Figure 2A-2. Location and Classification of Water Quality Monitoring Stations in Arthur R. Marshall Loxahatchee National Wildlife Refuge

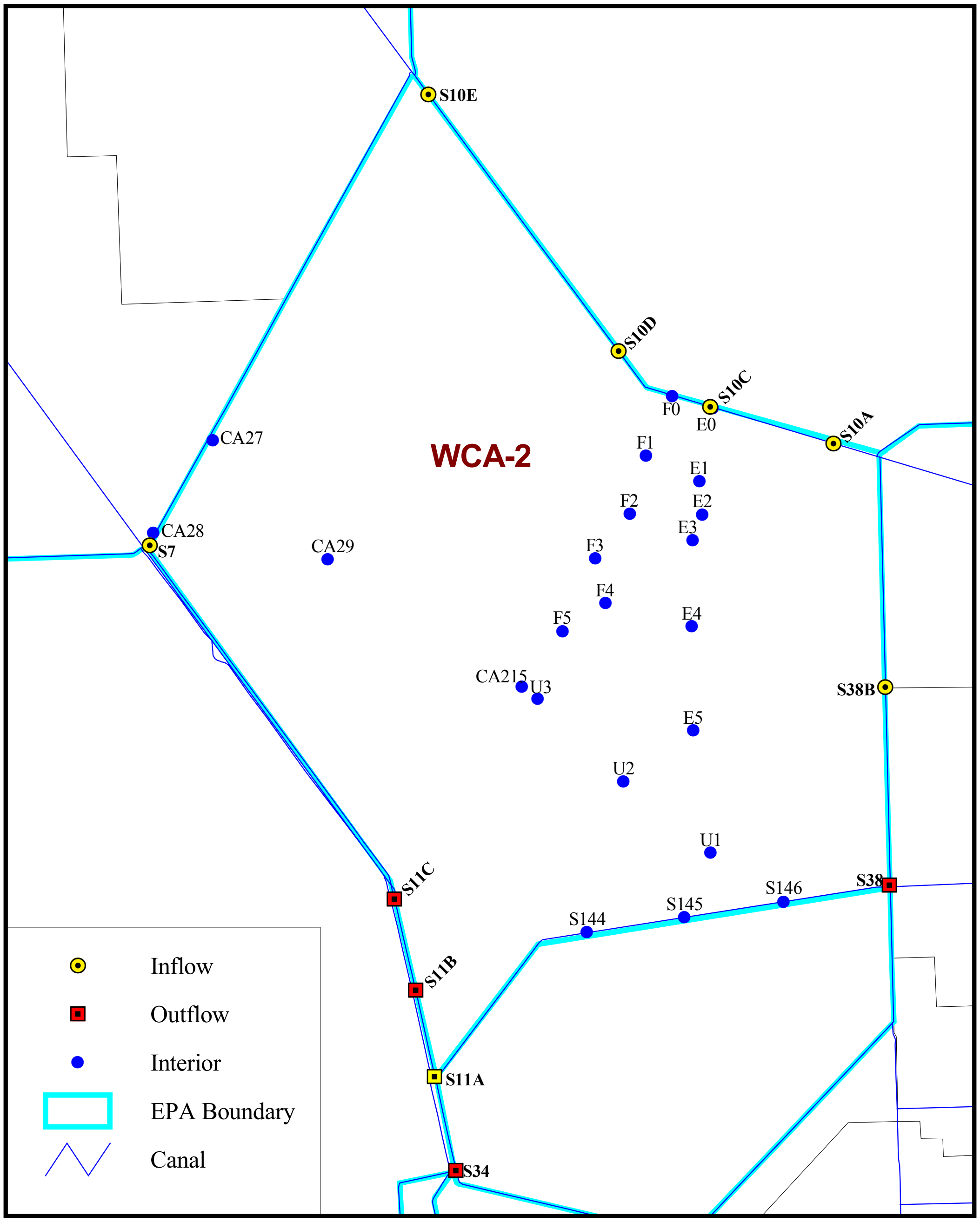

Figure 2A-3. Location and Classification of Water Quality Monitoring Stations in Water Conservation Area 2

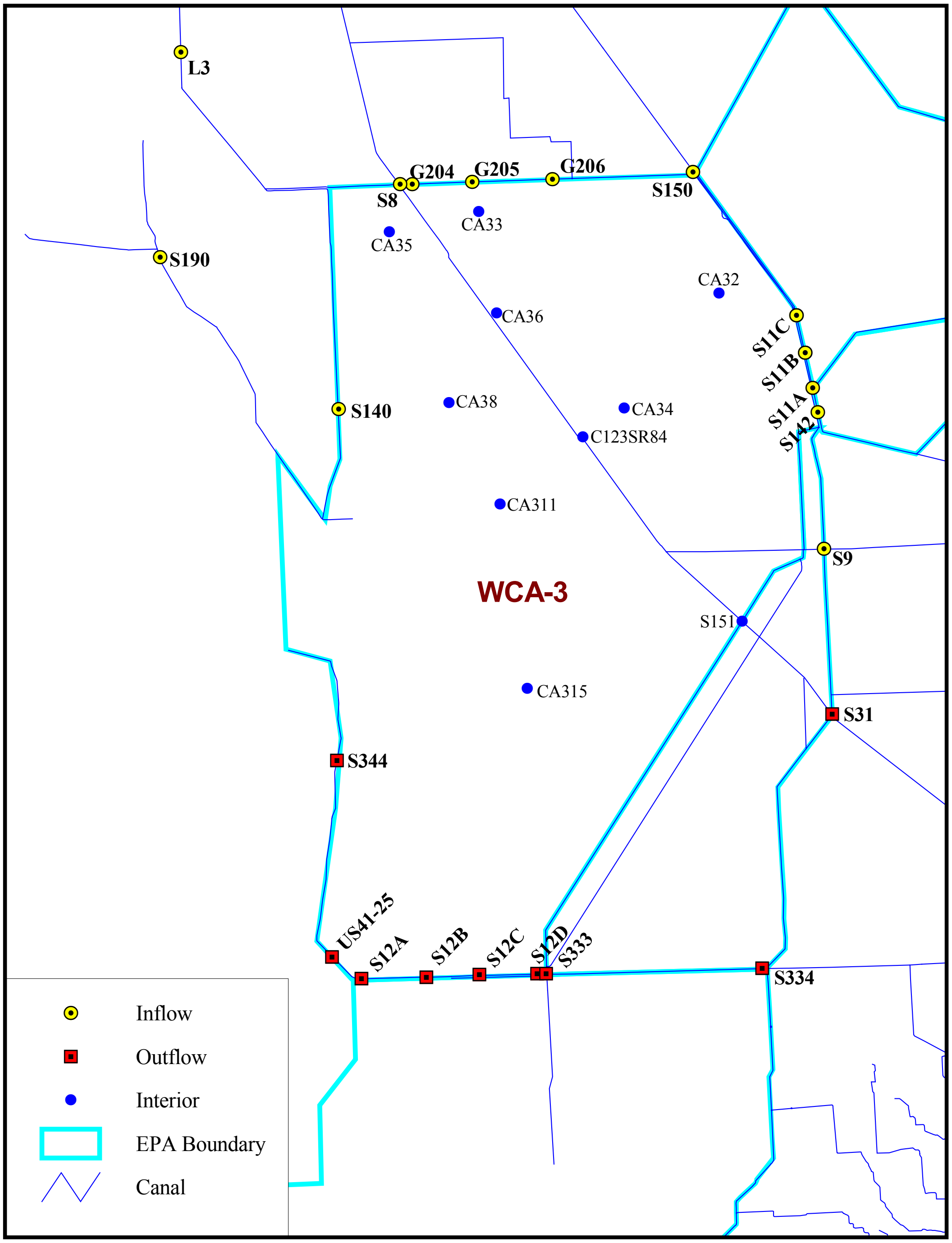

Figure 2A-4. Location and classification of water quality monitoring stations in Water Conservation Area 3.

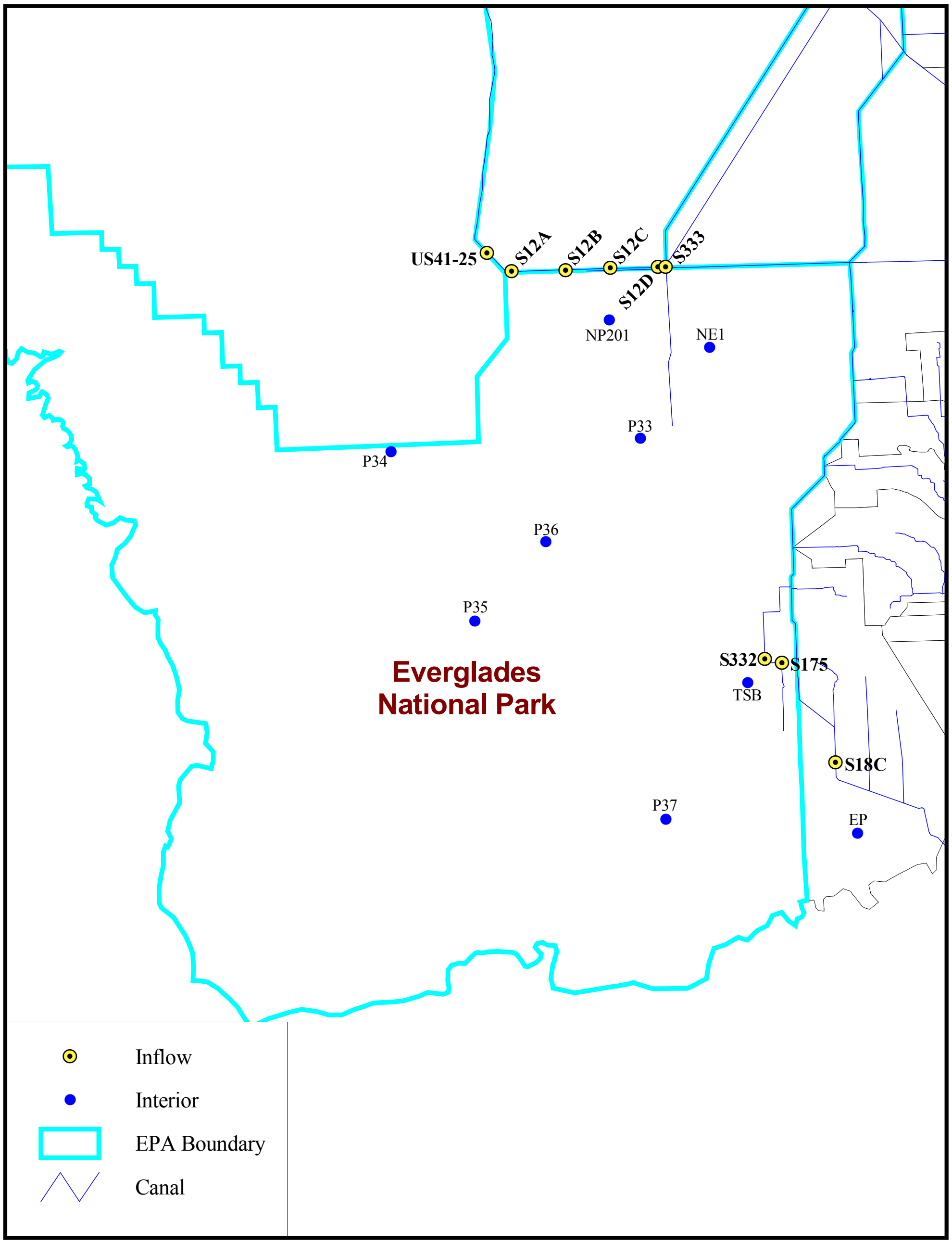

Figure 2A-5. Location and classification of water quality monitoring stations in Everglades National Park.

