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

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SUMMARY

This chapter provides a review of the water quality for each Everglades Protection Area (EPA) region during Water Year 2003 (WY2003) (May 1, 2002 through April 30, 2003). The focus of this chapter is to provide an update to the *2003 Everglades Consolidated Report*. Status of the EPA water quality was determined by an analysis of the water quality variables that did not meet water quality criteria, as specified in Section 62-302.530 of the Florida Administrative Code (F.A.C.). These criteria establish enforceable management and societal goals for water quality conditions within the EPA. The primary objective of this chapter is to provide a synoptic view of water quality standards compliance on a regional scale (Arthur R. Marshall Loxahatchee National Wildlife Refuge [Refuge], Water Conservation Areas 2 and 3 [WCA-2 and WCA-3], and Everglades National Park [ENP or Park]). Discussions of any temporal or spatial trends observed for the variables identified as concerns or potential concerns are also provided. Annual excursion rates were summarized in a manner similar to methods employed in the *1999 Everglades Interim Report* and previous Everglades Consolidated Reports (ECRs). For the *2004 Everglades Consolidated Report*, water quality variables that did not meet existing standards were classified into three categories based on excursion frequencies that were statistically tested using the binomial hypothesis test. This chapter also provides a discussion of the factors contributing to excursions from applicable water quality criteria and an evaluation of the natural background conditions for which existing standards may not be appropriate. The results of the evaluation detailed in this chapter are summarized below.

- Dissolved oxygen (DO) was designated as a concern for all EPA regions and classes due to frequent concentrations below the current criterion of 5.0 milligrams per liter (mg/L). However, a site-specific alternative criterion (SSAC) that recognizes the naturally low DO regime characteristic of periphyton-dominated wetlands (such as the Everglades) has been developed by the Florida Department of Environmental Protection (FDEP) and has been proposed for adoption this year. The application of the SSAC to DO data collected in WY2003 resulted in a reduction in the number of monitoring stations (from 134 to 26) in which DO was identified as a concern. The DO regimes at most of the remaining 26 sites are depressed either by nutrient enrichment or groundwater infiltration and are accurately designated as below natural marsh background levels by the SSAC.
- As in previous years, alkalinity was classified as a concern for the interior of the Refuge during WY2003 due to an excursion rate of 20.7 percent. Based on regional assessments, pH was not identified as either a concern or a potential concern for any

area. However, localized high exceedance rates (ranging from 12 to 51 percent) were recorded at several interior Refuge stations for the five-year period from WY1999 through WY2003, resulting in pH being classified as a concern for stations LOX5, LOX8, LOX11, and LOX13 and as a potential concern for stations LOX9 and LOX16. The low alkalinity and pH levels in the interior of the Refuge are natural conditions resulting from the rainfall driven nature of the area's hydrology. Therefore, these excursions should not be considered in violation of the current standard.

- Similar to previous periods, conductivity was categorized as a concern for Refuge inflows and as a potential concern for WCA-2. However, unlike previous periods, a large number of exceedances were also recorded at interior stations (F2, F3, F4, F5, CA215, and CA29) in WCA-2 that were located outside the direct influence of inflows. Because these exceedances occurred late in the dry season, they may be related to groundwater seepage and/or the concentration of ions associated with the evaporation of marsh water.
- Like WY2002, un-ionized ammonia (NH_3) was categorized as a concern for WCA-2 inflows during WY2003 due to a large number of excursions (10) at sites E0 and F0 located within the spreader canal that receive inflows from the Hillsboro canal. Elevated dissolved ammonia concentrations were the primary cause of the WY2002 and WY2003 excursions at stations E0 and F0.
- Fifteen pesticides were detected between December 2001 and September 2002. Of these pesticides, atrazine, chlorpyrifos ethyl, and diazinon were classified as concerns. Pesticide excursions for the period of record occurred at inflows to all areas except the Refuge.

PURPOSE

This chapter provides an assessment of water quality constituents exceeding water quality standards or causing or contributing to adverse impacts in the Everglades Protection Area (EPA). More specifically, the primary purpose of this chapter is to provide an overview of the status of water quality in the EPA, relative to Class III criteria, during Water Year 2003 (WY2003) (May 1, 2002 through April 30, 2003). The water quality evaluation presented in this chapter updates previous analyses presented in the *1999 Everglades Interim Report* and the 2000, 2001, 2002, and 2003 Everglades Consolidated Reports. More specifically, this chapter and its associated appendices use water quality data collected during WY2003 to achieve the following objectives:

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 may not be appropriate
3. Summarize sulfate concentrations in the EPA and indicate spatial and temporal trends
4. Provide an update concerning the status of an alternative criterion for dissolved oxygen (DO) in Everglades marsh waters
5. Present an updated review of pesticide and priority pollutant data made available during WY2003

Nutrient (total phosphorus [TP] and total nitrogen [TN]) analyses that were presented in this chapter in previous ECRs have been expanded and moved to Chapter 2C in the *2004 Everglades Consolidated Report*.

METHODS

An approach similar to the regional synoptic approach used in previous ECRs was applied to WY2003 data to provide an overview of the status of compliance with water quality criteria in the EPA. The consolidation of regional water quality data 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 majority of the water quality data evaluated in this chapter was retrieved from the South Florida Water Management District's (SFWMD or District) DBHYDRO database. Water quality data from the nutrient gradient sampling stations monitored by the Everglades Systems Research Division in the northern part of WCA-2A, the southwestern part of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge), the west-central portion of Water Conservation Area 3A (WCA-3A), and Taylor Slough in Everglades National Park (ENP or Park) were obtained from the SFWMD's Everglades Research Database. Before water quality data are entered into either database, the SFWMD follows strict quality assurance/quality control (QA/QC) procedures approved by the Florida Department of Health under the National Environmental Laboratory Accreditation Conference (NELAC) certification process. Both sampling and analytical methods are documented in the SFWMD Quality Assurance Manual and in Standard Operating Procedures (SOPs) that are reviewed and updated annually. Contract laboratories used by the District also must be NELAC certified and must maintain the appropriate Quality Assurance Manual and SOPs.

EVERGLADES PROTECTION AREA WATER QUALITY SAMPLING STATIONS

The surface water in the portion of the Everglades represented by the sampling stations used in this report is classified as Class III freshwater of the state (Section 62-302.400, Florida Administrative Code [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 Refuge and the Park are classified as Outstanding Florida Waters (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 Paragraphs 62-4.242(2) and (3), F.A.C. is to be permitted in Outstanding Florida Waters (Section 62-302.700, F.A.C.).

Water quality sampling stations located throughout the Water Conservation Areas (WCAs) and the Park were categorized as inflow, interior, or outflow sites within each region based on their location and function (**Figure 2A-1**). This organization of monitoring sites allowed a more detailed analysis of the water quality status in each region of the EPA and assisted in the evaluation of potential causes for observed excursions from Class III water quality criteria. Several interior structures convey water between different regions in the EPA and are therefore designated as both inflow and outflow stations based on this categorization system. For example, the S-10 structures act as both outflow stations for the Refuge and inflow sites to WCA-2. Additionally, the S-11 structures are designated as outflows from WCA-2, as well as inflow points to WCA-3. The S-12 structures S-355A, S-355B, and S-333 are outflows from WCA-3 and are also inflow sites to the Park. The interior sites of each region consist of marsh and canal stations in addition to structures that convey water within the area. In addition to inflow, outflow, and interior sites, the Refuge has an additional site category (rim canal sites) to account for the fact that much of the water entering the interior of the Refuge is conveyed in rim canals that border the east and west levees of the Refuge. Waters discharged to the L-7 rim canal will either overflow into the Refuge interior when canal stages exceed the levee height or will bypass the marsh and be discharged to WCA-2A through the S-10 structures. The extent (distance) to which rim canal overflows permeate the marsh depends on the relative stages of the L-7 rim canal and the Refuge interior.

Several changes to the classification of inflow stations have been made for purposes of the *2004 Everglades Consolidated Report* to accurately reflect how the system currently functions. The network now reflects the diversion of S-5A and S-6 flows into STA-1W and STA-2, respectively. The S-5A, S-5AS, and S-6 structures have been removed as inflows to the Refuge. STA-1W diversion structures G-300 and G-301 were added as inflows to the Refuge. Likewise, G-338 and G-339 were added as inflows to the Refuge and WCA-2, respectively, to capture diversions from STA-2. For the STA diversion structures (G-300, G-301, G-338, and G-339), only water quality collected during diversion events were utilized in this report. Additionally, the STA-2 discharge structure G-335 was added as an inflow to WCA-2. It is anticipated that in future years additional alterations will be made to the monitoring network in response to the Everglades Construction Project (ECP) and Comprehensive Everglades Restoration Plan (CERP). The location and classification of monitoring stations used in this report are presented in **Figures 2A-2** through **2A-5**.

Although much of the data from the non-Everglades Construction Project (non-ECP) structures are 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 8B of the *2004 Everglades Consolidated Report* to simplify and improve the readability of this chapter.

The current SFWMD monitoring programs are described by Germain (1998). Sampling frequency varies by site depending on site classification, variable group, and hydrologic conditions (water depth and flow). Additionally, the District has created a Website describing its water quality monitoring projects, including project descriptions and objectives (http://www.sfwmd.gov/org/ema/envmon/wqm). The District's Website currently provides limited, site-specific information. Generally, interior monitoring stations were sampled monthly for most variables reported in this chapter. Water control structures (inflows and outflows) were typically sampled biweekly, when flowing, and monthly otherwise.

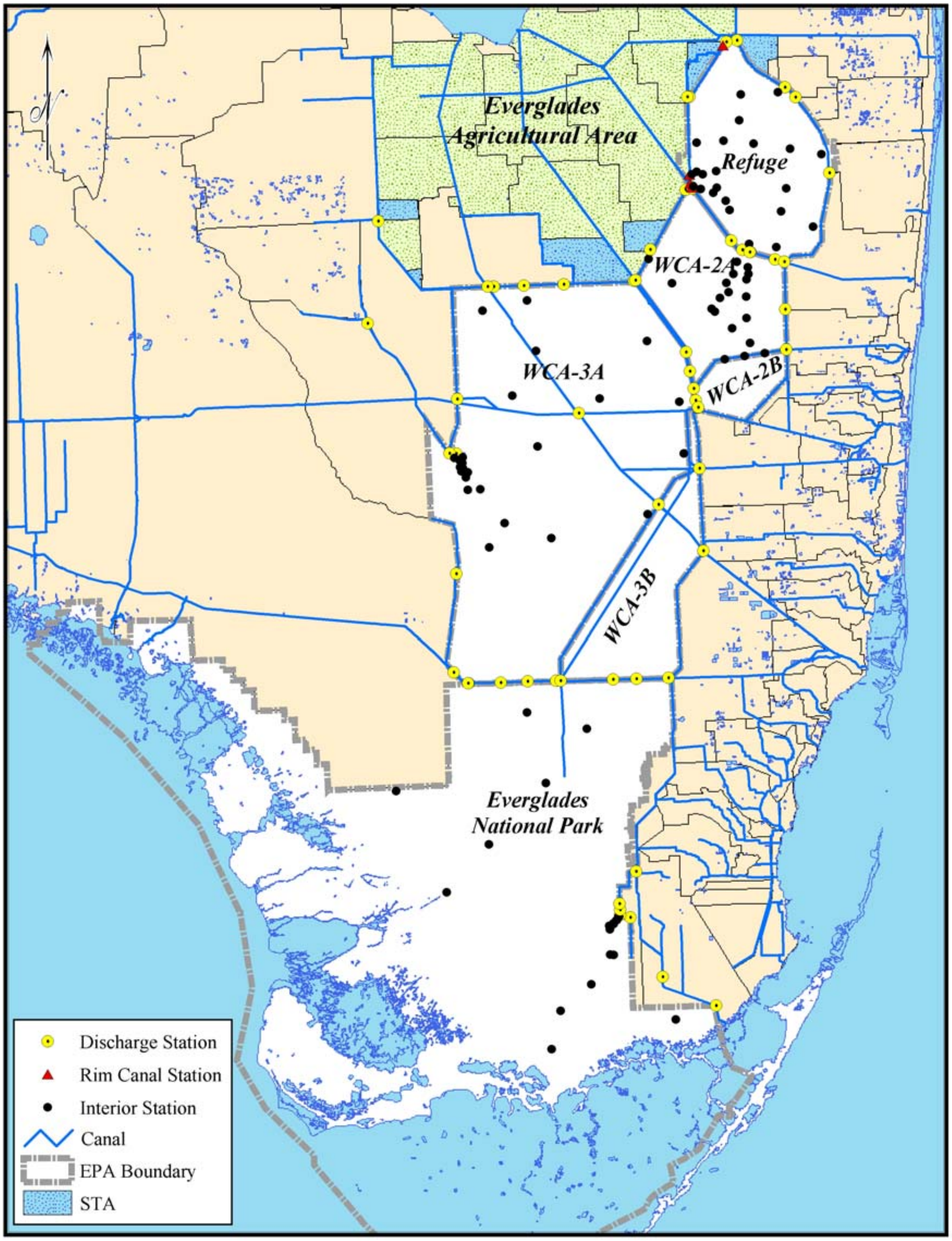

Figure 2A-1. Everglades Protection Area (EPA) regions and water quality monitoring stations.

