TECHNICAL PUBLICATION

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Vegetation Mapping (1998-2006) and Field Surveys (1995-2006) in the Everglades Agricultural Area Stormwater Treatment Areas

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ABSTRACT

The primary objective of this technical publication is to compile information from STA vegetation maps made from 1998 to 2006. A secondary goal is to assess the comparability of vegetation areal coverage derived from field surveys conducted at a network of sites within each STA with areal coverages based on vegetation maps.

Summary vegetation maps revealed changes in STA plant communities, but there are too few maps to elucidate any long-term temporal or spatial patterns. Collectively, 123 plant taxa were identified in the STAs from 1995 to 2006. Plant taxa richness was strongly correlated with the sampling effort in each STA. Analysis indicated that field surveys are not adequate substitutes for mapping if the objective is to estimate vegetation areal coverage.

1.0 INTRODUCTION

The South Florida Water Management District (District or SFWMD) and the U.S. Army Corps of Engineers have built six large treatment wetlands, referred to as Stormwater Treatment Wetlands (STAs), in the Everglades Agricultural Area (EAA) (**Figure 1**) as part of a State and Federal initiative to protect the Everglades (Chimney and Goforth, 2001; Sklar et al., 2005). These treatment wetlands are intended to reduce high phosphorus concentrations in surface runoff coming from the EAA before this water reaches the northern portion of the present-day Everglades, i.e., the Water Conservations Areas. Each STA is subdivided into a number of treatment cells by interior levees (**Figure 2**). Detailed descriptions of the STAs can be found in past volumes of the District's annual Everglades Consolidated Report and South Florida Environmental Report[1].

Treatment wetlands reduce the concentration of water-borne pollutants through natural biogeochemical processes (Kadlec and Wallace, 2009). Wetland biogeochemistry, in turn, is intimately associated with the extent and condition of the wetland's vegetation community (Reddy and DeLaune, 2009). Because of the important relationship between wetland treatment performance and vegetation, the vegetation communities in the STAs have been monitored throughout their operational histories. This effort was mandated as a condition of STA operating permits and by the Process Development and Engineering section of the District's Long Term Plan (Burns & McDonnell, 2003).

The vegetation communities in the STAs have been monitored using two different approaches: (1) vegetation maps were prepared for each STA based on the spatial distribution of different vegetation types interpreted from aerial photographs and (2) field surveys were conducted at a network of sites within each wetland to catalog plant taxa and assess vegetation areal coverage of the dominant taxa. The field-survey program was initiated as a cost-effective alternative to mapping for characterizing the plant community. The primary objective of this technical publication is to compile information from STA vegetation maps made from 1998 to 2006 into a single document. A secondary goal is to assess the comparability of vegetation areal coverage derived from field surveys with areal coverages based on vegetation maps, i.e., can field surveys as they were implemented provide areal coverage information comparable to areal coverage estimates derived from vegetation maps. An analysis of the potential relationship between changes in the plant community and STA treatment performance is beyond the scope of this report.

2.0 METHODS

2.1 Vegetation Maps

A series of aerial photographs was taken of each STA at a scale of 1:6,000 on a number of overflights using high-contrast large-format infrared film. The photographs from each overflight were digitized to generate electronic images. These images were then rectified to surveyed Global Positioning System (GPS) control points and combined into a photo-mosaic suitable for use as a Geographic Information System (GIS) background image. Vegetation was classified into distinct "vegetation types" through interpretation of the infrared signatures on the electronic image and verified by ground-truth field surveys as needed. Some vegetation types represented a single plant taxa (e.g., sawgrass, cattail), while others included a mixture of taxa (e.g., misc.

[1] https://my.sfwmd.gov/portal/page/portal/pg_grp_sfwmd_sfer/pg_sfwmd_sfer_prevreport

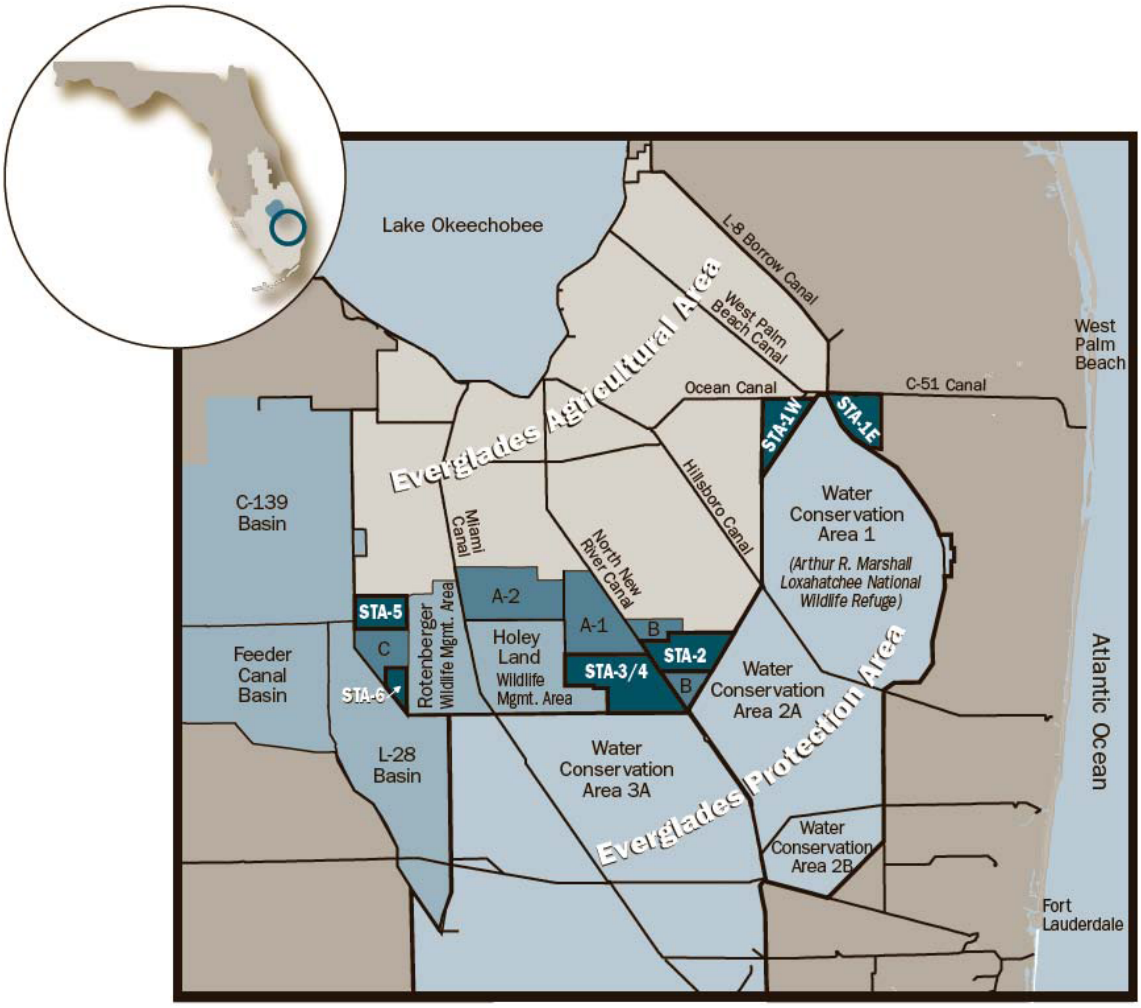

Figure 1. Location of the Everglades Agricultural Area Stormwater Treatment Areas (STA-1E, STA-1W, STA-2, STA-3/4, STA-5 and STA-6) in relation to other landscape features in south Florida.

grasses, broadleaf emergents). Vegetation maps were prepared using ArcView® or ArcGIS® software in which polygons for each vegetation type were coded with a unique color and pattern. The vegetation type assigned to a given polygon represented the dominant infrared signature (≥ 50% areal coverage) for that area. A minimum mapping unit of 400 to 625 m^2 was employed for all maps. The total areal coverage of each vegetation type was derived by summing the areas of like polygons. Vegetation maps were prepared by several different consulting firms under contract to the District. No inter- or intra-contractor mapping calibrations were performed.

2.2 Vegetation Field Surveys

Field surveys were conducted from 2003 to 2006 to monitor the plant community at a network of geo-referenced sites that had been established in the STAs for other District sampling programs. These sites, referred to as the "original sites", were arranged in a grid pattern with nominal 1,350-ft spacing between sites (**Appendix 1**). Additional geo-referenced sites, referred to as "added sites", were established specifically for vegetation sampling and complemented the

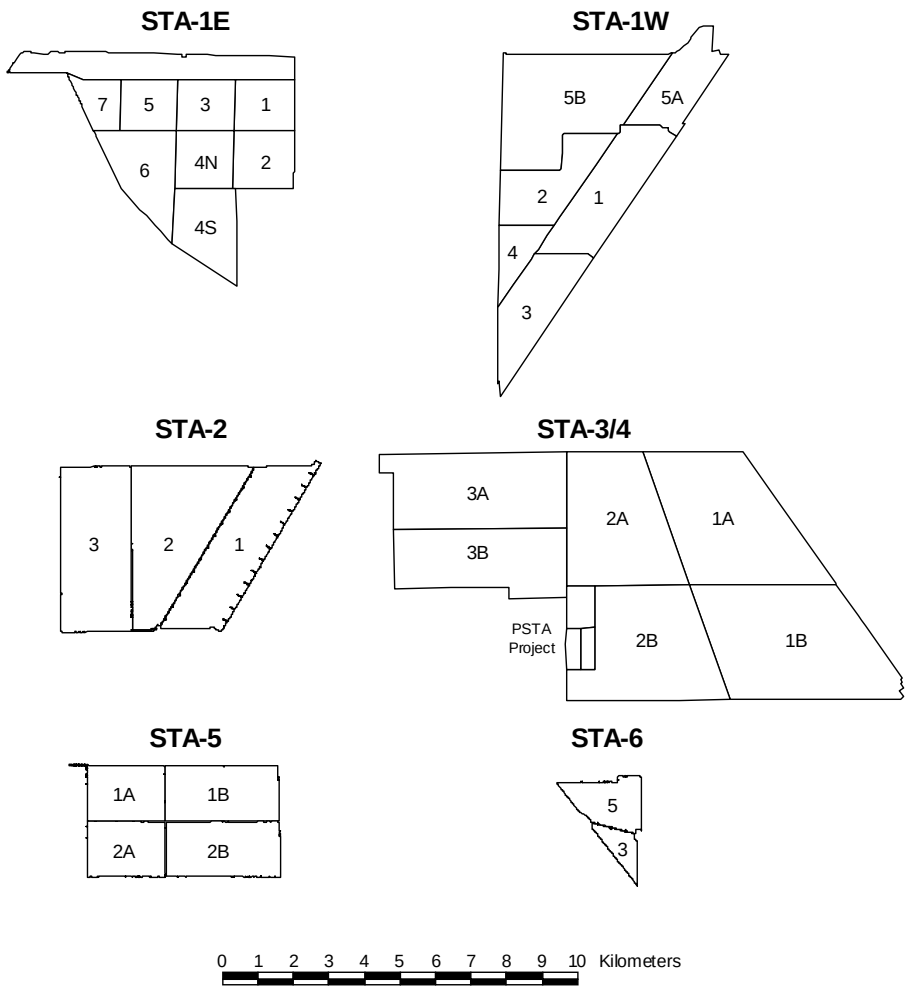

Figure 2. Arrangement of treatment cells within the STAs. The STAs are drawn to scale and shown as they were configured up through 2006.

original sites in Cells 4N, 5 and 6 of STA-1E, Cells 2 and 4 of STA-1W and Cells 1 and 2 of STA-2. All sites were situated within the marsh; the interior levees separating the treatment cells were not surveyed. Sites were located in the field by their GPS coordinates.

Three different census methods were used to conduct field surveys in the STAs. The surveys in 2003 employed a 1-m^2 quadrat constructed from ½ in PVC pipe (**Figure 3**, Panels A & B). The quadrat was haphazardly tossed out into marsh at each site. The percent areal coverage of each plant taxa within the quadrat was estimated (usually in 5% increments) by a single observer. One quadrat was evaluated per site. Total areal coverage for all plant taxa (including a category for "open water") always summed to 100%. In 2004 and 2005, a 5-m section of ½-inch PVC pipe fitted with 10 foam floats spaced at 0.5-m intervals along the length of the pipe, hereafter referred to as a "pole transect", was used to assess areal coverage (**Figure 3**, Panels C & D). One field technician entered the water facing north at each site and positioned the pole transect immediately to his/her right oriented in an east-west direction. A second field technician then moved along the length of the pole transect and estimated the areal coverage of all plant taxa (including a category for "open water") at each of the 10 floats. In 2004, the dominant taxa (i.e.,

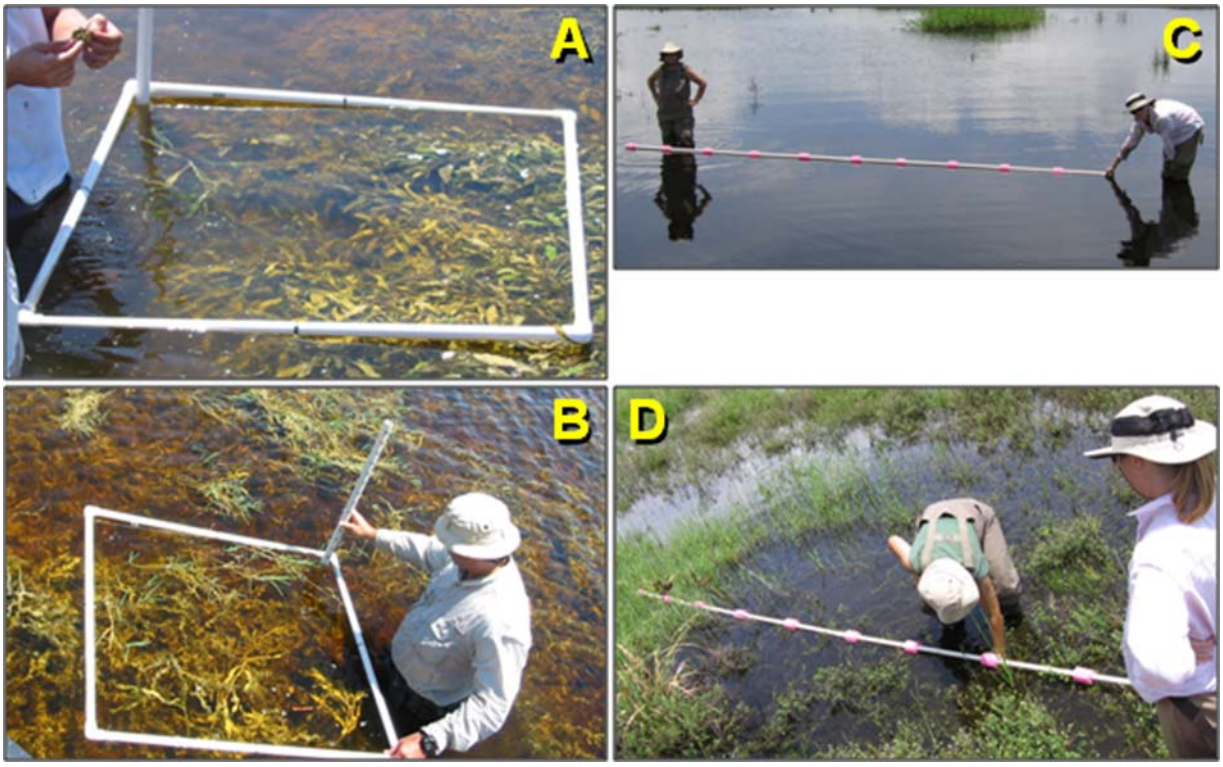

Figure 3. Sampling equipment used to conduct vegetation field surveys in the STAs. Panels A & B: 1-m^2 quadrat; Panels C & D: 5-m pole transect.

the taxa with the greatest areal coverage) and three sub-dominant taxa (i.e., the taxa with the next three highest areal coverages) were recorded at each float location, while in 2005 only the dominant and one sub-dominant taxa were recorded. One pole transect was evaluated per site in both years. In 2006, an observer positioned at the bow of the boat examined the plant community within an area defined by an arc with a radius of approximately 3-m that extended out from the bow; this survey method is hereafter referred to as a "boat-survey". The areal coverage of all plant taxa within each boat-survey were recorded using a simple three-point ordinal scale: "1" indicated taxa presence up to 33.3% areal coverage, "2" indicated taxa presence from 33.3% up to 66.6% areal coverage and "3" indicated taxa presence of 66.6% or greater areal coverage. One boat-survey was conducted per site. Plant taxa not found at a particular site were assigned an areal coverage value of zero in the site × taxa data matrix prepared for each sampling date. Field surveys were conducted by two different consulting firms under contract to the District. No inter-contractor or inter-census method calibrations were performed.

A separate program of field surveys was conducted to monitor SAV at a network of georeferenced sites in the PSTA Implementation Project cells located in Cell 2B of STA-3/4 (**Appendix Figure 1-4**; Burns & McDonnell, 2003; Pietro *et al.*, 2008). SAV areal coverage at these sites was evaluated using the boat-survey method.

A supplemental list of plant taxa was compiled by a graduate-level botany class from Florida Atlantic University during a field survey of Cell 1 of the Everglades Nutrient Removal Project

(ENRP)[2] in June 1995. Vegetation areal coverage was not estimated at this time and access to the wetland was restricted to travel along the interior levees.

2.3 Data Analysis

The vegetation classification scheme used to map each of the STAs varied from map to map (see **Appendices 2** to **7**). For example, the 2005 vegetation map for STA-1E identified 37 different vegetation types, 11 of which represented cattail or cattail mixed with other plant taxa, while the 2006 map for this STA had only nine vegetation types with one type for cattail. Over the years, 73 different vegetation types were defined for the STAs. The symbology (pattern and color) used to represent each vegetation type also varied from map to map. Because of these map-to-map differences and the large number of vegetation types, a simple higher-order classification scheme was used to summarize the vegetation mapping data; each vegetation type was assigned to one of five groups: cattail, other emergent aquatic vegetation (EAV), floating aquatic vegetation (FAV), submersed aquatic vegetation–open water (SAV-OW) or "other". The "other" category included vegetation types such as "treated areas", "upland", "barren", "spoil" and areas that experienced dry-out. These groups are consistent with how the District traditionally has summarized STA vegetation coverage. The areal coverages of vegetation groups in individual vegetation maps were compared to the areal coverages of vegetation groups derived from corresponding field surveys using chi-square analyses (SAS Proc Table; SAS v9.1, SAS Institute, Inc., Cary, NC). Analyses were restricted to the nine cases where the STA was mapped and field surveys were conducted in all treatment cells: STA-2, STA-5 and STA-6 in 2003 and all the STAs in 2006.

3.0 RESULTS AND DISCUSSION

3.1 Vegetation Maps

The operating permit for each STA required that a baseline vegetation map be generated after the facility became operational. Baseline vegetation maps were prepared in 1998 for STA-6, 2001 for STA-5, 2002 for STA-1W, 2003 for STA-2 and 2005 for STA-1E and STA-3/4. The STAs were mapped at varying intervals in the years after the baseline map; all the STAs were mapped in 2005 and 2006 (**Table 1**)[3]. The original vegetation maps produced by the contractors together with summary tables of areal coverage for all vegetation types are provided in **Appendices 2** through **7**. Summary vegetation maps based on the higher-order classification scheme described above together with the percent areal coverage of each vegetation group for the entire STA are shown in **Figure 4**[4]. The percent areal coverage for vegetation groups within individual treatment cells for each map is summarized in **Appendix 8**.

The STAs were not mapped at the same frequency: STA-5 and STA-6 were mapped four times, STA-1W and STA-2 were mapped three times and STA-1E and STA-3/4 were mapped only twice (**Table 1**). Because areal coverage data were not available for the 1998 STA-6 vegetation map, a corresponding summary vegetation map could not be made (see **Figure 4**). The

[2] The ENRP was the District's demonstration treatment wetland that operated from 1993 through 1999 when it was incorporated into the footprint of STA-1W (Guardo et al., 1995; Chimney and Goforth, 2006).

[3] Vegetation in the ENRP was mapped 12 times, either quarterly or semi-annually, from 1993 through 1998. These data have been summarized in Chimney et al. (2000) and are not included in this report.

[4] The areal coverage associated with the "shrub" group listed in **Appendices 2** to **7** was combined with the EAV group areal coverage in the preparation of **Figure 4**.

baseline vegetation map for each STA was prepared only after the plant community had become well established. As a result, the initial grow-in of cattail and EAV was not always documented, although expansion of cattail is apparent in STA-1E and STA-5 (**Figure 4**). Examination of the summary vegetation maps revealed other changes in STA plant communities noted below, but there are too few maps to elucidate any long-term temporal or spatial patterns. The reduction of FAV areal coverage in STA-1W, STA-3/4 and STA-5 was attributed to the District's vegetation management program that has actively controlled these taxa in the STAs. The increase in areal coverage of "other" in 2006 compared to previous years resulted from the purposeful lowering of water levels for STA enhancement or vegetation rehabilitation projects (i.e., in STA-1W Cell 5B and STA-3/4 Cell 3B; see Pietro *et al*., 2007 for a description of these projects) or unintentional dry-out resulting from a severe regional drought (i.e., in STA-5 Cells 1A, 2A and 2B and STA-3/4 Cell 1B).

Table 1. Schedule of vegetation mapping and field surveys in the STAs from 1998 to 2006. Shaded table cells indicate years when vegetation maps were prepared, while annotations within table cells indicate the year and location (treatment cells) of field surveys.

	STA-1E	STA-1W	STA-2	STA-3/4	STA-5	STA-6
1998						
1999						
2000						
2001						
2002						
2003		1,2,3,4	all cells		all cells	all cells
2004		all cells	all cells		all cells	all cells
2005	all cells	all cells	all cells	all cells	all cells	all cells
2006	4N,5,6	2B,4,5B		PSTA	2A,2B	

Not all differences between summary vegetation maps necessarily correspond to changes in the plant community. For example, the 2005 map of STA-6 shows areas of cattail at the east end of Cell 5, while the 2006 map indicates that all the cattail had been replaced by EAV (see red ovals on STA-6 maps in **Figure 4**). A more reasonable explanation for this difference is that the photo-interpreter of each map differed in how they classified the polygons in question rather than a complete replacement of cattail by other taxa. Undoubtedly, some of the differences between summary vegetation maps for the other STAs can be ascribed to variability in photo interpretation of what was actually the same vegetation type, while other differences reflect real taxa shifts. An analysis of such mapping inconsistencies is beyond the scope of this report.

Because water absorbs virtually all of the infrared portion of incident sunlight (Wetzel, 2001), the water column was usually opaque to the infrared film used to photograph the STAs. This made it impossible for the photo-interpreters to discriminate areas with SAV from open water areas with any consistency (hence the use of the SAV-OW vegetation type). A feasibility study that assessed using hyperspectral imaging to map the STAs (SAIC, 2002) suggested that SAV could be detected beneath the water surface by this technology (see Figure 6-6 in **Appendix 9**). However, the District has not pursued hyperspectral imaging for use in the STAs.

3.2 Vegetation Field Surveys

The spatial density of the original-site network varied among STAs; the lowest site density was in STA-2 (45 ac/site or 0.022 sites/ac), while the highest site density was in STA-6 (28 ac/site or 0.036 sites/ac; **Table 2**). All the original and added sites in STA-1W (discounting the one original site that was located on the levee between Cells 1 and 2), STA-5 and STA-6 were surveyed at least once (**Appendix Figures 1-1** to **1-6**). Fifteen original sites in STA-2 Cell 2 were not surveyed because this cell was being used by the U.S. Army Corps of Engineers for a nutrient-removal demonstration project. Fifty-six original sites in STA-2 were inaccessible due to the presence of standing timber that prevented boat travel and were not surveyed. The majority of original sites in STA-3/4 (316 of 399) were not surveyed. The number of sites in the network that were surveyed during a given year ranged from a low of 21% of sites in STA-3/4 to a high of 100% of sites in STA-5 and 6 (**Table 2**). The number of inaccessible sites increased in 2006 due to low water levels in the STAs caused by the regional drought, which impeded boat travel.

Collectively, 123 plant taxa were identified in the STAs from 1995 to 2006 (**Appendix 10**). Eighty percent of these taxa (98 taxa) are classified as being obligate wetland, facultative wetland or facultative taxa, 27% (33 taxa) are non-native to Florida and 80% (99 taxa) can grow as perennials. Taxa richness ranged from 22 taxa in STA-6, 26 taxa in STA-1E, 27 taxa in STA-2, 41 taxa in STA-3/4 and STA-5 and 104 taxa in STA-1W. The high number of taxa found in STA-1W compared to the other STAs included the plants identified along the interior levees in the ENRP in 1995 (interior levees were not surveyed in the other STAs). When only the 2003 to 2006 field survey data were considered, 55 taxa were identified in STA-1W. Taxa richness was strongly correlated with the total number of field sites that were surveyed in each STA (r^2 = 0.8951; **Figure 5** – Panel B). The taxa discovery curve for the STAs appeared to be approaching an asymptote, suggesting that most of the taxa present in the plant communities have been identified (**Figure 5** – Panel A).

Chi-square analysis of the vegetation group data revealed that there were significant differences between areal coverages based on vegetation maps and areal coverages derived from the field surveys for each of the nine maps analyzed (**Appendix 11**). A sufficient number of field sites may not have been surveyed in STA-2, STA-3/4 and STA-6 in 2005 to characterize the entire plant community adequately (**Appendix 12**). However, the lack of agreement between field surveys and vegetation maps for the other cases where there appeared to be sufficient sites distributed over the STA indicated that field surveys are not adequate substitutes for mapping if the objective is to estimate vegetation areal coverage.

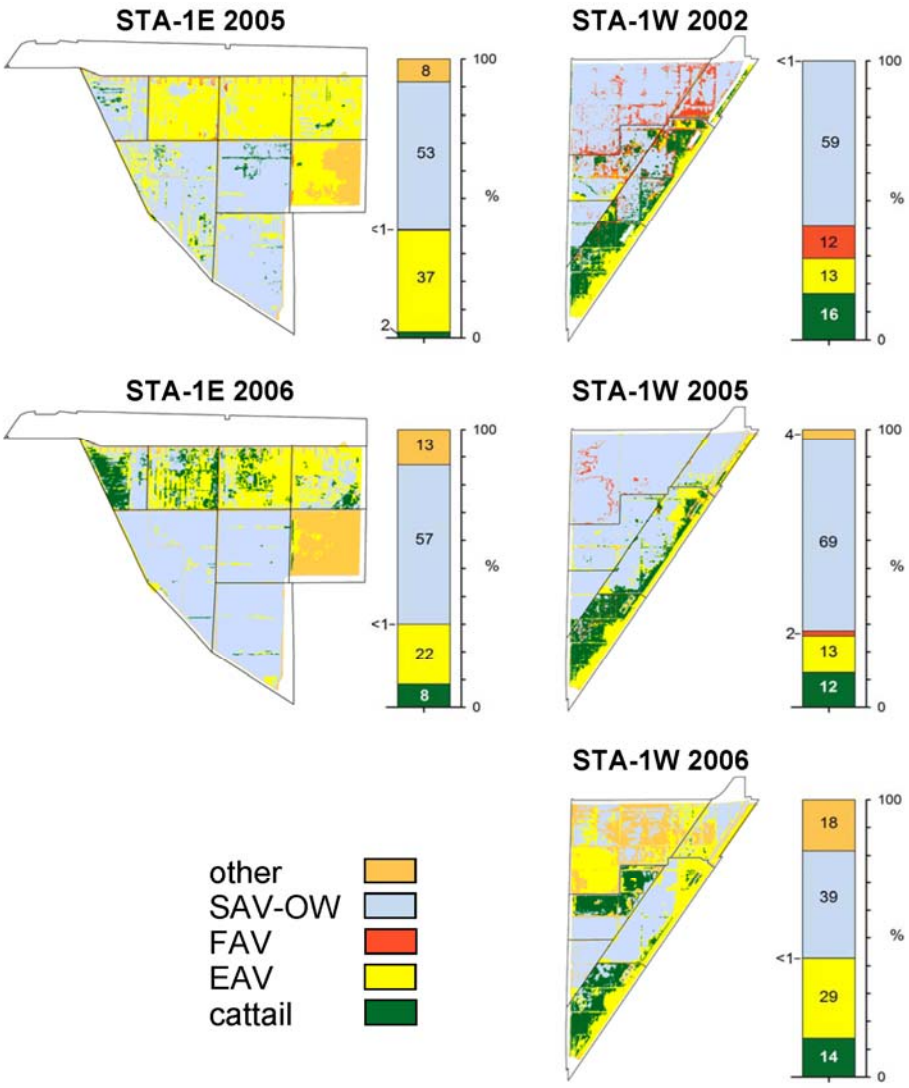

Figure 4. Summary vegetation maps for the STAs based on the following vegetation groups: cattail, emergent aquatic vegetation (EAV), floating aquatic vegetation (FAV), submersed aquatic vegetation-open water (SAV-OW) and other. Stacked bar charts indicate the percent coverage by vegetation group for each map. Note that vegetation maps are not shown at the same scale. Because areal coverage data were not available for the 1998 STA-6 vegetation map, a summary vegetation map could not be generated. See Section 3.1 for an explanation of the red ovals shown on STA-6 maps.

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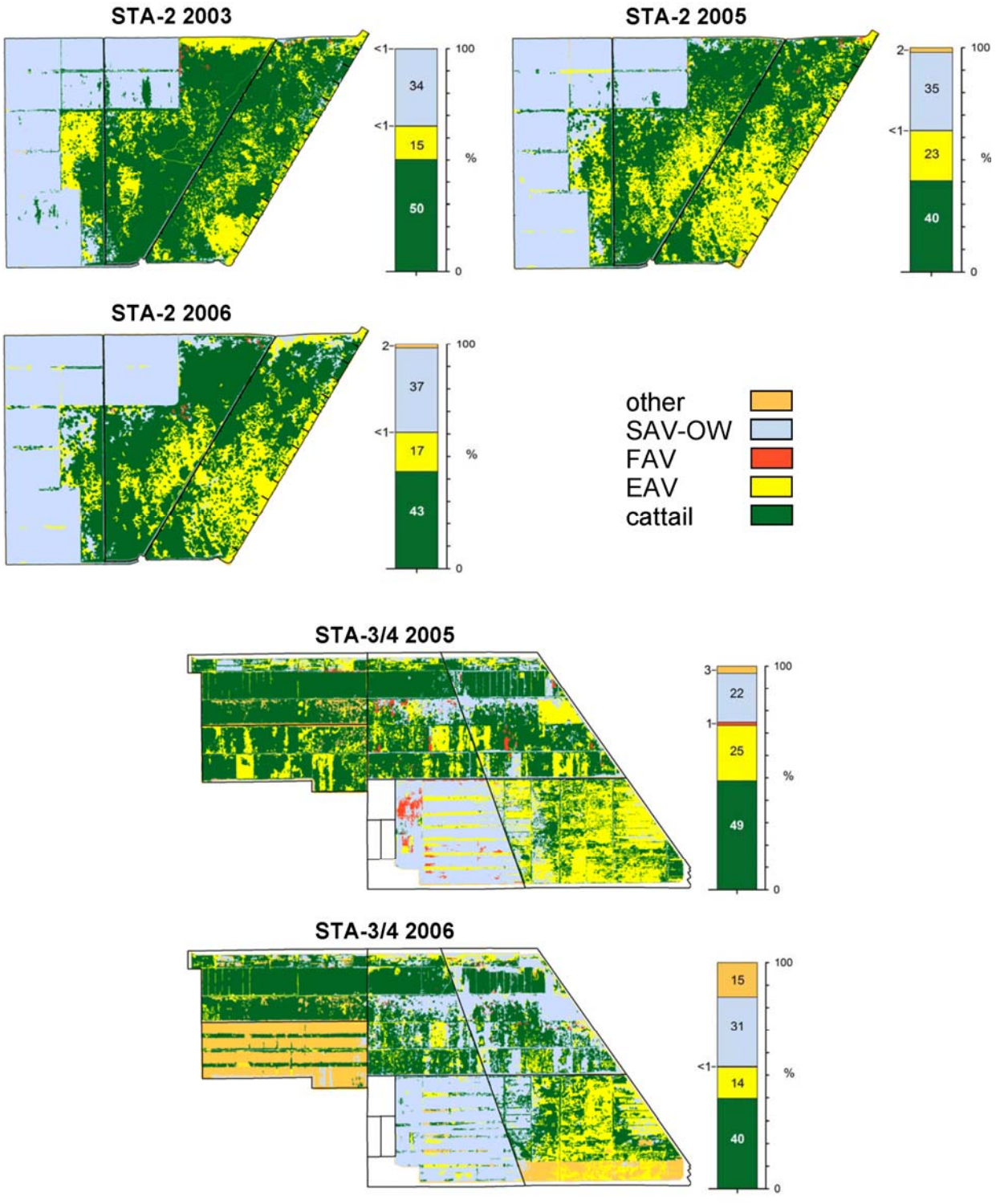

Figure 4 . (Continued).

