

## **Enhanced Water Quality Monitoring and Modeling Program for the A.R.M. Loxahatchee National Wildlife Refuge Quarterly Update Report – January 2009**

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### Overview

This update is a summary of activities since the previous status report of October 2008 on the implementation of the Refuge's Enhanced Water Quality Monitoring and Modeling Program. A project overview, and other detailed information about the program can be found at: [http://sofia.usgs.gov/lox\\_monitor\\_model/](http://sofia.usgs.gov/lox_monitor_model/). The primary objective of this overall program focuses on providing information for use in ecological management of the Refuge (Brandt et al. 2004; Harwell et al. 2005; USFWS 2007a, b).

The Refuge's monitoring component of this program also addresses one of the Consent Decree Principals recommendations (17 December 2003):

#### ***B. Enhancing Monitoring of the Refuge***

*Design and implement an enhanced monitoring program to improve spatial and temporal understanding of factors related to phosphorus dynamics.*

The Refuge's modeling component of this program also addresses several of the Consent Decree Principals recommendations (17 December 2003):

#### ***C. Modeling of the Refuge***

- 1. Develop a water quality/hydraulic model for the Refuge with a phosphorus cycling component.*
- 2. Evaluate issues associated with phosphorus loads and transports within the L-40 and L-7 canals.*
- 3. Develop and track a simple phosphorus mass-balance model for the Refuge.*

### Information Availability

Through collaboration with USGS, information from the Refuge's Enhanced Water Quality Monitoring and Modeling Program has been made available on the USGS' SOFIA web site at: [http://sofia.usgs.gov/lox\\_monitor\\_model/](http://sofia.usgs.gov/lox_monitor_model/).

Final data for monthly samples through May 2006 are publicly posted on DBHYDRO by the SFWMD at <http://www.sfwmd.gov/org/ema/dbhydro/index.html>. Data for June 2006-December 2008 are posted on the Technical Oversight Committee's web site at [https://my.sfwmd.gov/portal/page?\\_pageid=2235,4688652,2235\\_4688399&\\_dad=portal&\\_schema=PORTAL](https://my.sfwmd.gov/portal/page?_pageid=2235,4688652,2235_4688399&_dad=portal&_schema=PORTAL). This report includes information from samples collected through December 2008.

### Water Quality Data Analyses Update

Primary efforts for this quarter involved exploring mechanisms to continue translating information from the program to aid in Refuge management decisions, and continued work on data analyses for the 4<sup>th</sup> Annual Report.

### Monitoring Update (July 2008 – September 2008)

Sampling of the enhanced water quality monitoring network (**Figure 1**) occurred at 37 stations in October 2008, 37 stations in November 2008, and 37 stations in December 2008 (**Table 1**).

Total phosphorus data available to date for January 2008 to December 2008 are presented in **Table 1**. Maps of stations where samples were collected for October 2008 through December 2008 are presented in **Figures 2-4**.

Conductivity sonde deployment information for January 2008 to December 2008 is presented in **Table 2**.

### Modeling Update

During the final quarter of 2008, the Refuge modeling team changed focus from model development and calibration, to completing models as publicly available versions. With technical review and advice of Drs. Robert Kadlec and William Walker, the simple models, programmed in Berkeley Madonna, and the complex spatially-explicit MIKE-FLOOD model were quantitatively compared to further develop our understanding and to better assure the credibility of the models. Cumulative and annual budgets for both water volume and constituents were developed for all of the models. Efforts were also directed toward documentation of model use and appropriate application.

### Next Steps

The next steps for this program include completion of the next Annual Reporting, and additional model development and application.

### References

[http://sofia.usgs.gov/lox\\_monitor\\_model/](http://sofia.usgs.gov/lox_monitor_model/)

Brandt, L.A., Harwell, M., Waldon, M. (2004) Work Plan: Water Quality Monitoring and Modeling for the A.R.M. Loxahatchee National Wildlife Refuge: 2004-2006. Prepared for the A.R.M. Loxahatchee National Wildlife Refuge. April, 2004. 33 pp.

