A.R.M. LOXAHATCHEE NATIONAL WILDLIFE REFUGE

ENHANCED WATER QUALITY PROGRAM

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ACRONYMS AND ABBREVIATIONS

ACME Special Drainage District, Village of Wellington
acre-ft acre-feet (volume reported as one acre in area by one foot in depth)
cfs cubic feet per second
Cl chloride
cm centimeter
DBHYDRO SFWMD's web portal for water quality data
DCS depth from water surface to consolidated substrate
DOI US Department of Interior
EAA Everglades Agricultural Area
EVPA Federal Consent Decree compliance sampling network for Refuge
ft feet
FWM flow-weighted mean
km kilometer
L liter
LOXA Refuge's expanded water quality monitoring network
m meter
mg milligram
MIKE-FLOOD coupled one and two-dimensional finite difference model
NGVD National Geodetic Vertical Datum
NO_x total concentration as nitrogen of oxides of nitrogen, $NO_2 + NO_3$
Refuge A.R.M. Loxahatchee National Wildlife Refuge
s second
SFWMD South Florida Water Management District
SO_4 sulfate
STA Stormwater Treatment Area
Tdepth depth of clear water column
TN total nitrogen
TP total phosphorus
µg microgram
$\mu S\ cm^{-1}$ microSiemens per centimeter (measure of conductivity)
USACE U.S. Army Corps of Engineers
USFWS U.S. Fish and Wildlife Service
USGS U.S. Geological Survey
WCA Water Conservation Area

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EXECUTIVE SUMMARY

Congress appropriated funds to the U.S. Fish and Wildlife Service in 2004 which funded an enhanced water quality monitoring network and hydrodynamic and water quality models to improve the scientific understanding of water quality in the Arthur R. Marshall Loxahatchee National Wildlife Refuge[1] (Refuge). The network and models provide information that is used in management decisions to better protect Refuge resources. The enhanced water quality monitoring network complements the compliance network monitored as a part of the 1992 Federal Consent Decree (Case No. 88-1886-CIV-MORENO) by characterizing the water quality of a larger Refuge area, particularly the fringe area potentially impacted by canal water intrusions. Monthly grab samples have been collected at 37 to 39 stations located in the marsh and canal since June 2004. The number of grab sample stations has reduced to 37 in recent years because two stations located near the canal were overrun with cattail making them inaccessible. Continuous measurements of conductivity additionally have been collected along seven transects, four of which extend from surface water discharge points in the canal into the interior. This report is the sixth annual report, with analyses focused on January through December 2010, and with comparisons made to the preceding years (2004 through 2009).

Water quality data and analyses of canal water intrusion into the Refuge marsh presented in this report documents continued intrusion of rim canal water into the Refuge interior, adding to a growing information base about canal water impacts to the Refuge. Intrusion of nutrient-rich and high conductivity water from the canal network surrounding the Refuge has been shown to negatively impact Refuge flora and fauna. Important insights gained from 2010 canal water intrusion analyses include:

- Canal water intruded into the marsh up to 2.6 km depending on timing and location.
- Rainfall total in 2010 for the Refuge and contributing basins was slightly lower than the historic average (1963 through 2009); however, the temporal distribution of rainfall was unique, resulting in a wetter dry season and a drier wet season. Regardless, inflows to the Refuge were lower than inflow volumes during average rainfall years (i.e., 2004). While, the reduction in canal water inflows to the Refuge may have been linked to rainfall conditions, a substantial volume of water that could have been treated by STA1E and STA1W was instead delivered east to tide (the east coast – Lake Worth Lagoon). Reduced treatment capacity may have been a driver to not maximize the STAs treatment capacity. Regardless, the environmental decisions, coupled with water management strategies applied in 2010 have resulted in water levels going into the 2011 dry season being a foot lower than needed to promote the proper recession rates and water depths for a healthy bird fledgling season.
- Intrusion of canal water into the marsh was sustained for a considerable period after inflows declined at the end of October. The extent of canal water intrusion into the

[1] Public Law 108-108; see House Report No. 108-195, p. 39-41 (2004)

marsh was maintained by the lack of water discharges from the Refuge during and after the high rate inflows from July through October. These conditions have been shown to exacerbate Consent Decree excursions as was observed in November 2008 during the total phosphorus (TP) excursion event which occurred after inflows during November were reduced.

Analyses of these data continue to support previously suggested management practices that have the potential to minimize intrusion. A few of these recommendations are summarized as balancing inflow and outflow volumes, reducing the duration of inflows, and reducing inflow rates when the canal stage is lower than the marsh stage.

Based on the surface water conductivity data, the Refuge was classified into four geographic zones: (1) Canal Zone; (2) Perimeter Zone, located from the canal to 2.5 km (1.6 miles) into the marsh; (3) Transition Zone, located from 2.5 km (1.6 miles) to 4.5 km (2.8 miles) into the marsh; and (4) Interior Zone, greater than 4.5 km (2.8 miles) into the marsh. Overall, water quality conditions in the Perimeter continue to be different from, and more impacted than, the Interior Zone. Cattail expansion in the Refuge marsh, negative impacts to periphyton and *Xyris* spp. in response to nutrient and mineral enrichment, and displacement of sawgrass in the canal water-exposed areas of the marsh are a few examples of marsh impacts.

This report continues to document that water movement between the canals and the marsh is influenced by rainfall, structure-controlled water inflow and outflow into perimeter canals, the difference between canal and marsh stages, and marsh elevation. When combined with our understanding of canal water intrusion influence on the marsh, these data continue to suggest that high-nutrient water is having a negative impact on the Refuge marsh (e.g., enriched soil TP, displacement of sawgrass by cattails, loss of *Xyris* spp., etc.).

In 2009, we performed a second round of vegetation characterization and this year we provide a preliminary analysis of those data. Results of these analyses suggest that the similarity of plant communities (presence/absence using Sorensen's Similarity Index) among the water quality zones shifts in response to duration of drought and inundation. Further, assessment of select indicator plant species suggest that *Typha spp*. continues to expand into the interior marsh, while *Eriocaulon spp*., *Eleocharis spp*., and *Xyris spp*., which are generally indicative of unimpacted marsh conditions, did not show expansion at most of the water quality stations. Several more years of collection and analysis of these data is necessary to moderate variability resulting from sample collection conditions and samplers.

In 2010, the Simple Refuge Screening Model (SRSM) was successfully applied to assess a water management recommendation proposed by the South Florida Water Management District (SFWMD). In November 2010, the SRSM was applied to evaluate the potential for delivering "make-up water" to the Refuge. Because of the unique rainfall pattern in 2010 (rainy dry season/dry wet season) and exceptionally low stages in the wet season, SFWMD offered to deliver nutrient enriched water from Lake Okeechobee to the Refuge in an attempt to offset the lower than normal stages observed during the wet season of 2010. Results from the SRSM suggested that the Refuge water levels achieved the high stage performance measure (PM) (water stage greater than 17 ft three to four weeks in a row of three to four consecutive years) three water years (May through April) in a row (2008, 2009, 2010) and as such it would be acceptable to not achieve the high stage PM in water year 2011 (May 2010 through April 2011), thus the “make-up water” was rejected by Refuge management.

ANNUAL PROGRAM SUMMARY[2]

The objective of this section is to provide a general descriptive summary of environmental conditions, canal water intrusion into the Refuge marsh (movement of water from the perimeter canal into the marsh interior), and associated water quality in the Refuge from January through December 2010 following approaches presented in previous annual reports (USFWS 2007a, b; USFWS 2009; USFWS 2010a, b). Further, we compare results, particularly total phosphorus (TP), in 2010 to results presented in previous water quality reports covering the period from January 2004 through December 2009 (Harwell et al. 2005; USFWS 2007a, b; USFWS 2009; USFWS 2010a, b). Thus, this section serves as an update to the 2009 annual report (USFWS 2010b). This section briefly characterizes environmental conditions (e.g., rainfall, canal flows, marsh and canal stages, and water quality) associated with events of canal water intrusion into the marsh and water quality conditions during 2010. This year, we also discuss results from the vegetation surveys conducted in 2007 and 2009 as well as a model application developed and used to make a water management decision.

Background

Prior to June 2004, water quality in the Refuge interior was monitored primarily using the 1992 Federal Consent Decree (Case No. 88-1886-CIV-MORENO) compliance network (EVPA). These 14 stations (**Figure 1**), monitored since 1978, characterize the central region of the interior marsh, leaving a relatively large region uncharacterized, predominantly in the outer, impacted fringe of the wetland (Harwell et al. 2005; USFWS 2007a, b; USFWS 2009; USFWS 2010a, b). In June 2004, the Refuge initiated an enhanced water quality monitoring network (LOXA) intended to improve the scientific understanding of water movement in and out of the Refuge marsh, water quality in the marsh, and to provide information that can be incorporated into water management decisions to better protect Refuge resources (Brandt et al. 2004). The enhanced monthly sampling focuses on areas near surface water discharge stations in areas uncharacterized by the EVPA network (**Figure 1**).

Water delivered to the Refuge originates as direct rainfall and canal water discharges from the surrounding basins. Stormwater treatment areas (STA) 1W and 1E treat the majority of water delivered to the Refuge via canals. Canal discharges are driven by rainfall in the surrounding basins, with a large volume delivered to the Refuge from the L-8 and S-5A basin (Burns and McDonnell Engineering Co, Inc. 2005). The L-8 basin discharges are generally a mixture of water from Lake Okeechobee and the S-5A and C-51 basins (Gary Goforth, Inc. 2008). The STA1E water control plan indicates that during this interim period (through 2015), water discharges to tide (east coast – Lake Worth Lagoon) should approach 150,000 acre-ft, while the remainder of the water should be treated and distributed throughout the Everglades Protection Area (Refuge south to Florida Bay). Stormwater Treatment Areas 1W (180,000 acre-ft annually

[2] Prepared by: Donatto D. Surratt, Michael G. Waldon

capacity) and 1E (165,000 acre-ft annually capacity) are to treat some of this water (Gary Goforth, Inc. 2008).

Water levels in the Refuge are managed by the U.S. Army Corps of Engineers (USACE) based on the 1995 Water Regulation Schedule (USFWS 2000; USFWS 2007a, b; **Figure 2**). Inflows to the Refuge from the STAs or through bypass around the STAs are controlled by SFWMD, while discharges from the Refuge are controlled by USACE. Since 2009, staff from the Refuge has held weekly calls with USACE to provide input on timing and volumes of discharges from the Refuge.

Methods

Environmental Conditions. Rainfall, flow, stage, and additional water quality data were downloaded from the South Florida Water Management District (SFWMD) data web portal, DBHYDRO and data were current as of March 20, 2011 (http://my.sfwmd.gov/portal/page?_pageid=2235,4688582&_dad=portal&_schema=PORTAL). All stage data presented in this report are relative to the NGVD 1929 datum. Data from the USGS 1-7 stage gage (**Figure 1**) were used as estimates of marsh stage values; canal stage data from the headwater gage of the G-94C outflow spillway structure (**Figure 1**) were used for continuity with previous reports. These data were also used to assess the number of days the canal and marsh stages were greater than 17 ft in any year, with 21 to 28 days being optimal for providing desired stages going into the dry season for proper recession and adequate water for hatchling foraging. Refuge inflow and outflow were aggregated as the total daily average flow. Inflow records for ACME-1, ACME-2, G-310, G-251, S-362, G-300, and G-301 were used for daily average inflow into the canals; outflow records at G-300, G-301, G-94A, G-94B, G-94C, S-10A, S-10C, S-10D, and S-39 were used for daily average outflow out of the canals (**Figure 1**). Data from G-338 also were considered, but the discharges were sparse and not included in these analyses. Daily rainfall data were averaged from the LOXWS, S-6, S-39, and S-5A weather stations to represent Refuge rainfall (**Figure 1**). Rainfall for the C-51 is represented by S-5A and WPB AIRP, and Pahokee1 and Pahokee2 represent rainfall for the S5A basins. Flows to the east of the Refuge from the S-5A, C-51, and L-8 basins are represented by pump structure S-155A.

Intrusion Monitoring. We determined the spatial and temporal extent of high conductivity canal water intrusion into the Refuge under different hydrologic conditions with emphasis on six ofthe seven Refuge conductivity transects (**Figure 1**), where temperature-compensated conductivity is collected hourly using conductivity data loggers. Also, we related changes in the extent of intrusion to water management activities affecting canal stages and flows into the Refuge, and determined the influence of natural meteorological events and hydrologic mechanisms on intrusion of high conductivity canal water.

We used the six conductivity transects to track water movement between the canal and the first six kilometers of the marsh (**Figure 1**). Two transects (STA-1E and STA-1W) were established near the outflow of STA-1W and STA-1E discharge structures. Two of the remaining transects (ACME-2 and Southeast) were established on the east side of the Refuge south of the STA-1E discharge structure. We established the Southeast (SE) transect late in July 2007 to capture canal water intrusion in areas not previously characterized. The final two transects (S-6 and Extreme Southwest) were established on the west side of the Refuge south of the STA-1W discharge structure. The Extreme Southwest (ESW) transect also was established late in July 2007 to capture canal water intrusion signals in areas previously not characterized.

Conductivity acts as a conservative tracer of canal water; there are no biological or chemical processes in the surface water that significantly alter conductivity. Thus, these data can be used to track canal water intrusion into the marsh, which ultimately can be examined in relationship to water management operations.

Seventy-five percent of canal monthly conductivity values were greater than 779 $\mu S\ cm^{-1}$ and the maximum was 1,299 $\mu S\ cm^{-1}$. Monthly Interior Zone conductivity levels remained below 120 $\mu S\ cm^{-1}$ through 2010. Given this large difference in conductivity between the canal and the interior marsh, we use two conductivity levels, 350 and 500 $\mu S\ cm^{-1}$, to help identify the distance into the interior marsh that canal water penetrated. Tracking was done using isopleths of conductivity generated from the hourly conductivity data. Isopleths are lines connecting points of equal value for a given metric. Elevation contours on a topographic map are examples of isopleths.

The two isopleths (350 and 500 $\mu S\ cm^{-1}$) were chosen to sufficiently cover the conductivity gradient observed from the canal into the marsh. Further, laboratory and field studies have shown that high conductivity waters (>300 $\mu S\ cm^{-1}$) have adverse impacts on the ecosystem community structure (e.g., reduced growth rate of *Xyris* spp. (McCormick and Crawford 2006), shifts from sawgrass to cattail communities (Richardson 2010), altered periphyton community structure (Sklar et al. 2005).

Marsh Total Phosphorus. As in past years, monthly water quality samples were collected from the EVPA and LOXA monitoring networks (**Figure 1**). The EVPA network consists of 14 interior marsh stations collected cooperatively with the SFWMD and Refuge staff. Refuge staff solely-collect water samples from the 37 stations (five in the canal and 32 in the marsh) in the LOXA network. The number of grab sample stations has reduced from 39 to 37 since the program's inception because two stations located near the canal were overrun with cattail, making them inaccessible for water quality sampling. Samples for both networks generally are analyzed for more than 20 water quality parameters. Sample collection is confounded by water depth and sample station accessibility. When clear water depths are between 10 and 20 cm (3.9 and 7.9 inches), only partial samples are collected and analyzed for 6 of the 29 water quality parameters, including: TP, chloride, sulfate, temperature, depth, and specific conductance. When the clear water depths are below 10 cm (3.9 inches), no samples are collected and no data are recorded. This report only presents TP data. **Appendix A** presents summary statistics for all water quality parameters measured in the LOXA network.

Vegetation Characterization. The vegetation characterization project began in 2007 and was envisioned to answer questions about hydrologic and water quality dynamics that exist for each water quality station. Project methodology has been described in greater detail in previous Annual Reports (USFWS 2009, USFWS 2010a, b). Briefly, vegetation sampling was established as linear, north-to-south transects (50 m) in sloughs adjacent (less than 100 m distance) to each water quality station (LOXA and EVPA). Percent cover for each plant species in a 1 m^2 quadrat was assessed at 5 m increments along the 50 m transect. An index was developed for the percent cover values to avoid calculations with zeros. Photos were taken of each transect from a standard northern position. The ends of each transect were marked permanently with 1/2"-diameter PVC poles. Data were collected during the wet and dry season in 2007 and 2009. The next round of data collection is scheduled for 2011 as each transect is sampled every other year. Presently, we have quantified vegetation as percent abundance for the various species at each water quality station. We compare vegetation density by water quality zones between the two years and as distance from the canal into the marsh for select emergent species. The water quality zone assessment compares all observed vegetation among zones and between years and is based on Sorensen's similarity index (Looman and Campbell 1960). The index is calculated as:

$$QS = \frac{2C}{A+B},$$

where QS is the quotient of similarity, A and B are the number of species in samples A and B, and C is the number of species shared by the two samples. Species (*Eriocaulon spp*., *Eleocharis spp*., *Xyris spp*., and *Typha spp*.) that act as indicators of hydrologic or water quality changes were selected for assessment of spatial change (distance from canal) between 2007 and 2009. Interpreting the response of these indicators through time and space is complicated. *Typha spp*., a species indicative of elevated TP concentrations, tend to increase in size and spatial expanse as TP concentration increase, but *Typha spp*. is also resilient in response to shifts in hydroperiods and water depths. Alternatively, increases in *Eriocaulon spp*., *Eleocharis spp*., or *Xyris spp*. suggest that water quality and/or hydrology condition have improved in the area. Neither of these species are resistant to decreases in hydroperiods and as such communities take longer to recover from drought conditions than *Typha spp*.

