

**Enhanced Water Quality Monitoring and Modeling Program for the  
A.R.M. Loxahatchee National Wildlife Refuge  
Quarterly Update Report – December 2013**

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Overview

This update is a summary of activities since the previous status report of September 2013 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 (Brandt et al. 2004) focuses on providing information for use in ecological management of the Refuge (e.g., USFWS 2007a, b; USFWS 2009; USFWS 2010a, b; USFWS 2012a; USFWS 2012b; USFWS 2013).

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.*

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://my.sfwmd.gov/dbhydroplsqli/show\\_dbkey\\_info.main\\_page](http://my.sfwmd.gov/dbhydroplsqli/show_dbkey_info.main_page). Data for June 2006-December 2013 are posted on the Technical Oversight Committee's web site at <http://www.sfwmd.gov/toc/>. This report includes information from samples collected through December 2013.

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 working on the program's Annual Report.

Monitoring Update (October – December 2013)

Sampling of the enhanced water quality monitoring network (**Figure 1**) occurred at 15 stations in October (federal furlough prevented further collections and these samples were collected on the last day of September 2013 to at least represent October), 31 in November, and 37 in December 2013 (**Table 1**).

Total phosphorus data available to date for January 2013 through December 2013 are presented in **Table 1**. Maps of stations where samples were collected for the months from October through December 2013 are presented in **Figures 2-4**.

Conductivity sonde deployment information for January 2013 through December 2013 is presented in **Table 2**.

#### Next Steps

The next steps for this program include additional efforts on the Annual Report, and additional model development and application.

#### References

- 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.
- 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.
- 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.
- USFWS. (2009) A.R.M. Loxahatchee National Wildlife Refuge - Enhanced Water Quality Monitoring and Modeling Program – 4<sup>th</sup> Annual Report – July 2009. LOXA09-007, U.S. Fish and Wildlife Service, Boynton Beach, FL. 106 pp.
- USFWS. (2010a) A.R.M. Loxahatchee National Wildlife Refuge - Enhanced Water Quality Monitoring and Modeling Program – 5<sup>th</sup> Annual Report – September 2010. LOXA08-007, U.S. Fish and Wildlife Service, Boynton Beach, FL. 43 pp.
- USFWS. (2010b) A.R.M. Loxahatchee National Wildlife Refuge - Enhanced Water Quality Monitoring and Modeling Program – 6<sup>th</sup> Annual Report – October 2010. LOXA09-011, U.S. Fish and Wildlife Service, Boynton Beach, FL. 42 pp.
- USFWS. (2012a) A.R.M. Loxahatchee National Wildlife Refuge - Enhanced Water Quality Monitoring and Modeling Program – 7<sup>th</sup> Annual Report – February 2012. LOXA12-001, U.S. Fish and Wildlife Service, Boynton Beach, FL. 115 pp.
- USFWS. (2012b) A.R.M. Loxahatchee National Wildlife Refuge - Enhanced Water Quality Monitoring and Modeling Program – 8<sup>th</sup> Annual Report – October 2012. LOXA12-004, U.S. Fish and Wildlife Service, Boynton Beach, FL. 68 pp.
- USFWS. (2013) A.R.M. Loxahatchee National Wildlife Refuge - Enhanced Water Quality Monitoring and Modeling Program – 8<sup>th</sup> Annual Report – June 2013. LOXA13-001, U.S. Fish and Wildlife Service, Boynton Beach, FL. 71 pp.

**Table 1.** Total phosphorus data (ppb) available for January 2013 – December 2013 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 are shown in Figure 1.