EVERGLADES PROTECTION AREA DATA ANALYSIS PERIOD

Water quality data collected from monitoring stations within EPA regions during WY2001 (May 1, 2000 through April 30, 2001) are evaluated and discussed in this chapter. Additionally, pesticide data presented herein were collected during quarterly sampling events conducted between March and November 2000. The pesticides period of record was selected as an update to data presented in the 2001 Consolidated Report, rather than reflecting a water year.

WATER QUALITY DATA EVALUATED

The District monitors approximately 109 water quality parameters within the EPA (Bechtel et al., 1999 and 2000). Given this chapter's focus on excursions from state water quality criteria, the evaluation was limited to parameters with Class III criteria pursuant to Chapter 62-302, F.A.C. The parameters evaluated included total phosphorus, total nitrogen, 62 pesticides, and the following 19 water quality constituents:

- Alkalinity
- Dissolved Oxygen
- Specific Conductance
- pH
- Total Silver
- Total Antimony
- Total Arsenic
- Total Beryllium
- Total Cadmium
- Total Chromium
- Total Copper
- Total Iron
- Total Mercury
- Total Lead
- Total Selenium
- Total Thallium
- Total Zinc
- Turbidity
- Un-ionized ammonia

DATA SCREENING AND HANDLING

Water quality data were screened based on laboratory qualifier codes. Any datum with an associated fatal qualifier (e.g., contamination, out of holding time, matrix interference) was removed from the analysis. All data passing the qualifier screening were used in the analysis, including statistical outliers.

An additional consideration in the handling of water quality data is the accuracy of the laboratory method used. Each water quality constituent has a Method Detection Limit (MDL) that defines the minimum concentration or level at which the constituent can be identified. The MDL is usually statistically above the background noise level associated with a test and constituent concentrations at or near the MDL may not be quantified within established limits of accuracy or precision. The Practical Quantitation Limit (PQL) represents a practical and routinely achievable quantification level with a relatively good certainty that a reported value is reliable (APHA, 1995). For the analyses presented in this chapter, data reported to be less than the MDL were assigned a value of the MDL unless otherwise noted.

There are an increasing number of laboratories performing Everglades work, particularly associated with CERP implementation. Ongoing efforts are seeking to maintain comparability of data generated by all sources (e.g., laboratories, agencies). To maintain comparability in total phosphorus data the Department has conducted a periodic inter-laboratory split-sample study known as the Everglades Round Robin (ERR) (Lin and Niu, 1999; Lin and Niu 2001). The ERR program was chiefly designed to address issues related to the development of a numeric phosphorus criterion for the Everglades. Currently, the design of the ERR is being reviewed and potentially altered to address data comparability associated with CERP monitoring and impaired waters evaluations.

Additionally, as a means of insuring that analytical results obtained are of the highest quality and are as comparable as possible among laboratories, the Department has developed a set of guidelines for the selection of laboratories to perform Everglades phosphorus analyses (**Appendix 2A-1**). The Department has recommended that agencies involved in Everglades related water quality monitoring (e.g., SFWMD, U.S. Army Corps of Engineers and Department) formally agree to follow these selection guidelines. Progress towards implementing these guidelines has been made through presentations to the Everglades Technical Oversight Committee and interagency meetings and workshops.

EXCURSION ANALYSIS

There is little evidence within the scientific literature for the existence of *de facto* water quality assessment methods including excursion analysis (Griffith et al., 2001). The USEPA "provides many types of guidance for different regulatory programs, yet the analysis recommendations differ between programs, and efforts do not seem to be coordinated between programs." (Griffith et al., 2001). Given the lack of clear direction the SFWMD and Department have developed and clearly documented herein an excursion analysis protocol for use in this report. This protocol was selected to be consistent with previous Everglades reports and to provide a concise summary to decision makers and the public.

To evaluate compliance with water quality criteria in WY2001, constituent concentrations were compared to their respective Class III criteria specified in Chapter 62-302, F.A.C. In addition to Class III criteria, pesticides were evaluated based on chronic toxicity values. An excursion was recorded when a parameter exceeded the applicable numeric criteria or was chronically toxic. The excursions for each EPA region were tabulated providing both the total number of samples and percent of samples not in exceedance of the criteria.

The three-category system previously employed in the 1999 Interim and 2000 and 2001 Consolidated Reports (Bechtel et al., 1999; Bechtel et al., 2000; Weaver et al., 2001) was used to rank the severity of excursion from water quality criteria. Parameters were categorized by region and class (i.e., inflow, outflow, rim, interior) as being of Concern, Potential Concern, or No Concern according to the frequency of excursions as specified in **Table 2A-1**. Pesticides were additionally categorized based on detection (measurement >MDL) frequency. The excursion categories are meant to provide some guidance in the interpretation of monitoring results. Use of the 5 percent break point between parameters classified as Potential Concerns and those identified as Concerns parallels the common scientific practice of allowing a 5 percent rejection limit in statistical analyses. The categories provide a means to rank the severity of excursions from water quality criteria and allow tracking of temporal and spatial trends.

Table 2A-1. Definitions of excursion categories for water quality constituents in the EPA

Excursion Category	Class III Waters	Pesticides
Concern	> 5% excursions	Class III criterion and/or toxicity levels exceeded
Potential Concern	Up to 5% excursions	>MDL[1]
No Concern	No excursions	≤MDL

[1] MDL = Method Detection Limit

Since there is no numeric criterion for phosphorus at this time, total phosphorus (TP) data were divided into three categories based on the frequency of measurements above 10 µg/L (parts per billion, ppb) and above 50 µg/L. This approach is consistent with the Settlement Agreement (1991), which requires the SFWMD's Stormwater Treatment Areas (STA) to achieve a long term TP discharge concentration average of 50 µg/L, and also requires long term TP averages of approximately 10 µg/L in the Refuge interior marshes and in the inflows to the Park. Furthermore, 10 µg/L is the default phosphorus criterion specified by the EFA. Once a P criterion and compliance measurement methodology for the EPA are adopted, the evaluation of P in subsequent reports will be revised accordingly.

The excursion analyses presented herein and in previous reports utilize a raw-score method. One limitation of a raw score approach, such as discussed above, is that it does not account for sample size and thus may not be consistent across all sample sites. For example, 1 of 6 measurements above the criterion is clearly a weaker case for impairment than 6 of 36 (NRC 2001). The National Research Council (2001) suggested that a binomial hypothesis test could be used in water quality evaluations to take sample size into account. Recent adoption of the state's Impaired Waters Rule (Chapter 62-303, F.A.C.), which utilizes a binomial hypothesis test to list impaired waters, establishes some precedence for using this method in Florida. In order to facilitate evaluation method comparability (a concern of the Peer Review Panel) the Department and SFWMD are considering adopting a binomial test consistent with the Impaired Waters Rule, as a means of evaluating water quality standards violations in future Consolidated Reports. However, several technical issues related to the applicability of the Impaired Waters binomial test to the SFWMD water quality data remain to be resolved. Additionally, maintaining comparability among annual Consolidated Reports is an important issue that must be considered.

SUMMARY OF PRIOR REPORT FINDINGS

1999 INTERIM REPORT

Chapter 4 of the 1999 Interim Report provided a review of compliance with state water quality criteria in the EPA as of April 1998. Water quality data were divided into a baseline period (October 1, 1978 through September 30, 1988) and into individual recent water years (1990 through 1998) to determine if any changes in water quality were evident during the 1990s when compared to the baseline period. With a few exceptions, water quality during the 1990s was in compliance with existing state water quality criteria. Dissolved oxygen, specific conductance, alkalinity, pH, un-ionized ammonia, iron, beryllium, chlorpyrifos ethyl, endosulfan, ethion, and parathion methyl were placed in the most severe excursion category (Concern) for one or more EPA areas. Of the parameters classified as Concerns, dissolved oxygen stood out as the most pervasive, being a Concern in every basin. However, a majority of the dissolved oxygen excursions were due to natural conditions within the marsh and therefore did not necessarily constitute violations of state water quality standards.

Changes in TP loads and median concentrations were also analyzed following the direction of water flow from north to south through the EPA. When TP loads discharging into the EPA between the baseline (1978-1988) and recent water years (1990-1998) were compared, it appeared that the Refuge was the only region to receive a higher load in recent years. For inflows to WCA-2 and WCA-3, TP concentrations and loads differed relatively little from the baseline period, while average TP loads into the Park since WY1990 decreased. Based on a 10 µg/L default standard and a 50 µg/L interim criterion specified in the EFA, TP was placed in the Concern category in all EPA regions except for the Park and interior marsh sites in the Refuge, where it was placed in the Potential Concern category.

2000 CONSOLIDATED REPORT

The 2000 Consolidated Report provided an update to the Interim Report with the addition of WY1999 data. Additionally, it presented an analysis of water quality constituent data at Non-Everglades Construction Project (Non-ECP) structures during the second year of monitoring consistent with reporting requirements stated in Specific Conditions 5 and 12 of the Non-ECP Permit (FDEP No. 06,5025907098). The same categorical system used in the Interim Report to rank excursions was employed in the 2000 Consolidated Report. As in WY1998, dissolved oxygen, specific conductance, alkalinity, pH, un-ionized ammonia, iron, and total beryllium were placed in the Concern category in one or more areas within the EPA. Additionally, the pesticide diazinon was classified as a Concern for inflows to WCA-2. Dissolved oxygen continued to have high rates of excursions from the state criterion of 5.0 mg/L for all regions of the EPA. Similarly, the patterns noted in the Interim Report for alkalinity, pH, and conductivity largely persisted during WY1999.

Total phosphorus loads and median concentrations in the inflows to each EPA region during WY1999 were within the ranges observed in the previous nine water years. Concentrations of TP at non-ECP structures show no trends in comparison with previous periods with the exception of structures ACME1DS and G94D, where an increasing concentration trend was evident. As in WY1998, TP was placed in the Concern category (>50 µg/L) in all EPA regions except for the Park and interior marsh sites in the Refuge, where it was placed in the Potential Concern (>10 µg/L) category.

2001 CONSOLIDATED REPORT

Chapter 4 of the 2001 Consolidated Report provided an overview of the status of compliance with water quality criteria in the EPA for WY2000 (May 1, 1999 through April 30, 2000). It built upon and provided an update to water quality analyses previously presented in 1999 Everglades Interim and 2000 Consolidated Reports. Unlike previous reports, this report also provided a discussion of the factors contributing to excursions from applicable water quality criteria and provided an evaluation of the natural background condition where existing standards are not appropriate.

Comparison of the water quality data with applicable Class III water quality criteria found excursions for only eight parameters during WY2000. These excursions were localized to specific areas of the EPA, with the exception of dissolved oxygen, which exhibited excursions in all areas. For at least one EPA region; alkalinity, conductivity, dissolved oxygen, iron, pH, and turbidity were classified as parameters of Concern. Alkalinity, conductivity, iron, pH and turbidity were also classified as Potential Concerns in one or more additional areas. Due to excursion rates of less than five percent, lead and unionized ammonia were designated as parameters of Potential Concern, in specific EPA regions. Additionally, the pesticides DDT, DDE, DDD, endosulfan (total alpha and beta), and diazinon each exceeded either Class III criteria or chronic toxicity values on one occasion.

The report additionally presented a proposed Site Specific Alternative Criterion (SSAC) for marsh dissolved oxygen and a chronic toxicity based guidelines for the evaluation of pesticides and priority pollutants. The DO SSAC utilized a mathematical model describing the relationship between DO, time of day, and temperature to define a compliance limit. This approach takes into consideration the wide daily variations that occur naturally within the marsh. The proposed DO SSAC was applied to WY2000 DO data and resulted in a far lower excursion rate than did an analysis based upon the state Class III water quality criterion of 5.0 mg/L.

Median inflow TP concentrations were within the range of concentrations observed throughout the historical period since 1978, with the exception of WCA-3 where inflow concentrations were slightly higher during WY2000. Overall, inflow concentrations decreased from north to south with the highest concentrations entering the Refuge (median=68 µg/L) and the lowest flowing into the Park (median=8 µg/L). Similar to previous periods, median interior marsh concentrations were low in WY2000 and ranged by area from 5 to 13 µg/L. The lowest interior marsh concentrations were observed in the Park, where a substantial proportion (22 percent) of the samples were less than the 4 µg/L MDL.

