Assessment of the Ecological Status and Trends of Northeastern Shark River Slough

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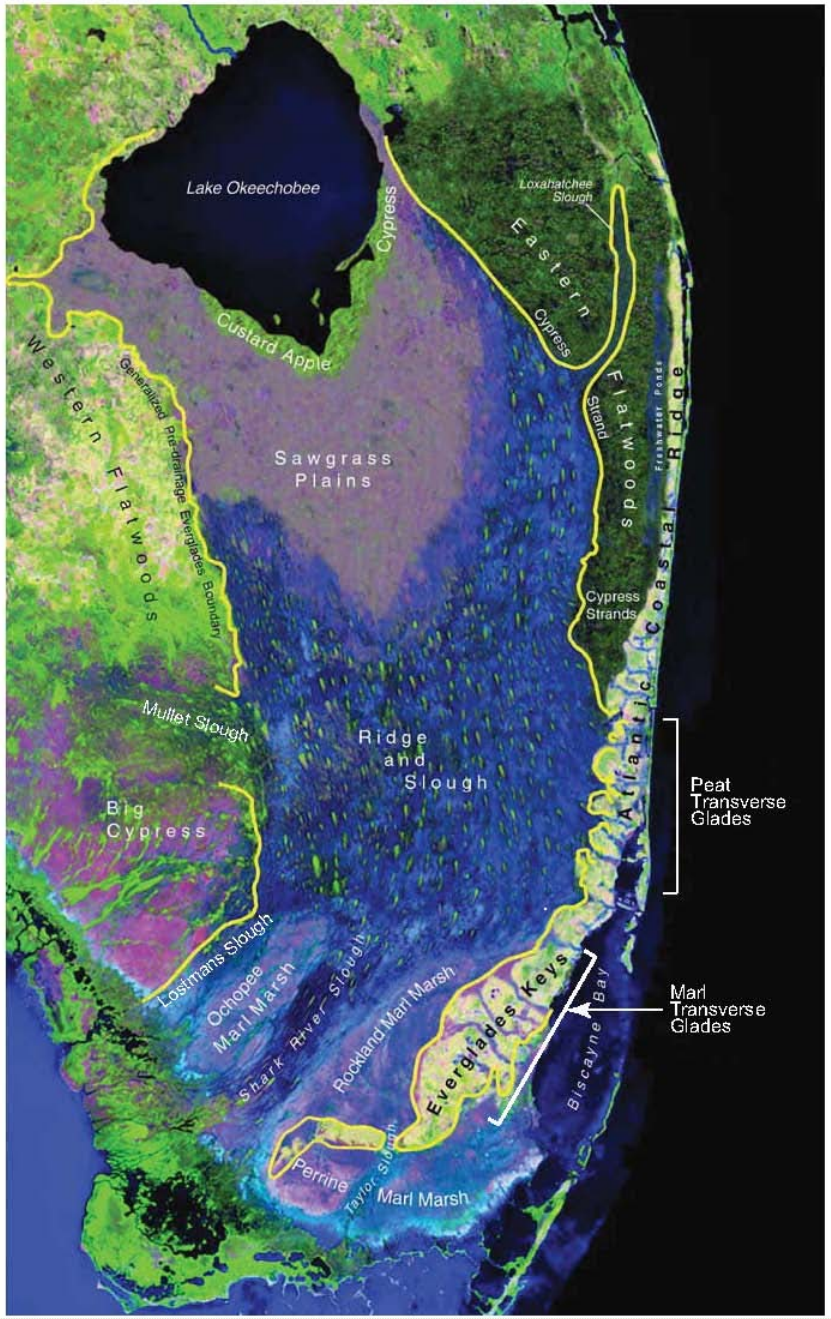
History of NESRS

- Part of River of Grass flow-way
- Ridge, Slough, Marl Prairie landscape morphology
- Initially modified by construction of Tamiami Trail (1915-1928)
- Not part of ENP until 1989



McVoy et al. 2011

Recent Modifications

Completed:

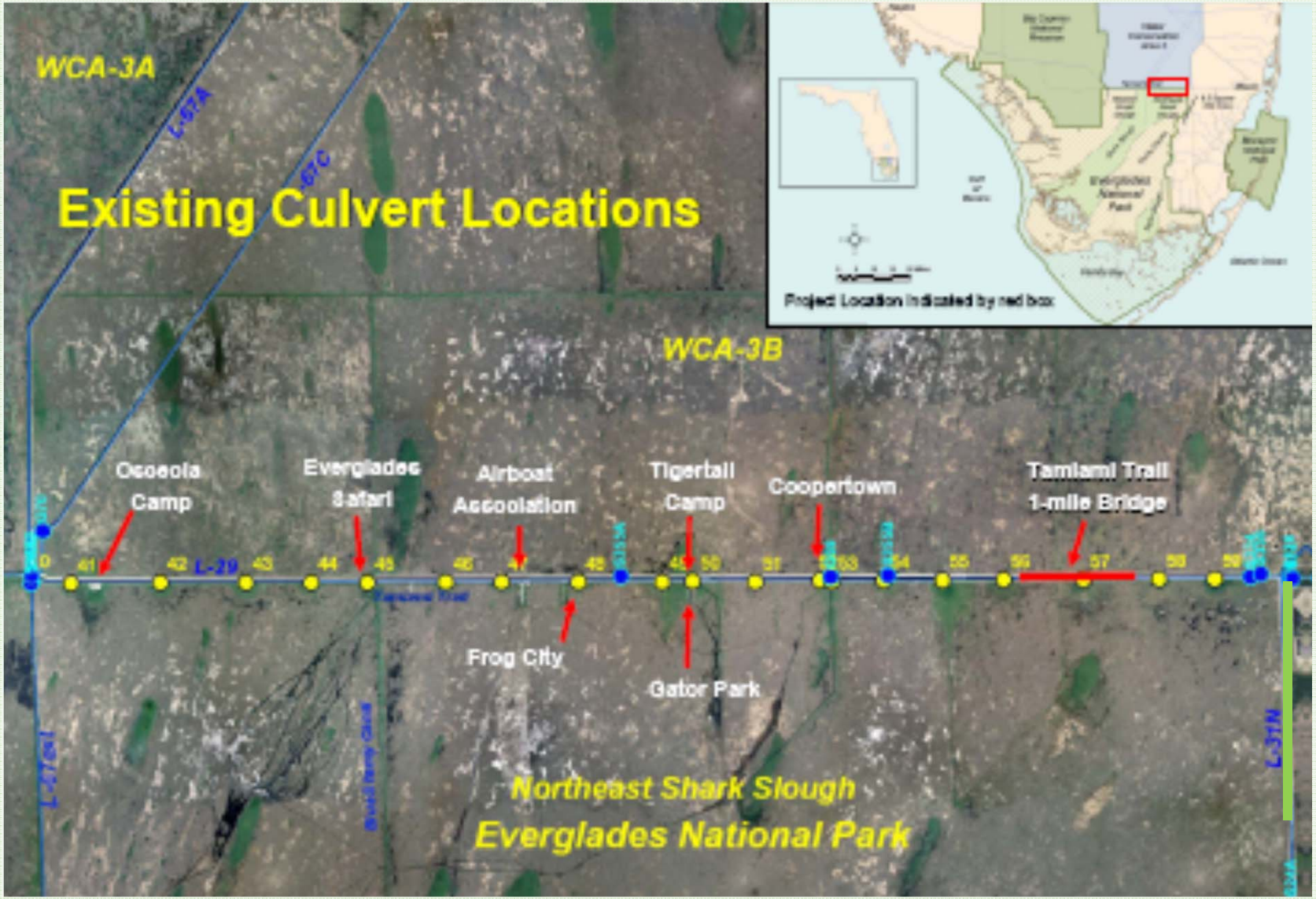
- Seepage Barrier
  - Finished July, 2012
  - 2 mi long, app. 1 m wide, 35 ft. deep
  - Made of cement/bentonite
  - Model estimates of 8.2% increase in sheet flow through NESRS for 2 mi barrier
    - (20% near, 5% far for area about 1.7 mi W)
  - Data collected to date shows that it is affecting hydrology in NESRS

