Appendix 5-1: Annual Permit Report for the North Palm Beach County - Part 1 Project, G-160 and G-161 Components

Permit Report (Operational Year 2009)
Permit Numbers: EI 50-0128848-004 and EI-0244327-002

Beth Kacvinsky

Note: This document, dated February 12, 2010, was provided to the Florida Department of Environmental Protection, Southeast District Office, by the South Florida Water Management District.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

February 12, 2010 **Ref. #: 02122010-03**

Mr. William C. Kennedy
Water Resource Management and Environmental Planning
Florida Department of Environmental Protection
Southeast District Office
400 N. Congress Avenue Suite 200
West Palm Beach, FL 33401

Dear Mr. Kennedy:

Subject: Environmental Resource Permit No. EI 50-0128848-004 and No. EI-0244327-002

Environmental Resource Permit (ERP) No. EI 50-0128848-004 was issued by the Florida Department of Environmental Protection (FDEP) to the South Florida Water Management District (District) and Palm Beach County to construct and operate the C-18 Canal Control Structure (G-160). ERP No. EI-0244327-002 was issued to the District and the City of West Palm Beach to construct and operate the G-161 Water Control Structure Phase II. Specific Conditions 7 and 10, respectively, of those permits require the permittee(s) to submit an annual report within 45 days of the end of each year of operation. Because these structures will operate in concurrence to restore a more natural flow to the Loxahatchee Slough and River, the two reports have been combined. The enclosed G-160/G-161 structures annual report is intended to fulfill the permit reporting requirements for Operation Year 2009.

Please let me know if you have questions or concerns regarding this submittal. I can be reached at (561) 686-8800 x 3721 or via e-mail at bkacvins@sfwmd.gov.

Sincerely,

Georgia Vince
Section Leader
Everglades Restoration & Capital Projects

Enclosure

c: Tori White, USACE
Jason Andreotta, FDEP
Inger Hansen, FDEP

Comprehensive Report on Results of 5-Year Operation Monitoring Program for the G-160 and G-161 Projects
FINAL
02/12/2010

Introduction

Environmental Resource Permits No. EI 50-0128848-004 and No. EI-0244327-002 issued by the Florida Department of Environmental Protection (FDEP) to the South Florida Water Management District (District) authorized the District to construct and operate the C-18 Canal Control Structure (G-160) Project and the G-161 Water Control Structure Phase II Project (permits are included as attachments 1 and 2). Specific Conditions 7 and 10, respectively, require the District to submit an annual report within 45 days of the end of each year of operation. Because these structures will operate concurrently, and are designed to restore a more natural hydroperiod to the Loxahatchee Slough while increasing the flows to the Northwest Fork Loxahatchee River, the two reports have been combined. This G-160/G-161 Projects Annual Report is intended to present the results of the permit-mandated monitoring for the G-160 and G-161 structures that occurred in Operation Year 2009. Incremental operation of the G-160 structure was initiated on June 1, 2009, increasing the stage from elevation 15.5' NGVD to elevation 16.5' NGVD (in previous years G-160 was maintained at elevation 15.5' in the dry season and elevation 15.0' in the wet season. With the increase in stage, Palm Beach County re-initiated the semi-annual monitoring of vegetation in the Loxahatchee Slough. The focus of this report is the monitoring set forth in the 5-Year Operation Monitoring Plan (Plan) for the G-161 Water Control Structure Phase (G-161 Project) to implement Specific Condition 9 (I) – (IV) of Permit No. EI-0244327-002.

The purpose of the G-161 monitoring program is to characterize the success of the G-161 Project in achieving its anticipated beneficial objectives of restoring a more natural hydroperiod and flow to wetlands, sloughs, ponds, and floodplains, and rivers downstream of the G-161 Project without compromising water quality relative to baseline conditions. In addition, it is anticipated that restoring a more natural timing, magnitude, duration, and frequency of flow in the downstream flowing waters will also restore a more natural salinity gradient in the downstream system, with associated benefits for estuarine and marine flora and fauna. However, contribution of the G-161 Project to the restoration of natural hydroperiod to this system, individually or together with the related G-160 Project, is constrained by regional water availability. Operating schedules may still be controlled or

influenced by other local government regulations or permits. Full benefits of the G-160 and G-161 structures are not anticipated to be realized until regional water is available in amounts adequate to provide restorative flows to the Loxahatchee River NW Fork.

To the extent practicable and appropriate, the G-161 Project monitoring program will be carried out in coordination with and by extension of the virtually identical monitoring program for the adjacent G-160 Project using the same methods, procedures, and reporting format. This is intended to ensure comparability of results and continuity of interpretation, while avoiding unnecessary duplication of effort.

The 5-Year Operation Monitoring Program Plan for the G-161 Project is Attachment 3 and reference (3). The revised Interim Operation Plan is Attachment 4.

Specifically, the Monitoring Plan provides for:

1. Continuous water level monitoring during operations at locations upstream and downstream of the G-161 structure via stage gauges with telemetry to support the calculation of the flow rate through the G-161 structure;
2. Wet and dry season ground-level vegetation monitoring of eight (8) 3m x 3m plots with associated staff gauges distributed along flow paths in the wetland areas of interest to evaluate the effect of Project-related hydrological changes on the vegetation community;
3. Upland, wetland, and aquatic wildlife observations incidental to vegetation monitoring;
4. Vegetation monitoring of the entire system via aerial photography with ground-truthing using those vegetation plots in 2010 to compare to the pre-construction baseline aerial photograph taken in 2005; and
5. Monthly water quality monitoring during periods of flow via grab sampling upstream of the G-161 structure and the Control 2 Pump Station to evaluate the status of and trends in post-operational water quality relative to pre-operational baseline.

Monitoring Station Locations

The G-160 and G-161 structures in South Florida are shown in Figure 1, along with the natural areas to be restored by the operation of these structures in conjunction with the availability of regional water of sufficient quantity and quality to provide for restorative flows. Other relevant structures and environmental features include the G-92 culvert, and S-46 spillway, the water catchment area (Grassy Waters Preserve), the

Loxahatchee Slough, the Northwest Fork Loxahatchee River, and the Loxahatchee Estuary.

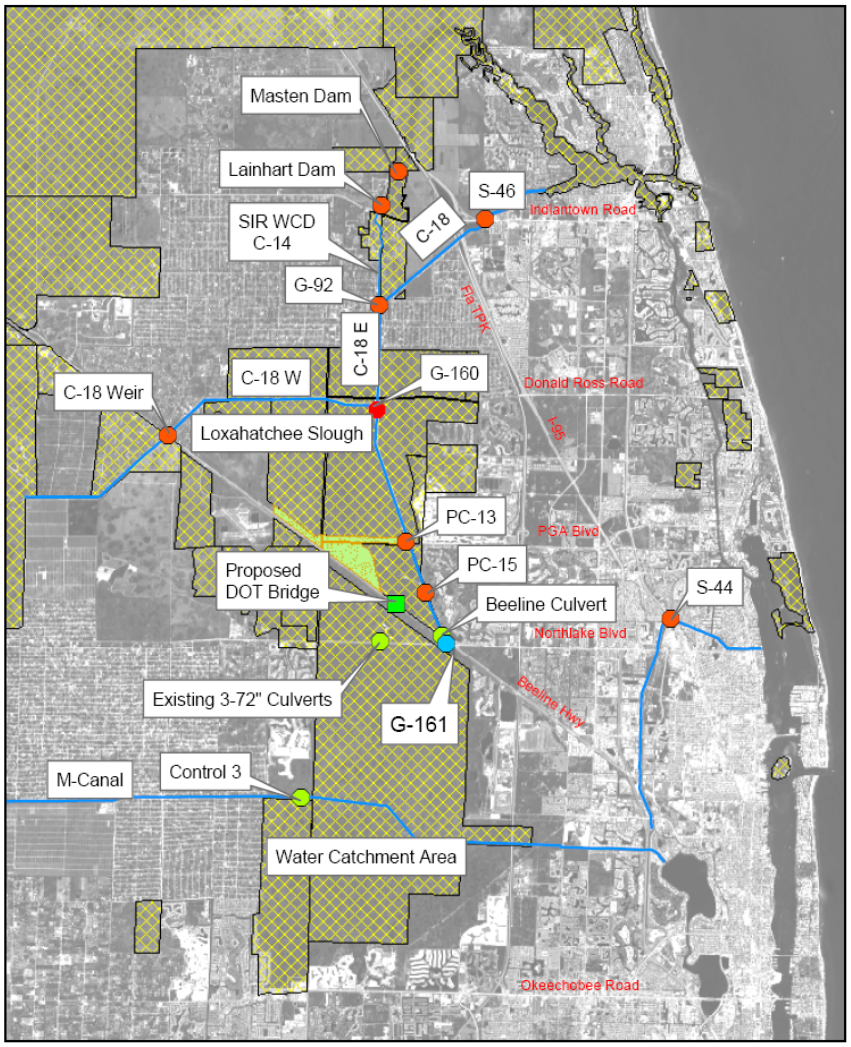


Figure 1: Site Map Showing G-161 and Other Structures

Summary of Operation of G-160, G-161 & S-46 in 2009

During the 2009 dry season (from November 2, 2008 to May 8, 2009), the SFWMD experienced record low rainfall, with a basin wide rainfall average of 7.46 inches, about 34% of the historical average, and one of the driest periods on record since 1932 ("Dry Season Water supply from the Loxahatchee Slough to the Northwest Fork of the Loxahatchee River", A.

Akpoji, May 2009)(Appendix 4). During this time period, the District used available storage in the C-18 canal to deliver daily flows of 35 cfs or higher to the NW Fork Loxahatchee River. However, by February 21, 2009, the canal's local storage was exhausted and the flow over Lainhart Dam fell below 35 cfs. The District lowered the control elevations for the project culverts along the C-18 canal, allowing water to be delivered to the river from the Loxahatchee slough. Accessing the storage within the Slough allowed deliveries to Lainhart to provide supplemental flows to the NW Fork Loxahatchee River; however, the severity of the drought and the lack of availability water from the regional water management system resulted in flows over Lainhart being reduced to less than 34 cfs late in the dry season.

Beginning on June 1, 2009, the stage upstream of the G-160 structure was raised to elevation 16.5' NGVD, in order to maintain stages within the Loxahatchee Slough that were consistent with the proposed slough hydroperiod. Target Slough stages range from a low of 15.5' NGVD in late May, increasing to 17.5' NGVD by mid July through mid October and then receding slowly back to 15.5' NGVD by the following May. The stage upstream of the G-160 structure remained at elevation 16.5' through December 31, 2009. The structure is effectively operated such that during rainfall events, when stages upstream of the G-160 structure rise to elevation 16.8' NGVD the structure is opened to allow the stages to recede and is closed once they reach elevation 16.2' NGVD. Stage monitoring was also reinitiated in the east and west Loxahatchee slough in 2009. Graphic representation of G-160 operation and associated slough stages are shown in Figure 2. Flows through G-161, G160 and at Lainhart Dam are shown in Figure 3. Relevant data are included in Appendices 1 and 2. The stage recording stations at LoxEst and LoxWst were decommissioned in 2008 due to safety concerns and were re-commissioned in June 2009.

Additionally, the District began operating the G-161 Structure during the early 2009-2010 dry season to deliver supplemental flow through the C-18 canal to the Loxahatchee River NW Fork. The structure was operated several times during the early dry season, in late October and early November and again in mid-December, delivering between 10 and 20 cfs, augmenting flow to the NW Fork. Water quality samples were collected at G-161 and the City of West Palm Beach Control 2 Pump Station in association with the structure operation to comply with the permit requirement to conduct water quality collection and analysis monthly during periods of flow.

Figure 2. G-160 Operation and Loxahatchee Slough Stages (at LoxWst and LoxEst).

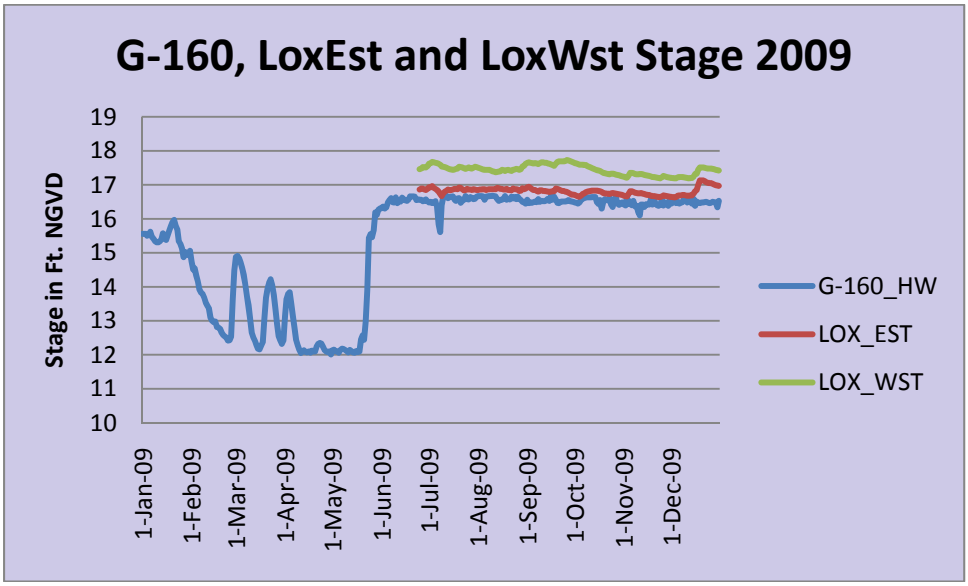
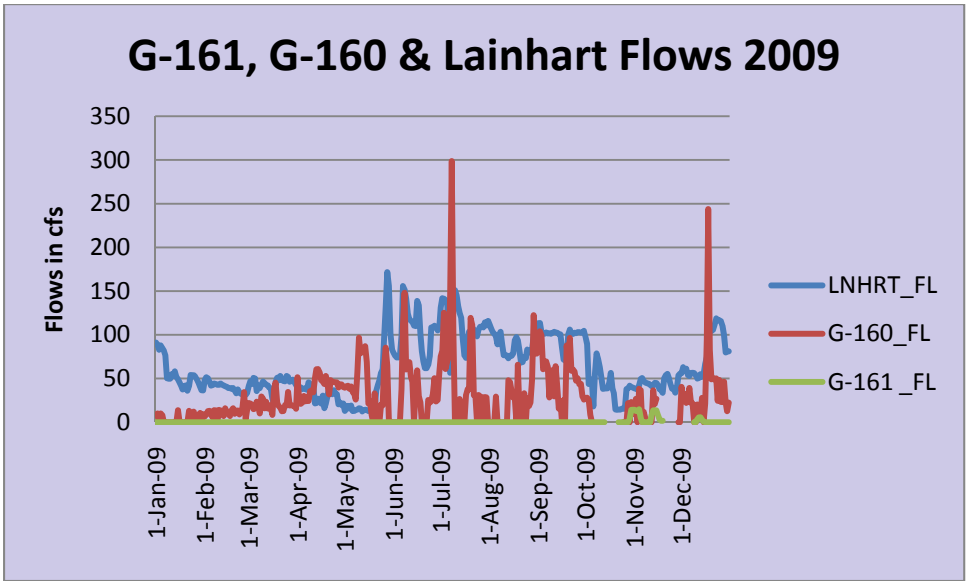


Figure 3. Flow at G-160, G-161 and Lainhart Dam



Specific Condition 6 of Environmental Resource Permit No. EI 50-0128848-004 requires the District to evaluate the effect of operating the G-160 structure on the stage and flow at S-46. G-160, G-161 and S-46 flows for calendar year 2009 are shown below in Figure 4. The G-160, G-161 and S-46 flow data are reproduced in Appendix 2.