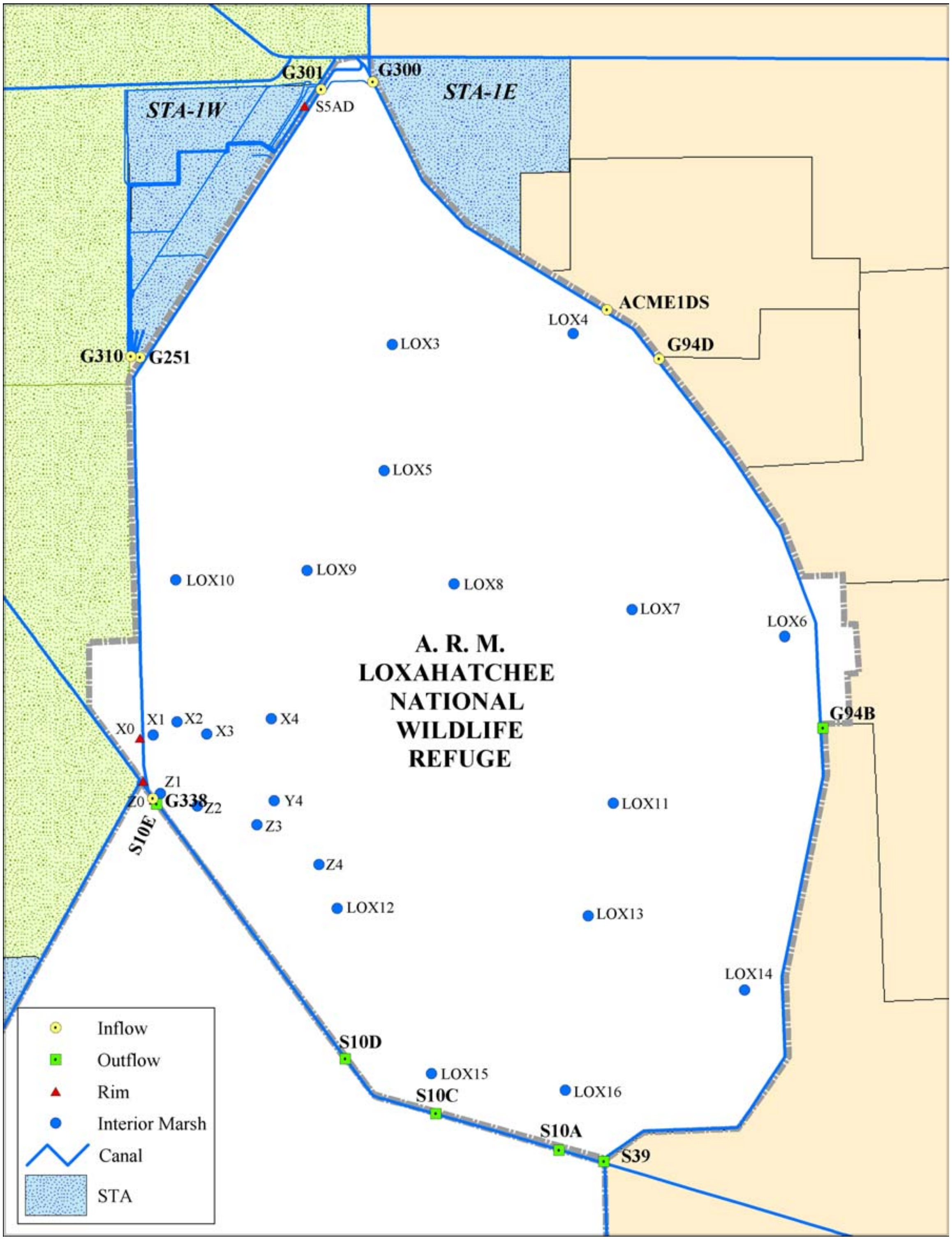

Figure 2A-2. Location and classification of water quality monitoring stations in the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge).

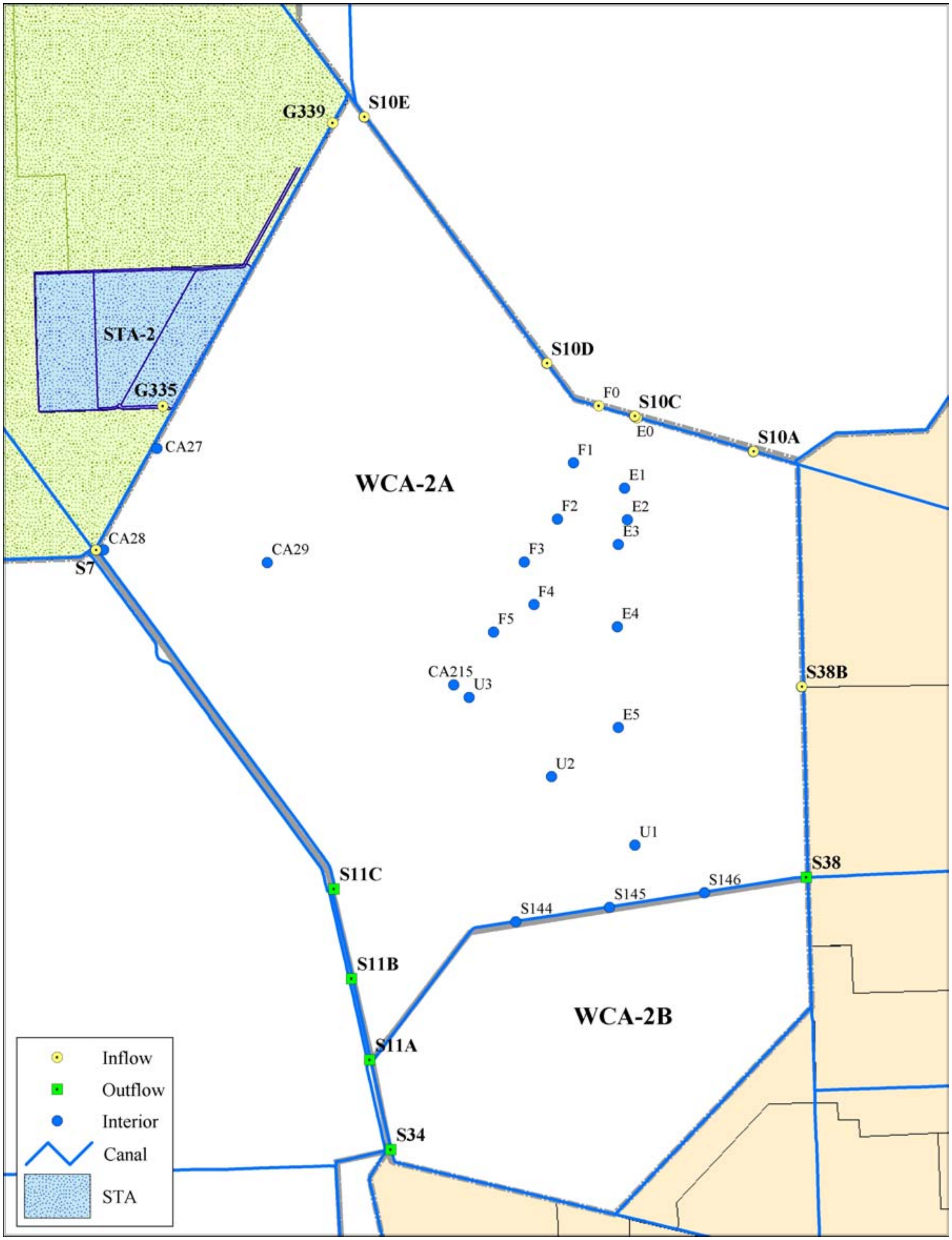

Figure 2A-3. Location and classification of water quality monitoring stations in Water Conservation Area 2 (WCA-2).

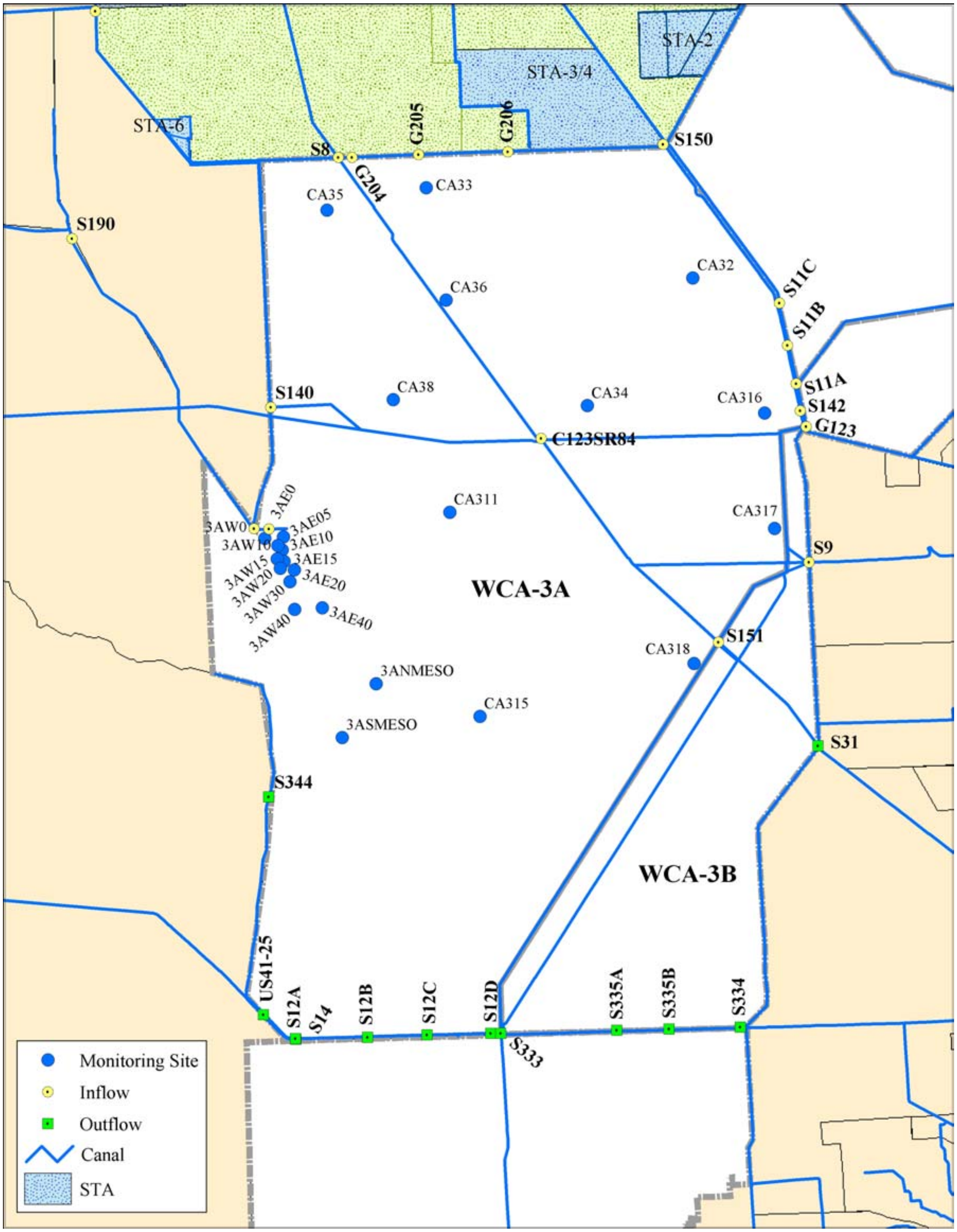

Figure 2A-4. Location and classification of water quality monitoring stations in Water Conservation Area 3 (WCA-3).

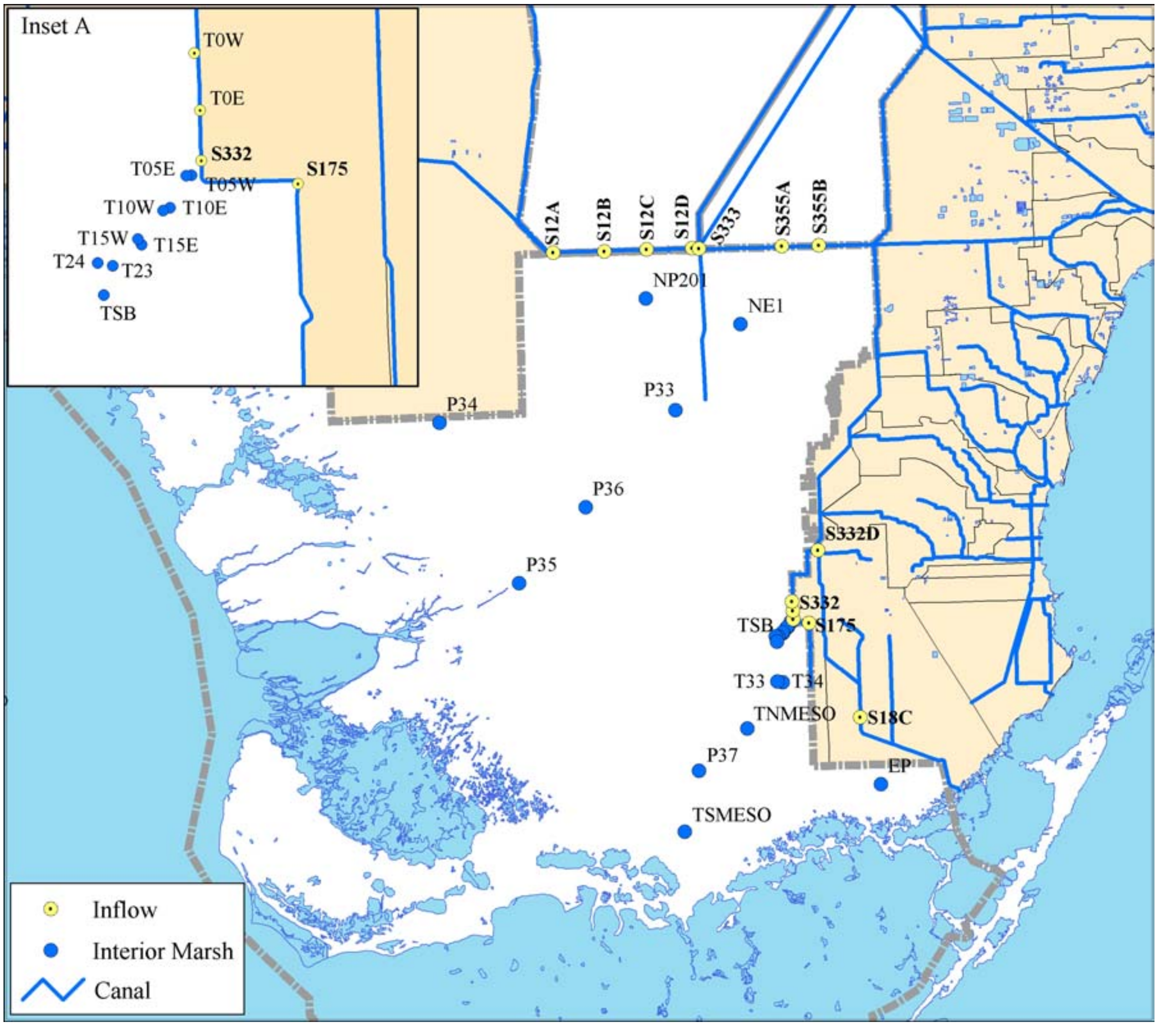

Figure 2A-5. Location and classification of water quality monitoring stations in the Everglades National Park. Inset A provides the location of transect monitoring stations downstream of C-111 inflows in Taylor Slough.

EVERGLADES PROTECTION AREA DATA ANALYSIS PERIOD

Water quality data collected from monitoring stations within the EPA regions during WY2003 (May 1, 2002 through April 30, 2003) are evaluated and discussed in this chapter. Additionally, pesticide data presented in this chapter were collected during quarterly sampling events conducted between December 2001 and September 2002. The pesticides' period of record was selected as an update to the data presented in the *2003 Everglades Consolidated Report*, rather than reflected by the water year.

