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Marl Prairie/Slough Gradients; Patterns and Trends in Shark Slough and Adjacent Marl Prairies (CERP monitoring activity 3.1.3.5), First Annual Report (2005)

Michael Ross
Southeast Environmental Research Center, Department of Environmental Studies, Florida International University

Pablo Ruiz
Southeast Environmental Research Center, Department of Environmental Studies, Florida International University

Jay Sah
Southeast Environmental Research Center, Department of Environmental Studies, Florida International University

Susana Stofella
Southeast Environmental Research Center, Department of Environmental Studies, Florida International University

Nilesh Timilsina
Southeast Environmental Research Center, Department of Environmental Studies, Florida International University

See next page for additional authors

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Authors
Michael Ross, Pablo Ruiz, Jay Sah, Susana Stofella, Nilesh Timilsina, and Erin Hanan

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Marl Prairie/Slough Gradients;
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(CERP monitoring activity 3.1.3.5)

First Annual Report (2005)

Southeast Environmental Research Center
Department of Environmental Studies
Florida International University

Michael Ross
Pablo Ruiz
Jay Sah
Susanna Stoffella
Nilesh Timilsina
Erin Hanan

Jan 16, 2006

Executive Summary

The work on CERP monitoring item 3.1.3.5 (Marl prairie/slough gradients) is being conducted by Florida International University (Dr Michael Ross, Project Leader), with Everglades National Park (Dr. Craig Smith) providing administrative support and technical consultation. As of January 2006 the funds transferred by ACOE to ENP, and subsequently to FIU, have been entirely expended or encumbered in salaries or wages. The project work for 2005 started rather late in the fiscal year, but ultimately accomplished the Year 1 goals of securing a permit to conduct the research in Everglades National Park, finalizing a detailed scope of work, and sampling marsh sites which are most easily accessed during the wet season. 46 plots were sampled in detail, and a preliminary vegetation classification distinguished three groups among these sites (Sawgrass marsh, sawgrass and other, and slough) which may be arranged roughly along a hydrologic gradient from least to most persistently inundated . We also made coarser observations of vegetation type at 5-m intervals along 2 transects totaling ~ 5 km. When these data were compared with similar observations made in 1998-99, it appeared that vegetation in the western portion of Northeast Shark Slough (immediately east of the L-67 extension) had shifted toward a more hydric type during the last 6 years, while vegetation further east was unchanged in this respect. Because this classification and trend analysis is based on a small fraction of the data set that will be available after the first cycle of sampling (3 years from now), the results should not be interpreted too expansively. However, they do demonstrate the potential for gaining a more comprehensive view of marsh vegetation structure and dynamics in the Everglades, and will provide a sound basis for adaptive management.

Introduction

As a program established to monitor and assess the ecological effects of Everglades restoration, the Monitoring and Assessment Program (MAP) will provide the data and analytical support necessary to implement adaptive management. We report here on progress made in 2005 on the MAP Project activity "Marl Prairie/Slough Gradients; patterns and trends in Shark Slough marshes and associated marl prairies". Progress was substantial, despite a delay in the funding stream that made it necessary for FIU to move forward without an activated budget until September 2005. At this writing, salary and expense categories in the FY 2005 have been entirely expended, and currently encumbered wages will be entirely exhausted by ~ March 1, 2006.

Three major achievements of the Marl prairie/slough gradient project in 2005 were: (1) to gain permits for sampling within Everglades National Park (ENP) and Big Cypress National Preserve (BCNP), (2) to complete a detailed sampling plan for the 3-year duration of the project, including Shark Slough sites to be sampled during wet season and marl prairie locations to be sampled during dry season, and (3) to sample Year 1 wet season sites and begin to build an historical interpretation of the sampling domain in ENP and BCNP. This document reports on each of those activities in turn.

1. **Permitting.** We applied for the permit in May 2005. Because many of the sampling locations are distant from established trails, it was necessary to petition for a variance from ENP wilderness rules in order to access these sites by a combination of airboat (most slough sites) and helicopter (all prairie and some slough locations). Our petition was considered by the ENP Wilderness Committee on Oct 13 (an earlier scheduled meeting was postponed due to hurricane recovery activities in ENP). At the Oct 13 meeting, our access plans were approved, though some minor modifications were required. We received the permit a few weeks later.

2. **Preparation of the sampling plan.** A sampling plan was agreed upon in consultation with Craig Smith, vegetation ecologist at the South Florida Natural Resource Center

(ENP). Our sampling layout consists of five transects. Two transects begin in the eastern prairies, cross the slough, and end in the western prairies, while three others focus on portions of the entire gradient. Sampling locations are to be distributed at intervals of 300-500 meters along each transect, and the entire transect network will be sampled during each 3-year cycle. Several of the transects overlap with vegetation transects sampled by FIU in earlier projects, thus allowing some context for interpretation of vegetation change. The sampling plan, with projected sampling locations, is included as Appendix 1 in this document.

3. **Wet season sampling.** The remainder of this report summarizes the methods, results, and discussion of our sampling experience during the 2005 wet season, when we sampled in Northeast Shark Slough (NESS).

Wet season sampling in 2005

Methods

After some field estimation of site-to-site variation using our proposed sampling methodology, we decided to increase the plot sampling intensity in the slough. For the areas accessible by airboat, we increased the sample from 2 plots per km to 4 plots per km (for slough sites accessible only by helicopter, we retained the proposed sampling interval) (Table 1). The increased sampling intensity will enable us to make a more meaningful comparison of current vegetation with that present along the same transects in 1998-99 (Ross et al. 2001; Ross et al. 2003). The sampling methods utilized in 2005, which are outlined in the Sampling Plan (Appendix 1), go somewhat beyond the methods employed in the earlier study. For instance, structural data collected in 2005 but not in 1998-99 can be used to estimate macrophyte biomass, once allometric regressions have been developed. We also record water depths in each plot; these data may be used to supplement relationships between vegetation and hydrology developed in our earlier work (Ross et al. 2003). The two data sets share a core of compositional information that is suitable for temporal comparison, which we plan to incorporate in our longterm analyses, and do so for some 2005 data below.