- Tamiami Trail Bridge
  - Finished March, 2013
  - 1 mi long, 2 lane highway
  - Water to be put under in stages (7.5 to 8.5 ft); part of CERP/CEPP overall plans


Photo: Himadri Biswas

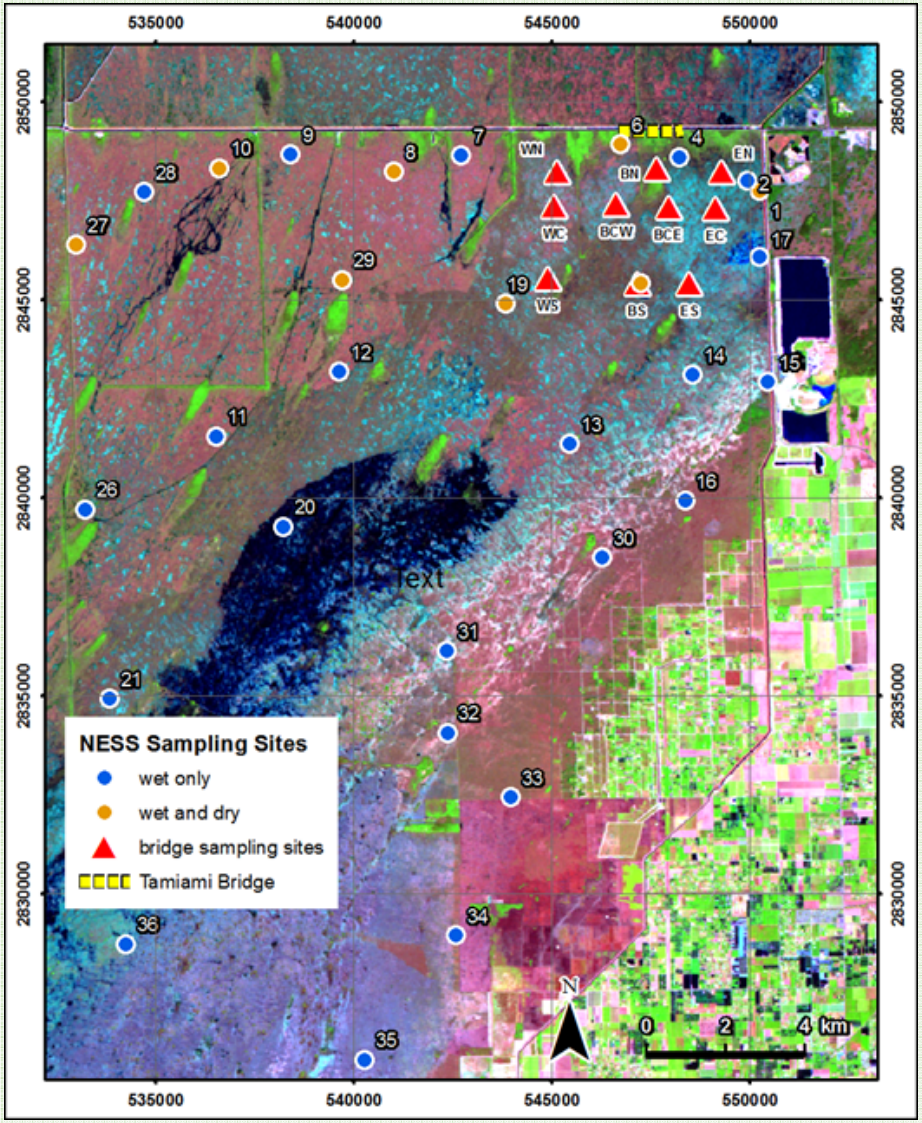
Planned

- Changes in canal (water level) operational schedule
- Additional 2.6 mi bridge further west (then even more)



Seepage barrier

Sampling: Before-After-Control-Intervention (BACI) design



Sampled 30 census site and 10 intensive sites downstream of bridge and Tamiami Trail

Intensive sites with paired impacted (near-bridge) and reference (downstream) sites arranged along three 4K transects

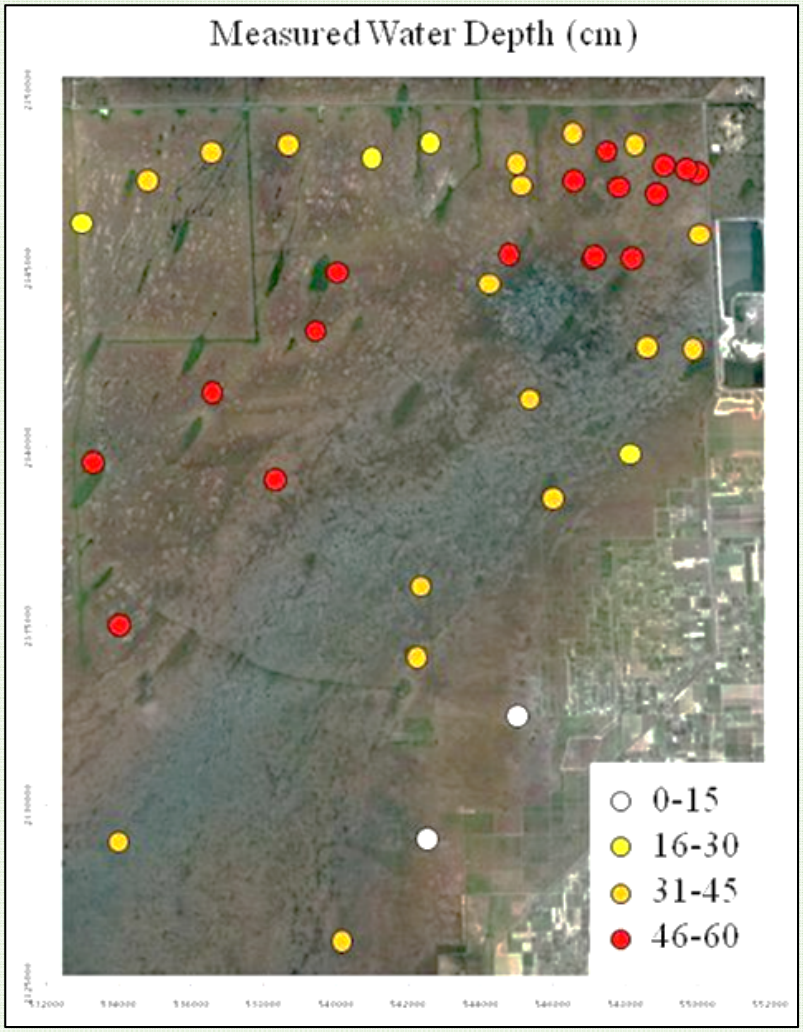
Sampled:

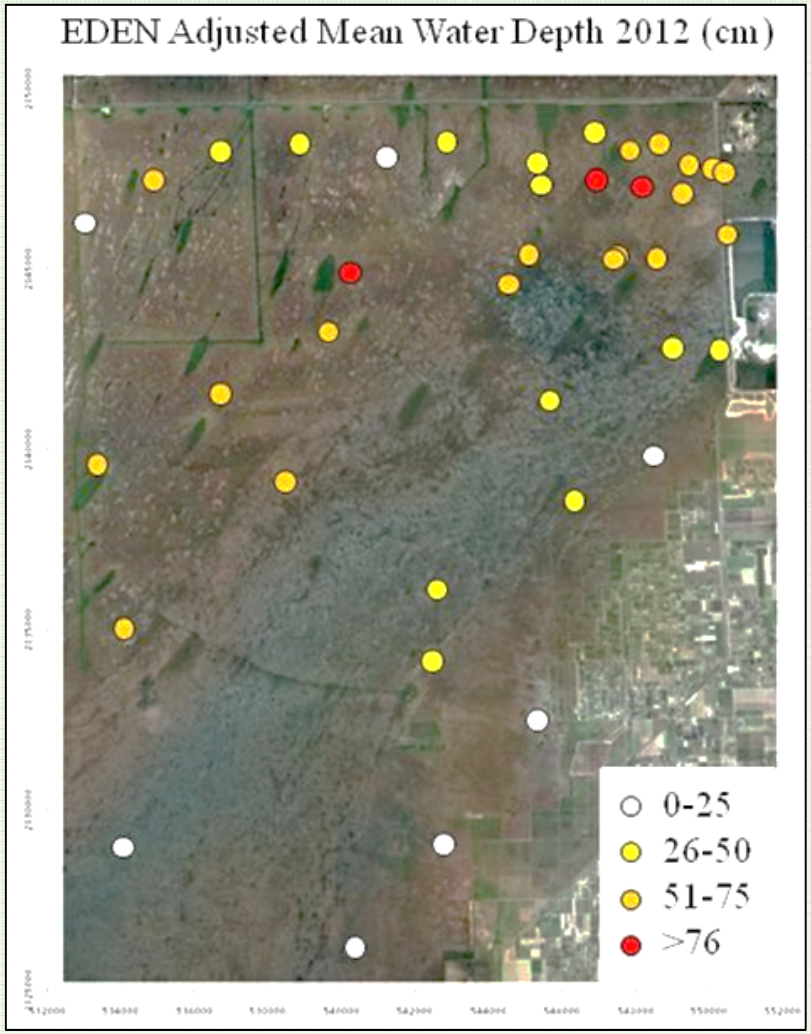
- Water and soil depth and quality
- Periphyton abundance and distribution
- Aquatic consumer composition and abundance
- Vegetation community structure at several scales

Dry/Wet season, 2012

Deeper Water Runs Northeast to Southwest

lowest on northern and eastern edges

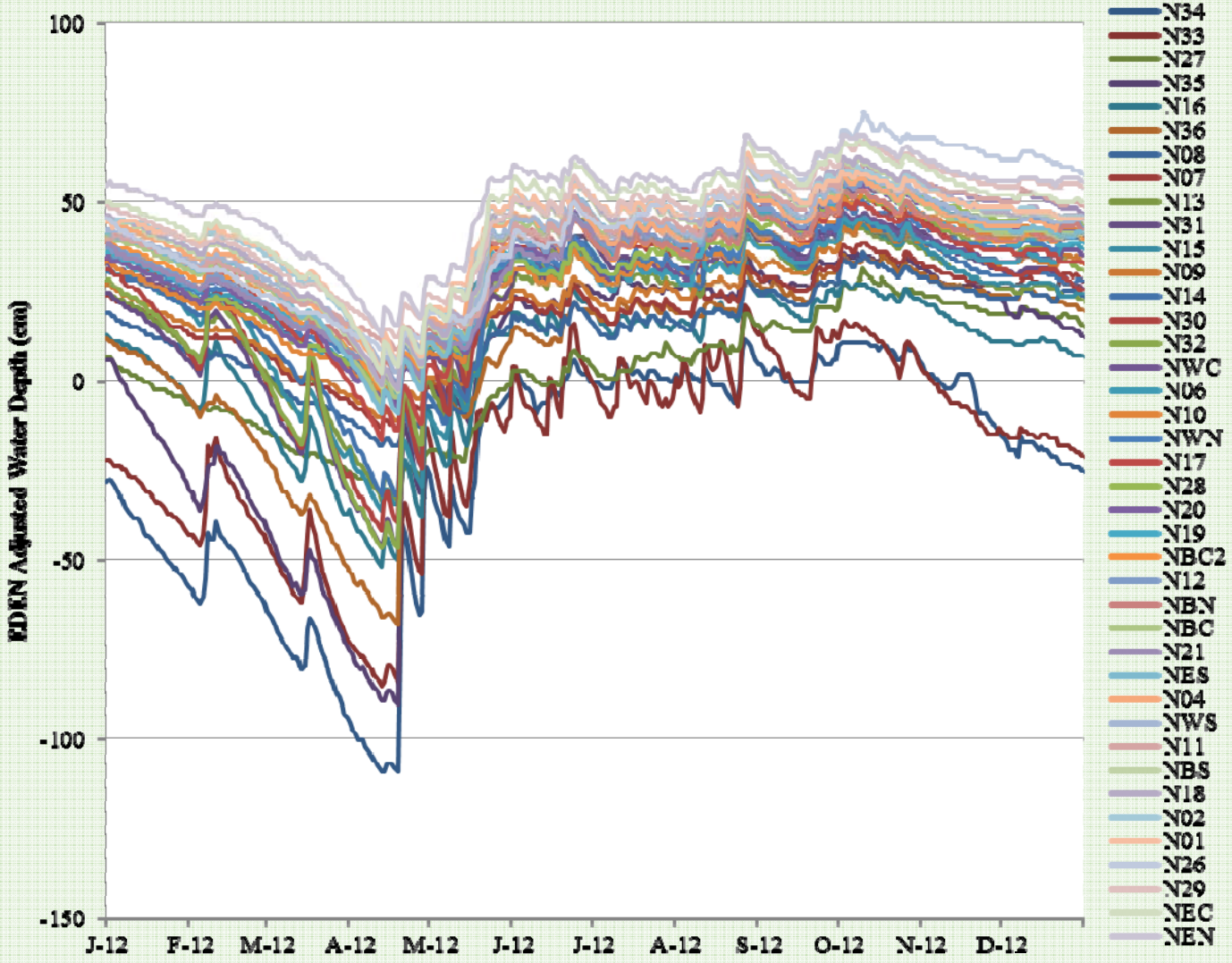




Census sites: averaged 27 cm depth

Intensive sites: averaged 52 cm depth

Hydroperiod varied among sites and ranged from 128-256 days



Variation in Adjusted EDEN Water Depth in NESRS, 2012

Water nutrients typical of marl prairies

	n	TP	NO_2	N+N	NH4	TN	TOC
		µg L^{-1}	µg L^{-1}	µg L^{-1}	µg L^{-1}	µg L^{-1}	mg L^{-1}
Census	29	8.13±0.49	0.83±0.39	17.71±2.5	37.92±6.27	707±26	14.1±0.6
Intensive	10	11.19±1.34	0.23±0.23	13.38±4.61	31.07±7.46	732±24	13.7±0.3

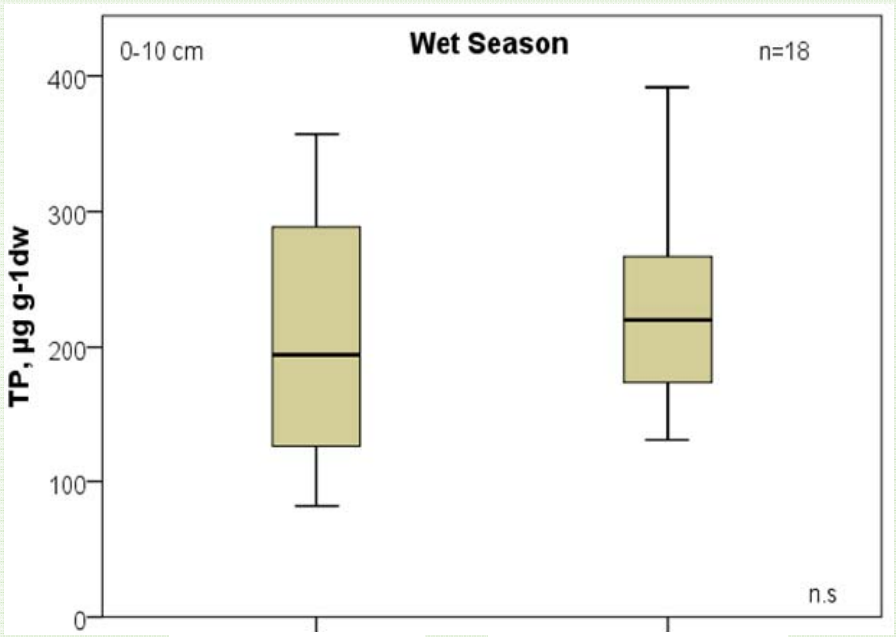
Water physiochemical parameters at Census and Intensive sites sampled in September 2012; SRP below detection levels