Harwell, M. Surratt, D., Waldon, M., Walker, B., Brandt, L. (2005) A.R.M. Loxahatchee National Wildlife Refuge Enhanced Water Quality Monitoring and Modeling Interim Report. April, 2005. 106 pp.

USFWS. (2007a) A.R.M. Loxahatchee National Wildlife Refuge - Enhanced Monitoring and Modeling Program – 2<sup>nd</sup> Annual Report – February 2007. LOXA06-008, U.S. Fish and Wildlife Service, Boynton Beach, FL. 183 pp.

Report No. LOXA09-001

USFWS. (2007b) A.R.M. Loxahatchee National Wildlife Refuge - Enhanced Water Quality Monitoring and Modeling Program – 3<sup>rd</sup> Annual Report – October 2007. LOXA07-005, U.S. Fish and Wildlife Service, Boynton Beach, FL. 116 pp.

**Table 1.** Total phosphorus data (ppb) available for January 2008 – December 2008 from the Enhanced Water Quality Monitoring Program for: (a) marsh, and (b) canal stations for the A.R.M. Loxahatchee National Wildlife Refuge. Graphical representation of station locations is shown in Figure 1.

a) Marsh stations

Marsh Station	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
LOXA101	6	11	15	-	-	-	7	8	11	14	3	10
LOXA102	10	10	9	-	-	-	U	7	7	15	3	28
LOXA103	5	9	8	-	-	-	U	11	8	16	3	15
LOXA105	8	16	17	-	-	-	3	18	14	17	11	10
LOXA106	7	10	10	-	-	-	U	12	8	14	7	10
LOXA107	U	6	-	-	-	-	-	7	6	10	7	4
LOXA108	U	9	6	-	-	-	U	6	5	9	3	13
LOXA109	10	8	20	18	-	-	U	8	11	13	7	7
LOXA110	U	7	6	-	-	-	-	6	7	10	7	3
LOXA111	U	11	5	3	-	-	U	3	9	10	3	6
LOXA112	8	9	15	6	-	-	U	8	21	12	7	8
LOXA113	U	3	11	14	-	-	U	4	4	7	7	5
LOXA114	5	4	6	6	-	-	U	5	7	10	3	7
LOXA116	46	48	120	69	X	X	X	X	X	X	X	X
LOXA117	12	13	14	-	-	-	11	12	18	24	9	10
LOXA118	6	9	9	6	-	11	4	8	10	15	8	10
LOXA119	7	12	7	6	-	7	4	3	7	10	3	6
LOXA120	6	6	7	7	100	5	4	3	5	6	3	3
LOXA121	X	X	X	X	X	X	X	X	X	X	X	X
LOXA122	8	9	13	14	-	-	U	12	15	15	6	7
LOXA123	X	X	X	X	X	X	X	X	X	X	X	X
LOXA124	9	8	7	4	-	-	U	7	20	18	3	5
LOXA126	16	7	8	8	-	-	7	3	6	11	3	4
LOXA127	5	6	11	4	-	-	5	3	5	11	3	3
LOXA128	U	15	12	4	-	-	5	3	8	7	3	3
LOXA130	10	8	12	10	-	16	9	10	7	16	10	13
LOXA131	7	7	8	7	-	-	21	5	3	7	3	8
LOXA133	19	29	16	-	-	-	-	38	19	31	18	21
LOXA134	8	18	11	10	-	-	10	9	10	15	8	12
LOXA136	9	17	13	-	-	-	26	16	21	64	9	14
LOXA137	6	16	10	13	-	-	U	10	14	17	3	10
LOXA138	5	8	8	8	-	-	U	8	15	9	3	5
LOXA139	U	9	4	-	-	-	U	7	14	12	3	11
LOXA140	6	10	10	-	-	-	U	10	3	10	3	12
LOXA141	6	10	16	8	-	-	8	4	13	12	6	6
MAX	46	48	120	69	100	16	26	38	21	64	18	28
MIN	5	3	4	3	100	5	3	3	3	6	3	3

U indicates that compound was analyzed but not detected.