## a) Marsh stations

Marsh Station	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
LOXA101	23	19	21	-	14	179	21	18	15	-	9	31
LOXA102	11	10	6	-	-	16	-	-	15	-	5	15
LOXA103	8	6	-	-	-	21	-	-	11	-	7	12
LOXA105	20	17	13	-	9	153	15	-	21	14	14	36
LOXA106	9	8	6	-	-	19	6	-	23	11	7	28
LOXA107	8	-	-	-	-	12	-	-	-	9	U	4
LOXA108	6	-	-	-	-	10	5	7	7	2	2	11
LOXA109	7	6	6	8	7	13	6	10	15	-	7	25
LOXA110	10	12	8	7	5	8	5	6	6	-	2	6
LOXA111	5	4	3	7	4	8	5	6	6	-	2	5
LOXA112	6	6	6	5	6	17	6	9	9	-	6	16
LOXA113	12	U	5	10	5	7	4	6	5	-	U	7
LOXA114	8	3	7	8	6	24	4	7	6	-	U	6
LOXA117	14	8	6	12	7	16	10	10	14	16	17	16
LOXA118	9	9	3	6	6	9	5	7	8	8	8	9
LOXA119	7	5	6	9	8	7	5	8	9	6	8	7
LOXA120	8	4	7	4	5	6	5	8	8	4	4	5
LOXA122	13	9	6	13	8	11	7	10	13	-	13	17
LOXA124	19	11	12	-	7	185	10	13	25	-	10	26
LOXA126	12	4	4	U	4	13	14	10	7	-	13	10
LOXA127	7	4	7	6	5	3	5	10	7	-	7	7
LOXA128	7	6	8	-	4	6	5	7	5	-	U	7
LOXA130	9	13	5	5	5	22	6	8	10	-	6	16
LOXA131	6	4	4	4	7	9	6	8	10	-	3	11
LOXA133	16	26	9	-	-	29	11	-	23	-	15	27
LOXA134	10	8	5	4	7	14	6	7	10	-	8	20
LOXA136	17	26	10	-	14	21	10	12	14	18	14	31
LOXA137	12	10	6	7	8	14	5	8	11	9	8	15
LOXA138	17	8	7	4	7	12	4	7	9	3	U	6
LOXA139	4	11	7	-	6	9	5	6	5	3	U	11
LOXA140	14	10	7	-	5	27	6	8	10	-	6	12
LOXA141	14	9	11	11	11	9	7	12	10	-	10	13
MAX	23	26	21	13	14	185	21	18	25	18	17	36
MIN	4	3	3	4	4	3	4	6	5	2	2	4

U indicates that compound was analyzed, but the concentration was below the minimum detection limit.