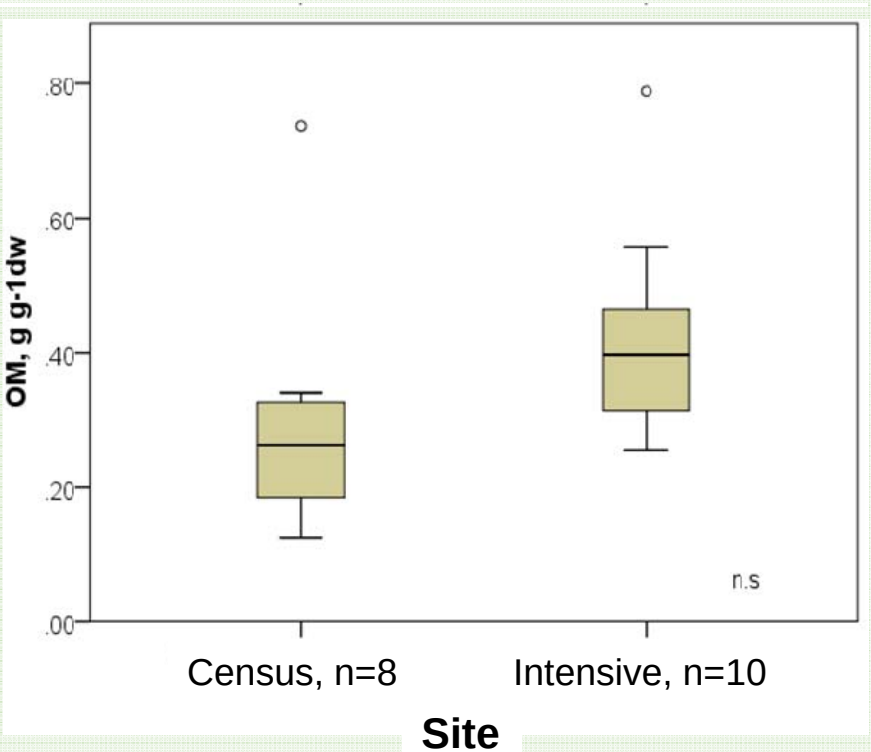
Soil physiochemical characteristics typical of marl prairies; intensive sites with OM input

Depth/Site	n	pH	FBD	OM	TP	TN	TC
			g dw cm^{-3}	g g^{-1} dw	µg g^{-1} dw	mg g^{-1} dw	mg g^{-1} dw
Soil 0-10 cm							
All	18	7.44±0.04	0.37±0.03	0.33±0.05	200.87±26.95	14.80±1.75	238.80±21.07
Intensive	10	7.40±0.06	0.34±0.05	**0.41±0.06**	236.91±38.44	17.74±2.7	**281.57±28.61**
Census	8	7.49±0.06	0.41±0.03	**0.24±0.04**	155.82±32.77	11.12±1.21	**185.34±19.37**
SS 0-2 cm							
All	18	7.43±0.03	0.32±0.03	0.41±0.04	305.14±29.87	18.31±1.89	270.48±22.26
Intensive	10	7.42±0.01	0.32±0.04	0.40±0.05	294.14±38.74	17.91±2.5	266.68±26.06
Census	8	7.44±0.06	0.32±0.04	0.44±0.07	318.90±49.14	18.8±3.06	275.22±40.11
SS 2-10 cm							
All	18	7.48±0.04	0.39±0.04	0.34±0.04	182.59±28.09	14.57 ± 1.90	238.08±23.3
Intensive	10	7.46±0.06	0.35±0.06	**0.43±0.06**	**223.38±37.22**	**18.21 ± 2.87**	**291.56±30.86**
Census	8	7.51±0.07	0.43±0.04	**0.21±0.04**	**131.61±37.63**	**10.02 ± 1.07**	**171.23±16.92**

Values are mean ± SE. Significant difference between Intensive and Census sites as determined by ANOVA are in bold. Absence of designation denotes no significant difference.

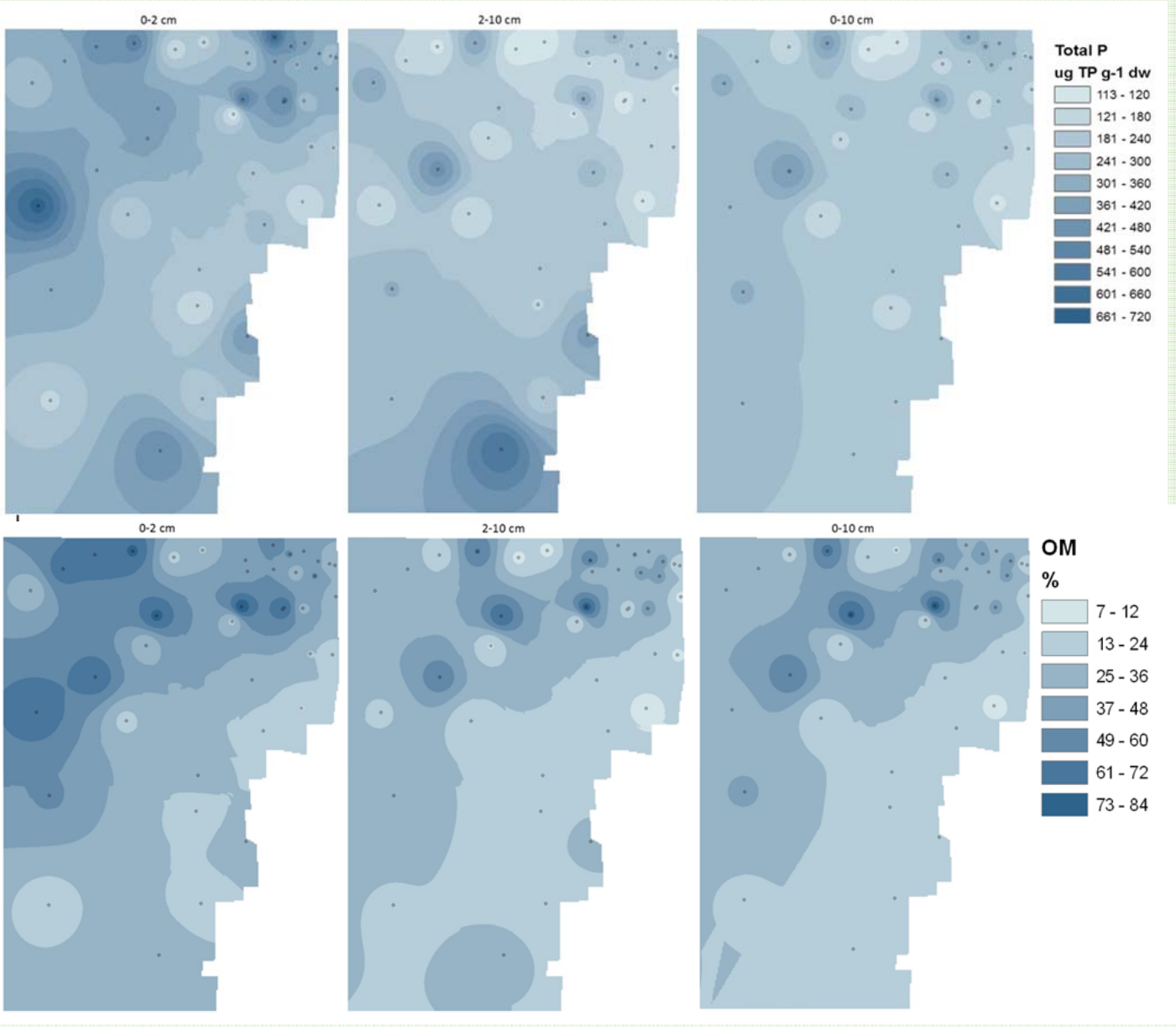
Intensive site soil TP similar to northern census sites