Additionally, maximum monthly flows at S-46 for the period 2005 through 2009 are shown in Figure 5; average monthly flows for the same period are shown in Figure 6 and monthly rainfall for the same period is included in Figure 7. While monthly rainfall at S-46 was similar, particularly in June, July and August to previous years, flows through S-46 in 2009 did not exceed 200 cfs, while flows in years with similar rainfall were frequently higher than 200 cfs. As G-161 operation was initiated in late October, antecedent rainfall conditions and flows at Lainhart Dam were carefully monitored in order to ensure that water as was being delivered through G-161, the operation of S-46 was not triggered by increasing stages in the C-18 canal. If forecasts indicated that rainfall events were imminent, G-161 was closed until such time as runoff conditions subsided.

Figure 4. 2009 Flows @ G-160, G-161 and S-46.

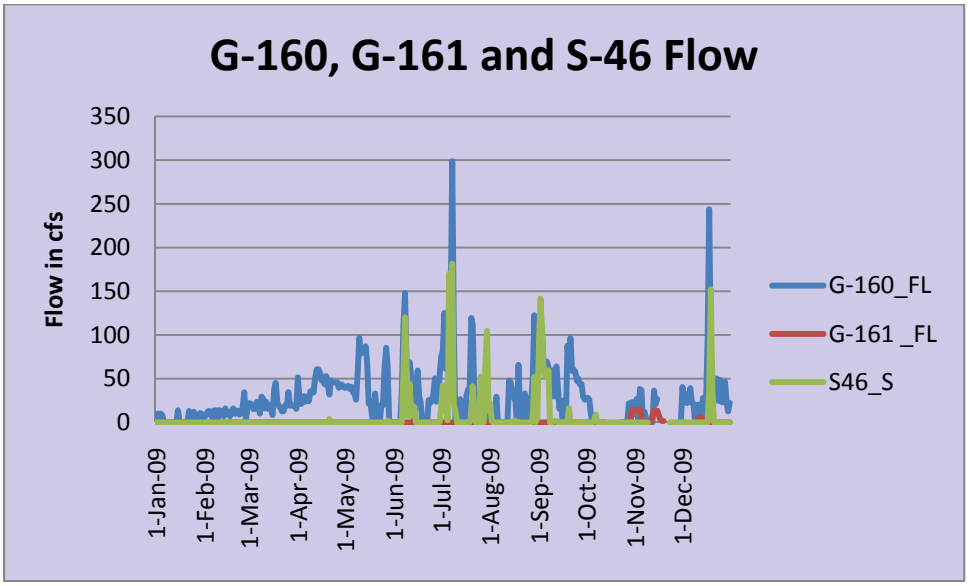


Figure 5. Maximum Daily Flows through S-46

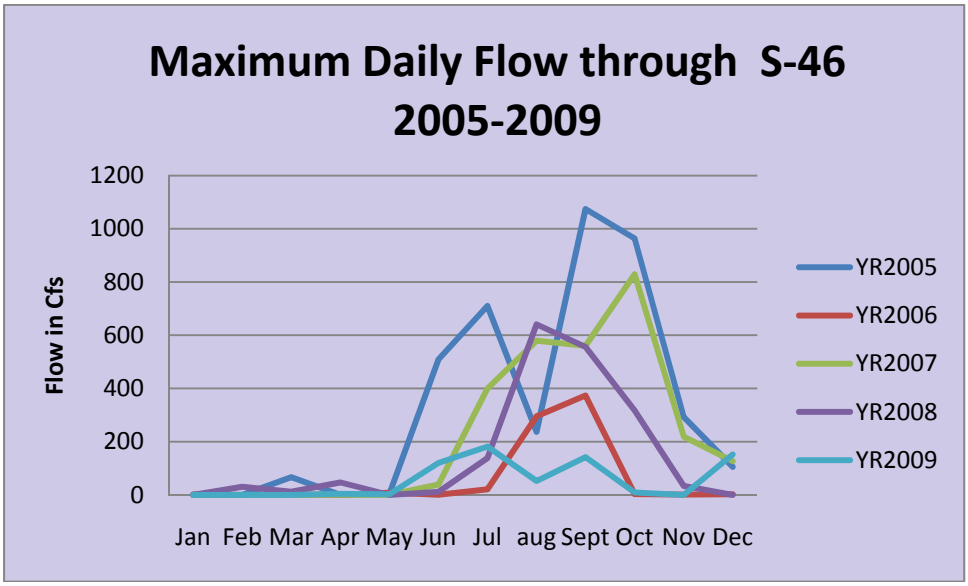


Figure 6. Average Daily Flows through S-46

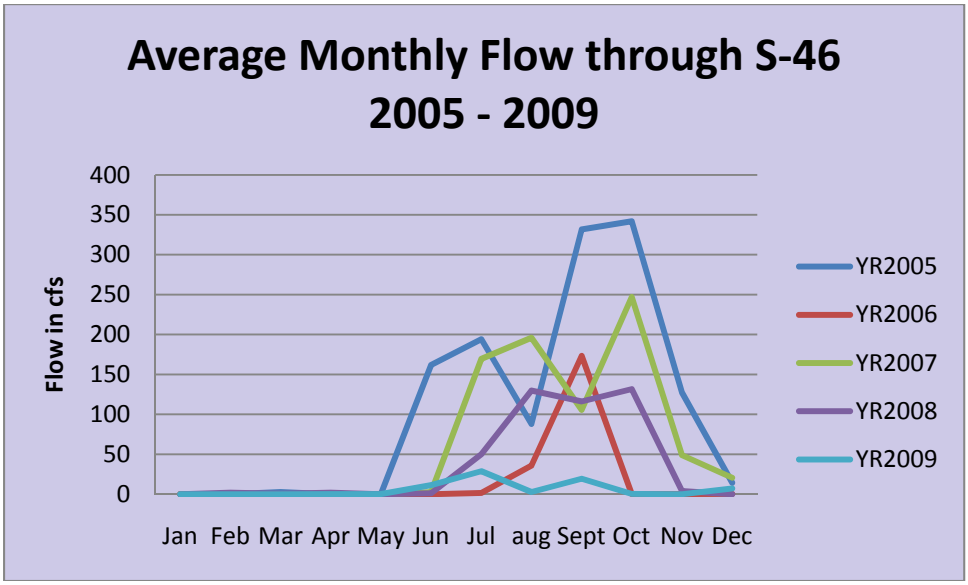
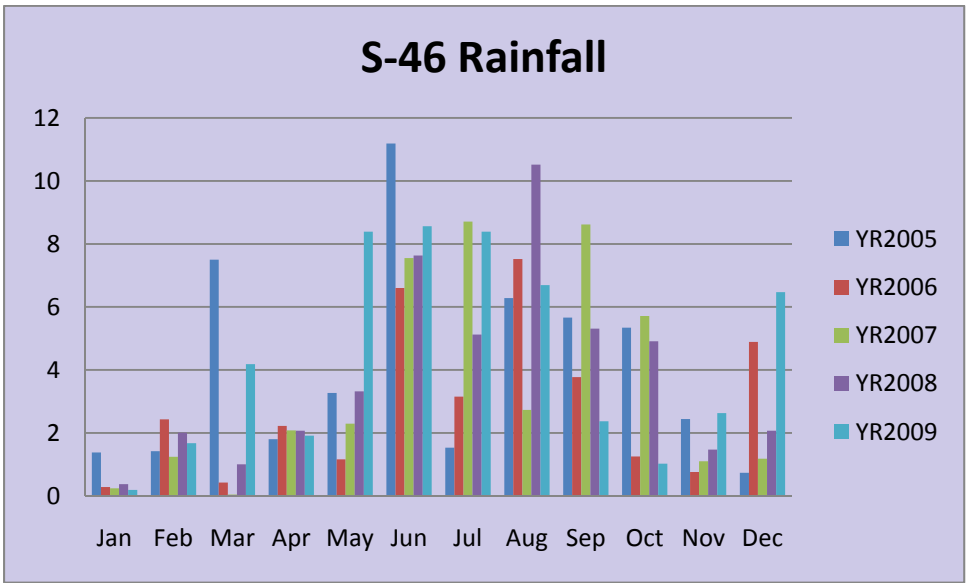


Figure 7. Monthly Rainfall at S-46 (2005-2009)



Vegetation Monitoring

The pre-operational baseline vegetation conditions in the Loxahatchee Slough were defined by the semi-annual monitoring conducted in the wet and dry seasons from 2002 to 2007 by Palm Beach County. The annual reports, the Baseline Report, and 5-Year Report have been previously submitted to FDEP and are incorporated by reference (6) for purposes of defining pre-operational baseline vegetation conditions in the Loxahatchee Slough, taking into account seasonal and inter-annual variability. Concurrently with the increase in stage elevation at the G-160 structure beginning June 1, 2009, Palm Beach County reinitiated the semi-annual monitoring of vegetation in the Loxahatchee Slough. The data collected by the County during the wet-season monitoring event are shown in Table 1. Although specified in the FDEP-approved 5-Year Operation Monitoring Plan for the G-161 Project, semi-annual vegetation monitoring and apple snail cluster observations within the Grassy Water Preserve have not been conducted. The initiation of these activities will begin when regional water of adequate quantity and quality is available to be delivered through the G-161 structure. This will meet the intent of the monitoring plan to ensure that changes in water quality or quantity brought about by the delivery of regional water through the GWP and G-161 to for deliveries to the Northwest Fork Loxahatchee River are not adversely affecting the preferred prey of the endangered snail kite.

Table 1. Summary of wet season 2009 survey (provided by Palm Beach County)

Monitoring Station	Vegetative Community Type	Dominant Plant Species	Average Number of Individuals per Quadrat (Sample Standard Deviation=*s*)	Cover Class (DAUB)	Average Depth of Water at Station (in inches)
1	Swale	Herbaceous 1. *Eleocharis cellulosa* Shrub 1. *Cephalanthus occidentalis* Canopy No canopy layer	 216 (**s**=81.5) 1 (**s**=1.7) n/a	 1.7 0.3 n/a	22
2	Swale	Herbaceous 1. *Eleocharis cellulosa* 2. *Rhynchospora tracyi* Shrub 1. *Taxodium distichum* Canopy No canopy layer	 180 (**s**=50.5) 6 (**s**=5.5) 0.3 (**s**=0.6) n/a	 1.3 0.7 0.3 n/a	18.7
3	Swale	Herbaceous 1. *Eleocharis cellulosa* 2. *Rhynchospora tracyi* Shrub No shrub layer Canopy No canopy layer	 167 (**s**=85.6) 21 (**s**=18.1) n/a n/a	 1.3 0.7 n/a n/a	17.7
4	Hydric Hammock	Herbaceous 1. *Psychotria nervosa* 2. *Blechnum serrulatum* Shrub 1. *Psychotria nervosa* 2. *Urena lobata* Canopy 1. *Sabal palmetto* 2. *Rapanea punctata*	 78 (**s**=122.9) 4 (**s**=2.0) 21 (**s**=28.4) 14 (**s**=20.9) 5 (**s**=3.6) 3 (**s**=3.8)	 0.7 1.0 0.7 0.7 1.7 0.7	Saturated

Monitoring Station	Vegetative Community Type	Dominant Plant Species	Average Number of Individuals per Quadrat (Sample Standard Deviation=*s*)	Cover Class (DAUB)	Average Depth of Water at Station (in inches)
5	Wet Flatwoods	Herbaceous 1. *Dichanthelium commutatum* 2. *Blechnum serrulatum* Shrub 1. *Rapanea punctata* 2. *Serenoa repens* Canopy 1. *Pinus elliottii* var. *densa* 2. *Rapanea punctata*	 4 (**s**=6.4) 2 (**s**=4.0) 7 (**s**=9.8) 2 (**s**=2.9) 3 (**s**=2.5) 12 (**s**=13.2)	 0.3 0.3 1.0 0.3 1.3 1.3	1.5

Wetland Mitigation Area

The wetland mitigation area was planted in November 2006, replanted in April 2007 in response to inadequate survival of transplants, primarily due to the drought, and monitored quarterly from May 2007 through May 2008 to evaluate survival and exotics incursion relative to a pre-operational baseline survey conducted in February 2007. Those reports are incorporated by reference (10). Issues regarding excessive deposition of plant biomass and sediments that were observed in the engineered channel between G-161 and the Beeline Highway Culvert will be addressed by evaluating options for permanent sediment and vegetation traps at the upstream end of the G-161 structure. The associated spread of undesirable wetland and upland plants will be controlled and corrected by the City of West Palm Beach under the two-party MOU with the District. Subsequently, the City implemented exotic species control measures in and adjacent to the G-161 flow-way channel pursuant to its responsibility for routine maintenance of the G-161 Project on October 26, 2009. An inspection by District and FDEP staff on October 29, 2009, confirmed both the survival of > 80% of the planted species and < 5% incursion of exotic plant species when the treated areas responded to the control measures over the next several months. The results of the follow-up inspection, which was conducted on January 11, 2010, will be summarized in next year's annual report.