X indicates station no longer sampled.

**Table 1 cont.**

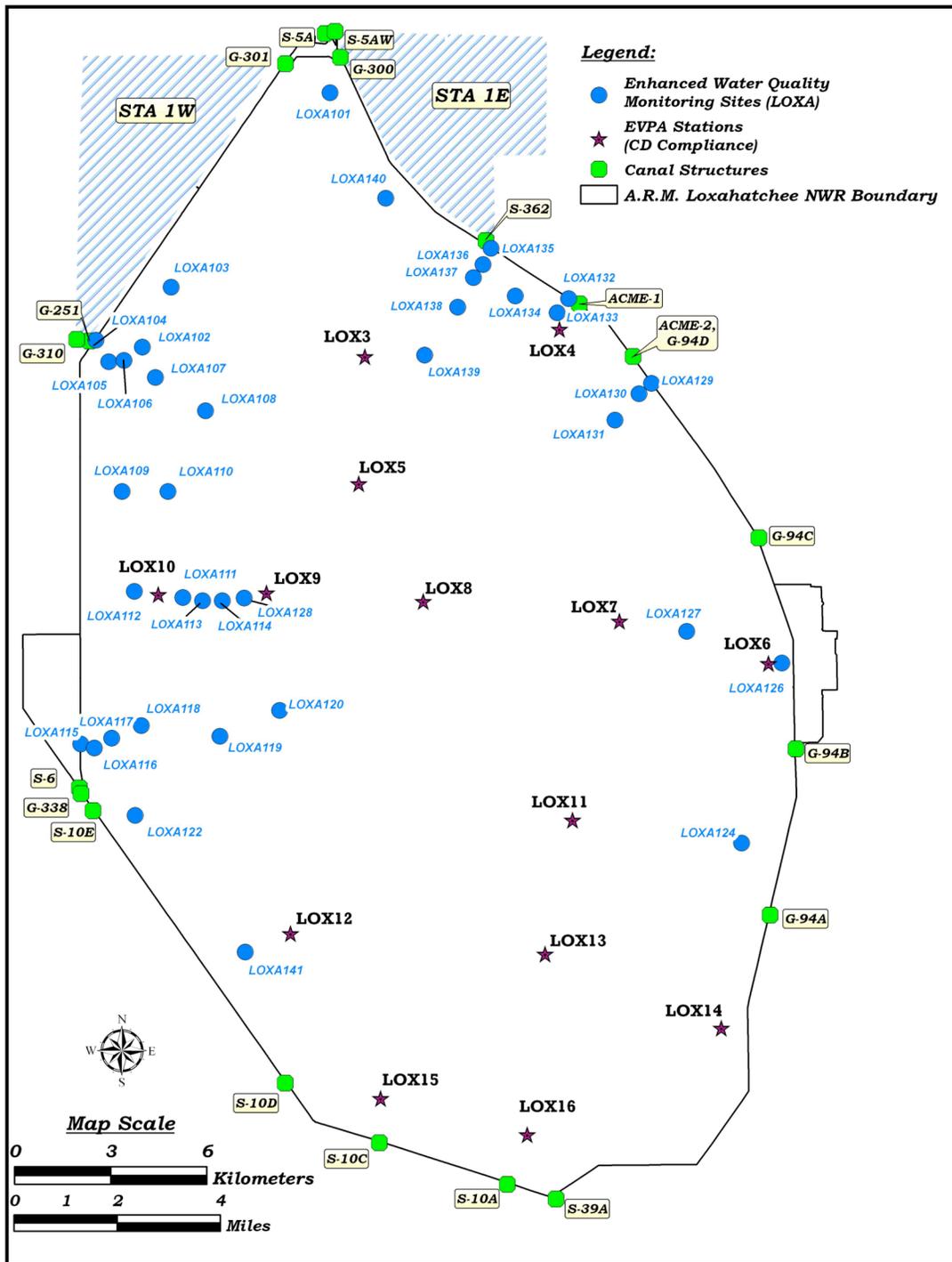
b) Canal stations

Canal Station	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
LOXA104	26	37	35	24	44	54	32	36	36	33	34	26
LOXA115	22	27	27	18	26	33	31	46	36	33	23	12
