

Enhanced Water Quality Monitoring and Modeling Program for the A.R.M. Loxahatchee National Wildlife Refuge Quarterly Update Report – October 2008

Prepared by:

Matt Harwell, A.R.M. Loxahatchee National Wildlife Refuge

With contributions from Donatto Surratt, and Mike Waldon

Overview

This update is a summary of activities since the previous status report of July 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/. 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/.

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-September 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. This report includes information from samples collected through September 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 4th Annual Report.

Information from the monitoring and modeling program was presented as part of the A.R.M. Loxahatchee National Wildlife Refuge's Annual Science Workshop being held in conjunction with the July/August 2008 Greater Everglades Ecosystem Restoration Conference (<http://conference.ifas.ufl.edu/GEER2008/>) in Naples, FL. The presentations made at the conference are listed at the end of the References section below.

Monitoring Update (July 2008 – September 2008)

Sampling of the enhanced water quality monitoring network (**Figure 1**) occurred at 34 stations in July 2008, 37 stations in August 2008, and 37 stations in September 2008 (**Table 1**).

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

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

Modeling Update

Continued progress was made during this quarter. The modeling team's third modeling workshop was held as part of the Refuge's Annual Science Workshop at the 2008 Greater Everglades Ecosystem Restoration conference (a list of presentations is at the end of the References section). The modeling team also met with the chair of the Independent Modeling Review panel to receive advice on future review efforts.

During this reporting period, one peer-reviewed journal article from the Modeling Program was accepted for publication (Wang et al., In Press).

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/

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 – 2nd 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 – 3rd Annual Report – October 2007. LOXA07-005, U.S. Fish and Wildlife Service, Boynton Beach, FL. 116 pp.

Wang, H., Meselhe, E. A., Waldon, M. G., Surratt, D. D., Abdou, S., Chen, C., Harwell, M. C. (2008). Compartment design for wetland water quality modeling and analysis in the Northern Florida Everglades, USA. Journal of Environmental Hydrology. Vol. 16, Paper 36. Available at: www.hydroweb.com.

Presentations given at the 2008 Greater Everglades Ecosystem Restoration Conference:

Harwell, M. C., Aumen, N. G., Brandt, L. A., Surratt, D. D., Waldon, M. G. (2008) Adaptive management in a learning environment – a case study of hydrology and water quality in the A.R.M. Loxahatchee National Wildlife Refuge. Oral Presentation at the 2008 Greater Everglades Ecosystem Restoration Conference. July, 2008.

Chen, C., Meselhe, E. A., Waldon, M. G., Wang, H., Harwell, M. C. (2008) Hydrodynamic and water quality modeling of the A.R.M. Loxahatchee Refuge, North Everglades, Florida. Poster at the 2nd USGS Modeling Workshop. February, 2008.

Chen, C., Meselhe, E. A., Waldon, M. G., Wang, H., Harwell, M. C., Griborio, A. (2008) Spatially-explicit Hydrodynamic and Water Quality Modeling of the A.R.M. Loxahatchee National Wildlife Refuge, Part I - Model Setup. Oral Presentation at the 2008 Greater Everglades Ecosystem Restoration Conference. July, 2008.

Entry, J. A., Surratt, D. D., Harwell, M. C., Waldon, M. G., Aumen, N. G. (2008) Influence of stormwater inflow on water quality gradients in the Arthur R. Marshall Loxahatchee National Wildlife Refuge. Oral Presentation at the 2008 Greater Everglades Ecosystem Restoration Conference. July, 2008.

Gibble, R. E., McCormick, P. V., Harwell, M. C. (2008) Effects of Chemistry and Hydrology on Seed Germination and Plant Community Development in a Northern Everglades Wetland. Poster Presentation at the 2008 Greater Everglades Ecosystem Restoration Conference. July, 2008.