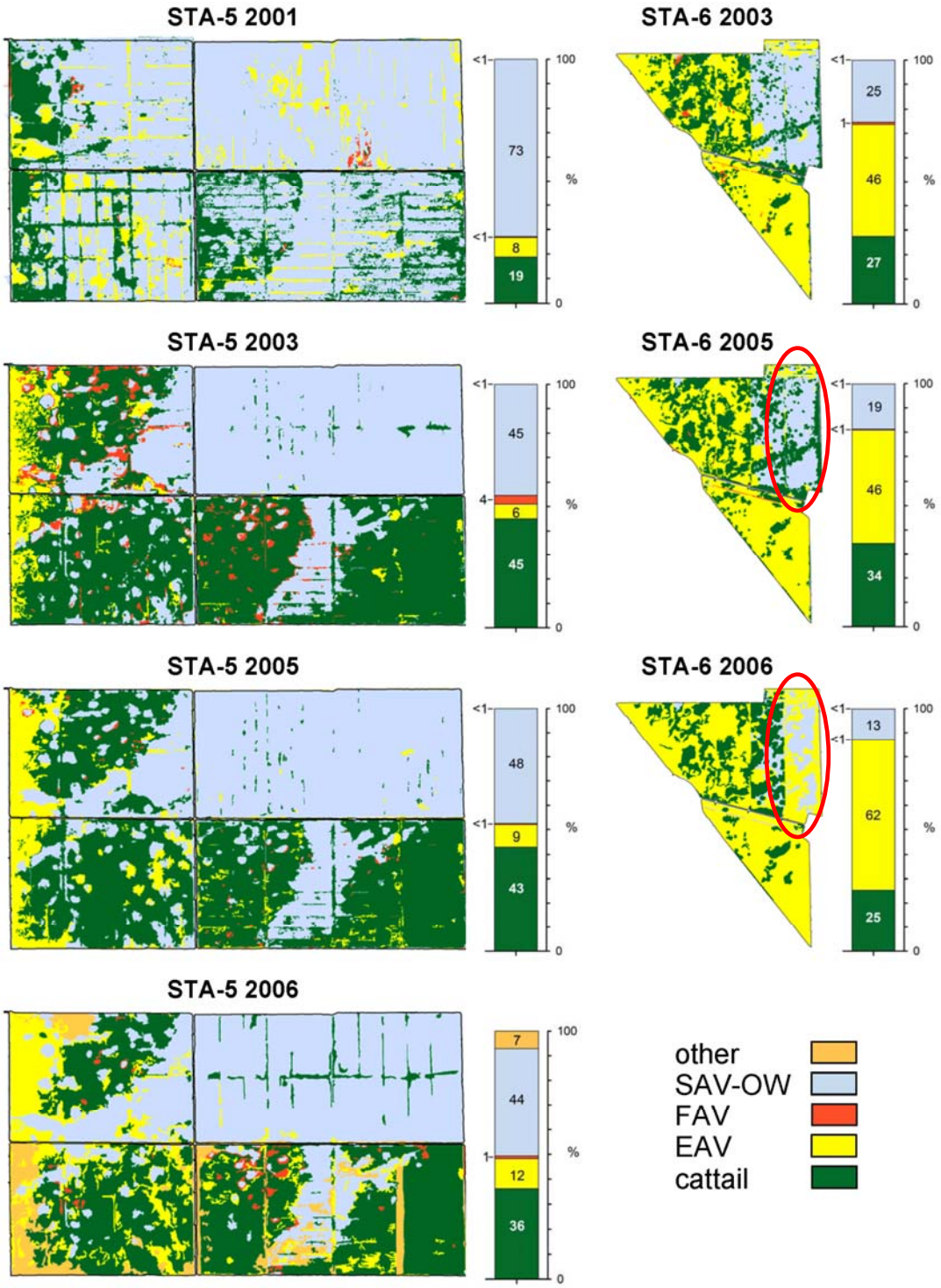

Figure 4 . (Continued).

Table 2. Utilization of field survey sites in the STAs from 2003 to 2006.

STA	# original sites[1] (visited)	# original sites (not visited)	# added sites[1]	# total sites	STA surface area (ac)	Surface area per original site (ac/site)	Range of # sites visited/yr[2]	Range of % sites visited/yr[3]
STA-1E	110	15	132	257	5,132	41	101 - 192	39 - 75
STA-1W	173	1	41	215	6,670	38	90 - 187	42 - 87
STA-2	83	57	36	176	6,338	45	45 - 100	26 - 57
STA-3/4	83	316	200	599	16,543	41	83 - 83	21 - 21
STA-5	112	0	0	112	4,110	37	33 - 112	29 - 100
STA-6	31	0	0	31	870	28	23 - 31	74 - 100

[1] See text for definition of original and added field survey sites.
[2] Minimum and maximum values reflect original + added sites visited in a given year for all STAs except STA-3/4 where minimum and maximum values reflect only the # of original sites visited.
[3] Values calculated as (minimum # sites visited/total # sites) x 100 and (maximum # sites visited/total # sites) x 100 for all STAs except for STA-3/4 where values were calculated as (minimum # sites visited/original # sites) x 100 and (maximum # sites visited/original # sites) x 100.

4.0 ACKNOWLEDGEMENTS

I would like to thank Stephen Colon (CH2MHill), Erin Fogarty-Kellis (District) and Amy Peters (CH2MHill) for their assistance with assembling and processing the STA map and field-survey data files. Kathy Pietro (District) provided the taxa list from the 1995 ENRP field survey and Mike Bodle (District) reviewed the STA plant list. Stephen Colon helped with data analysis for **Figure 4**.

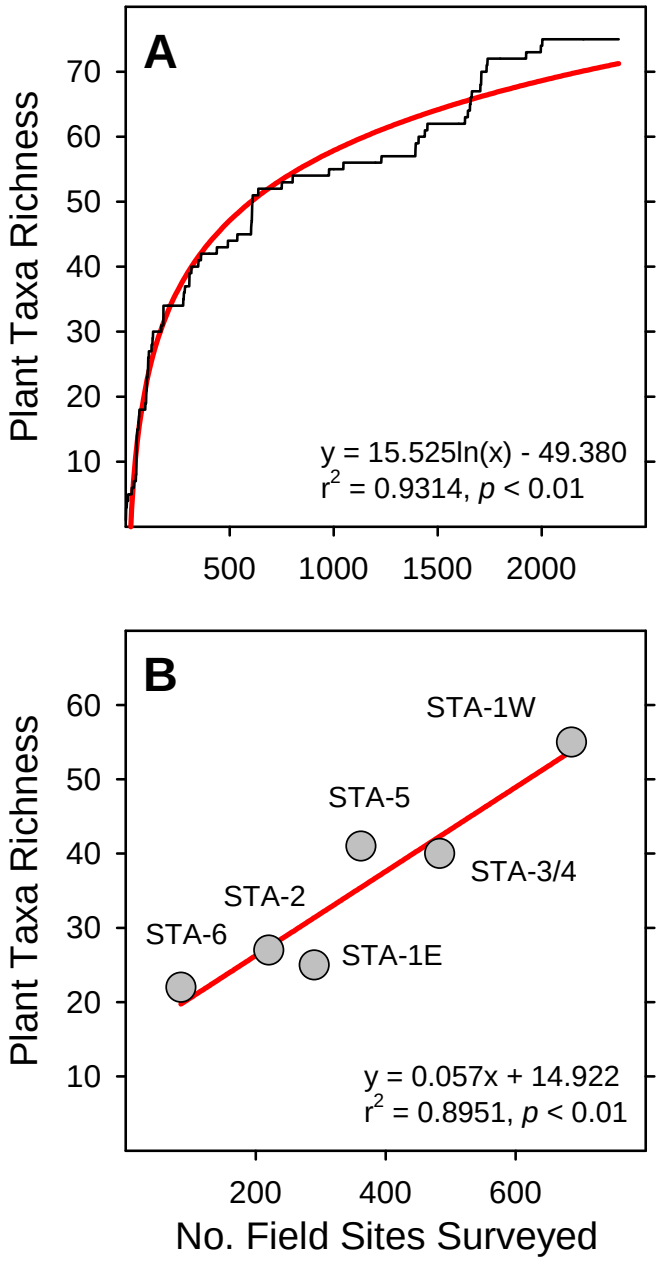

Figure 5. Plant taxa richness in the STAs based on field surveys (2003 - 2006) in relation to sampling effort. Panel A: taxa discovery curve –taxa richness vs. cumulative number of sites surveyed in all the STAs; Panel B: taxa richness vs. the total number of sites surveyed in each STA.

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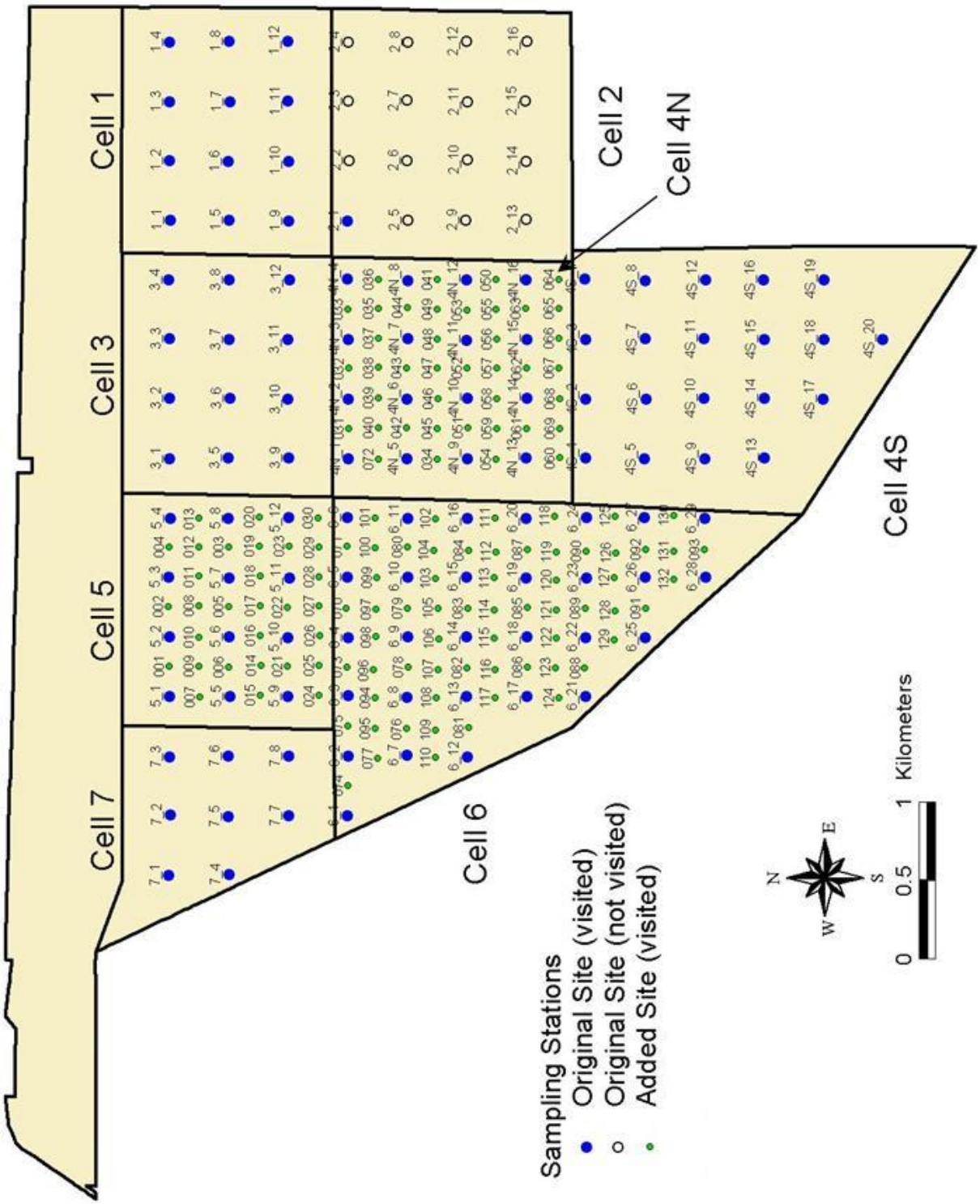
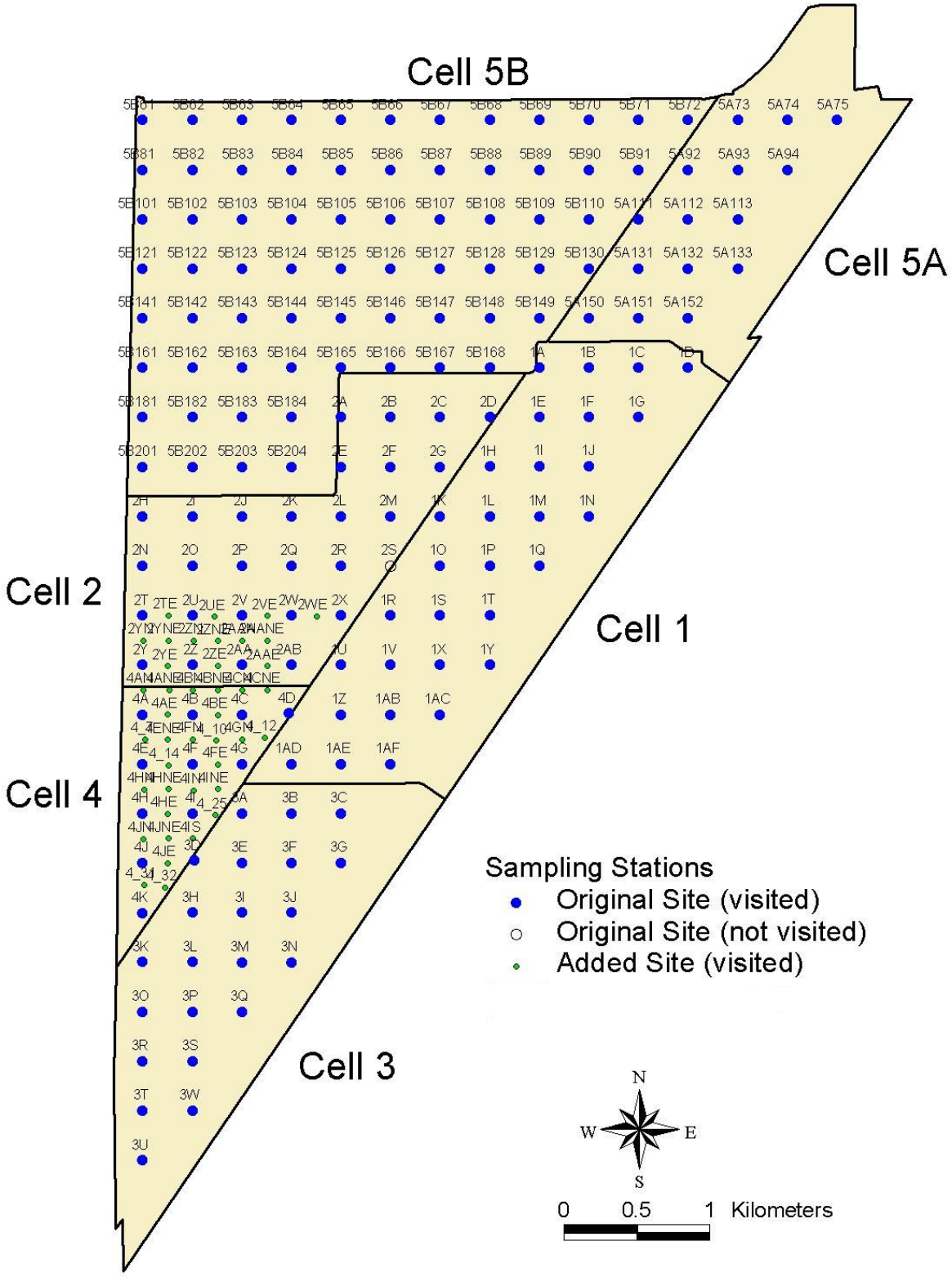
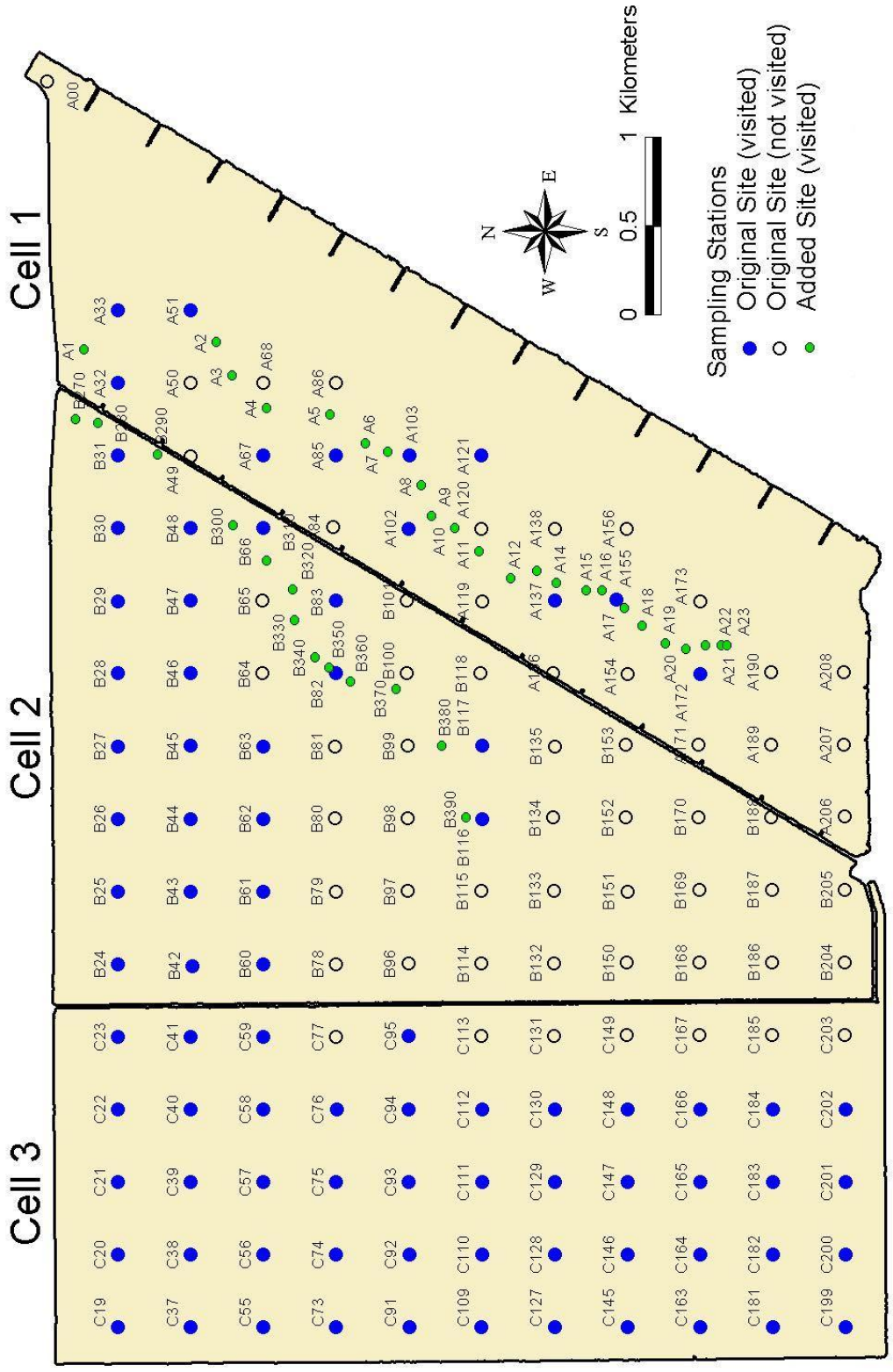
Appendix 1: Location of STA Vegetation Field-Survey Sites



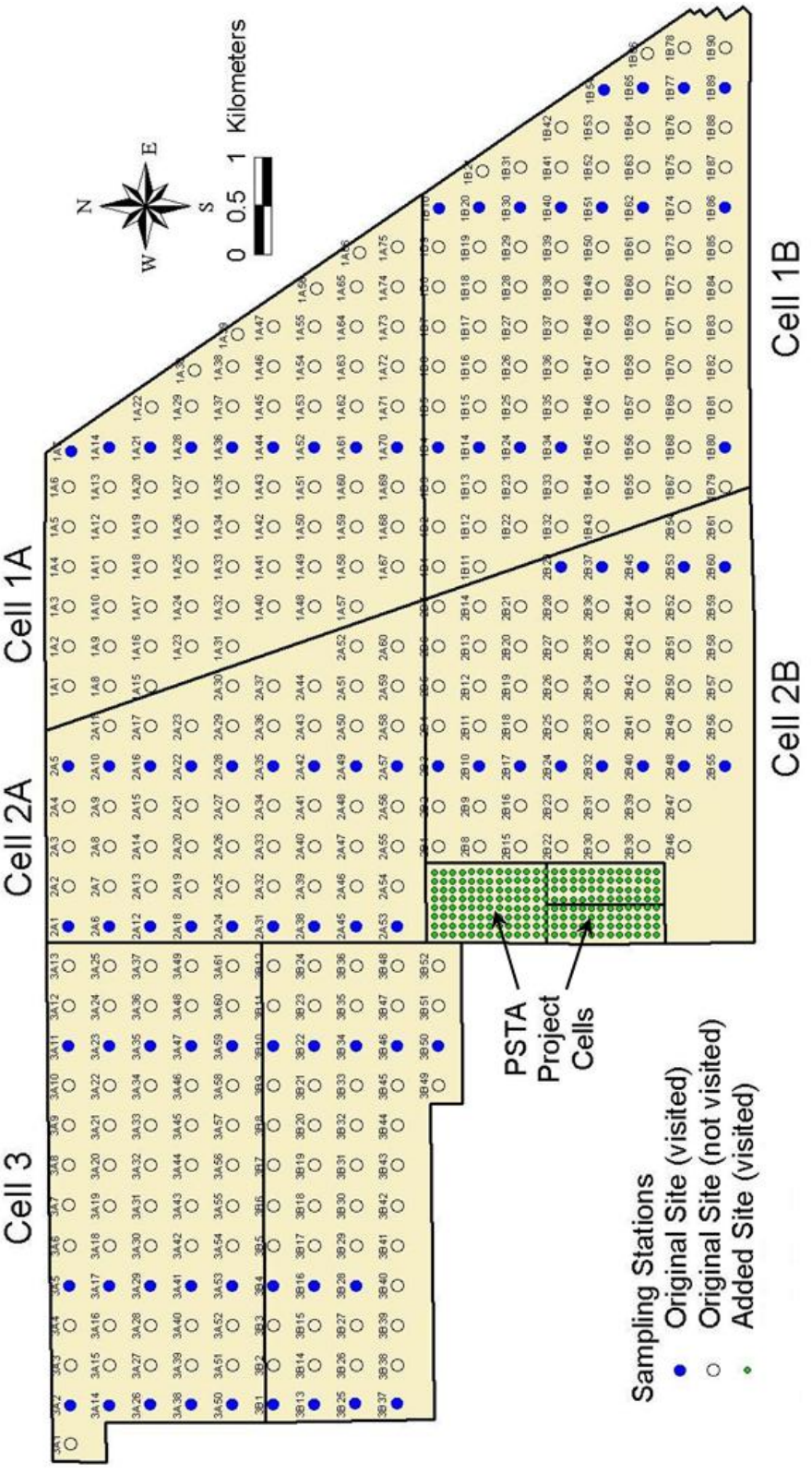
Appendix Figure 1-1. Location of vegetation field-survey sites in STA-1E.



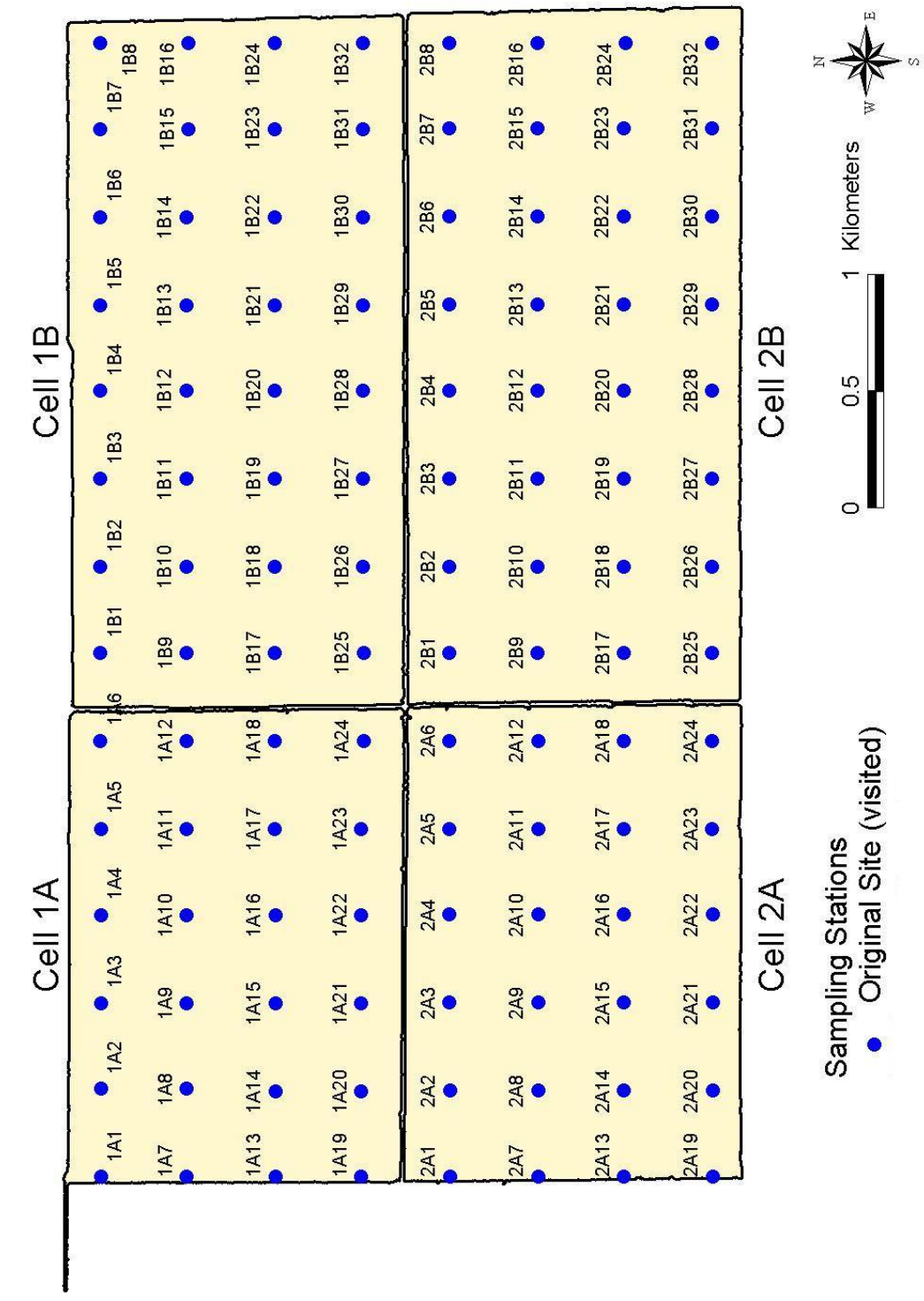
Appendix Figure 1-2. Location of vegetation field-survey sites in STA-1W.



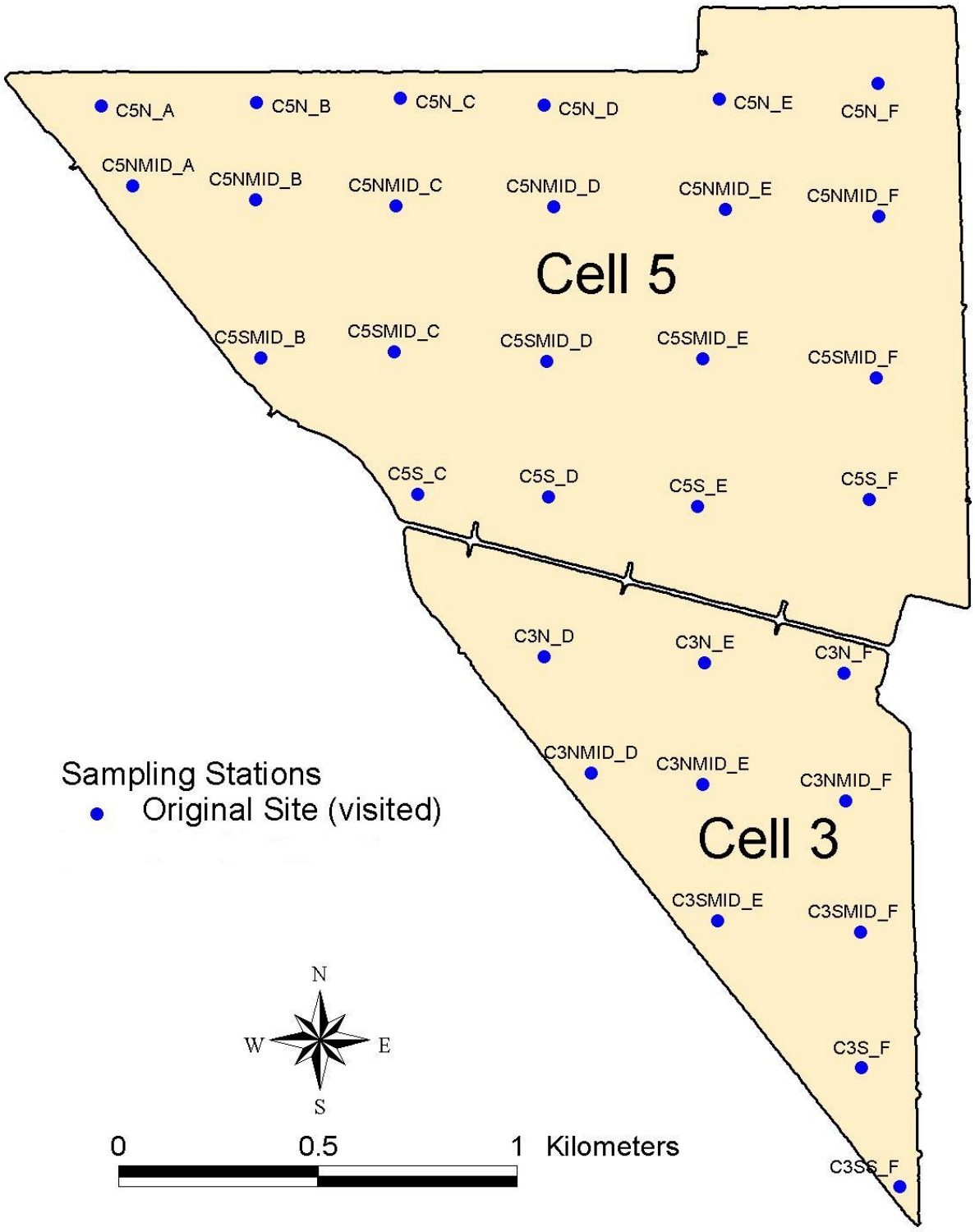
Appendix Figure 1-3. Location of vegetation field-survey sites in STA-2.



Appendix Figure 1-4. Location of vegetation field-survey sites in STA-3/4.