Water Quality Zones. The Refuge interior was classified into several geographic zones based upon conductivity data variability and changes in median conductivity as a function of distance from the perimeter canal as presented in USFWS 2007a, b; 2009; 2010a, b. For the analyses presented here, the following zones were identified:

- Canal: stations located in the canal
- Perimeter: stations located from the canal to 2.5 km (1.6 miles) into the marsh
- Transition: stations located from 2.5 km to 4.5 km (1.6 to 2.8 miles) into the marsh
- Interior: stations located greater than 4.5 km (2.8 miles) into the marsh

Model Implementation. In November 2010, the Simple Refuge Screening Model (SRSM), described in previous annual reports (USFWS 2007a and b, 2009, 2011a and b), was applied to evaluate the potential for delivering "make-up water" to the Refuge. Because of the unique rainfall pattern in 2010 (rainy dry season/dry wet season) and exceptionally low stages in the wet season, SFWMD offered to deliver nutrient enriched water from Lake Okeechobee to the Refuge in an attempt to offset the lower than normal stages observed during the wet season of 2010. A best management practice (BMP) rule was assessed by SFWMD to determine the potential volume of water (111,030 acre-ft) that could be delivered to the Refuge in 2011. The SRSM evaluation assessed the last three years of stage with respect to the high stage performance measure (PM), which suggest water stages in the Refuge canal should exceed 17 ft for three of four weeks in three of four consecutive years.

Results

Environmental Conditions: S-5A and C-51 Basins. The 2010 S-5A (590,220 acre-ft) and C-51 (549,660 acre-ft) basins' rainfall volumes were lower than the average annual volumes since 1963 for the two basins (643,415 and 652,112acre-ft respectively – **Figure 3a**). The 2010 S-5A rainfall volume was approximately 45,000 acre-ft greater than in 2009, while the 2010 C-51 volume was approximately 63,000 acre-ft greater than in 2009. Basin S-5A rainfall volumes in 2010 was 7 and 1% higher than the drought years 2006 and 2007, while basin C-51 rainfall volume in 2010 was 13 and 28% higher than in 2006 and 2007, respectively. Alternatively, the 2010 rainfall volume in S-5A and C-51 was 11% and 15% lower than in 2008, the first year following several years of severe drought conditions. Dry season (November through May) 2010 rainfall in S-5A (373,620 acre-ft) and C-51 (275,940 acre-ft) were higher than most years since 2004 (**Figure 3a and b**) and since 1963 at the 94^{th} and 66^{th} percentile, respectively. Alternatively, wet season (June through October) 2010 rainfall in S-5A (291,900 acre-ft) and C-51 (323,460 acre-ft) were lower than most years since 2004, and since 1963 at the 9^{th} and 11^{th} percentile, respectively.

Flows through S-155A and inflow to STA1E operate in concert and the first two years of STA1E full operation (2006 and 2007) were drought years, yielding less than the 150,000 acre-ft guideline annual volume that can be delivered to the east coast (**Figure 4**). From 2008 through 2010, the volume of water delivered to the east coast has rapidly increased above the 150,000 acre-ft guideline by 7 to 58%. In 2010, the volume of water discharged through S-155A was approximately 260,000 acre-ft.

In 2006 and 2007, inflows to STA1E (**Figure 5a**) were lower than the treatment capacity (165,000 acre-ft yr^{-1}; Gary Goforth, Inc. 2008) at 116,440 and 103,828 acre-ft yr^{-1}, respectively. In 2008, inflows to STA1E increased above the treatment capacity to 190,530 acre-ft, but in 2009 and 2010, inflows to STA1E declined well below the design capacity to 56,370 acre-ft and 54,173 acre-ft, 34 and 33% of the treatment capacity, respectively.

In 2006 and 2007, inflows to STA1W (**Figure 5b**) were lower than the treatment capacity (180,000 acre-ft yr^{-1}; Gary Goforth, Inc. 2008) at 138,549 and 93,717 acre-ft yr^{-1}, respectively. In 2008, inflows to STA1W increased above the treatment capacity to 185,008 acre-ft, but in 2009 and 2010, inflows to STA1W declined to 166,007 and 146,003 acre-ft, 92 and 81% of treatment capacity, respectively.

Environmental Conditions: Refuge. Rainfall on the Refuge in 2010 was approximately 595,000 acre-ft, similar to 2009, 11% lower than in 2008, 18% greater than in 2007, 13% greater than in 2006, 3% greater than in 2005, 20% greater than in 2004, and 5% lower than the historic (1963 through 2010) average (**Figure 6a**). Dry season 2010 rainfall on the Refuge (344,520 acre-ft) was higher than most years since 2004 (**Figure 6b**) and since 1963 at the 91th percentile. Alternatively, wet season 2010 rainfall on the Refuge (315,018 acre-ft) was lower than most years since 2004, and since 1963 at the 11th percentile.

Refuge canal total annual inflow in 2010 (208,123 acre-ft) was lower than any year since 2004 with the exception of 2007 (178,507 acre-ft), a drought year (**Figure 6c**). Canal inflow volumes in 2009, 2008, 2006 (extreme drought year), 2005, and 2004 were 14 to 80% higher than in 2010. Dry season inflow (88,031 acre-ft) in 2010 was at the 80th percentile for the period of record from 2004 through 2010, while wet season inflow (132,431 acre-ft) was at the 0th percentile.

Daily flow peaked several times throughout the year in 2010 (**Figure 7a and 8a)**. In March 2010, daily flow peaked to more than 4,000 cfs and remained above 1,400 cfs for six consecutive days. Following the inflow peak, inflows were more variable ranging from 0 to 1,100 cfs until late May 2010. Outflows from the Refuge were initiated a few days prior to the inflow peak and the outflow rates increased from approximately 800 cfs in early March to more than 3,000 cfs through early April, and were maintained higher than 1,200 cfs from mid-April through late May. This event removed approximately 249,407 acre-ft of water from the Refuge during this period (74 days). A second major surge of inflow occurred in late-August 2010, when inflows increased above 1,000 cfs, for several days. After the inflow surge, inflows would become more variable ranging from approximately 200 to 1,900 cfs through early October. These inflows were not matched with outflows and the Refuge gained approximately 71,740 acre-ft over 45 days.

In 2010, canal and marsh stages were greater than 16.71 ft (5.09 m) 25% of the year (**Figure 7b and 8b, Table 2**), which were lower stages than the same amount of time for canal (16.83 ft) and marsh (16.81 ft) stages observed during the drought year - 2007. The number of days exceeding or meeting 17 ft in the marsh or the canal (21 to 28 days) necessary to provide the adequate water levels for ecological benefit was not met in 2010 (zero in the marsh and seven in the canal) or 2009 (zero in both the canal and marsh). During the drought year of 2007, this criterion was far exceeded with 54 and 53 days greater than or equal to 17 ft in the canal and marsh, respectively. No other year since 2004 had a greater number of days exceeding this high water level except 2008, the first full year out of the drought.

Daily canal and marsh stage did not follow the water regulation schedule in 2010. The substantial loss of water from March through May 2010 was related to a stage recession rate of 0.1 ft wk^{-1}, which is 1.25 to 2 times higher than the desired dry season recession rate. Net inflow volumes during the ascension period from late-August through early October were not great enough to raise canal stage high enough to reach the top of the water regulation schedule from late September through November.

Intrusion Monitoring. The distance of canal water intrusion into the marsh peaked twice during 2010. General canal water intrusion into the marsh extended 0.7 and 1.3 km (0.4 and 0.8 miles) on the east and west sides of the northern Refuge. In March 2010, the first major intrusion peak in 2010 occurred and intruded 2.6 and 2.0 km (1.6 and 1.2 miles) into the marsh on the east and west sides of the Refuge, particularly in the northern sections (**Figure 7c-e** and **8c-e**, respectively). This intrusion event was coincident with continuous elevated inflows (> 1,400 cfs (42 m^3 s^{-1})) for more than a week leading to the intrusion event and rising canal (0.46 ft wk^{-1}; 14 cm wk^{-1}).

A second major intrusion event occurred in mid-September 2010. During this event, canal water intruded 1.5 and 2.0 km into marsh on the east and west sides of the northern Refuge, respectively. The intrusion event slowly receded to mean levels of intrusion through November 2010. The relatively slow rate of canal water receding from the marsh coincided with the relatively low rate of canal water discharge from the marsh, which actually resulted in a net gain in water through most of September, October, and November. The September-October 2010 intrusion peak is common to all years since 2006, while the Marsh 2010 intrusion peak was unique to 2010 and coincident with the wetter than normal dry season (November through May) (**Figure 7c-e**).

Total Phosphorus and Intrusion Dynamics. Flow-weighted mean TP concentration discharged to the Refuge from STA1E and STA1W in 2010 were generally highest from January through March, prior to the onset of the wet season, ranging from 37 to 106 ppb (**Figure 9a**). Discharge FWM TP concentrations from the two STAs began to decline in April 2010, and after June 2010, concentration from both structures ranged between 13 and 36 ppb. Canal TP concentrations peaked in April 2010 and the peak followed the increase in inflows during March. In general, the canal TP concentrations followed the pattern of the STAs discharge concentrations, however, the canal concentrations did not decline below 24 ppb in any month of 2010.

Interestingly, the marsh zones, Perimeter, Transition, and Interior, did not strictly follow the TP pattern observed in the discharges or the canal. Instead, from January through April, TP concentrations in each zone declined monthly (**Figure 9b**). The marsh TP concentrations did not immediately respond to the large influx of canal water observed in March 2010. However, as inflows continued with the onset of the wet season, Perimeter and Transition Zone TP concentrations began to increase. In September 2010, Perimeter Zone TP concentrations peaked at 17 ppb consistent with the surge of water discharged from the STAs during mid to late August. These inflows continued and the TP concentrations remained at or above 10 ppb for the rest of the year. Transition and Interior Zone TP concentrations were less flashy than the Perimeter Zone TP concentrations and remained below 10 ppb through the entire year. Interestingly, from January through April 2010, Interior Zone TP concentrations were higher than Transition Zone TP concentrations, likely because of the greater potential for TP reflux from the soils where there is greater open water areas and less vegetation to sequester TP – consistent with the Interior Zone habitats.

Vegetation Characterization. We observed differences in vegetation communities across water quality zones based on the 2007 and 2009 vegetation survey data. In 2007, 30 plant species were observed across the zones (23 in the Perimeter Zone, 14 in the Transition Zone, and 20 in the Interior Zone) and 34 (18 in the Perimeter Zone, 14 in the Transition Zone, and 20 in the Interior Zone) were observed across the zones in 2009. Based on Sorensen's similarity index for the 2007 dataset, the Transition Zone vegetation was similar to the Perimeter (70%) and Interior Zones (76%), while the Perimeter and Interior Zones (60%) were moderately similar. In 2009, this pattern of similarity shifted, with the greatest similarity between the Interior and Perimeter Zones (74%), and more moderately between the Transition and Perimeter Zones (56%) and Transition and Interior Zones (59%).

Assessment of a few indicator vegetative species (*Eleocharis spp.*,, *Eriocaulon spp.*, *Xyris spp*., and *Typha spp.*) at the water quality stations showed a decline in percent cover in 2009 (**Figure 10a-d**). The spatial pattern for each species except *Xyris spp.* shifted downward in 2009 from cover observed in 2007. *Eleocharis spp*. percent cover in 2007 was high as 25% in the first 5.7 km into the marsh from the canal, but declined to less than 5% across the marsh in 2009. *Eriocaulon spp.* percent cover was high as 12 to 13% in 2007 at about 6 km into the marsh from the canal, but declined to < 5% across the marsh in 2009. *Xyris spp*. percent cover in 2007 was <5% and remained somewhat consistent through 2009. *Typha spp*. percent cover in 2007 was as high as 15% in the first kilometer into the marsh from the canal and declined to less than 5% in 2009. It should be noted that at 1.7 km into the marsh from the canal on the west side of the Refuge (LOXA116), *Xyris spp.* and other vegetation have been completely replaced with a monotypic stand of *Typha spp.*

Model Implementation. Based on the SRSM evaluation of the high stage PM, the Refuge water levels achieved the high stage PM three water years (May through April) in a row (2008, 2009, 2010) and as such it would be acceptable to not achieve the high stage PM in water year 2011 (May 2010 through April 2011), thus the "make-up water" was rejected by Refuge management.

Discussion

Since the initiation of the enhanced water quality monitoring and modeling program, the 2010 environmental conditions for the Refuge and contributing basins represent the first year of higher rainfall than normal dry season rainfall combined with lower rainfall than normal wet season rainfall. These unique rainfall conditions led to some unique water management decisions and resulting hydrologic and water quality dynamics. Beyond the unique rainfall conditions, water management operations that control water delivers to the Refuge in response to rainfall, appear to have diverted water away from the Refuge in greater volumes than were expected with regards to the identified volume of 150,000 acre-ft (Gary Goforth Inc. 2008). Further, the diversion of water resulted in the volume of water being delivered to the Refuge via the STAs being below the design capacities for each of these STAs. In fact, since 2004, the design capacities for the STAs have not been achieved with the exception of 2008, when both STA1E and 1W received volumes of water that exceeded the design capacities. While it is not necessary to deliver water to the STAs that reach the design capacity, it is odd to deliver water to tide (away from the Everglades), when there is capacity to treat this water and deliver it to the Everglades.

Because of the relatively higher rainfall resulting in increased inflows to the Refuge at the beginning of 2010, a higher volume of water was released from the Refuge in an attempt to follow the recession rate prescribed by the Refuge's water regulation schedule. The lower than normal rainfall during the wet season coupled with the water releases from the Refuge resulted in the Refuge stages remaining lower than normal heading into the dry season and a failure to follow the ascension portion of the regulation schedule. Further, the high stage mark of >17 feet for three to four weeks during the wet season was not achieved and water depths at the end of 2010 were almost one foot lower than the regulation schedule, which likely will have deleterious effects for the ecosystem, particularly nesting birds and vegetation in the more northern region of the Refuge.

To offset the low stages going into 2011, in November 2010, SFWMD offered to deliver "make-up water" to the Refuge. This "make-up water" would consist of nutrient laden waters from Lake Okeechobee and had a high potential of overloading the already poorly performing STAs (STA1E and 1W). Because our modeling assessment of the high stage PM suggested we had met the performance measure three years in a row (a conditions that must be meet three of four consecutive years), Refuge management decided to accept the lower than normal water stages heading into 2011, instead of overloading the STAs with phosphorus enriched Lake Okeechobee waters.

The higher than normal rainfall at the beginning of 2010 resulted in higher than normal inflow during the early part of the year and an unusual spike in canal water intrusion in March 2010. Total phosphorus concentrations in flows to the Refuge peaked during March with concentrations as high as 100 ppb, while the marsh zones TP concentrations remained below 10 ppb. While outflow from the Refuge actually preceded the spike in inflows in early March, the outflows would not increase to high enough rates to reduce the distance of canal water intrusion for at least one week to follow the peak in inflows. It should be noted, that the rainfall event was anticipated and managed for, but there was no way to anticipate the magnitude of this rainfall event and as such no means to anticipate the rates of inflows that would be necessary to safely move the massive volumes of water. Thus, anticipating the necessary discharge volume to prevent the intrusion event was complicated with uncertainty. Regardless, the volumes and rates of outflow reduced the distance of canal water intrusion after about two weeks, which is a rather long period of time for the marsh to be directly inundated with the nutrient and mineral laden canal water.

Another major intrusion event occurred in September 2010 following several days of elevated rainfall in the Refuge and contributing basins. The lower than normal rainfall at the onset of the wet season, coupled with inflows, were enough to keep water stages in the Refuge from falling below the water regulation schedule for the months from May to early July, regardless canal stage fell well below marsh stages through early August. Rainfall and inflow from late July through August resulted in a rapid canal stage rise and canal stages exceeding marsh stages in early September, resulting in a canal water intrusion spike. Unlike the March 2010 intrusion event, the September intrusion event delivered surface water TP concentrations elevated above 10 ppb into the marsh Perimeter Zone. The intrusion event lingered for about two weeks mostly because the inflows were not balanced with outflows. Because the system was already experiencing rainfall shortage and the Refuge stages were below the water regulation schedule, releasing water from the Refuge during these inflow events was not an option.

Previous annual reports for the Refuge (Harwell et al. 2005; USFWS 2007a, b; USFWS 2009; USFWS 2010a, b) have presented water management suggestions, including dry-down frequencies and minimization of canal water intrusion. Some of those suggestions focused on controlling inflows and outflows to minimize canal water intrusion into the marsh. In the 2005, 2006, 2007, 2008, and 2009 annual reports, we suggested that if canal water inflows were necessary, the inflow rate should be below 200 cfs (6 $m^3\ s^{-1}$) and for a short duration (< five days). Alternatively, if high inflows were necessary and canal and marsh stages were greater than the marsh sediment elevation, then outflows should be timed to inflows and be greater than inflows. The recommended timing, volume, or duration of outflows with respect to inflows was not extensively observed in 2010, similar to 2004 through 2007, most of 2008, and 2009. We continue to support the water management recommendation to reduce canal water intrusion as characterized here and in previous reports (USFWS 2007a, b; USFWS 2009; USFWS 2010a, b). Some of these management recommendations include (**Table 1**):

- Refuge inflows should be short duration (≤ 5 days) pulses of < 200 cfs (6 $m^3\ s^{-1}$) when absolute canal/marsh stage difference is < 0.2 ft (< 0.1 m) and interior water depths are < 0.5 ft (< 0.2 m).

- Refuge inflow rates can be moderate (200 to 400 cfs; 6 to 11 $m^3\ s^{-1}$) for short durations if marsh stage is > 0.6 ft (> 0.2 m) higher than canal stage and waters depths are < 0.3 ft (< 0.1 m).

- If Refuge inflows must be extended beyond short-duration pulses at high volumes and there is nowhere else to send water during these inflows, outflow should occur as soon as possible to moderate the extent of intrusion.

We have presented our recommendations at several forums to water managers and the various agencies responsible for making water management decisions. These forums include direct communication from Refuge managers, Refuge specific weekly water coordination meeting with the USACE, quarterly regional water coordination meetings, and periodic calls with the Corps of Engineers. The quarterly water coordination meetings focus on water management for the northern portion of the Everglades (from Lake Okeechobee down to Water Conservation Area 2) and consist of multiple agencies (e.g., U.S. Fish and Wildlife Service, National Park Service, Corps of Engineers, Lake Worth Drainage District, Florida Fish and

Wildlife Conservation Commission, South Florida Water Management District). Periodic calls with the Corps of Engineers focus on water management under the various water regulation schedules for each of the Water Conservation Areas.