WATER YEAR 2001 RESULTS

Water year 2001 data, for water quality parameters with Class III criteria, are summarized in **Appendix 2A-2**. Comparison of the water quality data with applicable Class III water quality criteria found excursions for eight parameters during WY2001. These excursions were localized to specific areas of the EPA, with the exceptions of dissolved oxygen and unionized ammonia, which exhibited excursions in all regions. For at least one EPA region alkalinity, conductivity, dissolved oxygen, iron, pH, total silver, and turbidity were classified as parameters of Concern (**Table 2A-2**). Conductivity, iron, pH and turbidity were also classified as Potential Concerns in one or more additional areas. Due to excursion rates less than five percent un-ionized ammonia was designated as a parameter of Potential Concern throughout many EPA regions and classes (**Table 2A-2**). Diazinon was the only pesticide to be classified as a Concern during the water year due to an exceedance of its chronic toxicity guideline. No other parameters exceeded state water quality criteria during WY2001 and therefore will not be discussed within this chapter.

Parameters placed in the Concern or Potential Concern categories in previous reports or for WY2001 are presented in **Table 2A-3** by three time periods (i.e., historical period encompassing WY1978 through WY1999, WY2000, and the current WY2001) to evaluate any temporal trends present. Numerous differences were noted between the WY2001 results and the previous periods. Notable differences include an increase in the DO excursion frequency within the Refuge, WCA-2, and Park interiors; decrease in DO excursions for WCA-2 and WCA-3 inflows and WCA-2 and Refuge outflows; an increase in the number of un-ionized ammonia excursions system wide; and a decrease in conductivity excursions within Refuge inflows, outflows, and rim. These and additional differences will be discussed in greater detail below.

Water Year 2001 was hydrologically dominated by persistent and severe drought throughout the EPA. Based on known soil/water interactions associated with dry down and re-wetting, the drought probably influenced water quality conditions throughout the year and may be at least partially responsible for some of the excursion frequency differences previously noted. The diminished rainfall altered water management practices, including distribution, timing and quantity, and resulted in dramatic reductions in surface water inflows to the WCAs and Park ranging from 32 to 64 percent (see Chapter 6). These alterations had the potential to change the distribution of constituent loads at inflow structures and biogeochemical processes within the marsh, which in turn could have influenced excursion rates. The influence of the drought on water quality excursions will be discussed below. In addition to the drought, the drawdown of Lake Okeechobee from April through June 2000 and a tropical disturbance in October 2000 were potentially significant hydrologic events during the water year. However, based on a review of water quality and flow data contained within the SFWMD database, neither the Lake Okeechobee releases nor the tropical disturbance appears to have been a major factor influencing water quality excursions during WY2001.

Parameters exhibiting excursions during WY2001 are reviewed in greater detail below. The review will include discussions concerning the environmental significance associated with the observed excursions, potential causes of the excursions, and any actions taken to resolve the associated concerns including the evaluation of the applicable criteria and natural background conditions within the EPA.

Table 2A-2. Summary of water quality data and excursions from applicable criteria in the EPA for WY2001. Only parameters with excursions in the given region and class are listed. Excursion categories of Concern, Potential Concern, and No Concern are denoted by "C", "PC", and "NC", respectively

Region	Class	Parameter	Class III Criteria	N	Mean	Std. Deviation	Min.	Max.	Excursion Category	Excursion %
Refuge	Inflow	Conductivity (µmhos/cm)	≤1,275[1]	231	979	258	313	1461	C	6.5
		DO (mg/L)	≥5	231	3.76	2.27	0.08	13.51	C	74.0
		pH	≥6.0, ≤8.5	231	7.46	0.30	5.15	8.57	PC	0.9
		Iron (mg/L)	≤1	30	0.28	0.27	0.02	1.02	PC	3.3
		Total Silver (µg/L)	≤0.07	10	0.06	0.01	<0.05	0.074	C	10.0
		Turbidity (NTU)	≤29[2]	105	7.24	7.39	0.74	46.4	PC	1.0
		Un-ionized NH_4 (mg/L)	≤0.02	104	0.003	0.01	0.0001	0.05	PC	1.0
	Interior	Alkalinity (mg/L)	≥20	170	136	94	10	345	C	14.7
		Conductivity (µmhos/cm)	≤1,275	309	438	334	8	1412	PC	0.3
		DO (mg/L)	≥5	267	2.74	1.80	0.19	9.68	C	88.0
		pH	≥6.0, ≤8.5	276	6.70	0.55	5.43	7.66	C	14.1
	Outflow	Conductivity (µmhos/cm)	≤1,275[1]	72	765	249	168	1287	PC	1.4
		DO (mg/L)	≥5	73	4.31	2.17	0.47	9.73	C	64.4
		Un-ionized NH_4 (mg/L)	≤0.02	58	0.002	0.004	0.00004	0.03	PC	1.7
	Rim	Conductivity (µmhos/cm)	≤1,275[1]	70	913	213	444	1420	PC	4.3
		DO (mg/L)	≥5	59	4.29	1.88	1.20	8.46	C	64.4
		Turbidity (NTU)	≤29[2]	24	10.33	9.69	1.60	35.0	C	8.3
		Un-ionized NH_4 (mg/L)	≤0.02	47	0.003	0.004	0.0002	0.022	PC	2.1
WCA2	Inflow	Conductivity (µmhos/cm)	≤1,275	73	836	240	388	1466	PC	2.7
		DO (mg/L)	≥5	74	4.27	2.10	0.47	9.73	C	64.9
		Un-ionized NH_4 (mg/L)	≤0.02	57	0.002	0.004	0.0001	0.03	PC	1.8
	Interior	Conductivity (µmhos/cm)	≤1,275[1]	248	815	318	159	2535	PC	4.8
		DO (mg/L)	≥5	239	3.21	1.97	0.13	9.44	C	82.8
		Un-ionized NH_4 (mg/L)	≤0.02	178	0.002	0.004	0.00004	0.024	PC	1.7
	Outflow	DO (mg/L)	≥5	61	4.70	2.09	0.90	8.58	C	49.2
		Un-ionized NH_4 (mg/L)	≤0.02	61	0.003	0.01	0.00004	0.06	PC	1.6
WCA3	Inflow	Conductivity (µmhos/cm)	≤1,275[1]	237	726	159	263	1558	PC	0.8
		DO (mg/L)	≥5	237	4.19	2.17	0.52	9.79	C	61.6
		Turbidity (NTU)	≤29[2]	138	3.09	3.73	0.35	32.90	PC	0.7
		Un-ionized NH_4 (mg/L)	≤0.02	157	0.003	0.01	0.0001	0.06	PC	2.5
	Interior	DO (mg/L)	≥5	139	3.57	2.00	0.29	10.32	C	78.4
		Turbidity (NTU)	≤29	74	2.25	3.98	0.32	32.5	PC	1.4
	Outflow	DO (mg/L)	≥5	204	3.56	1.58	1.08	8.94	C	81.4
PARK	Inflow	DO (mg/L)	≥5	258	3.93	1.68	0.30	8.67	C	75.2
	Interior	DO (mg/L)	≥5	80	4.98	2.83	0.27	12.02	C	60.0
		Total Iron (mg/L)	≤1	63	0.37	0.50	<0.001	2.03	C	11.1
		Un-ionized NH_4 (mg/L)	≤0.02	73	0.003	0.004	0.0002	0.03	PC	2.7

1. Specific conductance shall not be increased 50% above background or to 1275 µmho/cm, which ever is greater.

2. Turbidity ≤ 29 NTU above natural background conditions.

Table 2A-3. Summary of excursions from Class III criteria in the Everglades Protection Area for WY2001, WY2000, and historic data (1978-1999). Note: Number in front of parenthesis gives number of excursions while number within parenthesis specifies total number of samples collected

Region	Class	Parameter	Historic (1978-1999)		2000 Water Year		2001 Water Year	
			Percent Excursions	Number of Excursions	Percent Excursions	Number of Excursions	Percent Excursions	Number of Excursions
Refuge	Inflow	Conductivity	27.5	461 (1674)	13.0	32 (246)	6.5	15 (231)
		Dissolved Oxygen	77.1	1295 (1679)	63.4	156 (246)	74.0	171 (231)
		pH	0.6	10 (1671)	0.0	0 (245)	0.9	2 (231)
		Total Iron	3.3	14 (422)	6.1	3 (49)	3.3	1 (30)
		Total Lead	0.7	1 (152)	0.0	0 (23)	0.0	0 (11)
		Total Silver	70.0	14 (20)	0.0	0 (6)	10.0	1 (10)
		Turbidity	2.4	42 (1755)	11.5	12 (104)	1.0	1 (105)
		Un-ionized NH_4	2.3	35 (1509)	0.0	0 (124)	1.0	1 (104)
	Interior	Alkalinity	29.8	372 (1247)	24.8	51 (206)	14.7	25 (170)
		Conductivity	0.4	5 (1124)	0.3	1 (344)	0.3	1 (309)
		Dissolved Oxygen	75.9	805 (1060)	77.4	182 (235)	88.0	235 (267)
		pH	10.3	122 (1182)	14.6	35 (240)	14.1	39 (276)
		Un-ionized NH_4	0.2	2 (1014)	0.0	0 (162)	0.0	0 (168)
	Outflow	Conductivity	13.8	129 (935)	7.9	5 (63)	1.4	1 (72)
		Dissolved Oxygen	67.0	624 (931)	69.8	44 (63)	64.4	47 (73)
		pH	0.2	2 (915)	1.6	1 (63)	0.0	0 (73)
		Turbidity	0.8	8 (956)	3.1	2 (64)	0.0	0 (60)
		Un-ionized NH_4	1.2	11 (895)	1.6	1 (63)	1.7	1 (58)
	Rim	Conductivity	17.2	99 (576)	15.2	10 (66)	4.3	3 (70)
		Dissolved Oxygen	74.8	428 (572)	53.5	23 (43)	64.4	38 (59)
		pH	0.2	1 (563)	0.0	0 (45)	0.0	0 (61)
		Total Iron	1.1	3 (268)	0.0	0 (25)	0.0	0 (15)
		Turbidity	1.7	6 (349)	8.0	2 (25)	8.3	2 (24)
		Un-ionized NH_4	0.6	3 (503)	0.0	0 (43)	2.1	1 (47)
WCA-2	Inflow	Conductivity	16.1	162 (1005)	8.8	5 (57)	2.7	2 (73)
		Dissolved Oxygen	70.0	700 (1000)	68.4	39 (57)	64.9	48 (74)
		pH	0.3	3 (982)	0.0	0 (57)	0.0	0 (74)
		Total Copper	1.1	1 (88)	0.0	0 (11)	0.0	0 (7)
		Turbidity	1.0	11 (1143)	3.5	2 (57)	0.0	0 (58)
		Un-ionized NH_4	0.9	9 (954)	1.8	1 (57)	1.8	1 (57)
	Interior	Conductivity	8.2	193 (2345)	1.1	4 (348)	4.8	12 (248)
		Dissolved Oxygen	78.3	1763 (2252)	76.2	224 (294)	82.8	198 (239)
		pH	0.8	18 (2337)	0.7	2 (293)	0.0	0 (236)
		Total Cadmium	1.0	1 (104)	0.0	0 (17)	0.0	0 (4)
		Total Zinc	1.0	1 (104)	0.0	0 (17)	0.0	0 (4)
		Turbidity	0.2	2 (1298)	0.0	0 (122)	0.0	0 (68)
		Un-ionized NH_4	1.2	26 (2100)	0.8	2 (259)	1.7	3 (178)
	Outflow	Conductivity	2.1	25 (1199)	0.0	0 (72)	0.0	0 (61)
		Dissolved Oxygen	66.9	802 (1199)	76.4	55 (72)	49.2	30 (61)
		pH	0.4	5 (1186)	0.0	0 (72)	0.0	0 (61)
		Turbidity	0.2	3 (1215)	0.0	0 (74)	0.0	0 (61)
		Un-ionized NH_4	0.4	5 (1166)	0.0	0 (69)	1.6	1 (61)

Table 2A-3. Continued.