Methods for identification of community type along the transects at 5-meter intervals differed from those proposed (Appendix 1) only in the sawgrass types, where we distinguished three classes (tall sawgrass, sawgrass, and sparse sawgrass) instead of the two categories proposed. Our previous work indicates that these three types represent a sequence of increasing flooding duration.

On several of the sampling forays, we were accompanied by a member of Dr. Evelyn Gaiser's South Florida Periphyton Research Group (FIU). Because periphyton is considered to be an excellent indicator of environmental conditions in some south Florida ecosystems (Gaiser et al 2005), we thought it worthwhile to do some exploratory collection that might serve as a linkage between macrophyte and periphyton assemblages. We therefore collected and prepared a small group of samples for analysis at a later date.

Preliminary examination of data suggested that one site in Transect 2 was in bayhead forest, with species components very different from all other sites. Outlier analysis also distinguished this site on the basis of average distance (Bray-Curtis) of each site from all other sites (its average distance was more than 2 standard deviations from the mean). We eliminated the site, and classified the remaining 44 sites by applying agglomerative cluster analysis to species cover data, after eliminating species that occurred in only one plot and relativizing mean species cover values in each plot to the total for all species present therein. Bray-Curtis dissimilarity was used as the distance measure for cluster analysis, and the flexible beta method was used to calculate relatedness among groups and/or individual sites (McCune and Grace 2002). Non-metric multidimensional scaling (NMS) ordination enabled us to visualize relationships among plant communities and sample sites.

Results:

In the slough portions of Transects 1 and 2 we sampled vegetation in 45 plots (Figure 1). In all, 40 macrophyte species were encountered (Table 2). The cluster analysis suggested a separation of species assemblages into three groups (Figure 2). Stress in the ordination of the same data was low (0.06), signifying that species assemblages were well-ordered at the scale of the data set (Figure 3). Group B1 (Sawgrass Marsh) was the most homogeneous of the three groups, and was segregated to the far right in the ordination diagram (Figure 3). This group was composed of *Cladium jamaicense* and little else (Table 3). Group B2 (Sawgrass and others) is dominated by sawgrass, but is not monospecific; the group includes important representation of *Eleocharis cellulosa, Utricularia purpurea, Bacopa caroliniana, Pontederia cordata*, etc (Table 3). Sites are distributed immediately left of Group B1, but exhibit considerable within-group heterogeneity. Finally, the cluster analysis defines a very heterogeneous Group A (Slough), in which the most common species are *Utricularia purpurea* and *Eleocharis cellulosa* (Table 3). Though sites in this group generally experience the longest hydroperiods of the three groups, several short hydroperiod sites and species are also included. We expect that once our sampling network includes more sites, the classification procedure will distinguish several categories within this diverse grouping. .

As described earlier, visual characterizations of marsh vegetation were performed along portions of Transects 1 and 2 in both 1998-99 and 2005. Table 4 provides the frequencies of 5-m segments in various cover classes, as estimated in the field in both years. We simplified the data by eliminating the sparsely distributed Typha and Bayhead Forest types, and created 6 broad cover classes according to the dominant plant species and growth form. These categories can be arranged along a gradient of increasing hydroperiod, as follows: Tall sawgrass/dead sawgrass < Sawgrass < Sparse sawgrass < Spikerush marsh < water lily. For each point, we determined whether its cover class was indicative of more hydric conditions, less hydric conditions, or similar conditions in 2005 in comparison to 1999. On Transect 1 we found that 18.7% of the locations were more hydric, 19.0% were less hydric, and 62.3% hadn't changed during the period, while for Transect 2E these frequencies were 26.2, 14.0, and 59.8%, respectively. The spatial distribution of these changes in NESS suggests a strong east-west gradient, i.e., vegetation on Transect 2E and the western portion of Transect 1 becoming more hydric and sites further east on Transect 1 becoming less so (Figure 4). Application of a chi-square test to the full data set indicated a significant effect of Transect on the probability and direction of change ($p=0.013$). Subsequently, observed frequencies of "wetter" and "drier" vegetation on each transect were tested against the null hypothesis that the overall trend was neutral. Both chi-square and Monte Carlo tests indicated a significant tendency toward more hydric vegetation on Transect 2E ($p=0.03$), but no trend one way or the other for Transect 1.

References

Gaiser, E.E., A. Wachnicka, P.L. Ruiz, and M.S. Ross. 2005. Diatom indicators of ecosystem change in subtropical coastal wetlands. pp. 127-144 In: Estuarine Indicators. S. Bartone, ed. CRC Press. 531 pp.

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Ross, M.S., D.L. Reed, J.P. Sah, P.L. Ruiz, and M.T. Lewin. 2003. Vegetation:environment relationships and water management in Shark Slough, Everglades National Park. Wetlands Ecology and Management 11: 291-303.

Ross, M. S., P. L. Ruiz, D. L. Reed, K. Jayachandran, J. P. Sah, and M. T. Lewin. 2001. Assessment of marsh vegetation responses to hydrological restoration in Shark Slough, Everglades National Park. Final Report *for* Everglades National Park. 43 pp. + 27 figures.