LOXA129	24	40	18	34	49	37	23	52	34	42	21	19
LOXA132	28	35	21	29	40	31	20	56	35	48	24	22
LOXA135	25	33	19	32	40	26	13	65	54	49	13	22
MAX	28	40	35	34	49	54	32	65	54	49	34	26
MIN	22	27	18	18	26	26	13	36	34	33	13	12

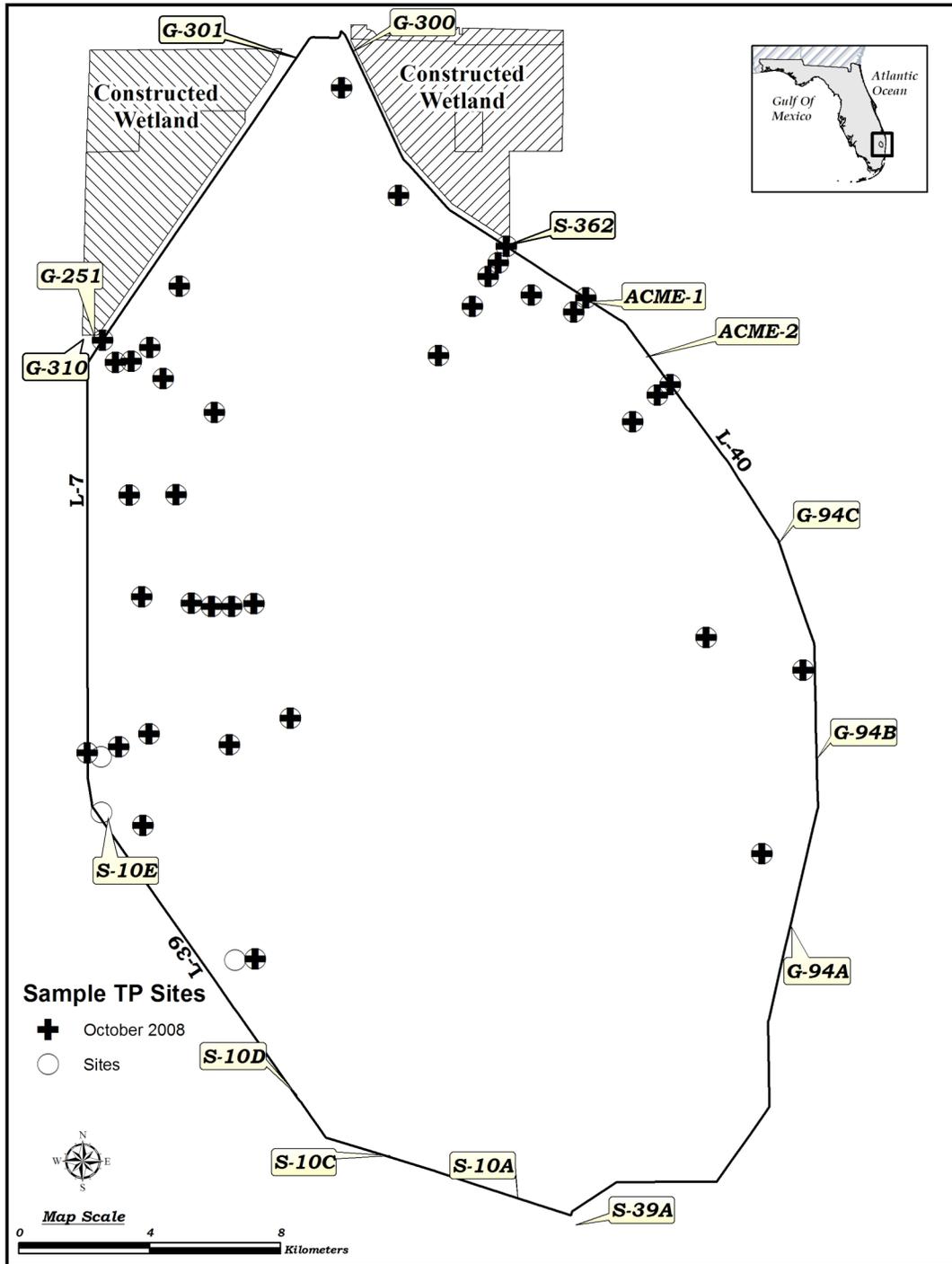
U indicates that compound was analyzed but not detected.