Soil Total P concentration (µg g^{-1} dw) and organic matter content (g g^{-1} dw) at 0-10 cm soil depth increments for samples collected in September 2012 at the 18 northern sites (in proximity to the Tamiami canal) composed of census, non-bridge (n = 8) and intensive, bridge sites (n = 10)

Distribution of soil organic matter paralleled NE to SW soil TP distribution



Floc had slightly higher nutrient content as compared to soil

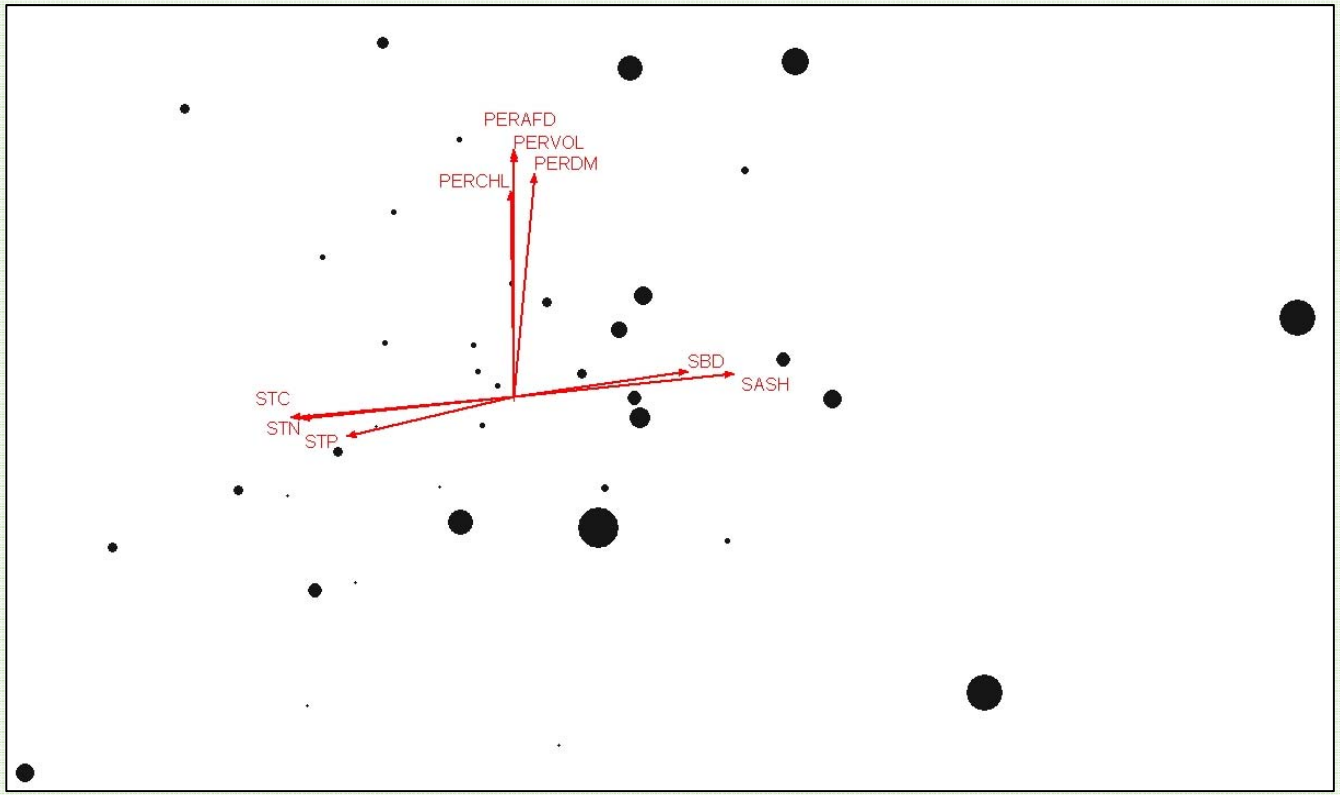
Depth Increment Site Description	n	pH	FBD	OM
Floc			g dw cm^{-3}	g g^{-1} dw
All	29	7.62 ± 0.05	0.05 ± 0.01	0.53 ± 0.04
All Northern	13	7.56 ± 0.06	0.05 ± 0.01	0.57 ± 0.04
Intensive / Bridge	10	†**7.83 ± 0.08**[a]	†0.03 ± 0.01 [a]	0.56 ± 0.05
Northern non-Bridge	6	**7.40 ± 0.04**	0.07 ± 0.02	0.58 ± 0.08
Census	19	7.51 ± 0.05[b]	0.06 ± 0.01[b]	0.52 ± 0.05

Depth Increment Site Description	n	TP	TN	TC
Floc		µg g^{-1} dw	mg g^{-1} dw	mg g^{-1} dw
All	29	341.70 ± 32.79	18.67 ± 1.25	267.04 ± 11.55
All Northern	13	351.75 ± 43.64	20.30 ± 1.75	288.28 ± 15.83
Intensive / Bridge	10	287.24 ± 41.84	18.45 ± 1.62	276.00 ± 15.40
Northern non-Bridge	6	384.29 ± 81.98	20.57 ± 3.19	283.50 ± 28.82
Census	19	367.50 ± 43.51	18.78 ± 1.73	262.33 ± 15.83

Values are mean ± SE. Significant differences by ANOVA between intensive and northern, non-bridge sites are in bold type.