Vegetation Dynamics Summary. We assessed temporal (2007 and 2009) and spatial differences in vegetation data across water quality zones. Spatially, we characterized difference in all the observed vegetation, while temporally we examined select emergent vegetation as distance from canal into the marsh. Plant community composition showed that the water quality Transition Zone operated as an intermediate area between the Perimeter and Interior Zones for vegetation in 2007, showing moderate to strong similarity with the Perimeter and Interior Zones. The strength of the Transition Zone similarity with the Perimeter and Interior Zones declined in 2009, but more unexpectedly, the similarity between the Perimeter and Interior Zones was much stronger. Water levels in 2009 were higher than those in 2007 and the greater water depth may be related to a decline in similarity between the Transition Zone and Perimeter and Interior Zone in 2009 as higher depths tend to reduce the visibility of some submerged and emergent vegetation. Alternatively, differences in the time for collection of samples during each year may have been a driver of differences observed. The sampling protocol has been adjusted to ensure samples are collected during the same periods.

Temporally, there was a decline in each of the selected emergent vegetation types (*Eriocaulon spp.*, *Eleocharis spp.*, *Xyris spp.*, and *Typha spp.*). Considering the increase in water levels and canal water penetration into the marsh over the two years as well as elevated levels of TP concentrations near the canal, the reduction in *Eriocaulon spp*. and *Eleocharis spp*. were expected particularly closest to the canal. The decline in observed *Typha spp*. cover, on the other hand, was counter-intuitive. Although, the percent cover of *Typha spp*. declined in 2009, the spread of *Typha spp.* further into the interior of the marsh was observed at stations (i.e., LOXA112) were *Typha spp.* was not previously observed. Longer hydroperiods and elevated TP concentrations can result in *Typha spp.* expansion (Davis 1994; Newman et al. 1996), which, though not documented by an increase in percent cover, was observed by spread of *Typha spp*. to previously unimpacted stations. In short, to generate management recommendation based on our vegetation monitoring, we must continue this study and collect enough data to reduce the variability that may result from differences in sampling periods, surveyor knowledge, or hydrologic and water quality dynamics.

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Table 1. Evolution of water management recommendation based on water quality analysis since 2004.

Recommendation
Refuge inflows should be short duration (≤ 5 days) pulses of < 5655 L s^{-1} (< 200 cfs) when absolute canal/marsh stage difference is < 0.1 m (< 0.2 ft) and interior water depths are < 0.2 m (< 0.5 ft).
Refuge inflow rates can be moderate 5655 to 11,310 L s^{-1} (200 to 400 cfs) for short durations if marsh stage is > 0.2 m (> 0.6 ft) higher than canal stage by and waters depths are < 0.1 m (< 0.3 ft).
Refuge inflows should be discontinued when the canal stage is > 0.1 m (> 0.2 ft) higher than marsh stage, unless the rainfall or outflow volumes are 3 to 4-times higher than the inflows.
Refuge inflows should be discontinued when the canal stage is > 0.2 ft (> 0.1 m) higher than marsh stage, unless the rainfall or outflow volumes are equal to or greater than inflows.
If Refuge inflows must be extended beyond short-duration pulses, outflow should be greater than inflow and last several days longer.
If Refuge inflows must be extended beyond short-duration pulses, outflow should be equal to or greater than inflow and last several days longer.
If Refuge inflows must be maintained at high rates, the S-10s and S-39 should be opened to create outflow 3 or 4-times higher than inflow.
If Refuge inflows must be maintained at high rates, the S-10s and S-39 should be opened in conjunction with canal inflows to create outflow equal to higher than inflow.
If Refuge inflows must be extended beyond short-duration pulses at high volumes and there is nowhere to send water during these inflows, outflow should proceed as soon as practicable to moderate the extent of intrusion the marsh receives from the original inflows.

Table 2. Mean, 25th and 75th percentiles, and number of days marsh (1-7) and canal (G94C) stage are greater than or equal to 17 ft.

	Mean		25th Percntile		75th Percntile		Days >= 17 ft	
	1-7	G-94C	1-7	G-94C	1-7	G-94C	1-7	G-94C
Year	ft	ft	ft	ft	ft	ft	days	days
2004	16.37	15.51	16.04	14.94	16.68	16.57	21	17
2005	16.30	16.09	16.12	15.71	16.46	16.36	0	0
2006	16.32	16.17	16.08	15.82	16.57	16.58	14	17
2007	16.35	15.83	15.96	14.92	16.81	16.83	53	54
2008	16.68	16.46	16.49	16.21	16.92	16.89	65	62
2009	16.35	16.03	16.16	15.71	16.59	16.54	0	0
2010	16.62	16.39	16.52	16.05	16.71	16.71	0	7

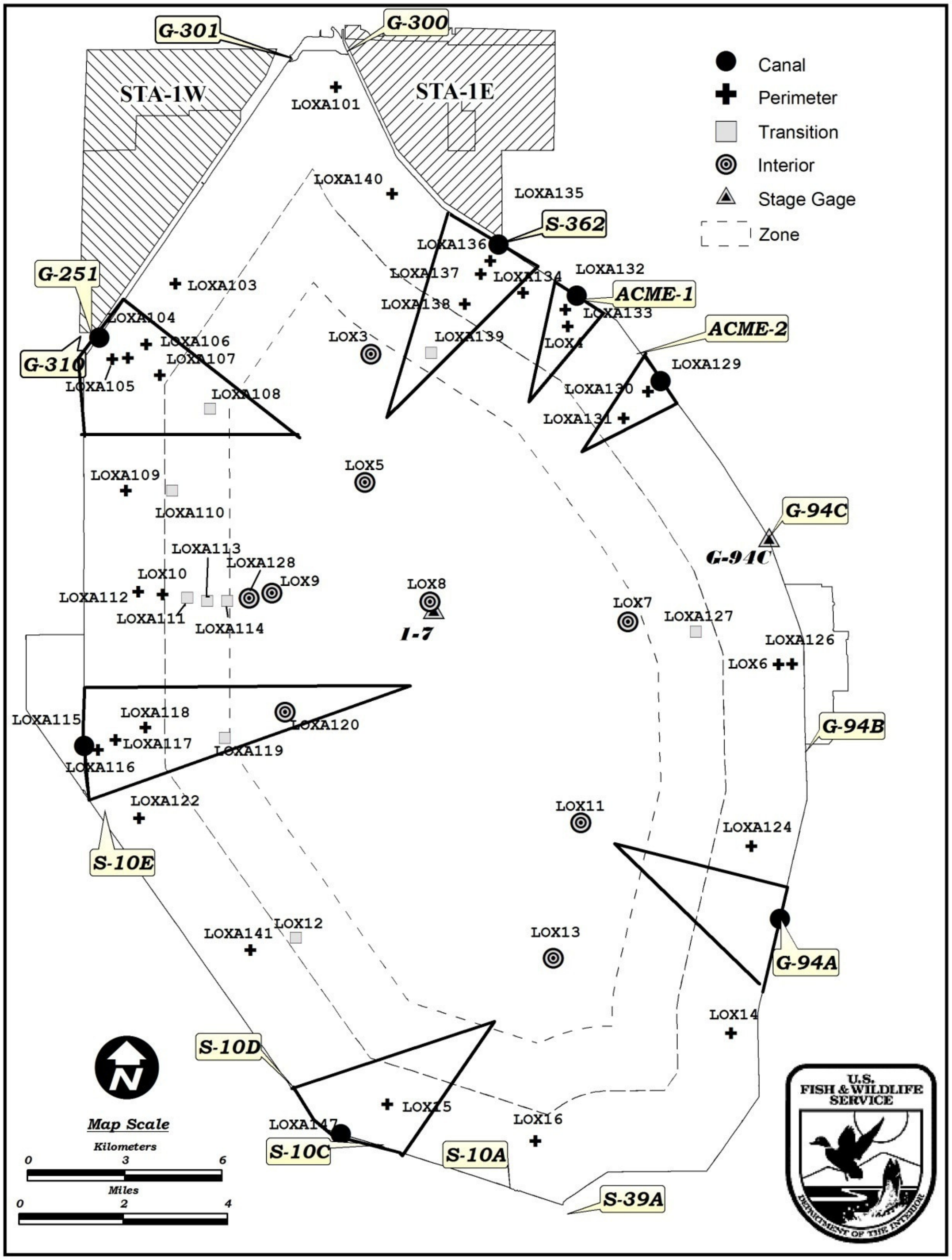
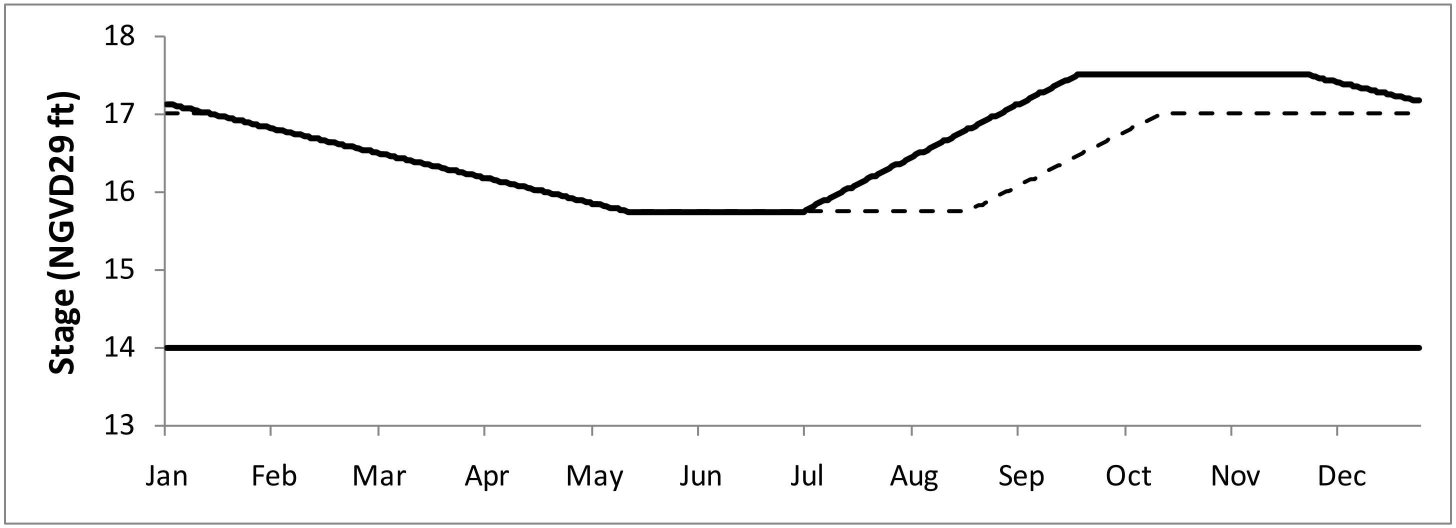


Figure 1. LOXA (LOXA###) and EVPA (LOX#) water quality monitoring stations, inflow and outflow structures, and canal and marsh stage gages used in this report. Solid polygons delineate transects, dashed polygons represent marsh zones.



DATES	USE GAGE	CONDITIONS
1 Jan - 30 Jun	1-8 Canal	All
1 Jul - 31 Dec	1-8 Canal	Except as noted below
	Avg. 1-7, 1-8T, 1-9	During rising stage when canal stage exceeds average.

ZONE	RELEASES
A1	Up to maximum at S-10 (and S-39 when agreed between Corp and SFWMD). Water supply releases as needed.
A2	S-10 releases based on Corps forecasts. Water supply releases as needed. If Lake Okeechobee stage is above WCA-1 stage or no more than one foot below WCA-1 stage, then water supply release from WCA-1 must be preceeded by an equivalent volume of inflow.
B	Water supply is needed. If Lake Okeechobee stage is above WCA-1 stage or no more than one foot below WCA-1 stage, then water supply releases from WCA-1 must be preceeded by an equivalent volume of inflow.
C	No net releases from WCA-1. Any water supply releases must be preceeded by an equivalent volume of inflow.

Figure 2. Water Regulation Schedule for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (USACE 1994).

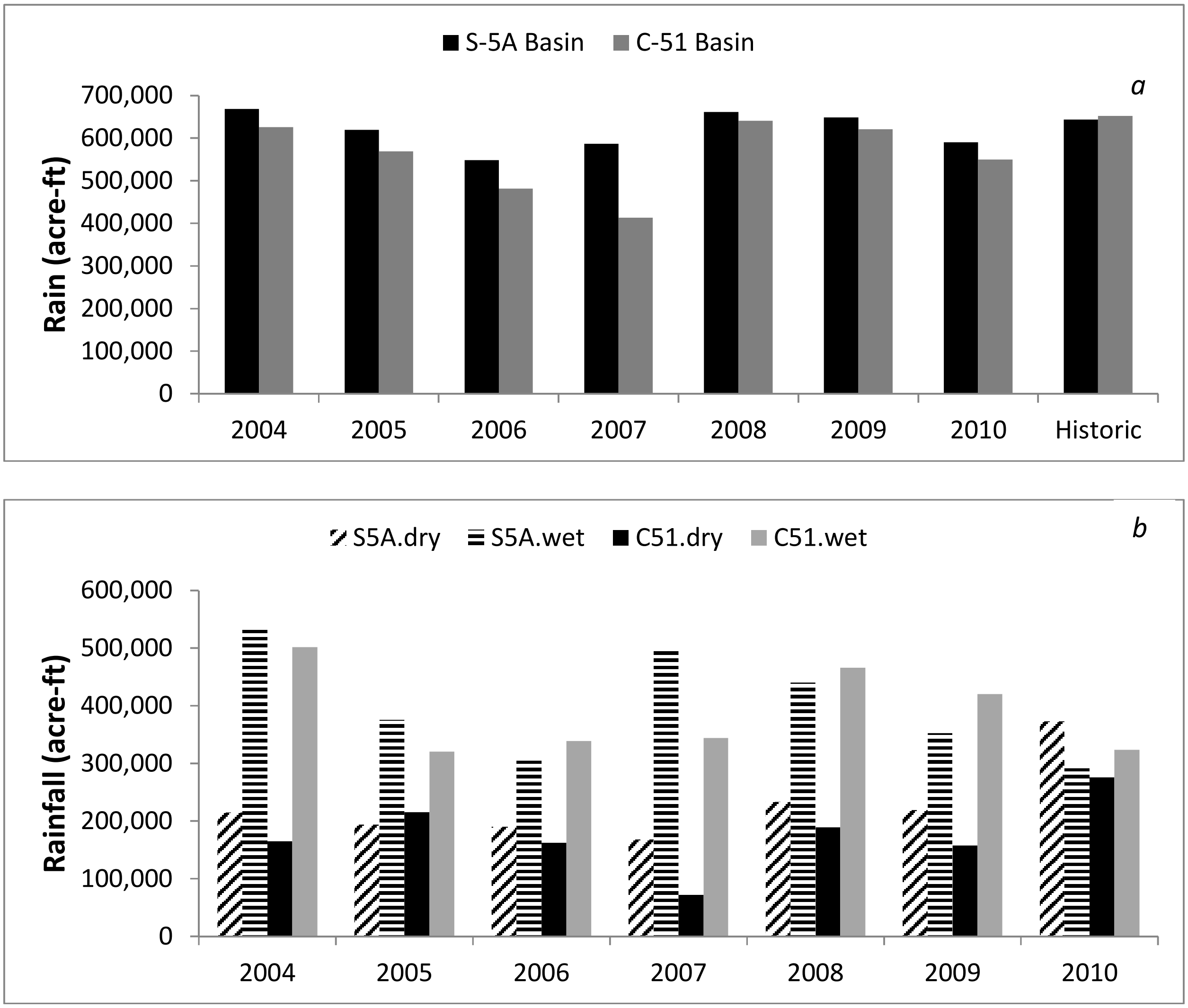


Figure 3. (*a*) Total annual and (*b*) dry and wet season rainfall for the S-5A and C-51 basins. Historic rainfall was determined from 1963 through 2010.

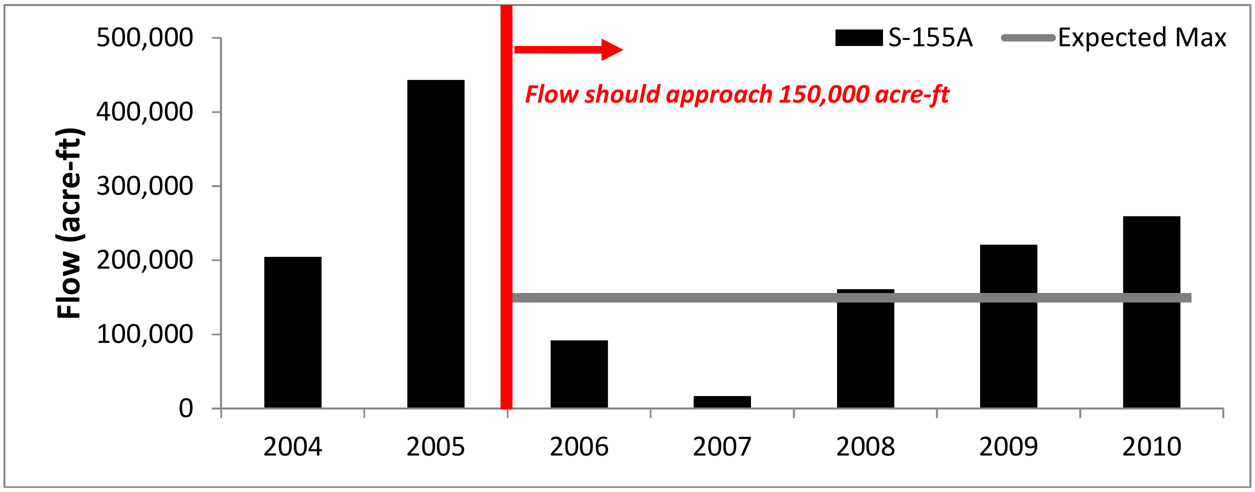


Figure 4. Total annual flows through the S-155A structure. The red vertical bar represents the period when flows through S-155A should approach 150,000 acre-ft as a mixture of L-8 and C-51 basin runoff (Gary Goforth, Inc. 2008). The horizontal grey bar represents the expected maximum (150,000 acre-ft) through S-155A.