WCA-3	Inflow	Conductivity	1.8	55 (3088)	0.0	0 (256)	0.8	2 (237)
		Dissolved Oxygen	69.8	2141 (3067)	77.4	199 (257)	61.6	146 (237)
		pH	0.6	17 (3039)	0.8	2 (257)	0.0	0 (237)
		Total Beryllium	12.5	1 (8)	0.0	0 (4)	0.0	0 (4)
		Total Copper	1.1	3 (285)	0.0	0 (38)	0.0	0 (30)
		Total Iron	1.3	7 (538)	2.3	1 (44)	0.0	0 (46)
		Total Lead	0.4	1 (283)	0.0	0 (36)	0.0	0 (25)
		Total Silver	87.5	28 (32)	0.0	0 (16)	0.0	0 (16)
		Total Zinc	0.3	1 (291)	0.0	0 (38)	0.0	0 (30)
		Turbidity	1.8	53 (2978)	0.0	0 (168)	0.7	1 (138)
		Un-ionized NH4	0.2	5 (2753)	0.0	0 (178)	2.5	4 (157)
	Interior	Conductivity	0.3	5 (1505)	0.0	0 (317)	0.0	0 (163)
		Dissolved Oxygen	81.7	1042 (1275)	91.8	178 (194)	78.4	109 (139)
		pH	0.3	4 (1563)	0.0	0 (195)	0.0	0 (136)
		Total Iron	0.9	9 (962)	0.0	0 (133)	0.0	0 (29)
		Turbidity	0.4	6 (1408)	0.0	0 (161)	1.4	1 (74)
		Un-ionized NH_4	0.2	2 (1321)	0.0	0 (154)	0.0	0 (73)
	Outflow	Dissolved Oxygen	73.1	2269 (3106)	81.8	148 (181)	81.4	166 (204)
		pH	1.3	40 (3066)	0.0	0 (180)	0.0	0 (204)
		Total Cadmium	0.6	5 (808)	0.0	0 (79)	0.0	0 (61)
		Total Iron	0.3	4 (1424)	0.0	0 (126)	0.0	0 (79)
		Total Lead	0.3	2 (800)	0.0	0 (75)	0.0	0 (57)
		Total Zinc	0.5	4 (806)	0.0	0 (75)	0.0	0 (60)
		Un-ionized NH_4	0.1	3 (2320)	0.0	0 (142)	0.0	0 (115)
PARK	Inflow	Dissolved Oxygen	70.9	2629 (3710)	79.7	228 (286)	75.2	194 (258)
		pH	1.5	54 (3677)	0.0	0 (285)	0.0	0 (258)
		Total Cadmium	1.0	12 (1187)	0.0	0 (114)	0.0	0 (86)
		Total Copper	0.1	1 (1190)	0.0	0 (114)	0.0	0 (86)
		Total Iron	0.3	7 (2099)	0.0	0 (178)	0.0	0 (108)
		Total Lead	0.3	3 (1191)	0.0	0 (112)	0.0	0 (81)
		Total Zinc	0.3	4 (1187)	0.0	0 (107)	0.0	0 (86)
		Un-ionized NH_4	0.6	17 (2882)	0.0	0 (239)	0.0	0 (130)
	Interior	Conductivity	1.9	21 (1107)	0.0	0 (99)	0.0	0 (79)
		Dissolved Oxygen	46.1	513 (1113)	42.0	42 (100)	60.0	48 (80)
		pH	1.9	19 (986)	1.0	1 (100)	0.0	0 (80)
		Total Cadmium	0.4	4 (1106)	0.0	0 (98)	0.0	0 (63)
		Total Copper	0.3	3 (1087)	0.0	0 (95)	0.0	0 (63)
		Total Iron	8.7	99 (1134)	5.3	5 (94)	11.1	7 (63)
		Total Lead	0.4	4 (1106)	1.0	1 (98)	0.0	0 (63)
		Turbidity	0.6	7 (1117)	0.0	0 (98)	0.0	0 (80)
		Un-ionized NH_4	2.2	21 (943)	0.0	0 (95)	2.7	2 (73)

DISSOLVED OXYGEN

Oxygen is a necessity for life on Earth, including plants and animals. Due to oxygen's importance to life, it is important to understand the processes that influence dissolved oxygen (DO) concentrations in the Everglades. In any aquatic system, water column DO concentrations are regulated by a variety of sources and sinks. These controlling factors are balanced in healthy systems. The primary oxygen sinks include chemical oxidation and aerobic respiration by vegetation, periphyton, and other organisms in both the water column and sediments. Photosynthesis and atmospheric exchange are the primary oxygen sources. Within marsh habitats, the principal photosynthetic contributors are periphyton and submerged aquatic vegetation (P/SAV) located in open water sloughs with a minor contribution by phytoplankton. The rate of photosynthetic production is largely dependent upon light intensity and occurs only during the photoperiod (daylight). In open water slough communities, where light penetration is adequate, photosynthesis by P/SAV typically results in increasing oxygen concentration during daylight hours (Belanger and Platko 1986, McCormick et al., 1997). At night, after photosynthesis has slowed, respiration and sediment oxygen demand (SOD) reduce oxygen concentrations until the next morning when the cycle starts again. The changing balance between photosynthesis and respiration over a 24-hour period produces the characteristic cyclic diel fluctuations in DO concentrations (Belanger and Platko, 1986; McCormick et al., 1997; Weaver 2000).

As in previous water years, DO was classified as a parameter of Concern for all EPA regions and classes during WY2001. Overall, 74 percent of the 1,860 DO measurements collected during WY2001 were below the 5.0 mg/L Class III criterion. The frequency of DO measurements falling below 5.0 mg/L ranged from 49 to 88 percent among the EPA regions. Although the overall excursion frequency for the EPA was similar to previous periods, differences for specific regions and classes were noted. In general, interior marsh excursion rates increased during WY2001 relative to both the historic period (5 to 14 percent) and WY2000 (7 to 18 percent). Only within the interior of WCA-3 did excursion frequencies decrease. Excursion frequencies for WCA-2 and WCA-3 inflows and WCA-2 and Refuge outflows decreased (3 to 27 percent) from the excursion rates observed during the two historic periods.

It is widely accepted that DO concentrations are normally low in macrophyte dominated marsh environments, such as the Everglades, due to natural processes of photosynthesis and respiration (Belanger and Platko 1986, McCormick et al., 1997). Since the low DO concentrations often measured in the Everglades represent the natural variability in this type of ecosystem, the Department does not consider these excursions violations of the DO standard. Therefore, the Class III criterion of 5.0 mg/L is not believed to be appropriate for the Everglades. This position is supported by Paragraph 62-302.500(1)(f), F.A.C., which states that "*dissolved oxygen levels that are attributable to natural background conditions or man-induced conditions which cannot be controlled or abated may be established as alternative dissolved oxygen criteria for a water body or portion of a water body.*" A discussion of the Department's efforts to establishing a Site Specific Alternative Criterion (SSAC) for Everglades marsh DO was presented in the 2001 Consolidated Report (Weaver et al., 2001). The proposed SSAC utilizes a mathematical model that describes the relationship between DO and time of day and temperature to define the compliance limit. This approach takes into consideration the wide daily variations that occur in the marsh. In contrast, a single number SSAC would not be representative of background conditions across all times and temperature ranges and would at times be either under-protective or over-protective.

Compliance with the SSAC is to be based on an annual average concentration. Annual average DO, at any given station, must be maintained above an annual limit calculated from an equation defined by sample collection time and temperature (**Figure 2A-6**). The period of one year provides a characterization of the DO regime at a site and accounts for the infrequent occurrence of naturally low values. Continuing efforts to formally adopt the SSAC require public notice and hearing, and finally approval by the Secretary of the Department.

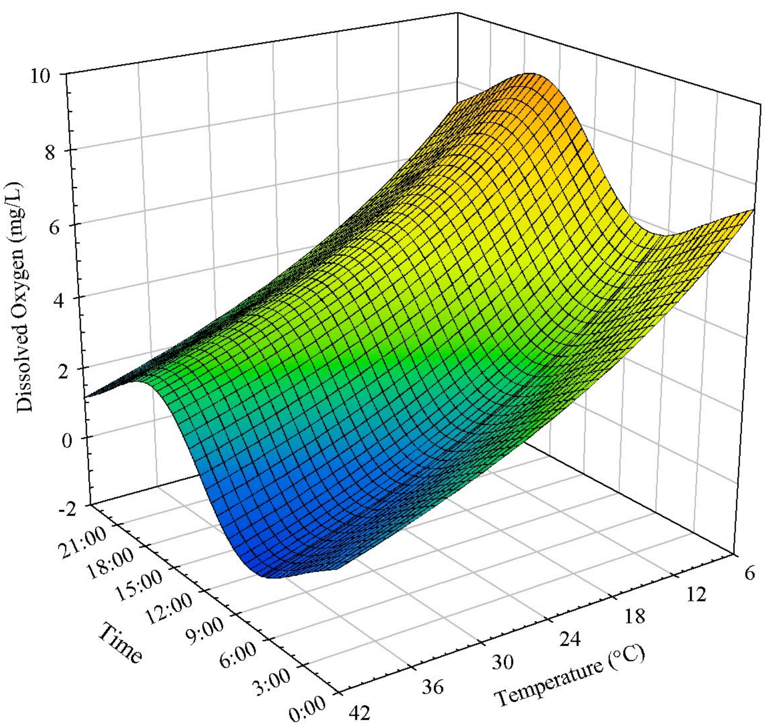

Figure 2A-6. Annual dissolved oxygen compliance limit for interior mash stations in the EPA. The curve is a function of temperature and sample collection time.

The proposed SSAC recognizes the natural background condition, allows differentiation between impacted and background conditions, and provides more realistic information on ecosystem status than the existing Class III criterion. In order to further evaluate the DO concentrations measured during WY2001 the proposed SSAC was applied to WY2001 DO data from interior, rim canal, inflow, and outflow stations in the EPA. Although the SSAC was developed for open water marsh stations, water discharging to the Everglades should meet the SSAC in order to prevent violations in the receiving waters of the marsh. The Class III standard would still be applicable to canal waters that do not immediately discharge to the marsh. Utilizing the proposed SSAC on WY2001 data resulted in a substantially lower excursion rate than did the analysis based upon the 5.0 mg/L criterion, that is, DO concentrations at most stations were within the range of natural background conditions (**Table 2A-4**). Site-specific results are provided in **Appendix 2A-3**. Of particular interest was the performance of the STA-1W outflow (ENR012), because it provides some predictive information regarding the future performance of the STAs. As was the case in WY2000, ENR012 passed the DO SSAC test for

WY2001. Stations that failed to meet the SSAC were generally influenced by either hydrogeomorphic conditions or nutrient enrichment. A high percentage of water control structures (*i.e.*, inflow and outflow sites) failed the SSAC test. This high rate of non-compliance is likely due to disturbance of bottom sediments and the intrusion of low DO ground water into the surface water at these structures. Sediments are commonly mixed with canal surface waters during pumping events. These sediments typically increase oxygen demand within the water column and subsequently result in reduced DO concentrations (Environmental Services & Permitting, Inc., 1992). Ground water intrusion is a common occurrence at Everglades pumping stations and canals dug below the water table. The influence of ground water on DO at these structures potentially represents a "man-induced condition, which cannot be controlled or abated" and will need to be addressed separately. The second group of stations failing the SSAC is interior marsh stations known to be impaired due to phosphorus enrichment (e.g., E1, E2, Z1, CA28). Conditions at these stations are expected to remain impaired until sediment phosphorus concentrations are reduced and the biological communities recover. Since the DO levels in the marsh are highly dependent on the biological communities present, compliance with the SSAC may represent a simple measure of the recovery (e.g., performance measure) of the impacted areas. Notable exceptions to the site groupings above are sites U1 and NE1 in WCA-2A and the Park, respectively. Both U1 and NE1 are relatively unimpacted marsh sites. In particular, DO concentrations at NE1 were extremely low (mean=1.89 mg/L) with three out of eleven observations less than 1.0 mg/L. It is unclear why these stations failed the SSAC for WY2001, but the drought conditions and low water levels may have played a role.