Water Quality

The pre-operational baseline water quality conditions are defined by routine monitoring of District structures along the various flow-ways involving the M Canal, the C-18 Canal, the Grassy Waters Preserve, the Loxahatchee Slough, the Northwest Fork Loxahatchee River, and the Loxahatchee River Estuary (8). Those data are augmented by the special studies conducted by the District for the L-8 Reservoir Project in 2004-2006 under the Environmental Resource Permit that predated the CERPRA permit issued in March 2007. The annual reports documenting and analyzing those data are now published as an appendix to the annual South Florida Environmental Report in March of each year and are incorporated by reference (9) but are not appended to this report and the results are not summarized here. The City of West Palm Beach regularly collects water samples within the interior marsh of the Grassy Water Preserve. Those data have been requested, but have not yet been received from the City. The will be forwarded under separate cover.
Operation of G-161 to deliver supplemental flows to the Northwest Fork Loxahatchee River was initiated in late November 2009. As per the permit, the District is required to collect and analyze water quality at the Control 2 pump station and downstream of the G-161 structure monthly during periods of flow. The results are contained in Table 1. With the exception of dissolved oxygen (DO), there were no exceedances of applicable water quality standards at the point of discharge (pending confirmation from Guy Germain).

Table 2. Water Quality Results for Samples Collected Per G-161 Operation

Station	Date	TEMP	D.O.	Sp. Cond.	pH	Turb
ID	YYYYMMDD	Deg C	mg/L	µS/cm	Units	NTU
G161	20091102	26.3	1.51	277	6.8	0.6
G161	20091116	21.5	3.19	345	6.7	1.6
G161	20091203	22.4	3.84	322	6.8	0.9
L8.CNL	20091102	26.5	4.94	448	7.4	20.8
L8.CNL	20091116	22	6.71	484	7.5	45.8
L8.CNL	20091203	22.9	7.18	503	7.6	8.4

Station ID	Date YYYYMMDD	TSS mg/L	NOX mg/L	NH4 mg/L	TKN mg/L	TN mg/L	SO4 mg/L	OPO4 mg/L	TPO4 mg/L
G161	20091102	<3	<.005	0.006	0.99	0.995	6.2	<.002	0.012
G161	20091116	<3	0.01	0.015	0.91	0.92	12.6	<.002	0.01
G161	20091203	<3	<.005	0.016	0.92	0.925	13.3	<.002	0.01
L8.CNL	20091102	15	0.293	0.044	1.14	1.433	30	0.056	0.114
L8.CNL	20091116	30	0.332	0.028	1.32	1.652	33.2	0.053	0.151
L8.CNL	20091203	7	0.208	0.027	1.01	1.218	28.8	0.036	0.074

Na mg/L	Station ID	Date YYYYMMDD	K mg/L	Hardness mg/L	NO3 mg/L	Cl mg/L	Mg mg/L	Ca mg/L
19.6	**G161**	20091102	2.6	65.8	<.005	32	4	19.8
25.5	**G161**	20091116	3.8	93.6	0.01	41.6	6	27.7
25	**G161**	20091203	3.8	91.1	<.005	42.6	6	26.6
30.4	**L8.CNL**	20091102	5.3	148.5	0.286	51.2	9.9	43.1
32.6	**L8.CNL**	20091116	5.8	157	0.327	55.2	10.7	45.2
32.2	**L8.CNL**	20091203	5.2	164.8	0.202	54.6	10.1	49.3

References

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2. SFWMD. 2007. Interim Operation Plan for the G-161 Project Phase II. South Florida Water Management District, West Palm Beach, FL.

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4. FDEP. 2005. Grassy Waters Preserve: Summary of Water Quality Monitoring January 2004 – March 2005. Southeast District Water Quality Office. Port St. Lucie, FL. June

5. Evans, D.E. (2007). ANNUAL REPORT For the period July 1, 2005 to September 30, 2006 CERP/RECOVER/MAP PROJECT Assessment of Mercury Bioaccumulation in Sentinel Fish in South Florida NOS Agreement Code MOA-204-191/6945. Nat'l. Oceanic and Atmospheric Administration, Center for Coastal Fisheries and Habitat Research, 101 Pivers Island Road, Beaufort NC, 28516. March.

6.a. Zahina, J. and J. Kramp. 2004. Vegetation Communities within the Loxahatchee Slough: A GIS-based Analysis of the Baseline Conditions (1995-2000) Before the Construction and Operation of the G-160 Structure. Water Supply Department, South Florida Water Management District, West Palm Beach, FL. February.

6.b. PBC. 2003-2007. Loxahatchee Slough Restoration and G-160 Monitoring Reports. Prepared for the South Florida Water Management District under a Memorandum of Agreement (C-13357) by the Department of Environmental Restoration, Palm Beach Co., FL. December-January-February.

6.c. Zahina, J.G. and J. Kramp. 2008. Vegetation Communities in the Loxahatchee Slough Natural Areas: A GIS-Based Analysis of the Change from 2000 to 2005 Associated with the Operation of the G-160 Structure. Water Supply Department, South Florida Water Management District, West Palm Beach, FL. April.

7. Germain, G. 2003-2009. L-8 Reservoir Project: Annual Water Quality Assessment Report for Water Year 2003-2008. Appendix 7A-4 Chapter

7: Comprehensive Everglades Restoration Plan Annual Report in G. Redfield and S. Ollis, Eds., **South Florida Environmental Report**, South Florida Water Management District, West Palm Beach, FL. March.

8. Walker, P. and M. Hedgepeth. 2009. "The Loxahatchee River Estuary" Chapter 12 in Redfield and Ollis, Eds. ***The South Florida Environmental Report***. South Florida Water Management District, West Palm Beach, FL. March: 12-16 to 12-26.

9a. Zahina, J. 2007. G-161 Flow-Way Mitigation Area Time-Zero Vegetation Monitoring Report. Water Supply Division, South Florida Water Management District. February.

9b. Zahina, J. 2007-2008. (Quarterly) G-161 Flow-Way Mitigation Area Vegetation Monitoring Reports. Water Supply Division, South Florida Water Management District. May, August, November, February, and May.

Appendices:

Appendix 1: 2009 G-160 and Associated Slough Stage Data

Appendix 2: 2009 Structure Flow Data

Appendix 3: Palm Beach County Slough Vegetation Report

Appendix 4 - Dry Season Water Supply from the Loxahatchee Slough to the Northwest Fork of the Loxahatchee River – May 2009

Attachments:

Attachment 1 Copy of G-160 Environmental Resource Permit

Attachment 2 Copy of G-161 Environmental Resource Permit

Attachment 3 Copy of G-161 5-Year Operations Monitoring Plan

Attachment 4 Interim Operation Plan

Appendix 1: 2009 G-160 and Associated Slough Stage Data

Contact: Beth Kacvinsky

Note: This supporting information is available upon request.

Appendix 2:
2009 Structure Flow Data

Contact: Beth Kacvinsky

Note: This supporting information is available upon request.

Appendix 3: Loxahatchee Slough Restoration and G-160 Monitoring Plan First Post Operational Field-based Vegetation Monitoring Report

Note: This document, dated January 2010, was provided to the South Florida Water Management District and Florida Department of Environmental Protection by Palm Beach County, Department of Environmental Resources Management

Loxahatchee Slough Restoration and G-160 Monitoring Plan
First Post Operation Field-based Vegetation Monitoring Report

Prepared for:

The South Florida Water Management District

and

The Florida Department of Environmental Protection

January 2010

Prepared by:

Palm Beach County
Department of Environmental Resources Management

Executive Summary

A mutually agreeable arrangement was reached between Palm Beach County's Department of Environmental Resources Management (County) and the South Florida Water Management District (SFWMD) with regard to the execution of the Loxahatchee Slough Restoration and G-160 Monitoring Plan (Plan). The Plan requires that the County conduct baseline (current) and post-construction/operation (G-160 Structure) vegetation and hydrological monitoring within the Loxahatchee Slough Natural Area (Slough). The purpose of the monitoring plan is to determine the effectiveness of the first tier improvements completed under the North Palm Beach County Comprehensive Water Management Plan and to provide a measure of success in achieving restoration targets. The results are expected to provide the SFWMD with beneficial information that will allow adjustments to the operation of the G-160 Structure to most effectively meet the Plan's objectives. The work includes two approaches to monitoring vegetation, a field-based site-specific component and a GIS-based landscape-level analysis. This report presents the findings from the field-based component of the vegetation surveys and hydrological data collection conducted during the wet season (between August 1 and September 15) of 2009. It represents the first year of post operation monitoring that will be combined with the landscape-level monitoring summary report prepared by the SFWMD.

The field-based vegetation and hydrological monitoring involves the collection of data from a total of five field stations. At each station, three rectangular nested vegetation quadrats, one staff gauge, and one photopoint were established. Vegetation parameters measured within the quadrats are species composition, density (total/unit area), cover [Daubenmire Cover Class (1-6)], and qualitative descriptions. The staff gauges are used to obtain water elevations relative to sea level (NGVD). The depth of the water within the quadrats is also measured. The photopoints were established to take a composite panoramic photograph of the vegetation at each station from the same location, angle, and perspective during each survey event.

Stations 1-3 are situated in swale communities dominated by spikerush (*Eleocharis cellulosa*) with very little shrub layer and virtually no canopy layer. Station 4 is a mature hydric hammock dominated by wild coffee (*Psychotria nervosa*) and swamp fern (*Blechnum serrulatum*) in the understory, and cabbage palm (*Sabal palmetto*) and laurel oak (*Quercus laurifolia*) in the canopy layer. The herbaceous layer is very sparse and severely damaged (tilled) by feral hogs (*Sus scrofa*). Station 5 is comprised of wet flatwoods where the herbaceous layer is highly variable, the shrub layer is dominated by cabbage palms and myrsine (*Rapanea punctata*), and the canopy is dominated by slash pine (*Pinus elliottii* var. *densa*). Surface water is generally not present at Stations 4 and 5 during the wet or dry seasons, however during the 2009 wet season monitoring, Station 4 was saturated and Station 5 had standing water at one of the plots. Panoramic photographs were taken at each of the five photopoint locations to give both quantitative (shrub and herbaceous layer heights) and qualitative representations of the vegetative community types described above.

Introduction

The extant areas of the Loxahatchee Slough are comprised of approximately 16,000 acres of pine flatwoods, swale, wet prairies, hydric hammock, strand swamp, slough, dome swamp, depression marsh, and disturbed areas within the County-owned Hungryland Slough Natural Area (approximately 3,000 acres) and the Loxahatchee Slough Natural Area (approximately 12,800 acres) (Figure 1). The Loxahatchee Slough contains the headwaters of the Loxahatchee River, one of Florida's two federally designated Wild and Scenic Rivers. The site is one of the most ecologically diverse tracts of protected land in Palm Beach County, including nine distinct habitat types, the largest oak hammock and swale/slough in the County, and 63 federally or state-listed species of plants and animals (Gann *et al.*, 2001). The hydrology of the Loxahatchee Slough has been severely altered through the construction of drainage canals, flood protection berms, and increased anthropogenic water consumption. Overdrainage and hydroperiod alterations have contributed to the establishment of invasive exotic plant species such as melaleuca (*Melaleuca quinquenervia*), Old-world climbing fern (*Lygodium microphyllum*), and Brazilian pepper (*Schinus terebinthifolius*), which has led to decreases in habitat quality for native flora and fauna.

In order to increase water control and restore the historic hydroperiod to the Slough, in 2003 the G-160 structure was constructed in the C-18 canal immediately south of the intersection with its western leg, the C-18W (Figure 2). The structure will allow water managers operational flexibility for the purposes of water supply, flood protection, and environmental restoration, including hydrologic restoration of the Loxahatchee Slough to provide water to meet the base flow requirements for the Northwest Fork of the Loxahatchee River. From August 10, 2005 until June 1, 2009, the SFWMD operated the gates on the G-160 at 15.5 ft. NGVD during the dry season and 15.0 ft. NGVD during the wet season because of difficulties reaching an agreement between the SFWMD and Northern Palm Beach County Improvement District, the City of Palm Beach Gardens and the South Indian River Water Control District. The 15.0 ft./15.5 ft. NGVD operating schedule that started in 2005 was so low that it had no effect on increasing water elevations within the Loxahatchee Slough. During the spring of 2009, the Florida Department of Environmental Protection mandated the SFWMD to begin to raise the elevation of the water in the C-18 canal by June 1, 2009 at 16.5 ft. NGVD during the wet season and 15.5 ft. NGVD during the dry season. Because the G-160 structure was not operated above 15.5 ft. NGVD, the County ceased monitoring in September 2006. When the SFWMD began to raise the elevation to 16.5 ft. NGVD in June 2009, the County resumed monitoring by performing the fall, wet season monitoring event. Therefore, this report only includes new information collected from that single event with very little comparisons and conclusions from previous monitoring events. The monitoring plan was developed to assess the effects of the operation of the G-160 water control structure (and subsequent raising of water elevations) on the vegetation communities within the Loxahatchee Slough and to determine if restoration goals are being met.

Methods

A total of five permanent vegetation and hydrological monitoring stations were established in the Loxahatchee Slough Natural Area at pre-determined locations both east and west of the C-18 canal (see Figure 2). The pre-determined locations were selected because they are representative of major habitat types found within the Loxahatchee Slough, which are anticipated to be affected by the operation of the G-160 structure. At each of these five locations, three nested vegetation quadrats, one staff gauge, and one photopoint were established. The vegetation plots were positioned within the given community type using random compass directions and distances that were selected from a random numbers table and paced off as described in the SFWMD Save Our Rivers Environmental Monitoring Protocols (Van Horn and Van Horn 1993). The staff gauge and photopoint were then positioned centrally between the three vegetation quadrats at each station. The vegetation plots, staff gauges, and photopoints shall be monitored twice a year, once during the wet season (between August 1- September 15) and once during the dry season (between February 1 and March 15).

The vegetation plots are a nested design that includes a small (0.25m x 3m) herbaceous quadrat within a medium sized (1m x 12m) shrub quadrat, which is in turn contained within a larger (3m x 24m) canopy quadrat. The quadrat dimensions were permanently established in the field by installing four foot pieces of rebar (1/2 inch diameter) approximately two feet into the ground and covering them with a five-foot long PVC pipe (3/4 inch diameter) at each quadrat corner. The methods and monitoring definitions of herbaceous, shrub, and canopy are included as Attachment A. Vegetation parameters measured within the quadrats included species composition, density (total/unit area), cover [Daubenmire Cover Class (1-6)], and qualitative descriptions. Within the herbaceous quadrat, each individual plant was counted and recorded by species. An estimate of the vegetative cover (total surface area of the 0.25m x 3m quadrat covered by vegetation) was then recorded by species. This estimate was recorded as a particular Daubenmire Cover Class (1-6), each of which represents a range of percentages of vegetative cover (Attachment B). The qualitative observations (e.g. vigor of plant, overall appearance), and any other relevant observations (e.g. plant alive/dead, no herbaceous layer) were also recorded. Within the shrub quadrat and canopy quadrat, the same parameters were recorded as in the herbaceous quadrat.