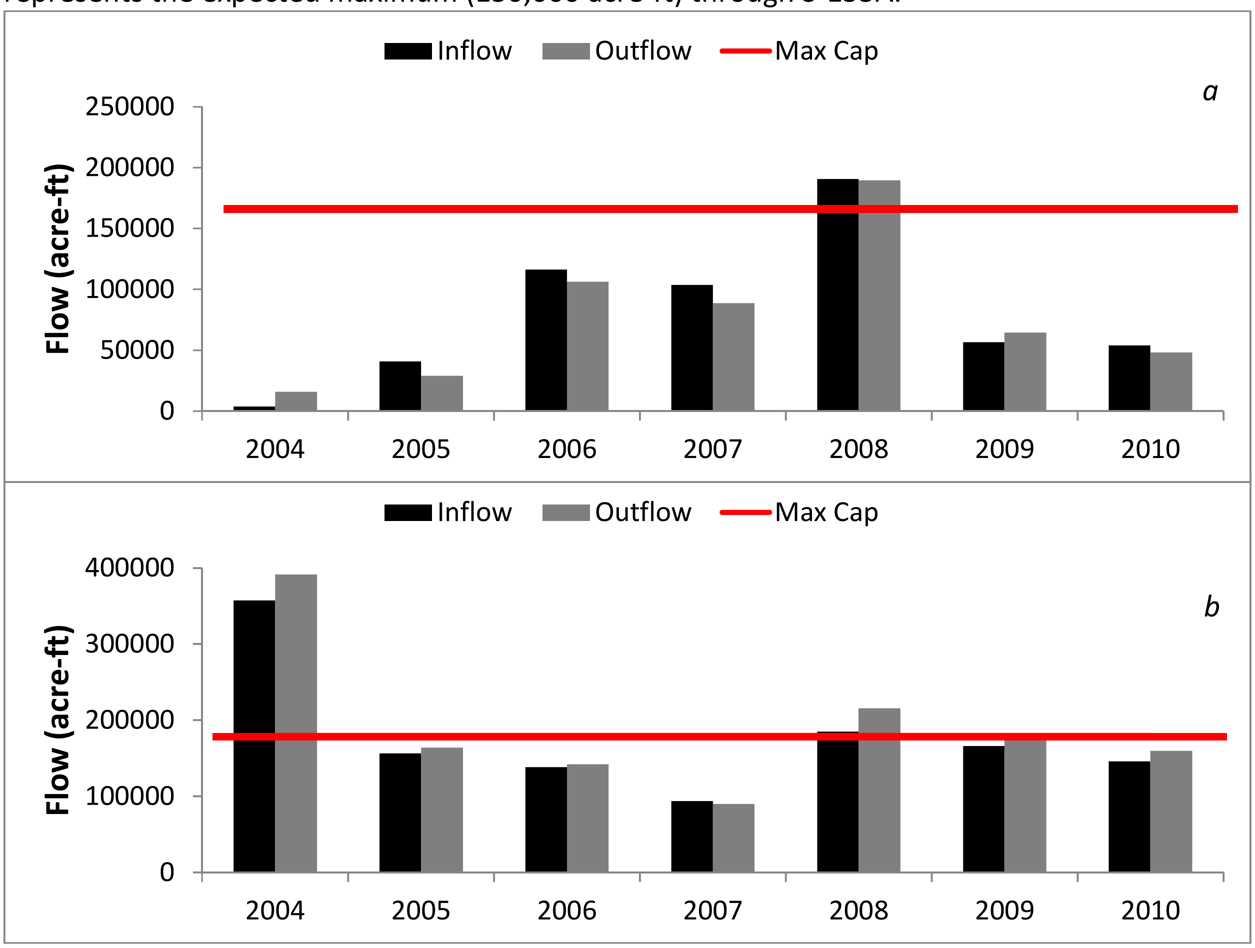


Figure 5. (a) STA1E and (b) STA1W annual inflow and outflow volumes. Horizontal red lines represent maximum treatment capacities for STA1E (165,000 acre-ft) and STA1W (180,000 acre-ft; Gary Goforth, Inc. 2008).

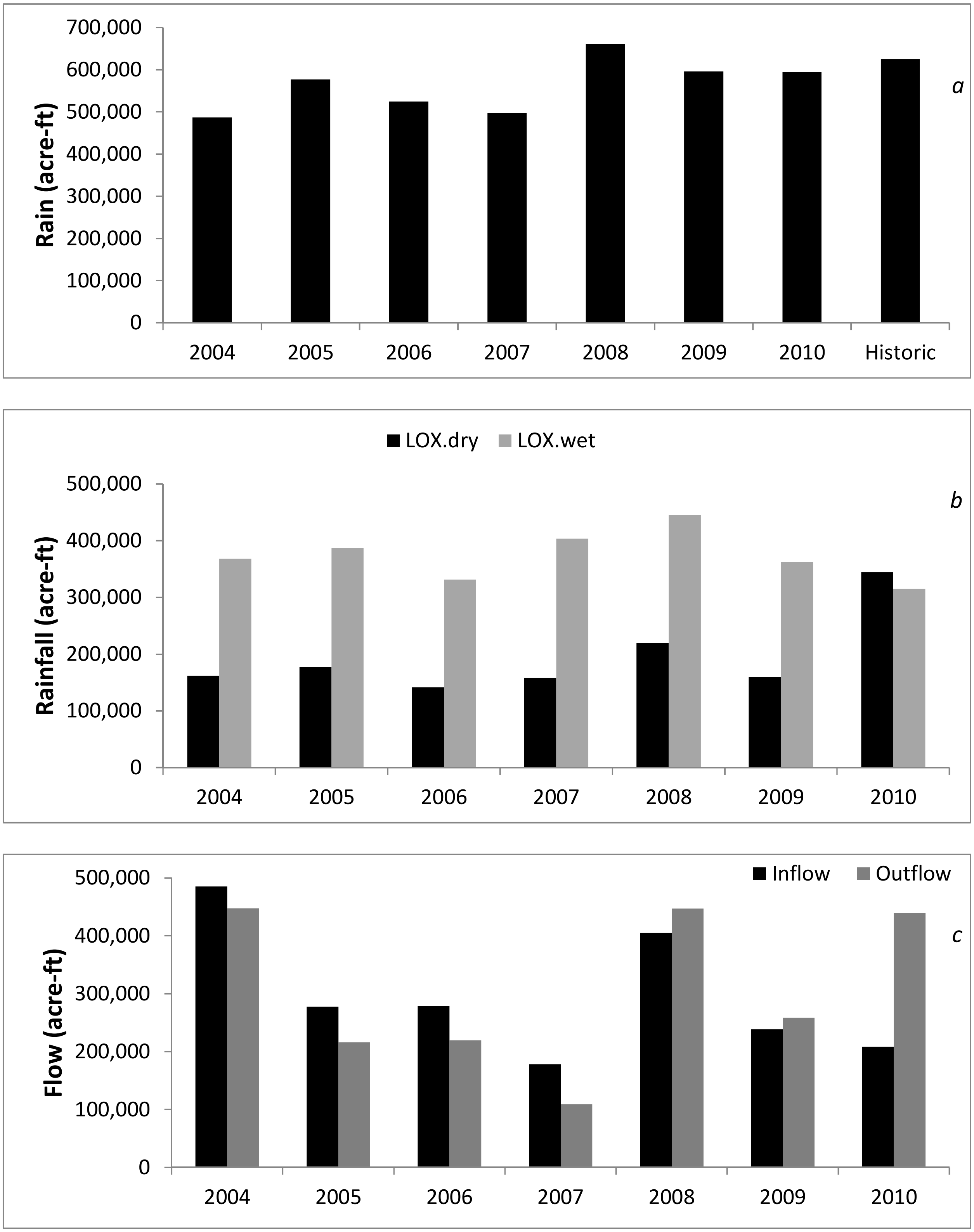


Figure 6. (*a*) Total annual rainfall, (*b*) total dry and wet season rainfall, and (*c*) inflow and outflow for the Refuge. Historic rainfall was determined from 1963 through 2010.

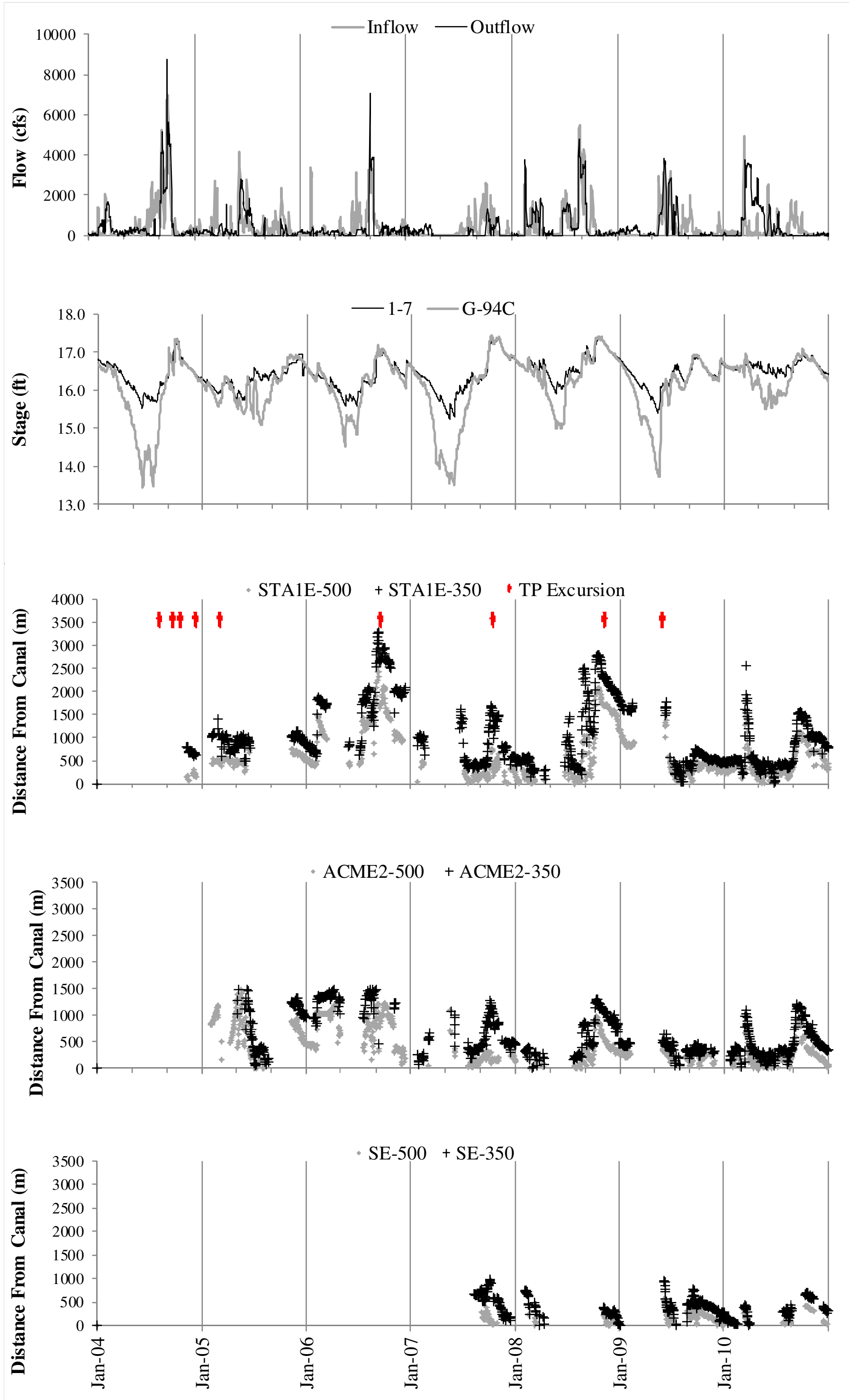


Figure 7. a) Inflow and outflow rates (cfs) summed for all structures from January 2004 to December 2009. b) Canal (G-94C) and marsh (1-7) stage levels (NGVD29). The 350 µS cm^{-1} and 500 µS cm^{-1} conductivity isopleths used to track canal water movement into and out of the marsh interior for: c) STA-1E, d) ACME-2, and e) SE transects. Red arrows indicate total phosphorus Consent Decree excursions.

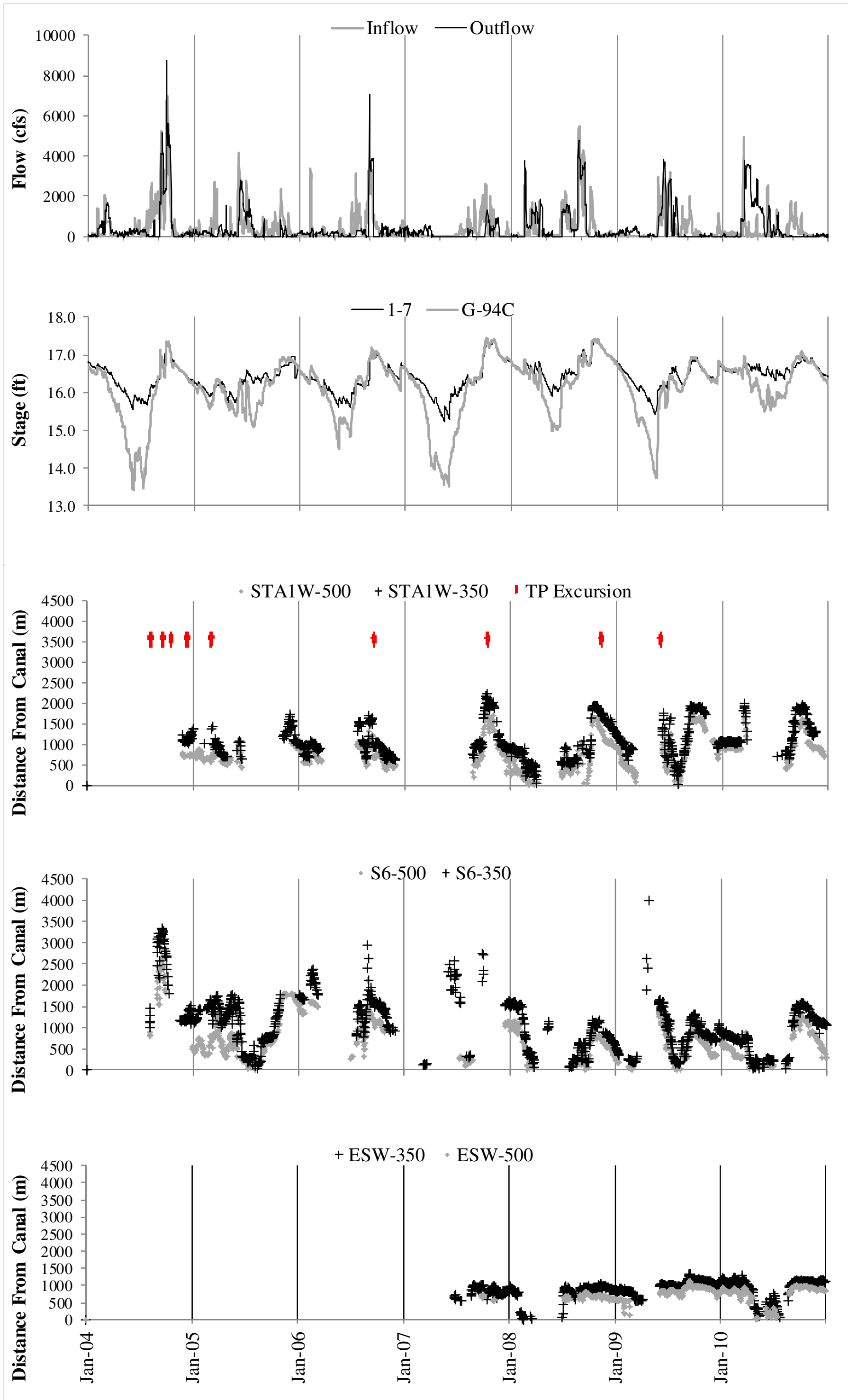


Figure 8. a) Inflow and outflow rates (cfs) summed for all structures from January 2004 to December 2009. b) Canal (G-94C) and marsh (1-7) stage levels (NGVD29). The 350 µS cm^{-1} and 500 µS cm^{-1} conductivity isopleths used to track canal water movement into and out of the marsh interior for: c) STA-1W, d) S-6, and e) the new ESW transects. Red arrows indicate total phosphorus Consent Decree excursions.