Table 2A-4. Comparison between the number of stations categorized as Concern using the current Class III Criterion and the proposed SSAC for WY2001.

Region	Class	Number of Stations	Class III Criterion	SSAC
			Percent/(Number)	Percent/(Number)
Refuge	Inflow	6	100 (6)	0 (0)
	Interior	23	100 (23)	35 (8)
	Outflow	6	100 (6)	0 (0)
	Rim	4	100 (4)	0 (0)
WCA-2	Inflow	6	100 (6)	17 (1)
	Interior	22	100 (22)	45 (10)
	Outflow	5	100 (5)	0 (0)
WCA-3	Inflow	14	100 (14)	14 (2)
	Interior	10	100 (10)	10 (1)
	Outflow	9	100 (9)	11 (1)
Park	Inflow	9	100 (9)	0 (0)
	Interior	9	78 (7)	11 (1)

ALKALINITY AND pH

Alkalinity is a measure of the acid neutralization capacity of water. It provides a measure of the buffering capacity of water. In most surface water bodies, the buffering capacity is primarily the result of the equilibrium between carbon dioxide and carbonate and bicarbonate ions (i.e., CO_2, HCO_3^-, CO_3^{2-}). The dissociation of calcium carbonate, magnesium carbonate, or other carbonate containing compounds entering the surface water through weathering of carbonate containing rocks and minerals (e.g., limestone, calcite, etc.) contribute to the buffering capacity of the water. Therefore, in areas influenced by canal inflows that are primarily composed of mineral rich agricultural runoff and groundwater such as WCA-2, WCA-3 and the Park, alkalinity levels are relatively high. Conversely, areas such as the interior of the Refuge, which receives most of its hydrologic load through rainfall, have very low alkalinities. Alkalinity protects aquatic life against dramatic pH changes. Rapid pH changes are difficult for living organisms to adapt to and thus result in severe stress and may be lethal to sensitive species. Therefore, it is important that surface waters exhibit some minimal level of alkalinity or buffering capacity to restrict dramatic pH swings. The current Class III criterion for alkalinity specifies that alkalinity shall not be depressed below 20 mg $CaCO_3$/L.

The pH value is defined as the negative $\log_{(\text{base } 10)}$ of the hydrogen ion (H^+) activity. In low ionic strength freshwaters, the activity of the H^+ ion is approximately equal to the concentration of H^+ ions. Since pH is based on a log scale, each pH unit change represents a tenfold change in the concentration of H^+ ions (acidity). For example, a solution at pH 3 is ten times more acidic than one at pH 4. Most living organisms, especially aquatic life, function best in a pH range of 6.0 to 9.0, although individual species have specific ideal ranges. Below a pH of 5.0, most fish fail to spawn and below 4.0, many species die. Amphibians are particularly sensitive to extreme pH levels as well as drastic pH changes. Some amphibian declines have been attributed to declining pH (Wyman, 1990). Additionally, the pH of water affects the toxicity and solubility of other substances (e.g., ammonia, aluminum, cadmium, iron). The current Class III criterion specifies that pH shall not be lowered below 6.0 units or raised above 8.5 units in predominately fresh waters.

There are a number of interrelationships among pH, photosynthesis and carbon dioxide (CO_2) in the water. When CO_2 enters freshwater, small amounts of carbonic acid are formed which then dissociate into hydrogen ions and bicarbonate ions, resulting in a lowering of pH. Since photosynthesis and respiration alter CO_2 concentration in the water, these processes exert an influence on pH. During the day, while photosynthetic processes are consuming CO_2, the concentration of carbonic acid declines and pH will rise. The addition of CO_2 by respiration at night reverses the reactions and lowers pH. In poorly buffered systems (low alkalinity), daily changes in pH can be dramatic.

Because of the close relationship between alkalinity and pH, the two parameters will be evaluated here together. Violations of state Class III water quality criteria for both parameters have historically occurred in the interior of the Refuge (Bechtel et al., 1999; Bechtel et al., 2000; Weaver et al., 2001). As was the case in previous years, alkalinity was designated as a parameter of Concern for the interior of the Refuge during WY2001 due to an excursion rate of 14.7 percent. Likewise, pH in the interior of the Refuge was identified as a parameter of Concern due to frequent values below the lower limit of 6.0 specified by the state criterion. Additionally, two pH values above 8.5 observed within the Refuge inflows resulted in the parameter being categorized as a Potential Concern.

The low alkalinities and pH values in the Refuge are primarily caused by the hydrologic nature of the area. The majority (54 percent) of water entering the Refuge is rainwater with low alkalinity (SFWMD, 1992). Along the western periphery of the area harder canal waters from the S-5A and S-6 structures permeate into the marsh along the L-7 rim canal. However, canal waters tend to penetrate only a few kilometers into the marsh and thus have little or no influence on the soft-water conditions within the interior. The dichotomy of the soft-water interior and hard-water periphery creates steep pH, alkalinity and other ionic gradients in the Refuge from the canals into the marsh (Swift and Nicholas, 1987; Richardson et al., 1990; Weaver et al., 2001).

Alkalinity within the Refuge decreases with distance from the rim canal and S-6 inflow structure (Weaver et al., 2001). In fact, the central region (i.e., LOX5, LOX7, LOX9, LOX11, LOX13) has the lowest alkalinity levels with average concentrations at or below the state criterion of 20 mg $CaCO_3$/L. Alkalinity excursions within the Refuge are therefore not caused by a discharge or pollution source. Rather these excursions are a result of the natural soft-water, rainfall-driven nature of the system. The low alkalinity values represent the normal background condition typical of this ecosystem; therefore, the Department does not consider these low values in the interior of the Refuge to be in violation of the state alkalinity standard.

Excursions for pH are closely linked to the naturally low alkalinities within the Refuge's interior marsh. Since the buffering capacity within the interior is low, small changes in the production or consumption of CO_2 by marsh biota or absorbance of CO_2 from the atmosphere produce significant changes in pH. Nearly all the excursions from the pH criterion have occurred at alkalinities below 50 mg $CaCO_3$/L (**Figure 2A-7**). Additionally, the greatest variability in pH has occurred at alkalinities less than 100 mg $CaCO_3$/L. Such fluctuations in pH at low alkalinity in areas free of discharges are typically caused by changes in CO_2 concentrations due to natural processes of photosynthesis and respiration within the environment. Since pH excursions within the interior of the marsh are linked to natural background alkalinity conditions, the Department does not consider pH levels within the interior of the Refuge to be in violation of state water quality standards.

The infrequent pH levels exceeding the 8.5 upper limit of the Class III criterion that have historically occurred throughout the system are probably the result of increased photosynthetic rates. As discussed previously, during photosynthesis CO_2 is consumed which shifts the carbonate system equilibrium resulting in higher pH levels. These higher pH levels may reflect natural phenomena or may be indicative of higher productivity resulting from nutrient enrichment in areas influenced by canal inflows. High pH levels will continue to be monitored during future monitoring years to more fully evaluate their causes.

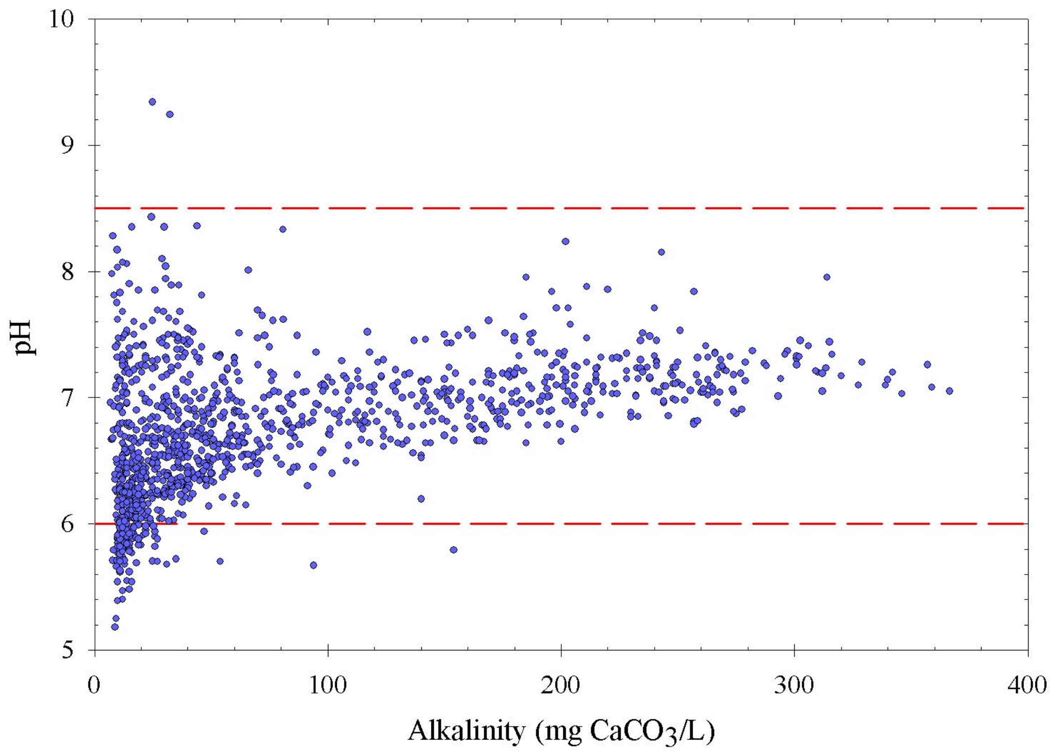

Figure 2A-7. Relationship between pH values and alkalinity within the interior marsh of Loxahatchee National Wildlife Refuge from May 1994 to April 2001. Dashed horizontal lines show the lower (6.0) and upper (8.5) Class III pH criteria.

SPECIFIC CONDUCTANCE

Specific conductance (conductivity) is a measure of the ability of the water to conduct electrical current. It is an indirect measure of the total concentration of ionized substances (e.g., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, HCO_3^{-}, SO_4^{2-}) in the water. Conductivity will vary with the number and type of these ions in solution and in some cases can be used to differentiate among different water sources (i.e., groundwater, rainwater, agricultural runoff, municipal wastewater). Changes in conductivity beyond natural background variability can result in potentially deleterious effects to aquatic life. For example, very high conductivities would be detected under conditions of salt water intrusion, a situation which would be fatal to most fresh water organisms. The current state water quality criterion which allows a 50 percent increase in the specific conductance or 1275 µmho/cm, whichever is greater, is meant to preserve natural background conditions and thus protect aquatic organisms from stressful ion concentrations. Since background conductivities are assumed to be low within the EPA, excursions were calculated using the 1275 µmho/cm criterion.

Spatially, conductivity excursions occurred in the same regions (Refuge and WCA-2) during WY2001 as in previous water years. For WY2001 Conductivity was categorized as a parameter of Concern only for inflows to the Refuge. Additionally, conductivity was categorized as a Potential Concern for the Refuge rim canal, interior and outflows, WCA-2 inflows and interior, and WCA-3 inflows. A total of 36 conductivity excursions above 1275 µmho/cm were recorded during WY2001. However, since site S10D was classified as both an outflow from the Refuge and inflow to WCA-2 one excursion was counted twice, therefore only 35 unique conductivity excursions were observed during WY2001. Overall, the rate of conductivity excursions decreased from the historic period, particularly in the Refuge inflows, outflows (WCA-2 inflows), and rim canal (**Table 2A-3**). This reduction may be a result of drought induced diminished flows of high conductivity water to the Conservation Areas.