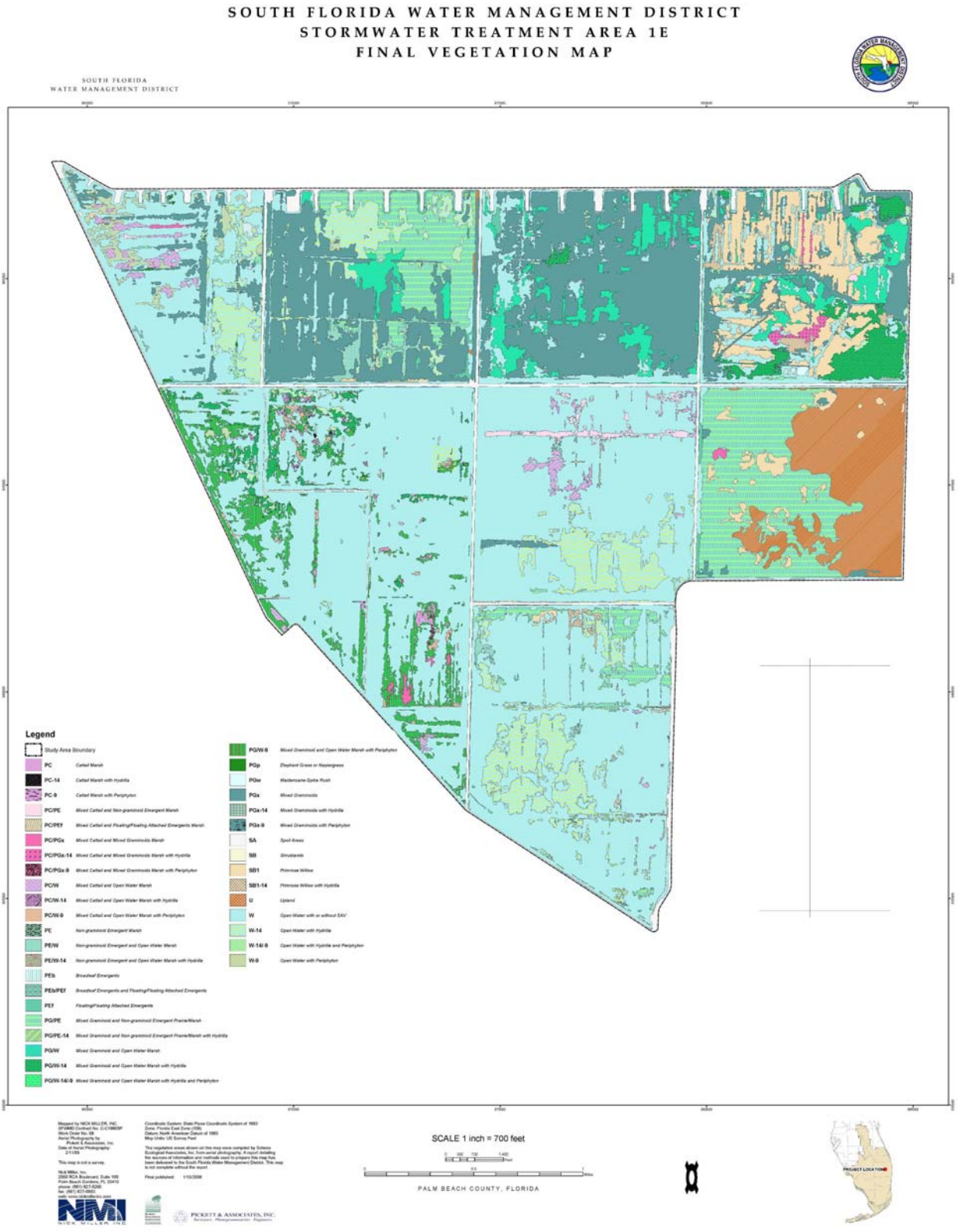


Appendix Figure 1-5. Location of vegetation field-survey sites in STA-5.

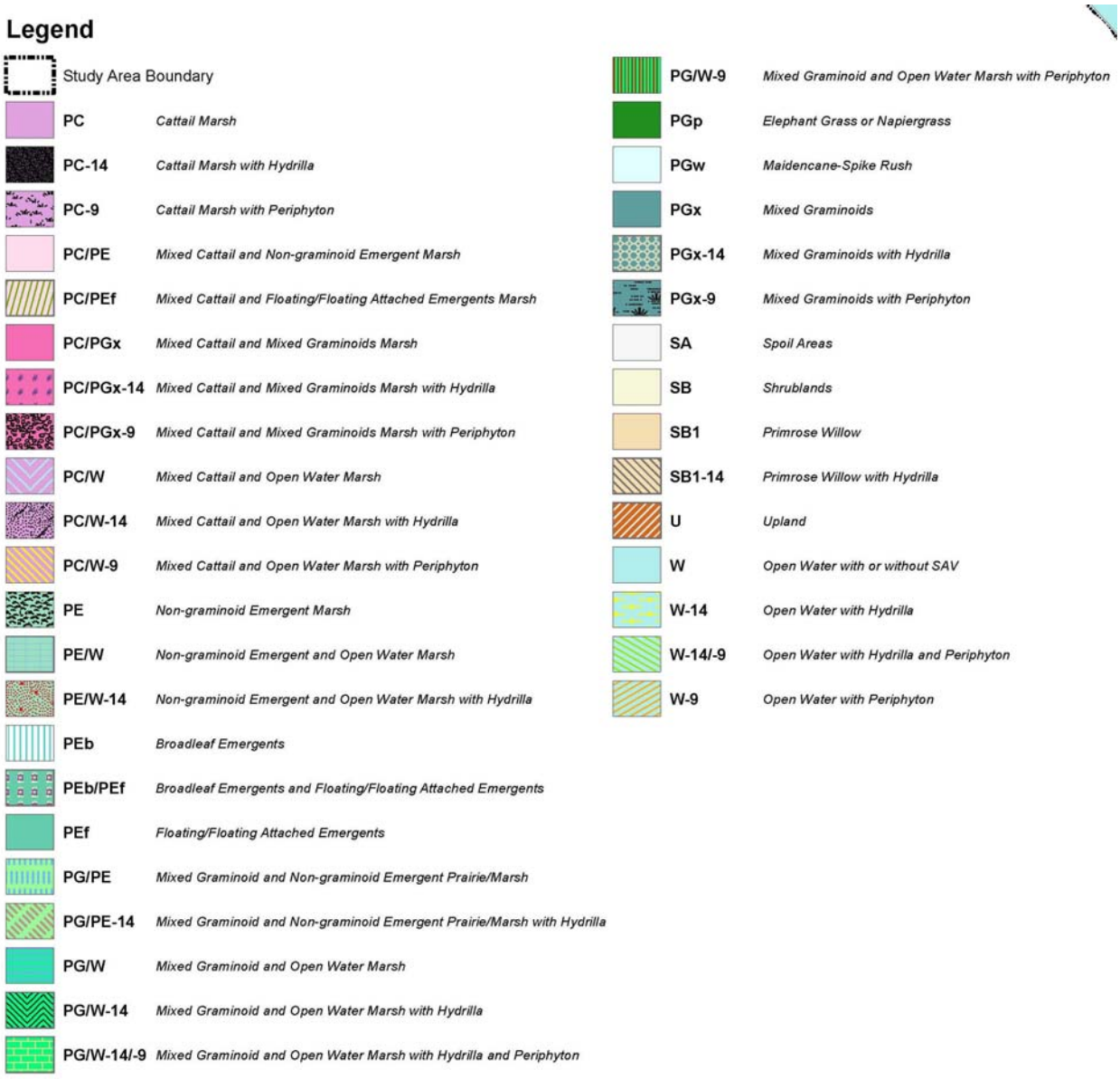


Appendix Figure 1-6. Location of vegetation field-survey sites in STA-6.

Appendix 2: STA-1E Vegetation Maps and Summaries of Areal Coverage by Vegetation Type



Appendix Figure 2-1. 2005 vegetation map of STA-1E. Map compiled by Nick Miller, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: February 11, 2005.

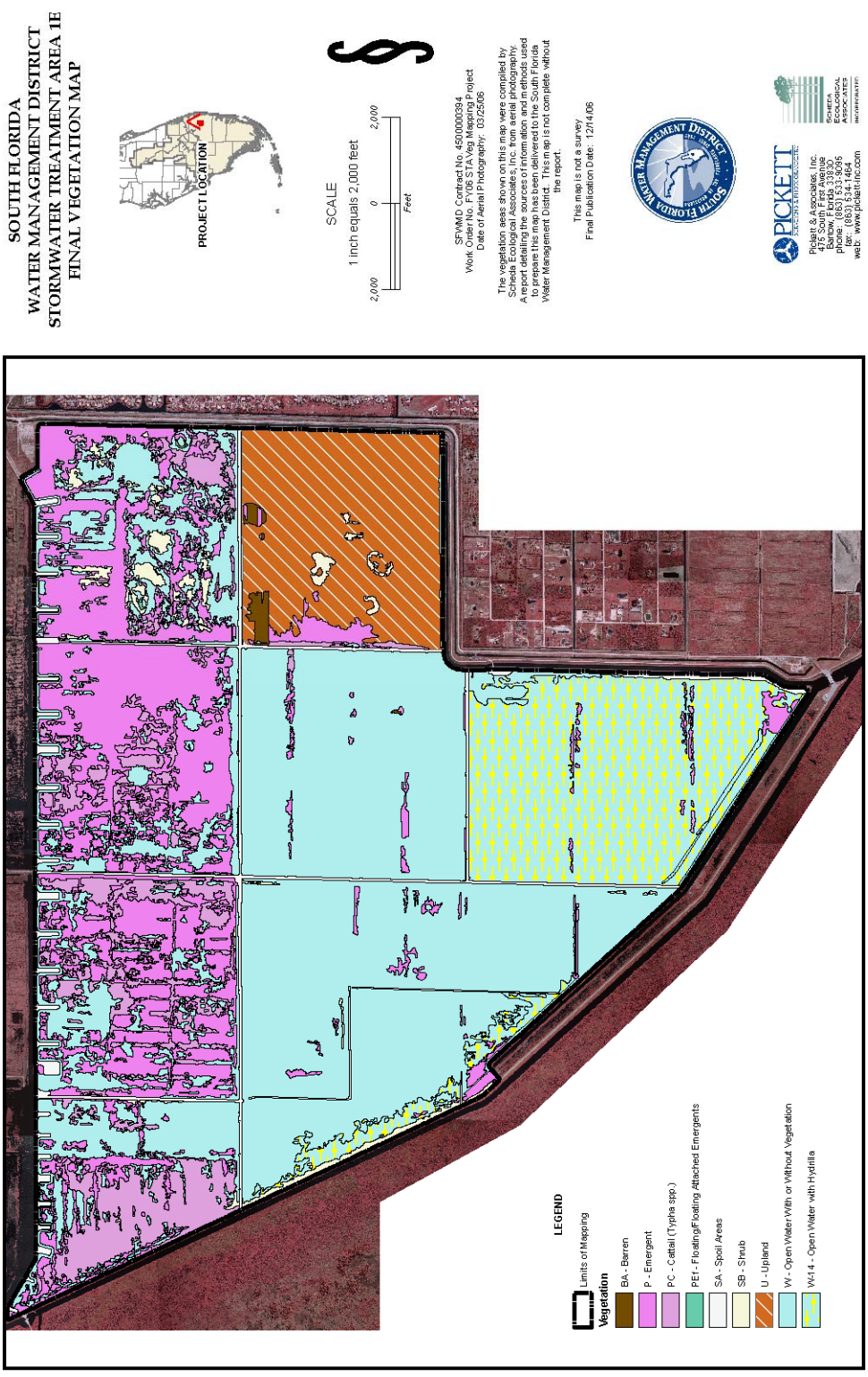


Appendix Figure 2-1. (Continued).

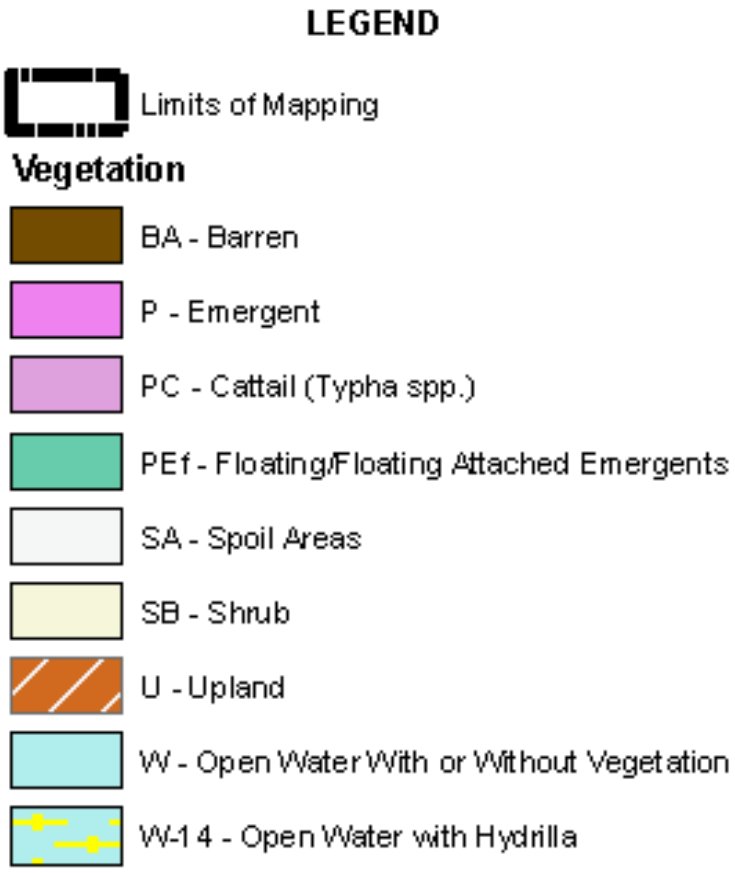
Appendix Table 2-1. Areal coverage of vegetation types mapped in STA-1E in 2005. Aerial photography taken on February 11, 2005. All areal coverages reported in acres.

				entire STA		Cell 1		Cell 2		Cell 3		Cell 4N		Cell 4S		Cell 5		Cell 6		Cell 7	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%
1	PC	cattail	Cattail	4.0	0.08	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	3.9	0.37	0.0	0.01
2	PC/PE	cattail	Mixed Cattail & Non-graminoids	19.9	0.39	0.8	0.13	0.0	0.00	0.0	0.00	17.9	2.77	0.0	0.00	0.4	0.07	0.0	0.00	0.8	0.20
3	PC/PEf	cattail	Mixed Cattail & Floating Aquatic Vegetation	5.7	0.11	0.0	0.00	0.0	0.00	0.0	0.00	2.1	0.32	3.6	0.48	0.0	0.00	0.0	0.00	0.0	0.00
4	PC/PGx	cattail	Mixed Cattail & Mixed Graminoids	9.3	0.18	1.9	0.34	1.6	0.29	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	4.3	0.40	1.5	0.35
5	PC/PGx-14	cattail	Mixed Cattail, Mixed Graminoids & Hydrilla	6.7	0.13	6.7	1.20	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
6	PC/PGx-9	cattail	Mixed Cattail, Mixed Graminoids & periphyton	0.9	0.02	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.9	0.08	0.0	0.00
7	PC/W	cattail	Mixed Cattail & Open Water	37.2	0.72	0.1	0.02	0.0	0.00	0.7	0.12	14.6	2.25	1.5	0.20	0.0	0.00	4.9	0.46	15.4	3.68
8	PC/W-14	cattail	Mixed Cattail, Open Water & Hydrilla	3.8	0.07	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	3.8	0.36	0.0	0.00
9	PC/W-9	cattail	Mixed Cattail, Open Water & periphton	9.2	0.18	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	9.2	0.87	0.0	0.00
10	PC-14	cattail	Cattail with Hydrilla	0.1	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.1	0.01	0.0	0.00
11	PC-9	cattail	Cattail and periphyton	1.2	0.02	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	1.2	0.11	0.0	0.00
12	PE	EAV	Non-graminoids	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
13	PE/W	EAV	Non-graminoids & Open Water	29.3	0.57	0.0	0.00	0.0	0.00	0.0	0.00	0.7	0.12	5.8	0.77	21.5	3.77	0.7	0.06	0.6	0.15
14	PE/W-14	EAV	Non-graminoids, Open Water and Hydrilla	0.6	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.6	0.06	0.0	0.00
15	PEb	EAV	Broadleaf Emergents	2.5	0.05	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.2	0.04	0.0	0.00	2.2	0.54
16	PEb/PEf	EAV	Broadleaf Emergents & Floating Emergents	0.3	0.01	0.3	0.05	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
17	PEf	FAV	Floating/Floating Attached Emergents	16.6	0.32	0.1	0.02	3.9	0.72	2.1	0.36	0.1	0.02	0.5	0.07	8.2	1.44	0.5	0.05	1.2	0.28
18	PG/PE	EAV	Mixed Graminoids & Non-graminoids	424.4	8.26	5.3	0.94	244.4	44.38	0.0	0.00	0.8	0.12	41.3	5.52	127.9	22.48	0.0	0.00	4.7	1.13
19	PG/PE-14	EAV	Mixed Graminoids & Non-graminoids with Hydrilla	0.3	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.3	0.03	0.0	0.00
20	PG/W	EAV	Mixed Graminoids & Open Water	159.1	3.10	50.4	9.06	0.0	0.00	82.0	13.86	0.0	0.00	0.0	0.00	26.1	4.60	0.6	0.05	0.0	0.00
21	PG/W-14	EAV	Mixed Graminoids & Open Water with Hydrilla	105.8	2.06	66.1	11.87	0.0	0.00	3.3	0.56	0.0	0.00	0.0	0.00	0.0	0.00	36.4	3.44	0.0	0.00
22	PG/W-14/-9	EAV	Mixed Graminoids & Open Water with Hydrilla and periphyton	0.5	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.5	0.05	0.0	0.00
23	PG/W-9	EAV	Mixed Graminoids, Open Water & periphyton	126.1	2.45	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	126.1	11.91	0.0	0.00
24	PGp	EAV	Napiergrass	1.4	0.03	0.0	0.00	0.0	0.00	0.4	0.07	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	1.0	0.24
25	PGw	EAV	Maidencane-Spike rush	1.8	0.04	1.8	0.32	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
26	PGx	EAV	Mixed Graminoids	814.2	15.84	113.6	20.41	5.8	1.06	388.0	65.58	5.1	0.79	0.6	0.08	256.5	45.09	0.2	0.02	44.3	10.59
27	PGx-14	EAV	Mixed Graminoids with periphyton	1.5	0.03	1.4	0.25	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.1	0.01	0.0	0.00
28	PGx-9	EAV	Mixed Graminoids and periphyton	0.4	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.4	0.04	0.0	0.00
29	SA	other	Spoil	188.8	3.67	20.4	3.66	16.0	2.90	27.8	4.69	13.8	2.13	30.8	4.12	26.7	4.69	28.8	2.72	24.7	5.91
30	SB	shrub	Shrub mixture	0.5	0.01	0.5	0.09	0.0	0.00	0.0	0.00	0.0	0.00	0.1	0.01	0.0	0.00	0.0	0.00	0.0	0.00
31	SB1	shrub	Primrose	192.6	3.75	160.1	28.77	27.8	5.04	0.0	0.00	0.0	0.00	2.2	0.29	1.5	0.26	0.1	0.01	1.0	0.24
32	SB1-14	shrub	Primrose with periphyton	15.5	0.30	11.0	1.98	0.0	0.00	0.0	0.00	0.0	0.00	4.4	0.59	0.0	0.00	0.0	0.00	0.0	0.00
33	U	other	Upland	237.0	4.61	0.0	0.00	235.6	42.78	0.0	0.00	0.0	0.00	0.0	0.00	1.4	0.25	0.0	0.00	0.0	0.00
34	W	SAV	Open Water with or without SAV	2351.2	45.74	103.7	18.63	15.6	2.83	85.9	14.52	512.9	79.26	541.0	72.26	34.6	6.08	815.6	77.04	241.8	57.82
35	W-14	SAV	Open Water with Hydrilla	338.9	6.59	12.5	2.25	0.0	0.00	1.3	0.21	79.0	12.21	116.9	15.61	61.8	10.86	17.9	1.69	49.5	11.84
36	W-14/-9	SAV	Open Water, Hydrilla & periphyton	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
37	W-9	SAV	Open Water with periphyton	33.4	0.65	0.0	0.00	0.0	0.00	0.2	0.03	0.0	0.00	0.0	0.00	2.2	0.39	1.6	0.15	29.4	7.03
			Totals	**5140.7**	100	**556.6**	100	**550.7**	100	**591.7**	100	**647.1**	100	**748.7**	100	**569.0**	100	**1058.7**	100	**418.2**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.



Appendix Figure 2-2. 2006 vegetation map of STA-1E. Map compiled by Pickett & Associates, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: March 25, 2006.



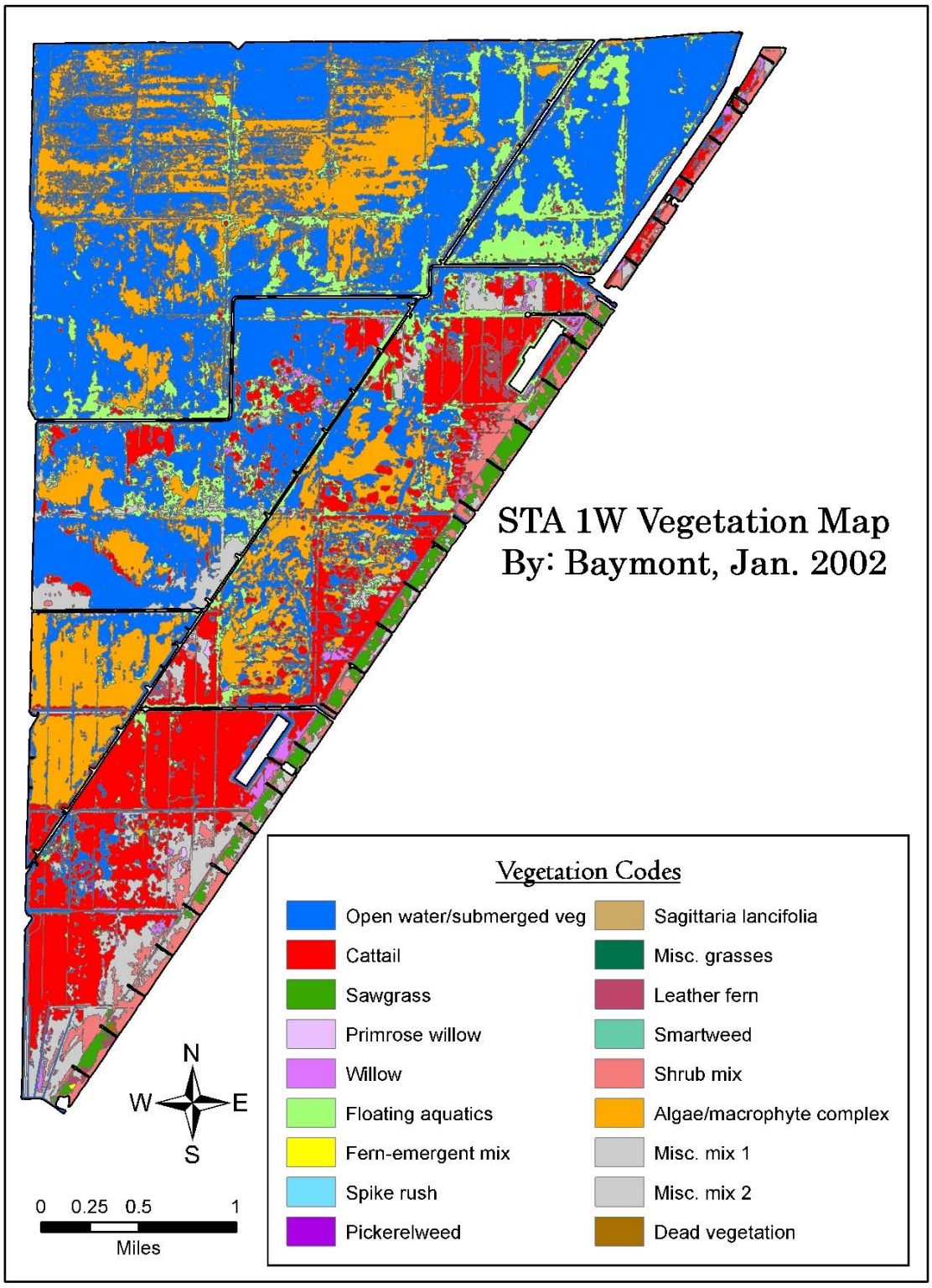
Appendix Figure 2-2. (Continued).

Appendix Table 2-2. Areal coverage of vegetation types mapped in STA-1E in 2006. Aerial photography taken on March 25, 2006. All areal coverages reported in acres.

				entire STA		Cell 1		Cell 2		Cell 3		Cell 4N		Cell 4S		Cell 5		Cell 6		Cell 7	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%
1	BA	other	Barren soil	14.9	0.29	0.0	0.00	14.6	2.65	0.0	0.00	0.3	0.05	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
2	P	EAV	Emergent herbaceous vegetation	1032.1	20.08	243.3	43.70	26.4	4.80	372.0	62.88	13.4	2.07	17.8	2.37	272.1	47.82	22.2	2.10	64.9	15.51
3	PC	cattail	Cattail	431.5	8.39	41.9	7.53	6.5	1.18	80.2	13.55	2.1	0.33	3.8	0.50	133.8	23.51	5.0	0.47	158.3	37.84
4	PEf	FAV	Floating/Floating Attached Emergents	2.1	0.04	1.2	0.22	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.2	0.03	0.0	0.00	0.7	0.17
5	SA	other	Spoil	181.0	3.52	20.3	3.64	17.1	3.11	23.7	4.01	14.2	2.20	29.1	3.89	24.4	4.29	29.1	2.75	23.0	5.51
6	SB	shrub	Shrub mixture	75.6	1.47	41.2	7.40	11.7	2.12	0.0	0.00	0.0	0.00	0.0	0.00	0.9	0.16	19.2	1.81	2.7	0.64
7	U	other	Upland	466.4	9.07	0.0	0.00	466.4	84.70	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
8	W	SAV	Open Water with or without SAV	2212.2	43.03	208.8	37.51	8.0	1.44	115.7	19.56	616.2	95.34	33.7	4.50	137.7	24.20	923.4	87.22	168.6	40.33
9	W-14	SAV	Open Water with Hydrilla	724.9	14.10	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	665.1	88.74	0.0	0.00	59.8	5.65	0.0	0.00
			Totals	**5140.7**	100	**556.6**	100	**550.7**	100	**591.7**	100	**646.3**	100	**749.5**	100	**569.0**	100	**1058.7**	100	**418.2**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.

Appendix 3: STA-1W Vegetation Maps and Summaries of Areal Coverage by Vegetation Type

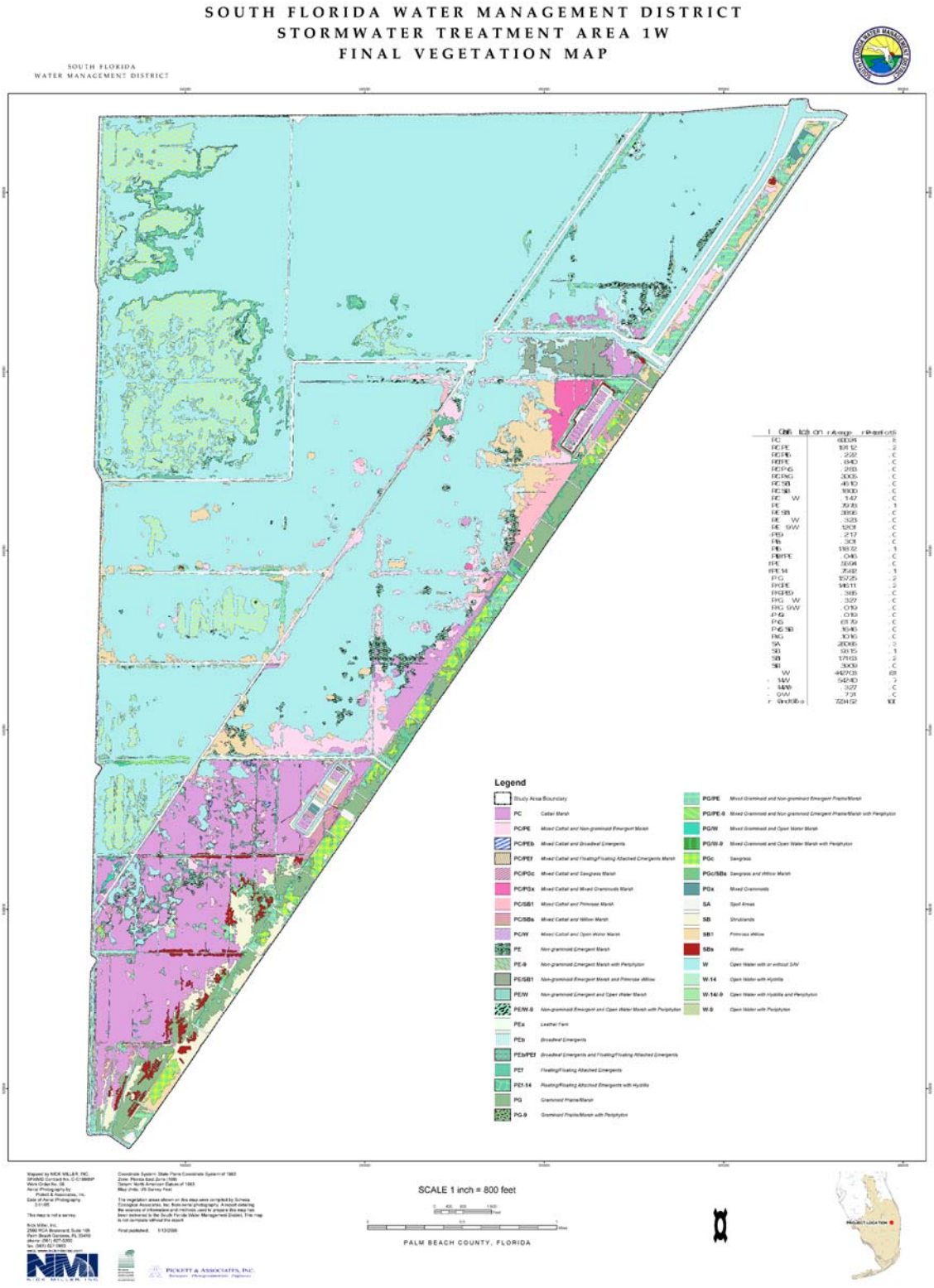


Appendix Figure 3-1. 2002 vegetation map of STA-1W. Map compiled by Agra Baymont, Inc. Date of aerial photography: January 8, 2002.