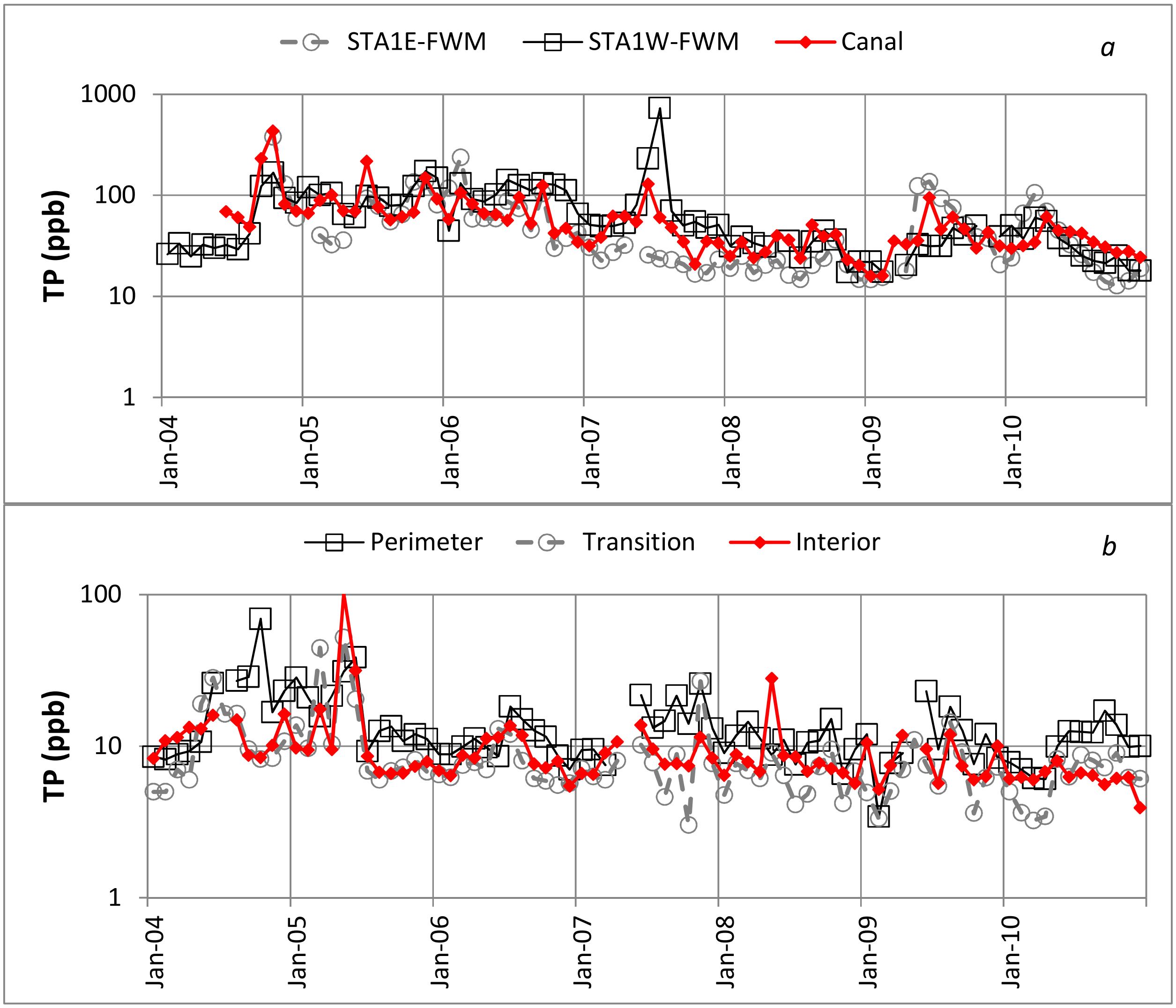
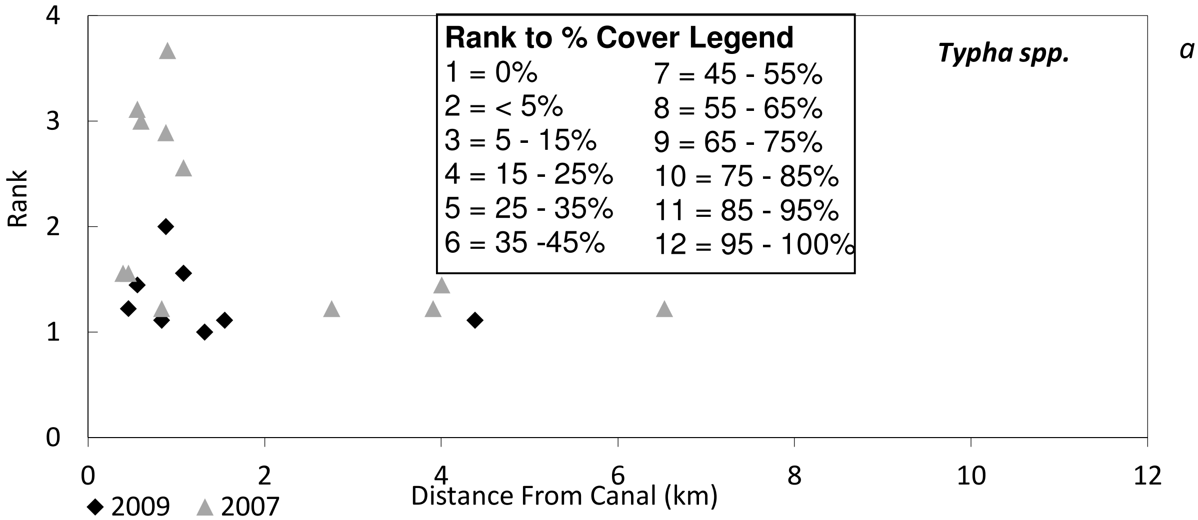
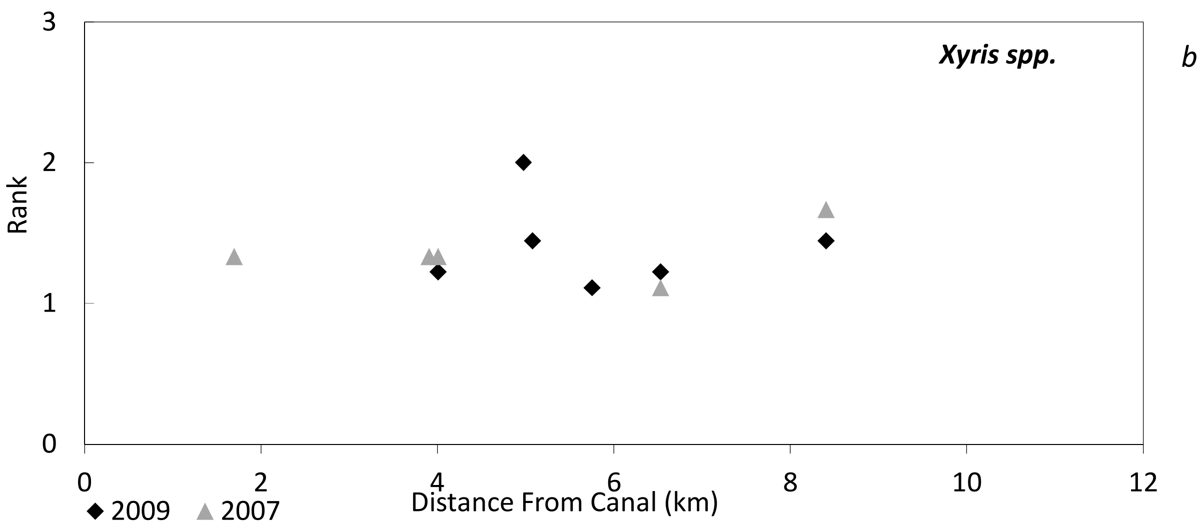


Figure 9. (a) Monthly TP FWM from Refuge inflow structures and TP concentration in the canal. (b) Monthly mean TP concentrations in marsh zones. The y-axes are based on a logarithmic scale.


Rank to % Cover Legend
1 = 0%
2 = < 5%
3 = 5 - 15%
4 = 15 - 25%
5 = 25 - 35%
6 = 35 -45%
7 = 45 - 55%
8 = 55 - 65%
9 = 65 - 75%
10 = 75 - 85%
11 = 85 - 95%
12 = 95 - 100%
Typha spp.
a
Rank
Distance From Canal (km)
2009
2007


Xyris spp.
b
Rank
Distance From Canal (km)
2009
2007

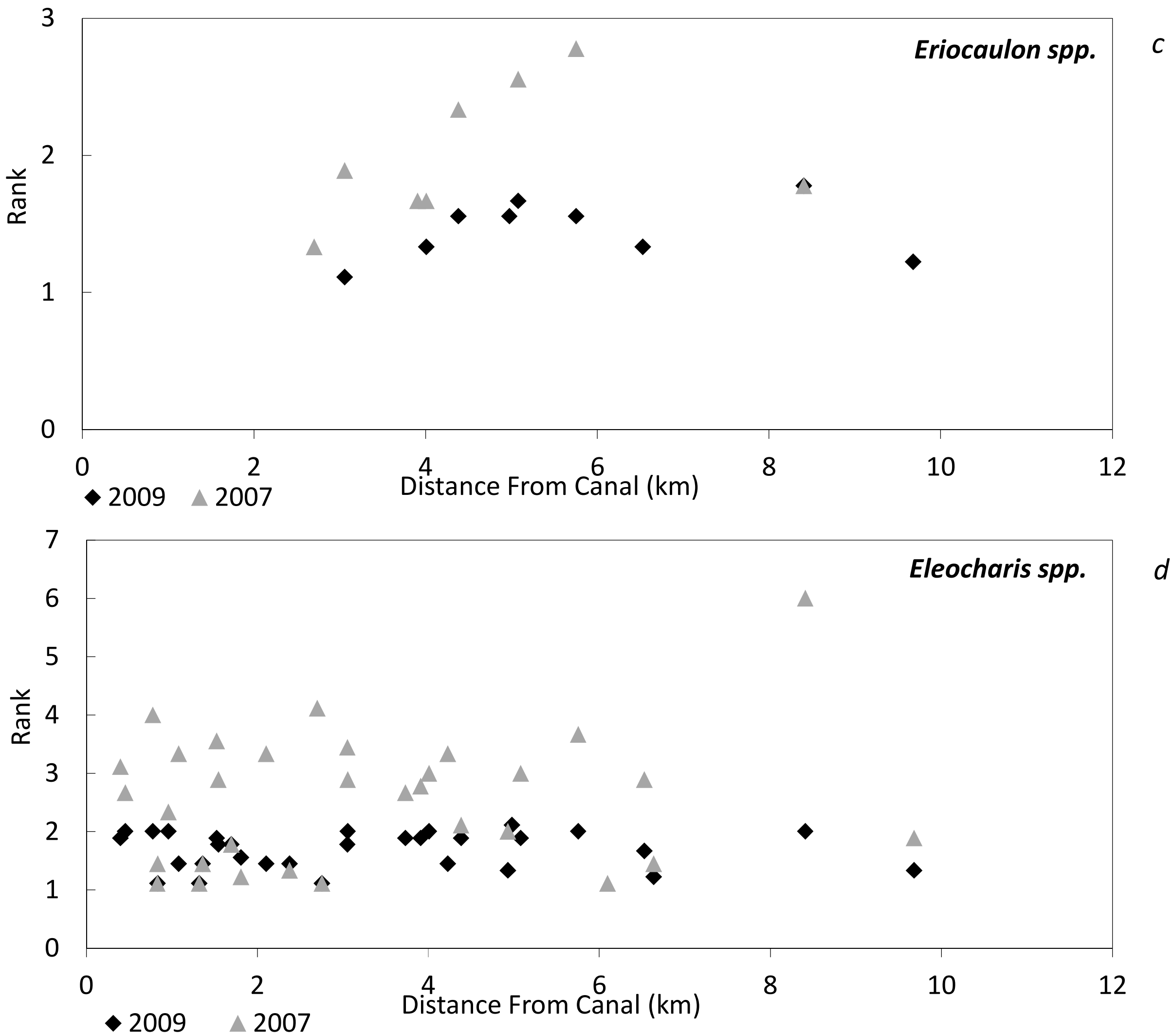


Figure 10. (*a*) *Typha spp*., (*b*) *Xyrix spp*., (*c*) *Eriocaulon spp*., and (d) *Eleocharis spp.* ranks for each sampled water quality station plotted as distance from canal into the marsh. Solid triangles represent samples collected in 2007, while solid diamonds represent samples collected in 2009.

APPENDIX A

Table A-1. *(a)* Parameter abbreviations spelled-out. *(b)* Individual EVPA and LOXA station summary statistics of water quality data for calendar year 2009. Where values were below the minimum detection limits, one-half of the minimum detection limit is reported (Weaver et al. 2008). Previous summary statistics (2004 – 2009) can be found in the previous annual reports (USFWS 2007a, b, 2009, 2010a, b).

ABBREVIATION	TERM	UNIT
TEMP	Temperature	Celsius
DO	Dissolved oxygen	mg L^{-1}
SPCOND	Specific conductance	$\mu S\ cm^{-1}$
pH	pH	
TURB	Turbidity	mg L^{-1}
TSS	Total suspended solids	mg L^{-1}
NOX	Nitrate+nitrite	mg L^{-1}
TKN	Total Kjeldahl Nitrogen	mg L^{-1}
TN	Total nitrogen	mg L^{-1}
OPO4	Orthophosphate	$\mu g\ L^{-1}$
TP	Total phosphorus	$\mu g\ L^{-1}$
SIO2	Silica	mg L^{-1}
CA	Calcium	mg L^{-1}
CL	Chloride	mg L^{-1}
SO4	Sulfate	mg L^{-1}
ALKALNYA	Alkalinity	mg L^{-1}
TDOC	Total dissolved organic carbon	mg L^{-1}
TOC	Total organic carbon	mg L^{-1}
TDS	Total dissolved solids	mg L^{-1}

b

STATION	STAT	TEMP	DO	SPCOND	PH	TURB	TSUSSD	NOX	TKN	TN	OPO4	TP	SIO2	CA	CL	SO4	ALKALNYA	TDORGC	TOTORCC	TDSSOL
A101	Count	10	10	10	10	5	10	5	5	5	5	10	5	5	10	10	5	5	5	5
	Mean	20.5	4.7	560	7.0	0.37	2.7	0.003	1.404	1.407	6.1	15.7	15.2	45	91	9	142.4	25.5	29.7	414.2
	StDev	7.1	1.7	159	0.2	0.08	1.2	0.002	0.137	0.136	3.1	7.3	9.5	4	33	9	17.9	10.4	1.8	40.2
	Min	7.0	2.3	280	6.8	0.28	1.0	0.002	1.230	1.235	1.5	7.4	4.3	40	30	2	119.0	7.2	27.0	369.0
	Max	29.1	7.4	745	7.5	0.47	5.3	0.005	1.600	1.602	10.1	31.6	26.7	49	120	34	160.0	31.6	31.3	460.0
A102	Count	6	6	6	6	2	6	2	2	2	2	6	2	2	6	6	2	2	2	2
	Mean	18.8	5.8	256	6.8	0.45	1.8	0.005	0.995	1.000	6.7	8.2	20.0	25	41	5	68.9	22.6	22.4	253.5
	StDev	5.7	2.6	109	0.2	0.04	0.8	0.000	0.078	0.078	0.2	5.1	0.9	1	20	5	4.0	1.2	1.3	2.1
	Min	13.9	2.0	169	6.5	0.42	1.0	0.005	0.940	0.945	6.5	3.9	19.3	24	26	1	66.0	21.7	21.5	252.0
	Max	27.5	9.0	395	7.1	0.48	2.5	0.005	1.050	1.055	6.8	16.3	20.6	25	70	13	71.7	23.4	23.3	255.0
A103	Count	6	6	6	6	3	6	3	3	3	3	6	3	3	6	6	3	3	3	3
	Mean	17.9	4.3	282	6.9	0.50	2.5	0.005	1.017	1.021	6.0	11.7	16.7	23	47	3	70.0	25.1	24.9	251.3
	StDev	7.1	2.3	150	0.3	0.18	0.3	0.000	0.162	0.162	1.6	4.5	7.3	10	27	4	28.8	4.5	4.3	101.3
	Min	8.3	1.5	164	6.5	0.32	2.0	0.005	0.830	0.835	4.7	6.6	8.3	13	26	1	41.2	20.3	20.4	142.0
	Max	27.7	7.5	528	7.3	0.68	3.0	0.005	1.120	1.125	7.8	20.0	21.0	34	88	10	98.8	29.1	29.0	342.0
A104	Count	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12
	Mean	22.5	5.5	851	7.6	2.09	4.3	0.049	1.838	1.919	7.6	31.3	15.6	56	129	51	177.8	29.9	29.5	524.6
	StDev	7.1	2.3	162	0.2	1.98	2.7	0.050	0.333	0.318	3.6	9.4	9.3	14	27	25	37.8	5.6	5.6	112.3
	Min	7.6	2.3	567	7.2	0.14	2.5	0.004	1.500	1.577	1.5	19.9	2.2	35	78	25	130.0	23.0	23.0	360.0
	Max	29.6	9.1	1102	7.9	7.70	9.5	0.167	2.420	2.481	16.0	56.0	30.0	79	161	101	237.0	40.8	41.0	724.0
A105	Count	11	11	11	11	6	11	6	6	5	6	11	6	6	11	11	6	6	6	6
	Mean	20.8	3.9	572	7.0	0.50	2.3	0.004	1.623	1.713	3.7	14.9	16.9	45	88	19	157.2	30.0	30.0	439.2
	StDev	7.0	1.9	196	0.3	0.15	0.8	0.002	0.325	0.276	2.2	7.7	8.9	10	31	20	13.3	4.4	5.3	96.8
	Min	7.7	1.5	250	6.7	0.32	1.0	0.002	1.190	1.415	1.0	1.5	6.2	31	33	3	135.0	24.4	22.4	284.0
	Max	29.0	7.3	847	7.5	0.78	4.0	0.005	2.100	2.105	6.6	25.5	28.3	58	121	67	170.0	36.1	36.6	549.0
A106	Count	11	11	11	11	5	11	5	5	5	5	11	5	5	11	11	5	5	5	5
	Mean	21.3	4.7	341	7.0	0.45	2.3	0.003	1.164	1.167	3.7	8.6	10.5	29	51	7	97.8	20.9	22.0	278.6
	StDev	7.0	2.4	164	0.2	0.14	1.1	0.002	0.282	0.283	2.1	5.5	10.6	11	29	10	28.8	6.0	4.8	124.0
	Min	7.6	1.8	189	6.7	0.29	1.0	0.002	0.900	0.902	1.5	1.5	0.4	20	20	1	73.2	13.0	18.0	160.0
	Max	29.5	9.2	647	7.4	0.62	5.0	0.005	1.510	1.515	6.7	15.6	22.2	44	104	28	132.0	28.2	28.4	419.0
A107	Count	5	5	5	5	2	5	2	2	2	2	5	2	2	5	5	2	2	2	2
	Mean	19.1	4.5	155	6.8	0.46	2.3	0.005	1.025	1.030	3.9	9.2	10.8	13	26	1	45.8	26.4	26.0	151.0
	StDev	6.8	1.7	22	0.3	0.04	0.8	0.000	0.035	0.035	1.6	7.0	0.6	0	2	0	4.5	4.4	3.5	15.6
	Min	11.4	1.6	126	6.4	0.43	1.0	0.005	1.000	1.005	2.7	1.5	10.3	13	23	1	42.6	23.3	23.5	140.0
	Max	27.4	6.1	187	7.3	0.49	3.0	0.005	1.050	1.055	5.0	18.6	11.2	14	29	1	48.9	29.5	28.4	162.0
A108	Count	10	10	10	10	3	10	3	3	3	3	10	3	3	10	10	3	3	3	3
	Mean	22.8	6.7	137	6.9	0.62	2.8	0.005	1.223	1.228	4.7	7.1	3.6	6	28	0	16.4	22.4	22.1	104.3
	StDev	6.7	2.2	24	0.3	0.23	0.7	0.000	0.227	0.227	2.2	2.5	0.4	1	7	0	1.1	2.3	1.9	4.7
	Min	10.7	4.2	103	6.4	0.36	2.0	0.005	1.050	1.055	2.9	1.5	3.2	6	19	0	15.4	20.6	20.5	99.0
	Max	32.8	11.1	188	7.3	0.79	4.0	0.005	1.480	1.485	7.1	9.9	4.0	7	42	1	17.5	25.0	24.2	108.0