The staff gauges were permanently established by installing 10 ft. painted signposts approximately four feet into the ground at each station. The elevations of the tops of these posts have been surveyed, which is used to obtain water elevations relative to sea level (NGVD). The depth of the water within the quadrats was also measured.

The photopoints were established to take a composite panoramic photograph of the vegetation at each station from the same location, angle, and perspective during each survey event. The photopoint was permanently marked in the field with a 4 ft. long piece of rebar (3/4 inch diameter) and covered with a 5 ft. piece of PVC pipe (3/4 inch diameter). The photos were taken at the five photomonitoring stations using the method described in 'Photomonitoring Protocol for Palm Beach County Natural Areas' (Attachment C). A Photomonitoring Record Form for each photostation described the purpose of the photopoint, location, direction of photos, and other information important for future monitoring events.

Data

Tables 1 and 2 summarize the results of the vegetation monitoring quadrats during the wet season surveys conducted in September 2006 and August 2009. For more detailed information about vegetation structure and composition, the individual station quadrat data sheets for the 2009 survey are included in Attachment B. The photos in Attachment D compare the stations from fall 2003 through 2006 (baseline events) to the first operational monitoring event in the fall of 2009.

Table 1: Summary of Wet Season 2006 Survey

Monitoring Station	Vegetative Community Type	Dominant Plant Species	Average Number of Individuals per Quadrat (Sample Standard Deviation=*s*)	Cover Class (DAUB)	Average Depth of Water at Station (in inches)
1	Swale	Herbaceous			10.7
		1. *Eleocharis cellulosa*	200 (*s*=106.2)	1	
		2. *Rhynchospora tracyi*	43 (*s*=35.4)	1	
		Shrub			
		1. *Cephalanthus occidentalis*	1 (*s*=1.7)	0.3	
		Canopy			
		No canopy layer	n/a	n/a	
2	Swale	Herbaceous			6.7
		1. *Eleocharis cellulosa*	125 (*s*=50.7)	1	
		2. *Rhynchospora tracyi*	72 (*s*=30.3)	1	
		Shrub			
		1. *Hypericum fasciculatum*	0.3 (*s*=0.6)	0.3	
		2. *Taxodium distichum*	0.3 (*s*=0.6)	0.3	
		Canopy			
		No canopy layer	n/a	n/a	
3	Swale	Herbaceous			7.6
		1. *Eleocharis cellulosa*	223 (*s*=281.2)	1.3	
		2. *Rhynchospora tracyi*	47 (*s*=40.8)	0.7	
		Shrub			
		1. *Cephalanthus occidentalis*	0.3 (*s*=0.6)	0.3	
		Canopy			
		No canopy layer	n/a	n/a	
4	Hydric Hammock	Herbaceous			Dry
		1. *Blechnum serrulatum*	10 (*s*=5.5)	1	
		2. *Erechtites hieraciifolius*	12 (*s*=20.2)	0.3	
		Shrub			
		1. *Urena lobata*	142 (*s*=99.9)	1.3	
		2. *Psychotria nervosa*	52 (*s*=79.9)	1.7	
		Canopy			
		1. *Sabal palmetto*	6 (*s*=2.5)	1.7	
		2. *Psychotria nervosa*	2 (*s*=1.5)	0.7	
5	Wet Flatwoods	Herbaceous			Dry
		1. *Dichanthelium commutatum*	4 (*s*=6.4)	0.3	
		2. *Chamaecrista fasciculata*	5 (*s*=8.1)	0.3	
		Shrub			
		1. *Urena lobata*	13 (*s*=21.9)	0.3	
		2. *Sabal palmetto*	22 (*s*=22.5)	1.3	
		Canopy			
		1. *Sabal palmetto*	5 (*s*=2.0)	1.3	
		2. *Rapanea punctata*	20 (*s*=23.1)	1.3	

Table 2: Summary of Wet Season 2009 Survey

Monitoring Station	Vegetative Community Type	Dominant Plant Species	Average Number of Individuals per Quadrat (Sample Standard Deviation=*s*)	Cover Class (DAUB)	Average Depth of Water at Station (in inches)
1	Swale	Herbaceous			22
		1. *Eleocharis cellulosa*	216 (*s*=81.5)	1.7	
		Shrub			
		1. *Cephalanthus occidentalis*	1 (*s*=1.7)	0.3	
		Canopy			
		No canopy layer	n/a	n/a	
2	Swale	Herbaceous			18.7
		1. *Eleocharis cellulosa*	180 (*s*=50.5)	1.3	
		2. *Rhynchospora tracyi*	6 (*s*=5.5)	0.7	
		Shrub			
		1. *Taxodium distichum*	0.3 (*s*=0.6)	0.3	
		Canopy			
		No canopy layer	n/a	n/a	
3	Swale	Herbaceous			17.7
		1. *Eleocharis cellulosa*	167 (*s*=85.6)	1.3	
		2. *Rhynchospora tracyi*	21 (*s*=18.1)	0.7	
		Shrub			
		No shrub layer	n/a	n/a	
		Canopy			
		No canopy layer	n/a	n/a	
4	Hydric Hammock	Herbaceous			Saturated
		1. *Psychotria nervosa*	78 (*s*=122.9)	0.7	
		2. *Blechnum serrulatum*	4 (*s*=2.0)	1.0	
		Shrub			
		1. *Psychotria nervosa*	21 (*s*=28.4)	0.7	
		2. *Urena lobata*	14 (*s*=20.9)	0.7	
		Canopy			
		1. *Sabal palmetto*	5 (*s*=3.6)	1.7	
		2. *Rapanea punctata*	3 (*s*=3.8)	0.7	
5	Wet Flatwoods	Herbaceous			1.5
		1. *Dichanthelium commutatum*	4 (*s*=6.4)	0.3	
		2. *Blechnum serrulatum*	2 (*s*=4.0)	0.3	
		Shrub			
		1. *Rapanea punctata*	7 (*s*=9.8)	1.0	
		2. *Serenoa repens*	2 (*s*=2.9)	0.3	
		Canopy			
		1. *Pinus elliottii* var. *densa*	3 (*s*=2.5)	1.3	
		2. *Rapanea punctata*	12 (*s*=13.2)	1.3	

Discussion of Findings

In Tables 1 and 2, the data from each of the three vegetation quadrats at each of the five vegetation monitoring stations were averaged by herbaceous layer, shrub layer, and canopy layer. The detailed data sheets in Attachment B reflect the species composition and structure of each of the three layers within the specific nested quadrats. Only the two species with the dominant vegetation cover percentage in each of the five stations were included. The data in this report represents the first collection of post operation data. For comparison purposes, the 2006 data was used as the final baseline. Stations 1-3 (Swale) had very similar results for the herbaceous layer, while the shrub layer experienced some changes. *Hypericum fasiculatum* disappeared from the shrub layer in Station 2 and *Cephalanthus occidentalis* disappeared from the shrub layer in Station 3. In Station 4, *Psychotria nervosa* replaced *Erechtites hieraciifolius* in the herbaceous layer, the shrub layer had the same species but in lower numbers, and the canopy layer had *Rapanea punctata* replace *Psychotria nervosa* in dominance. In Station 5, *Chamaecrista fasciculata* disappeared from the herbaceous layer, the shrub layer shifted dominance from *Urena lobata* and *Sabal palmetto* to *Rapanea punctata* and *Serenoa repens*, and the canopy layer lost some *Sabal palmetto* so that *Pinus elliottii* var. *densa* became the dominant species. Most of the changes in Stations 4 and 5 can be attributed to the extensive hog rooting in those plots. The 2006 Baseline conditions will continue to be compared with post-operation data in future reports.

The panoramic photographs taken at each of the photopoints give both quantitative (shrub and herbaceous layer heights) and qualitative representations of the vegetative community types described above (Attachment D). The only change to note is on the photos of Station 4 (Hydric Hammock), with the surge in shrub vegetation after Sept. 2004. This is attributed to the loss of canopy after the hurricanes of 2004 (Frances and Jeanne) and 2005 (Wilma) that affected Palm Beach County.

Another point of note is that the water levels at the monitoring stations (Attachment E) during the fall 2009 event most closely resembles the hurricane years of 2004 and 2005. Stations 1-3 averaged 19.5 inches of surface water in the 2009 wet season. Station 4 was saturated and Station 5 averaged 1.5 inches. The 2009 monitoring event is the only year that Station 5 (Wet Flatwoods) had any measurable standing water. This is quite notable since there was below normal rainfall in the months of Aug., Sept., and October 2009, with no tropical storms or large low pressure systems affecting the region.

Literature Cited

Gann, G., K. Bradley and S. Woodmansee. 2002. Habitats in South Florida. The Institute for Regional Conservation. Miami, Florida.

Van Horn, M. and K. Van Horn . 1993. 'Save Our Rivers' Environmental Monitoring Protocols. South Florida Water Management District. West Palm Beach, Florida.

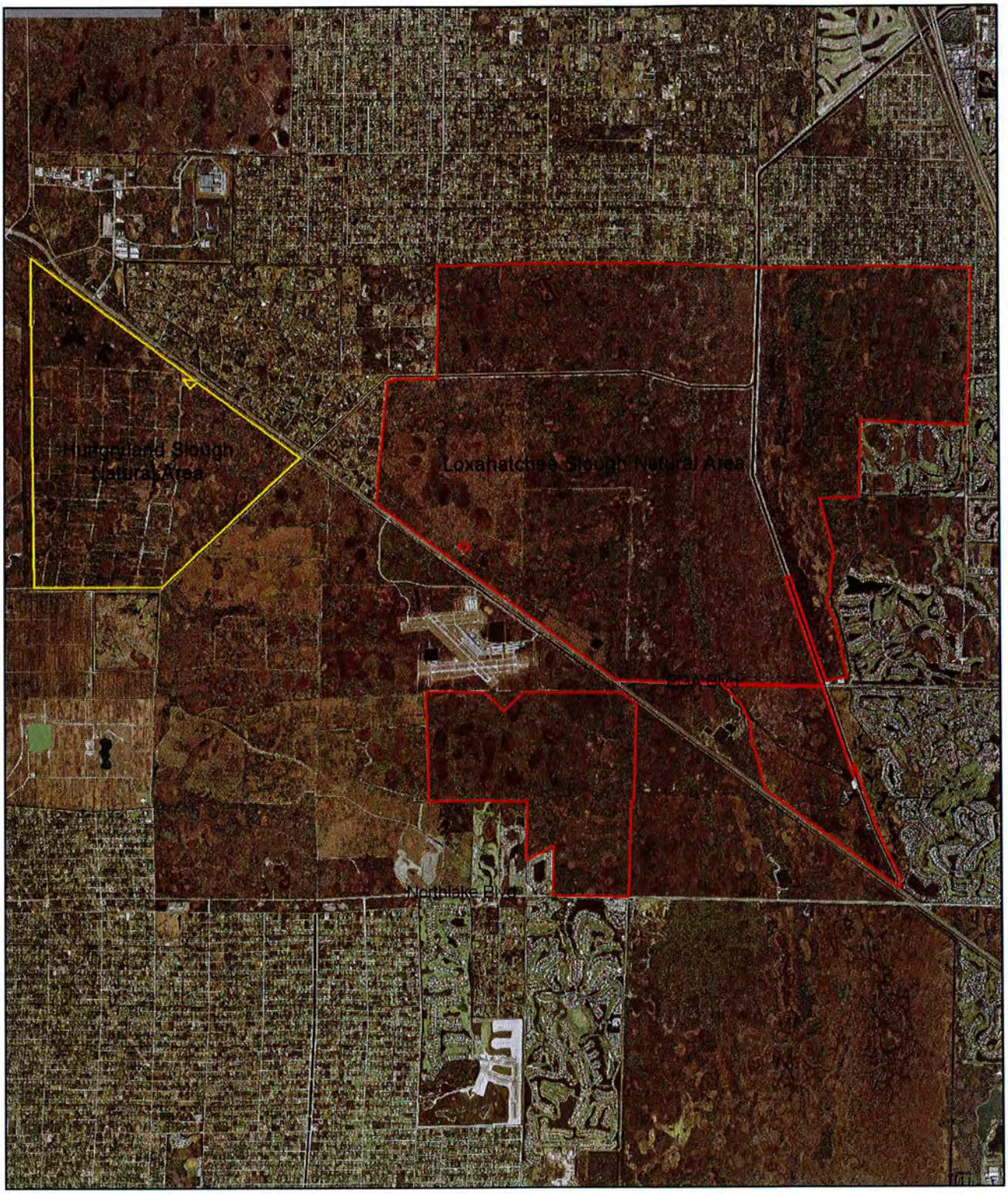
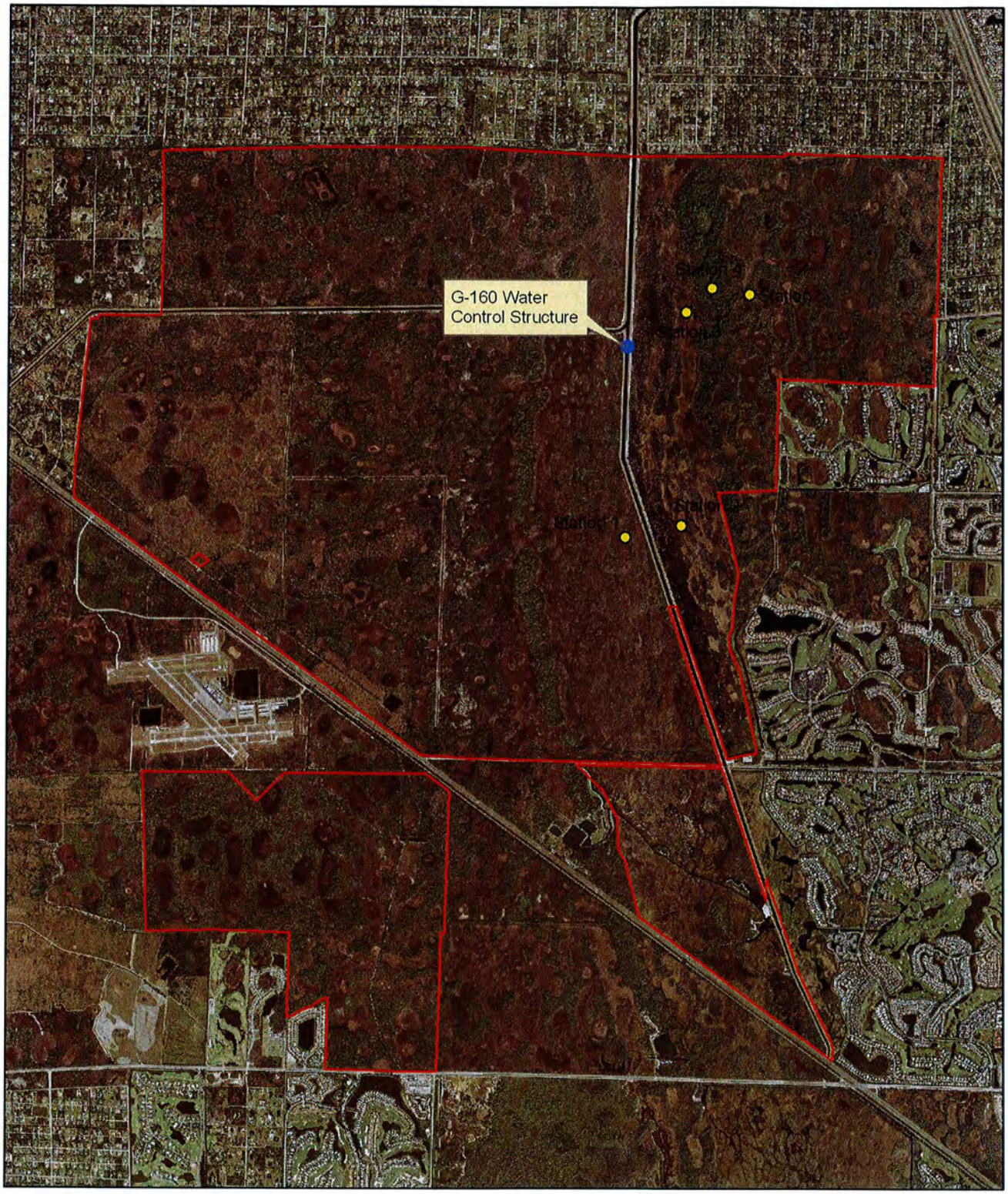