Similar to previous years, a majority of the conductivity excursions (23) during WY2001 occurred at either water control structures or within canals. Most (11) of the excursions recorded within the interiors of the Refuge and WCA-2 occurred at stations in close proximity to canal inflows. Several factors probably contribute to the reported conductivity excursions. One of the major sources of the elevated conductivity levels may be groundwater intrusion into the canal surface waters. Because groundwater tends to have a high mineral content and thus high conductivity, ground water intrusion would cause an increase in surface water conductivity. Because many of the canals are dug into bedrock and below the water table, seepage of groundwater into canals is a common occurrence in South Florida. Furthermore, normal operation of pumping stations can result in additional groundwater being pulled into the surface water. Additionally, agricultural activities such as the practice of field dewatering may contribute to the observed conductivity excursions. On a seasonal basis, the surficial aquifer is drawn down in some EAA agricultural areas to reduce flooding of low-lying fields. The water level in drainage ditches and canals in these areas are pumped to below the water table, causing groundwater to drain into these secondary canals, which subsequently flow into the primary canals supplying water to the EPA (Miller, 1988). Because the water in the surficial aquifer has a high ionic content, resulting from the dissolution of soil minerals and inorganic fertilizers, the addition of this groundwater to surface waters results in elevated conductivity levels. Drought conditions during WY2001 may have reduced the influence of agricultural activities on conductivity excursions, particularly in the northern Everglades where a reduction in the excursion frequency was observed. Other factors such as direct storm water runoff from agricultural or urban areas, extended periods of drought (evaporation without dilution), resuspension of sediments, and water releases from Lake Okeechobee during the draw down may have also contributed to the reported conductivity excursions. The Department intends to continue its evaluation of conductivity in EPA and EAA canals.

UN-IONIZED AMMONIA

Ammonia is a colorless gas with a pungent odor that is very soluble in water at low pH. Ammonia can serve as an important source of nitrogen for plant life, but is deleterious when present in excess. In water at low temperature and pH, ammonia undergoes hydrolysis to produce ammonium (NH_4^+) and hydroxide (OH^-) ions. The ammonium ions produced during this reaction are not toxic to aquatic life. However, at high pH levels, the hydrolysis is not as complete with increasing amounts of un-ionized ammonia (NH_3) remaining. For example, in freshwater at 25°C, an increase in pH from 7 to 8 results in an increase in the percent of total ammonia in the un-ionized form from 0.5 to 5.4 percent, while at a pH of 9 more than a third (36 percent) of the total ammonia is un-ionized. The resulting un-ionized ammonia is able to diffuse across cell membranes more readily and, subsequently, is acutely toxic to aquatic life.

There are many sources of ammonia including natural, nonpoint, and point sources. Natural sources include animal and human excrement and bacteria, which produce ammonia during decomposition of proteins and other nitrogenous organic compounds. About three-fourths of the ammonia produced by the United States is used in fertilizers, which can enter aquatic systems in runoff from agricultural land including cropland and livestock operations. Known point sources include sewage and waste treatment plants, various manufacturing processes, strip mining, and food processing. Accidental releases can also contribute significantly to ammonia concentrations in localized areas.

Ammonia is unique among regulated pollutants because it is a source of nitrogen, a nutrient required for life, as well as an endogenously produced toxicant that organisms have developed various strategies to excrete (i.e., waste product). Toxicity levels of ammonia are highly variable because they are affected by temperature, pH, dissolved oxygen concentrations, carbon dioxide concentrations, previous acclimation to ammonia, and the presence of other toxic compounds. Plants are more tolerant than animals, and invertebrates are more tolerant than fish. Increases in pH and temperature lead to increased levels of un-ionized ammonia. High external un-ionized ammonia concentrations reduce or reverse diffusion gradients utilized by organisms to excrete excess ammonia. This excess ammonia can accumulate in the organism resulting in alterations in metabolism, loss of equilibrium, hyperexcitability, increased respiratory activity and oxygen uptake, and increased heart rate. Even slightly elevated concentrations have been associated with a reduction in hatching success, reduction in growth rate and morphological development, and injury to gill tissue, liver, and kidneys. While extremely high levels can lead to convulsions, coma, and death in fish.

The current state Class III water quality criterion is ≤0.02 mg/L of un-ionized ammonia, calculated using pH, temperature, and ammonium measurements from the same sample. Fourteen measurements were above this criterion during WY2001. This is an increase over the four excursions reported for WY2000, but within the historical range of excursions reported since 1978. Unlike WY2000 where excursions were confined to WCA-2 inflows and interior sites, these fourteen excursions are more widespread, occurring in Refuge inflow, outflow, and rim canal, WCA-2 inflow, interior, and outflow, WCA-3 inflow, and the Park interior. Because certain stations are classified as outflows from one region and inflows to another region, there are two excursions appearing twice in this list. The first was listed as an excursion for the Refuge outflow and WCA-2 inflow and the second was duplicated for WCA-2 outflow and WCA-3 inflow. Therefore, there were actually only 12 unique excursions for un-ionized ammonia this water year and only two stations with multiple excursions reported. These were F0, an interior station in WCA-2, and S142, an inflow station for WCA-3. The two excursions occurring at F0 appear to result from high dissolved ammonia concentrations (both 1 mg/L) and are only slightly above the standard (0.0219 and 0.0234 mg/L). It is worth noting, that although F0 is classified as an interior station, it occurs proximal to the Hillsboro Canal and is a better reflection of canal conditions than of interior marsh conditions. Interestingly, the second excursion occurred in April, a month when a number of excursions (5 of the 12) were reported at various sites, including WCA-2 interior sites F0 and E0, WCA-3 inflow sites S142 and S11C, and the Park interior site P33. A review of the associated data indicates that these were probably the result of high dissolved ammonia levels at these sites during the month of April. As previously mentioned, Station S142 also had multiple excursions (3) for the water year, with two occurring in the anomalous month of April.

Overall, WY2001 excursion rates for un-ionized ammonia are within the historical range, but have increased since last water year. The increased un-ionized ammonia excursion rate for WY2001 may be related to the persistent drought conditions experienced and the associated oxidation of organic sediments throughout the system and the subsequent release of ammonia (Qui and McComb, 1996). This hypothesis is supported by a similar increase in the concentration of other elements, such as iron, that are normally dependent on sediment and hydrologic conditions. The Department will continue to evaluate unionized ammonia concentrations in future water years to determine if excursion rates continue to increase in frequency and spatial extent or if the increased number of excursions during WY2001 was a reflection of the abnormal climatic and hydrologic conditions present.

IRON

Iron is the fourth most abundant element, by weight, composing the Earth's crust and is present in natural surface waters at varying concentrations depending upon the geology of the area and chemical properties of the water body. In surface waters, iron is primarily found in two forms, the reduced ferrous (Fe^{2+}) iron and the oxidized ferric (Fe^{3+}) form, which can form a variety of other organic and inorganic compounds. The form of iron (ferric or ferrous) present in surface waters is influenced by pH and redox (reduction/oxidation) conditions. Most ferrous compounds, which are typically found under anaerobic (lacking dissolved oxygen) and acidic conditions, are soluble in water. Conversely, ferric iron compounds found in most alkaline (pH > 7.0) and aerobic waters are relatively insoluble and therefore, relatively inactive chemically or physiologically. Ferric iron is commonly associated with sediments, organometallic compounds, and humic materials, and has little effect on aquatic life due to its insolubility (USEPA, 1976).

Iron is an essential trace nutrient for plants and animals and is vital in the oxygen transport systems of all vertebrates and some invertebrates. However, iron in water is a nuisance to many human uses. Water that is high in iron has a metallic or medicinal taste and can stain laundry, concrete, stucco, and other materials. Additionally, under certain conditions excess iron can have toxicological or deleterious effects on aquatic organisms. Iron has been found to be toxic to Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) at concentrations of 0.32 mg/L (Warnick and Bell, 1969). Healthy fish populations have been maintained at iron concentrations ranging from below 0.9 to 10 mg/L, depending upon species and pH of the water (USEPA, 1976). In streams polluted by acid mine wastes, a rusty colored flocculent of $Fe(OH)_3$ forms within a "zone of recovery" as pH and DO levels increase. This flocculent forms a precipitate that can clog fish gills and smother eggs and bottom-dwelling organisms (USEPA, 1976). The current Class III iron criterion of 1.0 mg/L is based upon field observations and is believed to be protective of aquatic life. In reality, the form and solubility of iron, and therefore its toxicity varies depending on factors such as the alkalinity, DO, pH, hardness, temperature, redox status and biological activity of the water (USEPA, 1976).

The spatial distribution of iron was comparable to historical results. One excursion at a concentration of 1.02 mg/L was recorded at Refuge inflow station G94D. The excursion frequency within the Park interior was slightly higher (2.4 to 5.8 percent) than the historic periods due to seven iron measurements above 1.0 mg/L, particularly for site NE1 where six of the recorded excursions occurred. During WY2001, 75 percent of the iron measures from NE1 exceeded the criterion, in contrast to the historical period and WY2000 when the excursion rates were 43 and 25 percent, respectively. Interesting, all of the WY2001 iron excursions at NE1 were associated with unusually low DO concentrations (0.82 to 2.09 mg/L) compared to historical values (4.6 ± 1.9; mean ± std. dev.) for this station. It is unclear whether this association between iron and DO is causal (i.e., low DO resulted in the mobilization of ferrous iron to the water column) or merely associative (i.e., both were influenced by one or more other factors, such as water depth or oxidation of sediments).

Although the criterion was exceeded on several occasions, it was commonly only exceeded by a small margin. Concentrations exceeding the criterion ranged from 1.02 to 2.03 mg/L. Given the infrequent excursions and low concentrations, it is not likely that iron represents a significant threat to designated uses of the EPA. Furthermore, iron excursions have occurred in the absence of anthropogenic influences (e.g., discharge, construction) within the interior of the Park. Therefore, it is likely that infrequent values above 1.0 mg/L represent a combination of natural variability and disturbance of sediments during sample collection resulting in samples that are not representative of the true conditions in the southern Everglades. Iron concentrations in the surface waters within the EPA will continue to be monitored and evaluated in future reports.

TURBIDITY

Turbidity is a measure of water clarity or cloudiness and thus is an indirect measure of particulates, water color, and dissolved substances. It can be increased by soil erosion, waste discharge, urban runoff, bottom feeders like carp that stir up sediments, wind-induced resuspension of sediments, and algal growth. Turbid water can have a number of ecological effects (USEPA, 1976). Turbid waters become warmer as suspended particles absorb heat from sunlight, causing oxygen levels to fall. Reflection and absorption of light on suspended particles can reduce light penetration through the water resulting in a decrease in photosynthesis and subsequent lowering of oxygen levels. Suspended solids in turbid water can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. Settled particles smother eggs of fish and aquatic insects. Dependent upon particle composition, high turbidity can be indicative of elevated total phosphorus, total nitrogen and trace metal concentrations.

The current state criterion for turbidity is ≤29 NTU above natural background conditions. Based on a review of SFWMD monitoring data, natural background marsh turbidities tend to be low (<1.0 NTU), therefore for the purposes of this review background turbidity has been assumed to be 0 NTU. There were 5 excursions above this criterion (≤29 NTU) during WY2001. As a result of these excursions, turbidity was categorized as a Concern for the Refuge rim canal. Additionally, turbidity was classified as a Potential Concern for Refuge inflows and WCA-3 interior. All WY2001 excursions were associated with water control structures or canals, including WCA-3 where an excursion occurred at interior canal station C123SR84. With the exception of the Refuge rim canal, WY2001 turbidity excursion rates were similar to both historical periods. Water year 2001 turbidity excursions in the rim canal were elevated relative to the historical period (WY1978-WY1999), but were similar to WY2000. The Department intends to continue its evaluation of turbidity in the EPA.