STATION	STAT	TEMP	DO	SPCOND	PH	TURB	TSUSSD	NOX	TKN	TN	OPO4	TP	SIO2	CA	CL	SO4	ALKALNYA	TDORGC	TOTORCC	TDSSOL
A109	Count	12	12	12	12	10	12	10	10	9	10	12	10	10	12	12	10	10	10	10
	Mean	21.6	5.2	159	6.7	0.57	2.2	0.003	0.919	0.927	2.4	7.5	3.9	12	24	2	37.3	17.2	17.1	113.4
	StDev	6.6	2.5	62	0.3	0.28	0.9	0.002	0.136	0.142	1.7	3.3	4.2	3	13	3	6.1	1.8	2.1	43.9
	Min	7.6	1.2	84	6.3	0.25	1.0	0.002	0.680	0.685	1.0	1.5	0.1	8	10	1	28.0	13.2	13.5	56.0
	Max	28.6	9.3	289	7.5	1.20	4.0	0.005	1.100	1.102	5.2	11.3	12.5	18	54	9	45.5	19.6	19.8	200.0
A110	Count	12	12	12	12	5	12	5	5	5	5	12	5	5	12	12	5	5	5	5
	Mean	22.1	7.0	119	7.0	0.60	2.6	0.009	1.098	1.107	4.5	7.9	2.4	7	19	0	25.4	15.7	15.7	78.0
	StDev	7.0	1.7	26	0.4	0.17	0.8	0.007	0.268	0.274	2.8	2.1	1.7	1	5	0	4.9	2.2	2.3	21.8
	Min	6.6	4.6	85	6.6	0.46	1.0	0.005	0.790	0.795	1.0	4.2	0.4	6	13	0	21.5	13.3	13.1	53.0
	Max	30.5	10.3	170	7.8	0.88	4.0	0.020	1.500	1.520	8.5	10.3	4.4	8	28	1	33.3	18.0	18.0	110.0
A111	Count	12	12	12	12	7	12	7	7	7	7	12	7	7	12	12	7	7	7	7
	Mean	21.1	5.5	84	6.7	0.50	2.5	0.005	0.684	0.689	3.4	5.1	2.4	6	12	1	18.2	12.3	12.6	60.4
	StDev	6.9	1.9	14	0.8	0.16	0.8	0.004	0.114	0.115	2.2	2.7	2.0	1	3	0	4.2	1.4	1.3	11.6
	Min	7.4	3.1	63	6.0	0.27	1.0	0.002	0.540	0.542	1.0	1.5	0.3	4	8	1	12.9	9.8	10.4	41.0
	Max	28.3	8.6	111	8.3	0.75	4.0	0.014	0.900	0.905	6.7	9.4	5.8	7	18	1	23.0	14.5	14.6	80.0
A112	Count	12	12	12	12	8	12	8	8	8	8	12	8	8	12	12	8	8	8	8
	Mean	21.6	4.5	105	6.6	0.53	2.5	0.003	0.839	0.842	3.1	7.6	3.5	9	13	1	31.0	15.0	14.7	82.8
	StDev	6.8	2.1	22	0.5	0.23	0.7	0.002	0.118	0.119	1.2	4.6	2.0	1	4	0	5.6	1.9	1.4	21.1
	Min	7.4	1.4	71	6.2	0.30	1.0	0.002	0.690	0.692	1.5	1.5	1.6	8	8	1	24.3	13.0	13.0	43.0
	Max	29.4	7.5	142	8.1	0.89	4.0	0.005	1.040	1.045	4.6	17.4	6.3	11	20	1	38.0	18.3	16.7	110.0
A113	Count	12	12	12	12	8	12	8	8	8	8	12	8	8	12	12	8	8	8	8
	Mean	21.3	5.3	81	6.8	0.55	2.3	0.004	0.845	0.849	3.8	4.8	2.5	5	13	0	16.9	13.7	13.7	61.1
	StDev	6.9	1.8	14	0.6	0.18	0.5	0.001	0.138	0.138	3.0	2.7	1.6	1	4	0	4.7	1.2	1.1	16.3
	Min	7.3	3.4	63	6.0	0.23	1.0	0.002	0.640	0.645	1.5	1.5	0.3	4	8	0	13.0	12.0	12.0	28.0
	Max	28.8	8.1	108	8.0	0.80	2.5	0.005	1.060	1.065	10.0	9.7	5.0	6	20	1	27.9	15.6	15.4	87.0
A114	Count	12	12	12	12	8	12	8	8	8	8	12	8	8	12	12	8	8	8	8
	Mean	21.3	5.1	85	6.7	0.86	3.0	0.004	0.850	0.854	2.9	4.6	2.3	5	14	0	14.5	13.7	14.0	55.4
	StDev	6.7	2.8	13	0.5	0.87	2.2	0.005	0.125	0.124	1.2	3.4	1.5	0	4	0	3.1	1.6	1.8	11.6
	Min	7.8	1.2	69	5.9	0.39	1.0	0.002	0.680	0.685	1.5	1.5	0.4	4	8	0	12.0	10.7	10.9	37.0
	Max	28.9	10.1	107	7.4	2.93	9.5	0.015	1.070	1.075	5.0	11.7	5.0	6	21	1	21.9	15.5	16.4	71.0
A115	Count	11	10	11	11	11	12	12	12	11	12	12	12	12	12	12	12	12	12	12
	Mean	22.7	5.7	811	7.6	1.17	2.7	0.033	1.778	1.817	9.4	28.2	16.3	54	119	57	166.5	30.2	30.4	513.3
	StDev	6.4	2.6	279	0.3	0.52	0.8	0.026	0.455	0.484	4.7	5.8	8.9	19	42	28	53.0	7.6	7.5	169.7
	Min	12.9	2.3	265	7.0	0.64	1.0	0.002	0.950	0.952	1.5	20.0	4.4	19	31	9	71.0	17.0	17.0	180.0
	Max	30.6	9.4	1115	7.9	2.40	4.5	0.086	2.750	2.811	16.4	37.0	29.2	89	160	93	241.0	41.4	41.2	740.0
A117	Count	11	10	11	11	9	12	9	9	8	9	12	9	9	12	12	9	9	9	9
	Mean	20.6	4.2	330	6.9	0.78	2.5	0.005	1.111	1.121	4.5	14.5	10.0	26	46	9	82.3	22.3	22.5	246.7
	StDev	7.0	3.5	186	0.4	0.55	0.9	0.003	0.338	0.361	2.4	9.1	7.4	11	33	12	29.0	5.7	5.5	120.5
	Min	7.3	1.1	126	6.4	0.26	1.0	0.002	0.870	0.872	1.5	4.2	2.3	12	12	1	42.1	14.7	15.1	98.0
	Max	28.6	12.3	652	7.9	2.04	4.0	0.010	1.870	1.875	9.1	33.2	21.8	44	102	39	122.0	30.5	29.9	440.0

STATION	STAT	TEMP	DO	SPCOND	PH	TURB	TSUSSD	NOX	TKN	TN	OPO4	TP	SIO2	CA	CL	SO4	ALKALNYA	TDORGC	TOTORCC	TDSSOL
A118	Count	11	10	11	11	10	12	11	11	10	11	12	11	11	12	12	11	11	11	11
	Mean	20.9	5.9	139	6.7	0.42	2.2	0.003	0.866	0.874	4.0	7.6	6.1	10	19	1	33.5	15.3	15.5	102.4
	StDev	7.0	7.4	39	0.5	0.11	0.6	0.002	0.157	0.165	2.4	3.7	3.4	2	7	0	6.1	1.6	1.7	24.0
	Min	7.9	1.3	86	6.2	0.25	1.0	0.002	0.660	0.662	1.5	1.5	1.4	7	11	1	24.2	12.8	13.6	69.0
	Max	29.1	26.2	223	7.9	0.58	2.5	0.005	1.100	1.102	8.4	13.2	13.0	15	37	2	45.1	18.8	19.2	153.0
A119	Count	11	10	11	11	11	12	12	12	11	12	12	12	12	12	12	12	12	12	12
	Mean	22.0	10.2	105	6.9	0.74	2.3	0.004	1.052	1.062	4.5	6.6	4.5	8	15	0	26.1	16.4	16.6	86.7
	StDev	6.9	15.0	14	0.4	0.43	0.5	0.003	0.129	0.133	2.1	3.2	1.3	1	3	0	2.7	1.7	1.8	11.1
	Min	9.6	2.4	83	6.5	0.31	1.0	0.002	0.780	0.785	1.5	1.5	2.5	7	11	0	22.1	13.9	13.9	65.0
	Max	30.3	52.5	132	7.5	1.84	3.0	0.012	1.200	1.202	8.6	12.3	6.9	9	21	1	31.7	19.0	19.0	100.0
A120	Count	11	10	11	11	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12
	Mean	22.3	6.0	97	6.8	0.56	2.4	0.004	0.961	0.972	3.9	4.9	3.7	5	18	0	17.8	14.6	14.8	74.7
	StDev	6.5	2.7	9	0.5	0.17	0.8	0.002	0.139	0.143	1.5	2.3	1.9	0	3	0	6.3	1.6	1.7	13.0
	Min	10.5	3.3	85	6.2	0.24	1.0	0.002	0.740	0.745	1.5	1.5	1.0	5	14	0	12.5	12.6	13.0	55.0
	Max	29.6	11.3	110	7.6	0.84	4.0	0.008	1.300	1.302	6.3	8.1	6.3	6	23	1	32.0	18.0	18.0	92.0
A122	Count	11	10	11	11	10	12	10	10	9	10	12	10	10	12	12	10	10	10	10
	Mean	21.0	3.3	323	6.9	0.71	2.0	0.003	1.066	1.083	4.1	12.5	9.1	29	40	5	98.0	21.1	21.4	222.7
	StDev	6.4	2.3	137	0.4	0.39	0.7	0.002	0.194	0.201	3.2	6.6	4.6	11	22	5	29.6	3.9	3.9	81.6
	Min	9.7	1.1	113	6.5	0.25	1.0	0.002	0.860	0.862	1.5	1.5	2.5	13	9	1	40.8	13.3	13.8	80.0
	Max	28.1	8.4	495	7.5	1.46	2.5	0.009	1.370	1.375	11.2	20.9	16.3	42	70	15	130.0	26.0	26.1	329.0
A124	Count	11	10	11	11	8	12	8	8	7	8	12	8	8	12	12	8	8	8	8
	Mean	21.5	2.8	164	6.9	0.42	2.4	0.003	0.881	0.891	3.8	12.8	5.9	13	28	1	32.9	17.2	17.5	124.1
	StDev	6.6	1.4	55	0.3	0.11	0.8	0.002	0.108	0.114	2.1	4.2	5.0	3	11	0	12.2	1.2	1.2	35.7
	Min	12.5	0.8	117	6.4	0.27	1.0	0.002	0.750	0.755	1.5	6.7	0.7	10	17	0	16.0	16.0	15.0	78.0
	Max	29.6	5.0	273	7.4	0.62	4.0	0.005	1.070	1.075	7.0	19.0	13.0	19	52	2	49.2	19.0	19.0	177.0
A126	Count	12	11	12	12	10	12	10	10	9	10	12	10	10	12	12	10	10	10	10
	Mean	23.1	5.2	361	7.0	0.63	2.3	0.004	1.213	1.230	4.2	12.6	7.5	25	60	8	76.0	20.1	20.3	244.8
	StDev	7.0	2.6	199	0.3	0.28	0.8	0.002	0.214	0.223	3.0	5.5	7.7	14	35	12	40.6	4.3	4.5	133.4
	Min	12.6	0.6	140	6.5	0.35	1.0	0.002	0.950	0.956	1.5	3.2	0.1	11	17	1	30.0	15.0	15.0	100.0
	Max	32.2	9.5	767	7.7	1.27	4.0	0.008	1.630	1.635	8.8	20.1	19.4	53	121	40	152.0	27.6	28.0	486.0
A127	Count	10	9	10	10	7	11	7	7	6	7	11	7	7	11	11	7	7	7	7
	Mean	22.2	5.8	103	6.7	0.44	2.6	0.003	0.989	0.997	5.8	7.1	4.5	6	19	0	13.1	16.7	17.0	83.9
	StDev	6.8	2.9	12	0.5	0.17	1.1	0.001	0.065	0.071	2.9	5.0	3.6	1	3	0	3.2	2.3	2.1	14.2
	Min	13.2	1.6	85	6.0	0.28	1.0	0.002	0.940	0.942	1.5	1.5	0.7	5	14	0	8.5	15.0	15.4	69.0
	Max	32.6	8.3	125	7.6	0.79	4.0	0.005	1.130	1.135	10.1	17.6	8.3	7	23	1	17.6	21.6	21.6	112.0
A128	Count	12	11	12	12	6	12	6	6	6	6	12	6	6	12	12	6	6	6	6
	Mean	23.9	6.3	95	6.7	0.48	2.7	0.003	0.930	0.933	4.7	4.5	2.2	5	15	0	12.8	15.6	15.5	75.7
	StDev	6.9	1.9	15	0.5	0.10	1.2	0.002	0.148	0.147	2.2	2.9	1.8	0	5	0	2.8	1.4	1.9	18.3
	Min	11.4	3.9	73	6.1	0.32	1.0	0.002	0.690	0.695	1.5	1.5	0.2	5	2	0	9.0	13.9	13.8	61.0
	Max	31.7	10.0	121	7.5	0.60	5.0	0.005	1.100	1.102	8.1	9.3	4.7	6	21	1	17.0	18.0	19.0	110.0

STATION	STAT	TEMP	DO	SPCOND	PH	TURB	TSUSSD	NOX	TKN	TN	OPO4	TP	SIO2	CA	CL	SO4	ALKALNYA	TDORGC	TOTORCC	TDSSOL
A129	Count	12	11	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12
	Mean	23.4	3.8	600	7.2	1.91	3.8	0.045	1.418	1.477	9.0	40.8	8.7	42	95	21	124.8	22.5	22.5	367.7
	StDev	6.6	2.1	166	0.2	0.59	1.8	0.063	0.296	0.318	3.7	14.1	4.9	11	30	14	25.4	3.6	3.6	102.0
	Min	13.6	1.0	300	6.8	1.00	2.0	0.002	0.860	0.873	4.2	25.2	1.4	23	46	3	76.0	16.0	16.0	170.0
	Max	31.3	7.3	838	7.5	2.70	7.0	0.230	1.980	2.017	17.0	70.0	19.2	61	140	54	160.0	28.8	29.6	521.0
A130	Count	12	11	12	12	11	12	11	11	10	11	12	11	11	12	12	11	11	11	11
	Mean	22.9	3.6	282	6.8	0.63	2.2	0.004	1.174	1.196	4.5	11.0	7.4	22	42	5	63.9	19.9	20.1	195.2
	StDev	6.8	1.7	188	0.2	0.40	0.6	0.003	0.653	0.686	2.9	6.2	6.3	12	34	9	36.5	4.4	4.5	121.7
	Min	12.9	0.5	132	6.3	0.32	1.0	0.002	0.770	0.773	1.5	3.3	1.8	13	16	1	25.0	16.0	16.0	104.0
	Max	32.4	5.7	753	7.0	1.67	3.0	0.012	3.000	3.003	11.1	25.8	20.0	51	121	32	149.0	29.7	30.1	487.0
A131	Count	12	11	12	12	11	12	11	11	10	11	12	11	11	12	12	11	11	11	11
	Mean	23.7	6.3	108	6.8	0.58	2.2	0.003	1.131	1.138	4.1	7.9	5.4	10	18	1	28.9	18.8	18.9	104.0
	StDev	7.4	2.4	14	0.3	0.16	0.8	0.003	0.159	0.167	2.8	3.6	4.0	2	5	0	7.4	2.6	2.5	22.0
	Min	13.0	1.4	79	6.3	0.30	1.0	0.002	0.840	0.845	1.5	1.5	0.7	8	10	1	21.7	15.2	15.2	79.0
	Max	35.5	8.8	130	7.3	0.91	3.3	0.010	1.500	1.502	9.2	12.8	13.5	16	30	1	45.3	23.4	23.5	142.0
A132	Count	12	11	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12
	Mean	23.9	4.1	674	7.3	2.25	4.0	0.066	1.531	1.621	9.2	42.0	9.7	48	105	27	142.7	23.6	24.0	410.5
	StDev	6.4	2.1	206	0.2	1.32	1.5	0.089	0.347	0.383	7.2	13.8	7.6	14	37	22	37.8	6.0	6.0	133.4
	Min	15.4	1.7	338	7.0	1.08	2.5	0.007	0.940	0.961	1.5	26.0	1.8	27	53	4	84.0	17.0	17.0	190.0
	Max	31.2	7.5	1008	7.6	6.19	6.5	0.310	2.330	2.359	27.7	71.0	30.4	71	180	86	210.0	39.3	39.5	660.0
A133	Count	10	9	10	10	4	10	4	4	4	4	10	4	4	10	10	4	4	4	4
	Mean	21.8	3.4	319	6.7	1.06	2.5	0.004	1.385	1.389	5.8	23.7	12.5	33	51	4	92.9	20.9	24.7	303.8
	StDev	6.6	1.2	197	0.3	0.91	0.7	0.002	0.258	0.259	2.3	9.9	7.6	14	36	5	33.2	11.5	4.6	124.4
	Min	13.8	1.1	129	6.2	0.42	1.0	0.002	1.150	1.155	3.3	14.0	1.9	14	15	1	49.0	3.7	18.0	130.0
	Max	32.3	4.8	656	7.1	2.40	4.0	0.005	1.700	1.705	8.9	45.7	18.3	47	108	18	126.0	27.3	27.6	412.0
A134	Count	12	11	12	12	9	12	9	9	8	9	12	9	9	12	12	9	9	9	9
	Mean	23.2	5.5	236	7.0	0.59	2.5	0.003	1.043	1.051	4.7	11.8	7.1	20	37	3	56.6	18.9	19.2	184.1
	StDev	6.9	2.0	148	0.3	0.41	0.5	0.002	0.187	0.201	2.8	4.8	7.0	10	30	5	23.6	4.2	4.5	101.7
	Min	13.2	1.4	113	6.6	0.29	1.0	0.002	0.860	0.862	1.5	4.9	0.6	10	14	1	31.7	14.0	14.0	88.0
	Max	33.7	8.4	571	7.3	1.56	3.3	0.005	1.430	1.435	8.9	21.4	17.7	38	101	19	99.5	25.7	25.8	369.0
A135	Count	12	12	12	12	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12
	Mean	23.2	4.6	707	7.5	2.51	4.0	0.081	1.493	1.593	9.4	37.4	8.2	51	113	28	147.7	22.6	22.6	380.6
	StDev	6.5	2.2	176	0.2	1.86	2.2	0.096	0.322	0.400	9.1	16.6	4.7	14	35	13	38.1	3.7	3.4	145.4
	Min	12.8	2.0	394	7.2	0.86	2.5	0.006	1.000	1.028	1.5	20.0	1.8	32	62	6	95.0	17.0	18.0	2.4
	Max	30.8	8.4	981	7.7	7.04	9.0	0.330	2.000	2.330	34.7	72.0	14.9	73	180	47	210.0	28.0	27.3	520.0
A136	Count	9	9	9	9	6	9	6	6	6	6	9	6	6	9	9	6	6	6	6
	Mean	20.8	2.6	349	6.9	1.11	2.4	0.003	1.268	1.271	3.4	17.9	8.4	28	54	5	82.0	23.1	23.6	252.3
	StDev	7.3	1.1	214	0.4	1.36	1.1	0.002	0.200	0.202	2.3	8.1	8.9	15	40	8	35.7	4.6	4.2	136.0
	Min	7.9	0.2	143	6.5	0.34	1.0	0.002	1.100	1.102	1.5	6.8	1.3	16	14	1	55.0	19.0	20.0	150.0
	Max	29.3	4.0	739	7.6	3.86	4.7	0.005	1.540	1.545	6.6	33.0	20.2	51	117	24	135.0	30.3	30.1	441.0