Figure 1: Hungryland Slough and Loxahatchee Slough Natural Areas Location Map

N

0 0.5 1 2 3 4 Miles



N

Figure 2: G-160 Vegetation Monitoring Stations

0 0.375 0.75 1.5 2.25 3 Miles

ATTACHMENT A

Definitions for G-160 Vegetation Monitoring Stations at the Loxahatchee Slough Natural Area

Herbaceous layer = any *non-woody* plants, *excluding* seedlings of woody species that are presently non-woody (e.g. *Sabal palmetto*, *Hypericum* spp.), but *including* vines (e.g. *Vitis* spp., *Toxicodendron radicans).* Only count plants with at least half of their roots *within* the plot.

Shrub layer = any *woody* plant above the ground and *less* than, or equal to, 2.5 meters (8.2 feet) tall, excluding vines (which will *only* be recognized in the herbaceous plot canopy cover). Count *all Hypericum* spp. and *all* seedlings of potentially woody species in this plot. Shrub canopy cover class will be determined using trees rooted *both* inside *and* outside the plot.

Canopy layer = any *woody* plant greater than 2.5 meters tall, excluding vines. Only count the number of trees with more than half their root system within the plot. *Do not* count *seedlings* of canopy species; these will be counted within the shrub layer plot. Canopy cover class will be determined using trees rooted *both* inside *and* outside the plot.

Note: Always use the *first three letters* of both the genus and species names in the **Species** column on the Veg. Plot Data Sheets.

ATTACHMENT B

Vegetation Quadrat Data Sheets

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 1, Swale)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.

Observer (s): Melissa Tolbert, Harper Carroll, Dave Witmer

Date: 8 / 25 / 09

Station #: 1 A, B, C

GPS Location: See attached aerial photo for exact locations Management Unit: n/a

General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Note: String needs to be placed around the herbaceous plots to delineate their perimeters

Depth of water in plots: **22" (A), 22" (B), 22" (C)** Staff Gauge Reading: **17.49 ft NGVD** (SFWMD gauge)

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	278	2	
Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat B **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	124	1	

Shrub Plot (1x12 meters)			
Cep occ	3	1	stressed
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat C			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Herbaceous Plot (0.25x3 meters)			
Ele cel	247	2	
Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 2, Swale)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.

Observer (s): Melissa Tolbert, Harper Carroll, Dave Witmer

Date: 8 / 25 / 09

Station #: 2 A, B, C

GPS Location: See attached aerial photo for exact locations Management Unit: n/a

General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Depth of water in plots: **19" (A), 18.5" (B), 18.5" (C)** Staff Gauge Reading: **16.88 ft NGVD** (SFWMD gauge)

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	123	1	
Utr sp	--	1	not able to count
Pan hem	3	1	
Shrub Plot (1x12 meters)			
Seedlings of shrub or canopy species within plot			
Tax dis	1	1	
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat B **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	218	2	
Rhy tra	6	1	
Utr sp	--	1	not able to count

Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat C			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Herbaceous Plot (0.25x3 meters)			
Ele cel	200	1	
Rhy tra	11	1	
Utr sp	--	1	not able to count
Shrub Plot (1x12 meters)			
			no shrub layer
			Hyp fas from previous data was not found
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 3, Swale)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.

Observer (s): Melissa Tolbert, Harper Carroll, Frank Griffiths, Dave Witmer

Date: 8 / 26 / 09

Station #: 3 A, B, C

GPS Location: See attached aerial photo for exact locations Management Unit: n/a

General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Depth of water in plots: **16.5" (A), 18" (B), 18.5" (C)** Staff Gauge Reading: **3.54** feet from top of gauge

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	126	1	
Rhy tra	34	1	
Xyr amb	11	1	
Utr sp	--	1	not able to count
Shrub Plot (1x12 meters)			
			no shrub layer
			Cep occ from previous data not found
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat B **Herbaceous Plot (0.25x3 meters)**			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Ele cel	109	1	
Rhy tra	28	1	
Utr sp	--	1	not able to count

Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat C			Cannot see bottom of plot due to standing water, therefore, our ability to see plants that are completely under water is limited.
Herbaceous Plot (0.25x3 meters)			
Ele cel	265	2	
Shrub Plot (1x12 meters)			no shrub layer
Seedlings of shrub or canopy species within plot			
Canopy Plot (3x24 meters)			no canopy layer
Trees *rooted* within plot			
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 4, Hydric Hammock)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.
Observer (s): Melissa Tolbert, Harper Carroll, Frank Griffiths, Dave Witmer
Date: 8 / 31 / 09
Station #: 4 A, B, C
GPS Location: See attached aerial photo for exact locations Management Unit: n/a
General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Note: String needs to be placed around these plots to permanently delineate the perimeters

Depth of water in plot: **Saturated** inches Staff Gauge Reading: **N/A (no staff gauge)** feet NGVD

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A			
Herbaceous Plot (1x3 meters)			hog damage
Ble ser	6	1	
Dic com	8	1	
Psy ner	15	1	
Par qui	2	1	
Smi sp	2	1	
Shrub Plot (1x12 meters)			
Ure lob	38	1	
Psy ner	9	1	
Psy sul	5	1	
Seedlings of shrub or canopy species within plot			
Ure lob	114	1	
Que lau	3	1	
Sab pal	4	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Sab pal	8	2	
Eug axi	1	1	
Ile cas	1	1	
Ure lob	2	1	
Fic mic	1	1	
Per bor	1	1	
Mor rub	1	1	
Rap pun	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Mor rub	1	1	

Quadrat B			
Herbaceous Plot (1x3 meters)			
Ble ser	2	1	
Vit rot	3	1	
Psy ner	220	4	
Shrub Plot (1x12 meters)			
Psy ner	53	2	
Rap pun	11	1	
Seedlings of shrub or canopy species within plot			
Sab pal	4	1	
Que lau	2	1	
Ure lob	2	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Sab pal	6	2	
Psy ner	12	1	
Per bor	1	1	
Bac hal	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Quadrat C			hog damage
Herbaceous Plot (1x3 meters)			
Smi sp	4	1	
Ble ser	4	1	
Til set	2	1	
Dic com	1	1	
Shrub Plot (1x12 meters)			
Rap pun	3	1	
Ser rep	1	1	
Cal ame	1	1	
Ure lob	4	1	
Seedlings of shrub or canopy species within plot			
Ure lob	102	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Sab pal	1	1	
Que vir	1	1	
Rap pun	7	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Pin ell var. *den*		1	

Loxahatchee Slough Restoration and G-160 Monitoring Plan
Vegetation Quadrat Data Sheet (Station 5, Pine Flatwoods)

Note: See "Rules for Vegetation Monitoring Plots at the Loxahatchee Slough Natural Area" prior to conducting the surveys.
Observer (s): Melissa Tolbert, Harper Carroll, Frank Griffiths, Dave Witmer
Date: 8 / 31 / 09
Station #: 5 A, B, C
GPS Location: See attached aerial photo for exact locations Management Unit: n/a
General Comments: Cover Class (DAUB) is determined using the Daubenmire Cover Scale:

Cover Class	Cover (%)
1	0-5
2	6-25
3	26-50
4	51-75
5	76-95
6	96-100

Note: String needs to be placed around these plots to permanently delineate the perimeters

Depth of water in plots: **saturated (A), 4.5" (B), satur** Staff Gauge Reading: **6.83** feet from top of gauge

Species	# of individuals per quadrat	Cover Class (DAUB)	Comments (alive, dead,etc.)
Quadrat A			
Herbaceous Plot (1x3 meters)			hog damage
Vit rot	3	1	
Ble ser	7	1	
Rhy sp	3	1	
Dic ere	1	1	
Shrub Plot (1x12 meters)			
Rap pun	1	1	
Ser rep	5	1	
Ile gla	1	1	
Myr cer	1	1	
Seedlings of shrub or canopy species within plot			
Ure lob	21	1	

Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Pin ell var. *den*	1	1	
Sab pal	3	1	
Myr cer	1	1	
Rap pun	2	1	
Ile cas	1	1	
Ser rep	2	1	
Lyo fru	1	1	
Bac hal	1	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

Quadrat B

Herbaceous Plot (1x3 meters)			hog damage
Cla jam	1	1	
Lud rep	1	1	
Rhy sp	1	1	
Ele bal	3	1	
Plu sp	1	1	
Shrub Plot (1x12 meters)			
Rap pun	1	1	
Seedlings of shrub or canopy species within plot			
Sab pal	2	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Pin ell var. den	3	1	
Sab pal	3	1	
Rap pun	27	2	
Chr ica	1	1	
Myr cer	2	1	
Ile cas	2	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			
Chr ica		1	
Myr cer		1	

Quadrat C			
Herbaceous Plot (1x3 meters)			hog damage
Hyp ter	2	1	
Smi sp	1	1	
Eup cap	3	1	
Dic com	11	1	
Rhy sp	8	1	
Shrub Plot (1x12 meters)			
Rap pun	18	1	
Myr cer	1	1	
Sab pal	2	1	
Chy ica	1	1	
Seedlings of shrub or canopy species within plot			
Que lau	2	1	
Sab pal	5	1	
Ure lob	9	1	
Canopy Plot (3x24 meters)			
Trees *rooted* within plot			
Pin ell var. den	6	2	2 dead pine trees not included
Sab pal	4	1	
Rap pun	7	1	
Ile cas	4	1	
Myr cer	2	1	
Trees *not* rooted within plot but whose canopy contributes to canopy cover			

ATTACHMENT C

Photomonitoring Protocol for Palm Beach County Natural Areas

(Updated 10/7/02)

The following is to be used as a guideline for site managers for establishing photopoints and taking the photographs at each photomonitoring station required per the site management plan. The standards established here are to be treated as minimum requirements. It is assumed here that all photopoints shall always be established in accordance with the appropriate site management plan in addition to the standards set below. Individual site managers may decide additional photopoints are necessary to adequately monitor a particular event (e.g. extreme high water conditions, wildfire, etc.), or more comprehensive photos (e.g. a photo encompassing a 180 degree field of view photo instead of only approximately 110 degrees) are necessary to assess the success of a particular management activity. Note: See the appropriate management plan and the Burn Monitoring Protocol Memo for appropriate timing of photomonitoring events.

Objective:

To obtain a qualitative, long-term visual record of changes in vegetative structure and/or condition over time, including the effects of planned management activities. The visual record can become semi-quantitative with the use of a density board and/or range pole.

Equipment Required for Establishing Photopoints:

- Photopoint monitoring record form (see attachment)
- Aerial photograph of site
- GPS unit
- Measuring tape
- Monument stakes (rebar and PVC)
- Compass
- Camera
- Tripod (must have compass degree increments of at least 45 degrees on camera mount for horizontal movement left and right (our Mangrotto 3030 tripod has this))
- Range pole and/or density board

Methods:

1) Location Selection:

Establish permanent photopoints in areas where planned management activities are anticipated to occur and in areas where natural vegetation succession (of management interest) is expected to occur. Examples of planned management activities include the following:

- prescribed burns
- exotic vegetation removal/herbiciding
- mechanical cutting of vegetation (e.g. Hydro-axe, Brontosaurus, roller-chopping, mowing, logging. etc.)
- construction of public use facilities and/or management roads
- wetland/upland restoration

- volunteer events
- tree plantings
- construction of water control structures on-site
- adjacent property owner activities (construction)

Examples of areas of natural vegetation succession of management interest include the following:

- known listed species populations being outcompeted
- early (e.g. post-wildfire) or late (e.g. fire-suppressed) successional vegetation communities
- new invasions of exotic species
- insect pest (e.g. pine beetles, Mexican bromeliad weevils) or plant disease outbreaks

Site management plans may dictate the number and general locations of photopoints (e.g. one photo point per management unit), but the abovementioned conditions shall be considered in the micrositing of the photopoints.

At a minimum, each* management/burn unit *shall contain at least one photopoint within a vegetation community that is expected to carry fire during a wildfire or prescribed burn.

In addition, if practical, every* vegetation community *on-site shall contain at least one representative photopoint which captures at least one of the abovementioned planned management activities and/or vegetation conditions.

Additional photopoints may be deemed necessary (to be determined by the site manager) in order to appropriately represent the vegetation conditions on site.