Table 1: GPS coordinates of vegetation sampling points along two transects in Northeast Shark Slough (NESS), 2005

TRANSECT	POINT	X_COORD	Y_COORD
T-1	3500	542466	2839440
T-1	4000	542029	2839683
T-1	4500	541588	2839923
T-1	5000	541150	2840169
T-1	5300	540886	2840314
T-1	5500	540711	2840411
T-1	5800	540448	2840556
T-1	6000	540274	2840652
T-1	6300	540011	2840798
T-1	6500	539836	2840894
T-1	6900	539486	2841088
T-1	7000	539398	2841136
T-1	7300	539136	2841282
T-1	7500	538961	2841379
T-1	7800	538698	2841524
T-1	8000	538523	2841620
T-1	8300	538261	2841766
T-1	8500	538087	2841863
T-1	8800	537823	2842008
T-1	9000	537647	2842105
T-2	0	537477	2838897
T-2	500	537030	2839126
T-2	1000	536584	2839356
T-2	1500	536142	2839586
T-2	2000	535705	2839782
T-2	2500	535251	2840044
T-2	3000	534806	2840275
T-2	3500	534362	2840506
T-2	3800	534096	2840643
T-2	4000	533918	2840738
T-2	4300	533651	2840876
T-2	4500	533475	2840968
T-2	4800	533209	2841105
T-2	5000	533034	2841200
T-2	5500	532587	2841431
T-2	6000	532144	2841662
T-2	6500	531702	2841894
T-2	7000	531259	2842125
T-2	7500	530815	2842356
T-2	8000	530373	2842588
T-2	8500	529929	2842820
T-2	9000	529485	2843050
T-2	9500	529041	2843282
T-2	10000	528599	2843515
T-2	10500	528155	2843743

Table 2: Species recorded in 45 plots in Shark Slough surveyed in 2005

Form	Status	Species	Common Name	CODE
Herb	Native	*Aeschynomene pratensis*	Meadow jointvetch	AESPRA
Tree	Native	*Annona glabra*	Pond Apple	ANNGLA
Herb	Native	*Bacopa caroliniana*	Bacopa	BACCAR
Fern	Native	*Blechnum serrulatum*	Swamp Fern	BLESER
Shrub	Native	*Cephalanthus occidentalis*	Buttonbush	CEPOCC
Tree	Native	*Chrysobalanus icaco*	Cocoplum	CHRICA
Herb	Native	*Cladium jamaicense*	Sawgrass	CLAJAM
Herb	Native	*Crinum americanum*	String-lily	CRIAME
Herb	Native	*Cyperus haspan*	Haspan flatsedge	CYPHAS
Herb	Native	*Cyperus odoratus*	Fragant flatsedge	CYPODO
Herb	Native	*Dichanthelium dichotomum*	Cypress witchgrass	DICDIC
Herb	Native	*Eleocharies cellulosa*	Spikerush	ELECELL
Herb	Native	*Fuirena breviseta*	Saltmarsh umbrellasedge	FUIBRE
Herb	Native	*Hydrolea corymbosa*	Skyflower	HYDCOR
Herb	Native	*Hymenocallis palmeri*	Alligatorlily	HYMPAL
Tree	Native	*Ilex cassine*	Florida holy	ILECAS
Herb	Native	*Justicia angusta*	Watterwillow	JUSANG
Herb	Native	*Leersia hexandra*	Southern cutgrass	LEEHEX
Herb	Native	*Ludwigia alata*	Winged primrosewillow	LUDALA
Herb	Native	*Ludwigia repens*	Creeping primrosewillow	LUDREP
Tree	Exotic	*Melaleuca quinquenervia*	Punktree	MELQUI
Vine	Native	*Mikania scandens*	Climbing hempvine	MIKSCA
Herb	Native	*Mitriola petiolata*	Lax Hornpod	MITPET
Tree	Native	*Myrica cerifera*	Was myrtle	MYRCER
Herb	Native	*Nymphaea odorata*	Waterlily	NYMODO
Herb	Native	*Panicum hemitomon*	Maidencane	PANHEM
Herb	Native	*Panicum tenerum*	Bluejoint panicum	PANTEN
Vine	Native	*Parthenocissus quinquefolia*		PARQUI
Herb	Native	*Paspalidium geminatum*	Kissimmeegrass	PASGEM
Herb	Native	*Peltandra virginica*	Green arrow arum	PELVIR
Tree	Native	*Persea borbonia*		PERBOR
Herb	Native	*Pluchea rosea*		PLUROS
Herb	Native	*Pontederia cordata*	Pickerelweed	PONCOR
Herb	Native	*Potamogeton illinoensis*	pondweed	POTILL
Herb	Native	*Rhynchospora tracyi*	Beaksedge	RHYTRA
Herb	Native	*Sagittaria lancifolia*	Arrowhead	SAGLAN
Tree	Native	*Salix caroliniana*	Willow	SALCAR
Vine	Native	*Sarcostemma clausum*	White twinevien	SARCLA
Herb	Native	*Utricularia foliosa*	Leafy bladderwort	UTRFOL
Herb	Native	*Utricularia purpurea*	Purple bladderwort	UTRPUR

Table 3: Relative cover of the species found in the sites grouped in three vegetation types.

Species	**Species Code**	**(A) Slough**	**(B1) Cladium**	**(B2) Cladium & others**
Aeschynomene pratensis	AESPRA	0.17	0.12	0.04
Bacopa caroliniana	BACCAR	1.96	0.23	3.59
Blechnum serrulatum	BLESER		0.03	
Cephalanthus occidentalis	CEPOCC		0.25	0.00
Cladium jamaicense	CLAJAM	7.76	96.33	63.42
Crinum americanum	CRIAME	0.47	0.14	0.83
Eleocharies cellulosa	ELECEL	30.91	0.74	14.33
Hydrolea corymbosa	HYDCOR			0.04
Hymenocallis palmeri	HYMPAL	0.55	0.06	
Justicia angusta	JUSANG	0.00	0.16	0.13
Leersia hexandra	LEEHEX	0.05		
Nymphaea odorata	NYMODO	5.55	0.04	2.32
Panicum hemitomon	PANHEM	1.09	0.15	0.81
Panicum tenerum	PANTEN	0.05		
Paspalidium geminatum	PASGEM	0.99	0.02	0.04
Peltandra virginica	PELVIR	0.12	0.33	0.04
Pontederia cordata	PONCOR		0.04	3.19
Potamogeton illinoensis	POTILL	0.05		
Rhynchospora microcarpa	RHYMIC			0.00
Rhynchospora tracyi	RHYTRA	0.52	0.00	0.04
Sagittaria lancifolia	SAGLAN	0.74	0.15	
Utricularia foliosa	UTRFOL	0.35	0.27	2.25
Utricularia purpurea	UTRPUR	48.66	0.92	8.91

Table 4: Frequency of 5-m segments in several cover classes along Transects 1 and 2E in Northeast Shark Slough in 2000 and 2005.