STATION	STAT	TEMP	DO	SPCOND	PH	TURB	TSUSSD	NOX	TKN	TN	OPO4	TP	SIO2	CA	CL	SO4	ALKALNYA	TDORGC	TOTORCC	TDSSOL
A137	Count	12	12	12	12	7	12	7	7	7	7	12	7	7	12	12	7	7	7	7
	Mean	21.9	4.6	217	6.8	0.58	2.4	0.003	1.227	1.230	3.6	10.3	7.2	19	33	2	52.2	22.1	22.0	180.1
	StDev	7.6	1.6	111	0.4	0.22	0.3	0.002	0.167	0.168	2.2	4.0	7.9	8	24	2	15.3	4.1	3.7	75.5
	Min	5.9	0.4	117	6.2	0.32	2.0	0.002	1.020	1.025	1.5	5.3	0.9	13	12	0	38.0	17.0	17.0	120.0
	Max	30.3	6.3	453	7.7	1.00	3.0	0.005	1.440	1.445	6.8	18.0	19.3	30	82	6	74.0	28.2	26.6	290.0
A138	Count	12	12	12	12	4	12	4	4	4	4	12	4	4	12	12	4	4	4	4
	Mean	21.7	6.2	116	6.8	0.48	2.2	0.004	1.250	1.254	5.5	7.4	6.4	11	18	1	32.5	20.4	20.4	112.3
	StDev	7.4	2.6	30	0.5	0.09	0.7	0.002	0.059	0.059	1.7	4.0	4.7	2	5	0	6.5	1.1	1.6	14.3
	Min	5.9	2.1	39	6.3	0.35	1.0	0.002	1.170	1.175	3.9	1.5	0.2	8	12	0	25.0	19.0	18.0	96.0
	Max	30.1	12.7	147	7.8	0.57	3.3	0.005	1.300	1.302	7.4	16.5	10.8	13	27	1	38.7	21.6	21.6	127.0
A139	Count	12	12	12	12	2	12	2	2	2	2	12	2	2	12	12	2	2	2	2
	Mean	21.8	5.8	91	6.8	0.63	3.3	0.005	1.200	1.205	2.2	6.6	3.9	6	13	0	15.5	20.8	20.2	90.5
	StDev	7.3	2.2	17	0.4	0.01	1.7	0.000	0.212	0.212	1.7	2.7	0.7	0	6	0	1.4	4.3	3.2	14.8
	Min	6.3	2.0	63	6.2	0.62	2.0	0.005	1.050	1.055	1.0	1.5	3.4	6	0	0	14.5	17.7	17.9	80.0
	Max	30.0	8.4	119	7.4	0.63	7.0	0.005	1.350	1.355	3.4	11.0	4.4	6	23	1	16.5	23.8	22.4	101.0
A140	Count	11	11	11	11	4	11	4	4	4	4	11	4	4	11	11	4	4	4	4
	Mean	21.7	5.8	199	7.1	0.52	2.4	0.006	1.423	1.429	6.1	10.1	12.8	20	33	1	52.3	26.3	30.8	206.0
	StDev	6.9	2.0	94	0.4	0.15	0.8	0.006	0.110	0.114	1.1	4.5	8.0	8	21	1	18.5	12.9	3.9	71.8
	Min	7.7	2.6	118	6.6	0.42	1.0	0.002	1.300	1.302	5.1	1.5	2.2	10	15	1	29.0	7.0	25.0	110.0
	Max	30.7	8.4	413	7.8	0.74	4.0	0.015	1.520	1.525	7.4	18.1	19.5	29	73	5	74.2	33.1	33.6	284.0
A141	Count	11	10	11	11	11	12	12	12	11	12	12	12	12	12	12	12	12	12	12
	Mean	21.2	3.9	265	6.7	0.97	2.4	0.004	1.103	1.116	4.1	11.9	9.1	18	37	5	61.1	18.1	18.4	175.3
	StDev	6.3	1.7	136	0.4	0.82	0.8	0.001	0.171	0.176	2.6	4.4	4.3	9	21	7	27.2	3.4	3.4	78.7
	Min	9.4	1.2	105	6.2	0.32	1.0	0.002	0.840	0.845	1.5	1.5	4.6	8	13	1	29.0	12.0	12.6	84.0
	Max	28.4	5.9	493	7.4	2.69	4.0	0.006	1.420	1.425	10.3	19.9	15.5	33	74	22	98.2	24.0	23.8	310.0
LOX10	Count	12	12	12	12	4	5	4	5	2	4	12	4	4	12	12	4	4	7	4
	Mean	22.3	6.0	102	6.5	0.75	1.5	0.003	0.926	1.058	1.0	5.8	2.3	8	13	0	28.5	15.0	8.8	81.0
	StDev	6.7	2.6	12	0.2	0.06	0.0	0.000	0.159	0.205	0.0	0.9	3.6	1	3	0	1.7	1.4	8.1	9.3
	Min	10.6	1.2	84	6.1	0.70	1.5	0.003	0.800	0.913	1.0	4.0	0.3	7	8	0	27.0	12.9	0.1	68.0
	Max	29.2	10.6	125	7.0	0.80	1.5	0.003	1.200	1.203	1.0	7.0	7.7	9	17	1	30.0	16.2	16.9	90.0
LOX11	Count	12	12	9	12	10	10	10	10	6	9	12	10	10	12	12	10	10	12	10
	Mean	22.1	4.8	92	6.5	0.67	1.5	0.003	0.946	0.938	1.0	5.8	3.0	6	16	0	12.0	16.5	12.6	76.3
	StDev	6.6	2.8	18	0.6	0.26	0.0	0.001	0.062	0.055	0.0	1.5	1.6	1	2	0	2.7	1.6	7.6	11.1
	Min	9.7	0.7	75	5.9	0.40	1.5	0.003	0.860	0.863	1.0	3.0	1.1	5	13	0	10.0	13.1	0.1	58.0
	Max	28.6	9.1	131	8.1	1.20	1.5	0.006	1.060	1.003	1.0	9.0	5.3	8	19	0	18.0	18.5	18.0	90.0
LOX12	Count	12	12	9	12	12	12	10	12	6	11	12	12	12	12	12	12	12	12	12
	Mean	22.9	5.0	130	6.9	0.59	1.5	0.003	0.881	0.949	1.0	6.4	5.9	9	18	0	29.8	13.9	10.7	92.0
	StDev	6.4	2.4	29	0.6	0.18	0.0	0.001	0.141	0.155	0.0	1.0	2.3	2	3	0	7.4	1.3	6.2	15.2
	Min	11.3	1.3	94	6.2	0.30	1.5	0.003	0.740	0.783	1.0	5.0	2.3	6	13	0	19.0	11.4	0.6	76.0
	Max	29.1	9.2	181	8.3	0.90	1.5	0.005	1.200	1.203	1.0	8.0	9.8	12	23	2	42.0	16.0	16.0	120.0

STATION	STAT	TEMP	DO	SPCOND	PH	TURB	TSUSSD	NOX	TKN	TN	OPO4	TP	SIO2	CA	CL	SO4	ALKALNYA	TDORGC	TOTORCC	TDSSOL
LOX13	Count	11	11	9	11	9	9	9	8	4	8	11	9	9	11	11	9	9	11	9
	Mean	22.4	5.1	101	6.6	0.62	1.5	0.003	0.943	0.963	1.0	5.6	3.9	7	17	0	15.4	15.7	11.5	78.6
	StDev	6.5	2.2	7	0.5	0.13	0.0	0.001	0.126	0.162	0.0	0.9	1.9	1	2	0	1.9	0.7	7.3	14.4
	Min	10.9	2.5	91	5.9	0.40	1.5	0.003	0.800	0.843	1.0	4.0	2.0	5	15	0	13.0	14.7	0.1	46.0
	Max	30.1	8.8	113	7.6	0.80	1.5	0.005	1.200	1.203	1.0	7.0	6.6	8	20	0	18.0	16.4	16.7	96.0
LOX14	Count	12	12	9	12	12	12	12	12	8	11	12	12	12	12	11	12	12	11	12
	Mean	22.9	4.3	164	6.7	0.58	1.6	0.003	0.823	0.930	1.0	5.8	3.6	11	24	1	31.3	14.3	10.5	99.3
	StDev	6.4	2.4	58	0.4	0.24	0.4	0.000	0.117	0.174	0.0	1.3	2.8	3	10	2	9.8	0.8	6.5	35.3
	Min	11.4	1.6	102	6.1	0.40	1.5	0.003	0.670	0.783	1.0	4.0	0.5	8	15	0	18.0	13.1	0.4	64.0
	Max	29.1	8.6	254	7.7	1.30	3.0	0.003	1.100	1.283	1.0	8.0	7.9	17	39	5	45.0	15.6	15.4	150.0
LOX15	Count	12	12	9	12	12	12	11	11	7	11	12	12	12	12	12	12	12	12	12
	Mean	23.3	4.8	347	6.8	0.63	1.5	0.003	1.216	1.125	1.0	6.3	6.9	22	48	11	73.3	18.9	14.8	209.3
	StDev	6.2	2.3	170	0.7	0.15	0.0	0.000	0.200	0.308	0.0	1.5	3.8	10	26	9	33.3	3.2	9.0	100.3
	Min	12.5	1.2	120	4.8	0.40	1.5	0.003	0.800	0.683	1.0	4.0	1.3	10	19	1	31.0	14.6	0.5	92.0
	Max	29.8	9.8	544	7.6	0.90	1.5	0.003	1.560	1.563	1.0	10.0	12.9	34	84	29	119.0	24.0	24.0	342.0
LOX16	Count	12	12	9	12	12	11	10	11	6	11	12	12	12	12	11	12	12	11	12
	Mean	22.9	2.8	136	6.4	0.58	1.5	0.003	0.775	0.851	1.0	7.3	2.9	9	17	1	26.0	13.8	10.1	81.3
	StDev	6.0	1.9	48	0.5	0.16	0.0	0.001	0.169	0.193	0.0	2.3	1.9	2	4	1	8.5	1.0	6.2	37.6
	Min	12.2	0.7	92	5.8	0.30	1.5	0.003	0.580	0.673	1.0	4.0	0.3	6	12	0	12.0	12.5	0.4	11.0
	Max	29.6	6.6	242	7.5	0.90	1.5	0.006	1.210	1.213	1.0	12.0	5.9	13	25	2	39.0	15.5	15.1	154.0
LOX3	Count	11	11	11	11	1	1	1	1	2	1	11	1	1	11	11	1	1	4	1
	Mean	21.5	5.0	111	6.3	0.80	1.5	0.003	1.230	1.248	1.0	7.5	3.9	4	21	0	10.0	16.8	4.3	64.0
	StDev	7.0	2.2	26	0.4					0.021		2.3			4	0			8.4	
	Min	8.6	2.6	79	6.0	0.80	1.5	0.003	1.230	1.233	1.0	4.0	3.9	4	15	0	10.0	16.8	0.1	64.0
	Max	27.8	9.2	159	7.2	0.80	1.5	0.003	1.230	1.263	1.0	11.0	3.9	4	28	0	10.0	16.8	17.0	64.0
LOX4	Count	11	11	11	11	7	7	7	7	3	7	10	7	7	11	11	6	7	9	7
	Mean	22.1	5.3	245	6.6	0.87	1.5	0.003	1.116	1.193	1.0	9.0	7.0	21	38	1	64.3	26.5	18.0	192.9
	StDev	6.6	2.4	73	0.2	0.34	0.0	0.000	0.127	0.082	0.0	3.3	4.6	4	17	1	12.4	1.9	13.5	39.4
	Min	10.9	2.0	187	6.3	0.50	1.5	0.003	0.980	1.103	1.0	5.0	1.1	16	24	1	50.0	24.3	0.1	158.0
	Max	28.8	9.1	424	6.9	1.40	1.5	0.003	1.260	1.263	1.0	17.0	14.3	27	78	4	84.0	29.6	30.0	270.0
LOX5	Count	11	11	11	11	2	3	2	3	2	1	11	2	1	11	11	2	2	5	2
	Mean	21.7	5.0	90	6.2	0.85	1.5	0.004	1.533	1.263	1.0	8.2	3.2	6	17	0	11.0	19.8	8.0	87.0
	StDev	6.8	2.2	15	0.2	0.49	0.0	0.002	0.484	0.198		2.9	3.6		4	0	0.0	8.1	11.4	32.5
	Min	9.1	2.2	64	5.7	0.50	1.5	0.003	1.130	1.123	1.0	5.0	0.7	6	11	0	11.0	14.0	0.1	64.0
	Max	27.9	8.8	111	6.7	1.20	1.5	0.005	2.070	1.403	1.0	14.0	5.8	6	22	0	11.0	25.5	25.2	110.0
LOX6	Count	12	12	9	12	9	9	9	9	5	8	12	9	9	12	11	9	9	10	9
	Mean	21.9	4.1	210	6.9	0.64	1.5	0.003	1.091	1.101	1.0	5.5	6.4	14	32	1	41.1	16.8	11.8	146.7
	StDev	6.4	1.9	72	0.5	0.24	0.0	0.001	0.105	0.130	0.0	2.0	6.2	4	14	1	15.9	1.0	8.0	39.5
	Min	9.9	2.0	128	6.4	0.40	1.5	0.003	0.940	0.943	1.0	2.0	0.0	10	17	0	14.0	15.5	0.1	72.0
	Max	28.4	8.4	317	8.1	1.20	1.5	0.006	1.300	1.303	1.0	9.0	14.2	21	56	5	65.0	18.5	18.3	190.0

STATION	STAT	TEMP	DO	SPCOND	PH	TURB	TSUSSD	NOX	TKN	TN	OPO4	TP	SIO2	CA	CL	SO4	ALKALNYA	TDORGC	TOTORCC	TDSSOL
LOX7	Count	12	12	12	12	12	12	12	12	8	11	12	12	12	12	12	12	12	12	12
	Mean	23.1	5.3	95	6.2	0.82	1.5	0.003	1.059	1.066	1.2	6.7	4.4	6	15	0	12.4	18.8	14.7	71.7
	StDev	6.7	2.8	14	0.2	0.24	0.0	0.001	0.122	0.138	0.4	1.4	3.1	1	3	0	4.0	2.9	8.8	14.4
	Min	10.3	1.7	72	5.8	0.30	1.5	0.003	0.900	0.903	1.0	4.0	0.4	5	10	0	9.0	13.0	0.2	44.0
	Max	30.3	10.7	122	6.5	1.10	1.5	0.005	1.300	1.303	2.0	9.0	9.4	9	19	0	23.0	22.1	21.3	100.0
LOX8	Count	12	12	12	12	12	11	10	11	7	11	12	12	12	12	12	12	12	12	12
	Mean	23.0	4.3	89	6.1	0.74	1.5	0.003	1.045	1.001	1.0	7.3	3.3	4	16	0	9.8	17.4	14.0	63.4
	StDev	6.7	2.8	12	0.3	0.22	0.0	0.000	0.126	0.116	0.0	1.4	2.2	1	3	0	2.8	2.6	8.4	18.7
	Min	9.4	1.4	62	5.7	0.40	1.5	0.003	0.820	0.823	1.0	5.0	0.6	4	11	0	7.0	13.2	0.3	38.0
	Max	30.3	10.6	102	6.6	1.10	1.5	0.003	1.280	1.183	1.0	10.0	6.7	6	19	0	15.0	21.3	21.3	92.0
LOX9	Count	12	12	12	12	8	8	8	8	4	7	12	8	8	12	12	8	8	10	8
	Mean	22.3	4.7	107	6.2	0.91	1.5	0.003	1.201	1.008	1.0	5.3	2.9	5	19	0	14.8	16.5	12.1	91.0
	StDev	6.7	3.1	11	0.3	0.27	0.0	0.001	0.346	0.206	0.0	0.7	2.4	1	3	0	2.1	3.2	8.6	21.8
	Min	9.4	0.6	95	5.9	0.50	1.5	0.003	0.840	0.843	1.0	4.0	0.3	5	14	0	12.0	12.3	0.1	58.0
	Max	29.3	8.9	135	6.9	1.20	1.5	0.006	1.920	1.303	1.0	6.0	5.7	6	23	0	18.0	21.4	21.4	124.0

APPENDIX B

Table A-2. EVPA and LOXA stations classified into zones for analyses.