2) Establishing the Photopoint

The location from which the photograph is taken shall be permanently marked by placing rebar in the ground and covering it with a PVC tube. The rebar shall be placed *at least* 2 feet into the ground (or until completely stable) and the PVC covering should stand *at least* 4 feet above the ground (or until it is readily visible). The PVC can be left off if the point is in an area with a significant chance of being vandalized/removed or, the point can be easily encountered in the field in the future by ERM staff. Another rebar shall be placed in the ground at a reference point 15 feet from the photopoint in the direction of the central photo (i.e. one of four cardinal directions N, E, S, or W). This rebar should be *no more than* 3 feet above the ground and covering it with PVC will be optional. Both of these points can then be GPS'd with the Trimble Backpack unit (or other unit w/ sub-meter accuracy) and their location clearly described on the photopoint monitoring record form. Describing additional reference points (e.g. trees, structures, other unique features) may also make the point easier to re-locate in the future (e.g. photopoint is 28 meters at 114 degrees from 20" d.b.h. slash pine).

3) Taking the photo (Note: If the photopoint was established prior to this protocol, evaluate the significance of the difference between the previously taken photos and photos taken according to this protocol before initiating this methodology. If the site manager determines that significant information will be lost by adopting this protocol, continue to take the photos according to the previously written instructions, otherwise, initiate this methodology during the next photo session.)

Take 3 photos to compose a panoramic image of the target vegetation. Each of the 3 photos will be taken at 45 degree intervals (use the degree graduation marks on the tripod to make this alignment). Set the tripod up so that the camera mount is at 4.5 feet above the ground directly over top of the rebar and at a 90 degree angle to the ground (bring a level if the photopoints are on excessively uneven terrain). In addition, set up the tripod so that the "0" on the dial with the degree graduations (below the camera mount on top of the tripod) is facing the center point of your 3 photo panorama. The center point of the middle photo should be in line with one of four cardinal directions N, E, S, or W (place the compass on top of the camera to assist with this alignment). Holding the bottom tripod handle and progressing from right to left, or left to right, take a photo at "45" degrees (middle dot between "0" and "90"), "0", and end at "45" on the other side from where you started (total of three photos). The range pole or density board shall be placed at the reference point 15 feet from the photopoint and included in the middle photograph. The range pole can be placed directly over top of the rebar.

Note: Always take your photos using the widest angle "zoom" possible (on either camera). Press the "w" on the zoom lever until the image stops zooming out. This will give sufficient overlap between the photos in order to arrange a composite panorama if needed. In addition, always take photos using the 1600x1200 image size (if using the Sony Cybershot, open "Menu" and select "File/Image Size/1600x1200", if using the Nikon, select "Medium" quality) for optimum image clarity and practical storage capacity.

4) Image Storage

Using Adobe Photoshop Elements, compile the three photos into a panoramic photo and save as a single file (JPEG) with the name of the site, management unit, and photopoint number within the unit (if applicable), and the date it was taken. This file can then be viewed and printed as needed. Save copies of this file to the "Master" photomonitoring CD under the appropriate site folder and year.

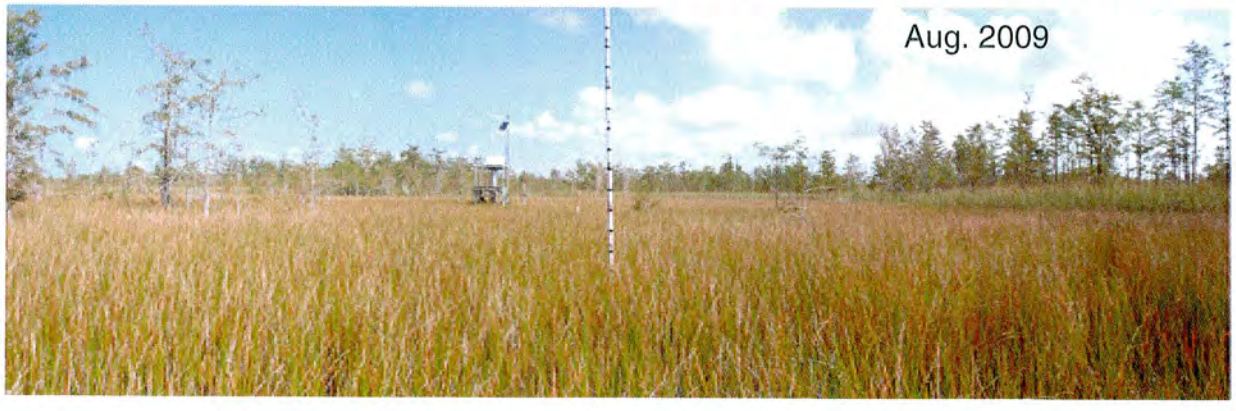
In addition, save *each* of the three individual photos taken at each photopoint individually, including the degree angle at which each photo was taken in the name of each file. These will be saved as back-up files of the panoramic mosaic if needed in the future.