Transect	Community	# of Observations 2000	# of Observations 2005
T1	Water Lilly	0	17
	Spikerush Marsh	87	66
	Spikerush Marsh & Melaleuca	11	0
	Sparse Sawgrass & Water Lilly	0	4
	Sparse Sawgrass	35	124
	Sparse Sawgrass & Melaleuca	0	6
	Sawgrass	585	430
	Sawgrass & Melaleuca	8	11
	Tall Sawgrass	71	121
	Tall & Dead Sawgrass	0	22
	Dead Sawgrass	4	0
T2	Cattail	1	1
	Water Lilly	0	32
	Spikerush Marsh & Water Lilly	0	3
	Spikerush Marsh	22	27
	Sparse Sawgrass	50	35
	Sawgrass	170	130
	Tall Sawgrass	31	45
	Bayhead Swamp	7	8

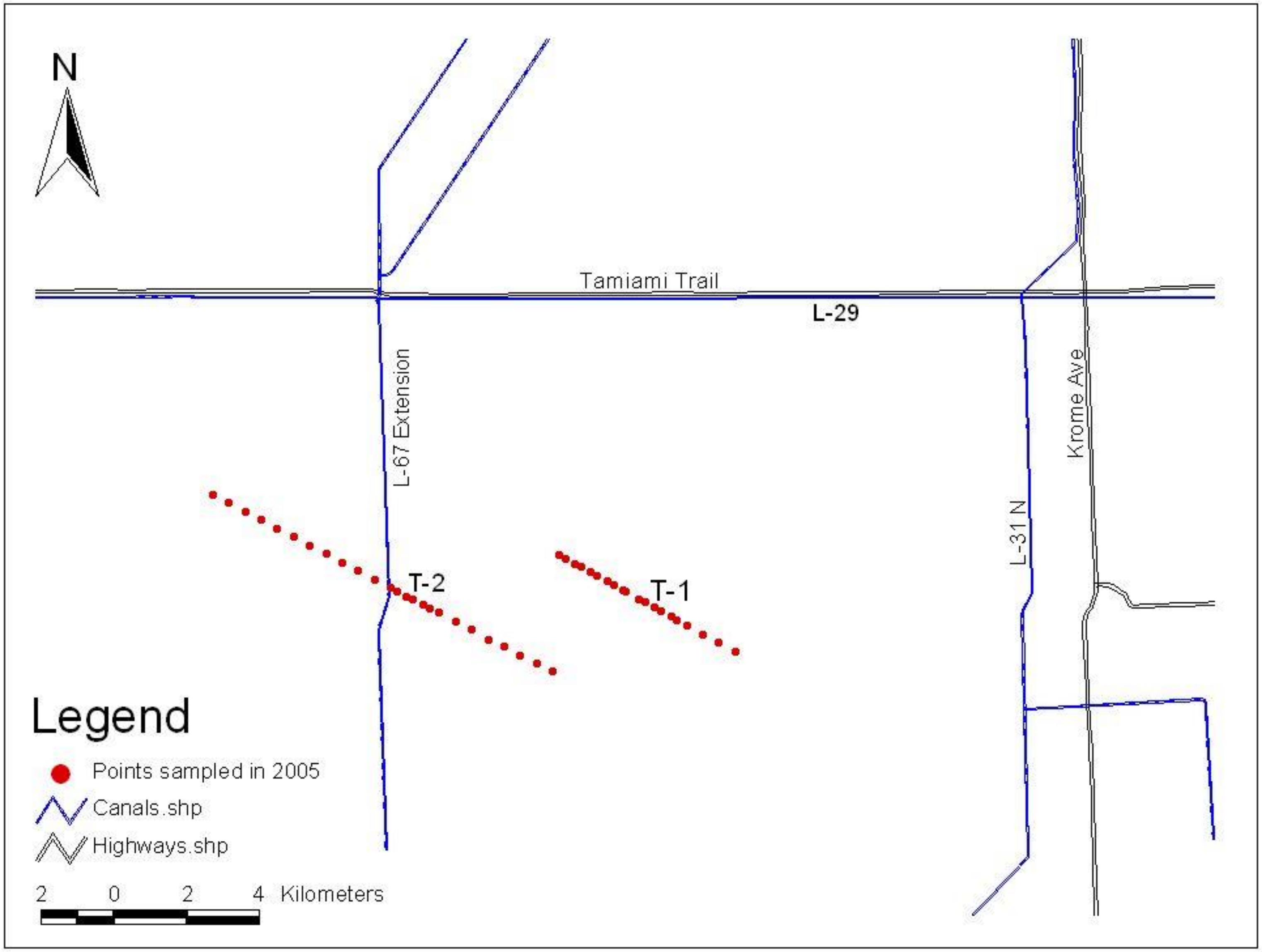

Figure 1: Location of vegetation sampling points along two transects in Northeast Shark Slough (NESS), 2005.