WATER QUALITY DATA EVALUATION

The District monitors approximately 109 water quality variables within the EPA (Bechtel et al., 1999 and 2000). Given this chapter's focus on water quality criteria, the evaluation was primarily limited to variables with Class III criteria pursuant to Chapter 62-302, F.A.C. The variables evaluated included sulfate, 62 pesticides, and the following 18 water quality constituents:

- Alkalinity
- Dissolved oxygen (in situ)
- Specific conductance at 25°C (in situ)
- pH (in situ)
- Total silver
- Total antimony
- Total arsenic
- Total beryllium
- Total cadmium
- Trivalent chromium
- Total copper
- Total iron
- 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, or reversal) was removed from the analysis. Values that exceeded possible physical or chemical measurement constraints (e.g., pH greater than 14), had temperatures well outside seasonal norms (e.g., 6°C in July), or represented data transcription errors were excluded. Statistical outlier analysis was not performed for these data. Overall, 1.08 percent of the WY2003 data including nutrients were excluded due to QA/QC issues. All data passing the qualifier screening were used in the analysis. Samples collected at the same location on the same day were considered as one sample, with the arithmetic mean used to represent the sampling period.

Additional considerations in the handling of water quality data are the accuracy and sensitivity of the laboratory method used. Each analytical method for a particular water quality constituent has a Method Detection Limit (MDL) that defines the minimum concentration or the level at which the constituent can be identified. The MDL is usually statistically above the background noise level associated with the analytical method. A constituent present at a concentration that is at or below the MDL may not be quantified within established limits of accuracy or precision using that method. The Practical Quantitation Limit (PQL) represents a practical and routinely achievable quantification level with a relatively good certainty that a value determined using that method is reliable (APHA, 1995). For purposes of summary statistics presented in this chapter, data reported as less than the MDL were assigned a value of one-half the MDL unless otherwise noted. All data presented in this chapter, including historical results, are handled consistently with regard to screening and MDL replacement. The percentages of results below detection (< MDL) for each constituent are reported in Appendix 2A-1.

EXCURSION ANALYSIS

The FDEP and the District have developed and clearly documented an excursion analysis protocol for use in the *2004 Everglades Consolidated Report*. The primary objective of the protocol is to provide a synoptic view of water quality standards compliance on a regional scale (Refuge, WCA-2, WCA-3, and Park). This protocol was developed to balance consistency with previous ECRs, other state of Florida ambient water quality evaluation methodologies (e.g., Impaired Waters 303(d) designations), and U.S. Environmental Protection Agency (USEPA) exceedance frequency recommendations, as well as to provide a concise summary to decision makers and the public. It is hoped that using this method will help ensure that the results of this evaluation will be compatible with information provided to water managers from other sources.

To evaluate compliance with water quality criteria in WY2003, 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 reported value above the given MDL exceeded the applicable numeric criteria (Chapter 62-302.530, F.A.C.) or was characterized as chronically toxic. The excursions for each region of the Everglades Protection Area were tabulated, providing both the total number of samples and the percent of samples exceeding the criteria.

Prior to the *2002 Everglades Consolidated Report* (2002 ECR), the ECRs utilized a raw-score approach to rank and categorize the severity of excursions from state water quality criteria (Bechtel et al., 1999 and 2000; Weaver et al., 2001 and 2002). Using this raw-score method, a variable was classified as a “concern” when more than 5 percent of the measurements exceeded numeric criteria. Although not previously stated, the underlying premise of this approach is that a variable is considered to be a management “concern” if its true exceedance (excursion) probability exceeds 5 percent. However, since the true exceedance probability cannot be measured, it must be estimated from a set of samples (i.e., a subset of the entire population) which introduces statistical uncertainty. The degree of uncertainty in the estimate depends on the true exceedance probability and sample size (e.g., smaller sizes are associated with greater uncertainty). For example, one out of six measurements above the criterion is clearly a weaker (more uncertain) case for impairment than six out of thirty-six, although both cases result in an excursion frequency of 16.7 percent (NRC, 2001). A statistically valid assessment of the estimate requires that some accounting for uncertainty in the estimate be incorporated into the analysis (Riggs and Aragon, 2002). Smith et al. (2001) and the NRC (2001) suggested that a binomial hypothesis test that evaluates the statistical significance of the frequency of excursions could be used in water quality evaluations to account for sampling uncertainty. Adoption of the state’s Impaired Waters Rule (IWR) (Chapter 62-303, F.A.C.) that uses a binomial hypothesis test to delineate impaired waters establishes precedence for the use of this statistical method in Florida. In support of the development of the IWR, Lin et al., (2000) reviewed statistical procedures for standards compliance assessments and recommended a nonparametric procedure for identifying impaired water body reaches in Florida based on a binomial distribution theory.

Although the binomial hypothesis test provides a better accounting for uncertainty than a raw-score approach, the sample size is still an important consideration in the reliability of excursion frequency estimation. Specifically, in water quality attainment decisions, both the Type I error (probability of falsely listing as a concern; false positive) and Type II error (probability of not listing when truly is a concern; false negative) are of concern. Sample sizes of at least 28 balance average error rates to below 15 percent and below 10 percent at sample sizes greater than 40 when a binomial approach is utilized (Smith et al., 2001; Riggs and Aragon, 2002)[1]. Riggs and Aragon (2002) stated that error rates for samples sizes less than 28 are probably too high to be acceptable to most regulators. As long as sample sizes are maintained at acceptable levels (> 28), binomial methodologies can be utilized to better balance and manage error rates than the previously utilized raw-score approach[2]. Based on these considerations and a review of the literature (e.g., Lin et al., 2000; Smith et al., 2001; Donohue and Looij, 2001; Riggs and Aragon, 2002), the raw-score approach was replaced in the *2003 Everglades Consolidated Report* and in the *2004 Everglades Consolidated Report* with a binomial hypothesis test.

An additional weakness of the evaluation methodology employed in previous ECRs is that the 5-percent excursion frequency selected to categorize a variable as a concern does not reflect current USEPA guidance, which recommends that a 10-percent rate of exceedance (excursion) from applicable water quality standards be used to delineate impaired water bodies for conventional pollutants or constituents (e.g., dissolved oxygen [DO], metals, conductivity, turbidity, ammonia [NH_3], and dissolved ions) (USEPA, 1997 and 2002). Essentially the conventional pollutants are constituents, which are expected to naturally occur and vary within the environment due to natural biogeochemical processes. The 10-percent USEPA guidance frequency accounts for natural background variability as well as for sampling and measurement errors. This guidance does not apply to constituents with human health-based criteria (e.g., beryllium and 2,4-dinitrophenol) or to unconventional pollutants (e.g., pesticides and herbicides). Given that the authors are seeking to increase consistency among assessments, the excursion categories were revised from previous ECRs to reflect USEPA guidance for water quality assessments while maintaining a multitiered categorical system similar to that employed in previous ECRs (**Table 2A-1**).

The binomial hypothesis test was utilized to evaluate water quality criteria excursions in the *2004 Everglades Consolidated Report* for conventional water quality constituents (i.e., constituents other than pesticides or with human health-based criterion, such as beryllium). Variables without excursions were categorized as no concern and are not discussed further in this chapter. For any variable with excursions and at least 28 samples during the period of record, the binomial hypothesis test at the 90-percent confidence level was applied to evaluate whether the given variable was a concern; that is, whether it exhibited an excursion rate greater than 10 percent. If the binomial hypothesis test failed to reject the null hypothesis (H_0: $f \leq 0.10$; H_A: $f > 0.10$), then the binomial test at the 90-percent confidence level was used to determine whether the

[1] Error rates for the raw-score approach are also substantially above acceptable levels at sample sizes less than 28 to 30. Furthermore, Type I error rates (greater than 40 percent) associated with the raw-score approach are unacceptably high even at large sample sizes (Smith et al., 2001) (e.g., at sample sizes greater than 100, the Type I error rate exceeds 40 percent).

[2] At sample size less than 20, neither a binomial nor a raw-score approach can be confidently employed to adequately control error rates (Smith et al., 2001; Riggs and Aragon, 2002).

variable was a potential concern (excursion rate from 5 to 10 percent, i.e., H_A: $f > 0.05$) or a minimal concern (an excursion rate of 5 percent or less, i.e., H_0: $f \leq 0.05$).

Because the binominal hypothesis test does not adequately balance statistical error rates at sample sizes of less than 28, variables with reported excursions and fewer than 28 samples were initially categorized as concern and potential concern based on excursion frequencies (raw scores) of greater than 20 percent and less than 20 percent, respectively[3]. It is assumed that an observed excursion frequency greater than 20 percent provides substantial reason to suspect that the true exceedance frequency may exceed 10 percent and warrants further investigation. Furthermore, given the high degree of uncertainty associated with small sample sizes (< 28), any excursions warrant further review. However, extreme caution must be exercised when interpreting results drawn from such small samplings. As a means to reduce uncertainty, any variable initially identified as a concern or potential concern based on fewer than 28 samples was further evaluated based on longer term (five years) excursion rates. Utilization of a longer period of record assumes that exceedance frequencies are constant among years, that is, there is no trend. Variables with human health-based criteria were evaluated under the assumption that the Class III criteria values represent instantaneous maximum concentrations for which any exceedance constitutes a non-attainment of designated use; therefore, beryllium was categorized as a concern for periods exhibiting any exceedances of the current Class III criterion.

The excursion categories are meant to provide some guidance in the interpretation of monitoring results by providing a means to rank the severity of excursions from water quality criteria, allow tracking of temporal and spatial trends, and provide a selection criterion for more detailed evaluations. The system can be thought of as a report card, with grades designated as passing (A-B), satisfactory (C), unsatisfactory (D), and failing (F). Not only does this system provide the public and decision makers with a measure of the overall water quality of the Everglades, but it also guides and prioritizes further review.

As a supplement to the binomial hypothesis test, 90-percent confidence intervals (90% C.I.) were calculated around the estimated exceedance frequencies for WY2003. Inclusion of confidence intervals provides the reader with a measure of uncertainty associated with frequency estimates and excursion analyses. For example, if the lower confidence bound (frequency minus the 90% C.I.) is greater then 10 percent, then it can be concluded with at least 90% certainty that that the variable is a concern. However, if the confidence bound includes 10 percent (or 5 percent), then it cannot be concluded that the variable is a concern (or potential concern).

Use of the binomial hypothesis test assumes a constant exceedance probability across all monitoring stations within area and class (e.g., WCA-2 interior, Park inflows)[4]. If this assumption

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[3] At sample sizes less than 28, the binomial hypothesis test is associated with unacceptably high Type II error rates (greater than 20 to 93 percent). A 20 percent raw-score criteria was selected, because it provides a better balance between error rates than either a binomial test or a 10 percent raw score, i.e., at sample sizes between 1 and 27, both Type I and II error rates are intermediate (between) those associated with a binomial test or 10 percent raw score. However, this error rate compromise does not fully address the uncertainty inherent in the analysis of such small samples. Analysis of longer periods of record or increased sampling frequencies is required to confidently categorize excursion frequencies and acceptably balance Type I and II error rates.

[4] Constant exceedance probability is also an assumption of the previously used raw-score approach.

is violated, then there is a chance that a regional concern level will be incorrectly elevated due to the influence of a high localized exceedance frequency. Conversely, there is a chance of masking localized high exceedances frequencies within the regionally aggregated frequency. For example, if a region represented by 10 stations had total of 120 samples with 10 exceedances at only one station, then the water quality variable would be categorized as a potential concern for the entire region; however, in reality the variable is likely not a concern at 9 stations but may be a concern at one. The assumption of homogeneous exceedance probabilities may not hold for every water quality variable within an area as large as the Everglades. Subdividing each region into smaller, more homogenous sub-water bodies is a potential approach to ensure adherence to this assumption. However, this method does not meet the chapter's objective of providing regional summaries at the water body level (i.e., Refuge, WCA-2, WCA-3, and Park). Therefore, methods to detect and delineate localized exceedance patterns within each water body were utilized to supplement and refine the regional analyses. The binomial hypothesis test and excursion criterion were applied to individual station data. Because there are insufficient data (< 28 samples) over a single annual period, to confidently estimate station level exceedance frequencies for most water quality variables, a longer period of record was necessary. Individual station assessments were based on the previous five years (WY1999 to WY2003), rather than on the single year used for regional analyses. Use of a five-year period provided sufficient data for most variables. No determination was made for any variable with less than 28 samples. If one or more monitoring stations were categorized at a higher level of concern than the region as a whole, then a localized exceedance was recorded. Localized exceedances were noted in the summary tables and discussed in greater detail.

Because the USEPA recommended that a 10-percent excursion frequency does not apply to pesticides, the pesticide evaluation method presented in this chapter is identical to the method used in previous ECRs. Pesticides were categorized based on the exceedance of Class III criteria or chronic toxicity values and detection (measurement > MDL) frequency (**Table 2A-1**).

Table 2A-1. Definitions of excursion categories for water quality constituents in the Everglades Protection Area. For conventional water quality constituents with at least 28 samples, frequencies were statistically tested using the binomial hypothesis test at the 90-percent confidence level.

Excursion Category	Conventional Water Quality Constituents	Pesticides
Concern	> 10% Excursion[1]	Class III criterion and/or toxicity levels exceeded
Potential Concern	> 5% and ≤ 10% Excursions[2]	> MDL[3]
Minimal Concern	≤ 5% Excursions	N/A
No Concern	No Excursions	≤ MDL

1. For sample sizes less than 28, an excursion frequency of greater than 20 percent was used to define the concern category.

2. For sample sizes less than 28, an excursion frequency of less than or equal to 20 percent was used to define the potential concern category.

3. MDL = Method Detection Limit

SUMMARY OF FINDINGS FROM PREVIOUS EVERGLADES CONSOLIDATED REPORTS

1999 TO 2002 EVERGLADES CONSOLIDATED REPORTS

Previous Everglades Consolidated Reports (ECRs) have demonstrated that, with few exceptions, water quality has been in compliance with existing state water quality criteria, though some excursions have been noted (Bechtel et al., 1999 and 2000; Weaver et al., 2001 and 2002). Reported excursions have generally been localized to specific areas of the Everglades Protection Area (EPA), with the exception of DO, which exhibited excursions in all areas. Furthermore, alkalinity, conductivity, iron, pH, and turbidity were identified as concerns for at least one EPA region in all previous ECRs. Additionally, the *1999 Everglades Interim Report* and *2000 Everglades Consolidated Report* identified total beryllium and un-ionized ammonia (NH_3) as concerns in localized areas of the EPA. However, the *2001 Everglades Consolidated Report* demonstrated that most of the reported beryllium excursions were due to the misapplication of the standard and therefore were not true excursions. Previous ECRs have also evaluated pesticide monitoring results and have identified atrazine, chloriphyros ethyl, endosulfan, ethion, parathion methyl, diazinon, dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethene (DDE), and dichlorodiphenyldichloroethane (DDD) as concerns in localized areas for various years during the period of record.