ATTACHMENT D

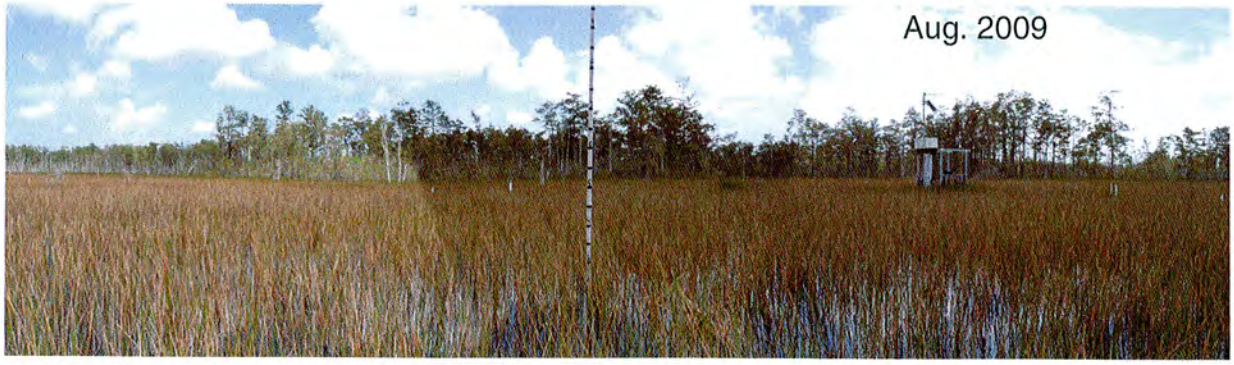
PANORAMIC PHOTOS

Fall 2003 - 2009

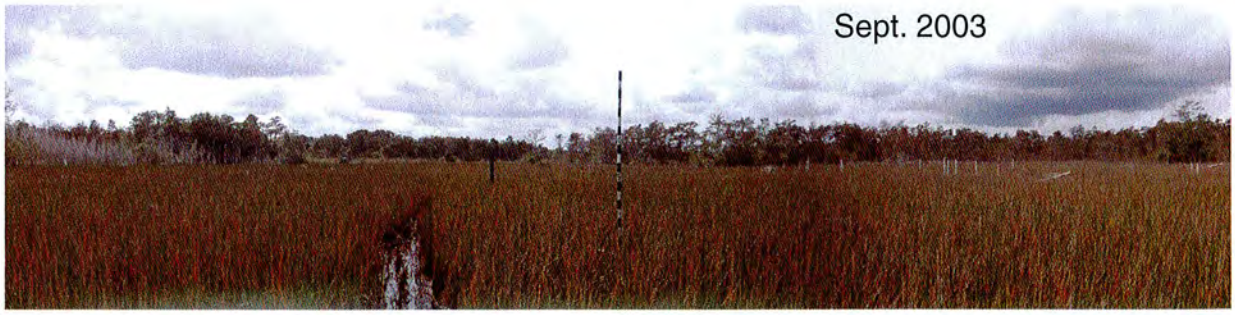
Photostation 1 – Swale

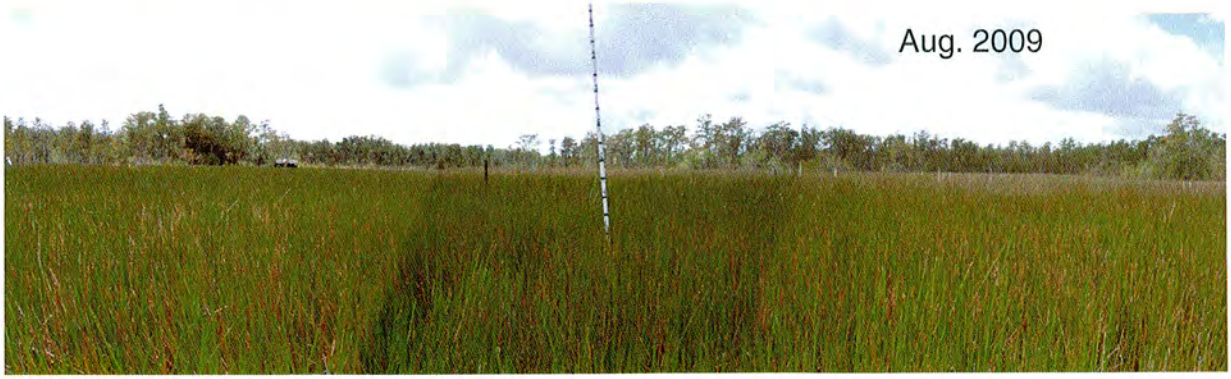


Photostation 2 – Swale



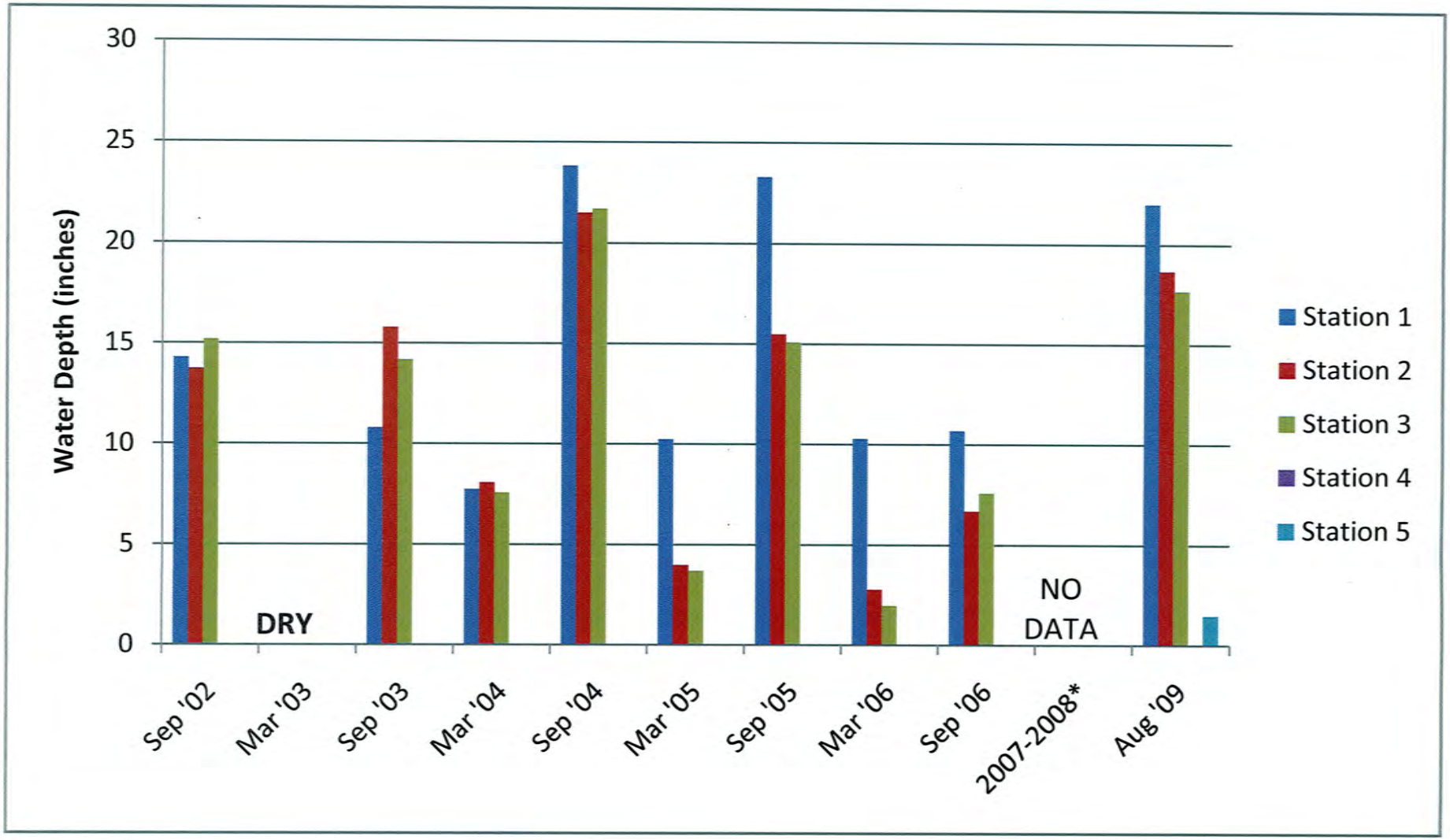
Photostation 3 – Swale



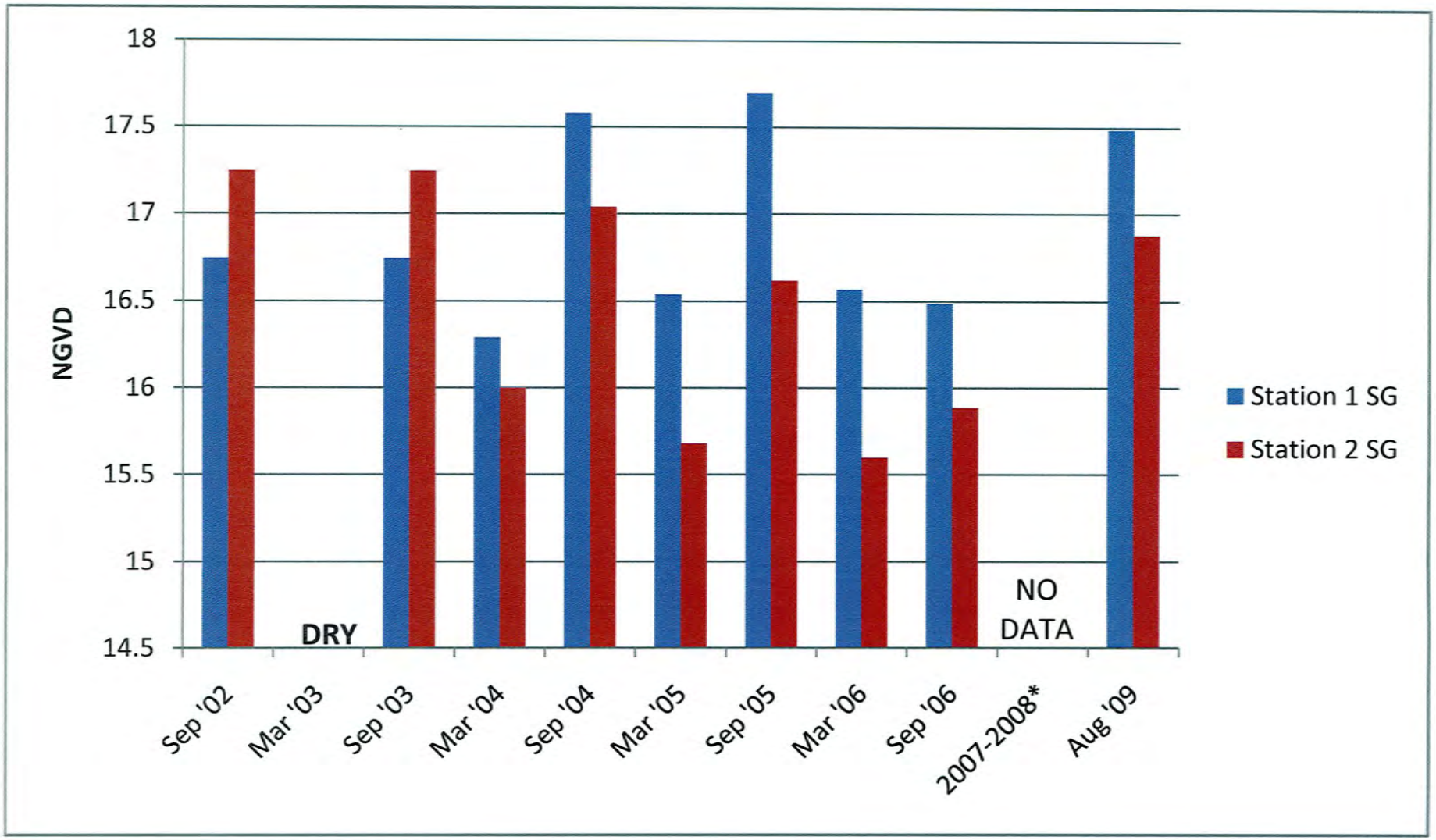


Photostation 4 – Hydric Hammock

Photostation 5 – Wet Flatwoods



Attachment E



Attachment E

Appendix 4: Dry Season Water Supply from the Loxahatchee Slough to the Northwest Fork of the Loxahatchee River

Ashie Akpoji

Dry Season Water Supply from the Loxahatchee Slough to the Northwest Fork of the Loxahatchee River

Minimum Flows and Levels Rule – Chap. 40E-8(221), F.A.C.

Ashie Akpoji, P.E.

May 2009

South Florida Water Management District
Water Supply Department
West Palm Beach, Florida

1. Introduction

During the 2009 dry season, the South Florida Water Management District (SFWMD or District) experienced record low rainfall in all portions of its jurisdiction making this season one of the driest on record since 1932. From November 2, 2008, to May 8, 2009, District meteorologists recorded a basin-wide average rainfall of 7.46 inches. This is about 34 percent of the historical average rainfall for the same period. This lack of rainfall has led to a deficit of about 14.41 inches. The C-18 Basin in eastern Palm Beach County experienced at least a 1-in-25-year dryness.

The substantially below normal rainfall concurrent with deficiencies in surface water storage are expected to continue until the wet season arrives in late May or early June. During this period, evaporation rates have remained high, with most wetlands in North Palm Beach losing about 0.1 foot per day.

An enhanced freshwater regime is necessary to prevent significant harm to the water resources and ecology of the Northwest Fork of the Loxahatchee River (NWFLR), pursuant to Sections 373.042 and 373.0421, F.S. By establishing the Minimum Flows and Levels (MFLs) mandate, along with implementation of the associated recovery strategy, it is the goal of the District to provide sufficient freshwater flows to the NWFLR, when all regional components for flow conveyance are completed.

During the current 2009 dry season which started on November 1, 2008, the District used available storage in the C-18 Canal to deliver daily flows of 35 cfs or higher, measured at Lainhart Dam, to the NWFLR. However, by February 21, 2009, the C-18 Canal's local storage was exhausted and water delivery to the river fell below 35 cfs and continued to decline. Flow augmentation using water stored in the local Loxahatchee Slough was needed to avert exceedance of the MFLs as defined below from Chap. 40E-8(221), F.A.C. wet not met:

> *A MFL exceedance occurs within the Northwest Fork of the Loxahatchee River when 1) Flows over Lainhart Dam decline below 35 cfs for more than 20 consecutive days; or 2) the average daily salinity concentration expressed as a 20-day rolling average exceeds two parts per thousand. The average daily salinity is representative of mid-depth in the water column (average of salinities measured at1.6 feet or 0.5 meter below the surface and 0.5 meter above the bottom) at river mile 9.2.*
>
> *A MFL violation occurs within the Northwest fork of the Loxahatchee River when an exceedance, as defined above, occurs more than once in a six-year period.*

It is important to emphasize that not all infrastructural improvements required to implement the recovery strategy are in place; therefore, the District's ability to meet the MFLs is still limited

On February 26, 2009, to avoid MFL exceedance, the District turned to the Loxahatchee Slough. The stage in the Loxahatchee Slough on February 26 was 16.45 feet, which was 0.1 foot above the target for that time of the year. Project culverts 11, 13, and 15 that hold the western slough stages were lowered to 16.0 feet to allow water delivery to meet the MFLs. These are the culverts on the western side of the C-18 Canal that control part of the slough west of the canal. The eastern slough, which is controlled by PC-12 and PC-14A, had no storage because its stage was below 15.5 feet (Figure 1).

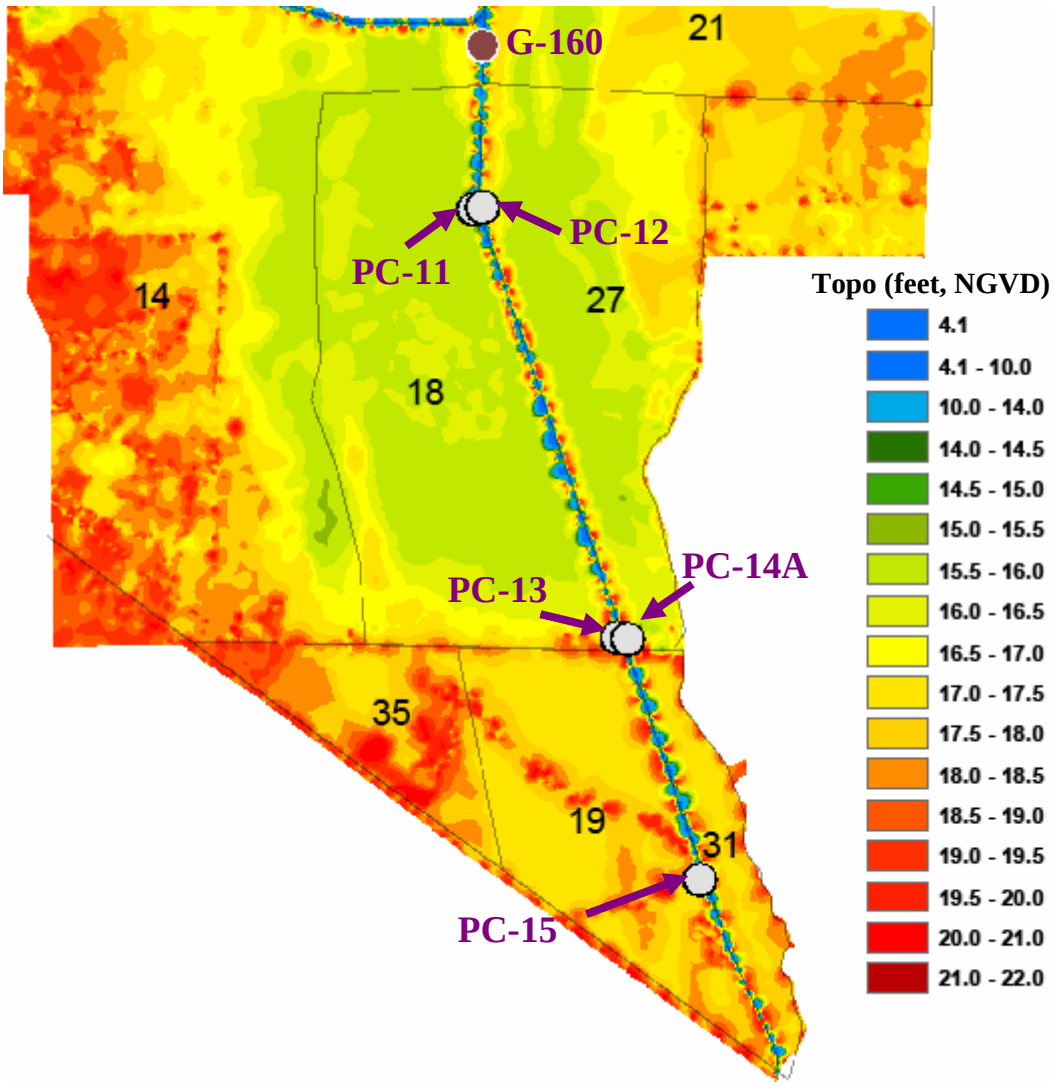


Figure 1. East and West Loxahatchee Slough. The west slough consists of Basins 14, 18, 19, and 35; the east slough consists of Basins 21, 27, and 31.

On March 17, 2009, stages dropped below the culvert settings of 16.0 feet and boards at the same western culverts were again lowered to 15.5 feet, the minimum stage of the lower bound of the hydroperiod of the Loxahatchee Slough. The effort during this 2009 dry season was to avoid exceedances or, at the minimum, reduce the number of occurrences from previous droughts.

2. Historical Minimum Flows and Levels Exceedances

There have been improvements in the historical delivery of water to meet the MFLs since 2003 when the MFL rule was passed. Table 1 shows the MFL exceedance history for the period 2000 to 2009. Before 2003, there were at least four exceedances per year, but thereafter, the number of exceedances has reduced. The months of October, November, and December have no recorded exceedances of MFLs since 2000, while the month of May has the most exceedances.

Table 1. Historical Minimum Flows and Levels Exceedances and Violations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2000			X		X	X			X
2001	X	X	X	X	X				
2002				X	X	X			
2003		X	X				X		
2004				XY	X	X			
2005	X	XY							
2006			X	X	XY				
2007		X	X	XY					
2008					X				
2009					XY				

X = MFL exceedances at Lainhart Dam: flow below 35 cfs for 20 or more consecutive days.
Y = Salinity exceedances of 2 ppt at River Mile 9.1: salinity expressed as a 20-day rolling average. No salinity data available before 2004.

3. Volume of Water Discharged from the Loxahatchee Slough during February to May 2009

The crest elevations of the western culverts, PC-11, PC-13, and PC-15, were lowered to 16.0 feet to deliver initially about 32 cfs to the C-18 Canal to raise the canal stage and enable water delivery to the NW Fork of the Loxahatchee River through G-160 and G-92 structures. The instantaneous flows delivered through each culvert were:

PC-11:	7.5 cfs
PC-11:	7.5 cfs
PC-15:	17.0 cfs

As slough stages fell, the flow eventually reduced to zero on March 12, 2009. By March 16, it became necessary to send more flow to the NWFLR; therefore, the project culverts were again lowered from a crest elevation of 16.0 feet to 15.5 feet NGVD, all three combining to deliver about 40 cfs initially.

Figure 2 shows the observed flows as measured at Lainhart Dam. A projected flow path using the historical trend of typical drought years (2001 and 2007) is also shown, underscoring the fact that without supplemental flow from the local Loxahatchee basin, MFL exceedances should have possibly occurred for five consecutive months from February to May, 2009 (see also Table 1). Historical stages in the Loxahatchee Slough as measured at PC-15 headwater between 2005 and 2008 are shown in Figure 3. During this period of record between 2003 and May 2009, stages fell to the lowest level of 12.69 on May 17, 2007.

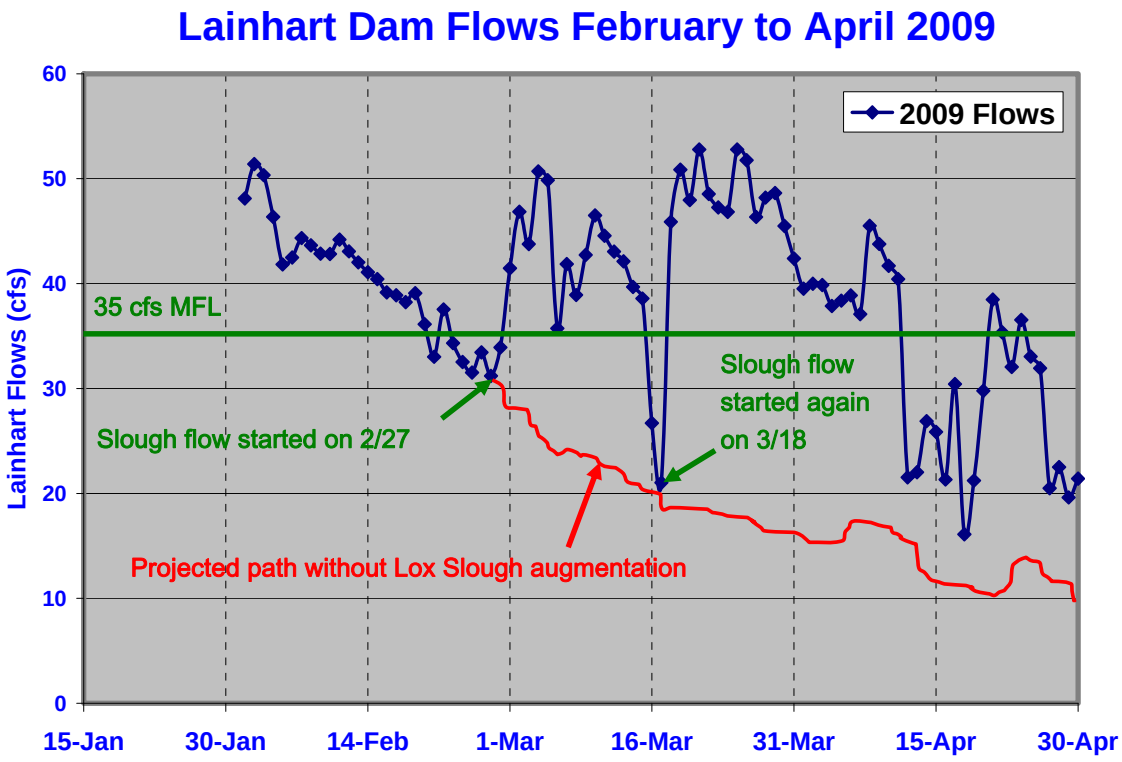


Figure 2. Observed and projected flows to the NW Fork of the Loxahatchee River during the 2009 dry season.