Appendix Table 3-1. Areal coverage of vegetation types mapped in STA-1W in 2002. Aerial photography taken on January 8, 2002. All areal coverages reported in acres.

				entire STA		Cell 1		Cell 2		Cell 3		Cell 4		Cell 5A		Cell 5B	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%
1	PC	cattail	Cattail	1135.6	16.40	428.8	29.89	115.0	11.23	514.2	51.13	25.9	7.18	37.2	5.44	14.3	0.59
2	PEa	EAV	Fern-emergent mix	1.1	0.02	0.6	0.04	0.0	0.00	0.5	0.05	0.0	0.00	0.0	0.00	0.0	0.00
3	PEa	EAV	Leather fern	29.7	0.43	23.2	1.62	0.0	0.00	6.5	0.64	0.0	0.00	0.0	0.00	0.0	0.00
4	PEb	EAV	Pickerelweed	4.5	0.07	0.0	0.00	0.0	0.00	4.5	0.45	0.0	0.00	0.0	0.00	0.0	0.00
5	PEb	EAV	*Sagittaria lancifolia*	1.0	0.01	0.0	0.00	0.0	0.00	1.0	0.10	0.0	0.00	0.0	0.00	0.0	0.00
6	PEf	FAV	Floating aquatics	810.8	11.71	183.5	12.79	143.5	14.02	18.7	1.86	9.5	2.62	172.8	25.24	282.8	11.72
7	PEo	EAV	Smartweed	1.8	0.03	0.8	0.06	0.7	0.07	0.0	0.00	0.0	0.00	0.2	0.03	0.0	0.00
8	PG/PE	EAV	Misc. mix 1	377.8	5.46	85.8	5.98	100.4	9.80	162.4	16.14	6.7	1.85	12.6	1.85	10.0	0.41
9	PG/PE	EAV	Misc. mix 2	40.6	0.59	0.0	0.00	0.0	0.00	40.6	4.04	0.0	0.00	0.0	0.00	0.0	0.00
10	PGc	EAV	Sawgrass	111.6	1.61	75.7	5.28	0.0	0.00	35.9	3.57	0.0	0.00	0.0	0.00	0.0	0.00
11	PGe	EAV	Spikerush	1.1	0.02	0.0	0.00	0.0	0.00	1.0	0.10	0.0	0.00	0.0	0.00	0.1	0.00
12	PGx	EAV	Misc. grasses	8.1	0.12	0.3	0.02	0.4	0.03	3.7	0.37	0.1	0.02	2.7	0.39	0.9	0.04
13	SB	shrub	Shrub mix	222.6	3.22	83.4	5.82	1.3	0.13	105.8	10.52	0.0	0.00	32.0	4.67	0.0	0.00
14	SB1	shrub	Primrose willow	5.1	0.07	2.8	0.20	0.0	0.00	2.3	0.23	0.0	0.00	0.0	0.00	0.0	0.00
15	SBs	shrub	Willow	76.8	1.11	23.1	1.61	13.9	1.35	29.3	2.91	0.1	0.01	9.8	1.43	0.8	0.03
16	TA	other	Dead vegetation	2.1	0.03	0.1	0.01	0.0	0.00	1.8	0.18	0.0	0.00	0.1	0.02	0.0	0.00
17	W	SAV	Algae/macrophyte complex	1298.7	18.76	261.0	18.19	90.8	8.86	1.6	0.16	238.0	65.88	1.7	0.25	705.7	29.25
18	W	SAV	Open water/submerged veg	2794.0	40.36	265.3	18.5	558.1	54.50	76.0	7.55	81.1	22.45	415.5	60.69	1398.1	57.95
			Totals	**6922.8**	100	**1434.6**	100	**1024.0**	100	**1005.7**	100	**361.2**	100	**684.7**	100	**2412.6**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.



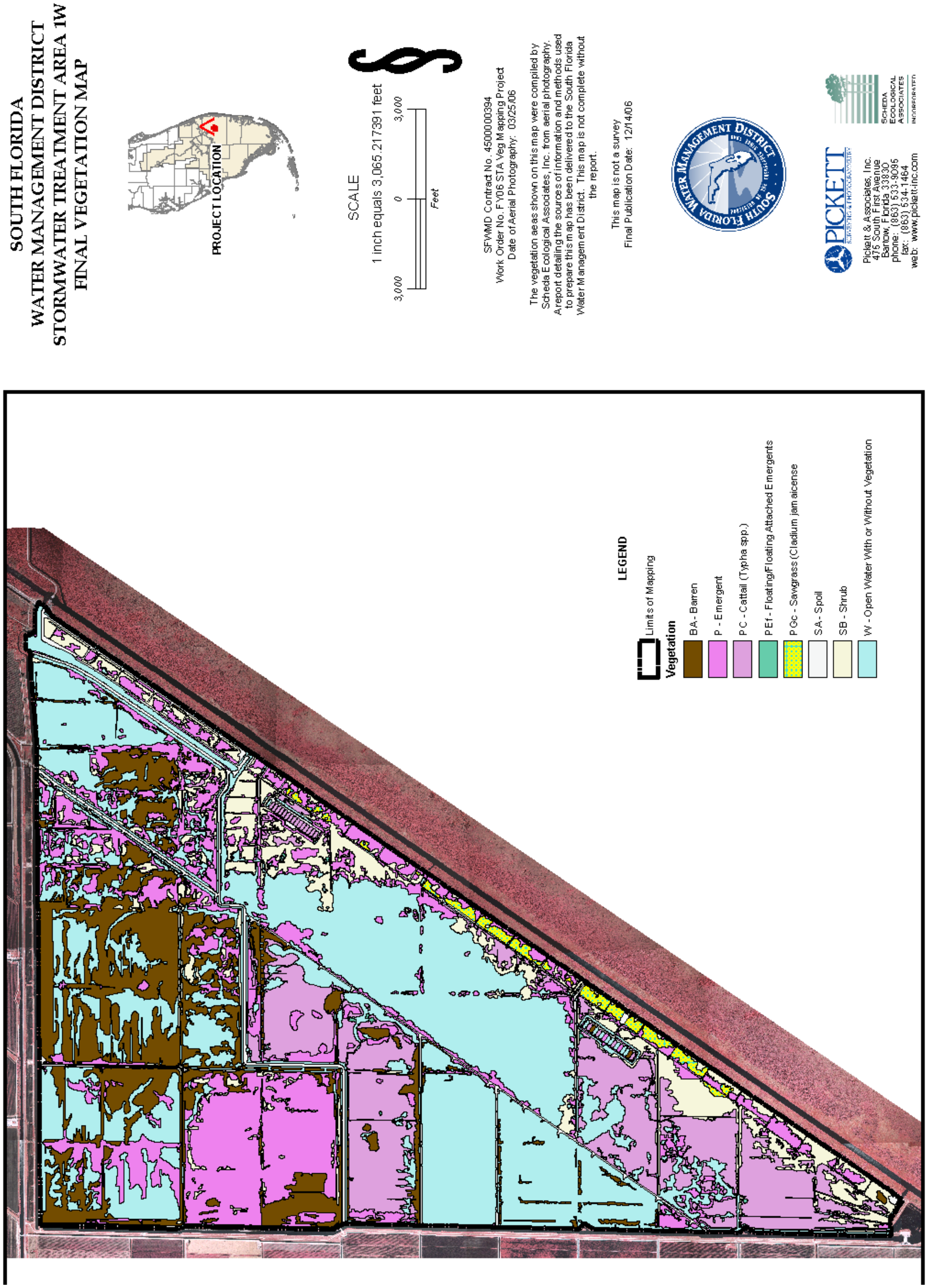
Appendix Figure 3-2. 2005 vegetation map of STA-1W. Map compiled by Nick Miller, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: February 11, 2005.

Appendix Figure 3-2. (Continued).

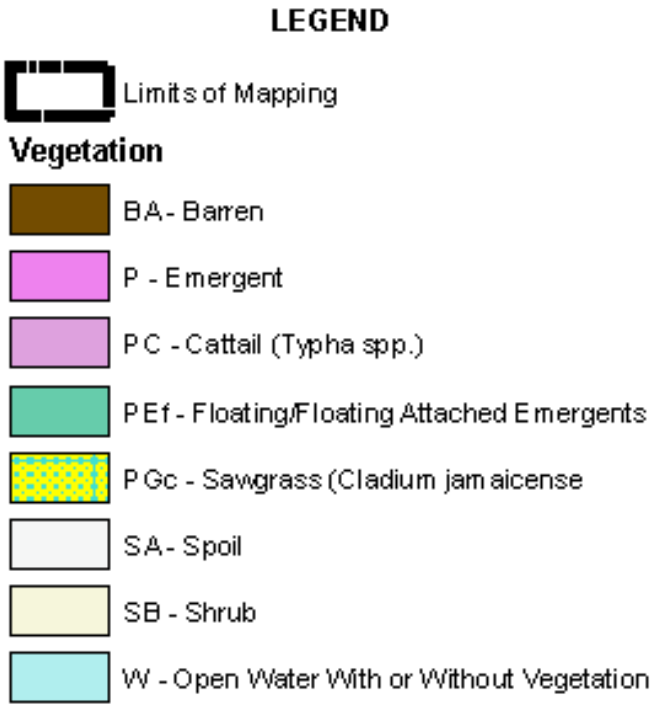
Appendix Table 3-2. Areal coverage of vegetation types mapped in STA-1W in 2005. Aerial photography taken on February 11, 2005. All areal coverages reported in acres.

				entire STA		Cell 1		Cell 2		Cell 3		Cell 4		Cell 5A		Cell 5B	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%
1	PC	cattail	Cattail	600.2	8.30	75.2	5.06	0.3	0.03	504.9	47.90	10.2	2.70	9.6	1.18	0.0	0.00
2	PC/PE	cattail	Mixed Cattail & Non-graminoids	191.1	2.64	119.5	8.03	20.1	1.92	34.5	3.28	3.4	0.89	13.5	1.66	0.2	0.01
3	PC/PEb	cattail	Mixed Cattail & Broadleaf Emergents	2.2	0.03	0.0	0.00	0.0	0.00	2.2	0.21	0.0	0.00	0.0	0.00	0.0	0.00
4	PC/PEf	cattail	Mixed Cattail & Floating Aquatic Vegetation	8.4	0.12	0.4	0.03	0.0	0.00	7.1	0.68	0.2	0.05	0.6	0.08	0.0	0.00
5	PC/PGc	cattail	Mixed Cattail & Sawgrass	2.8	0.04	2.8	0.19	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
6	PC/PGx	cattail	Mixed Cattail & Mixed Graminoids	30.0	0.42	28.1	1.89	0.0	0.00	1.0	0.09	0.0	0.00	0.9	0.12	0.0	0.00
7	PC/SB1	cattail	Mixed Cattail & Primrose	46.1	0.64	38.3	2.57	3.7	0.35	4.1	0.39	0.0	0.00	0.0	0.00	0.0	0.00
8	PC/SBs	cattail	Mixed Cattail & Willow	18.0	0.25	0.0	0.00	0.0	0.00	18.0	1.71	0.0	0.00	0.0	0.00	0.0	0.00
9	PC/W	cattail	Mixed Cattail & Open Water	1.5	0.02	0.7	0.05	0.0	0.00	0.6	0.06	0.1	0.03	0.0	0.00	0.0	0.00
10	PE	EAV	Non-graminoids	79.8	1.10	50.4	3.38	4.8	0.46	10.1	0.96	0.6	0.17	13.4	1.64	0.5	0.02
11	PE/SB1	EAV	Non-graminoids & Primrose	39.0	0.54	39.0	2.62	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
12	PE/W	EAV	Non-graminoids & Open Water	3.2	0.04	0.1	0.00	1.2	0.11	1.2	0.12	0.0	0.00	0.2	0.03	0.5	0.02
13	PE/W-9	EAV	Non-graminoids, Open Water and periphyton	12.0	0.17	0.0	0.00	2.5	0.24	0.0	0.00	0.0	0.00	9.2	1.13	0.3	0.01
14	PE-9	EAV	Non-graminoids and periphyton	2.2	0.03	0.0	0.00	0.0	0.00	1.9	0.18	0.3	0.08	0.0	0.00	0.0	0.00
15	PEa	EAV	Leather Fern	3.0	0.04	3.0	0.20	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
16	PEb	EAV	Broadleaf Emergents	118.7	1.64	84.4	5.67	11.0	1.05	5.4	0.51	0.0	0.00	17.5	2.15	0.5	0.02
17	PEb/PEf	EAV	Broadleaf Emergents & Floating Emergents	0.5	0.01	0.5	0.03	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
18	PEf	FAV	Floating/Floating Attached Emergents	55.9	0.77	16.7	1.12	1.2	0.12	26.0	2.47	0.0	0.00	4.1	0.50	7.9	0.32
19	PEf-14	FAV	Floating/Floating Attached Emergents with Hydrilla	75.8	1.05	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	75.8	3.09
20	PG	EAV	Graminoids	157.2	2.17	60.0	4.03	0.0	0.00	96.8	9.18	0.5	0.12	0.0	0.00	0.0	0.00
21	PG/PE	EAV	Mixed Graminoids & Non-graminoids	146.1	2.02	18.7	1.26	9.2	0.88	46.7	4.43	3.6	0.96	63.1	7.75	4.8	0.19
22	PG/PE-9	EAV	Mixed Graminoids & Non-graminoids with periphyton	3.8	0.05	0.0	0.00	0.0	0.00	0.0	0.00	3.8	1.02	0.0	0.00	0.0	0.00
23	PG/W	EAV	Mixed Graminoids & Open Water	3.3	0.05	0.0	0.00	0.0	0.00	0.5	0.05	2.5	0.66	0.0	0.00	0.3	0.01
24	PG/W-9	EAV	Mixed Graminoids, Open Water & periphyton	0.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.2	0.01
25	PG-9	EAV	Graminoids with periphyton	0.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.2	0.05	0.0	0.00	0.0	0.00
26	PGc	EAV	Sawgrass	61.8	0.85	30.1	2.02	0.0	0.00	31.7	3.00	0.0	0.00	0.0	0.00	0.0	0.00
27	PGc/SBs	EAV	Sawgrass & Willow	16.5	0.23	16.5	1.11	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
28	PGx	EAV	Mixed Graminoids	10.2	0.14	2.7	0.18	0.1	0.01	1.4	0.13	0.0	0.00	3.6	0.44	2.4	0.10
29	SA	other	Spoil	260.8	3.61	41.1	2.76	31.5	3.01	34.1	3.24	13.7	3.63	83.0	10.18	57.4	2.34
30	SB	shrub	Shrub mixture	93.1	1.29	2.8	0.19	0.3	0.03	89.8	8.52	0.0	0.00	0.3	0.03	0.0	0.00
31	SB1	shrub	Primrose	171.6	2.37	104.4	7.01	30.3	2.89	16.8	1.59	0.2	0.04	19.9	2.45	0.1	0.00
32	SBs	shrub	Willow	39.1	0.54	3.6	0.24	0.2	0.02	34.2	3.24	0.0	0.00	0.7	0.09	0.4	0.01
33	W	SAV	Open Water with or without SAV	4427.0	61.19	749.1	50.34	883.0	84.36	81.5	7.73	283.2	75.07	574.2	70.47	1856.1	75.65
34	W-14	SAV	Open Water with Hydrilla	542.4	7.50	0.0	0.00	47.1	4.50	1.4	0.14	49.3	13.07	0.0	0.00	444.5	18.12
35	W-14/-9	SAV	Open Water, Hydrilla & periphyton	3.3	0.05	0.0	0.00	0.0	0.00	0.0	0.00	1.5	0.39	0.0	0.00	1.8	0.07
36	W-9	SAV	Open Water with periphyton	7.3	0.10	0.0	0.00	0.3	0.03	2.2	0.20	4.0	1.05	0.9	0.11	0.0	0.00
			Totals	**7234.5**	100	**1488.0**	100	**1046.7**	100	**1054.2**	100	**377.3**	100	**814.8**	100	**2453.5**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.



Appendix Figure 3-3. 2006 vegetation map of STA-1W. Map compiled by Pickett & Associates, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: March 25, 2006.



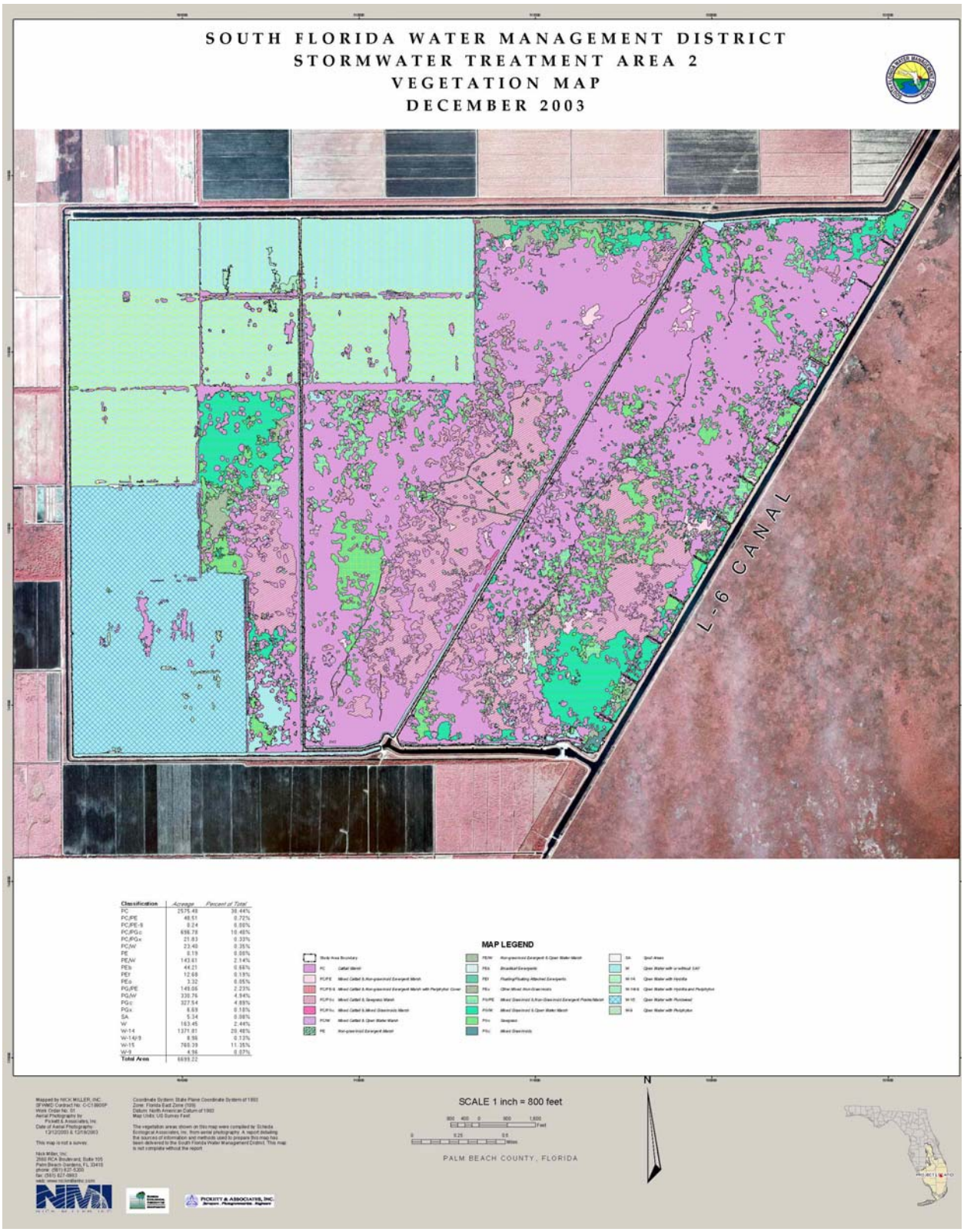
Appendix Figure 3-3. (Continued).

Appendix Table 3-3. Areal coverage of vegetation types mapped in STA-1W in 2006. Aerial photography taken on March 25, 2006. All areal coverages reported in acres.

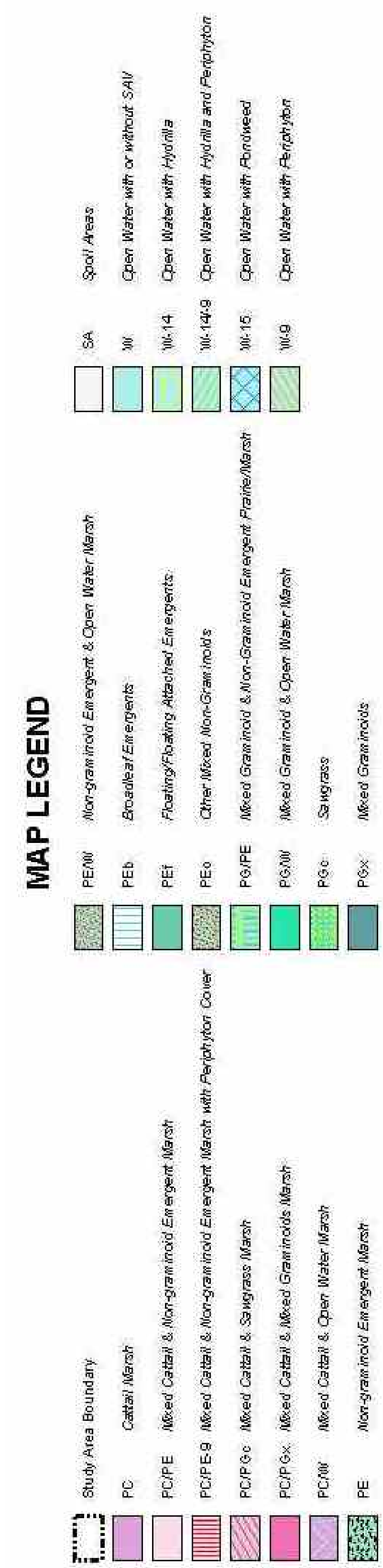
				entire STA		Cell 1		Cell 2		Cell 3		Cell 4		Cell 5A		Cell 5B	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%
1	BA	other	Barren soil	1048.0	14.49	0.0	0.00	83.4	7.97	3.2	0.30	24.7	6.55	105.7	12.97	831.0	33.87
2	P	EAV	Emergent herbaceous vegetation	1354.8	18.73	232.8	15.64	77.2	7.38	93.3	8.85	12.1	3.21	182.4	22.39	756.9	30.85
3	PC	cattail	Cattail	1000.3	13.83	56.3	3.78	427.5	40.84	508.2	48.21	0.6	0.17	6.1	0.75	1.6	0.06
4	PEf	FAV	Floating/Floating Attached Emergents	7.6	0.10	1.5	0.10	1.9	0.18	4.0	0.38	0.0	0.00	0.2	0.02	0.0	0.00
5	PGc	EAV	Sawgrass	72.4	1.00	32.7	2.19	0.0	0.00	39.8	3.77	0.0	0.00	0.0	0.00	0.0	0.00
6	SA	other	Spoil	278.6	3.85	45.8	3.08	37.4	3.57	33.9	3.21	17.6	4.66	76.5	9.39	67.5	2.75
7	SB	shrub	Shrub mixture	662.1	9.15	250.3	16.82	0.9	0.09	222.2	21.07	0.7	0.18	87.1	10.68	101.0	4.12
8	W	SAV	Open Water with or without SAV	2810.6	38.85	868.7	58.38	418.4	39.98	149.6	14.19	321.6	85.23	356.9	43.80	695.5	28.35
			Totals	**7234.5**	100	**1488.0**	100	**1046.7**	100	**1054.2**	100	**377.3**	100	**814.8**	100	**2453.5**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.

Appendix 4: STA-2 Vegetation Maps and Summaries of Areal Coverage by Vegetation Type



Appendix Figure 4-1. 2003 vegetation map of STA-2. Map compiled by Nick Miller, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: December 12 & 18, 2003.

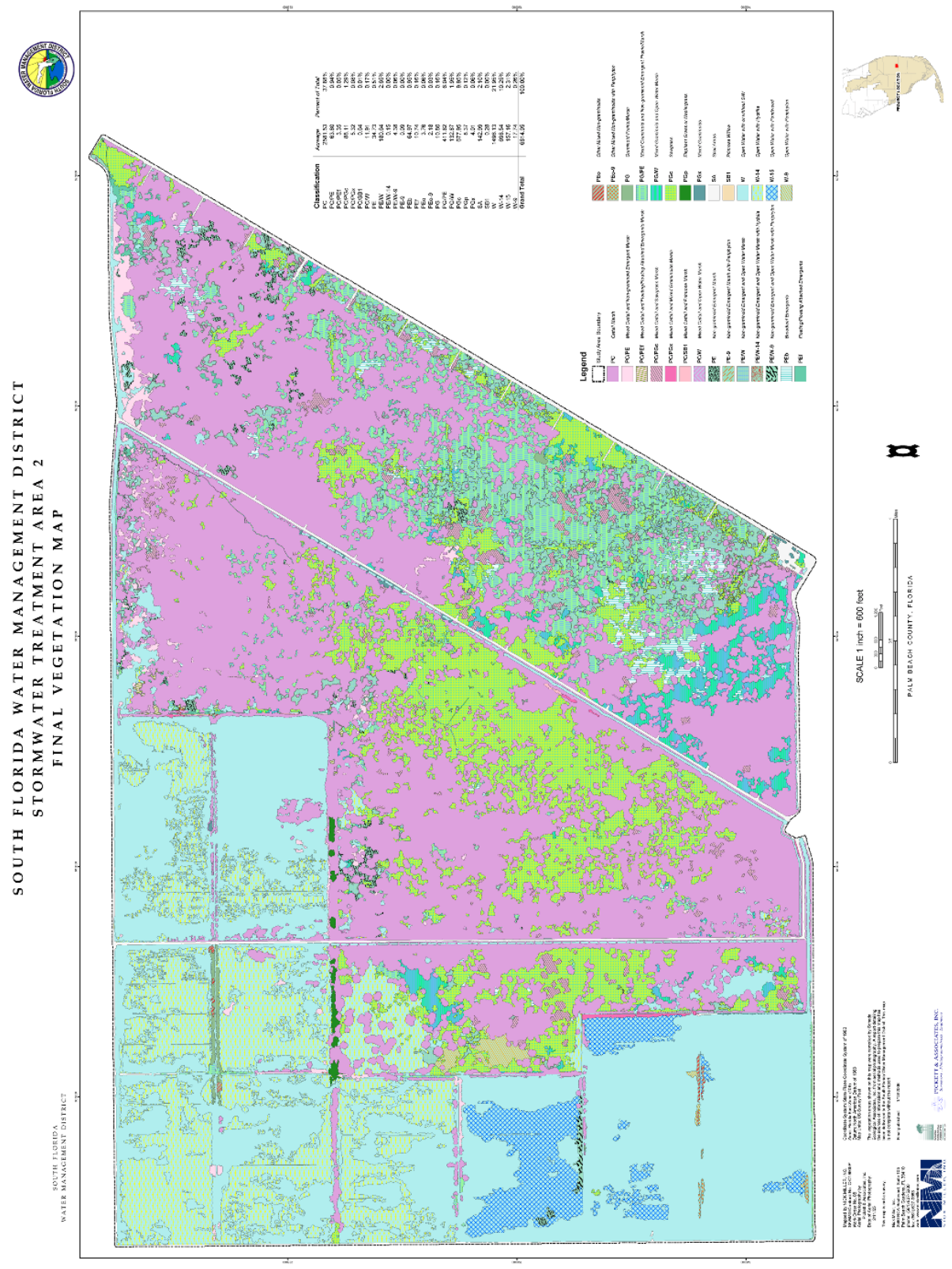


Appendix Figure 4-1. (Continued).

Appendix Table 4-1. Areal coverage of vegetation types mapped in STA-2 in 2003. Aerial photography taken on December 12 & 18, 2003. All areal coverages reported in acres.

				entire STA		Cell 1		Cell 2		Cell 3	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%
1	PC	cattail	Cattail	2575.5	38.44	1168.9	57.54	1165.5	49.10	241.0	10.51
2	PC/PE	cattail	Mixed Cattail & Non-graminoids	48.5	0.72	22.2	1.09	24.6	1.04	1.8	0.08
3	PC/PE-9	cattail	Mixed Cattail, Non-graminoids and periphyton	0.2	0.00	0.0	0.00	0.2	0.01	0.0	0.00
4	PC/PGc	cattail	Mixed Cattail & Sawgrass	696.8	10.40	262.9	12.94	351.4	14.80	82.5	3.60
5	PC/PGx	cattail	Mixed Cattail & Mixed Graminoids	21.8	0.33	0.4	0.02	7.8	0.33	13.5	0.59
6	PC/W	cattail	Mixed Cattail & Open Water	23.4	0.35	14.8	0.73	7.9	0.33	0.8	0.03
7	PE	EAV	Non-graminoids	0.2	0.00	0.2	0.01	0.0	0.00	0.0	0.00
8	PE/W	EAV	Non-graminoids & Open Water	143.6	2.14	24.0	1.18	95.9	4.04	23.7	1.03
9	PEb	EAV	Broadleaf Emergents	44.2	0.66	33.9	1.67	6.6	0.28	3.7	0.16
10	PEf	FAV	Floating/Floating Attached Emergents	12.7	0.19	4.3	0.21	8.3	0.35	0.0	0.00
11	PEo	EAV	Other Mixed Non-Graminoids	3.3	0.05	3.1	0.15	0.0	0.00	0.2	0.01
12	PG/PE	EAV	Mixed Graminoids & Non-graminoids	149.1	2.23	69.9	3.44	65.4	2.75	13.8	0.60
13	PG/W	EAV	Mixed Graminoids & Open Water	330.8	4.94	185.5	9.13	33.3	1.40	112.0	4.88
14	PGc	EAV	Sawgrass	327.5	4.89	177.4	8.74	94.2	3.97	55.9	2.44
15	PGx	EAV	Mixed Graminoids	6.7	0.10	5.9	0.29	0.4	0.02	0.4	0.02
16	SA	other	Spoil	5.3	0.08	3.7	0.18	0.0	0.00	1.6	0.07
17	W	SAV	Open Water with or without SAV	163.4	2.44	53.3	2.62	38.2	1.61	72.0	3.14
18	W-14	SAV	Open Water with Hydrilla	1371.8	20.48	0.8	0.04	474.1	19.97	896.9	39.10
19	W-14/-9	SAV	Open Water, Hydrilla & periphyton	9.0	0.13	0.0	0.00	0.0	0.00	9.0	0.39
20	W-15	SAV	Open Water with pondweed	760.4	11.35	0.0	0.00	0.0	0.00	760.4	33.15
21	W-9	SAV	Open Water with periphyton	5.0	0.07	0.0	0.00	0.0	0.00	4.9	0.21
			Totals	**6699.2**	100	**2031.4**	100	**2373.7**	100	**2294.1**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.



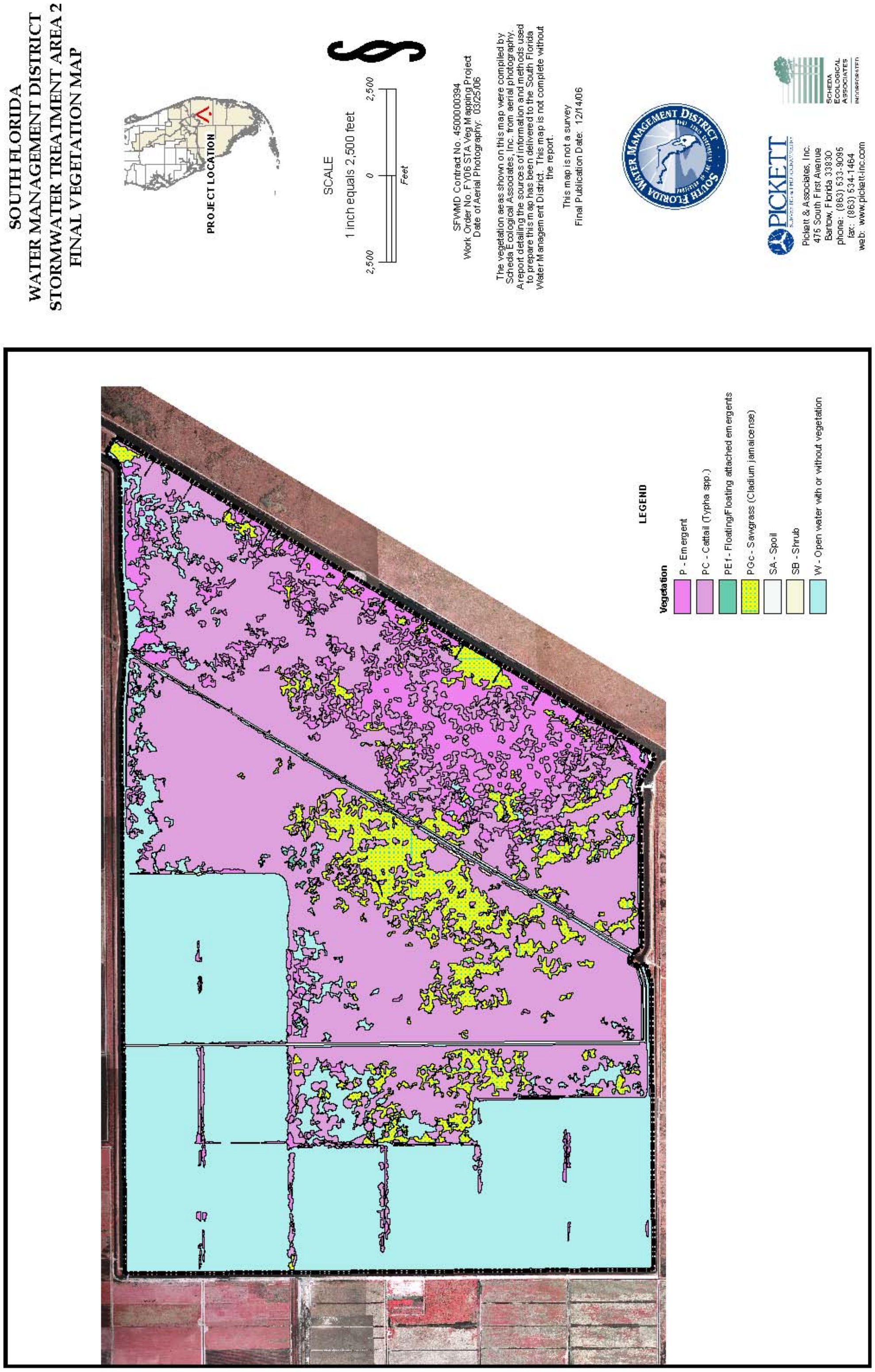
Appendix Figure 4-2. 2005 vegetation map of STA-2. Map compiled by Nick Miller, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: February 11, 2005.