SILVER

Silver is a nutritionally nonessential naturally occurring element. Its typical sources include natural geological processes, mining, electroplating, film-processing wastes, and water disinfection (Manahan, 1991). Silver is registered with the USEPA as a pesticide, for use in disinfectants, sanitizers, fungicides, and a swimming pool algaecide. It is also used within bacteriostatic water filters to treat domestic tap and swimming pool water (USEPA, 1993). The critical effect to humans is through the excessive ingestion of silver, which results in argyria, a medically benign but permanent bluish-gray discoloration of the skin (USEPA, 1976; USEPA, 1993). Silver is acutely toxic to aquatic organisms at relatively low levels; therefore the Department has established a class III water quality criterion of ≤0.07 µg/L for silver in order to protect flora and fauna.

A single silver value of 0.074 µg/L at ENR012, the STA-1W outflow structure and Refuge inflow, exceeded the Class III criterion and resulted in silver being characterized as a Concern for Refuge inflows. Because no anthropogenic silver sources are known from the area and geologic sources are improbable, the result is most likely due to laboratory or sample contamination or analytical interference. It is highly unlikely that silver poses a water quality problem to the EPA; however, monitoring should continue to confirm this conclusion.

TOTAL PHOSPHORUS AND TOTAL NITROGEN

Even though phosphorus and nitrogen do not have numeric criteria, the concentration of these nutrients in Class III waters is regulated by a narrative criterion that specifies that nutrient concentrations in a water body can not be altered so as to cause an imbalance in the natural populations of flora or fauna and shall be limited to prevent violations of other water quality standards. In an attempt to prevent further adverse biological impacts resulting from nutrient enrichment within the EPA, the Department is currently in the process of developing a numeric phosphorus criterion for the Everglades based on the interpretation of the narrative standard. Further details concerning the status of the Department's efforts are provided in Chapter 5 of this report and the 2001 ECR (Payne et al., 2001). Due to the importance of nutrient levels within the EPA, the concentrations of nitrogen and phosphorus measured during the 2001 water year are discussed below and compared to results from previous monitoring years.

Total Phosphorus

Since no numeric criterion currently exists, phosphorus concentrations are summarized to provide an overview of the current nutrient status of the Everglades and demonstrate temporal and spatial patterns. No excursion analysis can be performed at this time; however, the 10 µg/L EFA default phosphorus criterion and the 50 µg/L long-term limit for the STAs are used as a basis for comparison. Total phosphorus (TP) concentrations observed in WY2001, WY2000 and the historic period (WY1979 through WY1999) are summarized in **Table 2A-5**. For comparison, data for the current water year are presented against historical data.

Table 2A-5. Summary of total phosphorus concentrations (µg/L) in the Everglades Protection Area for WY2001, WY2000, and WY78-WY99.

Region	Class	Period	N	Mean (Arithmetic)	Std. Deviation	Minimum	Median	Maximum
LNWR	Inflow	WY78-WY99	2575	97.9	82.5	<4	76	489
		WY2000	359	82.8	71.1	10	68	418
		WY2001	301	64.9	53.5	16	47	305
	Interior	WY78-WY99	1548	14.5	25.3	<4	9	494
		WY2000	273	16.4	18.7	5	11	140
		WY2001	230	13.6	12.5	<4	10	99
	Outflow	WY78-WY99	962	74.5	61.8	6	55	495
		WY2000	64	75.8	43.5	24	62	210
		WY2001	71	58.1	49.3	13	45	306
	Rim	WY78-WY99	617	76.1	51.6	<4	62	473
		WY2000	50	91.4	56.8	34	71.5	290
		WY2001	48	74.2	45.1	35	59	263
WCA2	Inflow	WY78-WY99	1399	78.2	58.2	7	62	493
		WY2000	83	74.3	51.0	14	59	319
		WY2001	87	57.8	48.5	9	45	306
	Interior	WY78-WY99	2940	34.8	53.2	<4	14	490
		WY2000	321	34.2	46.9	<4	13	380
		WY2001	245	28.6	36.5	<4	12	240
	Outflow	WY78-WY99	1215	33.8	40.6	<4	21	446
		WY2000	73	27.6	38.1	6	15	199
		WY2001	61	22.5	17.4	<4	17	87
WCA3	Inflow	WY78-WY99	3739	59.4	61.4	<4	40	478
		WY2000	398	67.3	65.1	<4	47.5	347
		WY2001	393	40.2	40.2	8	26	289
	Interior	WY78-WY99	1668	20.3	31.5	<4	10	438
		WY2000	190	16.9	17.6	<4	11	103
		WY2001	123	20.1	23.0	<4	11	136
	Outflow	WY78-WY99	3266	15.0	21.0	<4	10	484
		WY2000	179	14.8	14.3	<4	12	171
		WY2001	202	22.6	15.0	6	18	90
Park	Inflow	WY78-WY99	3885	13.5	19.1	<4	9	484
		WY2000	306	10.8	7.0	<4	8	51
		WY2001	257	17.7	13.5	<4	13	75
	Interior	WY78-WY99	1126	10.6	22.0	<4	6	425
		WY2000	94	6.6	4.4	<4	5	38
		WY2001	80	10.2	11.3	<4	6	68

Median inflow TP concentrations were lower than the two historic periods, with the exception of the Park where inflow concentrations were higher during WY2001. As observed in previous years inflow, concentrations decreased from north to south with the highest concentrations entering the Refuge and WCA-2 (median=45-47 µg/L) and the lowest flowing into the Park (median=13 µg/L). Similar to historic periods, median interior marsh concentrations were low in WY2001 and ranged by area from 6 to 12 µg/L. The distribution of TP concentrations in all EPA regions for WY2001 is presented in **Figure 2A-8**. Over the entire EPA, 80 percent of TP measurements were below 50 µg/L with 24 percent of the measurements at or below 10 µg/L. The percentage of measurements at or below 10 µg/L declined dramatically from WY2000 levels (45 percent), particularly within WCA-3 outflows (28 percent decrease) and Park inflows (27 percent decrease). Additionally, there was a 24 percent decline since WY2000 in the frequency of TP concentrations greater than 50 µg/L in WCA-2 inflow waters. Many of the noted differences in median TP concentrations and frequency distributions can likely be attributed to drought conditions during WY2001. In the north less water was discharged from the EAA to the water conservations areas, thus reducing the overall TP load. Within the Conservation Areas low stages likely resulted in P recycling from the sediments and ultimately higher concentrations being carried to the Park.

As with previous years, a decreasing north to south gradient, indicative of settling, sorptive (both adsorptive and absorptive), assimilative (biological) and other biogeochemical processes in the marsh, was apparent. Inflow stations to the Refuge and Water Conservation Areas had the highest percent of measurements above 50 µg/L (24 - 46 percent). In contrast, only 3.5 percent of the TP measures from Park inflows were above 50 µg/L. High concentrations in the north are related to canal discharges composed primarily of agricultural runoff originating in the EAA.

TOTAL NITROGEN

Total nitrogen concentrations for WY2001, WY2000, and WY1979-WY1999 are summarized in **Table 2A-6**. Water Year 2001 TN concentrations fell within the range of the historic periods. Spatial patterns noted in the 2001 Consolidated persisted throughout WY2001. In contrast to TP there was no change in inflow concentrations of TN. A north to south gradient is apparent in the TN data, which likely reflects agricultural discharges in the north and assimilative processes within the marsh as water flows southward. The highest median concentrations were observed in the inflows to the Refuge (2.3 mg/L) and WCA-2 (2.0 mg/L). The lowest median concentrations were observed in the Park inflows and interior (1.0-1.1 mg/L).

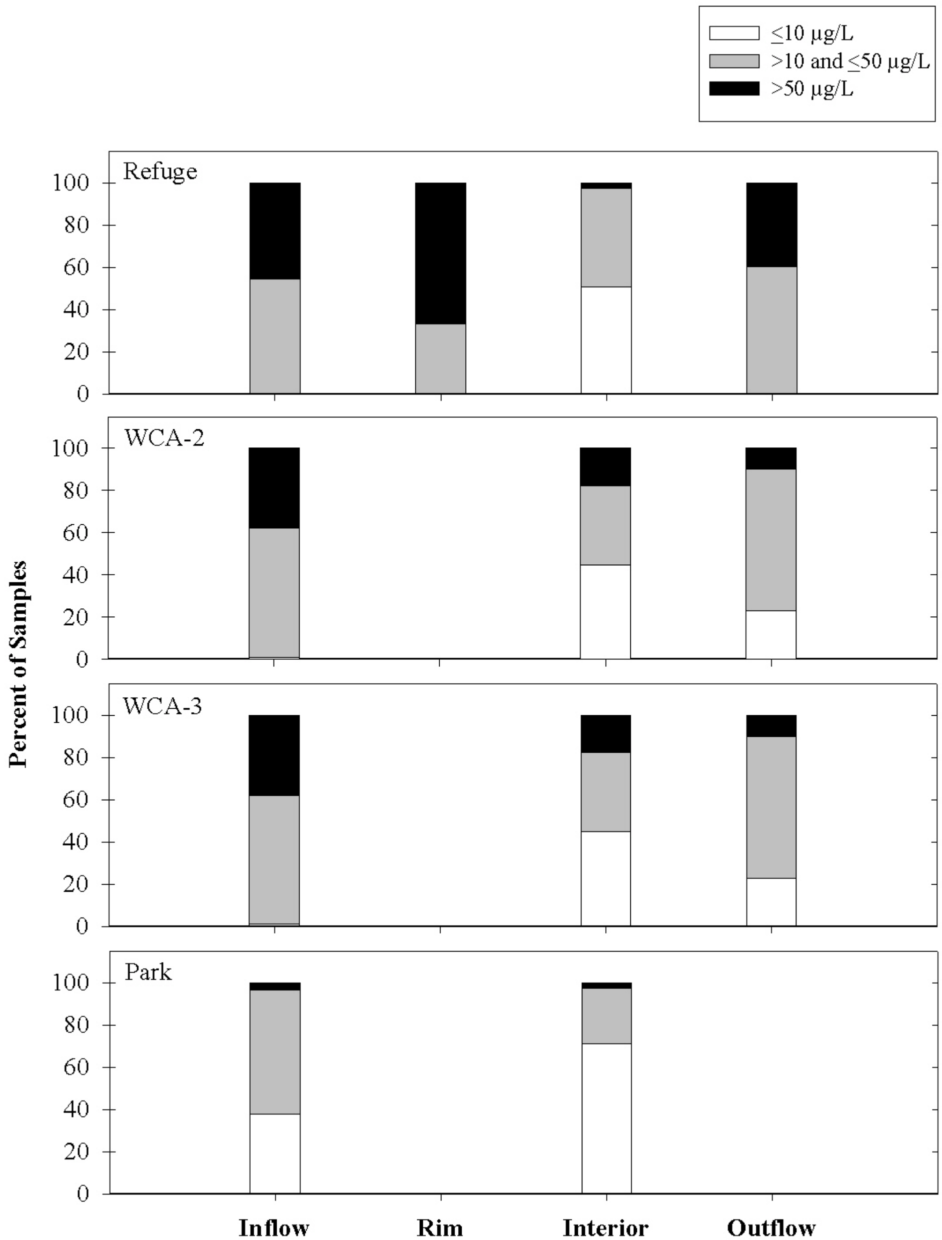

Figure 2A-8. Distribution of total phosphorus concentrations in samples collected in the EPA during WY2001.

Table 2A-6. Summary of total nitrogen concentrations (mg/L) in the Everglades Protection Area for WY2001, WY2000, and historic period (WY78-WY99).