- Gibble, R., Trent, T., Harwell, M. C. (2008) Investigating Food Quality Effects on the Florida Apple Snail: Water Chemistry Effects on Periphyton Assemblages in the Northern Everglades. Oral Presentation at the 2008 Greater Everglades Ecosystem Restoration Conference. July, 2008.
- Meselhe, E. A., Chen, C., Waldon, M. G., Wang, H., Harwell, M. C., Griborio, A. (2008) Spatially-explicit Hydrodynamic and Water Quality Modeling of the A.R.M. Loxahatchee National Wildlife Refuge, Part II - Model Application. Oral Presentation at the 2008 Greater Everglades Ecosystem Restoration Conference. July, 2008.
- Meselhe, E., Waldon, M. G., Chen, C., Roth, W., Wang, H., Harwell, M. C., Arceneaux, J. (2008) Hydrodynamic and water quality modeling of the A.R.M. Loxahatchee National Wildlife Refuge, Northern Everglades, Florida. Oral presentation at the American Water Resources Association 2008 Annual Conference. November, 2008.
- Surratt, D., Gibble, R., Harwell, M. C. (2008) Periphyton Community Changes in Response to Water Quality Changes within the A.R.M. Loxahatchee National Wildlife Refuge, Florida (USA). Poster Presentation at the 2008 Greater Everglades Ecosystem Restoration Conference. July, 2008.
- Waldon, M. G., Roth, W., Meselhe, E. (2008) Comparison of the South Florida Water Management Model (SFWMM) with a Simple Refuge Stage Model (SRSM) for the A.R.M. Loxahatchee National Wildlife Refuge. Oral presentation at the American Water Resources Association 2008 Annual Conference. November, 2008.
- Wang, H., Waldon, M. G., Meselhe, E. A., Harwell, M. C., Roth, W., Chen, C. (2008). Simplified Modeling of Surface Water Sulfate Dynamics in the A.R.M. Loxahatchee National Wildlife Refuge, Florida. Poster Presentation at the 2008 Greater Everglades Ecosystem Restoration Conference. July, 2008.

Table 1. Total phosphorus data (ppb) available for January 2008 – September 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
LOXA101	6	11	15	-	-	-	7	8	11
LOXA102	10	10	9	-	-	-	U	7	7
LOXA103	5	9	8	-	-	-	U	11	8
LOXA105	8	16	17	-	-	-	3	18	14
LOXA106	7	10	10	-	-	-	U	12	8
LOXA107	U	6	-	-	-	-	-	7	6
LOXA108	U	9	6	-	-	-	U	6	5
LOXA109	10	8	20	18	-	-	U	8	11
LOXA110	U	7	6	-	-	-	-	6	7
LOXA111	U	11	5	3	-	-	U	3	9
LOXA112	8	9	15	6	-	-	U	8	21
LOXA113	U	3	11	14	-	-	U	4	4
LOXA114	5	4	6	6	-	-	U	5	7
LOXA116	46	48	120	69	-	-	-	-	-
LOXA117	12	13	14	-	-	-	11	12	18
LOXA118	6	9	9	6	-	11	4	8	10
LOXA119	7	12	7	6	-	7	4	3	7
LOXA120	6	6	7	7	100	5	4	3	5
LOXA121	X	X	X	-	-	-	-	-	-
LOXA122	8	9	13	14	-	-	U	12	15
LOXA123	X	X	X	-	-	-	-	-	-
LOXA124	9	8	7	4	-	-	U	7	20
LOXA126	16	7	8	8	-	-	7	3	6
LOXA127	5	6	11	4	-	-	5	3	5
LOXA128	U	15	12	4	-	-	5	3	8
LOXA130	10	8	12	10	-	16	9	10	7
LOXA131	7	7	8	7	-	-	21	5	3
LOXA133	19	29	16	-	-	-	-	38	19
LOXA134	8	18	11	10	-	-	10	9	10
LOXA136	9	17	13	-	-	-	26	16	21
LOXA137	6	16	10	13	-	-	U	10	14
LOXA138	5	8	8	8	-	-	U	8	15
LOXA139	U	9	4	-	-	-	U	7	14
LOXA140	6	10	10	-	-	-	U	10	3
LOXA141	6	10	16	8	-	-	8	4	13
MAX	46	48	120	69	100	16	26	38	21
MIN	5	3	4	3	100	5	3	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
LOXA104	26	37	35	24	44	54	32	36	36
LOXA115	22	27	27	18	26	33	31	46	36
LOXA129	24	40	18	34	49	37	23	52	34
LOXA132	28	35	21	29	40	31	20	56	35
LOXA135	25	33	19	32	40	26	13	65	54
MAX	28	40	35	34	49	54	32	65	54
MIN	22	27	18	18	26	26	13	36	34

U indicates that compound was analyzed but not detected.