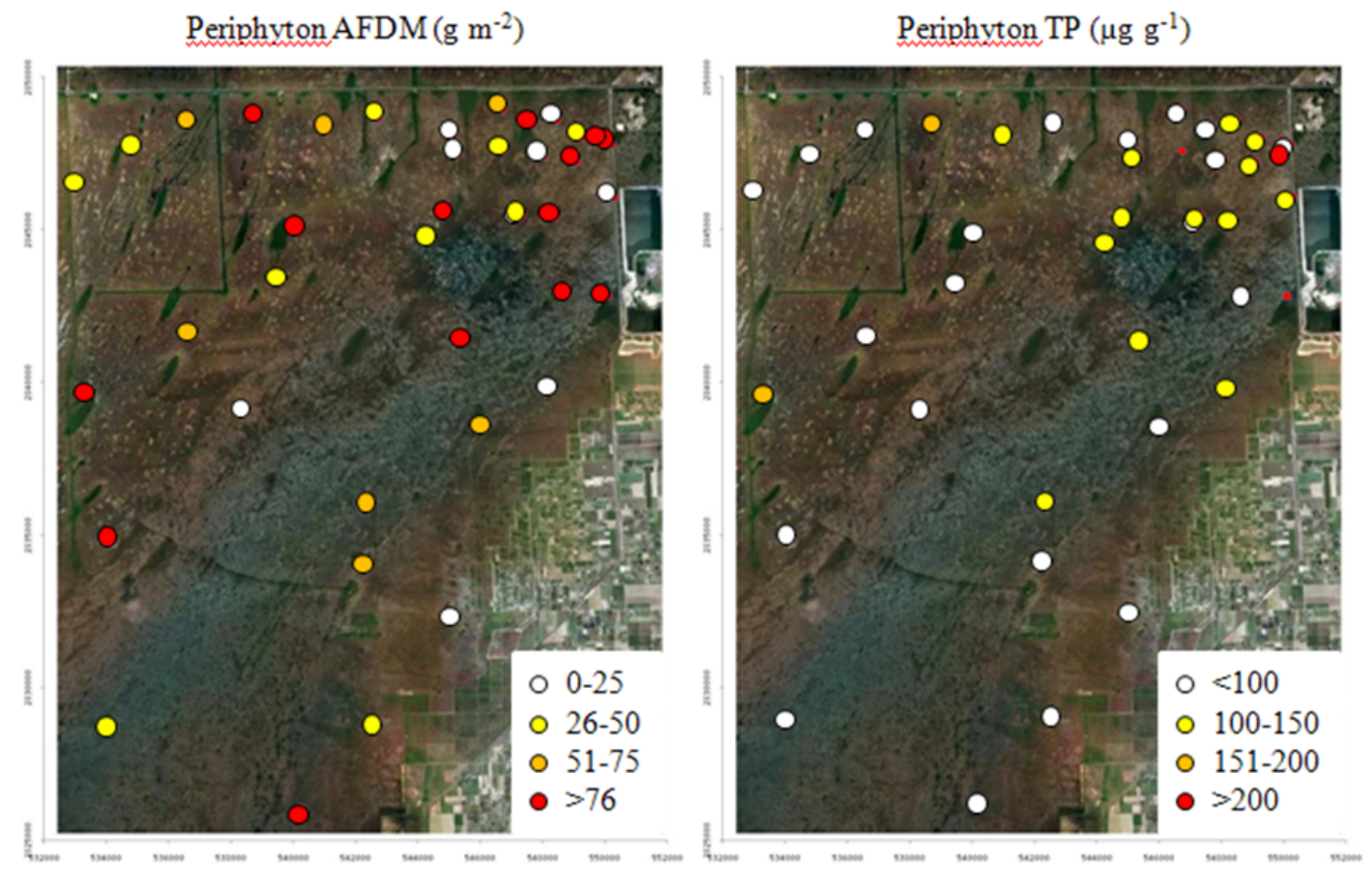
Periphyton was abundant and widely distributed in NESRS

Variability in periphyton samples explained by distance to Tamiami Trail

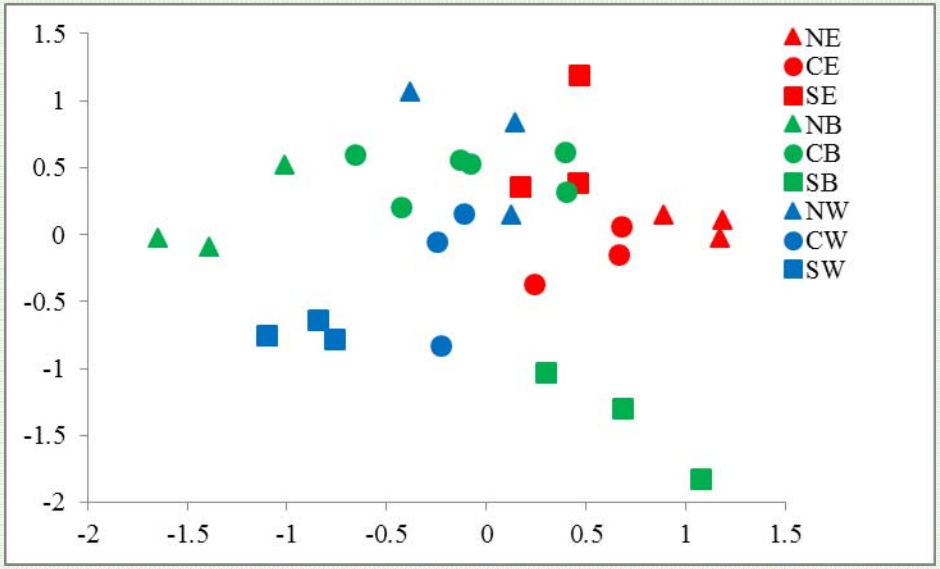


NMDS ordination of all sites sampled in the wet season, with points scaled according to distance from the Tamiami Trail, and vectors depicting the direction of influence of variables that explain more than 50% of the variance in site-to-site differences in NESRS. The horizontal axis is associated with soil properties and the vertical axis depicts variation in periphyton abundance, indicating that these features are strong drivers of environmental variance on the landscape.

Boundary sites more enriched in periphyton TP than central marl prairie sites; were all lower than downstream from canals or culverts along Tamiami Trail



Intensive site periphyton samples similar, so change in them will serve to detect trends



	Periphyton TP ($\mu g\ g^{-1}$)	Periphyton Mass ($g\ m^{-2}$)	Periphyton AFDM ($g\ m^{-2}$)	Organic Content (%)	Periphyton Chl a ($mg\ m^{-2}$)
Census Sites – Wet Season	124 (103)	158 (142)	59 (48)	41 (12)	17 (13)
Census Sites – Dry Season	218 (122)	272 (322)	73 (52)	46 (22)	19 (9)
Intensive Sites – Wet Season	87 (28)	225 (115)	91 (58)	39 (8)	25 (15)
Intensive Sites – Dry Season	163 (141)	303 (206)	108 (63)	38 (7)	22 (12)

Means and standard deviations of periphyton parameters sampled at census and intensive sites during the dry and wet seasons of 2011

Fish and invertebrate/other vertebrates collected in throw traps and drift fences were similar to those found in other regional studies