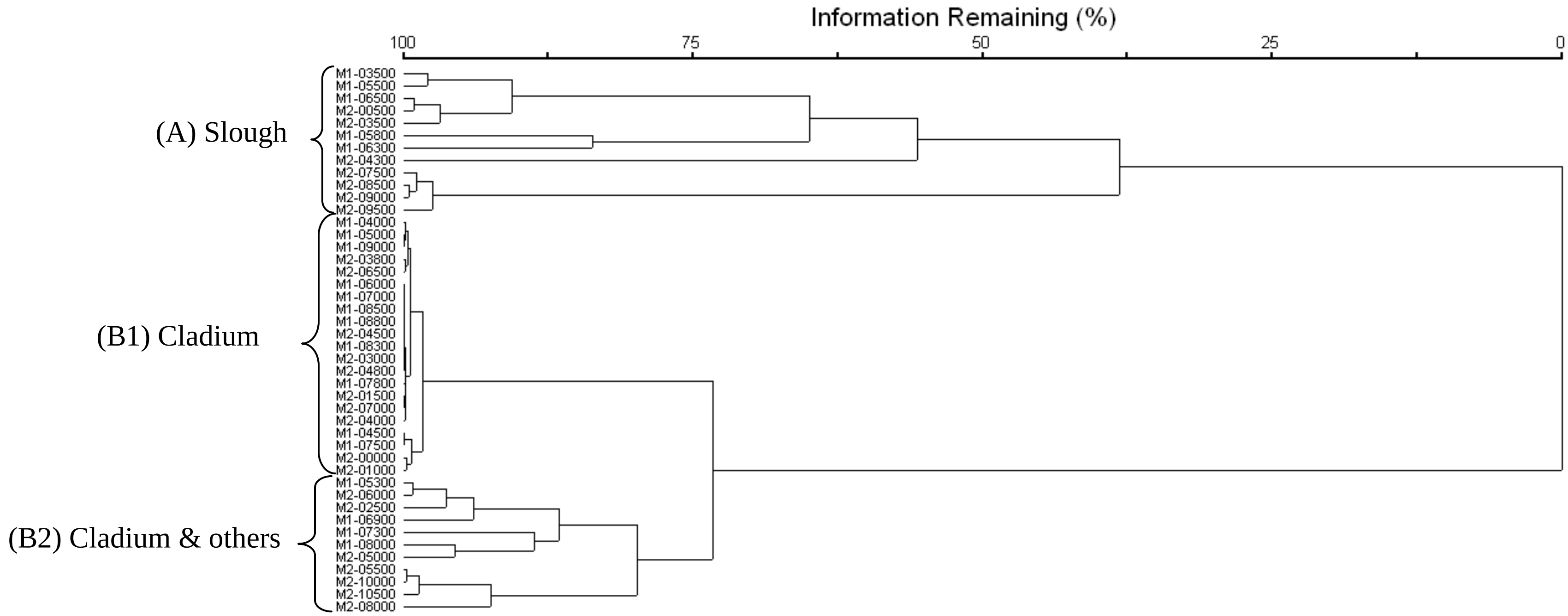

Figure 2: Vegetation types identified through cluster analysis of species cover values at 44 sites along two MAP transects sampled in 2005. Information remaining (%) is based on Wishart's objective function, following McCune and Grace (2002)

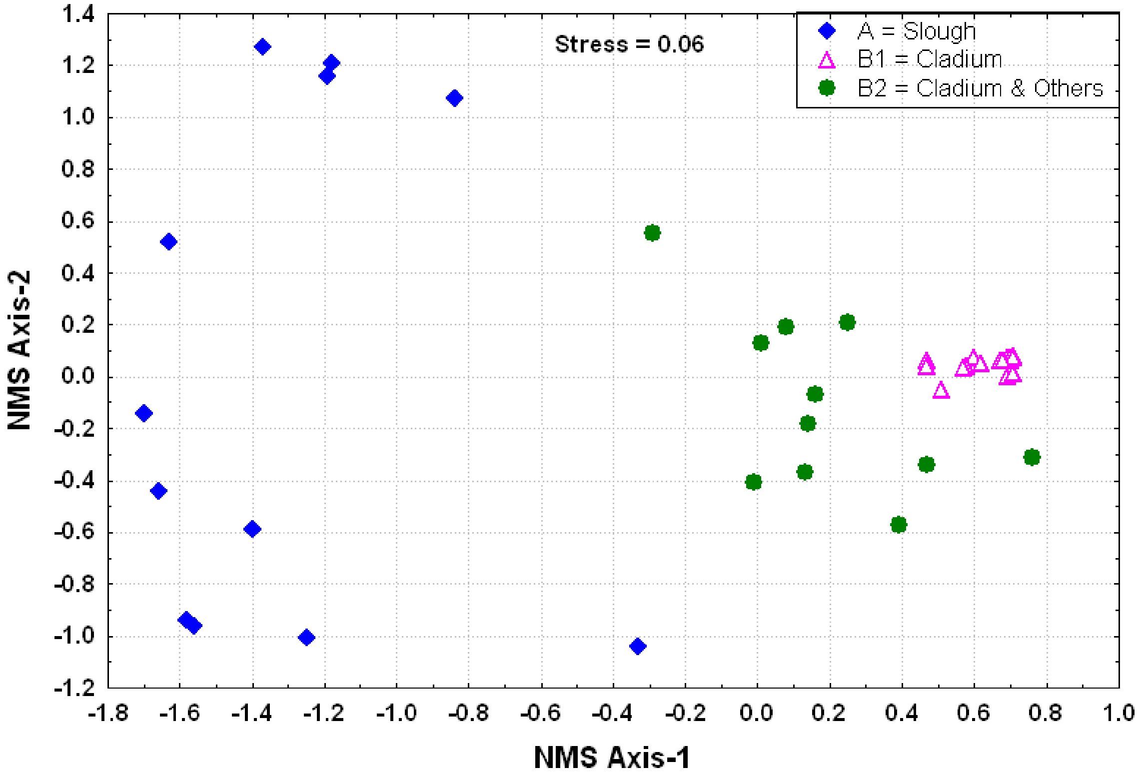

Figure 3: Site scores from 2-axis non-metric multidimensional scaling (NMS) ordination, based on relative cover at 44 sites on two MAP transects sampled in 2005. Vegetation groups are based on Cluster analysis.