Each of the previous ECRs have delineated DO as a concern for the entire Everglades, with nearly all monitoring stations exhibiting excursions during each year. However, a majority of the DO excursions were the result of natural conditions and processes within the marsh and therefore do not necessarily constitute violations of state water quality standards. To more accurately characterize the natural DO regime within the marsh, a potential site-specific alternative criterion (SSAC), which used a mathematical model to describe the relationship between DO, time of day, and temperature to define a measurement methodology, was developed by the FDEP and was presented in the *2001 Everglades Consolidated Report*. Application of the present SSAC for DO resulted in a significant reduction in the number of interior marsh stations at which DO was designated as a concern.

WY2001 was hydrologically dominated by a persistent and severe drought. Based on known soil/water interactions associated with dry-down and rewetting, the drought probably influenced water quality conditions throughout the year and might be at least partly responsible for some of the observed changes in excursion frequencies (2002 ECR). The diminished rainfall altered water management practices, including distribution, timing, and quantity of water and resulted in dramatic reductions (from 32 to 64 percent) in surface water inflows to the Park and the WCAs. These alterations had the potential to change both the distribution of constituent loads at inflow structures and biogeochemical processes within the marsh, which in turn likely influenced the concentration of water quality constituents and excursion rates.

2003 EVERGLADES CONSOLIDATED REPORT

Chapter 2A of the *2003 Everglades Consolidated Report* provided an overview of the status of compliance with water quality criteria in the EPA for WY2002 (May 1, 2001 through April 30, 2002). The chapter built upon and provided an update to water quality analyses presented in previous ECRs. Comparison of the water quality data with applicable Class III water quality criteria identified excursions for seven variables during WY2002. These excursions were localized to specific areas of the EPA, with the exception of DO, which exhibited excursions in all regions. Alkalinity, conductivity, un-ionized NH_3, and total beryllium were classified as concerns for the Refuge interior, Refuge inflow, WCA-2 inflows, and WCA-3 inflows, respectively. Additionally, conductivity was classified as a potential concern for the WCA-2 interior. Fifteen pesticides were detected between December 2000 and November 2001. Of these pesticides, atrazine, diazinon, alpha- and beta-endosulfan, and simazine were classified as concerns. No other variables exceeded state water quality criteria during WY2002.

WATER YEAR 2003 RESULTS

WY2003 data for water quality variables with Class III numeric criteria are summarized by region and monitoring station in Appendix 2A-1 and Appendix 2A-2, respectively. Comparisons of WY2003 water quality data with applicable Class III water quality criteria resulted in excursions for seven identified water quality variables. These excursions were localized to specific areas of the EPA, with the exception of DO, which exhibited excursions in all regions. Alkalinity and conductivity were classified as concerns for the Refuge interior and the WCA-2 interior, respectively (**Table 2A-2**). Additionally, total iron and turbidity were initially classified as concerns within the Refuge rim canal based on WY2003 data only, although the minimum sample size of 28 was not met. Therefore, the excursion analyses were based on a longer, five-year period of record that identified both total iron and turbidity as minimal concerns in the Refuge rim canal. Conductivity and un-ionized NH_3 were classified as potential concerns for WCA-2 inflows (**Table 2A-2**). Conductivity, pH, alkalinity, and un-ionized NH_3 were categorized as minimal concerns for several EPA regions due to infrequent and localized excursions. Water quality variables that were classified as minimal concerns will not be discussed further in this chapter. Fifteen pesticides were detected between December 2001 and September 2002. Of these pesticides, atrazine, chlorpyrifos ethyl, and diazinon were classified as concerns. No other variables exceeded state water quality criteria during WY2003 and therefore are not discussed in this chapter.

Excursion frequencies and categories for variables with any recorded excursions in the last five water years (WY1999 through WY2003) are summarized for three time periods (WY1978 through WY2001, WY2002, and WY2003) to evaluate the presence of any temporal trends (**Table 2A-3**). Excursion categories for all periods are based on the methodology previously described in this chapter (**Table 2A-1**). Additionally, excursion frequencies and categories for individual monitoring stations are summarized in Appendix 2A-2. Excursion frequencies for WY2003 were generally within the range of the historical periods for most water quality variables. Notable differences between WY2003 and the two other periods include the following: increased DO excursions for Park inflows and interior stations and WCA-3 interior and outflow stations; decreased excursion frequencies for DO at Refuge inflows and outflows, WCA-2 inflows and outflows, and WCA-3 inflows; and an increased number of specific conductance excursions for WCA-2 interior stations. The overall differences identified between all of these periods are discussed in greater detail below.

Water quality variables categorized as concerns or potential concerns for WY2003 are also reviewed in greater detail below. The review includes 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 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 Everglades Protection Area for WY2003.[1]

Area	Class	Variable	Units	Class III Criteria	N	Mean	Std. Deviation	Min.	Max.	Excursion %±90% C.I.	Excursion Category
Refuge	Inflow	Dissolved Oxygen	mg/L	≥5	127	3.74	2.37	0.13	10.2	70.9 ± 6.6	C
		Specific Conductance	µmhos/cm	≤1275[2]	127	896	225	467	1511	6.3 ± 3.5	MC (C)
	Rim	Dissolved Oxygen	mg/L	≥5	34	3.84	1.72	1.26	9	76.5 ± 11.9	C
		Specific Conductance	µmhos/cm	≤1275[2]	34	825	207	558	1531	5.9 ± 16.6	MC (C)
		Total Iron	µg/L	≤1000	4[3]	850	724	246	1902	25 ± 35.5	C/MC[3]
		Turbidity	NTU	≤29[3]	12[5]	18.9	16.6	3.4	52.4	25 ± 20.5	C/MC[5]
	Interior	Alkalinity	mg/L	≥20	213	107	78	4.5	236	20.7 ± 4.6	C
		Dissolved Oxygen	mg/L	≥5	231	2.92	2.08	0.19	10.1	84.8 ± 3.9	C
		pH	Units	≥6.0, ≤8.5	231	6.92	0.39	5.91	7.7	1.3 ± 1.2	MC (C)
	Outflow	Dissolved Oxygen	mg/L	≥5	66	5.24	2.25	1.61	9.9	48.5 ± 10.1	C
WCA-2	Inflow	Alkalinity	mg/L	≥20	98	238	72	10.0	376	1.0 ± 1.7	MC
		Dissolved Oxygen	mg/L	≥5	139	5.06	2.05	0.64	9.9	52.5 ± 7.0	C
		Specific Conductance	µmhos/cm	≤1275[2]	140	1018	242	387	1515	11.4 ± 4.4	PC (C)
		Un-ionized Ammonia	mg/L	≤0.02	98	0.006	0.012	0.0001	0.059	10.2 ± 5.0	PC (C)
	Interior	Dissolved Oxygen	mg/L	≥5	275	3.00	1.96	0.20	8.8	82.5 ± 3.8	C
		Specific Conductance	µmhos/cm	≤1275[2]	278	1079	398	479	2857	20.9 ± 4.0	C
	Outflow	Dissolved Oxygen	mg/L	≥5	50	5.12	2.11	0.91	10.3	44 ± 11.5	C
		pH	Units	≥6.0, ≤8.5	57	7.47	0.32	6.87	8.6	1.8 ± 2.9	MC
		Specific Conductance	µmhos/cm	≤1275[2]	57	913	181	431	1317	1.8 ± 2.9	MC
WCA-3	Inflow	Dissolved Oxygen	mg/L	≥5	306	5.09	2.42	0.18	13.5	47.7 ± 4.7	C
		pH	Units	≥6.0, ≤8.5	318	7.48	0.37	6.72	8.8	1.6 ± 1.1	MC
		Specific Conductance	µmhos/cm	≤1275[2]	315	772	193	307	1317	0.6 ± 0.73	MC
		Un-ionized Ammonia	mg/L	≤0.02	194	0.002	0.003	0.0001	0.032	0.5 ± 0.9	MC
	Interior	Dissolved Oxygen	mg/L	≥5	319	2.80	1.89	0.19	8.8	87.1 ± 3.1	C
	Outflow	Dissolved Oxygen	mg/L	≥5	194	3.37	1.64	0.40	8.4	83 ± 4.4	C
Park	Inflow	Dissolved Oxygen	mg/L	≥5	280	3.45	1.96	0.17	8.9	80 ± 3.9	C
	Interior	Dissolved Oxygen	mg/L	≥5	71	5.21	2.01	0.95	9.3	53.5 ± 9.7	C
		pH	Units	≥6.0, ≤8.5	80	7.57	0.30	6.74	8.53	1.3 ± 2.0	MC

1. Only water quality variables with excursions in the given region and class are listed. Excursion categories of concern, potential concern, and minimal concern are denoted by “C,” “PC,” and “MC,” respectively. Excursion categories with parentheses indicate a localized exceedance rate greater then regional (Area and Class) classification; that is, one or more stations exhibited higher exceedance rates between WY1999 and WY2003 than the WY2003 regional aggregate.

2. Specific conductance shall not be increased 50% above background or 1,275 µmhos/cm, whichever is greater.

3. Insufficient sample size to apply binomial hypothesis test to WY2003 data alone; analysis should be based on a longer period of record. For WY1999–WY2003, there was 1 exceedance out of 96 samples (Minimal Concern). Exceedance rates were not significantly different among the years at the 90% confidence level.

4. Turbidity ≤ 29 NTU is above natural background conditions.

5. Insufficient sample size to apply binomial hypothesis test to WY2003 data only; analysis should be based on a longer period of record. For WY1999–WY2003, there were 8 exceedances out of 128 samples (Minimal Concern). Exceedance rates were not significantly different among the years at the 90% confidence level.

Table 2A-3. Summary of excursions from Class III criteria in the Everglades Protection Area for WY2003, WY2002, and historical data (WY1978 through WY2001).

Region	Class	Variable	WY1978–WY2001		WY2002		WY2003	
			Number of Excursions	Percent Excursions (category)	Number of Excursions	Percent Excursions (category)	Number of Excursions	Percent Excursions (category)
Refuge	Inflow	Dissolved Oxygen	1746 (2330)	74.9 (C)	117 (143)	81.8 (C)	90 (127)	70.9 (C)
		pH	13 (2316)	0.6 (MC)	0 (143)	0 (NC)	0 (127)	0 (NC)
		Specific Conductance	607 (2329)	26.1 (C)	9 (143)	6.3 (MC)	8 (127)	6.3 (MC)
		Total Beryllium	2 (2)	100 (C)	--	--	--	--
		Total Iron	20 (516)	3.9 (MC)	0 (8)	0 (NC*)	0 (6)	0 (NC*)
		Total Silver	3 (35)	8.6 (MC)	--	--	--	--
		Turbidity	61 (1902)	3.2 (MC)	1 (84)	1.2 (MC)	0 (73)	0 (NC)
		Un-ionized Ammonia	39 (1935)	2 (MC)	0 (84)	0 (NC)	0 (73)	0 (NC)
	Rim	Dissolved Oxygen	477 (655)	72.8 (C)	36 (46)	78.3 (C)	26 (34)	76.5 (C)
		pH	3 (657)	0.5 (MC)	0 (44)	0 (NC)	0 (34)	0 (NC)
		Specific Conductance	100 (660)	15.2 (C)	3 (46)	6.5 (MC)	2 (34)	5.9 (MC)
		Total Beryllium	1 (2)	50 (C)	--	--	--	--
		Total Iron	3 (304)	1 (MC)	0 (7)	0 (NC*)	1 (4)	25 (C*/MC)
		Turbidity	11 (394)	2.8 (MC)	0 (20)	0 (NC*)	3 (12)	25 (C*/MC)
		Un-ionized Ammonia	3 (593)	0.5 (MC)	0 (32)	0 (NC)	0 (32)	0 (NC)
	Interior	Alkalinity	448 (1723)	26 (C)	34 (187)	18.2 (C)	44 (213)	20.7 (C)
		Dissolved Oxygen	1218 (1571)	77.5 (C)	201 (235)	85.5 (C)	196 (231)	84.8 (C)
		pH	205 (1736)	11.8 (C)	10 (226)	4.4 (MC)	3 (231)	1.3 (MC)
		Specific Conductance	9 (1642)	0.5 (MC)	0 (235)	0 (NC)	0 (231)	0 (NC)
		Total Copper	3 (283)	1.1 (MC)	--	--	--	--
		Un-ionized Ammonia	2 (1318)	0.2 (MC)	1 (129)	0.8 (MC)	0 (203)	0 (NC)
	Outflow	Dissolved Oxygen	745 (1112)	67 (C)	44 (66)	66.7 (C)	32 (66)	48.5 (C)
		pH	3 (1092)	0.3 (MC)	0 (65)	0 (NC)	0 (66)	0 (NC)
		Specific Conductance	152 (1115)	13.6 (C)	0 (65)	0 (NC)	0 (66)	0 (NC)
		Turbidity	10 (1080)	0.9 (MC)	1 (66)	1.5 (MC)	0 (64)	0 (NC)
		Un-ionized Ammonia	12 (1063)	1.1 (MC)	0 (65)	0 (NC)	0 (66)	0 (NC)
WCA-2	Inflow	Alkalinity	0 (1453)	0 (NC)	0 (102)	0 (NC)	1 (98)	1 (MC)
		Dissolved Oxygen	1033 (1445)	71.5 (C)	85 (134)	63.4 (C)	73 (139)	52.5 (C)
		pH	6 (1424)	0.4 (MC)	0 (134)	0 (NC)	0 (140)	0 (NC)
		Specific Conductance	224 (1449)	15.5 (C)	34 (134)	25.4 (C)	16 (140)	11.4 (PC)
		Turbidity	13 (1212)	1.1 (MC)	2 (76)	2.6 (MC)	0 (77)	0 (NC)
		Un-ionized Ammonia	32 (1345)	2.4 (MC)	19 (98)	19.4 (C)	10 (98)	10.2 (PC)
	Interior	Alkalinity	2 (3730)	0.1 (MC)	0 (237)	0 (NC)	0 (257)	0 (NC)
		Dissolved Oxygen	2491 (3105)	80.2 (C)	217 (269)	80.7 (C)	227 (275)	82.5 (C)
		pH	20 (3293)	0.6 (MC)	1 (249)	0.4 (MC)	0 (278)	0 (NC)
		Specific Conductance	281 (3216)	8.7 (PC)	29 (270)	10.7 (PC)	58 (278)	20.9 (C)
		Un-ionized Ammonia	12 (2769)	0.4 (MC)	0 (143)	0 (NC)	0 (255)	0 (NC)
	Outflow	Dissolved Oxygen	914 (1382)	66.1 (C)	35 (65)	53.8 (C)	22 (50)	44 (C)
		pH	6 (1365)	0.4 (MC)	0 (66)	0 (NC)	1 (57)	1.8 (MC)
		Specific Conductance	26 (1382)	1.9 (MC)	0 (61)	0 (NC)	1 (57)	1.8 (MC)
		Un-ionized Ammonia	6 (1350)	0.4 (MC)	0 (66)	0 (NC)	0 (57)	0 (NC)

Table 2A-3. Continued.