Appendix Figure 4-2. (Continued).

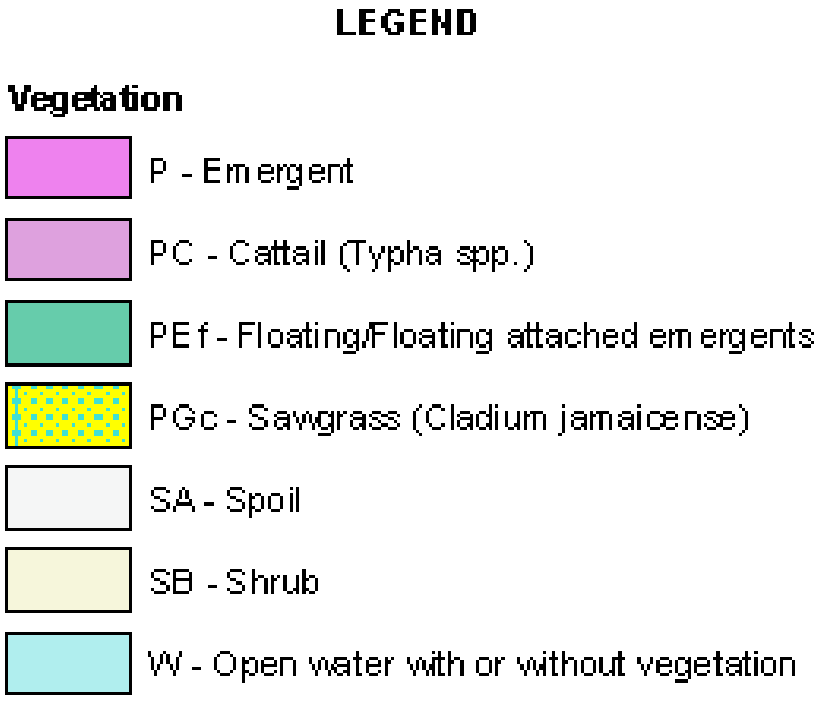
Appendix Table 4-2. Areal coverage of vegetation types mapped in STA-2 in 2005. Aerial photography taken on February 11, 2005. All areal coverages reported in acres.

				entire STA		Cell 1		Cell 2		Cell 3	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%
1	PC	cattail	Cattail	2581.5	37.88	1021.8	48.97	1275.9	53.01	283.9	12.23
2	PC/PE	cattail	Mixed Cattail & Non-graminoids	63.8	0.94	30.8	1.47	24.4	1.01	8.6	0.37
3	PC/PEf	cattail	Mixed Cattail & Floating Aquatic Vegetation	3.3	0.05	0.0	0.00	3.3	0.14	0.0	0.00
4	PC/PGc	cattail	Mixed Cattail & Sawgrass	88.1	1.29	48.7	2.33	23.5	0.98	15.9	0.69
5	PC/PGx	cattail	Mixed Cattail & Mixed Graminoids	5.3	0.08	0.2	0.01	1.5	0.06	3.7	0.16
6	PC/SB1	cattail	Mixed Cattail & Primrose	0.6	0.01	0.0	0.00	0.6	0.03	0.0	0.00
7	PC/W	cattail	Mixed Cattail & Open Water	11.9	0.17	2.3	0.11	8.8	0.37	0.8	0.03
8	PE	EAV	Non-graminoids	34.7	0.51	22.1	1.06	10.9	0.45	1.7	0.07
9	PE/W	EAV	Non-graminoids & Open Water	180.6	2.65	155.7	7.46	17.4	0.72	7.6	0.33
10	PE/W-14	EAV	Non-graminoids, Open Water and Hydrilla	0.2	0.00	0.0	0.00	0.2	0.01	0.0	0.00
11	PE/W-9	EAV	Non-graminoids, Open Water and periphyton	4.4	0.06	0.0	0.00	0.0	0.00	4.4	0.19
12	PE-9	EAV	Non-graminoids and periphyton	0.1	0.00	0.1	0.00	0.0	0.00	0.0	0.00
13	PEb	EAV	Broadleaf Emergents	65.0	0.95	60.0	2.88	3.0	0.13	1.9	0.08
14	PEf	FAV	Floating/Floating Attached Emergents	10.7	0.16	7.0	0.34	3.7	0.15	0.0	0.00
15	PEo	EAV	Other Mixed Non-Graminoids	3.8	0.06	0.0	0.00	0.4	0.01	3.4	0.15
16	PEo-9	EAV	Other Mixed Non-Graminoids with periphyton	2.2	0.03	0.0	0.00	0.0	0.00	2.2	0.09
17	PG	EAV	Graminoids	10.8	0.16	1.3	0.06	0.0	0.00	9.5	0.41
18	PG/PE	EAV	Mixed Graminoids & Non-graminoids	411.8	6.04	368.0	17.64	33.8	1.41	10.0	0.43
19	PG/W	EAV	Mixed Graminoids & Open Water	132.9	1.95	109.8	5.26	2.5	0.10	20.6	0.89
20	PGc	EAV	Sawgrass	677.9	9.95	162.7	7.80	386.0	16.04	129.3	5.57
21	PGp	EAV	Napiergrass	8.4	0.12	0.0	0.00	2.9	0.12	5.4	0.23
22	PGx	EAV	Mixed Graminoids	4.0	0.06	0.8	0.04	2.4	0.10	0.8	0.03
23	SA	other	Spoil	143.0	2.10	72.1	3.45	34.9	1.45	36.1	1.55
24	SB1	shrub	Primrose	0.3	0.00	0.0	0.00	0.3	0.01	0.0	0.00
25	W	SAV	Open Water with or without SAV	1496.1	21.95	23.1	1.11	441.8	18.35	1031.2	44.42
26	W-14	SAV	Open Water with Hydrilla	698.5	10.25	0.0	0.00	128.8	5.35	569.8	24.54
27	W-15	SAV	Open Water with pondweed	157.2	2.31	0.0	0.00	0.0	0.00	157.2	6.77
28	W-9	SAV	Open Water with periphyton	17.7	0.26	0.0	0.00	0.0	0.00	17.7	0.76
			Totals	**6814.9**	100	**2086.5**	100	**2406.8**	100	**2321.6**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.



Appendix Figure 4-3. 2006 vegetation map of STA-2. Map compiled by Pickett & Associates, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: March 25, 2006.



Appendix Figure 4-3. (Continued).

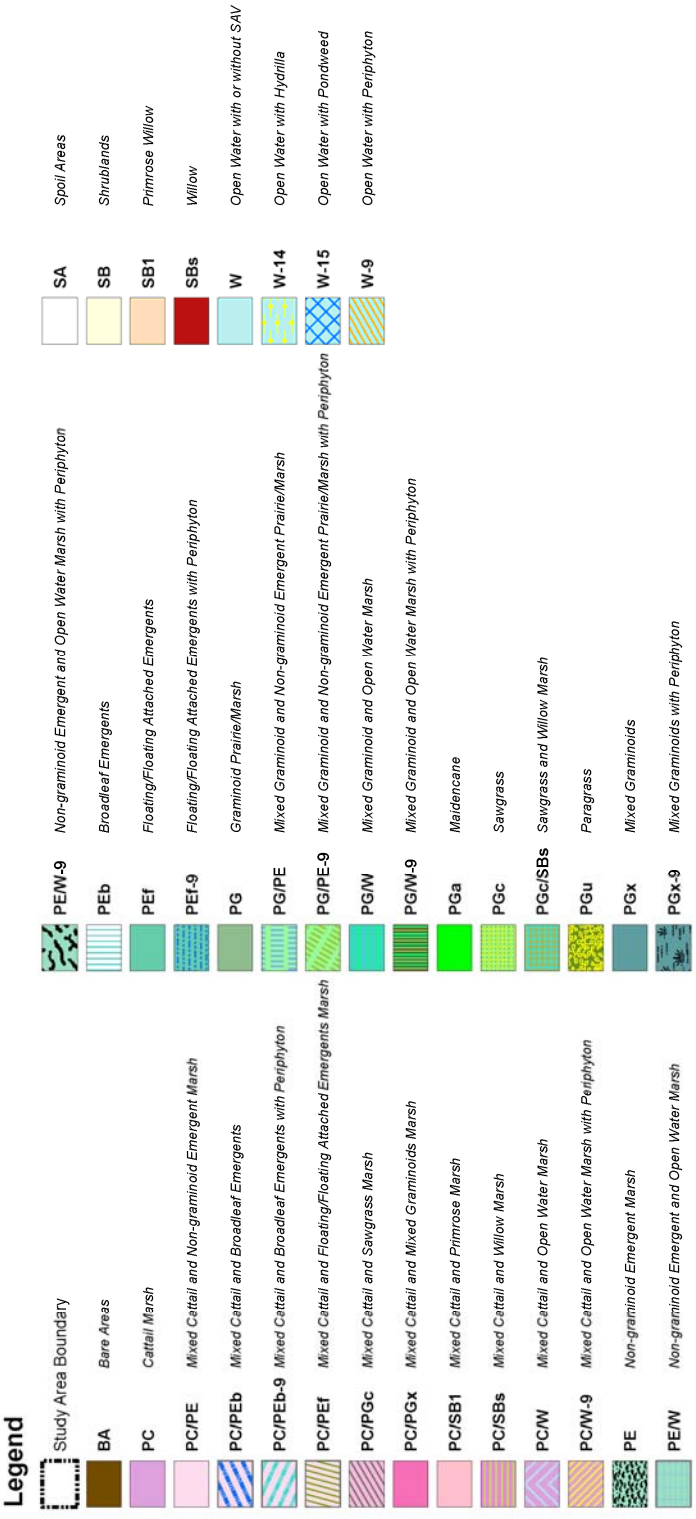
Appendix Table 4-3. Areal coverage of vegetation types mapped in STA-2 in 2006. Aerial photography taken on March 25, 2006. All areal coverages reported in acres.

				entire STA		Cell 1		Cell 2		Cell 3	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%
1	P	EAV	Emergent herbaceous vegetation	633.8	9.30	577.0	27.65	24.0	1.00	32.7	1.41
2	PC	cattail	Cattail	2953.3	43.34	1190.2	57.05	1406.6	58.44	356.4	15.36
3	PEf	FAV	Floating/Floating Attached Emergents	8.8	0.13	0.0	0.00	8.8	0.37	0.0	0.00
4	PGc	EAV	Sawgrass	539.6	7.92	168.4	8.07	278.4	11.57	92.7	4.00
5	SA	other	Spoil	119.9	1.76	50.1	2.40	34.7	1.44	35.1	1.51
6	SB	shrub	Shrub mixture	5.8	0.08	0.0	0.00	5.8	0.24	0.0	0.00
7	W	SAV	Open Water with or without SAV	2553.2	37.47	100.7	4.83	648.5	26.95	1804.0	77.72
			Totals	**6814.3**	100	**2086.5**	100	**2406.8**	100	**2321.0**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.

Appendix 5: STA-3/4 Vegetation Maps and Summaries of Areal Coverage by Vegetation Type

Appendix Figure 5-1. 2005 vegetation map of STA-3/4. Map compiled by Nick Miller, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: February 11, 2005.

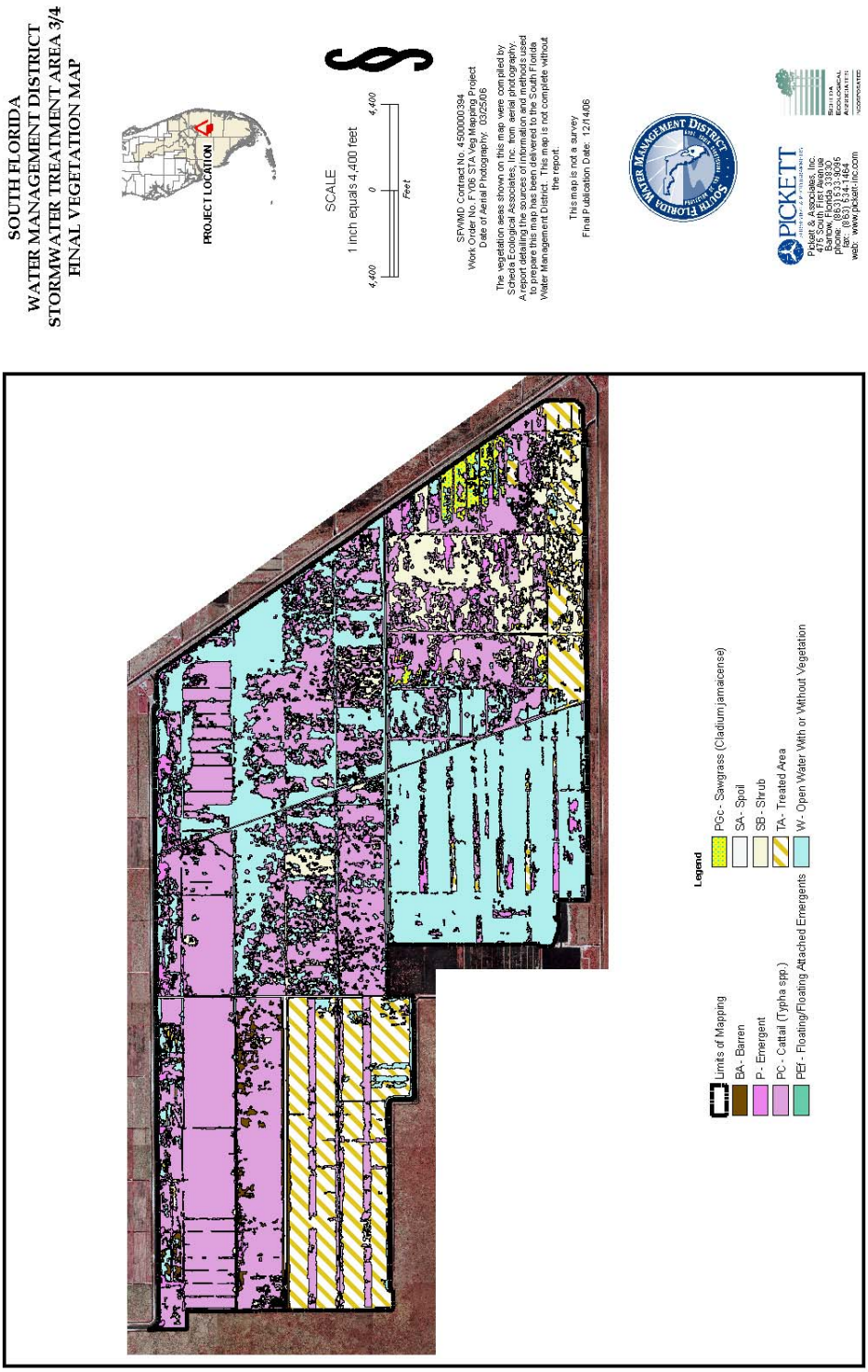


Appendix Figure 5-1. (Continued).

Appendix Table 5-1. Areal coverage of vegetation types mapped in STA-3/4 in 2005. Aerial photography taken on February 11, 2005. All areal coverages reported in acres.

				entire STA		Cell 1A		Cell 1B		Cell 2A		Cell 2B		Cell 3	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%
1	BA	other	Barren soil	198.3	1.23	0.0	0.00	0.4	0.01	0.0	0.00	5.0	0.21	192.9	4.23
2	PC	cattail	Cattail	5965.9	37.12	960.7	31.49	921.6	26.30	1565.4	61.91	2.9	0.12	2515.3	55.11
3	PC/PE	cattail	Mixed Cattail & Non-graminoids	41.5	0.26	21.6	0.71	1.1	0.03	5.1	0.20	0.2	0.01	13.6	0.30
4	PC/PEb	cattail	Mixed Cattail & Broadleaf Emergents	2.4	0.02	0.0	0.00	2.4	0.07	0.0	0.00	0.0	0.00	0.0	0.00
5	PC/PEb-9	cattail	Mixed Cattail & Broadleaf Emergents with periphyton	0.4	0.00	0.0	0.00	0.4	0.01	0.0	0.00	0.0	0.00	0.0	0.00
6	PC/PEf	cattail	Mixed Cattail & Floating Aquatic Vegetation	255.2	1.59	246.1	8.06	1.5	0.04	0.4	0.02	5.9	0.24	1.4	0.03
7	PC/PGc	cattail	Mixed Cattail & Sawgrass	23.6	0.15	8.6	0.28	15.0	0.43	0.0	0.00	0.0	0.00	0.0	0.00
8	PC/PGx	cattail	Mixed Cattail & Mixed Graminoids	334.8	2.08	119.9	3.93	46.8	1.34	2.2	0.09	4.3	0.18	161.6	3.54
9	PC/SB1	cattail	Mixed Cattail & Primrose	167.1	1.04	161.2	5.28	0.0	0.00	0.0	0.00	0.0	0.00	5.9	0.13
10	PC/SBs	cattail	Mixed Cattail & Willow	826.5	5.14	104.6	3.43	53.3	1.52	48.3	1.91	0.0	0.00	620.3	13.59
11	PC/W	cattail	Mixed Cattail & Open Water	203.4	1.27	177.3	5.81	9.2	0.26	9.7	0.38	0.7	0.03	6.5	0.14
12	PC/W-9	cattail	Mixed Cattail, Open Water & periphton	0.5	0.00	0.0	0.00	0.5	0.01	0.0	0.00	0.0	0.00	0.0	0.00
13	PE	EAV	Non-graminoids	2.4	0.01	0.0	0.00	0.1	0.00	0.0	0.00	0.0	0.00	2.3	0.05
14	PE/W	EAV	Non-graminoids & Open Water	178.7	1.11	26.5	0.87	0.2	0.01	141.6	5.60	0.4	0.02	10.0	0.22
15	PE/W-9	EAV	Non-graminoids, Open Water and periphyton	0.6	0.00	0.3	0.01	0.3	0.01	0.0	0.00	0.0	0.00	0.0	0.00
16	PEb	EAV	Broadleaf Emergents	8.0	0.05	0.0	0.00	8.0	0.23	0.0	0.00	0.0	0.00	0.0	0.00
17	PEf	FAV	Floating/Floating Attached Emergents	235.5	1.47	36.2	1.19	2.8	0.08	52.4	2.07	129.8	5.35	14.3	0.31
18	PEf-9	FAV	Floating/Floating Attached Emergents with periphyton	0.6	0.00	0.0	0.00	0.6	0.02	0.0	0.00	0.0	0.00	0.0	0.00
19	PG	EAV	Graminoids	24.3	0.15	16.9	0.56	0.0	0.00	7.2	0.29	0.0	0.00	0.1	0.00
20	PG/PE	EAV	Mixed Graminoids & Non-graminoids	41.8	0.26	5.8	0.19	9.0	0.26	0.0	0.00	17.3	0.71	9.7	0.21
21	PG/PE-9	EAV	Mixed Graminoids & Non-graminoids with periphyton	2.1	0.01	0.0	0.00	2.1	0.06	0.0	0.00	0.0	0.00	0.0	0.00
22	PG/W	EAV	Mixed Graminoids & Open Water	562.7	3.50	291.6	9.56	136.0	3.88	60.1	2.38	73.8	3.04	1.2	0.03
23	PG/W-9	EAV	Mixed Graminoids, Open Water & periphyton	3.4	0.02	0.0	0.00	3.4	0.10	0.0	0.00	0.0	0.00	0.0	0.00
24	PGa	EAV	Maidencane	0.2	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.2	0.00
25	PGc	EAV	Sawgrass	331.8	2.06	0.9	0.03	329.6	9.41	0.7	0.03	0.0	0.00	0.6	0.01
26	PGc/SBs	EAV	Sawgrass & Willow	39.1	0.24	3.4	0.11	35.7	1.02	0.0	0.00	0.0	0.00	0.0	0.00
27	PGu	EAV	Paragrass	243.1	1.51	26.7	0.88	57.5	1.64	37.9	1.50	0.0	0.00	121.0	2.65
28	PGx	EAV	Mixed Graminoids	1234.5	7.68	106.6	3.49	541.1	15.44	135.9	5.37	223.9	9.23	227.0	4.97
29	PGx-9	EAV	Mixed Graminoids and periphyton	1.4	0.01	0.0	0.00	1.4	0.04	0.0	0.00	0.0	0.00	0.0	0.00
30	SA	other	Spoil	314.0	1.95	38.3	1.25	40.5	1.16	34.4	1.36	42.8	1.77	158.0	3.46
31	SB	shrub	Shrub mixture	23.6	0.15	0.9	0.03	0.0	0.00	0.0	0.00	0.3	0.01	22.4	0.49
32	SB1	shrub	Primrose	18.2	0.11	4.9	0.16	0.4	0.01	0.0	0.00	0.7	0.03	12.1	0.27
33	SBs	shrub	Willow	1252.6	7.79	82.9	2.72	811.9	23.17	103.3	4.08	0.9	0.04	253.7	5.56
34	W	SAV	Open Water with or without SAV	3466.1	21.56	604.4	19.81	439.0	12.53	302.3	11.95	1916.2	79.02	204.2	4.47
35	W-14	SAV	Open Water with Hydrilla	21.8	0.14	0.0	0.00	0.0	0.00	21.8	0.86	0.0	0.00	0.0	0.00
36	W-15	SAV	Open Water with pondweed	0.8	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.8	0.02
37	W-9	SAV	Open Water with periphyton	45.8	0.28	4.9	0.16	32.4	0.92	0.0	0.00	0.0	0.00	8.5	0.19
			Totals	**16072.8**	100	**3051.2**	100	**3504.2**	100	**2528.6**	100	**2425.0**	100	**4563.7**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.



Appendix Figure 5-2. 2006 vegetation map of STA-3/4. Map compiled by Pickett & Associates, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: March 25, 2006.

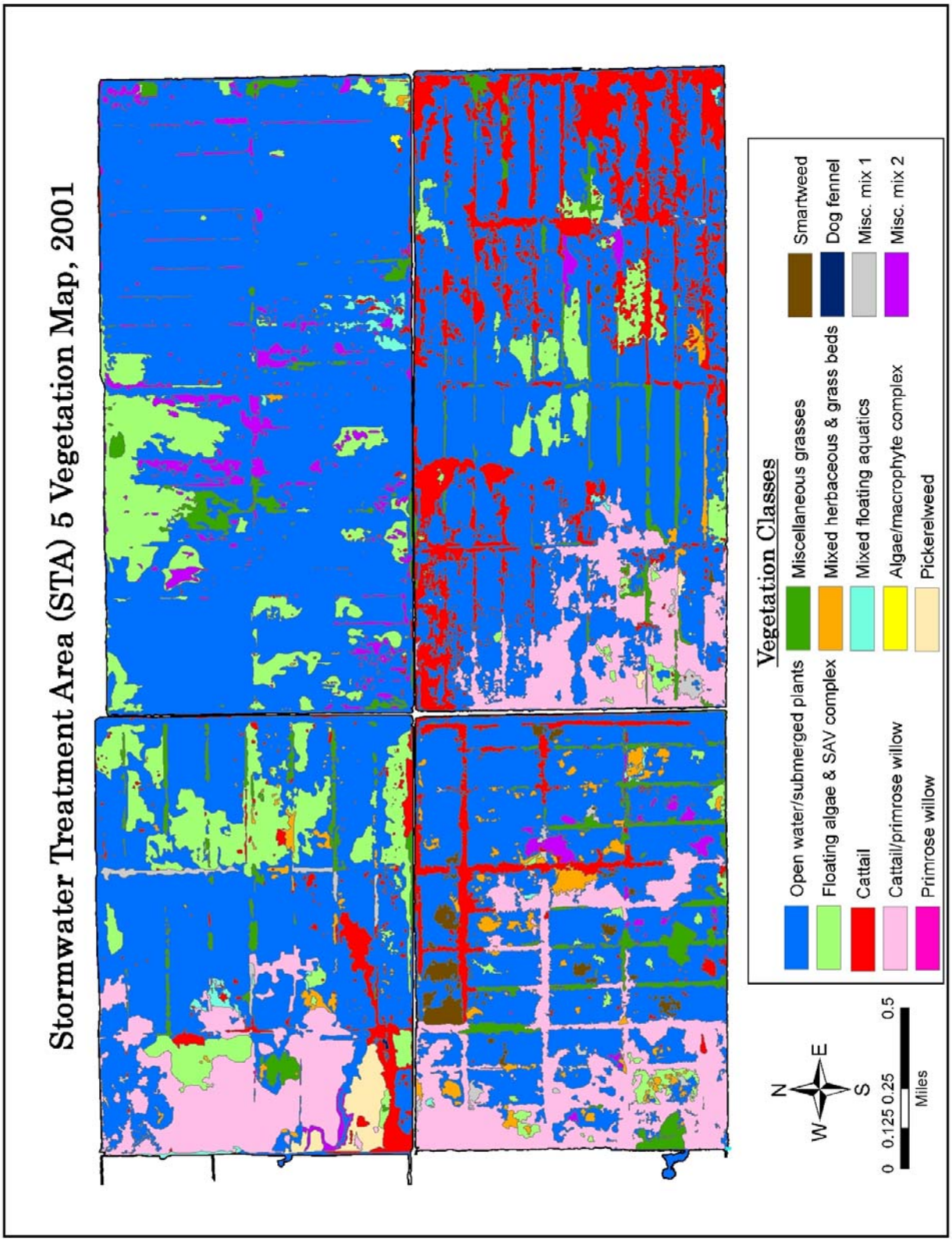
Appendix Figure 5-2. (Continued).

Appendix Table 5-2. Areal coverage of vegetation types mapped in STA-3/4 in 2006. Aerial photography taken on March 25, 2006. All areal coverages reported in acres.

				entire STA		Cell 1A		Cell 1B		Cell 2A		Cell 2B		Cell 3	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%	ac	%
1	BA	other	Barren soil	162.0	1.01	0.2	0.01	0.0	0.00	0.0	0.00	0.5	0.02	161.4	3.54
2	P	EAV	Emergent herbaceous vegetation	685.0	4.26	150.8	4.94	195.4	5.58	138.1	5.46	111.1	4.58	89.6	1.96
3	PC	cattail	Cattail	6371.4	39.64	1295.9	42.47	1163.9	33.21	1490.1	58.93	120.0	4.95	2301.7	50.44
4	PEf	FAV	Floating/Floating Attached Emergents	49.9	0.31	38.3	1.25	0.3	0.01	9.7	0.38	0.0	0.00	1.7	0.04
5	PGc	EAV	Sawgrass	175.6	1.09	0.0	0.00	175.6	5.01	0.0	0.00	0.0	0.00	0.0	0.00
6	SA	other	Spoil	267.9	1.67	39.6	1.30	42.6	1.22	29.4	1.16	47.8	1.97	108.5	2.38
7	SB	shrub	Shrub mixture	1378.5	8.58	152.8	5.01	954.3	27.23	175.2	6.93	0.3	0.01	96.0	2.10
8	TA	other	Treated Area	2034.8	12.66	0.0	0.00	438.9	12.52	0.0	0.00	50.1	2.07	1545.7	33.87
9	W	SAV	Open Water with or without SAV	4947.4	30.78	1373.9	45.02	533.6	15.23	686.1	27.14	2095.1	86.40	258.7	5.67
			Totals	**16072.5**	100	**3051.4**	100	**3504.4**	100	**2528.6**	100	**2424.9**	100	**4563.3**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.

Appendix 6: STA-5 Vegetation Maps and Summaries of Areal Coverage by Vegetation Type

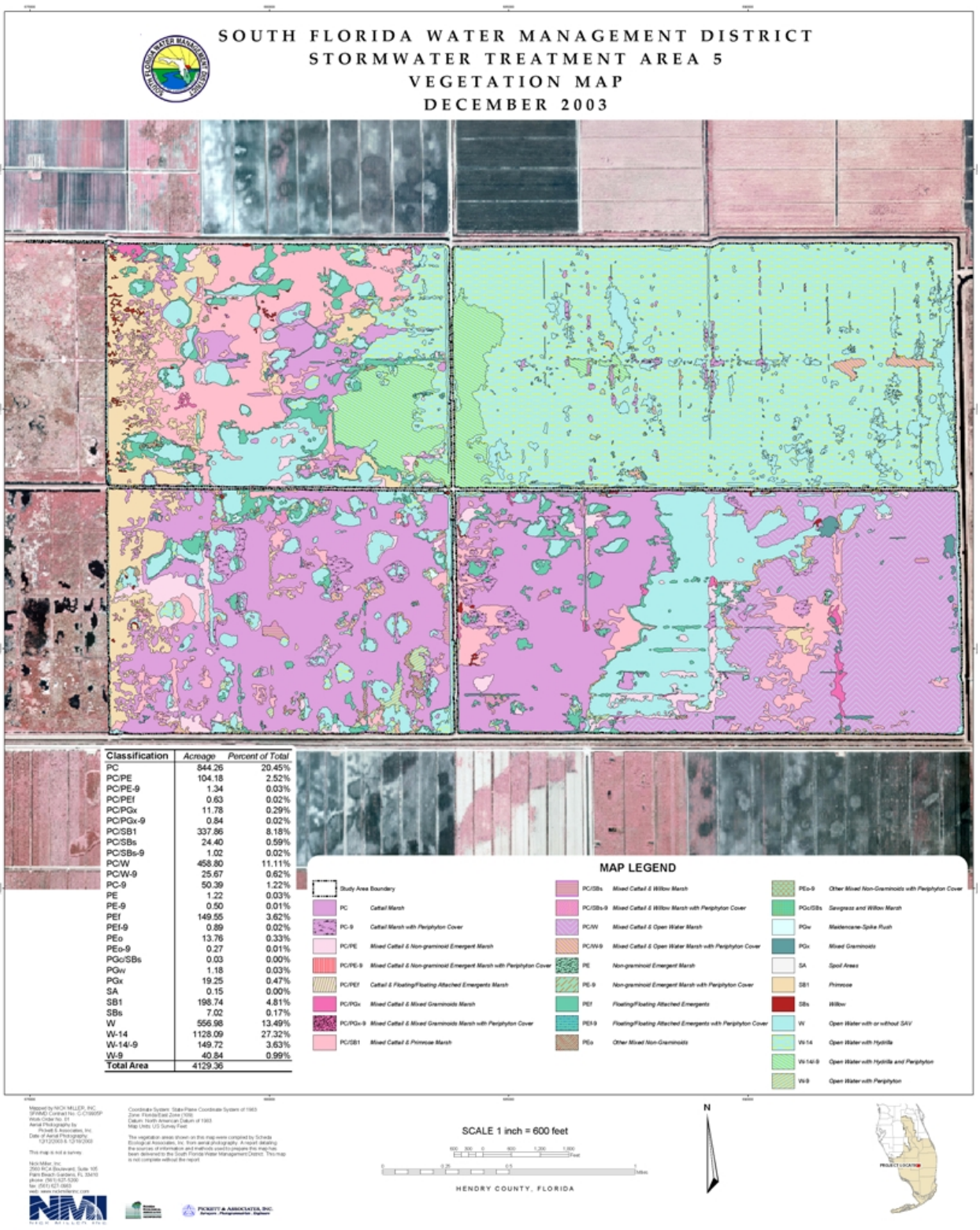


Appendix Figure 6-1. 2001 vegetation map of STA-5. Map compiled by GEONEX, Inc.

Appendix Table 6-1. Areal coverage of vegetation types mapped in STA-5 in 2001. All areal coverages reported in acres.