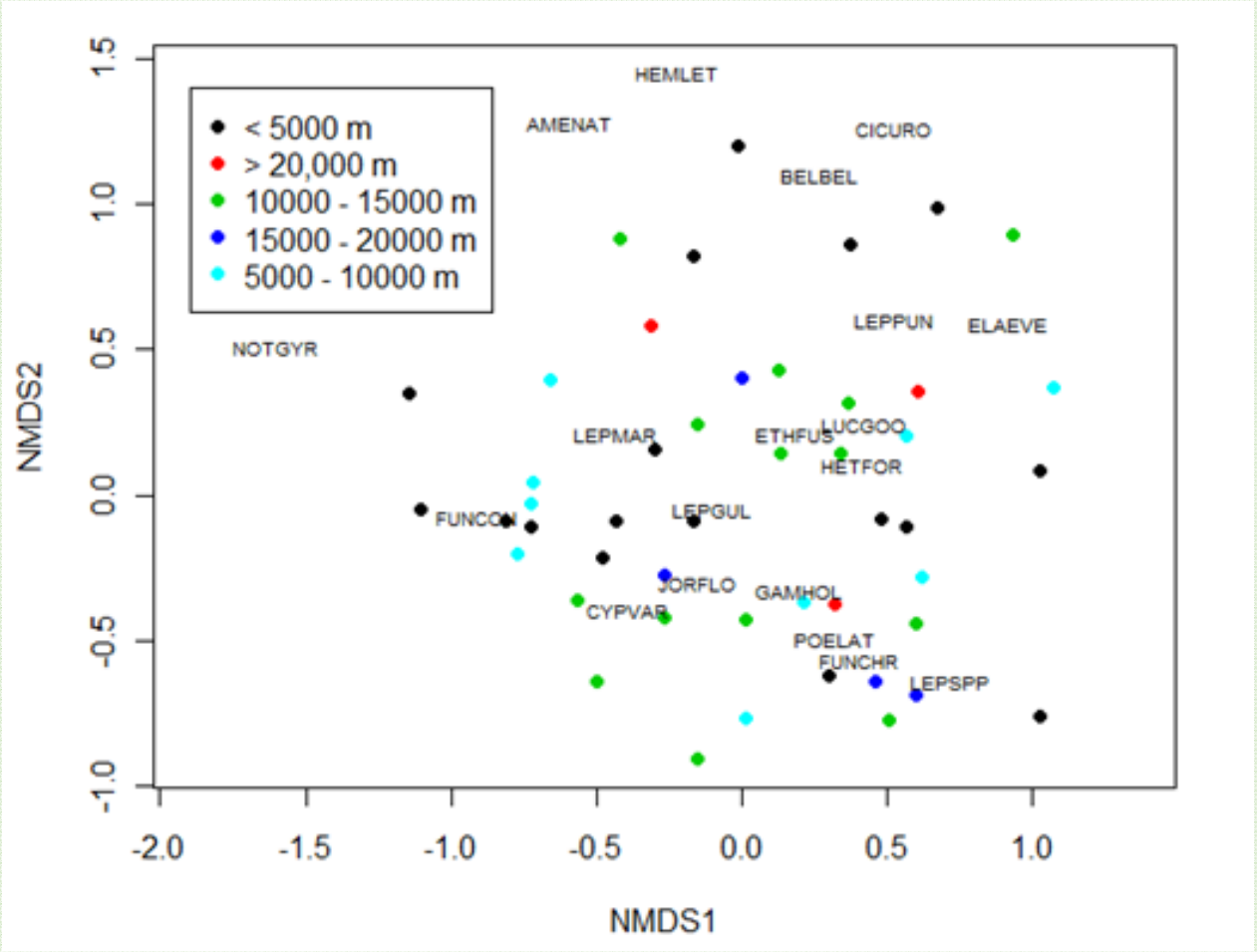
		Project			Total	
		CERP	MDW	NESRS	**Mean**	**Sum**
		N=27	N=21	N=114	**N=162**	
Common name	**Scientific name**					
Yellow bullhead	*Ameiurus natalis*	0.000	0.000	0.009	**0.006**	**1**
Tadpole madtom	*Noturus gyrinus*	0.037	0.000	0.000	**0.006**	**1**
Sheepshead minnow	*Cyprinodon variegatus*	0.000	0.095	0.009	**0.019**	**3**
Golden topminnow	*Fundulus chrysotus*	0.185	0.238	0.544	**0.444**	**72**
Marsh killifish	*Fundulus confluentus*	0.296	0.048	0.342	**0.296**	**48**
Flagfish	*Jordanella floridae*	0.222	0.000	0.860	**0.642**	**104**
Bluefin killifish	*Lucania goodei*	0.519	0.238	0.412	**0.407**	**66**
Pike killifish	*Belonesox belizanus*	0.074	0.000	0.035	**0.037**	**6**
Mosquitofish	*Gambusia holbrooki*	0.815	0.190	1.904	**1.500**	**243**
Least killifish	*Heterandria formosa*	1.741	0.238	1.930	**1.679**	**272**
Sailfin molly	*Poecilia latipinna*	0.037	0.000	0.325	**0.235**	**38**
Everglades pygmy sunfish	*Elassoma evergladei*	0.259	0.095	0.070	**0.105**	**17**
Warmouth	*Lepomis gulosus*	0.000	0.000	0.018	**0.012**	**2**
Dollar sunfish	*Lepomis marginatus*	0.037	0.190	0.123	**0.117**	**19**
Spotted sunfish	*Lepomis punctatus*	0.074	0.333	0.184	**0.185**	**30**
Sunfishes	*Lepomis* spp.	0.037	0.000	0.070	**0.056**	**9**
Swamp darter	*Etheostoma fusiforme*	0.000	0.000	0.009	**0.006**	**1**
Mayan cichlid	*Cichlasoma urophthalmus*	0.000	0.095	0.000	**0.012**	**2**
Jewel cichlid	*Hemichromis letourneauxi*	0.074	0.048	0.026	**0.037**	**6**
Unidentified fishes		0.000	0.000	0.053	**0.037**	**6**
Total		**4.407**	**1.810**	**6.921**	**5.840**	**946**

Mean number of fish captured in throw traps for 2012 wet season. Includes summaries of fish collected in nearby concurrently sampled sites from other projects (MODWATERS, CERP-MAP). Non-native species are highlighted.

		Project			Total	
		NESRS	CERP	MDW	**Mean**	**Sum**
		N = 114	N = 27	N = 21	**N = 162**	
Common Name	**Scientific Name**					
Sponge	*Spongilla lacustris*	0.018	0.037	0.000	**0.019**	**3**
Leeches	Class Hirudinea	0.009	0.000	0.000	**0.006**	**1**
Oligochaetes	Class Oligochaeta	0.018	0.111	0.000	**0.031**	**5**
Physid snail	*Haitia* spp.	0.018	0.000	0.000	**0.012**	**2**
Planorbid snail	*Planorbella* spp.	0.044	0.037	0.000	**0.037**	**6**
Apple snail	*Pomacea paludosa*	0.000	0.037	0.000	**0.006**	**1**
Mimic pondsnail	*Pseudosuccinea columella*	0.009	0.000	0.000	**0.006**	**1**
Everglades crayfish	*Procambarus alleni*	0.860	0.556	0.524	**0.765**	**124**
Slough crayfish	*Procambarus fallax*	2.395	1.407	0.095	**1.932**	**313**
Juvenile crayfish	*Procambarus* spp.	0.518	0.222	0.000	**0.401**	**65**
Grass shrimp	*Palaemonetes paludosus*	4.272	4.148	0.857	**3.809**	**617**
Creeping water bug	*Pelocoris femoratus*	1.333	2.148	0.095	**1.309**	**212**
Giant water bug	*Belostoma* spp.	0.254	0.259	0.000	**0.222**	**36**
Giant water bug	*Lethocerus* spp.	0.026	0.000	0.000	**0.019**	**3**
Adult giant water bug	Adult Lethocerus	0.009	0.000	0.000	**0.006**	**1**
Water striders	Family Gerridae	0.026	0.000	0.000	**0.019**	**3**
Aquatic beetle adults	Order Coleoptera	0.272	0.556	0.000	**0.284**	**46**
Diving beetle larva	*Cybister* spp.	0.018	0.000	0.000	**0.012**	**2**
Common green darner	*Anax junius*	0.000	0.037	0.000	**0.006**	**1**
Four-spotted pennant	*Brachymesia gravida*	0.026	0.000	0.000	**0.019**	**3**
Tropical pennants	*Brachymesia* spp.	0.009	0.000	0.000	**0.006**	**1**
Halloween pennant	*Celithemis eponina*	0.053	0.000	0.000	**0.037**	**6**
Banded pennant	*Celithemis fasciata*	0.009	0.000	0.000	**0.006**	**1**
Pennant	*Celithemis* spp.	0.044	0.185	0.000	**0.062**	**10**
Damselfly larvae	Family Coenagrionidae	0.254	0.185	0.000	**0.210**	**34**
Regal darner	*Coryphaeschna ingens*	0.035	0.000	0.000	**0.025**	**4**
Needhams skimmer	*Libellula needhami*	0.026	0.000	0.000	**0.019**	**3**
Skimmer	*Libellula* spp.	0.070	0.000	0.000	**0.049**	**8**
Blue dasher	*Pachydiplax longipennis*	0.009	0.074	0.000	**0.019**	**3**
Mayfly larvae	Order Ephemeroptera	0.009	0.074	0.000	**0.019**	**3**
Soldier fly larvae	Family Stratiomyidae	0.009	0.000	0.000	**0.006**	**1**
Cricket frog tadpole	*Acris gryllus*	0.026	0.000	0.000	**0.019**	**3**
Green tree frog adult	*Hyla cineria*	0.018	0.000	0.000	**0.012**	**2**
Pig/leopard frog tadpole	*Rana* spp. tp.	0.132	0.111	0.000	**0.111**	**18**
Peninsula newt	*Notophthalmus viridescens*	0.009	0.074	0.000	**0.019**	**3**
Total		**10.833**	**10.259**	**1.571**	**9.537**	**1545**

Total invertebrates and other vertebrates captured in throw traps for NESRS in September/October 2012 (wet season). Also included are summaries of invertebrates collected in nearby concurrently sampled sites from other projects (MODWATERS, CERP-MAP).