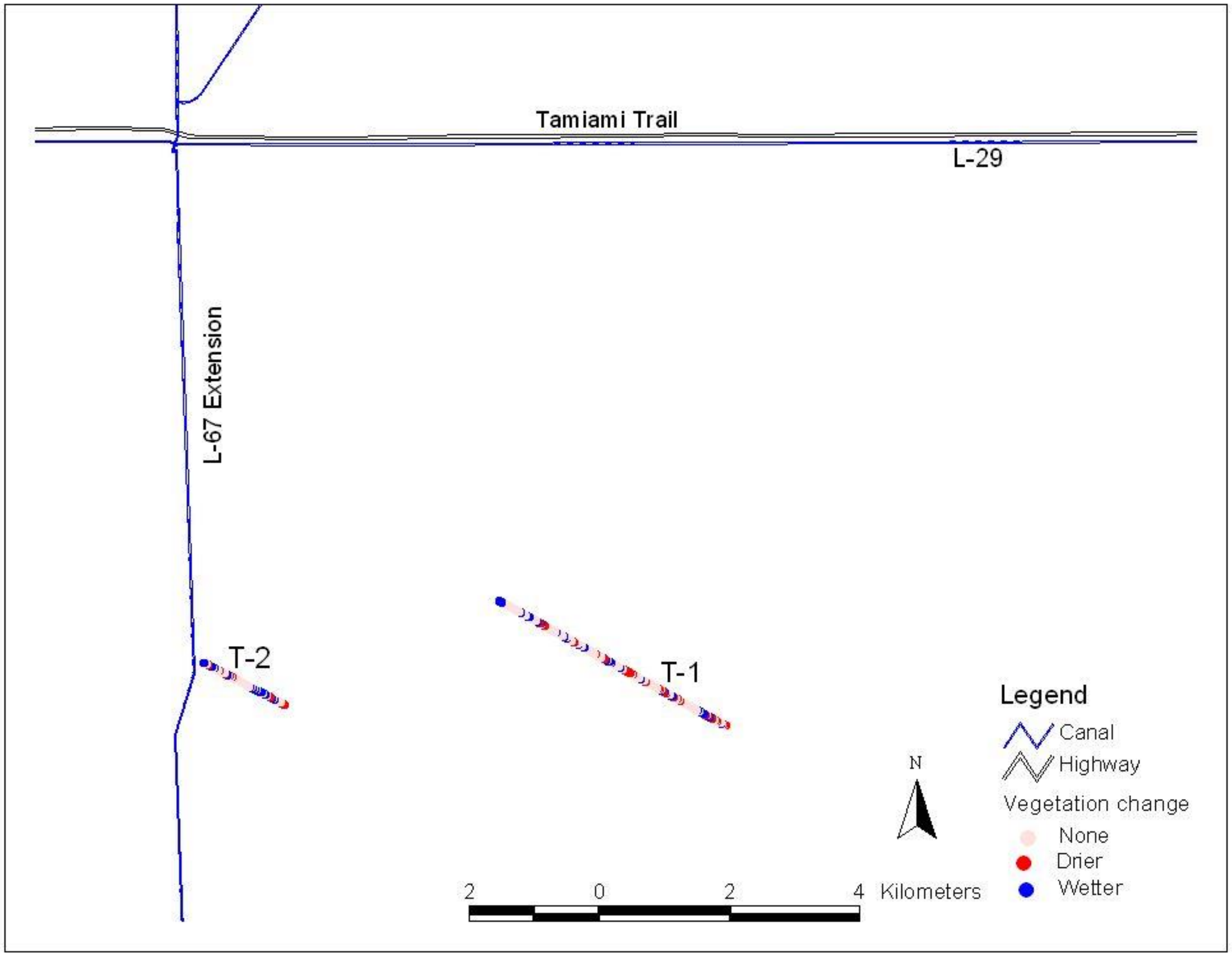

Figure 4: Change in hydrologic affinity of vegetation along two transects in NESS from 1999 to 2005.

Appendix-1

MAP Activity Title: Marl Prairie/Slough Gradients; Patterns and trends in Shark Slough and Marl Prairies

Detailed Scope of Work

Transect locations and sampling frequency

We will establish 5 transects in Everglades Park in order to monitor the position of the marl prairie – Shark Slough gradient, as well as the composition and structure of vegetation along it. Monitoring will include (1) sampling of vegetation composition and structure at fixed points along the transects, and (2) delineation of broad vegetation units in the wetlands intercepted by the transects. The entire transect network will be sampled within a three year cycle, with Shark Slough portions visited during the wet season and marl prairie portions during the dry season, to facilitate vegetation observation. The transect network illustrated in Figure 1 encompasses approximately 86 km. Transects 1 and 2 will be sampled in Year 1, Transect 3 in Year 2, and Transect 4 and 5 in Year 3.

Sampling methods

Plots will be established at 500 m intervals within the Slough landscape (101 points) and at 300 m intervals in the Prairie landscape (122 points) (Table 1). A nested plot design will be used to efficiently sample the range of plant growth forms present along the transects. At each station, a PVC or aluminum tube will be driven into the sediment to mark the SE corner of both a 10 x 10 meter tree plot and a 5 x 5 meter shrub/herb plot. In the tree plot, we will measure the DBH, crown length and width of any woody individuals ≥ 5 cm DBH, then calculate species cover assuming elliptical crown form. In the shrub/herb plot, we will estimate the cover class of each species of shrub (vines and woody stems ≥ 1m height and < 5cm DBH), using the following categories: < 1%, 1-4%, 4-16%, 16-33%, 33-66%, and > 66%. Species cover % of herbs and woody plants < 1 m height will be estimated in five 1-m^2 subplots located at the corners and center of the 5 x 5 m plot. Species present in the 5 x 5 m plot but not found in any of the subplots will be assigned a mean cover of 0.01%. We will also estimate herb biomass by assessing a suite of structural parameters in a 0.25 m^2 quadrat in the SE corner of each of the 5 herb subplots (see methods in Ross et al. 2003), and applying biomass regressions currently being developed.

In addition to the plot-based estimates of species composition, we will also assess the vegetation visually along the transects, noting the precise locations (nearest 5 m) of boundaries between broad vegetation categories. The Prairie portions will be accessed by foot, but the Slough portions require airboat access. We will assign Shark Slough vegetation to one of seven cover types: aquatic slough, spikerush marsh, sparse sawgrass, tall sawgrass, bayhead swamp, cattail marsh, and dead sawgrass/open water. Marl prairie vegetation will be assigned to several groupings of 9 cover types defined in Ross et al. (2004).