**Table 1 cont.**

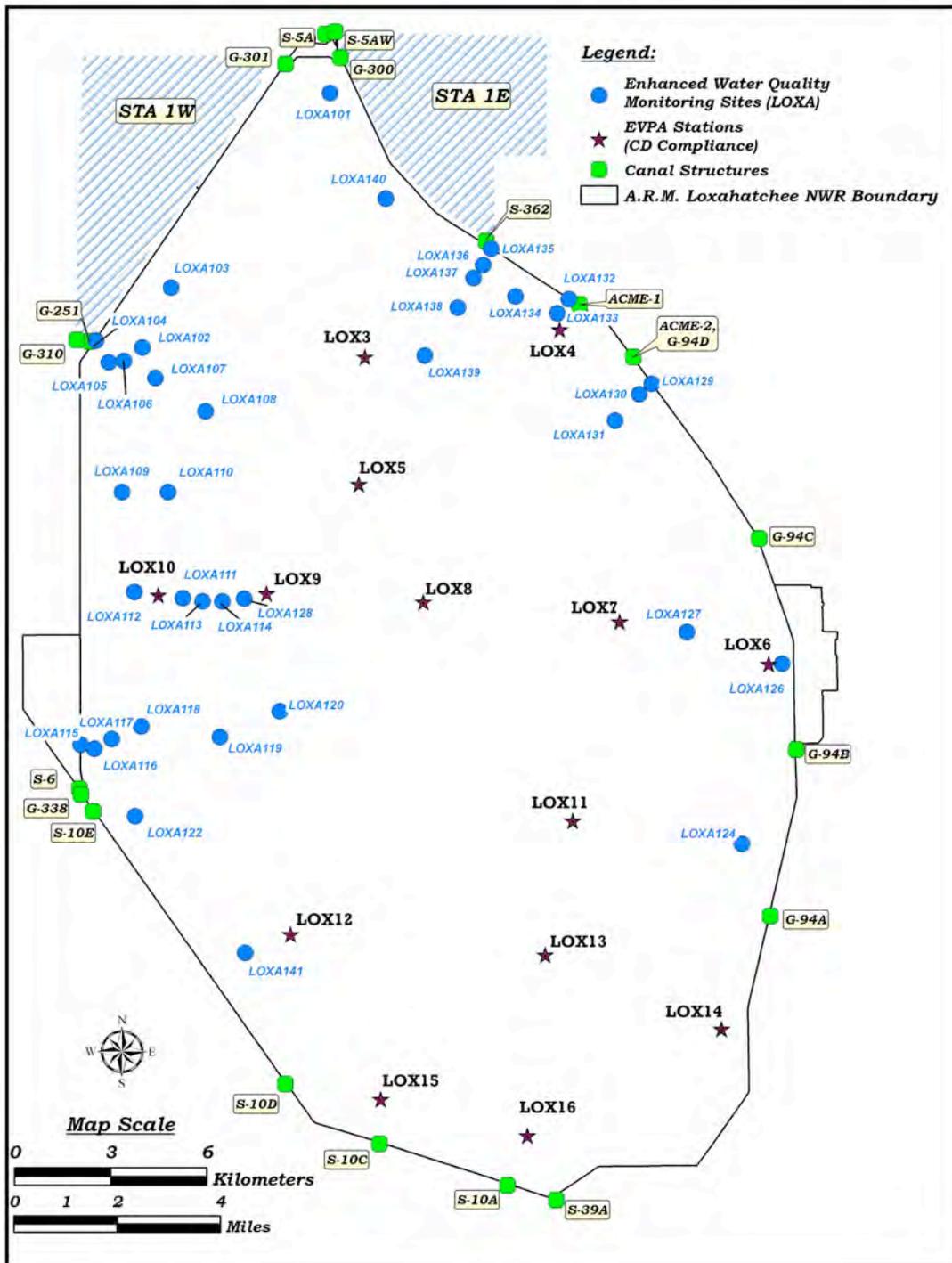
b) Canal stations

Canal Station	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
LOXA104	28	24	26	28	38	270	32	32	36	28	19	35
LOXA115	19	13	19	20	47	83	26	25	32	23	17	36
LOXA129	24	26	20	31	45	54	27	32	40	-	24	32
LOXA132	23	18	23	26	41	55	26	34	40	-	26	32
LOXA135	23	20	21	26	60	58	29	38	39	37	29	40
MAX	28	26	26	31	60	270	32	38	40	37	29	40
MIN	19	13	19	20	38	54	26	25	32	23	17	32