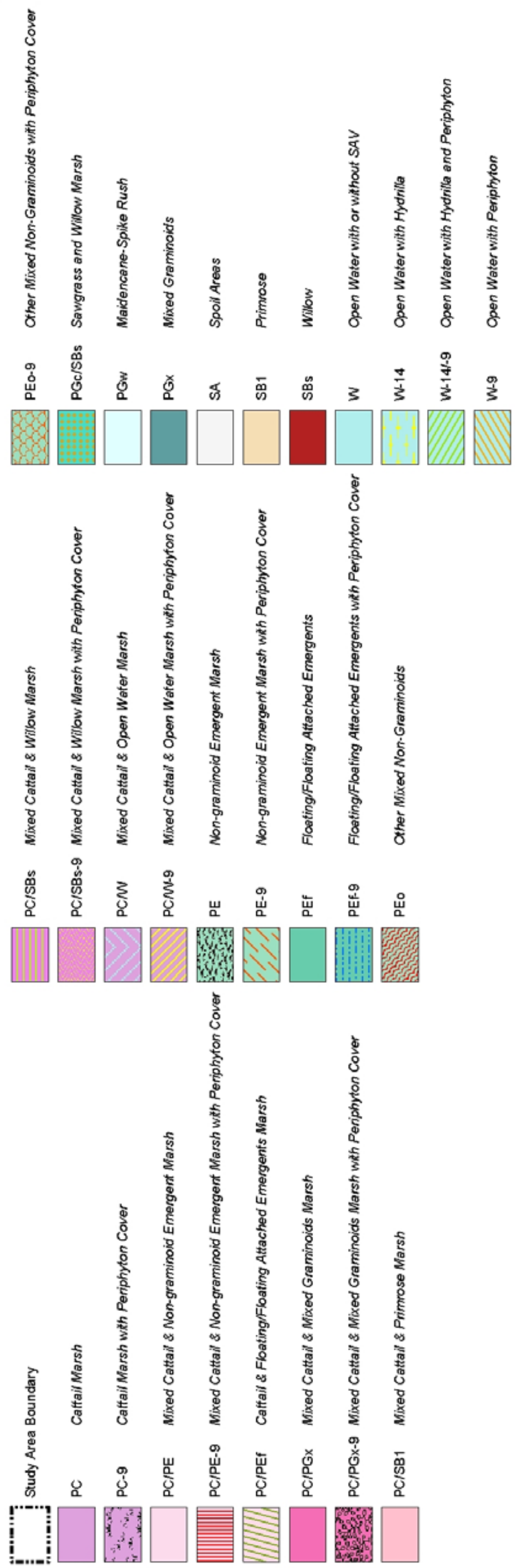
				entire STA		Cell 1A		Cell 1B		Cell 2A		Cell 2B	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%
1	PC	cattail	CATTAIL	342.1	8.20	46.2	5.37	5.1	0.42	53.4	6.32	237.4	19.14
2	PC	cattail	CATTAIL-PRIMROSE WILLOW	440.1	10.55	135.7	15.76	0.0	0.00	178.8	21.14	125.6	10.13
3	PEb	EAV	PICKERELWEED	23.0	0.55	21.5	2.50	0.0	0.00	0.0	0.00	1.5	0.12
4	PEb	EAV	DOG FENNEL	0.2	0.01	0.2	0.03	0.0	0.00	0.0	0.00	0.0	0.00
5	PEf	FAV	MIXED FLOATING AQUATICS	16.5	0.40	5.8	0.67	7.9	0.64	1.7	0.20	1.1	0.09
6	PEo	EAV	SMARTWEED	21.9	0.53	0.0	0.00	0.0	0.00	20.8	2.46	1.1	0.09
7	PG/PE	EAV	MIXED HERBACEOUS AND GRASS BEDS	50.7	1.22	10.5	1.21	1.8	0.15	31.5	3.72	6.9	0.56
8	PG/PE	EAV	MISC. MIX 1	17.9	0.43	8.4	0.97	0.0	0.00	4.9	0.58	4.6	0.37
9	PG/PE	EAV	MISC. MIX 2	84.3	2.02	3.7	0.43	63.0	5.15	12.6	1.49	5.1	0.41
10	PGx	EAV	MISCELLANEOUS GRASSES	135.3	3.24	26.1	3.03	28.7	2.35	46.1	5.46	34.4	2.77
11	SB1	shrub	PRIMROSE WILLOW	0.1	0.00	0.1	0.02	0.0	0.00	0.0	0.00	0.0	0.00
12	W	SAV	OPEN WATER/SUBMERGED PLANTS	2692.1	64.56	470.0	54.57	985.1	80.53	480.1	56.77	756.9	61.04
13	W	SAV	ALGAE/MACROPHYTE COMPLEX	0.5	0.01	0.0	0.00	0.5	0.04	0.0	0.00	0.0	0.00
14	W-9	SAV	FLOATING ALGAE AND SAV COMPLEX	345.2	8.28	133.0	15.44	131.1	10.71	15.8	1.87	65.3	5.27
			Totals	**4170.1**	100	**861.1**	100	**1223.2**	100	**845.7**	100	**1240.0**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.



Classification	Acreage	Percent of Total
PC	844.26	20.45%
PC/PE	104.18	2.52%
PC/PE-9	1.34	0.03%
PC/PEf	0.63	0.02%
PC/PGx	11.78	0.29%
PC/PGx-9	0.84	0.02%
PC/SB1	337.86	8.18%
PC/SBs	24.40	0.59%
PC/SBs-9	1.02	0.02%
PC/W	458.80	11.11%
PC/W-9	25.67	0.62%
PC-9	50.39	1.22%
PE	1.22	0.03%
PE-9	0.50	0.01%
PEf	149.55	3.62%
PEf-9	0.89	0.02%
PEo	13.76	0.33%
PEo-9	0.27	0.01%
PGc/SBs	0.03	0.00%
PGw	1.18	0.03%
PGx	19.25	0.47%
SA	0.15	0.00%
SB1	198.74	4.81%
SBs	7.02	0.17%
W	556.98	13.49%
W-14	1128.09	27.32%
W-14/-9	149.72	3.63%
W-9	40.84	0.99%
Total Area	4129.36	

Appendix Figure 6-2. 2003 vegetation map of STA-5. Map compiled by Nick Miller, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: December 12 & 18, 2003.

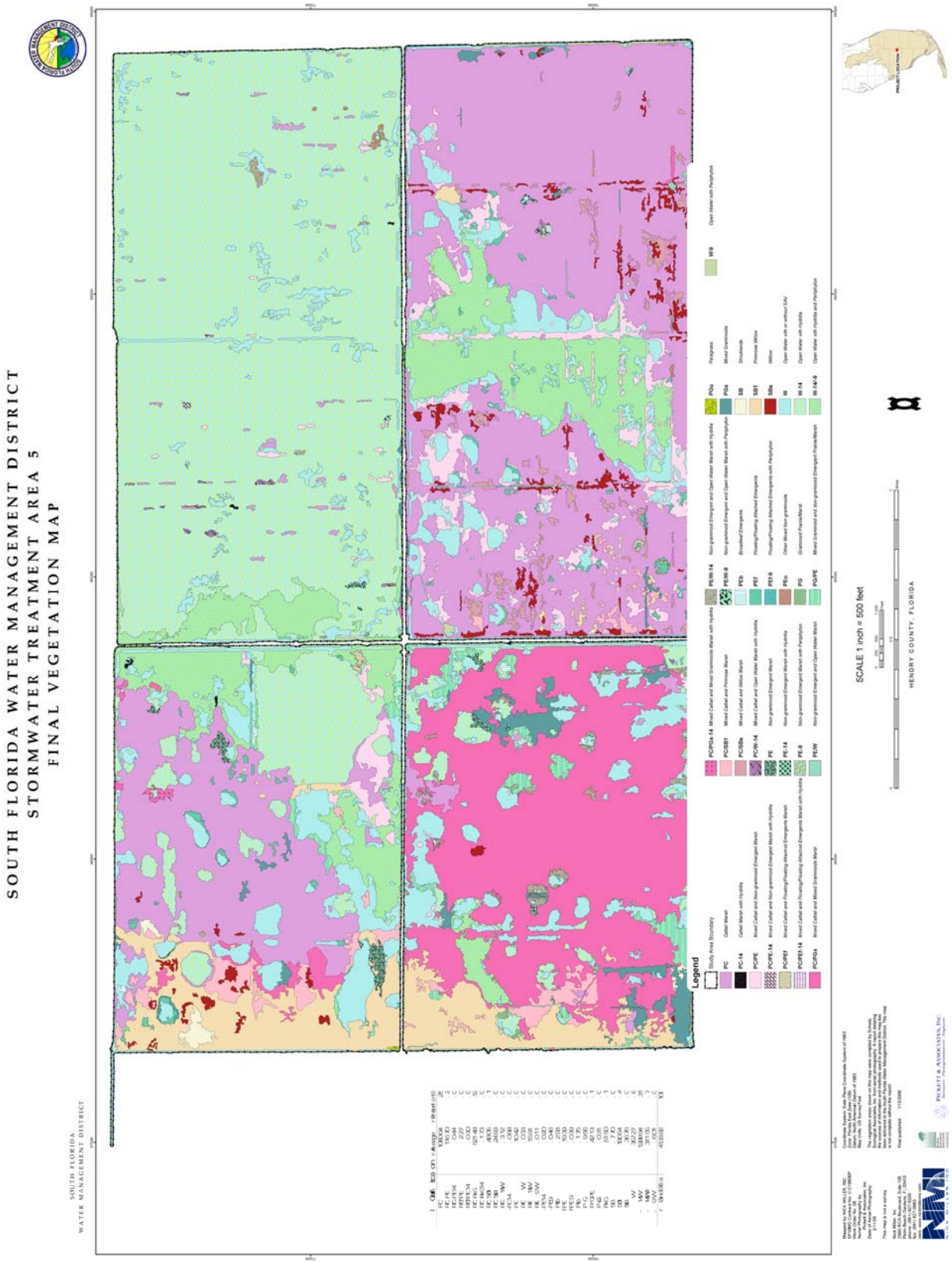


Appendix Figure 6-2. (Continued).

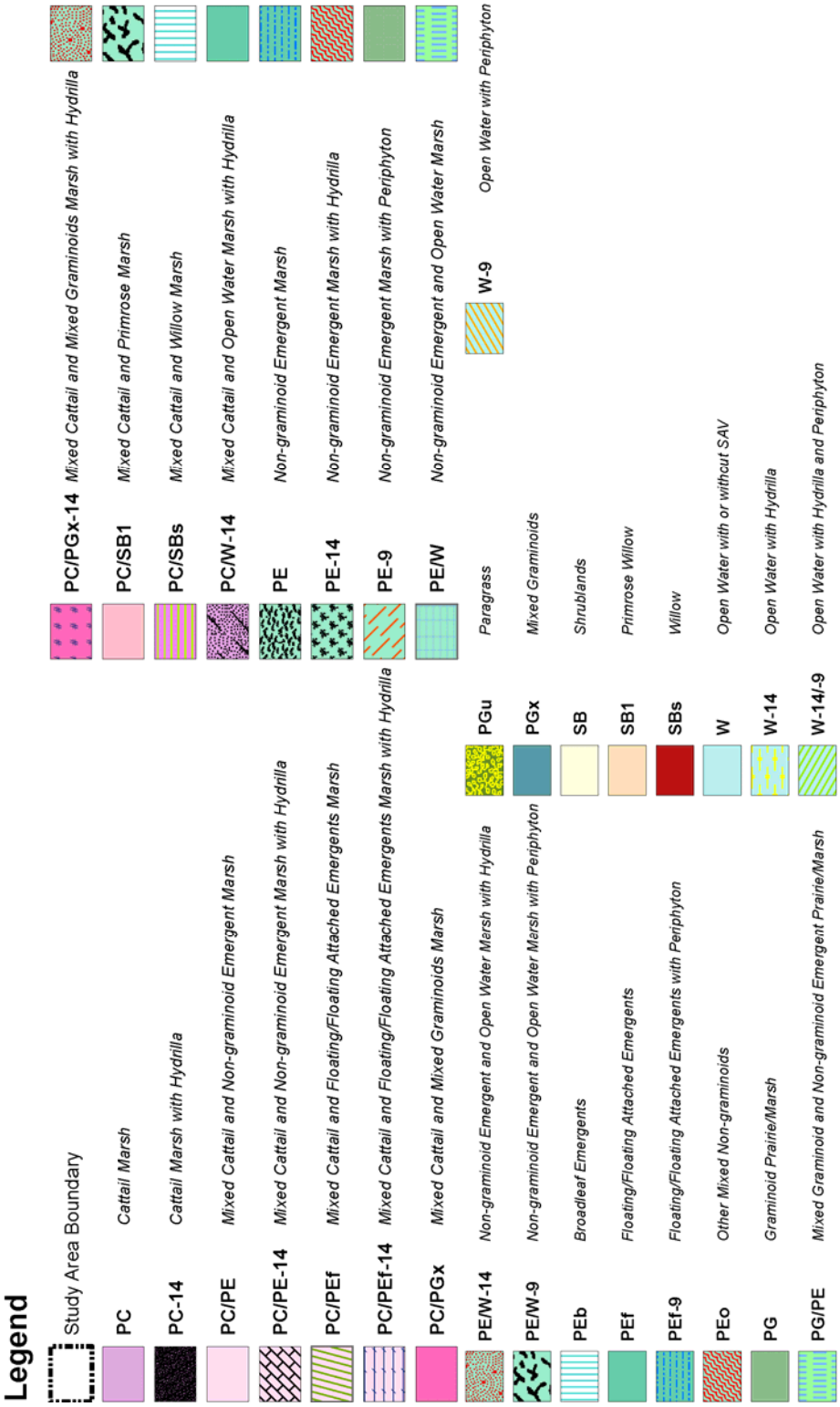
Appendix Table 6-2. Areal coverage of vegetation types mapped in STA-5 in 2003. Aerial photography taken on December 12 & 18, 2003. All areal coverages reported in acres.

				entire STA		Cell 1A		Cell 1B		Cell 2A		Cell 2B	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%
1	PC	cattail	Cattail	844.3	20.45	75.1	8.95	2.7	0.22	464.1	54.95	302.4	24.66
2	PC/PE	cattail	Mixed Cattail & Non-graminoids	104.2	2.52	26.9	3.20	0.0	0.00	35.9	4.25	41.4	3.38
3	PC/PE-9	cattail	Mixed Cattail, Non-graminoids and periphyton	1.3	0.03	0.8	0.10	0.0	0.00	0.4	0.04	0.2	0.01
4	PC/PEf	cattail	Mixed Cattail & Floating Aquatic Vegetation	0.6	0.02	0.6	0.08	0.0	0.00	0.0	0.00	0.0	0.00
5	PC/PGx	cattail	Mixed Cattail & Mixed Graminoids	11.8	0.29	4.2	0.50	0.0	0.00	0.3	0.03	7.4	0.60
6	PC/PGx-9	cattail	Mixed Cattail, Mixed Graminoids & periphyton	0.8	0.02	0.0	0.00	0.0	0.00	0.8	0.10	0.0	0.00
7	PC/SB1	cattail	Mixed Cattail & Primrose	337.9	8.18	215.7	25.70	0.0	0.00	34.5	4.09	87.7	7.15
8	PC/SBs	cattail	Mixed Cattail & Willow	24.4	0.59	6.8	0.81	0.0	0.00	11.0	1.30	6.6	0.54
9	PC/SBs-9	cattail	Mixed Cattail, Willow & periphyton	1.0	0.02	0.0	0.00	0.0	0.00	1.0	0.12	0.0	0.00
10	PC/W	cattail	Mixed Cattail & Open Water	458.8	11.11	3.3	0.39	0.5	0.04	13.9	1.65	441.1	35.98
11	PC/W-9	cattail	Mixed Cattail, Open Water & periphton	25.7	0.62	0.9	0.10	9.5	0.78	8.8	1.04	6.5	0.53
12	PC-9	cattail	Cattail and periphyton	50.4	1.22	2.7	0.32	8.2	0.67	17.1	2.02	22.4	1.83
13	PE	EAV	Non-graminoids	1.2	0.03	0.1	0.02	0.0	0.00	0.4	0.05	0.6	0.05
14	PE-9	EAV	Non-graminoids and periphyton	0.5	0.01	0.0	0.00	0.0	0.00	0.5	0.06	0.0	0.00
15	PEf	FAV	Floating/Floating Attached Emergents	149.6	3.62	72.6	8.66	0.0	0.00	26.7	3.16	50.2	4.09
16	PEf-9	FAV	Floating/Floating Attached Emergents with periphyton	0.9	0.02	0.0	0.00	0.0	0.00	0.9	0.11	0.0	0.00
17	PEo	EAV	Other Mixed Non-Graminoids	13.8	0.33	3.1	0.38	0.1	0.01	7.7	0.91	2.9	0.23
18	PEo-9	EAV	Other Mixed Non-Graminoids with periphyton	0.3	0.01	0.2	0.02	0.0	0.00	0.1	0.01	0.0	0.00
19	PGc/SBs	EAV	Sawgrass & Willow	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
20	PGw	EAV	Maidencane-Spike rush	1.2	0.03	0.0	0.00	0.0	0.00	1.2	0.14	0.0	0.00
21	PGx	EAV	Mixed Graminoids	19.2	0.47	2.5	0.30	1.2	0.10	2.6	0.31	12.9	1.05
22	SA	other	Spoil	0.2	0.00	0.0	0.00	0.0	0.00	0.2	0.02	0.0	0.00
23	SB1	shrub	Primrose	198.7	4.81	121.6	14.50	0.0	0.00	72.9	8.63	4.2	0.34
24	SBs	shrub	Willow	7.0	0.17	4.4	0.53	0.0	0.00	0.7	0.08	1.9	0.16
25	W	SAV	Open Water with or without SAV	557.0	13.49	125.7	14.99	100.5	8.24	105.1	12.45	225.6	18.40
26	W-14	SAV	Open Water with Hydrilla	1128.1	27.32	84.4	10.05	1025.7	84.08	17.5	2.07	0.5	0.04
27	W-14/-9	SAV	Open Water, Hydrilla & periphyton	149.7	3.63	81.0	9.66	68.7	5.63	0.0	0.00	0.0	0.00
28	W-9	SAV	Open Water with periphyton	40.8	0.99	6.3	0.76	2.8	0.23	20.3	2.41	11.4	0.93
			Totals	**4129.4**	100	**839.0**	100	**1219.9**	100	**844.5**	100	**1225.9**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.



Appendix Figure 6-3. 2005 vegetation map of STA-5. Map compiled by Nick Miller, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: February 11, 2005.



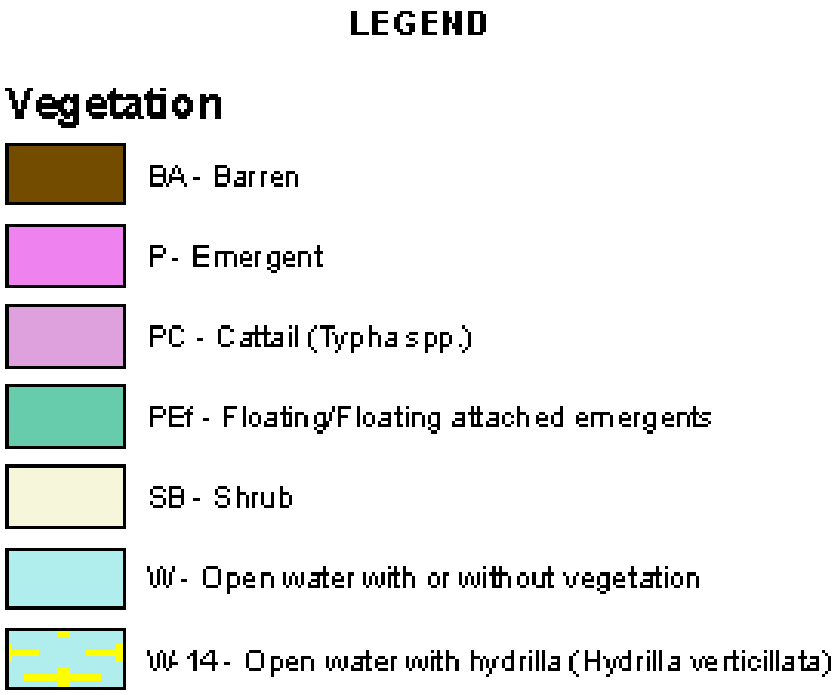
Appendix Figure 6-3. (Continued).

Appendix Table 6-3. Areal coverage of vegetation types mapped in STA-5 in 2005. Aerial photography taken on February 11, 2005. All areal coverages reported in acres.

				entire STA		Cell 1A		Cell 1B		Cell 2A		Cell 2B	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%
1	PC	cattail	Cattail	1060.0	25.64	275.1	32.69	8.1	0.66	13.0	1.54	763.9	62.27
2	PC/PE	cattail	Mixed Cattail & Non-graminoids	116.7	2.82	17.6	2.09	3.9	0.32	1.5	0.17	93.8	7.64
3	PC/PE-14	cattail	Mixed Cattail, Non-graminoids & Hydrilla	0.4	0.01	0.0	0.00	0.4	0.04	0.0	0.00	0.0	0.00
4	PC/PEf	cattail	Mixed Cattail & Floating Aquatic Vegetation	2.3	0.06	1.2	0.14	0.0	0.00	0.0	0.00	1.1	0.09
5	PC/PEf-14	cattail	Mixed Cattail, Floating Aquatic Vegetation & Hydrilla	0.3	0.01	0.0	0.00	0.3	0.02	0.0	0.00	0.0	0.00
6	PC/PGx	cattail	Mixed Cattail & Mixed Graminoids	521.5	12.62	15.7	1.87	0.3	0.02	504.5	59.67	0.9	0.08
7	PC/PGx-14	cattail	Mixed Cattail, Mixed Graminoids & Hydrilla	1.7	0.04	1.7	0.21	0.0	0.00	0.0	0.00	0.0	0.00
8	PC/SB1	cattail	Mixed Cattail & Primrose	48.0	1.16	24.3	2.89	0.0	0.00	16.5	1.95	7.3	0.59
9	PC/SBs	cattail	Mixed Cattail & Willow	24.8	0.60	0.0	0.00	0.0	0.00	0.0	0.00	24.8	2.02
10	PC/W-14	cattail	Mixed Cattail, Open Water & Hydrilla	3.1	0.08	0.0	0.00	2.4	0.20	0.1	0.01	0.6	0.05
11	PC-14	cattail	Cattail with Hydrilla	0.7	0.02	0.4	0.05	0.3	0.02	0.0	0.00	0.0	0.00
12	PE	EAV	Non-graminoids	10.4	0.25	6.4	0.77	1.1	0.09	2.4	0.28	0.6	0.05
13	PE/W	EAV	Non-graminoids & Open Water	0.3	0.01	0.0	0.00	0.0	0.00	0.2	0.02	0.2	0.01
14	PE/W-14	EAV	Non-graminoids, Open Water and Hydrilla	15.9	0.38	0.3	0.03	2.0	0.17	13.6	1.61	0.0	0.00
15	PE/W-9	EAV	Non-graminoids, Open Water and periphyton	0.1	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.1	0.01
16	PE-14	EAV	Non-graminoids and Hydrilla	0.2	0.00	0.0	0.00	0.2	0.02	0.0	0.00	0.0	0.00
17	PE-9	EAV	Non-graminoids and periphyton	0.5	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.5	0.04
18	PEb	EAV	Broadleaf Emergents	2.9	0.07	1.4	0.16	0.0	0.00	1.3	0.15	0.3	0.02
19	PEf	FAV	Floating/Floating Attached Emergents	19.4	0.47	8.0	0.95	0.0	0.00	0.1	0.01	11.3	0.92
20	PEf-9	FAV	Floating/Floating Attached Emergents with periphyton	0.4	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.4	0.03
21	PEo	EAV	Other Mixed Non-Graminoids	1.7	0.04	0.0	0.00	1.3	0.10	0.0	0.00	0.5	0.04
22	PG	EAV	Graminoids	9.6	0.23	2.8	0.34	5.5	0.45	0.8	0.09	0.4	0.04
23	PG/PE	EAV	Mixed Graminoids & Non-graminoids	42.1	1.02	9.6	1.14	1.3	0.11	30.1	3.56	1.2	0.10
24	PGu	EAV	Paragrass	0.3	0.01	0.3	0.04	0.0	0.00	0.0	0.00	0.0	0.00
25	PGx	EAV	Mixed Graminoids	51.5	1.25	4.7	0.56	1.8	0.14	34.6	4.10	10.4	0.84
26	SB	shrub	Shrub mixture	7.7	0.19	6.3	0.75	0.0	0.00	0.9	0.11	0.5	0.04
27	SB1	shrub	Primrose	190.5	4.61	112.3	13.35	0.1	0.01	72.6	8.59	5.5	0.45
28	SBs	shrub	Willow	36.8	0.89	7.4	0.88	0.0	0.00	1.0	0.11	28.4	2.32
29	W	SAV	Open Water with or without SAV	357.3	8.64	109.8	13.04	48.3	3.96	90.7	10.73	108.5	8.85
30	W-14	SAV	Open Water with Hydrilla	1288.9	31.18	138.3	16.44	1097.6	89.97	47.8	5.66	5.2	0.42
31	W-14/-9	SAV	Open Water, Hydrilla & periphyton	311.5	7.54	97.9	11.63	45.2	3.70	13.9	1.65	154.6	12.60
32	W-9	SAV	Open Water with periphyton	6.0	0.15	0.0	0.00	0.0	0.00	0.0	0.00	6.0	0.49
			Totals	4133.8	100	841.7	100	1219.9	100	845.5	100	1226.7	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.

Appendix Figure 6-4. 2006 vegetation map of STA-5. Map compiled Pickett & Associates, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: March 25, 2006.



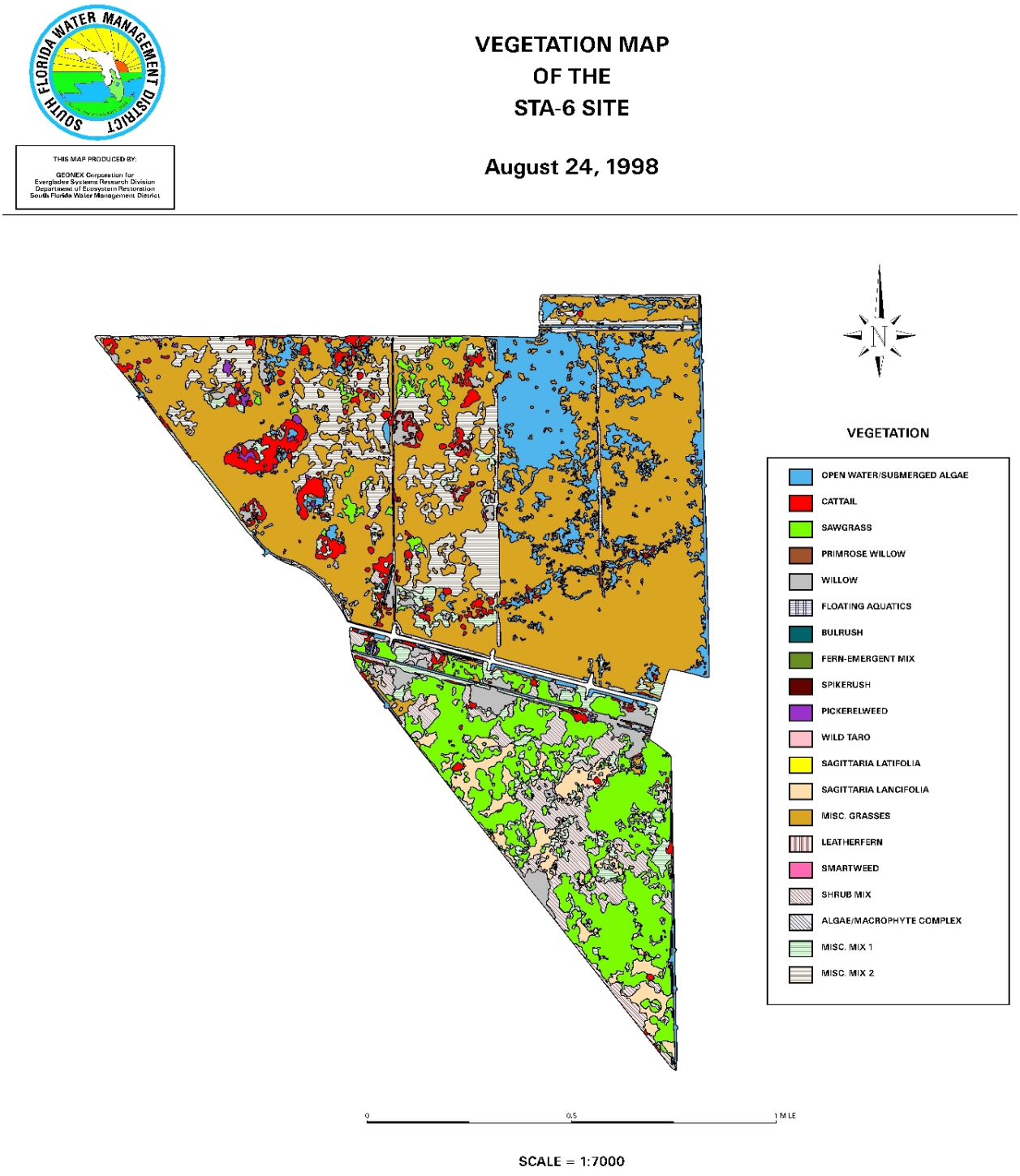
Appendix Figure 6-4. (Continued).

Appendix Table 6-4. Areal coverage of vegetation types mapped in STA-5 in 2006. Aerial photography taken on March 25, 2006. All areal coverages reported in acres.

				entire STA		Cell 1A		Cell 1B		Cell 2A		Cell 2B	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%	ac	%	ac	%
1	BA	other	Barren soil	292.4	7.08	30.2	3.61	6.1	0.50	136.3	16.14	119.7	9.78
2	P	EAV	Emergent herbaceous vegetation	423.4	10.26	199.3	23.77	7.2	0.59	154.0	18.22	62.9	5.14
3	PC	cattail	Cattail	1493.4	36.19	225.9	26.95	61.4	5.03	444.4	52.60	761.7	62.25
4	PEf	FAV	Floating/Floating Attached Emergents	46.0	1.11	4.7	0.56	0.0	0.00	6.1	0.73	35.1	2.87
5	SB	shrub	Shrub mixture	72.9	1.77	24.3	2.90	0.0	0.00	15.3	1.81	33.3	2.72
6	W	SAV	Open Water with or without SAV	1081.5	26.21	327.1	39.01	468.8	38.44	79.1	9.37	206.5	16.87
7	W-14	SAV	Open Water with Hydrilla	717.2	17.38	26.8	3.20	676.3	55.44	9.7	1.14	4.5	0.37
			Totals	4126.7	100	838.4	100	1219.7	100	844.9	100	1223.7	100

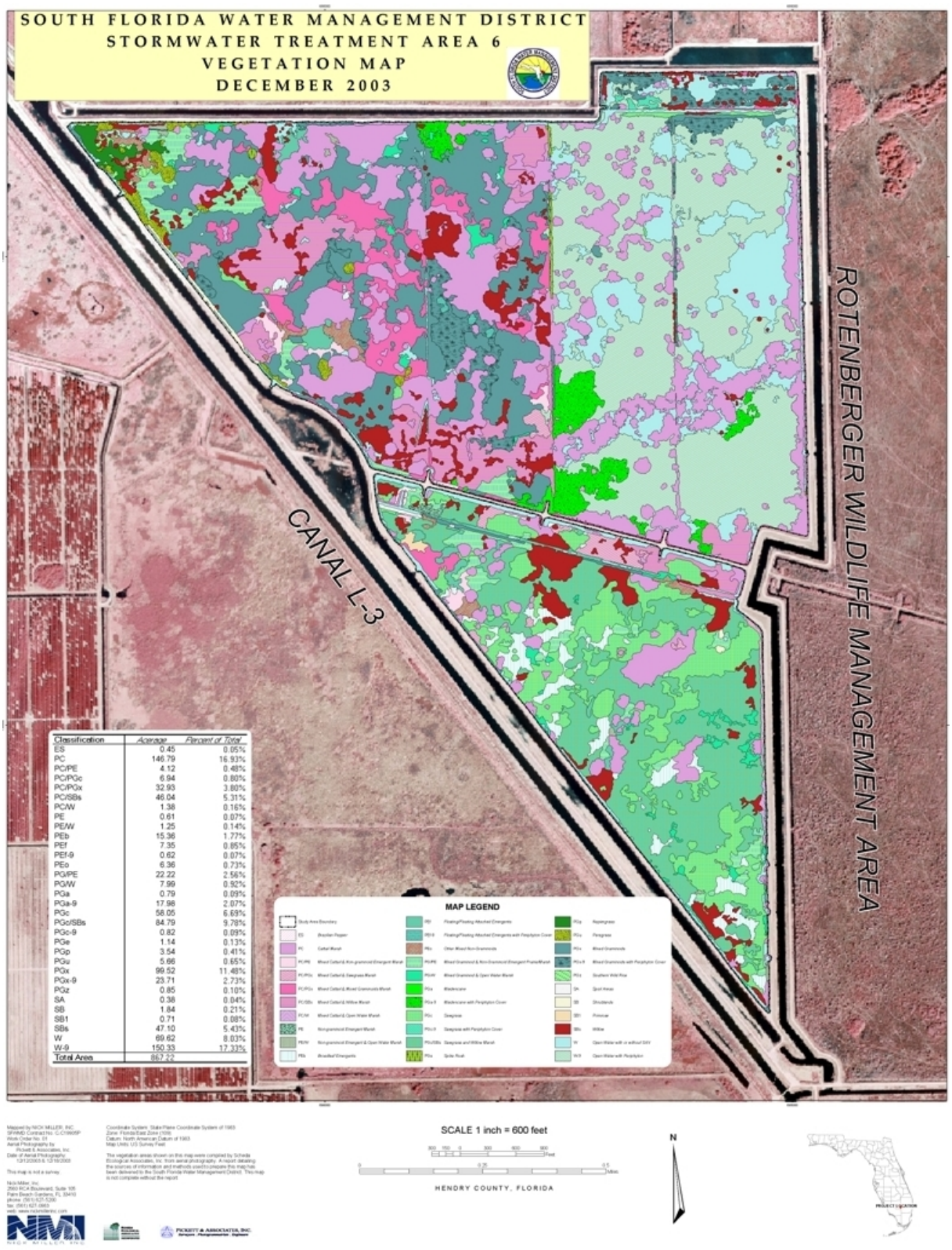
[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.