Region	Class	Variable	WY1978–WY2001 Number of Excursions	WY1978–WY2001 Percent Excursions (category)	WY2002 Number of Excursions	WY2002 Percent Excursions (category)	WY2003 Number of Excursions	WY2003 Percent Excursions (category)
WCA-3	Inflow	Dissolved Oxygen	2955 (4198)	70.4 (C)	180 (275)	65.5 (C)	146 (306)	47.7 (C)
		pH	28 (4162)	0.7 (MC)	2 (280)	0.7 (MC)	5 (318)	1.6 (MC)
		Specific Conductance	64 (4224)	1.5 (MC)	0 (269)	0 (NC)	2 (315)	0.6 (MC)
		Total Beryllium	1 (16)	6.3 (MC)	3 (3)	100 (C)	0 (3)	0 (NC)
		Total Iron	8 (848)	0.9 (MC)	0 (42)	0 (NC)	0 (41)	0 (NC)
		Turbidity	55 (3718)	1.5 (MC)	0 (176)	0 (NC)	0 (156)	0 (NC)
		Un-ionized Ammonia	9 (3712)	0.2 (MC)	0 (205)	0 (NC)	1 (194)	0.5 (MC)
	Interior	Alkalinity	4 (1650)	0.2 (MC)	0 (224)	0 (NC)	0 (291)	0 (NC)
		Dissolved Oxygen	1087 (1370)	79.3 (C)	232 (274)	84.7 (C)	278 (319)	87.1 (C)
	Outflow	Dissolved Oxygen	2702 (3678)	73.5 (C)	166 (212)	78.3 (C)	161 (194)	83 (C)
		pH	41 (3632)	1.1 (MC)	3 (214)	1.4 (MC)	0 (195)	0 (NC)
		Turbidity	0 (2826)	0 (NC)	3 (164)	1.8 (MC)	0 (163)	0 (NC)
		Un-ionized Ammonia	6 (2758)	0.2 (MC)	0 (162)	0 (NC)	0 (156)	0 (NC)
Park	Inflow	Dissolved Oxygen	2962 (4195)	70.6 (C)	211 (293)	72 (C)	224 (280)	80 (C)
		pH	51 (4160)	1.2 (MC)	3 (297)	1 (MC)	0 (280)	0 (NC)
		Total Lead	4 (1182)	0.3 (MC)	--	--	--	--
		Turbidity	0 (3256)	0 (NC)	3 (177)	1.7 (MC)	0 (178)	0 (NC)
		Un-ionized Ammonia	20 (3194)	0.6 (MC)	0 (184)	0 (NC)	0 (172)	0 (NC)
	Interior	Dissolved Oxygen	635 (1370)	46.4 (C)	53 (113)	46.9 (C)	38 (71)	53.5 (C)
		pH	20 (1241)	1.6 (MC)	1 (119)	0.8 (MC)	1 (80)	1.3 (MC)
		Total Copper	6 (1239)	0.5 (MC)	--	--	--	--
		Total Iron	113 (1300)	8.7 (PC)	--	--	--	--
		Total Lead	5 (1261)	0.4 (MC)	--	--	--	--
		Un-ionized Ammonia	21 (1180)	1.8 (MC)	0 (115)	0 (NC)	0 (79)	0 (NC)

Note: For the "Number of Excursions" columns, the number in front of the parentheses specifies the number of excursions, while the number inside the parentheses specifies the number of samples collected. Excursion categories of concern, potential concern, and minimal concern are denoted by "C," "PC," and "MC," respectively, and are provided within parentheses in the "Percent Excursions" columns. An asterisk (*) associated with an excursion category indicates an insufficient sample size (< 28) to confidently characterize the excursion frequency; categorization is preliminary, and further evaluation is required.

DISSOLVED OXYGEN

Oxygen gas dissolved in water is vital to the existence of most aquatic organisms. Oxygen is a key component in cellular respiration for both aquatic and terrestrial life. The concentration of DO in an aquatic environment is an important indicator of that environment's quality. Due to oxygen's importance to life, it is essential to understand the processes that influence DO concentrations in the Everglades. In any aquatic system, water column DO concentrations are regulated by a variety of sources and sinks. In healthy systems, these controlling factors are balanced. In the Everglades open-water slough communities, where light penetration is high, high photosynthetic rates by periphyton and submerged aquatic vegetation (P/SAV) result in increasing oxygen concentrations during daylight hours (Belanger and Platko, 1986; McCormick et al., 1997). At night, respiration and sediment oxygen demand (SOD) reduce oxygen concentrations. Under natural conditions, oxygen production exceeds respiration during the photoperiod, allowing the accumulation of an oxygen reserve, which prevents concentrations from decreasing to extremely low levels at night (< 1.0 to 2.0 mg/L). Cultural eutrophication results in increased productivity in the system and an increased accumulation of organic matter in the sediments. The breakdown of this organic matter increases the SOD, which results in oxygen declines throughout the diel cycle. Additionally, nutrient enrichment in the Everglades dramatically reduces the native P/SAV community and increases emergent aquatic vegetation coverage (Rutchey and Vilchek, 1994; McCormick et al., 1998; Payne et al., 1999, 2000, and 2001b). Emergent aquatic vegetation contributes little oxygen to the water column while also shading P/SAV and resulting in further reductions in DO production.

Similar to previous water years, DO was classified as a concern for all EPA regions and classes during WY2003. Overall, 72 percent of the 2,092 DO measurements collected during WY2003 were below the existing Class III criterion of 5.0 mg/L. The frequency of DO measurements that were below 5.0 mg/L ranged from 44 to 87 percent among the EPA regions. Although the overall excursion frequency for the EPA was similar to previous periods, the differences for specific regions and classes were noted. DO excursion frequencies increased from 6.6 to 9.4 percent at Park inflow and interior stations and from 2.5 to 9.5 percent at WCA-3 interior and outflow stations, compared to either of the previous periods (WY2002 or WY1978 through WY2001). Excursion frequencies were lower (ranging from 4 to 23 percent) at Refuge inflows and outflows, WCA-2 inflows and outflows, and WCA-3 inflows than in either of the previous periods.

As discussed above, it is widely accepted that DO concentrations are normally low (i.e., naturally less than 5.0 mg/L) in periphyton-dominated marsh environments, such as the Everglades, due to the 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 FDEP does not consider these excursions as violations of the DO standard. Therefore, the current Class III criterion of 5.0 mg/L is not considered to be appropriate for the Everglades.

To formally recognize the natural background conditions in the EPA marshes, the FDEP has developed a DO SSAC that was presented in the *2001 Everglades Consolidated Report* (Weaver 2000; Weaver et al., 2001). The SSAC uses a mathematical model to define a DO threshold based on sample collection time and water column temperature. Furthermore, Weaver (2000) provided a DO SSAC measurement methodology in development based on an annual average concentration. It was suggested that the annual average DO at an individual station should be maintained above the annual limit that is calculated from the DO SSAC mathematical model. It was also argued that a one-year period would provide a characterization of the DO regime at a site and account for the infrequent occurrence of naturally low values. The DO SSAC model and measurement methodology have been proposed for adoption this year. Continuing efforts to formally adopt an Everglades DO SSAC require public notice and hearing and final approval by the secretary of the FDEP.

To further evaluate the DO concentrations measured during WY2003, the SSAC was applied to WY2000 DO data from the interior, rim canal, inflow, and outflow stations in the EPA. The DO SSAC allows a more accurate differentiation between impacted and natural background conditions relative to DO and provides more realistic information on ecosystem status than that obtained from applying the existing Class III criterion. Although the SSAC was developed for open-water marsh stations, water discharging to the Everglades should meet the SSAC 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. Applying the SSAC to the WY2003 data resulted in a substantially lower excursion rate than the analysis based on the current Class

III criterion of 5.0 mg/L. The application of the SSAC indicates that 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.

Table 2A-4. Comparison between the number of stations categorized as concerns using the current Class III criterion and the proposed DO SSAC for WY2003.

Region	Class	Number of Stations	Class III Criterion	SSAC
			Percent of Stations (Number)	Percent of Stations (Number)
Refuge	Inflow	4	100 (4)	0 (0)
	Interior	23	100 (23)	26 (6)
	Rim	3	100 (3)	0 (0)
	Outflow	6	100 (6)	0 (0)
WCA-2	Inflow	8	100 (8)	0 (0)
	Interior	18	100 (18)	44 (8)
	Outflow	5	100 (5)	0 (0)
WCA-3	Inflow	17	94 (16)	0 (0)
	Interior	23	100 (23)	48 (11)
	Outflow	11	100 (11)	0 (0)
Park	Inflow	11	100 (11)	9 (1)
	Interior	9	67 (6)	0 (0)

Stations that failed to meet the SSAC were generally influenced either by altered hydrogeomorphic conditions caused by the construction of the canals and operation of the water control structures or by nutrient enrichment. Similar to the results reported in the 2001, 2002, and 2003 Everglades Consolidated Reports (Weaver et al., 2001, 2002, and 2003), several of the water control structures (inflow and outflow sites) failed the SSAC test during WY2003. This pattern of non-compliance is likely due to a combination of factors, including the disturbance of bottom sediments, intrusion of low DO groundwater into the surface water at these structures, and effects of nutrient enrichment. 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). Groundwater intrusion is common at the Everglades pumping stations and canals dug below the water table. The influence of groundwater on DO at these structures represents a potentially "human-induced condition, which cannot be controlled or abated" and should be addressed separately. The second group of stations failing the SSAC is the interior marsh stations known to be biologically impaired as a result of phosphorus (P) enrichment (E1, F1, Z1, and 3AW05). Conditions at these stations are expected to remain impaired until P concentrations in the surface water and sediment are reduced and the biological communities recover.

ALKALINITY AND pH

Alkalinity is a measure of water's acid neutralization capacity and provides a measure of the water's buffering capacity. In most surface water bodies, the buffering capacity is primarily the result of the equilibrium between carbon dioxide and bicarbonate and carbonate ions (CO_2,

HCO_3^-, and 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 and calcite) contributes to water's buffering capacity. Therefore, in certain areas (such as the Park, WCA-2, and WCA-3) that are influenced by canal inflows primarily composed of mineral-rich agricultural runoff and groundwater, alkalinity levels are relatively high. Conversely, other areas, such as the interior of the Refuge, which receive most of their 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, 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 this parameter shall not be lowered below 20 mg of calcium carbonate per liter ($CaCO_3$/L).

The pH value is defined as the negative $\log_{(\text{base } 10)}$ of the hydrogen (H^+) ion 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 a pH of 3.0 is 10 times more acidic than one at a pH of 4.0. 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. For instance, most fish fail to spawn if conditions are below a pH of 5.0, and many species die if conditions are below a pH of 4.0. Amphibians also 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, and iron). The current Class III criterion for pH specifies that this parameter 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 CO_2 in the water. When CO_2 enters fresh water, small amounts of carbonic acid are formed, which then dissociate into H^+ and CO_3^{2-} ions, thereby 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 rises. The addition of CO_2 by respiration at night reverses the reactions and lowers pH. In poorly buffered systems (low alkalinity), the daily changes in pH can be dramatic.

Given the close relationship between alkalinity and pH, these two variables are evaluated together in this section. Violations of state Class III water quality criteria for both variables have historically occurred in the interior of the Refuge (Bechtel et al., 1999 and 2000; Weaver et al., 2001, 2002 and 2003). As in previous years, alkalinity is designated as a concern for the interior of the Refuge for WY2003 due to an excursion rate of 20.7 percent. As stated above, the low alkalinity values in the Refuge are primarily attributed to hydrology. Although pH was not identified as either a concern or potential concern for any area based on regional assessments, localized high exceedance rates (12 to 51 percent) were recorded at several interior Refuge stations for the five-year period from WY1999 through WY2003. This resulted in pH being classified as a concern for stations LOX5, LOX8, LOX11, and LOX13 and classified as a potential concern for stations LOX9 and LOX16.

The low alkalinities and pH values in the Refuge are primarily caused by the hydrologic nature of the area. Most of the water entering the Refuge (approximately 54 percent) is low-alkalinity rainwater (SFWMD, 1992). Along the western periphery of the Refuge, harder canal waters 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 the 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), as shown on **Figure 2A-6**.

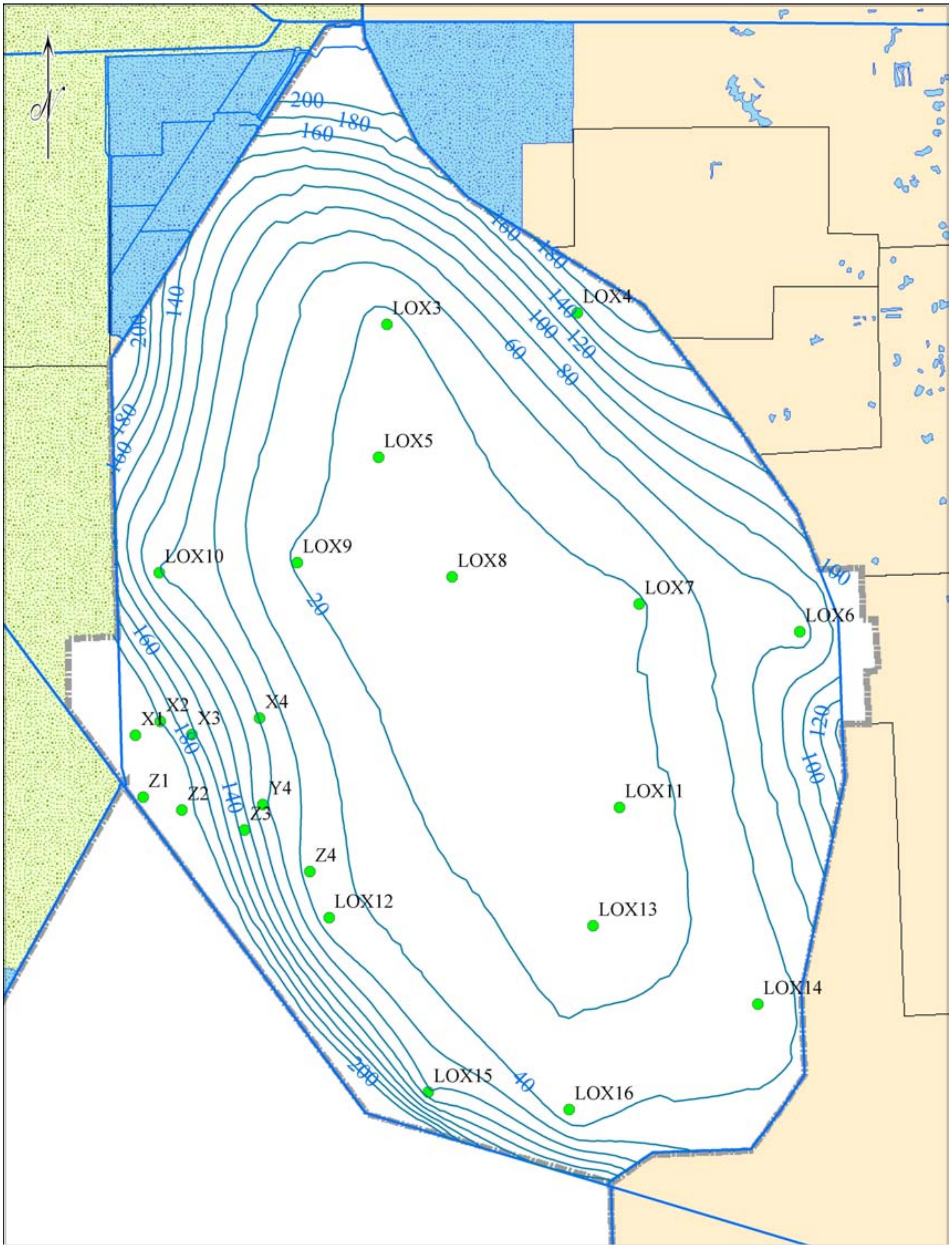


Figure 2A-6. Alkalinity concentration (mg/L) contours within the Arthur R. Marshall Loxahatchee National Wildlife Refuge. Values are expressed as the median for data collected at the rim canal, inflow, and interior marsh stations over the past five water years (WY1999–WY2003).