The Loxahatchee Slough is currently maintained by rainfall and culverts that the District recently replaced, but it could be severely impacted by severe droughts or

overdrainage. Culvert replacements, especially the PC-15 Culvert, which was completed in March 2008, has helped substantially to prevent overdrainage and made the slough a better-managed wetland than it was before the culverts replacement, pending the time the recovery strategy is fully implemented. Though the slough was operated within the lower bound of the hydroperiod in order to supply water to the NWFLR, the slough was still within 0.5 foot of its lower bound, much better than what was recorded in previous droughts (see also Figures 3 and 4).

Figure 5 shows the 20-day rolling average salinity at River Mile 9.1 as a function of the flows at Lainhart Dam between January and May 2009. Salinity reduced during periods of water delivery from the Loxahatchee Slough, but exceeded the 2 ppt MFL limit in May 2009 when water delivery from the slough stopped due to regional low stages.

4. Summary

In the absence of supplemental flow from the regional water management system as conceptualized in the CERP North Palm Beach Part I, there will be impacts, possibly significant harm to the water resources and ecology of the NWFLR. The interim efforts by the District to provide some freshwater relief to the NWFLR depend on available local storage in the Loxahatchee basin, pending the time regional water infrastructure improvements are completed and available L-8 regional water can be effectivey routed to the NWFLR.

However, tapping into local storage, when available, in order to augment flow to the river cannot be at the expense of the slough because both are protected systems. It is still important to balance the needs of the slough and those of the river while trying to augment flows to avoid MFL exceedances as avalable water supplies allow.

During the 2009 drought, augmentation of seasonal low flows to the NWFLR with excess water from the slough did no harm to the slough because stages were maintained as close as possible to the lower bound of the slough's hydroperiod.

Rainfall in late May 2009 helped to replenish the slough. As of May 26, 2009, the slough was 16.3 feet, about 0.75 foot above the target for this time of the year.

The experience gained from this operation will assist in future drought management of the Loxahathcee Slough and environmental water delivery to the NWFLR, pending the time regional facilities are completed to transport water from the regional water system, including the L-8 Reservoir to the NWFLR.

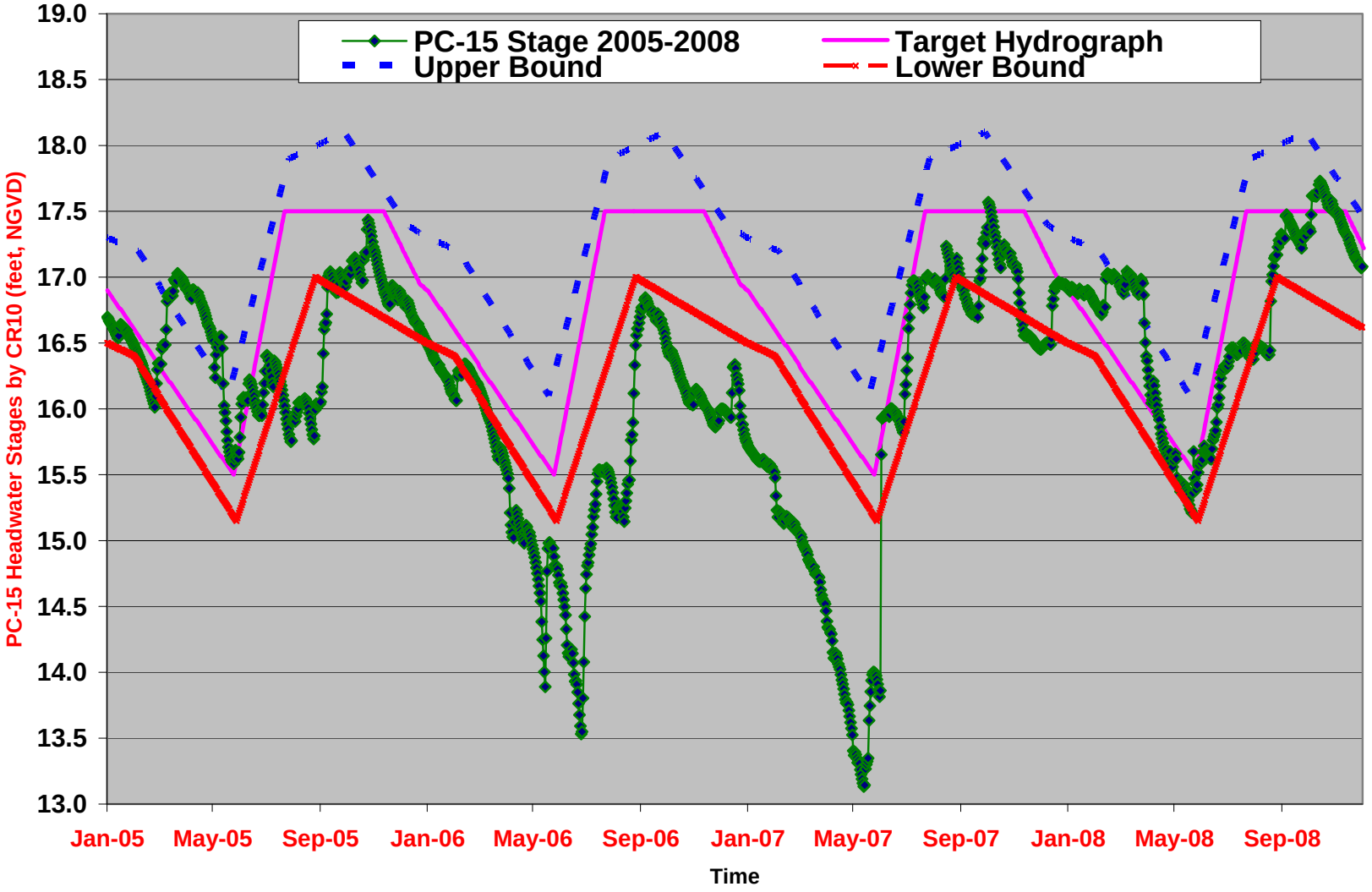


Figure 3. Stages in the Slough measured at PC-15, between 2005 and 2008, showing impacts of previous droughts.

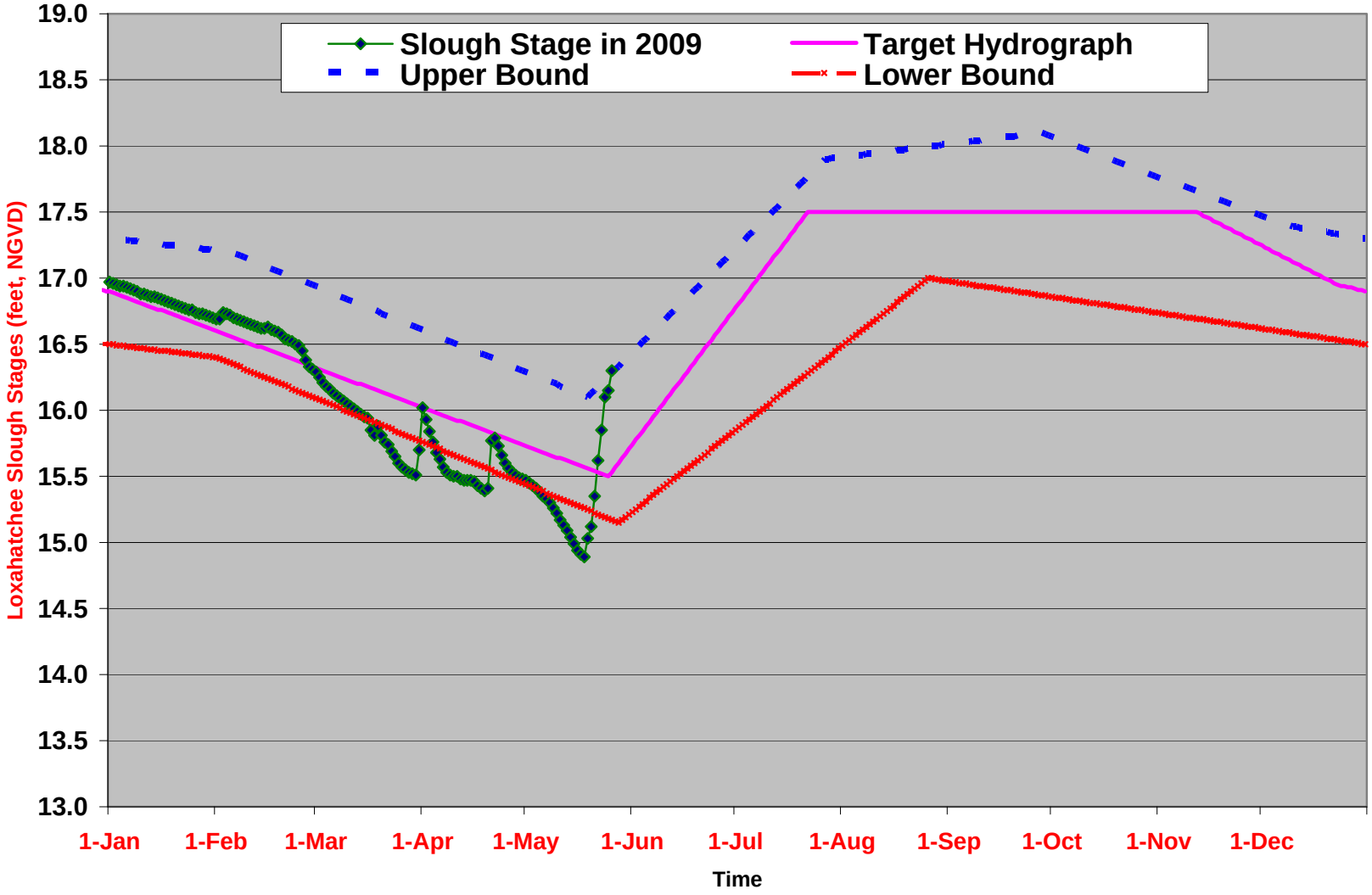


Figure 4. Observed stages in the Loxahatchee Slough at PC-15, superimposed on the hydroperiod.

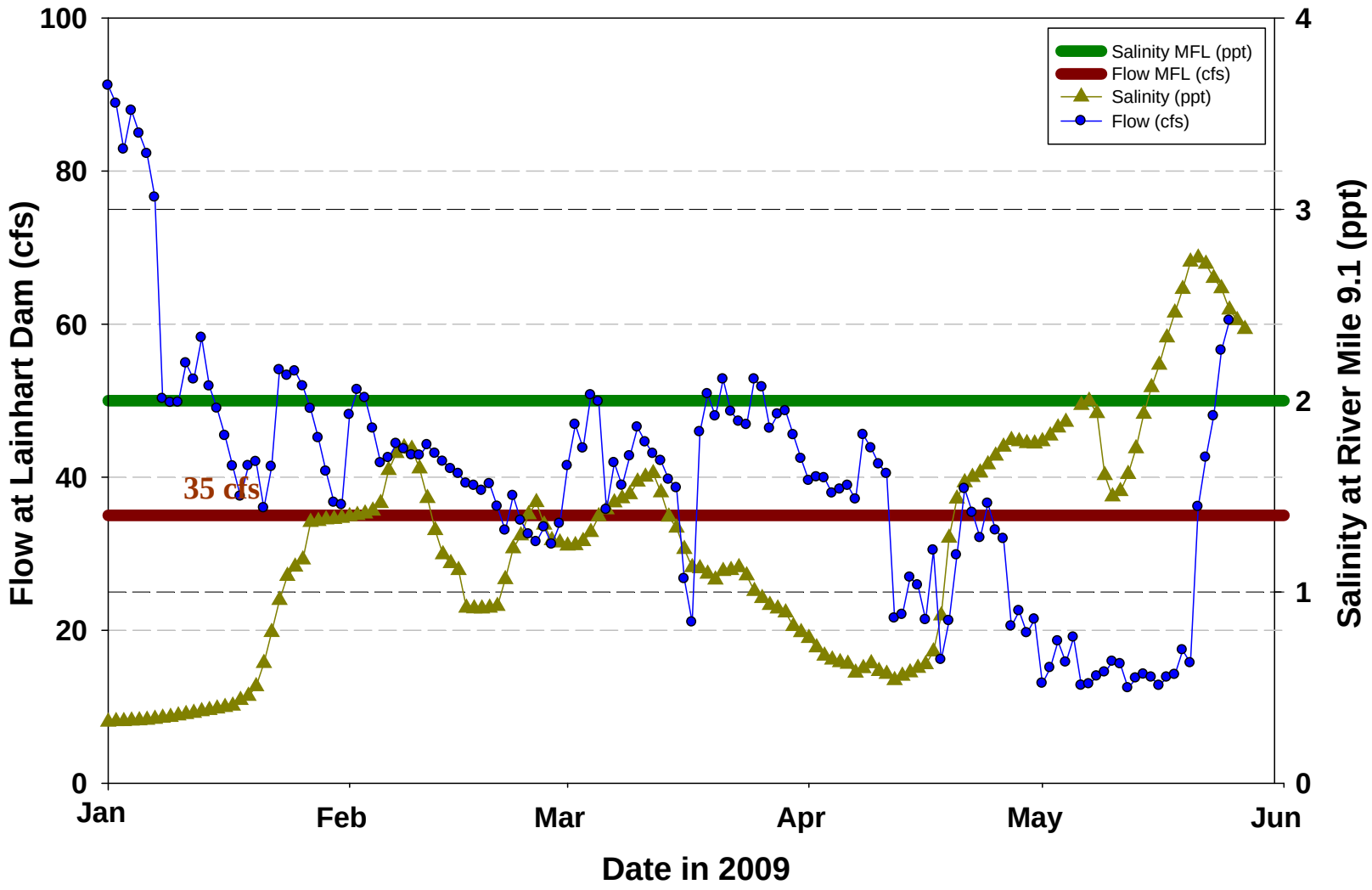


Figure 5. Flow at Lainhart Dam and salinity at River Mile 9.1 in the NW Fork of the Loxahatchee River.