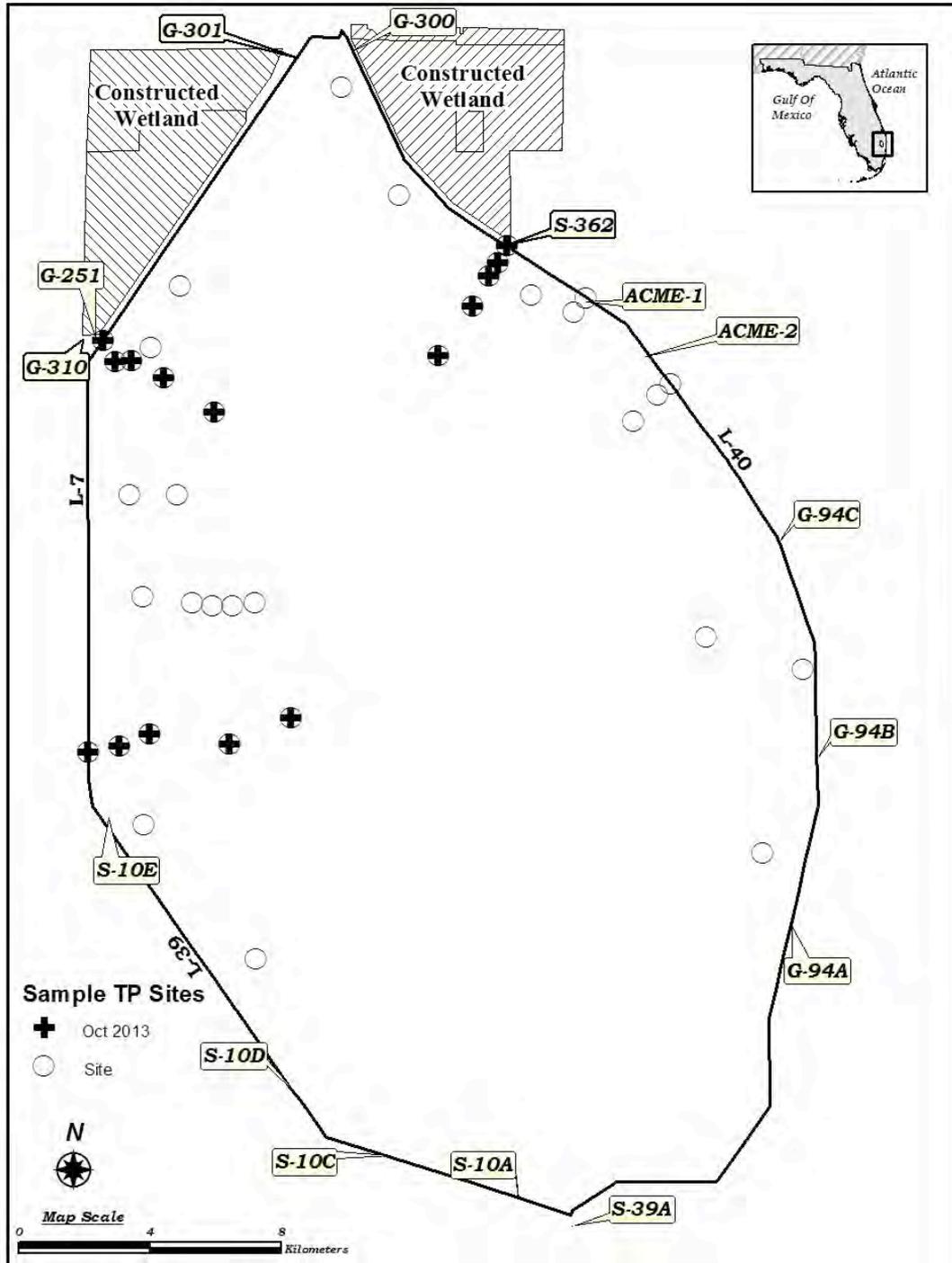
U indicates that compound was analyzed, but the concentration was below the minimum detection limit.

**Table 2.** January 2013 – December 2013 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 are shown in Figure 1. Stations labeled DECOM were decommissioned.