Region	Class	Period	N	Mean	Std. Deviation	Minimum	Median	Maximum
Refuge	Inflow	WY78-WY99	2592	3.5	2.6	<0.5	2.9	49.9
		WY2000	235	2.6	1.3	<0.5	2.2	9.4
		WY2001	154	2.5	1.1	<0.5	2.3	7.1
	Interior	WY78-WY99	1268	1.6	1.5	<0.5	1.3	36.7
		WY2000	206	1.5	0.7	<0.5	1.3	6.6
		WY2001	170	1.7	0.6	<0.5	1.7	3.3
	Outflow	WY78-WY99	977	2.7	1.7	<0.5	2.4	22.8
		WY2000	64	2.3	1.1	0.9	1.9	4.9
		WY2001	60	2.2	0.8	1.1	2.1	5.0
	Rim	WY78-WY99	620	2.7	1.5	<0.5	2.3	10.9
		WY2000	50	2.5	1.3	<0.5	2.0	7.7
		WY2001	48	2.5	1.0	0.7	2.3	5.6
WCA2	Inflow	WY78-WY99	1425	3.0	1.7	<0.5	2.7	22.8
		WY2000	81	2.5	1.0	0.8	2.2	4.9
		WY2001	77	2.1	1.0	<0.5	2.0	5.1
	Interior	WY78-WY99	2729	2.5	1.5	<0.5	2.2	37.2
		WY2000	285	2.0	0.7	<0.5	1.9	5.0
		WY2001	197	2.2	0.8	0.7	2.1	5.7
	Outflow	WY78-WY99	1239	2.2	0.9	<0.5	2.0	7.7
		WY2000	74	1.6	0.7	<0.5	1.4	4.4
		WY2001	61	1.6	0.4	0.8	1.6	2.9
WCA3	Inflow	WY78-WY99	3529	2.1	1.1	<0.5	1.8	10.8
		WY2000	278	1.8	0.9	0.7	1.5	6.4
		WY2001	210	1.7	0.6	<0.5	1.5	4.6
	Interior	WY78-WY99	1680	1.7	0.9	<0.5	1.5	10.0
		WY2000	161	1.2	0.4	<0.5	1.2	3.3
		WY2001	75	1.4	0.4	<0.5	1.4	2.9
	Outflow	WY78-WY99	2518	1.5	0.7	<0.5	1.4	14.9
		WY2000	144	0.9	0.3	<0.5	0.9	2.0
		WY2001	126	1.1	0.3	<0.5	1.1	2.1
Park	Inflow	WY78-WY99	3124	1.3	0.7	<0.5	1.3	14.9
		WY2000	244	0.8	0.2	<0.5	0.7	1.4
		WY2001	143	1.0	0.3	<0.5	1.0	2.1
	Interior	WY78-WY99	1156	1.5	1.6	<0.5	1.2	40.8
		WY2000	98	0.9	0.5	<0.5	0.8	2.7
		WY2001	80	1.3	0.7	<0.5	1.1	4.0

PESTICIDES

The SFWMD has maintained a pesticide monitoring program in south Florida since 1984. The pesticide network includes sites designated in the Park Memorandum of Agreement, the Miccosukee Tribe Memorandum of Agreement, the Lake Okeechobee Operating Permit and the Non-ECP Structure Permit. The current monitoring program in the EPA consists of 25 sites (**Figure 2A-9**). Sites were grouped according to basin.

Surface water concentrations of pesticides are regulated under criteria established in Chapter 62-302, F.A.C. Specific numeric criteria for a number of pesticides and herbicides (*e.g*., DDT, endosulfan, malathion) are listed in Section 62-302.530, F.A.C. Compounds not specifically listed, including many contemporary pesticides (e.g., ametryn, atrazine, diazinon,), are to be evaluated on the basis of acute and chronic toxicity. A set of toxicity based guidelines for non-listed pesticides were presented in the 2001 Consolidated Report (Weaver et al., 2001). These guidelines were developed based upon the requirement in Subsection 62-302.530(62), F.A.C. that surface waters of the state shall be free from "*substances in concentrations, which injure, are chronically toxic to, or produce adverse physiological or behavioral response in humans, plants, or animals*".

This report analyzes data collected during pesticide monitoring events conducted between March and November 2000. Monitoring results were evaluated relative to Class III criteria, chronic toxicity guidelines, and detected concentrations. Pesticides exceeding either the Class III criteria or chronic toxicity guideline were classified as a Concern for the basin in which the exceedance occurred. Parameters of Concern have a high likelihood of causing impairment to designated use. Detected parameters (>MDL) that did not exceed either a guideline or criteria were categorized as Potential Concerns. The Potential Concern classification signifies that the parameter is known to be present within the basin at concentrations that are reasonably believed to be below levels that result in biologic effects, but may at some future date or in interaction with other compounds become a problem. A third category (No Concern) was used for areas where a given parameter was not detected.

Between March and November 2000, 8 pesticides were detected in the EPA, with all parameters being categorized as a Potential Concern or No Concern, except diazinon (**Table 2A-7**). Diazinon was classified as a Concern in WCA-2 due to a single exceedance of its chronic toxicity guideline at S38 for the August 2000 sampling event. A single detection of methoxychlor at US41-25 resulted in the compound being classified as a Potential Concern for the Park. Unlike previous years endosulfan (alpha and beta) was not detected in the C-111 basin.

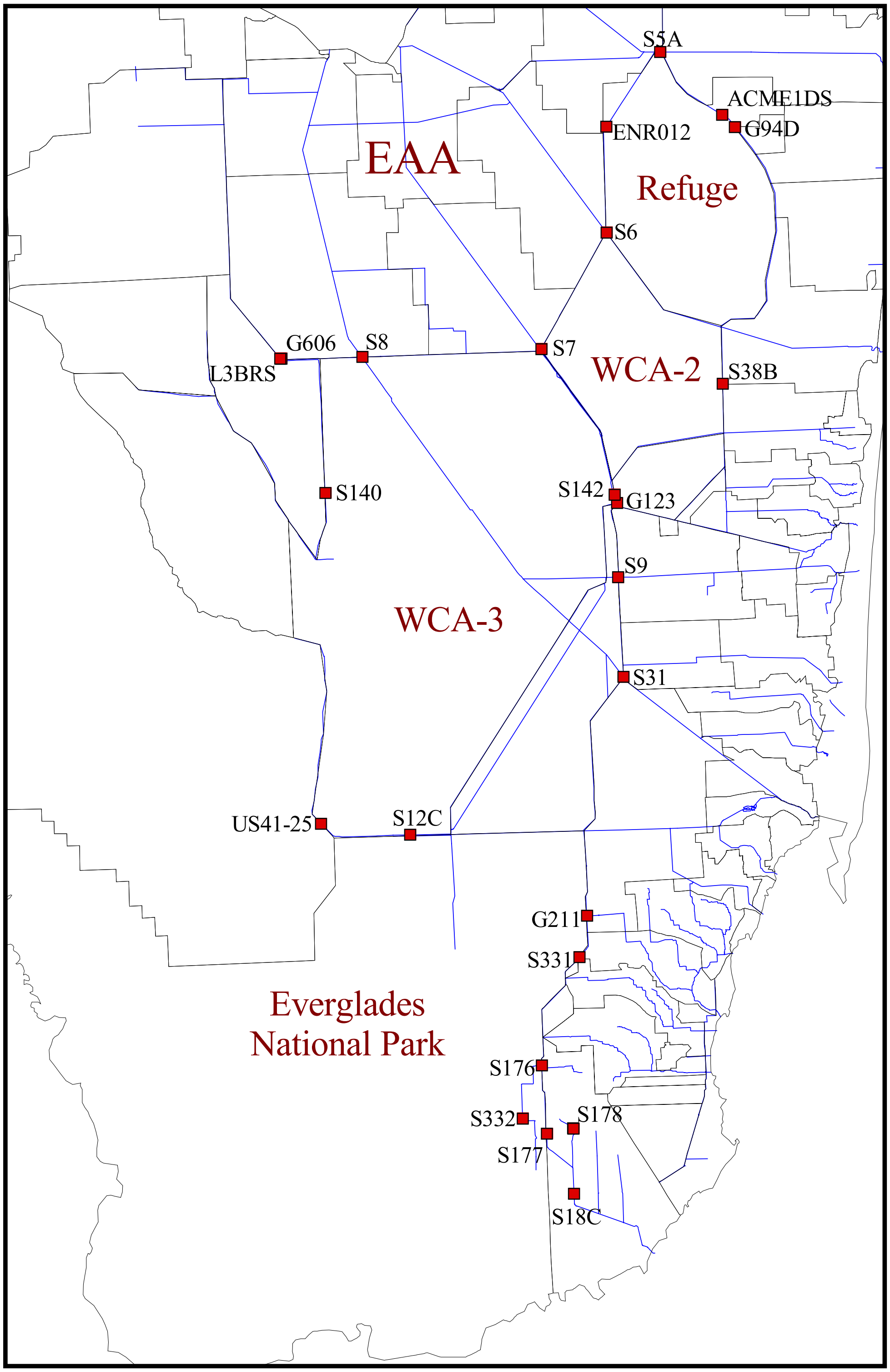

Figure 2A-9. Pesticide monitoring sites in the EPA.

Table 2A-7. Pesticide detections and exceedance categories in the EPA inflows, canals and structures between March and November 2000. The categories of "Concern" and "Potential Concern" are denoted by "C" and "PC", respectively, all others are considered "No Concern". Values within the parentheses are the number of detections and total number of samples

Parameter	C-111[1]	Park[2]	Refuge[3]	WCA-2[4]	WCA-3[5]
ametryn	(0:10)	PC (1:8)	PC (9:14)	PC (2:4)	PC (5:19)
atrazine	PC (4:10)	PC (3:8)	PC (8:14)	PC (2:4)	PC (10:19)
bromacil	(0:10)	(0:8)	PC (1:10)	(0:4)	PC (2:16)
diazinon	(0:10)	(0:8)	(0:10)	C (1:4)	(0:16)
hexazinone	(0:10)	(0:8)	PC (3:10)	(0:4)	PC (1:19)
methoxychlor	(0:10)	PC (1:8)	(0:10)	(0:4)	(0:16)
norflurazon	(0:10)	(0:8)	(0:10)	(0:4)	PC (2:19)
simazine	(0:10)	(0:8)	PC (1:10)	(0:4)	(0:16)

1. G211, S176, S177, S178 and S331.
2. S12C, S18C, S332 and US41-25.
3. ACME1DS, ENR012, G4D, and S5A.
4. S38B and S7.
5. G123, G606, L3BRS, S140, S190, S8, S9, S142, and S31.
6. Classification of Concern is based on exceedance of state Class III criterion.

Review of the previous year's sampling data shows continuation of the reduction in pesticide exceedances entering the northern Everglades from the EAA noted in the 2001 Consolidated Report (Weaver et al., 2001). During previous years, pesticide concentrations in excess of chronic toxicity guidelines have been detected in inflow waters to the Refuge, WCA-2 and WCA-3 (Weaver et al., 2001). Historically, the primary parameter of Concern originating from the EAA was atrazine. Over WY2001, no pesticides exceedances, including atrazine, were recorded in waters discharging from the EAA. Potentially, this improvement is an unplanned benefit of nutrient Best Management Practices (BMP) implemented within the basin. It is also possible that the lowered exceedance rate was at least partially due to drought conditions that persisted throughout WY2001. Since less water was likely discharged from agricultural areas, the pesticides would have been retained within the EAA for a longer period, allowing a greater level of degradation prior to discharge to the EPA. In addition to the exceedance reductions in the northern Everglades, there was a substantial decrease for the C-111 basin. Historically, endosulfan exceedances have been frequently recorded in the C-111. However, during the previous year no endosulfans were detected in the basin. Similar to northern Everglades, this exceedance reduction for the C-111 may be a result of drought conditions.

The diazinon exceedance observed at site S38B continues the pattern discussed in Weaver et al., 2001. Waters discharging from the North Springs Improvement District and ACME basins to WCA-2 and the Refuge, respectively, have contained diazinon concentrations in excess of the chronic toxicity guideline. Because the diazinon chronic toxicity guideline is below the current analytical MDL, there is substantial uncertainty in the severity of the problem. With the current MDL it is impossible to determine the actual frequency of biologically significant concentrations (excursions); however, the frequently detected excursions for several years should raise a concern. This issue warrants further investigation by the Department and SFWMD.

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