**Table 2.** January 2008 – December 2008 conductivity sonde deployment information, separated by transect, for the A.R.M. Loxahatchee National Wildlife Refuge. X = data collected from sonde deployment during that month. Graphical representation of station locations is shown in Figure 1.

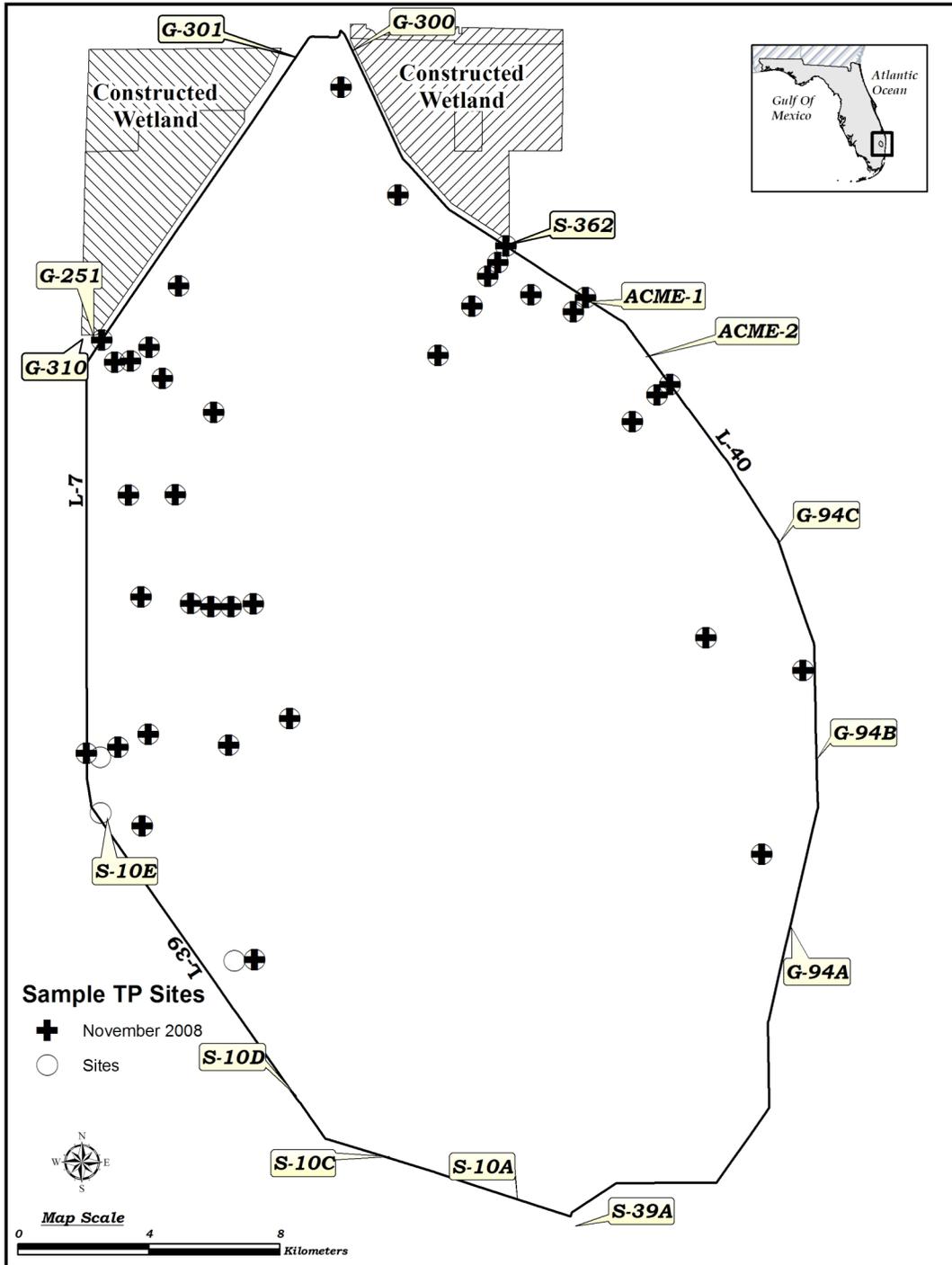
Site ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
LOXA104	X	X	X	X	X	X	X	X	X	X	X	X
LOXA105	X		X		X		X		X		X	
LOXA106	X		X		X		X		X		X	
LOXA107	X		X		X		X		X		X	
LOXA108	X		X		X		X		X		X	
LOXA111		X		X		X		X		X		X
LOXA112		X		X		X		X		X		X
LOXA113		X		X		X		X		X		X
LOXA114		X		X		X		X		X		X
LOXA115	X	X	X	X	X	X	X	X	X	X	X	X
LOXA116		X	X								X	X
LOXA117		X	X								X	X
LOXA118		X	X								X	X
LOXA119		X	X								X	X
LOXA120		X	X								X	X
LOXA126		X		X		X		X		X		X
LOXA127		X		X		X		X		X		X