Alkalinity within the Refuge decreases with distance from the rim canal (Payne et al., 2000; Weaver et al., 2001). In fact, stations in the central region of the Refuge have the lowest alkalinity levels, with median concentrations at or below the state criterion of 20 mg $CaCO_3$/L. Therefore, alkalinity excursions within the Refuge are not a result of a controlled discharge or pollution source but are due to the natural soft-water, rainfall-driven nature of the system. The low alkalinity values represent the normal background conditions typical of this ecosystem; therefore, the FDEP does not consider these low values in the interior of the Refuge to be in violation of state water quality standards.

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. All recent excursions (WY1999 through WY2003) from the pH criterion have occurred at alkalinities below 40 mg $CaCO_3$/L, which is consistent with patterns noted for previous periods (Weaver et al., 2001). Additionally, the greatest variability in pH has occurred at alkalinities of less than 100 mg $CaCO_3$/L (**Figure 2A-7**). Such fluctuations in pH at low alkalinities 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 FDEP does not consider pH levels within the interior of the Refuge to be in violation of state water quality standards.

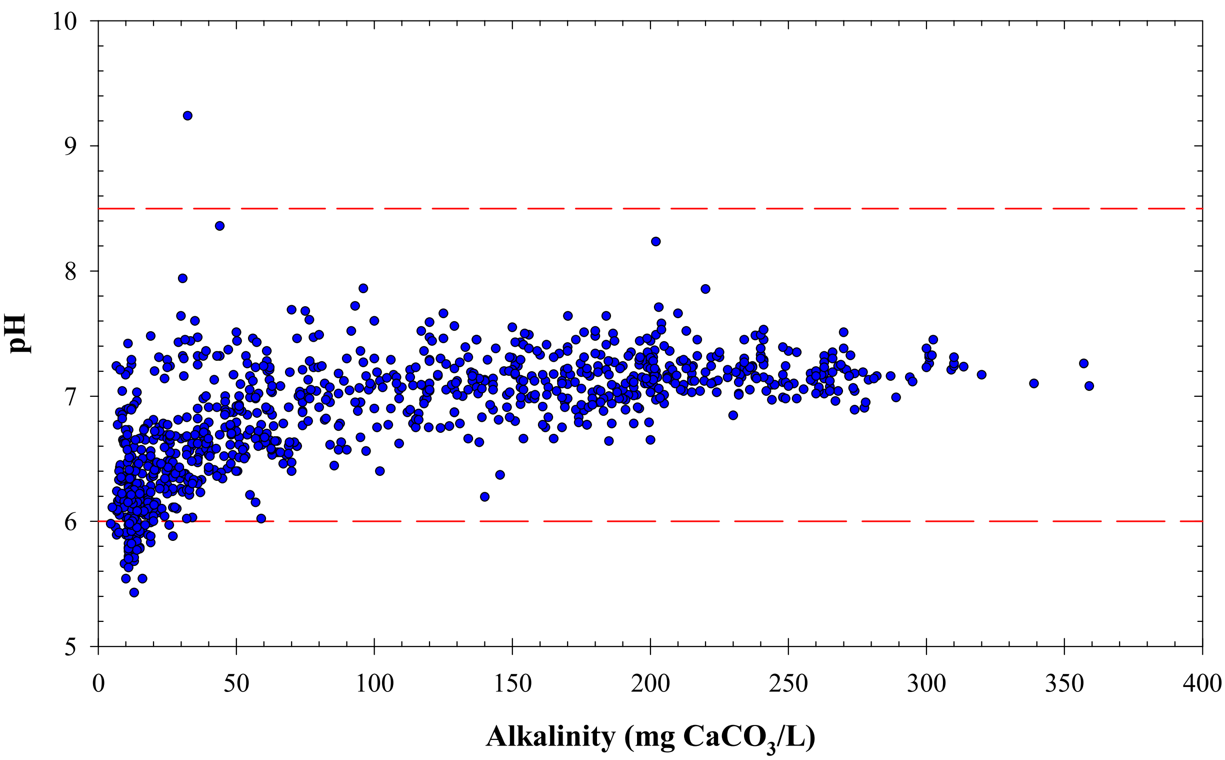


Figure 2A-7. Relationship between pH values and alkalinity within the interior marsh of the Arthur R. Marshall Loxahatchee National Wildlife Refuge from WY1999 through WY2003. Dashed horizontal lines show the lower (6.0) and upper (8.5) Class III pH criteria.

SPECIFIC CONDUCTANCE

Specific conductance (conductivity) is a measure of water's ability to conduct an electrical current and is an indirect measure of the total concentration of ionized substances (e.g., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, HCO_3^{-}, and SO_4^{2-}) in the water. Conductivity will vary with the number and type of these ions in solution. In some cases, it can be used to differentiate among various water sources, such as groundwater, rainwater, agricultural runoff, and 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 saltwater intrusion. The current state water quality criteria for Class III freshwaters, which allows for a 50-percent increase in the specific conductance or 1,275 microhms per centimeter (µmhos/cm), whichever is greater, is meant to preserve natural background conditions and protect aquatic organisms from stressful ion concentrations. Since background conductivities are low within the EPA, excursions were calculated using the 1,275 µmhos/cm criterion (Weaver et al., 2001 and 2002).

For WY2003, conductivity was categorized as a concern and a potential concern for the WCA-2 interior and inflow stations, respectively. Additionally, localized higher exceedance rates were observed at Refuge inflow station G-251 (13.1 percent; concern), Refuge rim canal station S-5AD (19.0 percent; concern), and WCA-2 inflow G-335 (44.4 percent; concern). As in previous years, many of the conductivity excursions during WY2003 occurred either at water control structures (28) or interior stations (27) located in close proximity to canal inflows. Previous ECRs explained that the elevated conductivity levels at water control structures and stations near canal inflows were probably linked to groundwater intrusion into canal surface waters (Weaver et al., 2001 and 2002). This groundwater intrusion can occur due to seepage into canals, via pumping station operation (which can pull additional groundwater into the surface water), and as a result of agricultural dewatering practices. The FDEP intends to continue its evaluation of conductivity in the EPA and Everglades Agricultural Area (EAA) canals.

Unlike previous periods, a large number of exceedances (31) also occurred at interior stations in WCA-2 distant from inflows (F2, F3, F4, F5, CA215, and CA29). WY2003 exceedances within the interior of WCA-2 were first recorded on October 21, 2002 at station F1 and were expanded to other stations through the end of the water year. During WY2003, the specific conductivity levels recorded at several of these stations, particularly F1, were well above the previous recorded values (**Figure 2A-8**). The source of these elevated values is uncertain but does not appear to be directly attributable to marsh inflows. There was no recorded flow at the upstream inflow structures (S-10A, S-10C, and S-10D) for two months prior to the initial excursion (October 21, 2002) at F1. Discharge occurred through the S-10A structure between January 7, 2003 and February 18, 2003, which approximately corresponds to the period when excursions were first observed at the more interior stations. However, even during these flow events, discharges through upstream structures were probably not the source of elevated marsh conductivities. Measured conductivities at all upstream inflow stations (S-10A, S-10C, S-10D, E0, and F0) were well below the interior levels (ranging from 369 to 1,175 µmhos/cm). The elevated conductivities appear to be related to a marsh phenomenon. Given that these exceedances occurred late in the dry season, they may be related to the concentration of ions associated with the evaporation of marsh water. Low water conditions in WCA-2 may have also allowed groundwater seepage in the vicinity of site F1, which subsequently traveled or expanded down the F transect (F1 to F5). Recent studies south of the S-10 structures support the hypothesis that groundwater seepage occurs during dry periods (Krest and Harvey, 2003).

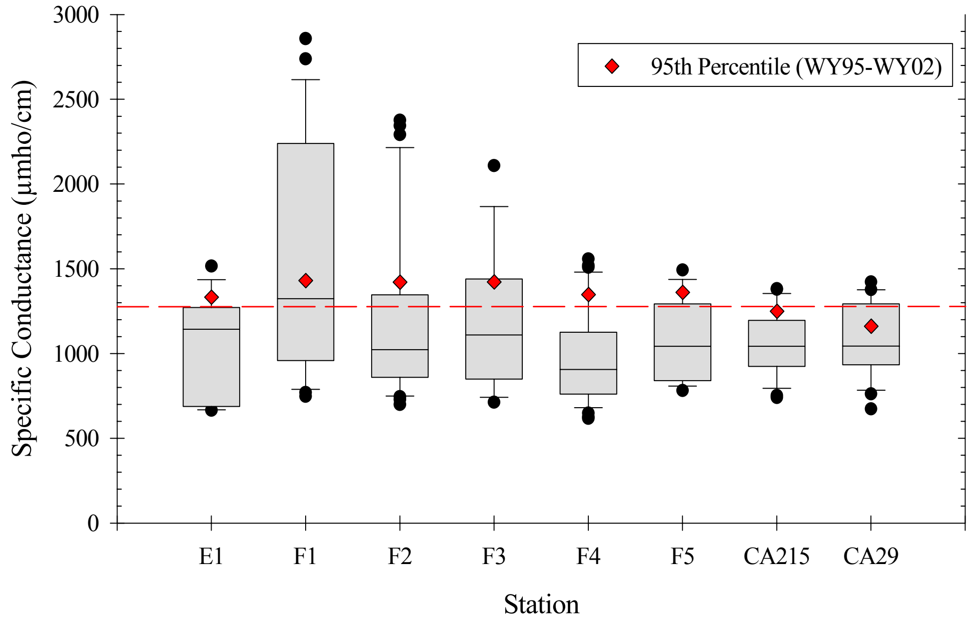


Figure 2A-8. Boxplot of WY2003 and 95th percentile for all prior specific conductance results at WCA-2 interior marsh stations with WY2003 excursions. Boxplots summarize WY2003 results. Whiskers indicate 10th and 90th percentiles. The 25th and 75th percentiles are shown by the bottom and top of each box, respectively. Station medians are shown as solid horizontal lines through each box. Black circles indicate WY2003 results beyond the 10th or 90th percentile. Red diamond symbols indicate the 95th percentile for all previous water years (WY1995–WY2002) and provide a measure of site-specific background conditions. The horizontal red dashed line depicts 1,275 µmhos/cm.

UN-IONIZED AMMONIA

Ammonia (NH_3) 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 of low temperature and pH, NH_3 undergoes hydrolysis to produce ammonium (NH_4^+) and hydroxide (OH^-) ions. The NH_4 ions produced during this reaction are not toxic to aquatic life. However, the hydrolysis is not as complete, and increasing amounts of un-ionized NH_3 remain at high pH levels. For example, in freshwater at 25°C, an increase in pH from 7.0 to 8.0 results in an increase in the percent of NH_3 in the un-ionized form from 0.5 to 5.4 percent. At a pH of 9.0, more than one-third (36 percent) of the total dissolved NH_3 (i.e., the concentration of NH_3 measured in the water column) is un-ionized. The resulting un-ionized NH_3 is able to diffuse across cell membranes more readily and is acutely toxic to aquatic life.

NH_3 is unique among regulated water quality constituents, because it is both a source of nitrogen (a nutrient required for life) and an endogenously produced toxicant for which organisms have developed a variety of strategies to excrete as a waste product. Toxicity levels of NH_3 are highly variable, because they are affected by temperature, pH, DO concentrations, CO_2 concentrations, previous acclimation to NH_3, and the presence of other toxic compounds.

Increases in both pH and temperature lead to increased levels of un-ionized NH_3. High external, un-ionized NH_3 concentrations reduce or reverse diffusion gradients used by organisms to excrete excess NH_3. This excess NH_3 can accumulate in the organism, resulting in altered metabolism, loss of equilibrium, hyperexcitability, increased respiratory activity and oxygen uptake, and increased heart rate. Even slightly elevated concentrations of NH_3 have been associated with a reduction in hatching success in some animals, a reduction in growth rate and morphological development in others, and injuries to gill tissue, liver, and kidneys. In fish, extremely high levels of NH_3 can result in convulsions, coma, and even death.

The current state Class III water quality criterion for un-ionized NH_3 is ≤ 0.02 mg/L. This value is derived from pH, temperature, and total dissolved NH_3 measurements from the same sample. During WY2003, 10 values that were calculated above this criterion were recorded. Based on the aggregated regional analysis, un-ionized NH_3 was categorized as a potential concern for WCA-2 inflows, which were localized at stations E0 and F0. Furthermore, based on an analysis of WY1999 through WY2003 data, un-ionized NH_3 was categorized as a concern for E0 and F0.

The localization of un-ionized NH_3 excursions at E0 and F0 continues a pattern that was initially noted in the *2003 Everglades Consolidated Report*. Stations E0 and F0 are located within the WCA-2A spreader canal, which receives Hillsboro canal discharges from the S-10A, S-10C, and S-10D structures and, in turn, flows over into the marsh when canal stages exceed the height of a low berm. A review of hydrologic and water quality monitoring records suggests that the high level of un-ionized NH_3 excursion at sites E0 and F0 were likely related to the stagnant, low-water conditions in the spreader canal during WY2002 and WY2003. The spreader canal can become stagnant and anaerobic during periods of no or low flow, such as when the S-10A, S-10C, and S-10D structures are closed, resulting in substantial changes in biogeochemical conditions and constituent concentrations within the canal. Flow records indicate that discharges via the S-10A, S-10C, and S-10D structures were limited during WY2002 and WY2003, with no flow during the un-ionized NH_3 excursion episodes (**Figure 2A-9**).