Table 2. January 2008 – September 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	2008									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
LOXA104	X	X	X	X	X	X	X	X	X	X
LOXA105	X		X		X		X		X	
LOXA106	X		X		X		X		X	
LOXA107	X		X		X		X		X	
LOXA108	X		X		X		X		X	
LOXA111		X		X		X		X		X
LOXA112		X		X		X		X		X
LOXA113		X		X		X		X		X
LOXA114		X		X		X		X		X
LOXA115	X	X	X	X	X	X	X	X	X	X
LOXA116		X	X							
LOXA117		X	X							
LOXA118		X	X							
LOXA119		X	X							
LOXA120		X	X							
LOXA126		X		X		X		X		X
LOXA127		X		X		X		X		X
LOXA128		X		X		X		X		X
LOXA129	X	X	X	X	X	X	X	X	X	X
LOXA130	X		X		X		X		X	
LOXA131	X		X		X		X		X	
LOXA132	X	X	X	X	X	X	X	X	X	X
LOXA133	X		X		X		X		X	
LOXA135	X	X	X	X	X	X	X	X	X	X
LOXA136	X		X		X		X		X	
LOXA137	X		X		X		X		X	
LOXA138	X		X		X		X		X	
LOXA139	X		X		X		X		X	
LOXA141										
LOXA142	X			X			X			
LOXA143		X		X		X		X		X
LOXA144		X		X		X		X		X
LOXA145		X		X		X		X		X
LOXA146		X		X		X		X		X
LOXA147		X			X		X			
LOXA148		X		X		X		X		X
LOXA149		X		X		X		X		X
LOXA150		X		X		X		X		X
LOXA151	X		X		X	X	X	X	X	X
LOXA152	X		X		X	X	X	X	X	
LOXA153	X				X	X	X	X	X	X
I-BC	X	X	X		X	X	X		X	X
LOX04	X		X		X		X		X	
LOX06		X		X		X		X		X
LOX07		X		X		X		X		X
LOX08		X		X		X		X		X
LOX09		X		X		X		X		X
LOX10		X		X		X		X		X
LOX15		X		X		X		X		X