LOXA128		X		X		X		X		X		X
LOXA129	X	X	X	X	X	X	X	X	X	X	X	X
LOXA130	X		X		X		X		X		X	
LOXA131	X		X		X		X		X		X	
LOXA132	X	X	X	X	X	X	X	X	X	X	X	X
LOXA133	X		X		X		X		X		X	
LOXA135	X	X	X	X	X	X	X	X	X	X	X	X
LOXA136	X		X		X		X		X		X	
LOXA137	X		X		X		X		X		X	
LOXA138	X		X		X		X		X		X	
LOXA139	X		X		X		X		X		X	
LOXA141											X	
LOXA142	X			X			X					X
LOXA143		X		X		X		X		X		X
LOXA144		X		X		X		X		X		X
LOXA145		X		X		X		X		X		X
LOXA146		X		X		X		X		X		X
LOXA147		X			X		X				X	X
LOXA148		X		X		X		X		X		X
LOXA149		X		X		X		X		X		X
LOXA150		X		X		X		X		X		X
LOXA151	X		X		X	X	X	X	X	X		X
LOXA152	X		X		X	X	X	X	X		X	X
LOXA153	X				X	X	X	X	X	X		X
I-8C	X	X	X		X	X	X		X	X	X	
LOX04	X		X		X		X		X		X	
LOX06		X		X		X		X		X		X
LOX07		X		X		X		X		X		X
LOX08		X		X		X		X		X		X
LOX09		X		X		X		X		X		X
LOX10		X		X		X		X		X		X
LOX15		X		X		X		X		X		X