Appendix 7: STA-6 Vegetation Maps and Summaries of Areal Coverage by Vegetation Type



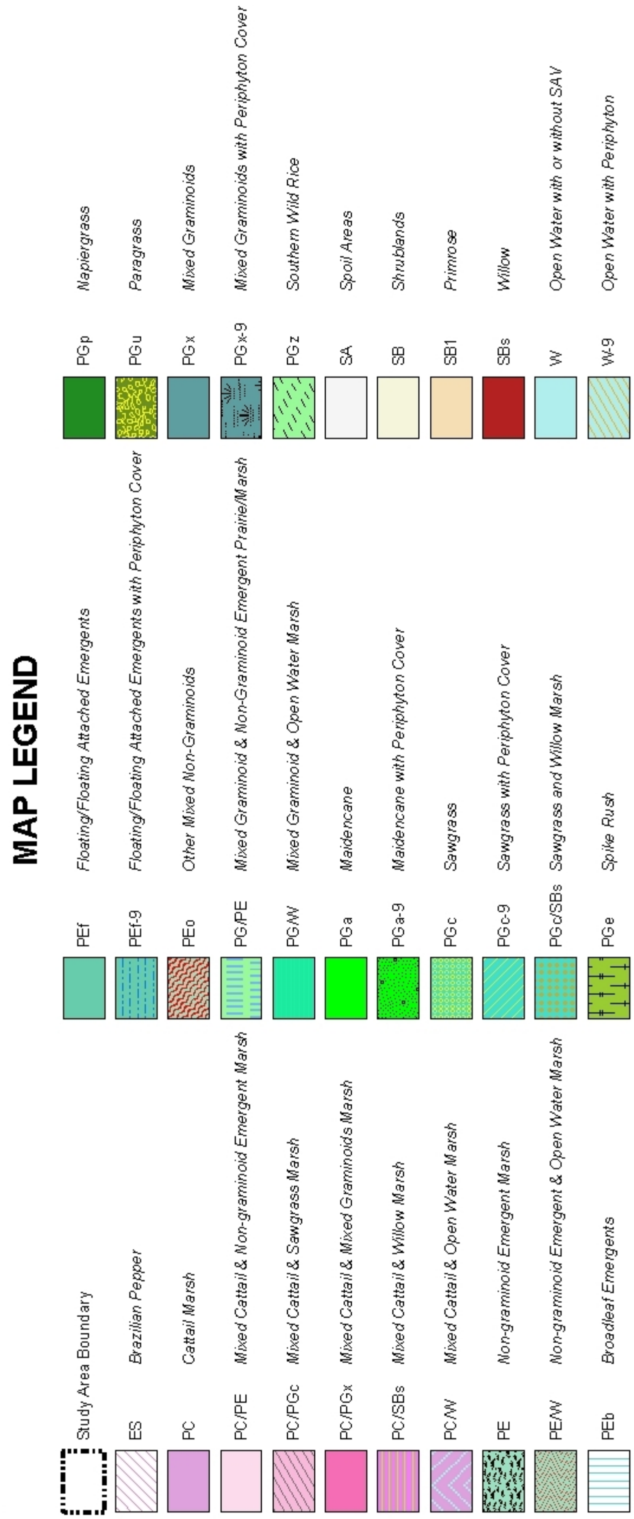
Appendix Figure 7-1. 1998 vegetation map of STA-6. Map compiled by GEONEX, Inc. Date of aerial photography: August 24, 1998.

Areal coverages for vegetation types mapped in STA-6 in 1998 are not available**.**



Classification	Acreage	Percent of Total
ES	0.45	0.05%
PC	146.79	16.93%
PC/PE	4.12	0.48%
PC/PGc	6.94	0.80%
PC/PGx	32.93	3.80%
PC/SBs	46.04	5.31%
PC/W	1.38	0.16%
PE	0.61	0.07%
PE/W	1.25	0.14%
PEb	15.36	1.77%
PEf	7.35	0.85%
PEf-9	0.62	0.07%
PEo	6.36	0.73%
PG/PE	22.22	2.56%
PG/W	7.99	0.92%
PGa	0.79	0.09%
PGa-9	17.98	2.07%
PGc	58.05	6.69%
PGc/SBs	84.79	9.78%
PGc-9	0.82	0.09%
PGe	1.14	0.13%
PGp	3.54	0.41%
PGu	5.66	0.65%
PGx	99.52	11.48%
PGx-9	23.71	2.73%
PGz	0.85	0.10%
SA	0.38	0.04%
SB	1.84	0.21%
SB1	0.71	0.08%
SBs	47.10	5.43%
W	69.62	8.03%
W-9	150.33	17.33%
Total Area	867.22	

Appendix Figure 7-2. 2003 vegetation map of STA-6. Map compiled by Nick Miller, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: December 12 & 18, 2003.

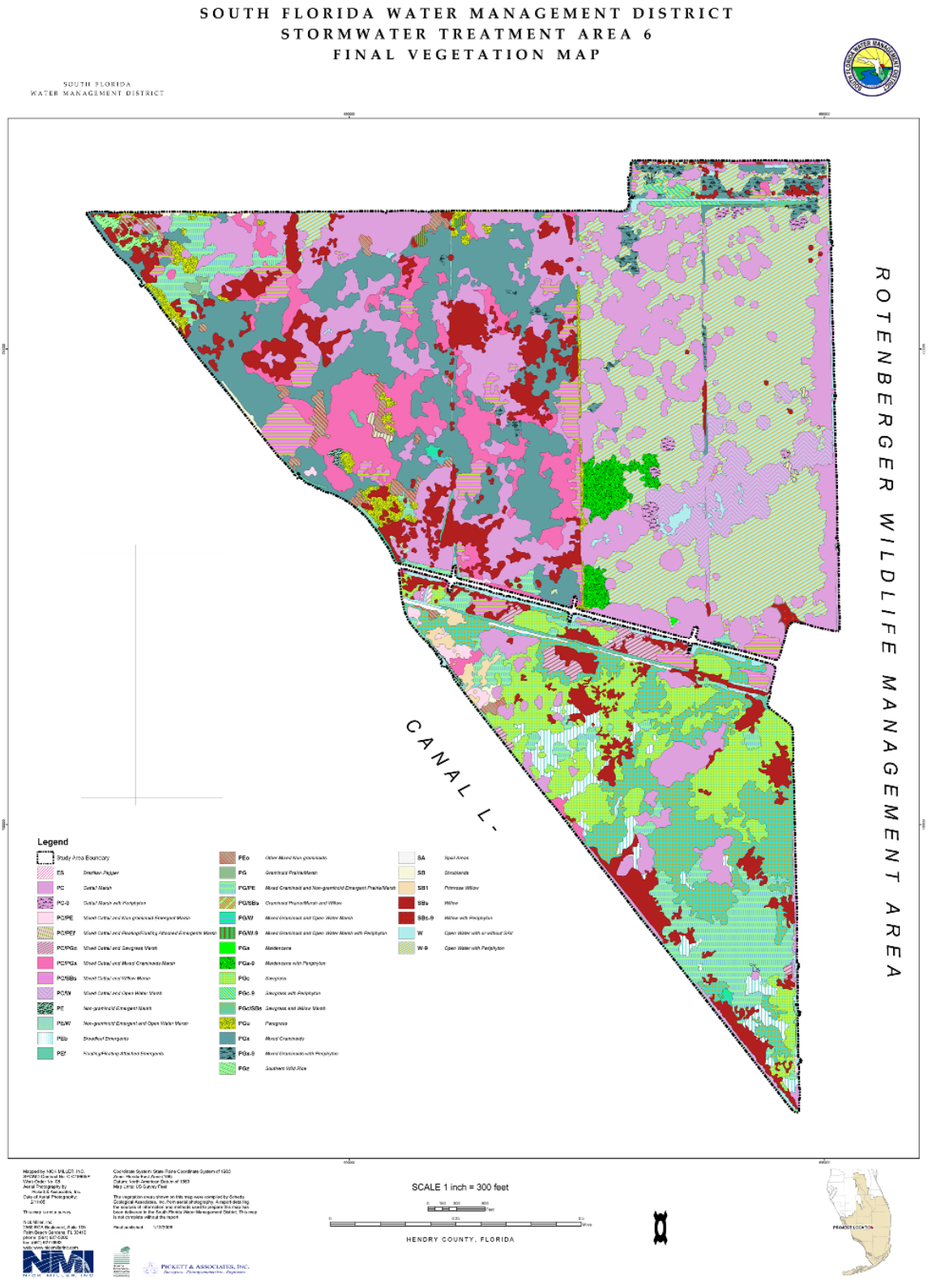


Appendix Figure 7-2. (Continued).

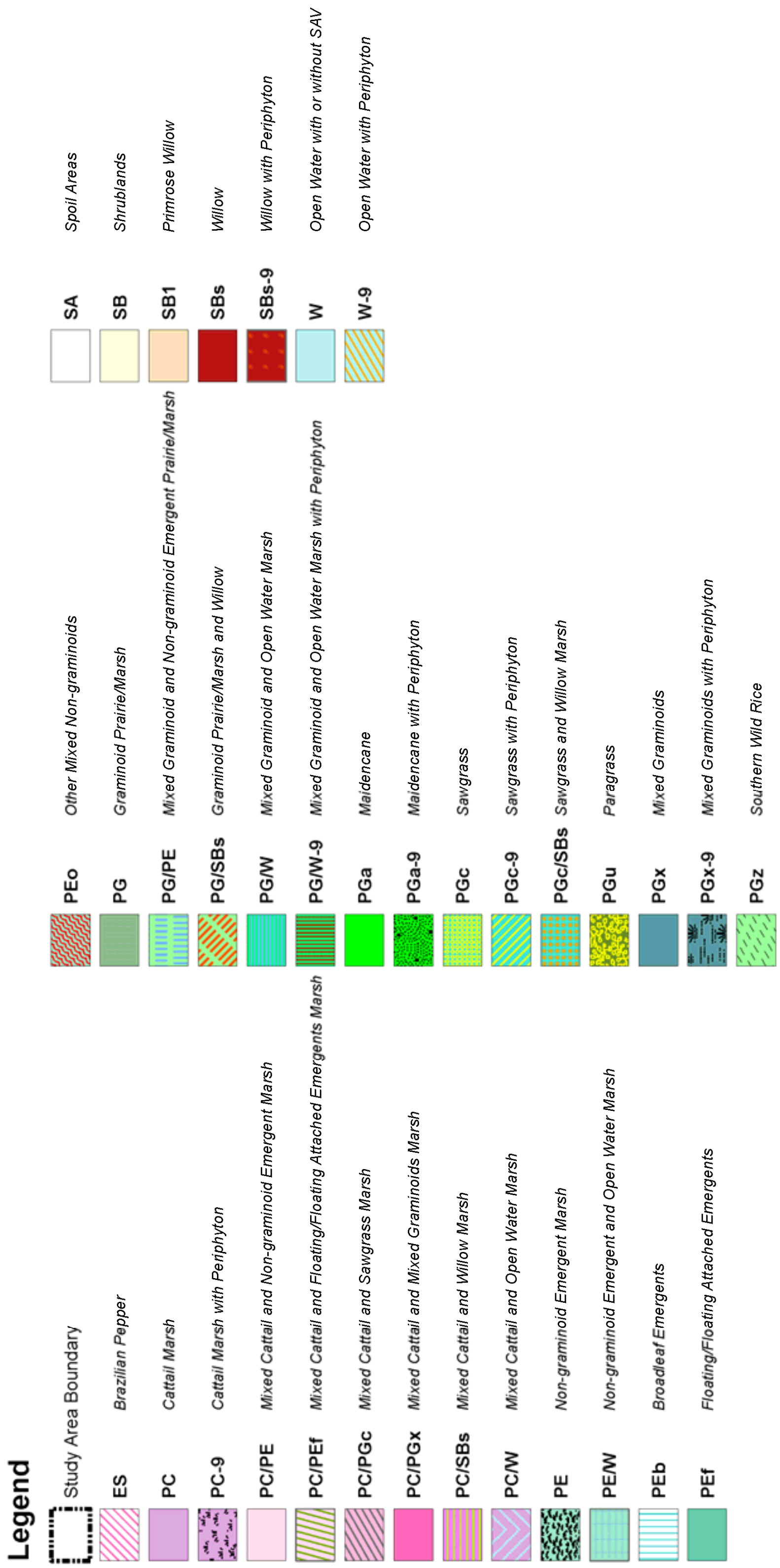
Appendix Table 7-1. Areal coverage of vegetation types mapped in STA-6 in 2003. Aerial photography taken on December 12 & 18, 2003. All areal coverages reported in acres.

				entire STA		Cell 3		Cell 5	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%
1	ES	shrub	Brazilian Pepper	0.4	0.05	0.4	0.18	0.0	0.00
2	PC	cattail	Cattail	146.8	16.93	19.8	8.15	127.0	20.35
3	PC/PE	cattail	Mixed Cattail & Non-graminoids	4.1	0.48	1.3	0.52	2.9	0.46
4	PC/PGc	cattail	Mixed Cattail & Sawgrass	6.9	0.80	5.8	2.37	1.2	0.19
5	PC/PGx	cattail	Mixed Cattail & Mixed Graminoids	32.9	3.80	2.2	0.91	30.7	4.92
6	PC/SBs	cattail	Mixed Cattail & Willow	46.0	5.31	4.3	1.75	41.8	6.69
7	PC/W	cattail	Mixed Cattail & Open Water	1.4	0.16	0.6	0.25	0.8	0.12
8	PE	EAV	Non-graminoids	0.6	0.07	0.6	0.25	0.0	0.00
9	PE/W	EAV	Non-graminoids & Open Water	1.2	0.14	0.7	0.27	0.6	0.09
10	PEb	EAV	Broadleaf Emergents	15.4	1.77	14.9	6.12	0.5	0.08
11	PEf	FAV	Floating/Floating Attached Emergents	7.4	0.85	4.0	1.67	3.3	0.53
12	PEf-9	FAV	Floating/Floating Attached Emergents with periphyton	0.6	0.07	0.0	0.00	0.6	0.10
13	PEo	EAV	Other Mixed Non-Graminoids	6.4	0.73	1.7	0.70	4.7	0.75
14	PG/PE	EAV	Mixed Graminoids & Non-graminoids	22.2	2.56	10.1	4.14	12.2	1.95
15	PG/W	EAV	Mixed Graminoids & Open Water	8.0	0.92	4.5	1.83	3.5	0.57
16	PGa	EAV	Maidencane	0.8	0.09	0.0	0.00	0.8	0.13
17	PGa-9	EAV	Maidencane and periphyton	18.0	2.07	0.0	0.00	18.0	2.88
18	PGc	EAV	Sawgrass	58.1	6.69	56.0	23.05	2.0	0.32
19	PGc/SBs	EAV	Sawgrass & Willow	84.8	9.78	84.8	34.87	0.0	0.00
20	PGc-9	EAV	Sawgrass and periphyton	0.8	0.09	0.0	0.00	0.8	0.13
21	PGe	EAV	Spike Rush	1.1	0.13	0.0	0.00	1.1	0.18
22	PGp	EAV	Napiergrass	3.5	0.41	0.0	0.00	3.5	0.57
23	PGu	EAV	Paragrass	5.7	0.65	0.0	0.00	5.7	0.91
24	PGx	EAV	Mixed Graminoids	99.5	11.48	3.7	1.53	95.8	15.35
25	PGx-9	EAV	Mixed Graminoids and periphyton	23.7	2.73	0.0	0.00	23.7	3.80
26	PGz	EAV	Southern Wild Rice	0.9	0.10	0.0	0.00	0.9	0.14
27	SA	other	Spoil	0.4	0.04	0.4	0.16	0.0	0.00
28	SB	shrub	Shrub mixture	1.8	0.21	0.2	0.10	1.6	0.25
29	SB1	shrub	Primrose	0.7	0.08	0.7	0.29	0.0	0.00
30	SBs	shrub	Willow	47.1	5.43	18.3	7.55	28.7	4.61
31	W	SAV	Open Water with or without SAV	69.6	8.03	8.1	3.33	61.5	9.86
32	W-9	SAV	Open Water with periphyton	150.3	17.33	0.0	0.00	150.3	24.09
			Totals	**867.2**	100	**243.1**	100	**624.1**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.



Appendix Figure 7-3. 2005 vegetation map of STA-6. Map compiled by Nick Miller, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: February 11, 2005.

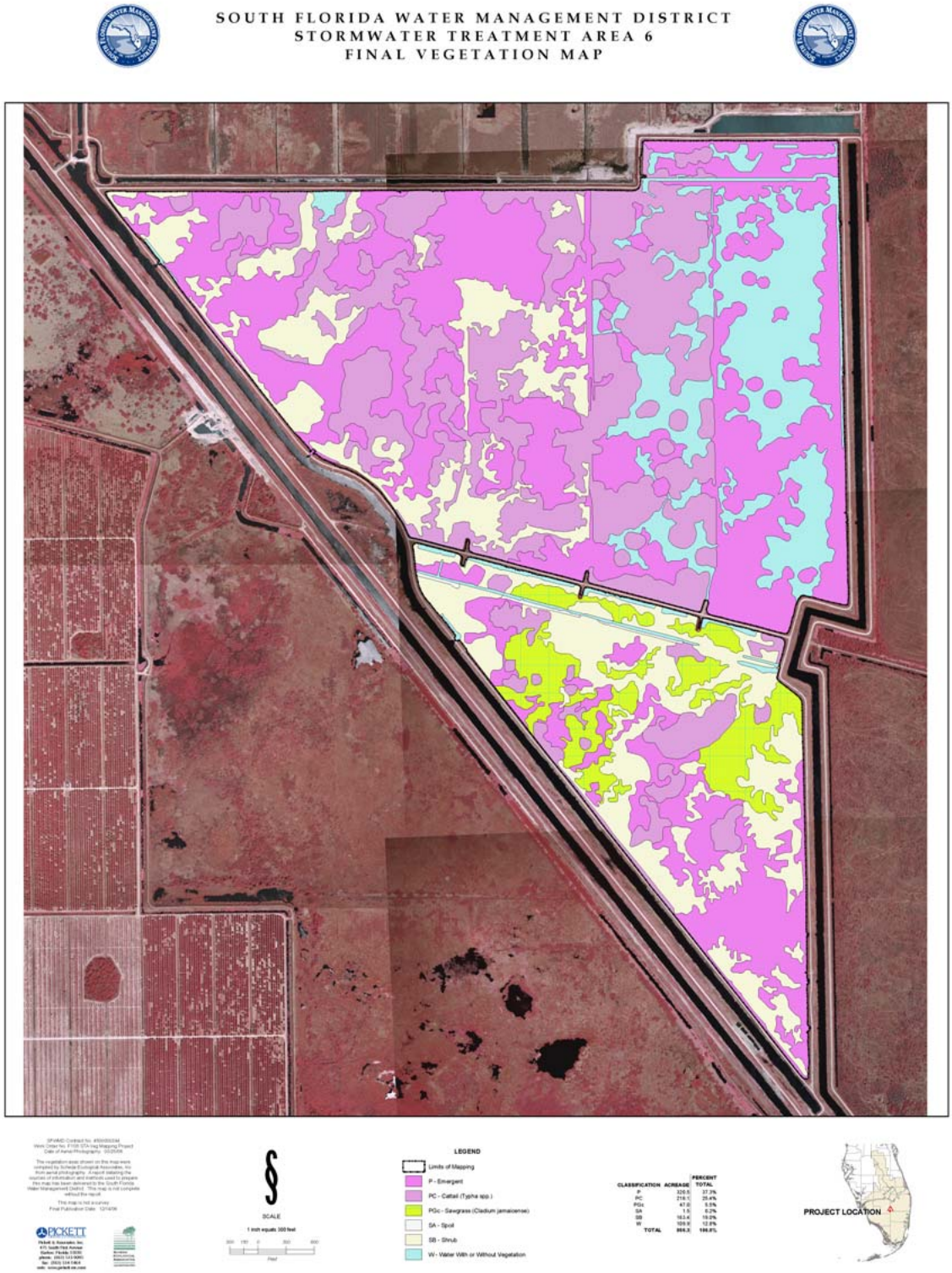


Appendix Figure 7-3. (Continued).

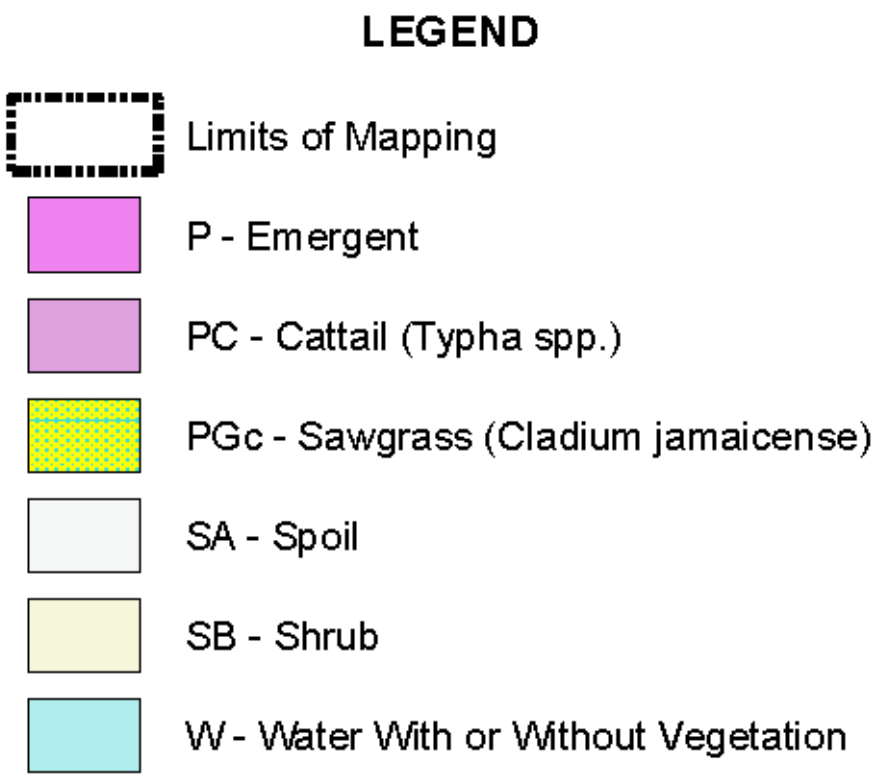
Appendix Table 7-2. Areal coverage of vegetation types mapped in STA-6 in 2005. Aerial photography taken on February 11, 2005. All areal coverages reported in acres.

				entire STA		Cell 3		Cell 5	
	Subclass	Group[1]	Vegetation Type	ac	%	ac	%	ac	%
1	ES	shrub	Brazilian Pepper	0.2	0.03	0.2	0.09	0.0	0.00
2	PC	cattail	Cattail	179.0	20.74	19.9	8.24	159.1	25.59
3	PC/PE	cattail	Mixed Cattail & Non-graminoids	2.8	0.32	2.3	0.96	0.4	0.07
4	PC/PEf	cattail	Mixed Cattail & Floating Aquatic Vegetation	1.1	0.13	0.1	0.03	1.1	0.17
5	PC/PGc	cattail	Mixed Cattail & Sawgrass	5.7	0.66	5.6	2.34	0.1	0.01
6	PC/PGx	cattail	Mixed Cattail & Mixed Graminoids	49.0	5.67	1.9	0.79	47.1	7.57
7	PC/SBs	cattail	Mixed Cattail & Willow	27.2	3.15	3.8	1.55	23.4	3.76
8	PC/W	cattail	Mixed Cattail & Open Water	29.8	3.46	2.6	1.09	27.2	4.38
9	PC-9	cattail	Cattail and periphyton	2.7	0.32	0.0	0.00	2.7	0.44
10	PE	EAV	Non-graminoids	0.8	0.09	0.4	0.17	0.4	0.07
11	PE/W	EAV	Non-graminoids & Open Water	0.5	0.06	0.4	0.17	0.1	0.01
12	PEb	EAV	Broadleaf Emergents	12.8	1.48	12.8	5.29	0.0	0.00
13	PEf	FAV	Floating/Floating Attached Emergents	3.1	0.35	2.0	0.85	1.0	0.16
14	PEo	EAV	Other Mixed Non-Graminoids	8.5	0.98	0.8	0.33	7.7	1.24
15	PG	EAV	Graminoids	0.7	0.09	0.0	0.00	0.7	0.12
16	PG/PE	EAV	Mixed Graminoids & Non-graminoids	48.9	5.67	36.9	15.27	12.0	1.94
17	PG/W	EAV	Mixed Graminoids & Open Water	1.2	0.13	0.4	0.15	0.8	0.13
18	PG/W-9	EAV	Mixed Graminoids, Open Water & periphyton	0.6	0.07	0.0	0.00	0.6	0.10
19	PGa	EAV	Maidencane	0.1	0.01	0.0	0.00	0.1	0.01
20	PGa-9	EAV	Maidencane and periphyton	9.4	1.09	0.0	0.00	9.4	1.51
21	PGc	EAV	Sawgrass	57.2	6.63	57.2	23.68	0.0	0.01
22	PGc/SBs	EAV	Sawgrass & Willow	56.6	6.56	55.7	23.06	0.9	0.15
23	PGc-9	EAV	Sawgrass and periphyton	2.0	0.23	0.0	0.00	2.0	0.32
24	PGu	EAV	Paragrass	9.9	1.15	0.0	0.00	9.9	1.60
25	PGx	EAV	Mixed Graminoids	99.8	11.56	0.0	0.00	99.8	16.05
26	PGx-9	EAV	Mixed Graminoids and periphyton	8.3	0.96	0.0	0.00	8.3	1.34
27	PGz	EAV	Southern Wild Rice	1.6	0.19	0.0	0.00	1.6	0.26
28	SA	other	Spoil	1.5	0.18	1.5	0.63	0.0	0.00
29	SB	shrub	Shrub mixture	1.5	0.17	0.3	0.14	1.1	0.18
30	SB1	shrub	Primrose	3.1	0.35	3.1	1.27	0.0	0.00
31	SBs	shrub	Willow	75.9	8.79	29.3	12.12	46.6	7.49
32	SBs-9	shrub	Willow and periphyton	1.2	0.14	0.0	0.00	1.2	0.20
33	W	SAV	Open Water with or without SAV	9.5	1.10	4.3	1.80	5.1	0.82
34	W-9	SAV	Open Water with periphyton	151.0	17.49	0.0	0.00	151.0	24.28
			Totals	**863.1**	100	**241.5**	100	**621.6**	100

[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.



Appendix Figure 7-4. 2006 vegetation map of STA-6. Map compiled Pickett & Associates, Inc. and Scheda Ecological Associates, Inc. Date of aerial photography: March 25, 2006.



Appendix Figure 7-4. (Continued).

Appendix Table 7-3. Areal coverage of vegetation types mapped in STA-6 in 2006. Aerial photography taken on March 25, 2006. All areal coverages reported in acres.

				entire STA		Cell 3		Cell 5	
	Subclass	Group1[1]	Vegetation Type	ac	%	ac	%	ac	%
1	P	EAV	Emergent herbaceous vegetation	320.5	37.26	69.4	28.82	251.2	40.53
2	PC	cattail	Cattail	218.1	25.35	28.0	11.62	190.1	30.68
3	PGc	EAV	Sawgrass	47.0	5.46	47.0	19.53	0.0	0.00
4	SA	other	Spoil	1.5	0.17	1.5	0.61	0.0	0.00
5	SB	shrub	Shrub mixture	163.4	18.99	88.5	36.79	74.8	12.08
6	W	SAV	Open Water with or without SAV	109.9	12.77	6.3	2.62	103.6	16.71
			Totals	**860.3**	100	**240.6**	100	**619.7**	100
	[1] EAV = emergent aquatic vegetation; FAV = floating aquatic vegetation; SAV = submersed aquatic vegetation.								

Appendix 8. Percent vegetation areal coverage from vegetation maps for the STA treatment cells organized into the following vegetation groups: cattail, emergent aquatic vegetation (EAV), floating aquatic vegetation (FAV), submersed aquatic vegetation-open water (SAV-OW) and other. Areal coverages for vegetation types mapped in STA-6 in 1998 are not available.

STA	Year	Cell	Type*	cattail	EAV	FAV	SAV-OW	other
STA-1E	2005	1	Mixed	2	74	<1	21	4
		2	SAV	<1	50	1	3	46
		3	Mixed	<1	80	<1	15	5
		4N	SAV	5	1	<1	91	2
		4S	SAV	1	7	<1	88	4
		5	Mixed	<1	76	1	17	5
		6	SAV	3	16	<1	79	3
		7	Mixed	4	13	<1	77	6
STA-1E	2006	1	Mixed	8	51	<1	38	4
		2	SAV	1	7	0	1	90
		3	Mixed	14	63	0	20	4
		4N	SAV	<1	2	0	95	2
		4S	SAV	1	2	0	93	4
		5	Mixed	24	48	<1	24	4
		6	SAV	<1	4	0	93	3
		7	Mixed	38	16	<1	40	6
STA-1W	2002	1	Mixed	30	21	13	37	<1
		2	Mixed	11	11	14	63	0
		3	Mixed	51	39	2	8	<1
		4	SAV	7	2	3	88	0
		5A	Mixed	5	8	25	61	<1
		5B	SAV	1	<1	12	87	0
STA-1W	2005	1	Mixed	18	28	1	50	3
		2	Mixed	2	6	<1	89	3
		3	Mixed	54	32	2	8	3
		4	SAV	4	3	0	90	4
		5A	Mixed	3	16	<1	71	10
		5B	SAV	<1	<1	3	94	2
STA-1W	2006	1	Mixed	4	35	<1	58	3
		2	Mixed	41	7	<1	40	12
		3	Mixed	48	34	<1	14	4
		4	SAV	<1	3	0	85	11
		5A	Mixed	1	33	<1	44	22
		5B	SAV	<1	35	0	28	37
STA-2	2003	1	Mixed	72	25	<1	3	<1
		2	Mixed	66	12	<1	22	0
		3	SAV	15	9	0	76	<1
STA-2	2005	1	Mixed	53	42	<1	1	3
		2	Mixed	56	19	<1	24	1
		3	SAV	13	8	<1	76	2
STA-2	2006	1	Mixed	57	36	0	5	2
		2	Mixed	58	13	<1	27	1
		3	SAV	15	5	0	78	2

Appendix 8. (Continued).