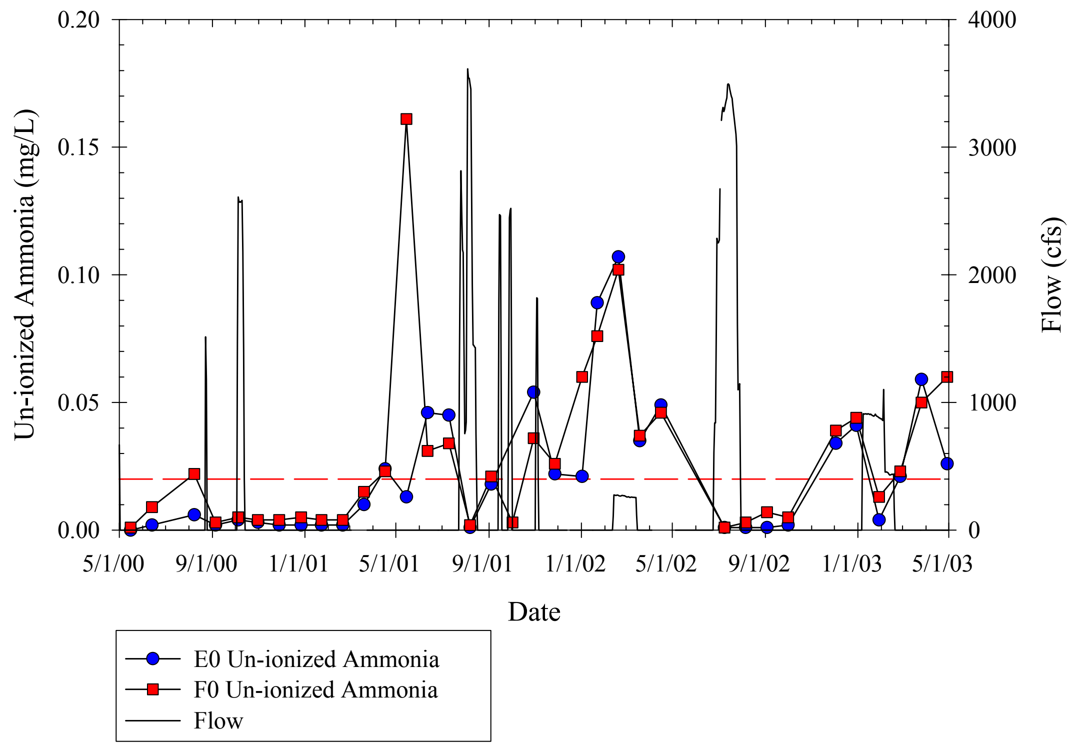
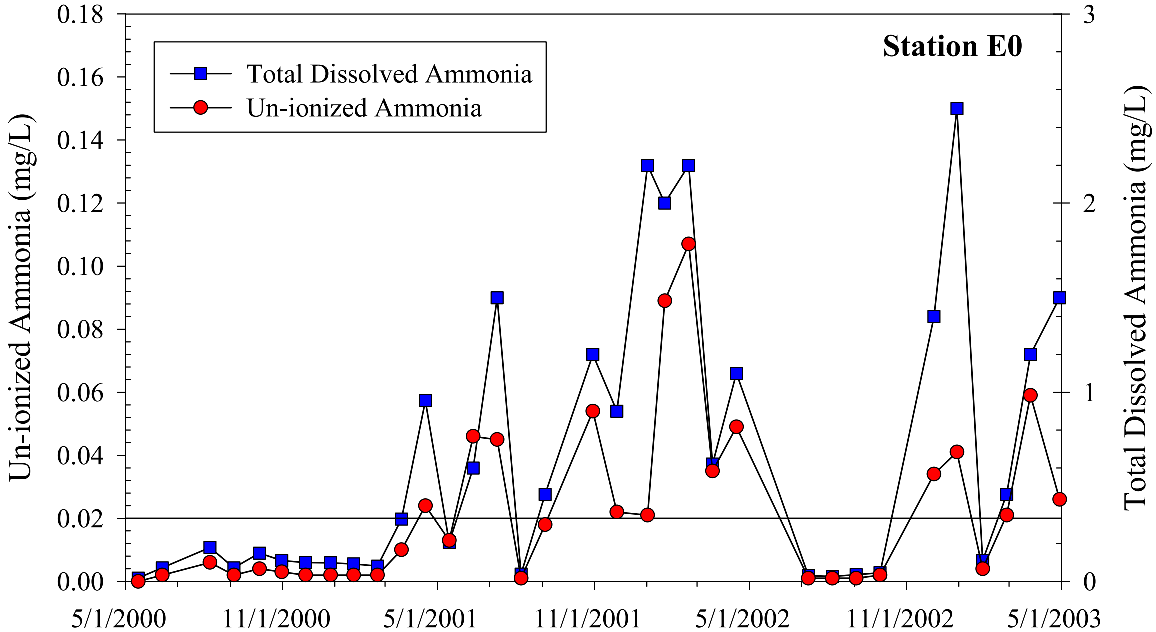


Figure 2A-9. Total average daily inflow volume through the S-10A, S-10C, and S-10D structures, and calculated un-ionized ammonia concentrations for sites E0 and F0 from WY2001 through WY2003. Horizontal red dashed line is the Class III un-ionized ammonia criterion (0.02 mg/L).

The elevated total dissolved ammonia concentrations measured in the canal likely arose from internal nitrogen cycling. Nutrient-enriched surface water within the spreader canal can support substantial growth of algae that accumulate when the canal is stagnant and is not being flushed by incoming water from the Hillsborough canal. When the accelerated growth of algae can no longer be supported, then the algae die, fall to the bottom, and decay, resulting in the release of ammonia under anaerobic conditions. Because DO is more quickly depleted in the overlying water, stagnant water conditions promote anaerobic conditions within the sediments.

Elevated total dissolved NH_3 levels were the proximal cause of the E0 and F0 un-ionized NH_3 excursions (**Figure 2A-10**), which is expected if the cause were related to the release of NH_3 caused by low-flow or stagnant conditions, as described above. For WY2003, the median total dissolved NH_3 concentrations at sites E0 and F0 were 0.29 and 0.49 mg/L, respectively. During the entire monitoring record at these two stations from WY1994 through WY2003, elevated total dissolved NH_3 concentrations were the proximal cause of all 51 un-ionized NH_3 excursions within the WCA-2 spreader canal. The significant influence of total dissolved NH_3 concentrations on WCA-2 spreader canal un-ionized NH_3 excursions is dissimilar from most excursions in other areas, which have been attributed primarily to high pH values (Bechtel et al., 1999 and 2000;

Weaver et al., 2001 and 2002). This phenomenon of periodically elevated total dissolved NH_3 concentrations is apparently isolated to the spreader canal and has not contributed to excursions in the marsh adjacent to the spreader canal. From WY1994 through WY2003, the total dissolved NH_3 concentrations at the marsh transect stations E1 and F1 (1.8 to 2.2 km) downstream of the spreader canal have been significantly lower (Kruskal-Wallis; $p < 0.0001$; median = 0.041-0.057 mg/L) than concentrations observed at stations E0 or F0 (median = 0.23-0.37 mg/L). The FDEP and SFWMD will continue to evaluate NH_3 in this area to better define the nature and causes of these excursions. It is anticipated that the results of these evaluations will be provided in future Everglades Consolidated Reports.



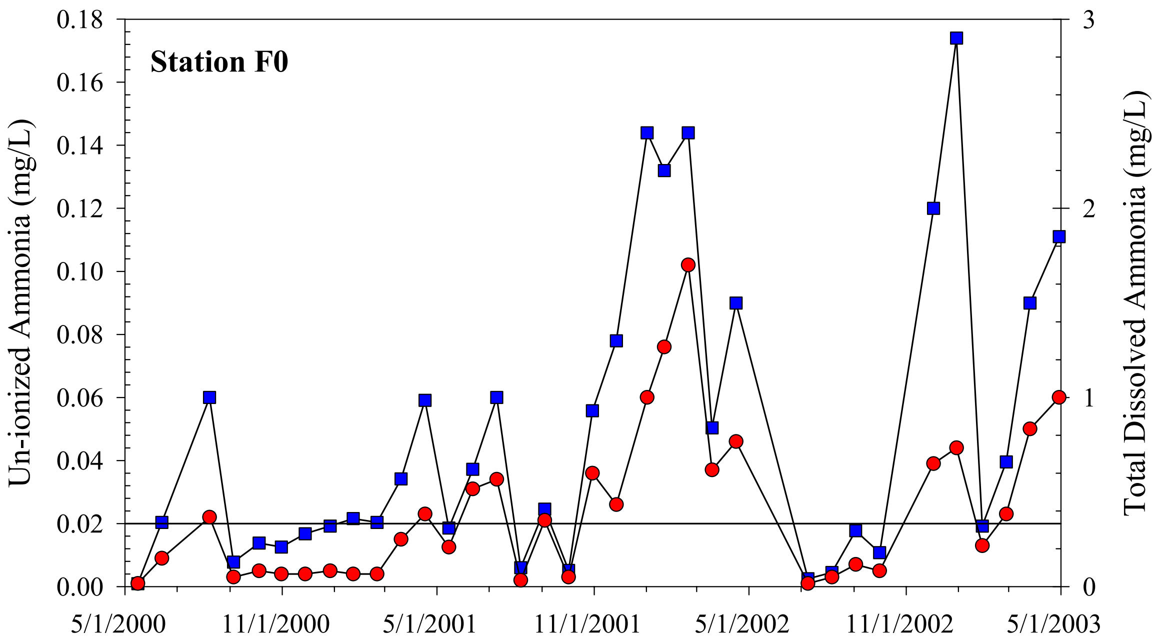


Figure 2A-10. Dissolved ammonia concentrations and calculated un-ionized ammonia values for sites E0 (top) and F0 (bottom) during WY2001 through WY2003. Horizontal solid black line is the Class III un-ionized ammonia criterion (mg/L).

SULFATE

Currently, the state has no surface water criterion for sulfate (SO_4^{2-}); however, recent research has provided evidence of a link between sulfur biogeochemistry in sediment and pore water and mercury methylation, as reported in previous ECRs (Atkeson and Parks, 2002; Atkeson and Axelrad, 2003). Sulfate in the surface waters of the Everglades is derived from a variety of natural and human sources. Bates et al. (2002) found that the major source of sulfate within the EPA was drainage from the Everglades Agricultural Area (EAA). Stormwater runoff from the EAA contains high concentrations of sulfate that arise from both the current and historical use of sulfur-containing fertilizers and soil amendments (Bates et al., 2002). Additionally, under some conditions in the Everglades, groundwater containing elevated sulfate levels can rise to the surface (Atkeson and Parks, 2002). The status of the ongoing sulfur-mercury relationship research is reported in Appendix 2B-3 of this report.

The sulfate monitoring results in the EPA are presented in this chapter to provide an overview of current concentrations, evaluate temporal and spatial patterns, and provide materials in support of discussions in Chapter 2B of the *2004 Everglades Consolidated Report*. Sulfate concentrations are summarized in **Table 2A-7** for WY2003, WY2002, and WY1978 through WY2001 based on arithmetic mean and median values.

Given that one of the primary sources of sulfate entering the EPA is stormwater runoff from the EAA, sulfate concentrations in the inflow and interior marsh generally follow trends similar to those observed for TP and TN. Additionally, sulfate concentrations also exhibit a general north-to-south gradient extending from the sources in the north to relatively unenriched areas in the south similar to those identified for nutrient levels (**Figure 2A-11**). High inflow concentrations in EAA runoff enter the Refuge, WCA-2 and, to a lesser extent, WCA-3. The highest concentrations within the EPA have been observed at the Refuge and WCA-2 inflow stations. However, as previously discussed, a significant amount of the surface water entering the Refuge does not permeate deeply in the marsh but remains around the periphery of the area in the rim canal and is discharged to WCA-2 through the S-10 structures. Due to this hydrologic characteristic, the Refuge interior has remained relatively uninfluenced by the inflow of sulfate-rich water. However, during WY2003 sulfate concentrations at interior marsh stations in the Refuge (median = 11.0 mg/L) were substantially elevated above both the long-term, historic median (3.6 mg/L) and the previous water year (2.3 mg/L). Among the EPA marsh areas, the interior of WCA-2 exhibits the highest sulfate concentrations and is the area most affected by EAA runoff, with a WY2003 median concentration of 32 mg/L. Sulfate concentrations at stations in the interior of WCA-3 have also been elevated by inputs of sulfate-enriched runoff, though this is not readily apparent from the 3.8 mg/L median concentration for WY2003. As demonstrated in the 1995, 1996, and 1999 USEPA Regional Environmental Monitoring and Program (REMAP) studies, a pronounced north-to-south sulfate gradient is evident within WCA-3 (Atkeson and Parks, 2002). This gradient is also apparent within the District's monitoring network (**Figure 2A-11**). The highest WY2003 sulfate concentrations within the WCA-3 interior were observed in the marsh near the Miami Canal in the northwestern part of the area at station CA36 (median = 11.5 mg/L). Concentrations decreased through the marsh, following the southerly flow of water. The lowest median sulfate concentration observed during WY2003 at sites in the WCA-3 marsh (median < 0.10 mg/L) was observed at station CA315, the most southerly sampling location in WCA-3.

Table 2A-7. Summary of sulfate concentrations (mg/L) in the Everglades Protection Area for WY2003, WY2002, and WY1978 through WY2001.