Literature Cited

Ross, MS, JP Sah, PL Ruiz, DT Jones, H Cooley, R Travieso, JR Snyder & C Schaeffer. 2003. Effect of hydrological restoration on the habitat of the Cape Sable seaside sparrow: annual report of 2003-2004. http://www.fiu.edu/~serp1/projects/capesable/2003_CSSS_Annual_Report.pdf

Ross, MS, JP Sah, PL Ruiz, DT Jones, H Cooley, R Travieso, JR Snyder & S Robinson. 2004. Effect of hydrological restoration on the habitat of the Cape Sable seaside sparrow: annual report of 2003-2004. http://www.fiu.edu/~serp1/projects/capesable/2004_CSSS_Annual_Report.pdf

Table 1: Coordinates (UTM17N) of proposed sampling transects.

TRANSECT	POINT	X_COORD	Y_COORD
T1	0	545351	2837847
T1	300	545088	2837992
T1	600	544826	2838137
T1	900	544563	2838282
T1	1200	544301	2838427
T1	1500	544038	2838573
T1	1800	543775	2838718
T1	2100	543513	2838863
T1	2400	543250	2839008
T1	2700	542988	2839153
T1	3000	542725	2839298
T1	3500	542463	2839443
T1	4000	542025	2839685
T1	4500	541587	2839927
T1	5000	541150	2840169
T1	5500	540712	2840411
T1	6000	540274	2840652
T1	6500	539837	2840894
T1	7000	539399	2841136
T1	7500	538962	2841378
T1	8000	538524	2841620
T1	8500	538086	2841862
T1	9000	537649	2842103
T2	0	537477	2838896
T2	500	537032	2839126
T2	1000	536587	2839356
T2	1500	536142	2839586
T2	2000	535697	2839816
T2	2500	535252	2840046
T2	3000	534807	2840276
T2	3500	534362	2840506
T2	4000	533918	2840738
T2	4500	533475	2840968
T2	5000	533031	2841199
T2	5500	532587	2841431
T2	6000	532144	2841662
T2	6500	531702	2841894
T2	7000	531259	2842125
T2	7500	530815	2842356
T2	8000	530373	2842588
T2	8500	529929	2842820
T2	9000	529485	2843050
T2	9500	529041	2843282
T2	10000	528599	2843515

TRANSECT	POINT	X_COORD	Y_COORD
T2	10500	528155	2843743
T3	0	542581	2825474
T3	300	542283	2825447
T3	600	541984	2825420
T3	900	541685	2825392
T3	1200	541387	2825365
T3	1500	541088	2825337
T3	1800	540789	2825310
T3	2100	540491	2825283
T3	2400	540192	2825256
T3	2700	539893	2825228
T3	3000	539594	2825201
T3	3300	539295	2825173
T3	3600	539085	2825387
T3	3900	538874	2825602
T3	4200	538664	2825816
T3	4500	538454	2826030
T3	4800	538243	2826244
T3	5100	538033	2826458
T3	5400	537822	2826672
T3	5700	537612	2826886
T3	6000	537402	2827100
T3	6300	537191	2827314
T3	6600	536981	2827528
T3	6900	536770	2827742
T3	7200	536560	2827956
T3	7500	536350	2828170
T3	7800	536139	2828385
T3	8100	535929	2828599
T3	8400	535718	2828813
T3	8700	535508	2829027
T3	9000	535298	2829241
T3	9300	535087	2829455
T3	9600	534877	2829669
T3	9900	534666	2829883
T3	10200	534456	2830097
T3	10500	534246	2830311
T3	10800	534035	2830525
T3	11100	533825	2830739
T3	11500	533544	2831025
T3	12000	533139	2831318
T3	12500	532734	2831610
T3	13000	532328	2831903
T3	13500	531923	2832196
T3	14000	531517	2832488

TRANSECT	POINT	X_COORD	Y_COORD
T3	14500	531112	2832781
T3	15000	530707	2833074
T3	15500	530301	2833366
T3	16000	529896	2833659
T3	16500	529490	2833952
T3	17000	529166	2834186
T3	17500	528680	2834538
T3	18000	528276	2834831
T3	18500	527870	2835124
T3	19000	527464	2835417
T3	19500	527060	2835710
T3	20000	526654	2836003
T3	20500	526249	2836296
T3	21000	525845	2836589
T3	21500	525440	2836882
T3	22000	525035	2837175
T3	22500	524630	2837469
T3	23000	524225	2837762
T3	23500	523820	2838055
T3	24000	523415	2838348
T3	24500	523010	2838642
T3	25000	522605	2838935
T3	25500	522201	2839228
T3	26000	521796	2839521
T3	26500	521391	2839815
T3	27000	520986	2840108
T3	27500	520567	2840372
T3	28000	520089	2840521
T3	28500	519612	2840669
T3	29000	519134	2840818
T3	29500	518657	2840967
T3	30000	518180	2841115
T3	30500	517702	2841264
T3	31000	517265	2841400
T3	31300	516965	2841400
T3	31600	516665	2841400
T3	31900	516365	2841400
T3	32200	516065	2841400
T3	32500	515765	2841400
T3	32800	515465	2841400
T3	33100	515165	2841400
T3	33400	514865	2841400
T3	33700	514565	2841400
T3	34000	514264	2841400
T3	34300	513965	2841400

TRANSECT	POINT	X_COORD	Y_COORD
T3	34600	513665	2841400
T3	34900	513365	2841400
T3	35200	513065	2841400
T3	35500	512765	2841400
T3	35800	512465	2841400
T4	0	523908	2808668
T4	300	523697	2808881
T4	700	523408	2809176
T4	1100	523132	2809448
T4	1400	522921	2809661
T4	1700	522709	2809873
T4	2100	522421	2810163
T4	2500	522138	2810446
T4	2800	521926	2810658
T4	3100	521714	2810870
T4	2500	521431	2811153
T4	3900	521148	2811436
T4	4200	520936	2811648
T4	4500	520724	2811860
T4	4900	520436	2812172
T4	5200	520230	2812380
T4	5500	520031	2812604
T4	6000	519700	2812978
T4	6500	519368	2813353
T4	7000	519062	2813701
T4	7500	518731	2814085
T4	8000	518408	2814454
T4	8500	518077	2814842
T4	9000	517759	2815214
T4	9500	517434	2815599
T4	10000	517096	2815978
T4	10500	516778	2816352
T4	11000	516451	2816727
T4	11500	516123	2817109
T4	12000	515798	2817489
T4	12500	515472	2817868
T4	13000	515146	2818247
T4	13500	514820	2818626
T4	14000	514494	2819005
T4	14500	514168	2819384
T4	15000	513842	2819764
T4	15500	513515	2820143
T4	16000	513189	2820519
T4	16500	512855	2820896
T4	17000	512537	2821281