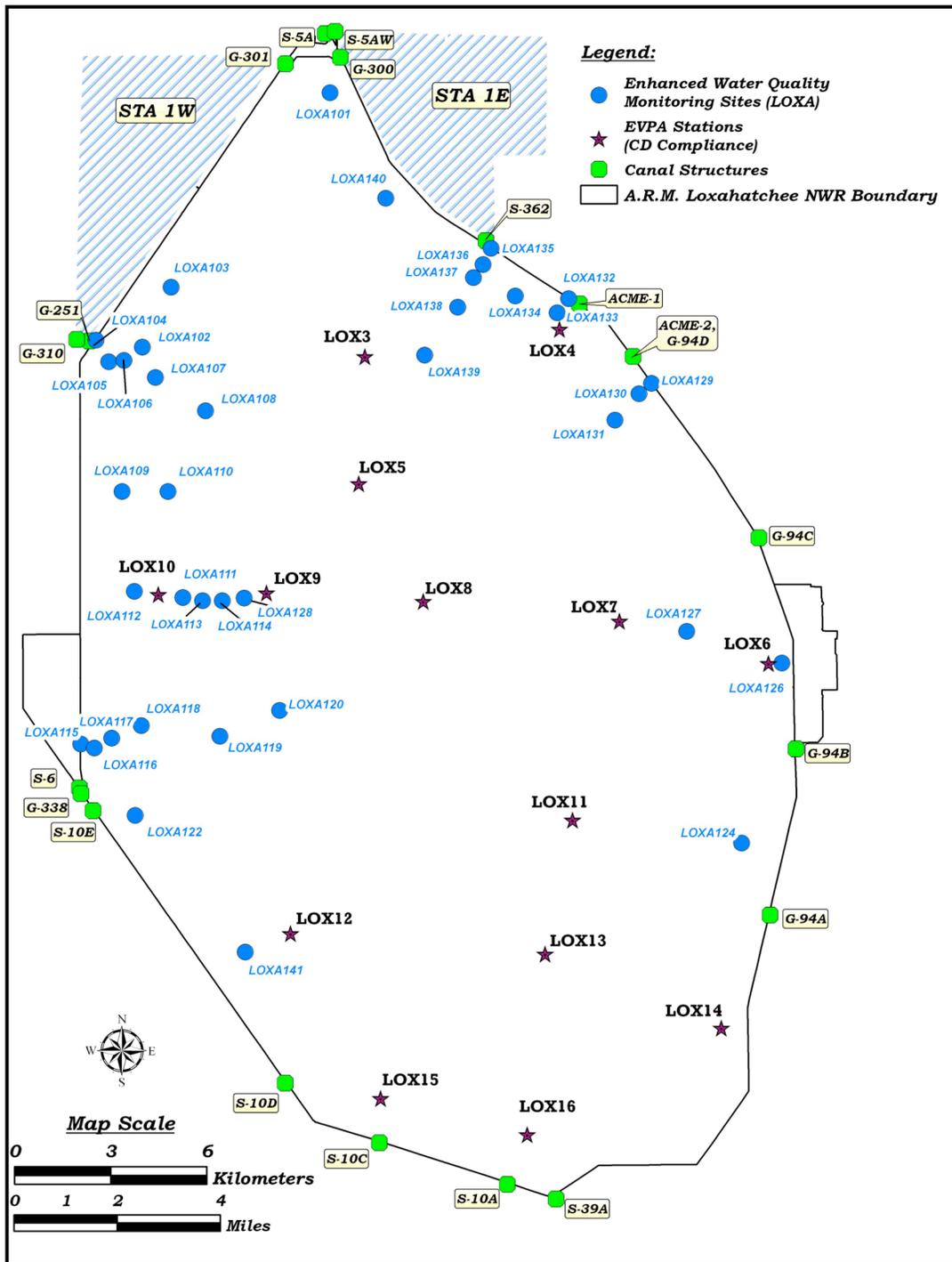


Figure 1. Location of Enhanced Water Quality Monitoring network stations (LOXA###), in relation to Consent Decree compliance stations (LOX##), for the A.R.M. Loxahatchee National Wildlife Refuge.