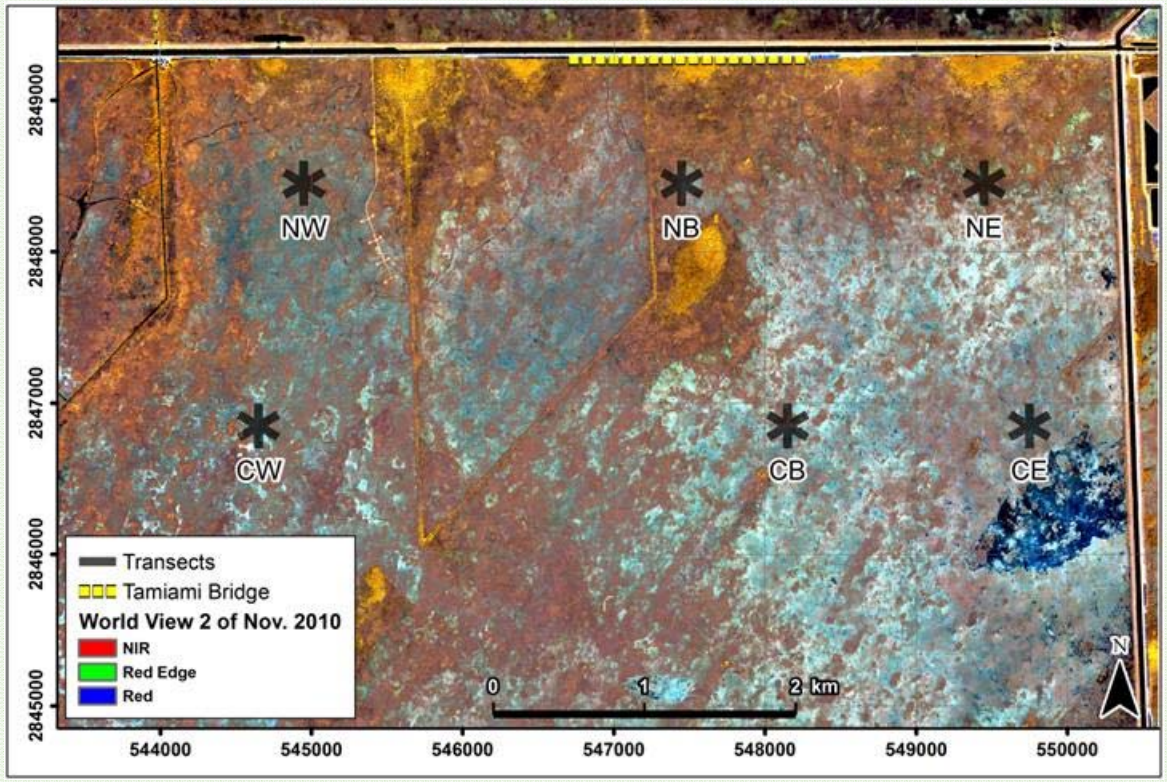
No relationship between fish community composition and distance from Tamiami Trail



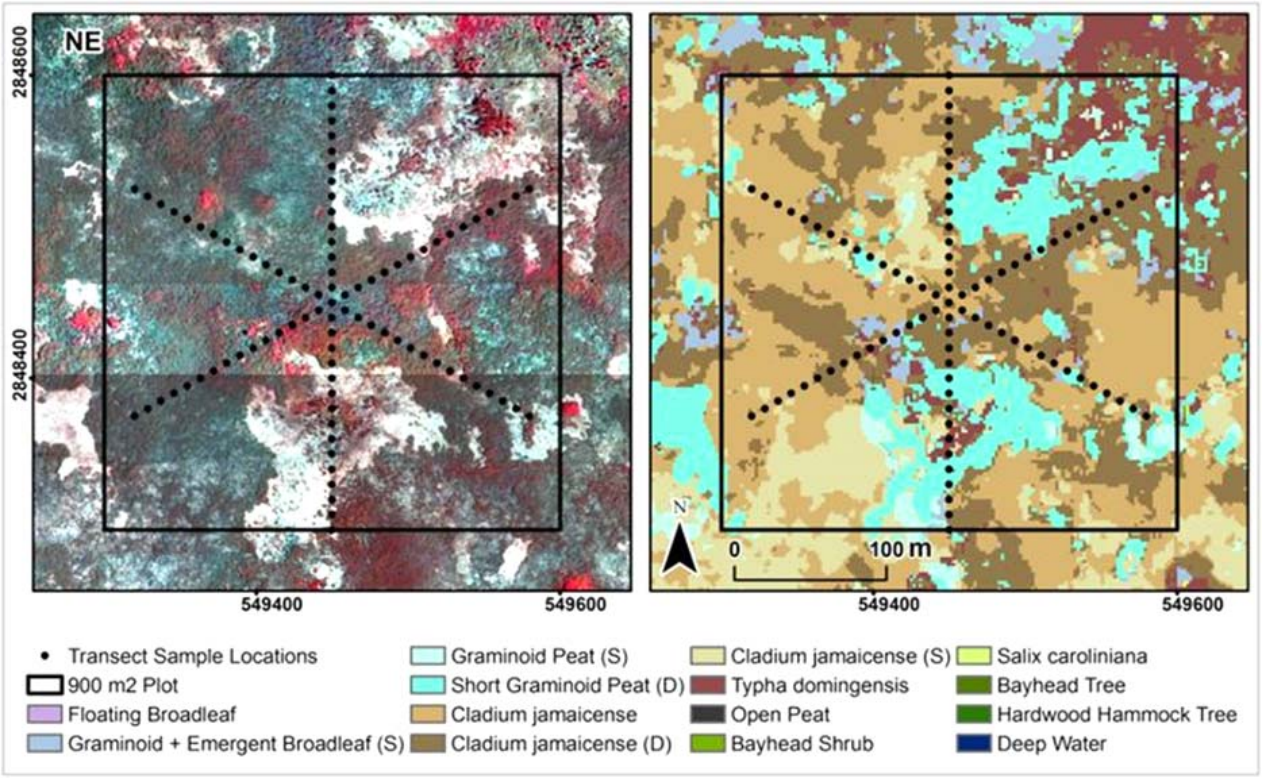
Non-metric multidimensional scaling plots of fish community composition for sites in northeast Shark River Slough ordered by project (A) and distance from Tamiami bridge (B).

Fish movement

Vegetation monitoring through ground-reference star transects and community mapping with WorldView-2 data



Overview map of vegetation sampling sites in the Northeast Shark Slough area below the Tamiami Trail. Six-armed stars mark the sites of the intensive field sampling vegetation transects. Sites are labeled with their relative locations: NW = north west; NB = north bridge; NE = north east; CW = central west; CB = central bridge; CE = central east



81% of samples dominated by sawgrass (*Cladium jamaicense*)

4% sawgrass in a mixed association with short graminoids (*Eleocharis cellulosa* or *Rhynchospora tracyi*)

12% short graminoid species with *E. cellulosa* most common (10%).

2% cattail (*Typha domingensis*)

1% shrubs (*Salix caroliniana* or *Cephalanthus occidentalis*), either alone or mixed with sawgrass

Conclusions

- Have established base-line water and soil depth and quality, periphyton, fish and invertebrate/other invertebrate, and vegetation characteristics for NESRS
- Data from this study are similar to what has been found in this region in studies over the past decade
- NESRS appears to be functioning as a short-hydroperiod marl prairie with little evidence of nutrient enrichment, except along the northern and eastern boundaries