Region	Class	Period	N	Arithmetic Mean	Std. Deviation	Median	Min.	Max.
Refuge	Inflow	1978–2001	714	58	46	49	<0.1	461
		2002	62	53	23	52	3.2	101
		2003	56	59	19	54	19.48	105
	Rim	1978–2001	515	53	27	47	1.6	140
		2002	47	55	25	55	14.12	110
		2003	34	56	18	50	37	120
	Interior	1978–2001	1704	15	74	3.6	0.1	2900
		2002	220	11	18	2.3	<0.1	110
		2003	212	20	22	11	<0.1	76
	Outflow	1978–2001	312	49	49	41	4.2	571
		2002	27	34	20	34	1.4	79
		2003	23	52	23	50	11	93
WCA-2	Inflow	1978–2001	578	52	45	46	6.2	644
		2002	72	40	17	38	8.0	79
		2003	69	52	19	52	16	93
	Interior	1978–2001	2836	46	27	43	0.1	370
		2002	224	34	23	29	4.3	180
		2003	244	40	90	32	5.5	1400
	Outflow	1978–2001	340	37	27	32	2.3	224
		2002	20	25	13	23	5.8	54
		2003	14	31	13	31	14	54
WCA-3	Inflow	1978–2001	938	27	26	19	0.5	286
		2002	71	16	13	11	1.8	56
		2003	58	18	14	12	1.3	54
	Interior	1978–2001	1487	12	16	6.8	0.1	262
		2002	242	6.5	12.3	3.0	<0.1	120
		2003	292	7.5	10.8	3.8	<0.1	83
	Outflow	1978–2001	471	14	17	9.5	<0.1	113
		2002	49	4.7	5.9	1.4	<0.1	23
		2003	38	3.8	6.9	0.3	<0.1	32
Everglades National Park	Inflow	1978–2001	436	14	18	9.4	<0.1	113
		2002	56	5.0	5.6	2.5	<0.1	23
		2003	36	3.4	4.9	1.9	<0.1	23
	Interior	1978–2001	1271	6.4	15.1	3.1	<0.1	207
		2002	102	11	42	2.2	<0.1	403
		2003	79	3.7	13.7	1.0	<0.1	120

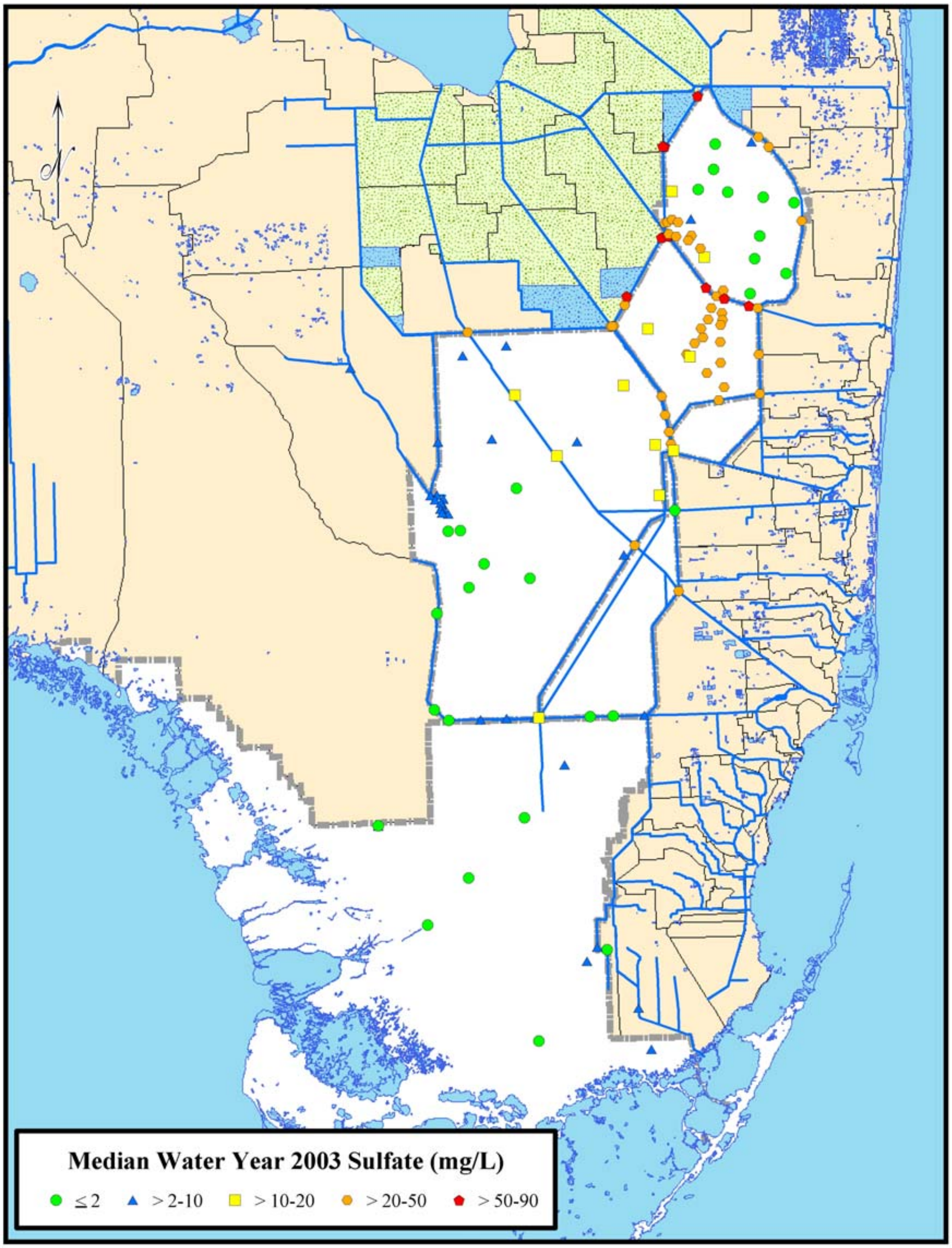


Figure 2A-11. Summary of median WY2003 sulfate concentrations (mg/L) at stations across the Everglades Protection Area. Median sulfate concentrations are classified utilizing four levels as follows: ≤ 2 mg/L, 2 to 10 mg/L, 10-20 mg/L, 20 to 50 mg/L, and > 50-90 mg/L.

PESTICIDES

The SFWMD has maintained a pesticide monitoring program in South Florida since 1984. The pesticide monitoring network includes sites designated in the Park Memorandum of Agreement (MOA), the Miccosukee Tribe MOA, the Lake Okeechobee Operating Permit, and the non-ECP Structure Permit. The current monitoring program in the EPA consists of 29 sites (**Figure 2A-12**). The sites were grouped by basin for analysis.

Surface water concentrations of pesticides are regulated under criteria established in Chapter 62-302, F.A.C. Chemical-specific numeric criteria for a number of pesticides and herbicides (e.g., DDT, endosulfan, and malathion) are listed in Section 62-302.530, F.A.C. Compounds not specifically listed, including many contemporary pesticides (e.g., ametryn, atrazine, and diazinon), are evaluated based on acute and chronic toxicity. A set of toxicity-based guidelines for non-listed pesticides were presented in the *2001 Everglades Consolidated Report* (Weaver et al., 2001). These guideline concentrations were developed based on the requirement in Section 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."

The *2004 Everglades Consolidated Report* analyzes data collected during pesticide monitoring events conducted between December 2001 and September 2002. Monitoring results were evaluated relative to Class III water quality criteria, chronic toxicity guidelines, and detected concentrations. Pesticides exceeding either the Class III criteria or chronic toxicity guideline concentrations were classified as concerns for the basin in which the exceedance occurred. Variables classified as "concerns" have a high likelihood of resulting in an impairment of the designated use of the water body. Detected water quality constituents (> MDL) that did not exceed either a guideline or criterion were categorized as a "potential concern". This classification signifies that the water quality constituent is known to be present within the basin at concentrations reasonably known to be below levels that result in adverse biologic effects, but may result in a problem at some future date or in interaction with other compounds. The "no concern" category was used to designate pesticides that were not detected at sites within a given area.

Fifteen pesticides were detected between December 2001 and September 2002. Atrazine, chlorpyrifos ethyl, and diazinon were classified as concerns based on exceedances of their respective chronic toxicity guideline concentrations. On April 17, 2002 and June 4, 2002, atrazine exceeded its guideline concentration at the S-6 structure (2.7 μg/L) and the S-38B structure (2.3 μg/L), respectively. Diazinon exceeded its chronic toxicity guideline at S-38B (0.053 μg/L) on December 18, 2001. On February 4, 2002, chlorpyrifos ethyl exceeded its chronic toxicity guideline at the S-177 structure (0.056 μg/L).

Pesticide excursions during the period of record occurred in all areas of the EPA except for the Refuge. Excursions and detections of triazine pesticides (atrazine and simazine) occurred at structures discharging EAA runoff to the northern EPA. These pesticides likely originated through agricultural applications in either the EAA or the Lake Okeechobee basins. The diazinon excursions originated from the predominately urban North Springs Improvement District (NSID) via S-38B. The diazinon excursion in NSID discharges continues a pattern noted in the three previous ECRs (Weaver et al., 2001, 2002, and 2003). Given the urban nature of the NSID basin and the common use of diazinon as an insecticide for the control of lawn pests (particularly fire ants), it is probable that diazinon is entering the surface water through runoff from residential lawn maintenance.

Table 2A-8. Pesticide detections and exceedance categories in the Everglades Protection Area inflows, canals, and structures between December 2001 and September 2002. The categories of "concern" and "potential concern" are denoted by "C" and "PC," respectively; all others are considered "no concern." Number of detections and total number of samples are in parentheses.

Variable	Refuge[1]	WCA-2[2]	WCA-3[3]	Park[4]	C-111[5]
Ametryn	PC (15:18)	PC (13:13)	PC (9:32)	(0:24)	(0:14)
Atrazine	PC (18:18)	C (12:13)	PC (21:32)	PC (7:24)	PC (5:14)
Bromacil	(0:9)	(0:10)	PC (1:32)	(0:24)	(0:14)
Chlorpyrifos ethyl	(0:9)	(0:10)	(0:32)	(0:24)	C (1:14)
Diazinon	(0:9)	C (1:10)	(0:32)	(0:24)	(0:14)
Dichlorophenoxy acetic acid, 2,4- (2-4-D)	(2:9)	(0:10)	(0:32)	(0:24)	(0:14)
Endosulfan sulfate	(0:9)	(0:9)	(0:32)	(0:24)	PC (1:12)
Endosulfan (total alpha and beta)[6]	(0:9)	(0:10)	(0:32)	PC (1:24)	PC (3:14)
Ethion	(0:9)	(0:10)	(0:32)	(0:24)	PC (1:14)
Hexazinone	PC (1:9)	PC (1:10)	PC (4:32)	(0:24)	(0:14)
Metolachlor	PC (2:9)	PC (1:10)	(0:32)	(0:24)	PC (1:14)
Metribuzin	(0:9)	(0:10)	(0:32)	(0:24)	PC (2:14)
Norflurazon	(0:9)	(0:10)	PC (8:32)	(0:24)	(0:14)
Prometryn	(0:9)	PC (1:10)	(0:32)	(0:24)	(0:14)
Simazine	PC (2:9)	PC (3:10)	PC (5:32)	(0:24)	(0:14)

1. ACME1DS, ENR012, G-4D, G-310, and S-5A (via STA-1W).
2. S-38B, S-6 (via STA-2), and S-7.
3. G-123, G-606, L3BRS, S-140, S-190, S-8, S-9, S-142, and S-31.
4. S-12C, S-18C, S-332, S-335A, S-355B, and US41-25.
5. G-211, S-176, S-177, S-178, and S-331.
6. Both alpha and beta endosulfan forms were detected, but are combined in the total and are considered as a single constituent.

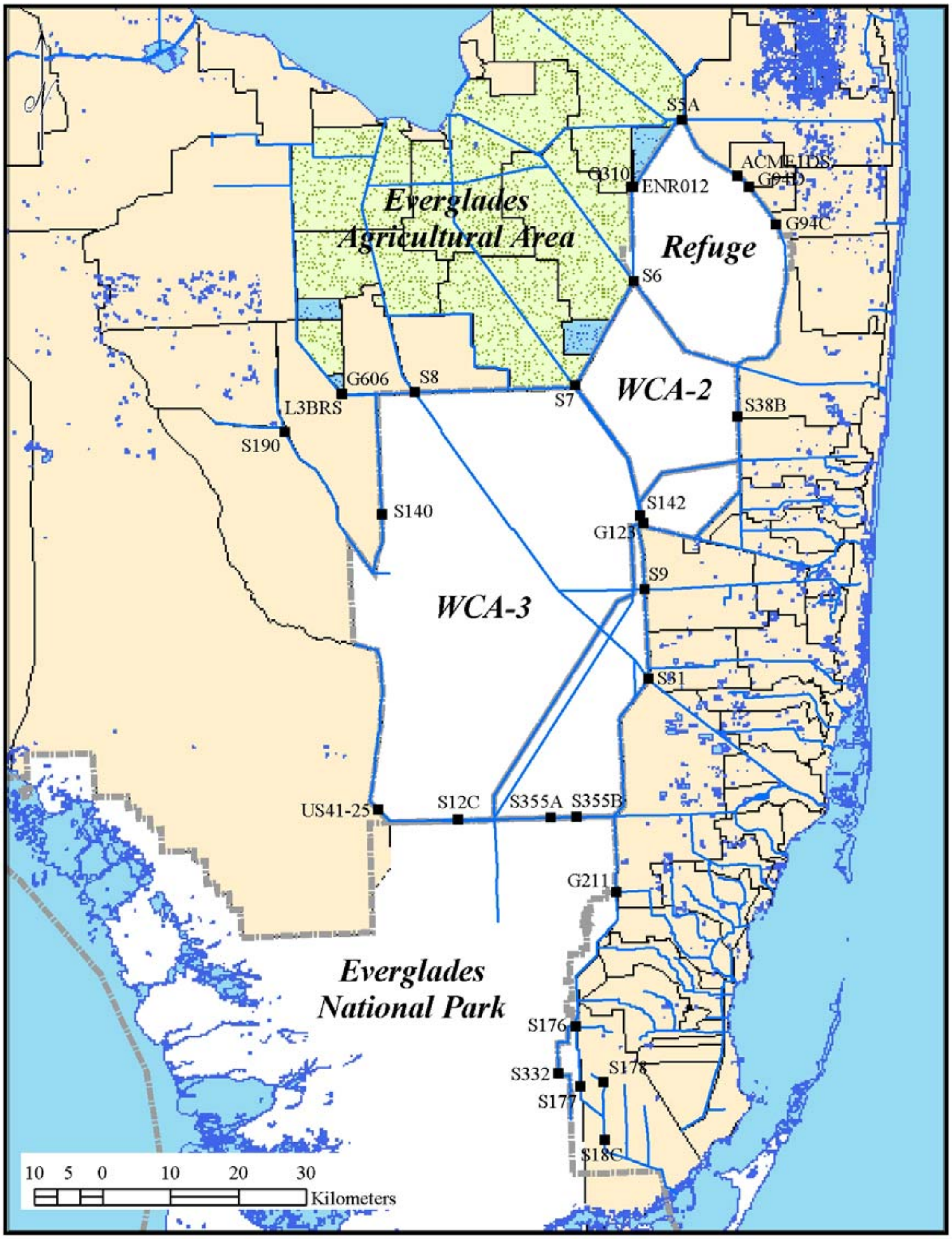


Figure 2A-12. SFWMD pesticide monitoring sites in the Everglades Protection Area.

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