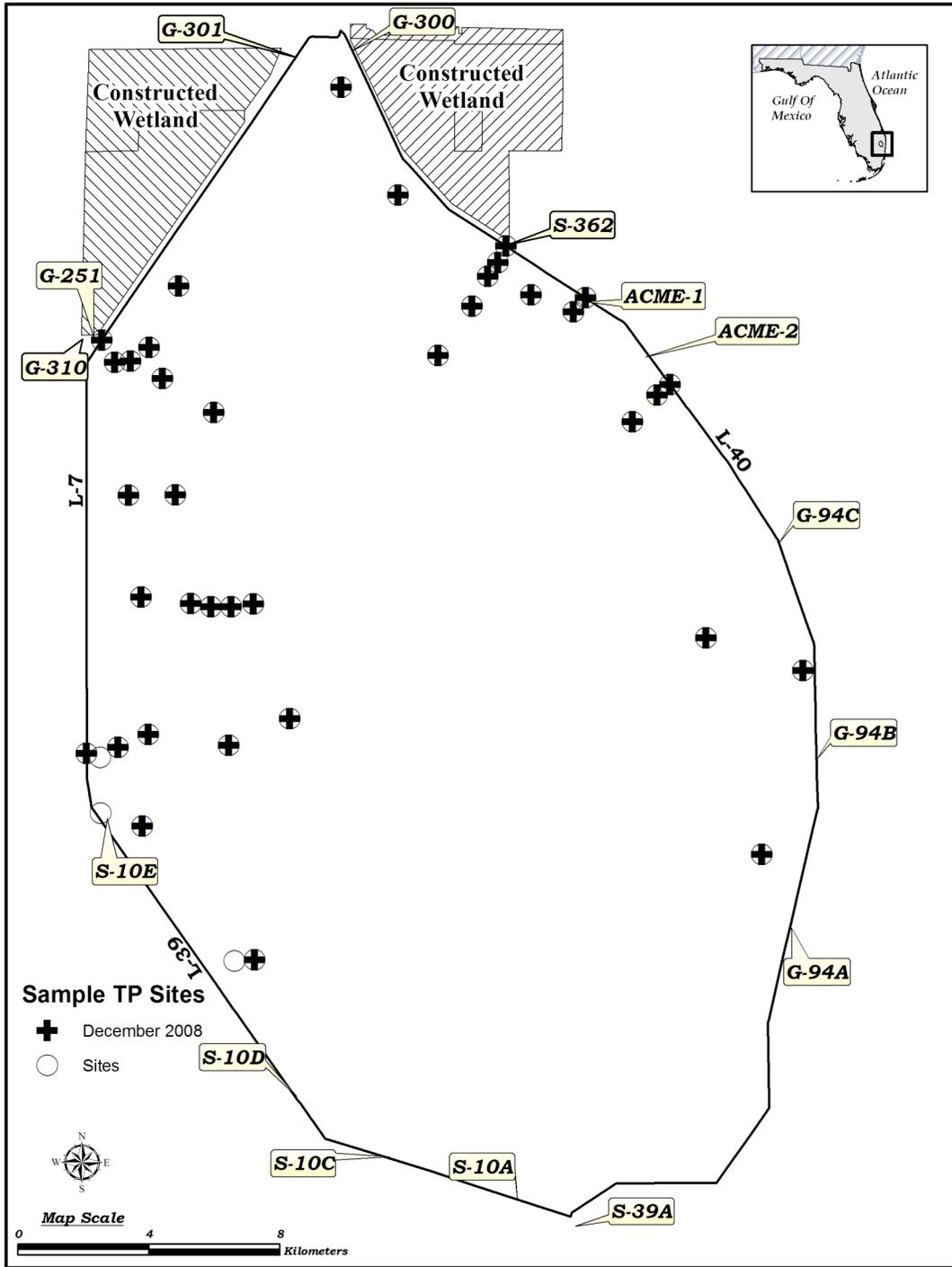
**Figure 1.** Location of Enhanced Water Quality Monitoring network stations (LOXA###), in relation to Consent Decree compliance stations (LOX##), for the A.R.M. Loxahatchee National Wildlife Refuge.



**Figure 2.** October 2008 map of total phosphorus sample collections from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area.



**Figure 3.** November 2008 map of total phosphorus sample collections from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area.



**Figure 4.** December 2008 map of total phosphorus sample collections from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area.