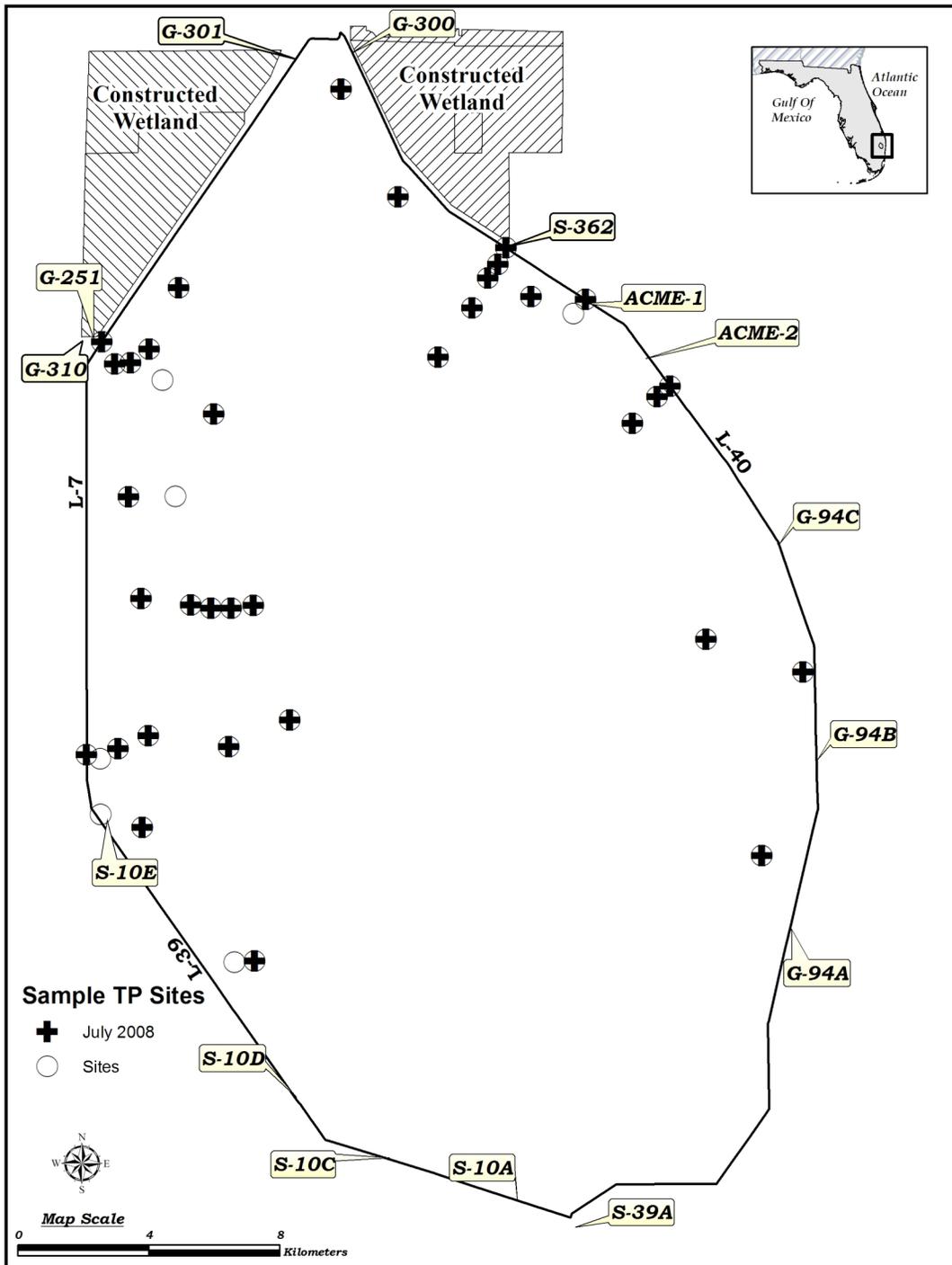


Figure 2. July 2008 map of total phosphorus sample collections from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that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

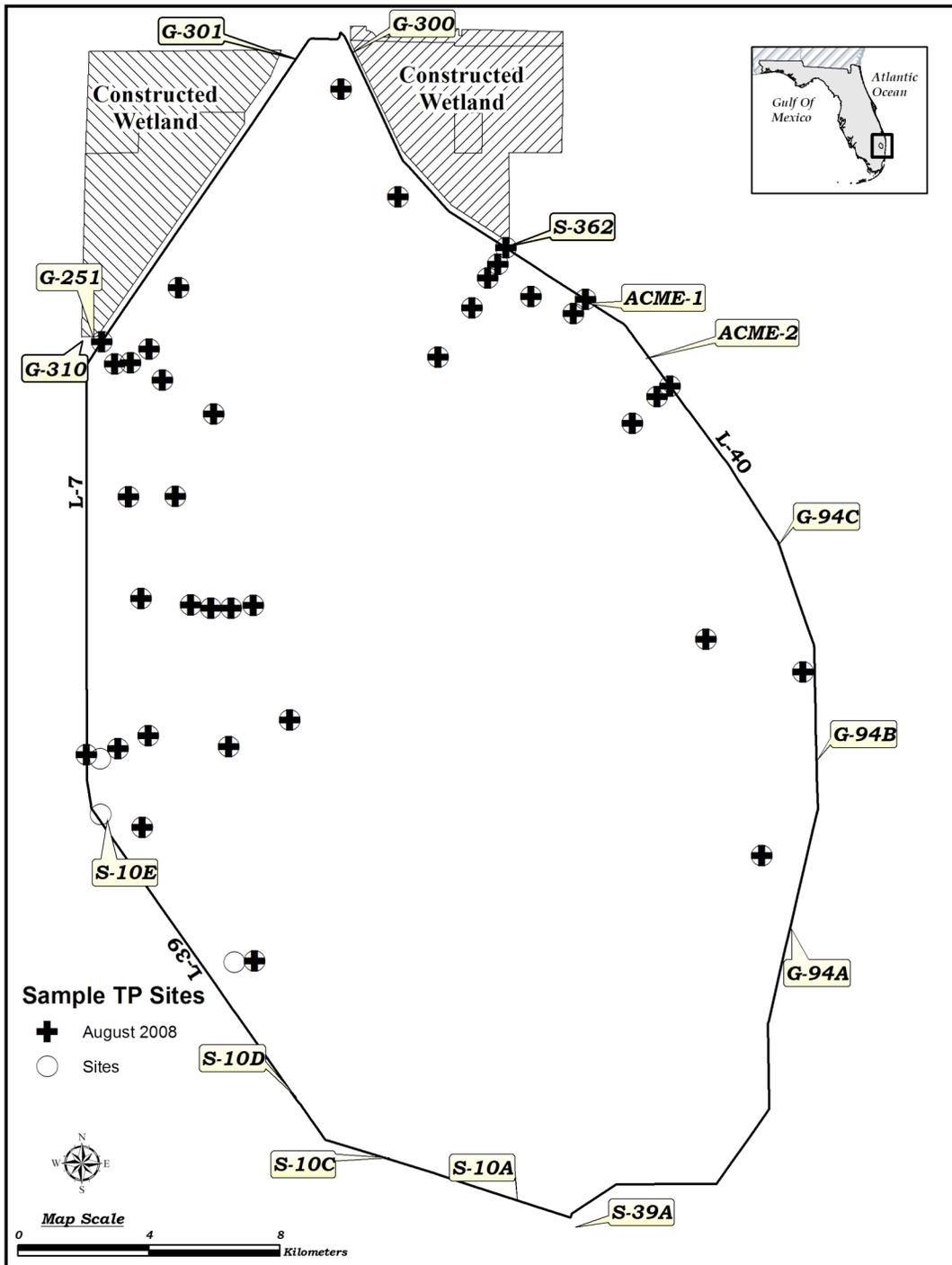


Figure 3. August 2008 map of total phosphorus sample collections from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that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