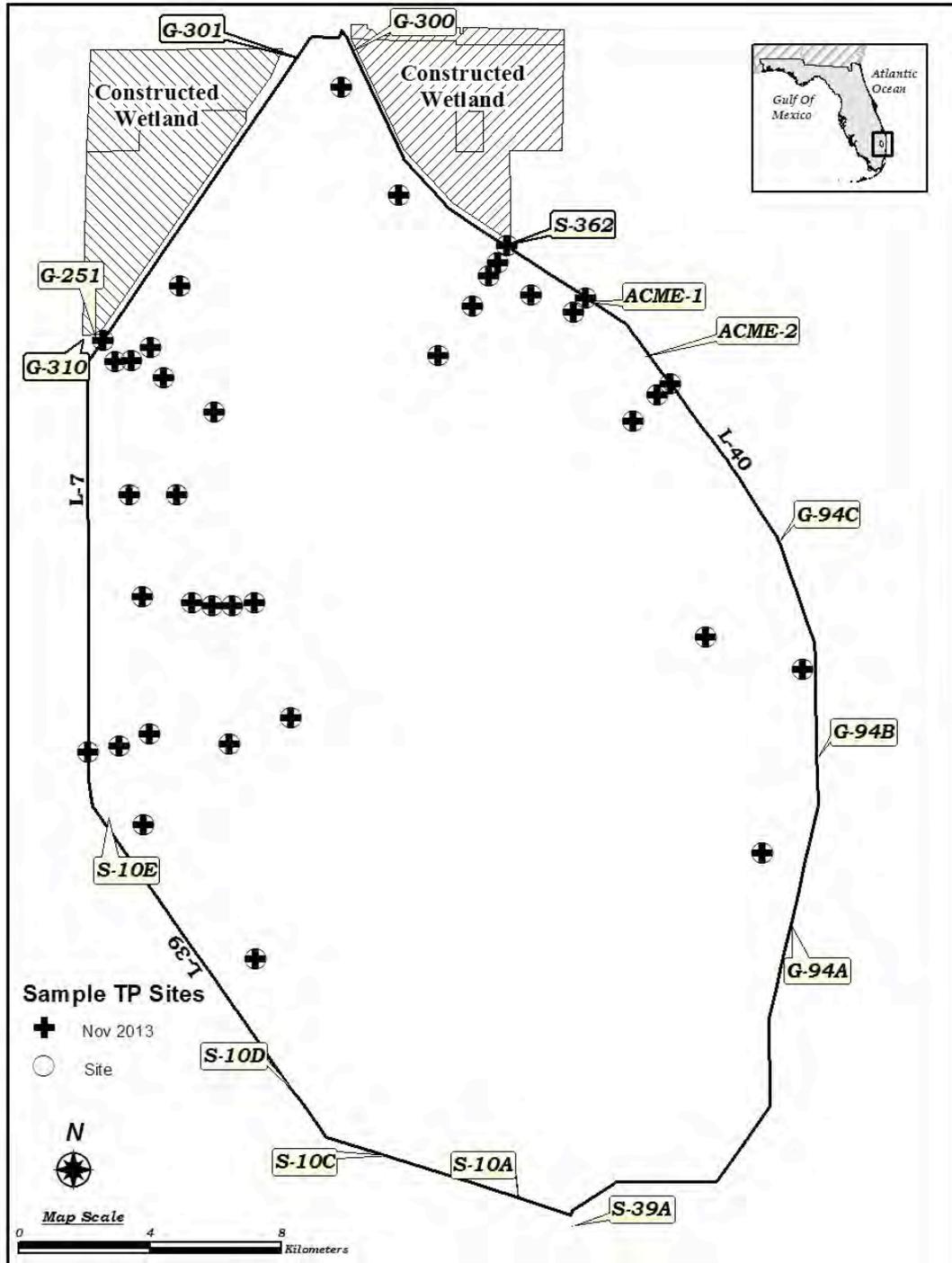
Site ID	2013											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LOXA104	X	X	X	X	X		X	X	X	X	X	
LOXA105		X		X		X		X		X		X
LOXA106		X		X		X		X		X		X
LOXA107		X		X		X		X		X		X
LOXA108		X		X		X		X		X		X
LOXA111	X		X		X	DECOM-->						
LOXA112	X		X		X	DECOM-->						
LOXA113	X		X		X	DECOM-->						
LOXA114	X		X		X	DECOM-->						
LOXA115	X	X	X	X	X		X	X	X	X	X	
LOXA116	X	X		X		X		X		X		X
LOXA117	X	X		X		X		X		X		X
LOXA118	X	X		X		X		X		X		X
LOXA119	X	X		X		X		X		X		X
LOXA120	X	X		X		X		X		X		X
LOXA126	X		X		X	DECOM-->						
LOXA127	X		X		X	DECOM-->						
LOXA128						DECOM-->						
LOXA129	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	
LOXA133		X		X		X		X		X		X
LOXA135	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
LOXA142		X	X	X	X		X	X	X	X		X
LOXA143				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	X	X	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		X
LOXA152	X	X	X	X	X		X	X	X	X		X
LOXA153	X	X	X	X	X		X	X	X	X		X
I-8C	X	X		X	X	X	X	X	X	X	X	X
LOX04		X		X		X		X		X		X
LOX06	X		X		X	DECOM-->						
LOX07	X		X		X	DECOM-->						
LOX08	X		X		X	DECOM-->						
LOX09	X		X		X	DECOM-->						
LOX10	X		X		X	DECOM-->						
LOX15		X		X		X		X		X		X