TRANSECT	POINT	X_COORD	Y_COORD
T4	17500	512205	2821660
T4	18000	511882	2822043
T4	18500	511552	2822412
T4	18900	511318	2822732
T4	19200	511195	2822992
T4	19600	510922	2823284
T4	19900	510716	2823503
T4	20200	510511	2823722
T4	20600	510217	2824036
T4	21000	509939	2824324
T4	21300	509731	2824539
T4	21600	509522	2824755
T4	22000	509224	2825064
T5	0	515992	2799188
T5	300	516283	2799261
T5	600	516575	2799333
T5	900	516866	2799406
T5	1200	517157	2799478
T5	1500	517448	2799551
T5	1800	517740	2799623
T5	2100	518031	2799696
T5	2400	518322	2799768
T5	2700	518613	2799841
T5	3000	518905	2799914
T5	3300	519196	2799986
T5	3600	519487	2800059
T5	3900	519778	2800131
T5	4200	520070	2800204
T5	4500	520361	2800276
T5	4800	520652	2800349
T5	5100	520943	2800421
T5	5400	521237	2800493
T5	5700	521526	2800564
T5	6000	521817	2800635
T5	6300	522111	2800706
T5	6600	522403	2800775
T5	6900	522693	2800848
T5	7200	522983	2800919
T5	7500	523274	2800991
T5	7800	523567	2801064
T5	8100	523858	2801134
T5	8400	524150	2801206
T5	8700	524441	2801277
T5	9000	524733	2801349

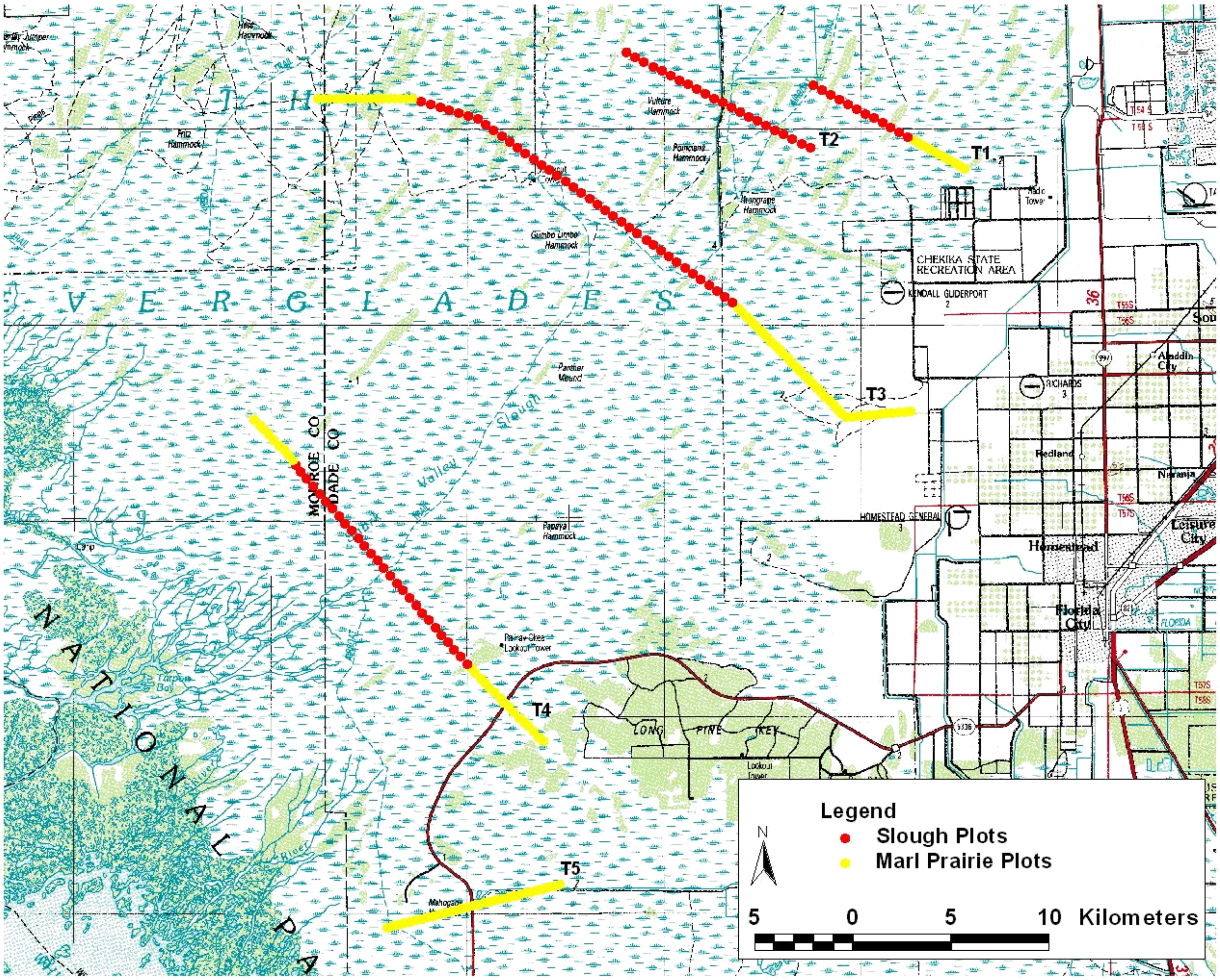

Figure 1: Location of proposed sampling transects