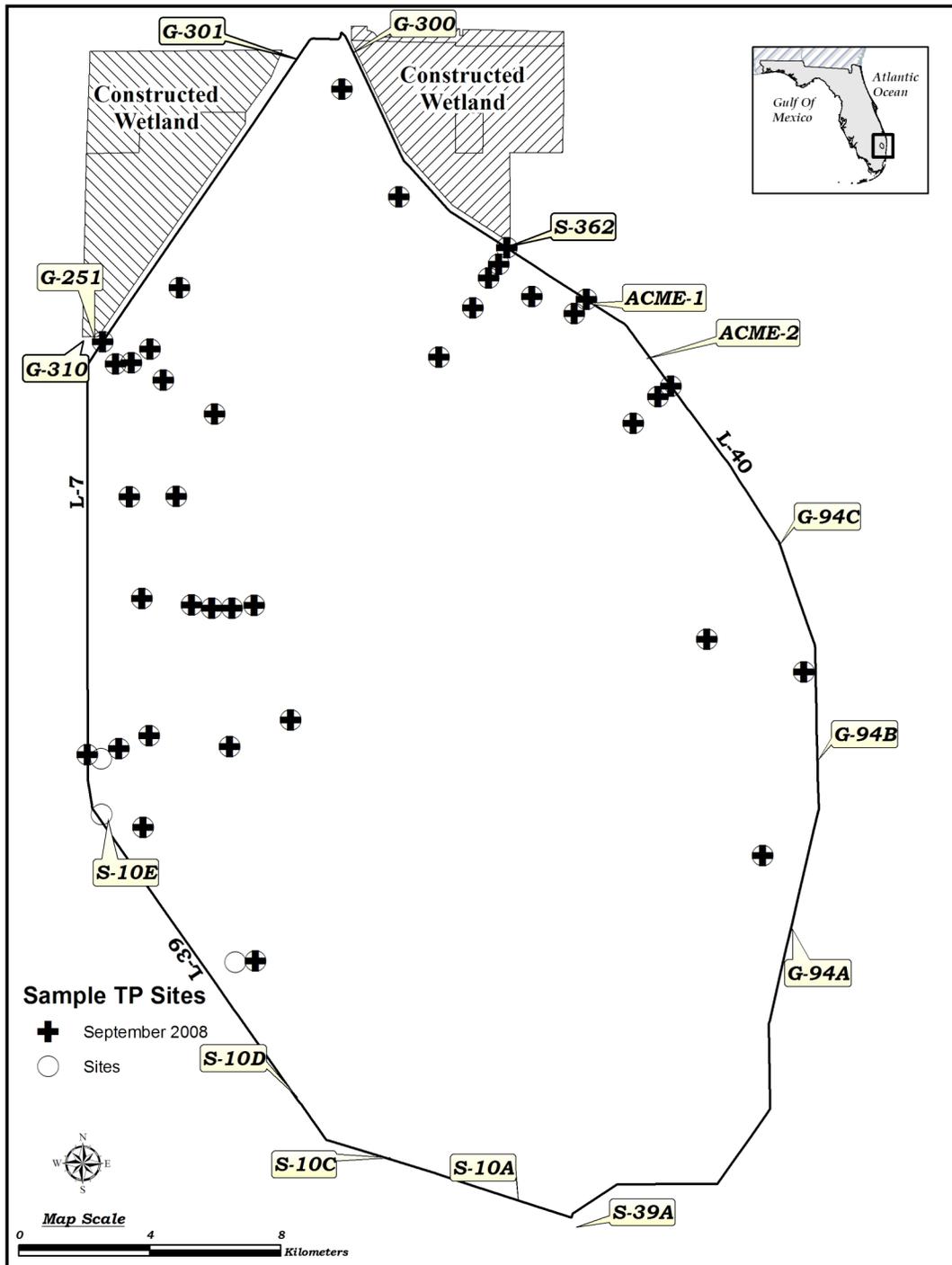


Figure 4. September 2008 map of total phosphorus sample collections from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of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