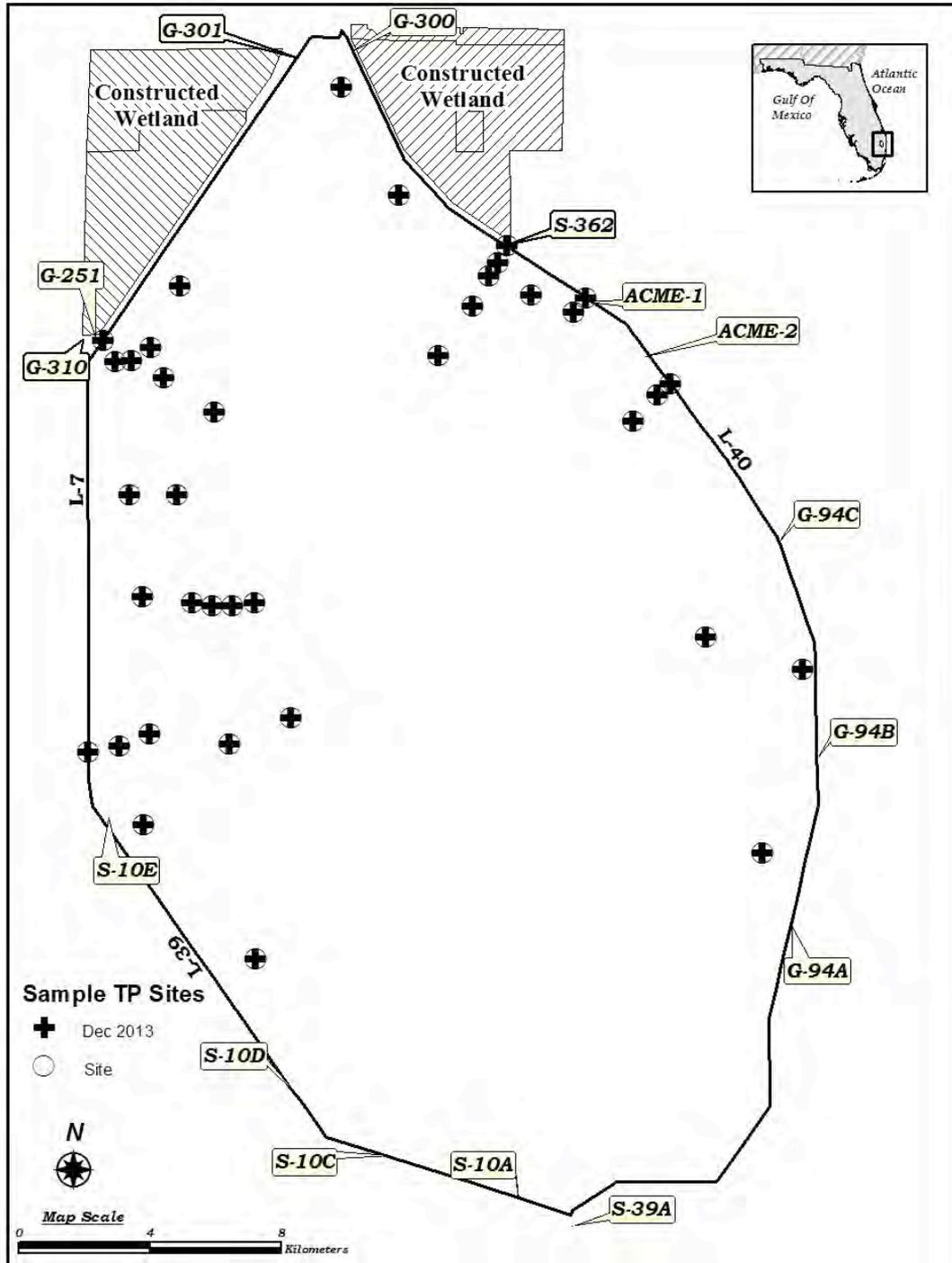
**Figure 1.** Location of Enhanced Water Quality Monitoring network stations (LOXA###), in relation to Consent Decree compliance stations (LOX##), for the A.R.M. Loxahatchee National Wildlife Refuge.



**Figure 2.** October 2013 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 2013 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 2013 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.