Canal	LOXA104, LOXA115, LOXA129, LOXA132, LOXA135
Perimeter (<2.5 km; <1.6 miles)	LOX4, LOX6, LOX10, LOX14, LOX15, LOX16, LOXA101, LOXA102, LOXA103, LOXA105, LOXA106, LOXA107, LOXA109, LOXA112, LOXA116, LOXA117, LOXA118, LOXA122, LOXA124, LOXA126, LOXA130, LOXA131, LOXA133, LOXA134, LOXA136, LOXA137, LOXA138, LOXA140
Transition (2.5 - 4.5 km; 1.6 - 2.8 miles)	LOX12, LOXA108, LOXA110, LOXA111, LOXA113, LOXA114, LOXA119, LOXA127, LOXA139
Interior(>4.5 km;> 2.8 miles)	LOX3, LOX5, LOX7, LOX8, LOX9, LOX11, LOX13, LOXA120, LOXA128

APPENDIX C

Table A-3. Monthly summary statistics (Count = # of samples, Mean = arithmetic mean, StDev = one standard deviation, Min = minimum, Max = maximum) for calendar year 2009. Previous summary statistics (2004 – 2008) can be found in the previous annual reports. Parameters summarized include: total phosphorus (TP), calcium (Ca), dissolved oxygen (DO), conductivity (COND), chloride (Cl), sulfate (SO4), and total water depth (Tdepth).

Parameter	Zone	STAT	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
TP (µg L^{-1})	C	Count	3	4	4	4	4	4	3	4	4	4	4	4
		Mean	28.3	30.1	31.3	58.9	43.5	40.3	34.2	33.8	29.8	26.7	27.6	24.0
		StDev	3.2	6.4	11.0	16.3	6.0	15.2	17.0	1.9	6.6	4.0	0.7	3.4
		Min	26.0	22.0	20.0	37.0	36.0	26.0	22.5	31.6	20.0	21.0	26.7	19.9
		Max	32.0	37.5	46.0	72.0	50.0	55.9	53.8	36.3	34.8	30.3	28.5	27.7
	P	Count	5	5	7	6	6	6	3	6	6	6	6	6
		Mean	6.9	6.8	5.6	6.1	9.4	11.8	12.2	11.4	15.5	13.4	9.7	8.5
		StDev	2.7	2.2	3.5	0.8	2.7	3.3	1.2	4.1	6.9	4.2	2.4	5.2
		Min	4.3	4.7	1.5	4.8	6.0	6.5	10.9	6.0	6.5	6.0	6.0	3.8
		Max	10.8	10.5	11.8	7.0	12.6	15.6	13.1	14.4	23.7	18.4	13.0	15.3
	T	Count	4	5	5	4	5	4	3	5	5	5	5	5
		Mean	4.6	3.7	3.4	4.0	8.4	6.7	9.2	8.1	7.7	8.7	6.8	6.8
		StDev	1.0	2.7	2.3	1.5	1.6	0.9	1.8	2.4	1.0	2.5	1.1	3.0
		Min	3.3	1.5	1.5	2.8	6.8	5.8	7.3	5.6	6.1	6.5	5.0	3.8
		Max	5.6	7.2	6.0	6.0	11.0	7.7	10.9	11.5	8.5	12.3	7.9	10.5
	I	Count	4	2	3	3	3	3	2	3	3	3	3	3
		Mean	6.0	4.5	4.8	5.8	7.5	6.0	6.5	6.4	5.4	6.5	6.2	3.7
		StDev	2.5	4.3	3.5	3.2	1.9	1.2	0.8	0.7	1.1	1.8	1.0	0.6
		Min	3.4	1.5	1.5	2.5	5.4	4.7	5.9	6.0	4.1	5.4	5.1	3.2
		Max	9.3	7.6	8.4	8.8	9.0	6.8	7.0	7.2	6.0	8.6	7.0	4.4
Ca (mg L^{-1})	C	Count	3	4	4	4	4	4	3	4	4	4	4	4
		Mean	55.6	64.3	42.7	46.8	31.2	57.9	42.5	38.5	70.0	59.8	56.8	51.2
		StDev	1.3	5.8	16.7	14.6	8.2	18.1	1.9	4.7	17.5	7.9	7.5	8.0
		Min	54.2	59.5	25.2	31.9	19.1	40.4	41.3	35.0	49.5	50.5	50.4	42.4
		Max	56.8	71.9	58.6	66.8	37.2	77.8	44.7	45.1	88.8	67.2	67.5	60.6
	P	Count	5	5	7	5	3	4	2	3	6	6	6	5
		Mean	17.2	19.0	15.4	12.0	10.9	12.4	9.3	10.3	27.7	26.2	22.8	19.8
		StDev	3.7	4.9	7.2	3.6	2.2	3.7	1.3	0.1	7.8	5.9	3.7	2.5
		Min	11.8	13.2	8.8	8.5	8.4	9.6	8.4	10.1	16.3	17.3	18.2	16.8
		Max	21.8	25.2	30.4	17.6	12.5	17.8	10.3	10.3	37.1	32.3	29.1	22.2
	T	Count	3	4	3	3	3	3	1	3	5	5	5	3
		Mean	7.2	7.2	7.5	6.9	6.5	6.9	7.4	6.3	6.9	7.7	7.1	8.4
		StDev	1.7	1.4	1.5	1.8	1.6	1.7		1.8	1.4	2.6	2.4	2.1
		Min	6.1	5.8	6.0	4.9	4.8	5.9	7.4	4.3	4.8	5.8	5.2	6.5
		Max	9.1	8.8	8.9	8.4	7.9	8.9	7.4	7.7	8.2	12.1	11.2	10.6
	I	Count	4	2	3	3	3	3	2	2	3	3	3	3
		Mean	5.3	5.4	5.5	5.5	5.3	5.3	4.9	6.2	5.3	5.5	5.8	6.6
		StDev	1.1	0.5	0.8	0.4	0.8	0.8	0.7	1.4	0.7	1.1	1.1	1.2
		Min	4.5	5.1	4.5	5.2	4.5	4.6	4.4	5.2	4.6	4.3	4.7	5.4
		Max	6.9	5.7	6.1	6.0	6.1	6.2	5.3	7.2	6.1	6.4	7.0	7.8

Parameter	Zone	STAT	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
DO (mg L^{-1})	C	Count	3	4	4	4	4	4	2	4	4	4	2	4
		Mean	8.6	7.4	6.6	4.5	2.5	3.3	2.6	2.8	3.2	4.3	5.0	8.3
		StDev	1.1	0.7	1.5	0.6	1.3	0.7	0.4	1.3	0.9	0.6	1.0	1.1
		Min	7.3	6.4	4.9	3.8	1.4	2.8	2.3	1.5	2.1	3.6	4.2	6.7
		Max	9.4	8.1	7.8	5.3	4.4	4.3	2.8	4.1	4.4	4.9	5.7	9.2
	P	Count	5	5	7	6	6	6	3	6	6	6	4	6
		Mean	6.8	6.0	6.8	4.3	2.8	3.8	3.5	4.1	1.9	5.4	4.9	5.6
		StDev	1.8	0.4	1.4	1.3	1.1	2.2	0.8	1.6	0.8	3.6	1.9	1.6
		Min	5.5	5.5	5.4	2.1	1.4	1.8	2.8	2.0	1.0	3.3	2.1	3.8
		Max	9.9	6.5	9.8	6.0	4.4	7.8	4.4	6.2	3.2	12.7	6.2	7.5
	T	Count	4	5	5	4	5	4	3	5	5	5	3	5
		Mean	7.9	7.6	7.1	5.2	3.6	3.2	5.9	4.4	3.6	15.1	6.2	7.0
		StDev	0.6	0.6	1.8	0.6	1.4	1.0	2.1	2.5	1.3	20.9	3.2	2.6
		Min	7.4	7.0	4.6	4.4	1.6	2.4	4.6	1.3	1.9	4.4	3.1	2.5
		Max	8.8	8.2	9.2	5.7	5.0	4.4	8.4	8.3	5.1	52.5	9.5	9.0
	I	Count	4	2	3	3	3	3	2	3	3	3	2	3
		Mean	9.3	6.5	7.4	5.5	3.8	5.0	3.7	3.2	3.4	3.8	2.7	7.5
		StDev	0.6	0.3	1.4	1.0	1.5	0.8	0.1	1.2	1.7	1.0	1.4	1.9
		Min	8.7	6.3	6.1	4.8	2.3	4.4	3.6	2.0	2.0	2.6	1.7	5.6
		Max	10.0	6.7	8.9	6.6	5.2	5.8	3.8	4.5	5.2	4.6	3.7	9.5
COND (µS cm^{-1})	C	Count	3	4	4	4	4	4	2	4	4	4	4	4
		Mean	794.8	943.9	636.4	598.6	443.6	870.5	685.8	636.7	968.6	856.7	828.8	756.0
		StDev	62.0	30.0	325.0	184.7	130.3	166.1	190.9	217.8	177.7	123.7	119.2	120.3
		Min	736.3	916.1	318.6	416.2	264.7	691.2	550.8	496.8	738.1	738.1	725.2	620.3
		Max	859.8	980.5	922.7	854.7	567.1	1051.0	820.8	959.3	1115.0	1006.0	999.1	901.6
	P	Count	5	5	7	5	6	6	3	5	6	6	6	6
		Mean	227.5	222.0	245.8	180.1	135.4	174.1	150.4	145.1	378.9	376.4	292.9	269.0
		StDev	44.9	52.4	120.4	27.1	25.4	62.5	9.7	41.7	127.2	74.9	62.7	49.5
		Min	151.5	158.7	118.6	157.5	92.4	123.3	139.8	103.0	184.1	257.5	203.7	181.8
		Max	262.3	279.5	476.0	225.3	160.2	294.1	158.9	201.1	513.8	445.8	379.1	324.8
	T	Count	4	4	5	3	5	4	3	4	5	5	5	5
		Mean	109.1	108.7	126.3	97.9	99.9	98.7	90.3	89.4	93.0	108.4	112.6	124.5
		StDev	15.9	6.0	13.1	15.0	12.3	4.9	24.1	20.5	14.5	34.8	39.1	23.8
		Min	94.6	103.9	108.0	86.2	84.5	94.0	62.6	67.4	71.5	77.6	85.6	102.5
		Max	131.8	116.9	143.3	114.9	113.6	104.6	107.0	116.4	107.3	162.1	181.0	151.2
	I	Count	4	2	3	2	3	3	2	2	3	3	3	3
		Mean	99.9	105.2	104.6	92.8	105.8	96.8	90.9	101.0	84.9	86.6	95.1	105.9
		StDev	9.8	0.0	13.2	0.2	9.4	12.1	14.2	26.0	6.0	3.1	7.9	2.0
		Min	92.8	105.2	89.8	92.6	98.6	89.5	80.9	82.6	79.1	83.1	86.8	104.3
		Max	114.0	105.2	115.2	93.0	116.5	110.8	101.0	119.3	91.0	88.7	102.5	108.1

Parameter	Zone	STAT	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
Cl (mg L^{-1})	C	Count	3	4	4	4	4	4	3	4	4	4	4	4
		Mean	118.9	162.5	105.4	86.1	58.1	120.1	109.5	102.1	138.9	134.4	131.8	124.5
		StDev	11.7	12.6	57.7	31.2	19.9	12.1	27.7	40.7	12.2	10.0	10.8	11.4
		Min	106.7	150.0	49.5	56.0	31.0	105.5	77.5	70.2	123.0	124.5	122.0	109.0
		Max	130.0	180.0	160.0	130.0	78.0	131.0	126.0	161.0	149.0	148.0	147.0	136.0
	P	Count	5	5	7	6	6	6	3	6	6	6	6	6
		Mean	32.9	36.6	38.1	24.1	16.2	21.9	17.2	18.9	57.7	63.0	48.0	45.3
		StDev	7.7	6.8	17.8	4.6	2.8	9.7	2.4	6.4	24.2	13.3	10.5	8.1
		Min	19.8	29.3	20.2	19.2	10.9	15.8	14.4	11.4	24.3	43.8	33.1	32.2
		Max	39.0	46.2	70.8	31.8	18.4	40.7	18.6	28.7	86.4	78.0	62.9	57.2
	T	Count	4	5	5	4	5	4	3	5	5	5	5	5
		Mean	18.0	21.2	23.3	16.4	14.3	13.8	13.7	13.7	11.9	16.4	17.6	22.3
		StDev	1.7	2.2	4.2	2.3	1.7	0.8	4.3	5.4	1.9	5.4	4.6	5.0
		Min	16.0	19.0	20.1	13.2	12.0	13.3	8.9	7.1	9.2	11.3	12.7	18.0
		Max	19.9	24.5	30.5	18.8	16.0	15.0	17.1	21.2	14.4	22.8	22.7	30.8
	I	Count	4	2	3	3	3	3	2	3	3	3	3	3
		Mean	18.1	20.1	17.0	17.7	16.4	15.9	15.7	17.0	13.0	14.1	16.2	20.5
		StDev	0.8	1.2	4.3	1.7	0.7	1.9	1.6	2.5	0.7	0.8	0.6	0.9
		Min	17.1	19.3	12.5	16.5	15.7	14.5	14.6	14.3	12.5	13.1	15.5	19.6
		Max	19.0	21.0	21.1	19.6	17.1	18.1	16.9	19.2	13.8	14.6	16.6	21.5
SO4 (mg L^{-1})	C	Count	3	4	4	4	4	4	3	4	4	4	4	4
		Mean	34.2	38.0	21.3	24.5	18.2	69.6	52.3	33.2	72.2	50.3	42.4	31.8
		StDev	11.3	10.5	21.0	13.2	11.2	30.5	26.8	22.9	26.1	18.1	27.6	27.0
		Min	25.7	29.0	3.6	14.0	9.3	40.1	21.8	14.8	36.2	30.9	21.5	9.8
		Max	47.0	51.0	48.0	43.0	34.0	101.0	72.1	65.4	93.0	71.9	81.7	69.3
	P	Count	5	5	7	6	6	6	3	6	6	6	6	6
		Mean	2.8	2.6	3.7	1.1	0.7	2.4	1.4	1.2	13.1	9.4	4.1	2.9
		StDev	1.8	1.2	6.4	0.4	0.2	3.0	0.6	1.0	8.3	5.4	2.3	1.3
		Min	0.6	1.1	0.3	0.5	0.3	0.6	0.8	0.5	1.1	2.3	0.7	0.8
		Max	5.4	3.9	18.1	1.5	1.0	8.4	2.0	3.2	21.0	16.8	7.0	4.2
	T	Count	4	5	5	4	5	4	3	5	5	5	5	5
		Mean	0.2	0.3	0.2	0.4	0.4	0.3	0.5	0.4	0.4	0.3	0.4	0.5
		StDev	0.1	0.2	0.2	0.2	0.3	0.2	0.1	0.2	0.2	0.7	0.2	0.1
		Min	0.0	0.0	0.0	0.1	0.1	0.1	0.4	0.1	0.0	-0.1	0.1	0.3
		Max	0.3	0.5	0.4	0.6	0.6	0.6	0.6	0.6	0.6	1.6	0.6	0.6
	I	Count	4	2	3	3	3	3	2	3	3	3	3	3
		Mean	0.0	0.0	0.0	0.1	0.1	0.1	0.1		0.0	0.0	0.1	0.2
		StDev	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.1	0.1	0.2
		Min	0.0	0.0	0.0	0.1	0.1	0.1	0.1		0.0	-0.1	0.1	0.1
		Max	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.1	0.3	0.5

Parameter	Zone	STAT	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
Tdepth (m)	P	Count	5	5	7	6	6	6	3	5	6	6	6	6
		Mean	0.4	0.3	1.4	0.3	0.9	0.2	1.8	3.3	7.5	0.4	0.4	0.3
		StDev	0.2	0.1	2.7	0.1	1.7	0.1	2.8	6.9	11.5	0.1	0.1	0.2
		Min	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.1
		Max	0.7	0.5	7.6	0.5	4.4	0.3	5.0	15.5	26.8	0.7	0.6	0.6
	T	Count	4	5	5	4	5	5	3	5	5	5	5	5
		Mean	0.4	0.4	0.3	0.4	0.3	0.3	1.6	3.1	3.2	0.4	0.4	0.3
		StDev	0.2	0.3	0.2	0.2	0.2	0.2	2.4	6.4	6.5	0.2	0.2	0.3
		Min	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.3	0.2	0.2	0.1
		Max	0.6	0.8	0.7	0.7	0.7	0.6	4.4	14.5	14.8	0.7	0.7	0.8
	I	Count	4	2	3	3	3	3	2	2	3	3	3	3
		Mean	0.4	0.3	0.3	0.3	0.3	0.2	4.9	9.6	9.6	0.3	0.3	0.2
		StDev	0.1	0.0	0.1	0.1	0.1	0.0	6.5	13.3	8.1	0.1	0.0	0.0
		Min	0.2	0.3	0.2	0.3	0.2	0.2	0.4	0.3	0.3	0.2	0.3	0.2
		Max	0.5	0.3	0.5	0.4	0.4	0.2	9.5	19.0	15.2	0.4	0.3	0.3