STA	Year	Cell	Type*	cattail	EAV	FAV	SAV-OW	other
STA-3/4	2005	1A	Mixed	59	19	1	20	1
		1B	SAV	30	55	<1	13	1
		2A	Mixed	65	19	2	13	1
		2B	SAV	1	13	5	79	2
		3	Mixed	73	14	<1	5	8
STA-3/4	2006	1A	Mixed	42	10	1	45	1
		1B	SAV	33	38	<1	15	14
		2A	Mixed	59	12	<1	27	1
		2B	SAV	5	5	0	86	4
		3	Mixed	50	4	<1	6	40
STA-5	2001	1A	Mixed	21	8	1	70	0
		1B	SAV	<1	8	1	91	0
		2A	Mixed	27	14	<1	59	0
		2B	SAV	29	4	<1	66	0
STA-5	2003	1A	Mixed	40	16	9	35	0
		1B	SAV	2	<1	0	98	0
		2A	Mixed	70	10	3	17	<1
		2B	SAV	75	2	4	19	0
STA-5	2005	1A	Mixed	40	18	1	41	0
		1B	SAV	1	1	0	98	0
		2A	Mixed	63	19	<1	18	0
		2B	SAV	73	4	1	22	0
STA-5	2006	1A	Mixed	27	27	1	42	4
		1B	SAV	5	1	0	94	<1
		2A	Mixed	53	20	1	11	16
		2B	SAV	62	8	3	17	10
STA-6	2003	3	Mixed	14	81	2	3	<1
		5	Mixed	33	33	1	34	0
STA-6	2005	3	Mixed	15	82	1	2	1
		5	Mixed	42	33	<1	25	0
STA-6	2006	3	Mixed	12	85	0	3	1
		5	Mixed	31	53	0	17	0

*Type denotes the District's vegetation community designation for the cell: Mixed = mixed marsh vegetation, which may include varying amounts of EAV, FAV and/or SAV; SAV = submersed aquatic vegetation.

Appendix 9: Remote Sensing Feasibility Study for Vegetative Change Monitoring at STA-1W

Prepared by:
Science Applications International Corporation (SAIC)

REMOTE SENSING FEASIBILITY STUDY FOR VEGETATIVE CHANGE MONITORING AT STA-1W

PREPARED FOR

South Florida Water Management District
Contract - PC P105086

March 6, 2002

Prepared by

Science Applications International Corporation
An Employee-Owned Company

Remote Sensing Feasibility Study for Vegetative Change Monitoring at STA-1W

Table of Contents

Acknowledgement

The Ecological Technologies Division of the South Florida Water Management District (SFWMD) sponsored this research effort.

EXECUTIVE SUMMARY

The goal of this project was to determine the effectiveness of remote sensing for monitoring SAV population changes. Because the water in the STA 1-W, Cell 5 is turbid and dyed by tannins and other organic solutes, which attenuate the spectral reflectance of submerged materials, this study was designed to assess the detectability of SAV with field and airborne spectrometers.

The hyperspectral data feasibility study that was completed for Cell 5 of STA 1-W has shown many positive indications of the feasibility of this methodology for classifying SAV. The information collected is not as comprehensives as would result from a pilot study, but the following items are encouraging:

- Ten distinct spectral signatures were discovered within the photosynthetic vegetation within the deep water area
- At least four spectral signatures appear to be SAV
- The data appears to show the sensors was able to penetrate the entire water column, as exhibited by the remnant crop rows visible within the images

Due to the airborne data collection portion of this project being internally funded by SAIC the resource allocation was not sufficient to perform a pilot study that would allow for more detailed conclusions. The type of additional information that could be determined with a pilot study that included groundtruthing could include:

- Speciation of submerged and emergent vegetation
- Vegetation condition (e.g., periphyton encrusted, floating, significantly below surface, flowering)
- Biomass Density

Initial costs estimates have shown that mapping products derived from a HSI aerial sensor could provide 40-64% cost savings relative to baseline methods. A fuller understanding of cost savings would be available upon the completion of a pilot project.

1.0 Background

The Everglades Construction Project (ECP) was mandated by the Everglades Forever Act of 1994 and is the responsibility of the South Florida Water Management District (SFWMD) to construct and operate. The ECP consists of a series of constructed wetlands called stormwater treatment areas (STAs) that use wetland plants to remove and sequester phosphorus from Everglades Agricultural Area (EAA) surface waters. Plants in the category of submerged aquatic vegetation (SAV) are particularly effective at removing phosphorus from EAA waters and are actively encouraged at several STAs. Finding a technique to track growth and species composition would be extremely valuable in optimizing the performance of these STAs. Since the STAs are spatially extensive, monitoring the entire network on a statistically significant scale could be very challenging and labor intensive. This is where the application of aerial or satellite-based remotes sensing technology should prove to be very cost-effective in yielding information essential to the long-term success of these constructed wetlands.

2.0 Objective of Study

The purpose of this study was to evaluate the potential for assessing the presence, the extent and possibly the speciation of SAV at STA 1-West (1-W) in Cell 5B using Hyperspectral Imaging (HSI) remote sensing. To that end, spectral reflectance of SAV and its environment was to be collected using either a portable spectrometer suspended a few feet above the water surface or an HSI system flown at an altitude of 5,000 to 7,000 feet (1,524m-2,134m). The spectra obtained using either one of these methods was then to be analyzed for presence of unique signatures of submerged vegetation.

3.0 Brief Description of HSI Technology

The amount of light reflected by a particular material (soil, vegetation, etc.), when measured as a function of wavelength -- can be used to uniquely identify key elements of that material's composition. This "spectrum" can be measured for a single material using a field spectrometer (see Section 5.2 below), or for each pixel in a digital image using an imaging spectrometer. Thus an imaging spectrometer produces a three-dimensional image combining spectral reflectance and wavelength information with location (commonly called hyperspectral imagery or HSI; see Figure 3-1) that contains compositional information for each pixel in the scene.

Reliable, readily available HSI sensors typically collect 100 – 250 wavelength channels between 0.4 and 2.5 μm (measuring reflected light only), at pixel spatial resolutions of 4 – 20 m. Because the data sets are large in size and difficult to interpret manually, numerous algorithms and software tools exist for extracting and mapping compositional information from HSI. Such tools detect and identify materials at sub-pixel levels, thus converting unwieldy HSI data sets into a handful of information layers that can be used to map vegetation classes, monitor land use, and generally answer a range of other environmental questions.

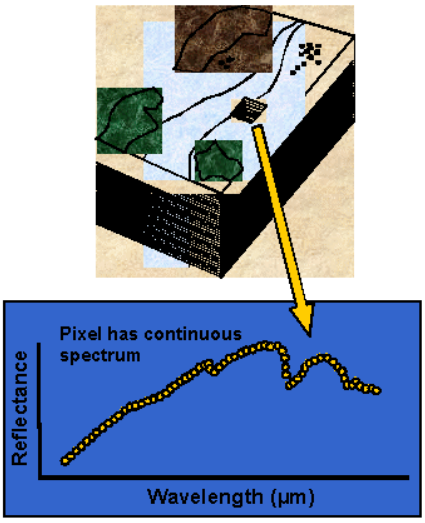


Figure 3-1: Conceptual drawing of hyperspectral image cube. For each pixel in the scene, continuous spectral information is measured. The bumps and wiggles in the spectrum (i.e., absorption bands, reflectance peaks, etc.) are indicative of the average composition of the pixel. HSI data can be queried mathematically to extract sub-pixel information as well.

4.0 Summary of Work Performed and Data Collected

SAIC collected both aerial and hand-held spectra from Cell 5 at STA-1W on 22 December 2001 and 23 January 2002, respectively. The former was possible due to availability of SAIC internal research and development (IR&D) funds that were used for collection and analysis of the aerial HSI data. The discussion in the remainder of this report covers the analysis of both sets of data.

4.1 Hyperspectral Data Collection

The HSI data collection consisted of one flightline, ~2.0 km by 10 km. The extent of the flightline (coordinates provided in WGS84) is illustrated in Figure 4-1. The data were collected on December 22, 2001, at approximately local noon, by the Probe-1 sensor owned by Earth Search Sciences, Inc. (ESSI).

As shown in Table 4-2, the Probe-1 sensor spans a wavelength range of 0.4 – 2.4 µm, which includes those wavelengths that are detectable by the human eye ("VIS," for visible), as well as the reflective portion of the infrared. (At longer wavelengths in the infrared, the energy is primarily thermal, the measurement of which requires a different sensor design and is not applicable to vegetation mapping.) A sampling interval of 10 – 20 nm is important because it indicates the narrowness of the spectral channel that is measured at each wavelength: too broad a sampling interval will cause a loss of many subtle spectral features. Probe-1 was flown at an altitude to allow a 4.5-m ground sample distance (GSD).

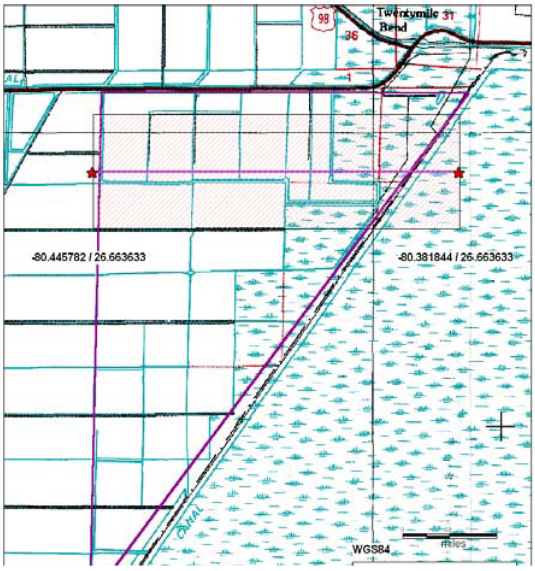


Figure 4-1: Map showing Probe-1 flightline (start and stop points marked by the red stars, and the entire swath shaded in red) relative to STA 1-W and Loxahatchee National Wildlife Refuge.

Table 4-1: Characteristics of the Probe-1 Hyperspectral Sensor

Module	Spectral range	Bandwidth across Module	Ave. spectral sampling interval
VIS	0.45 - 0.89 um	15 – 16 nm	15 nm
NIR	0.89 - 1.35 um	15 – 16 nm	15 nm
SWIR1	1.40 - 1.80 um	15 – 16 nm	13 nm
SWIR2	1.95 - 2.48 um	18 – 20 nm	17 nm

The standard product provided by Probe-1 is at-sensor radiance, precision-geocoded spectral image data and reflectance data. The reflectance calibration is accomplished using the ACORN ("Atmospheric CORrection Now") software, which uses MODTRAN 4 radiative transfer modeling to calculate the effect of atmospheric gases as well as molecular and aerosol scattering. This fast and accurate technique uses a look-up-table approach to mitigate atmospheric effects, including water vapor, on a pixel-by-pixel basis. These atmospheric characteristics are used to convert the calibrated sensor radiance measurements to apparent surface reflectance. As is routine, subsequent to ACORN, the data was processed through a smoothing algorithm (e.g., EFFORT). The ACORN software is relatively new (although based on significant experience with AVIRIS/JPL processing), and was supplemented by ground-based spectral measurements of an in-scene road. This allows a direct comparison of the spectra derived by ACORN in the HSI data to those measured with a field spectrometer on the ground.

4.2 Field Spectra Collection

On January 23, 2002 twelve spectra (300-1,100 nm, at 2 nm wavelength intervals) were gathered of several species of submerged and floating aquatic vegetation within STA-1W, Cell 5 (see Table 4-2). The following information was gathered at each location: 1) a LICOR 1800 Field Spectrometer reading; 2) photograph(s) of the monitoring area; 3) GPS gathered coordinate

information; 4) plant species present; 5) average depth of SAV below water surface; 6) sun and wind conditions. The above information has been compiled in Appendix A.

Spectral data was collected between 11:00 AM and 1:00 PM. During that time period cloud cover was approximately 20% with a constant wind of moderate intensity. The intensity of the wind led to rippling of the water surface, which can lead to noise/irregularities in reflectance data.

The field spectrometer was temporarily mounted to the airboat to give a consistent height of 0.7 m above the water surface and 1.1 m distance from the side of the boat. Once a suitable sampling site was located, every available means was used to stabilize the airboat so that the sampling area would remain consistent through the approximately 14-second sampling time. While the field spectrometer measured the spectral reflectance, the following data were collected for each site: photographs, latitude and longitude, species information and species location in the water column. The sampling stations were chosen to maximize the number of species captured at differing densities and depths.

Table 4-2: Species Observed During Field Sampling and Most Likely Present During the HSI Collection

Species	Common Name	Location	Coverage
Ceratophyllum demersum	Coontail	Submerged	Moderate
Najas guadalupensis	Southern Naiad	Submerged	Extensive
Hydrilla verticillata	Hydrilla	Submerged	Extensive
Eichornia crassipes	Water Hyacinth	Floating	Extensive
Pistia stratiotes	Water Lettuce	Floating	Seldom
NA	Periphyton Mats	Floating	Moderate
NA	Mixed Grasses	Emergent	Seldom
Hydrocotyle sp.	Water Pennywort	Emergent/Floating	Seldom

5.0 Comparative Review of HSI and CIR Aerial Photographs For Presence of Chlorophyll

In August of 2000 SFWMD collected aerial color infrared photographs (CIR) over STA1-W (see Figure 5-1). These photographs indicate that under the right circumstances, some SAV is visible from an airborne CIR system. Subtle differences in texture and color allow mapping of some vegetation types and extent within the STA. When three of the 128 Probe-1 HSI bands are used to create a comparable color composite (Figure 5-2) to that collected in CIR photography the data sets can be directly compared.

Qualitatively, the two images are similar, although the HSI data obviously offer lower spatial resolution. However, the many of the spectral bands in the HSI data allow better water penetration, as well as the semi-automated and quantitative mapping of subtle differences in vegetation classes across the scene, as discussed in Section 8 below. Field knowledge can also be readily incorporated into the HSI analysis. Because HSI data are calibrated to laboratory standards, the digital number (DN) values of any pixel in the scene are directly comparable to the DN values of any other pixel. Thus information from a known location (e.g., the vegetation type and depth) can be automatically mapped across the entire scene by mathematically identifying pixels with similar spectral information. The HSI data are rapidly processed and analyzed, with

the turn-around time from collection to analysis product taking between 2 and 5 weeks (including analyst involvement).

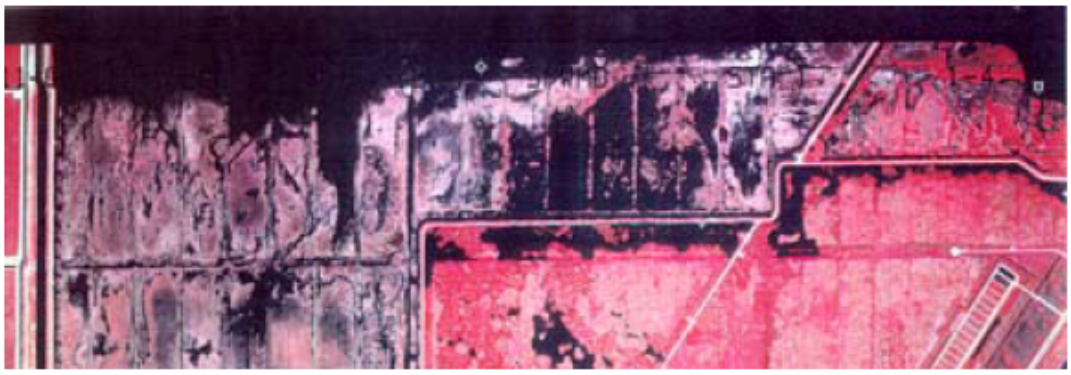


Figure 5-1: Scanned CIR photo of the same region as Probe-1.

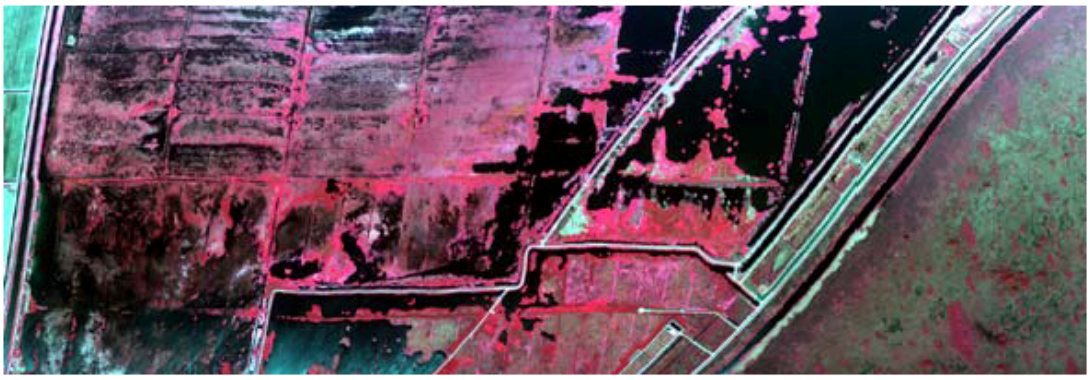


Figure 5-2: False color composite created from Probe-1 hyperspectral image, with 0.65 μm in red, 0.56 μm in green, and 0.45 μm in blue. The HSI data were not georectified for this study, but would be for future collections, particularly where precise identification of ground truth locations in the HSI scene is necessary.

6.0 Analysis of Basic Spectral Biology and SAV Spectra Obtained in STA Habitat

6.1 Overview of Field Spectra and Comparison to HSI Spectra

Spectra measure the amount of light reflected (or absorbed) by a substance as a function of wavelength. Absorption features are controlled by chemical content and structure and are therefore highly diagnostic. One of the most commonly used spectral properties is visible color. The human eye is sensitive to light between about 400-700 nm, the "visible region." As indicated in Figure 6-1, the wavelengths shorter than visible (<400 nm) are called "ultra-violet" and the longer wavelengths (>700 nm) are called the "near-infrared". Figure 6-1 includes the spectral signatures of leaves with different proportions of both photosynthetic and non-photosynthetic pigments. The dark green leaves have low reflectance (high absorption) in the

visible and peak near 550 nm (in the green). The yellow leaves are bright in both green and red wavelengths, while the red leaf's highest reflectance is near 630 nm (in the red). In all cases, the absorption (reflectance minimum) near 680 nm is due to chlorophyll, with the greener leaves having stronger and broader chlorophyll absorptions. Also note that all the leaf spectra are relatively bright in the near-infrared. That is why live, chlorophyll containing vegetation is bright red in infrared images where the "red" actually measures the reflectance in the near-infrared region (700-900 nm) rather than a visible wavelengths near 650 nm.

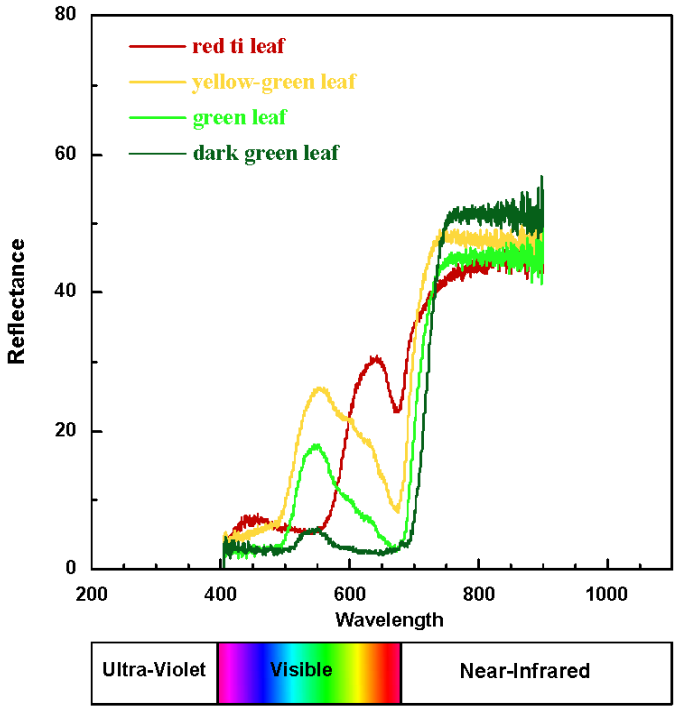


Figure 6-1: Reflectance spectra of healthy green and non-green vegetation. Percent reflectance is plotted against wavelength in nanometers (nm).

The Probe-1 hyperspectral measurements extend to the wavelengths longer than visible into the infrared region (the "short-wave infrared") as shown in Figure 6-2, which includes the three principal types of vegetation in the HSI scene. The healthy emergent vegetation (in green) includes the peak near 550 nm, the 650-700 nm chlorophyll absorption, and the strong rise into the infrared (800-900 nm) seen in the spectra in Figure 6-1. At longer wavelengths (see Figure 6-2) the emergent vegetation spectrum is dominated by absorptions due to water in the leaves, including relatively small absorptions near 950 and 1200 nm. (The gaps in these data between 1300-1500 nm and 1700-2000 nm are regions where absorptions from water in the atmosphere are so strong, that no measurements can be made of surface features). The submerged vegetation (in blue) also includes the standard vegetation features in the visible. However, compared to the emergent vegetation, the submerged vegetation has much lower reflectance (i.e., is darker) beyond 800 nm and after 1300 nm has a reflectance of essentially zero. This is because of strong absorptions from the overlying water. Finally, senescent vegetation (or "non-photosynthetic vegetation" –NPV -- in orange) which contains no water or chlorophyll, is dominated by

absorptions due to cellulose and lignin in the plant structure, these absorptions are present in healthy green vegetation, but masked by the stronger water and chlorophyll absorptions. Spectra of NPV typically increase in reflectance from the visible to the infrared and include diagnostic lignin and cellulose absorptions near 1550 nm and 2100 nm.

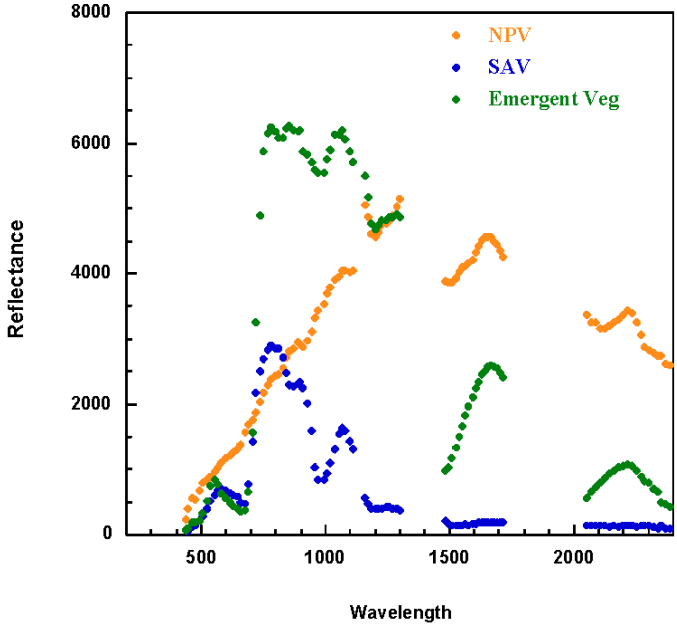


Figure 6-2: Reflectance spectra from HSI data (multiplied by 10,000 for computational reasons). Data are plotted in nm for ease of comparison to Figures 6-1 and 6-3; subsequent plots of HSI data are in micrometers (10^{-3} nm).

In addition to the airborne spectra, spectral measurements were made in the field with a portable spectrometer. Typical spectra are shown in Figure 6-3. For the airborne data shown in Figures 6-1 and 6-2, we have modeled and removed absorptions due to the atmosphere. However, the field spectrometer data measure the total amount of light reflected by the surface and the atmosphere (or the "radiance"). For comparison to the field data, radiance data collected with the airborne spectrometer are plotted in Figure 6-4. Several atmospheric features can be seen in these data, including the sharp absorption at 760 nm due to oxygen and water absorptions near 820 and 940 nm. Even in the presence of atmospheric absorptions, one can clearly detect chlorophyll absorptions in spectra of both submerged and emergent vegetation.

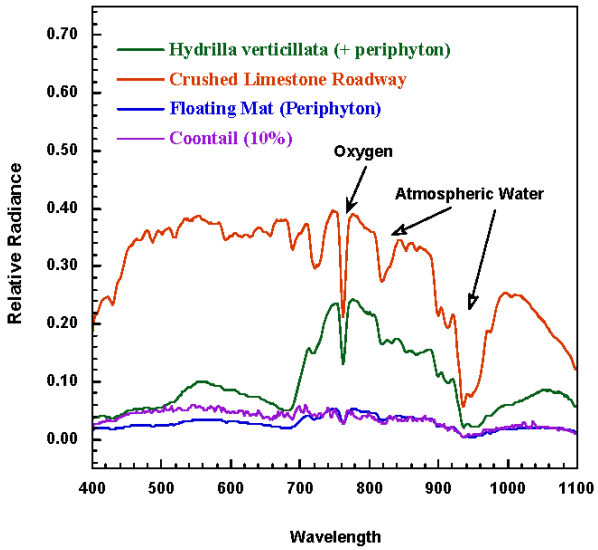


Figure 6-3: Radiance spectra from field (note that the data extend only to 1100 n, and are in units of relative radiance rather than reflectance).

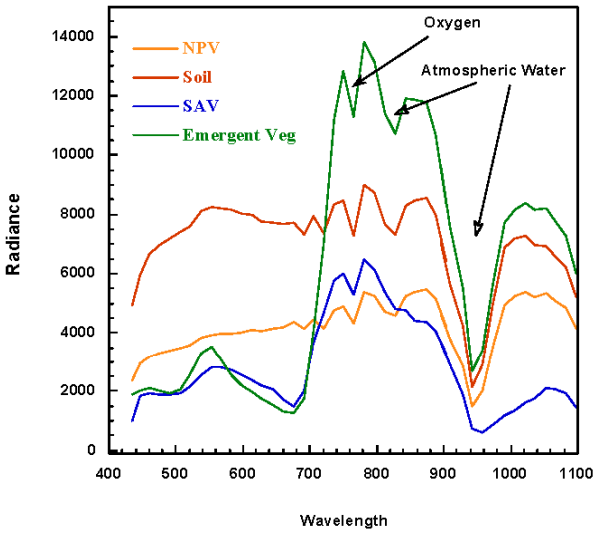


Figure 6-4: HSI spectra plotted for more direct comparison with field spectra (in units of radiance and from 400 – 1,100 nm only).

6.2 HSI Data Analysis

The Probe-1 HSI data were analyzed using SAIC's Abacus®[1] software and a spectral mixture analysis (SMA)-based approach [e.g., *Adams et al.*, 1993]. SMA deconvolves each pixel in the scene as a linear mixture of spectral endmembers (i.e., spectrally unique background materials), producing a series of abundance maps showing the subpixel abundance and distribution of each endmember in the scene (Figure 6-5). Unique and distinct combinations of endmembers can then used to define vegetation classes.

The 22 December Probe-1 data were analyzed in two phases. In Phase 1, the data were broken down into basic composition categories such as photosynthetic and non-photosynthetic vegetation, soil, and shade/shadow. Two distinct categories of green vegetation were found during this phase, one of which represents SAV in the scene and the other non-SAV (as illustrated in Figure 6-5). The representative spectrum of non-SAV is significantly brighter than the SAV spectrum, and does not appear to have been attenuated by water in any way.

In Phase 2, those pixels containing abundant green vegetation were analyzed in more detail, and a total of eleven spectrally unique vegetation endmembers were ultimately identified (see Appendix B for a complete description of each endmember). Four of these appear to be types of SAV and the remaining seven non-SAV (see Figure 6-6). The spectral characteristics that make these 11 vegetation types distinct from each other may be due to differences in species, condition (e.g., water depth, periphyton association, etc.), or biomass. Separating these variables in the HSI data would require a coordinated field and HSI collection campaign, as described in Section 9 below.

[1] Patent pending

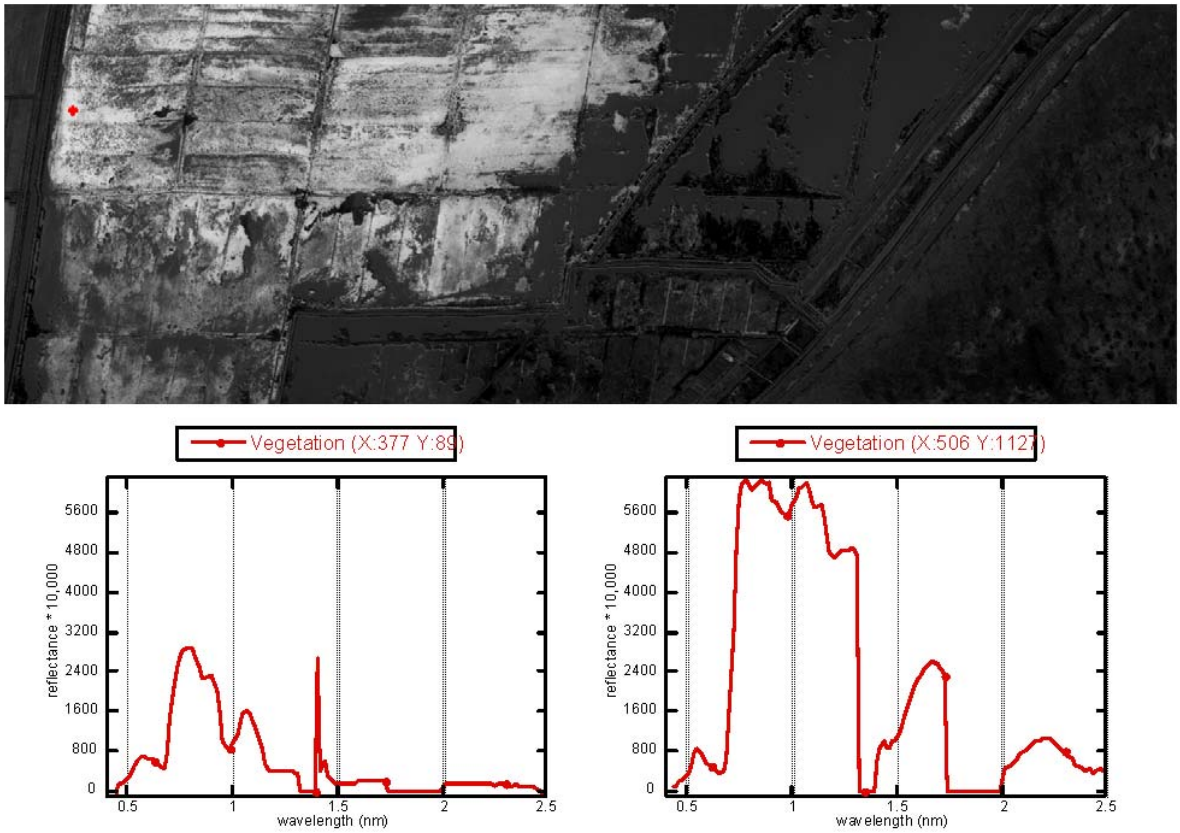


Figure 6-5: Example fraction images and endmember spectra (endmember locations are marked with a red dot), based on Abacus® Level 1 analysis of Probe-1 hyperspectral imagery. Two distinct classes of green (photosynthetic) vegetation were identified. The top image shows the distribution of a vegetation type whose spectrum is shown in the left-hand plot, and is believed to represent SAV. The bottom image shows the distribution of the material whose spectrum is plotted on the right, and is believed to represent non-SAV. Each pixel in these images is associated with a quantitative value indicating the % abundance of the given vegetation type (areas that are bright indicate a high abundance). The Level 2 (more detailed) Abacus® analysis breaks these two vegetation classes into a total of 11 different sub-categories (see Appendix B).

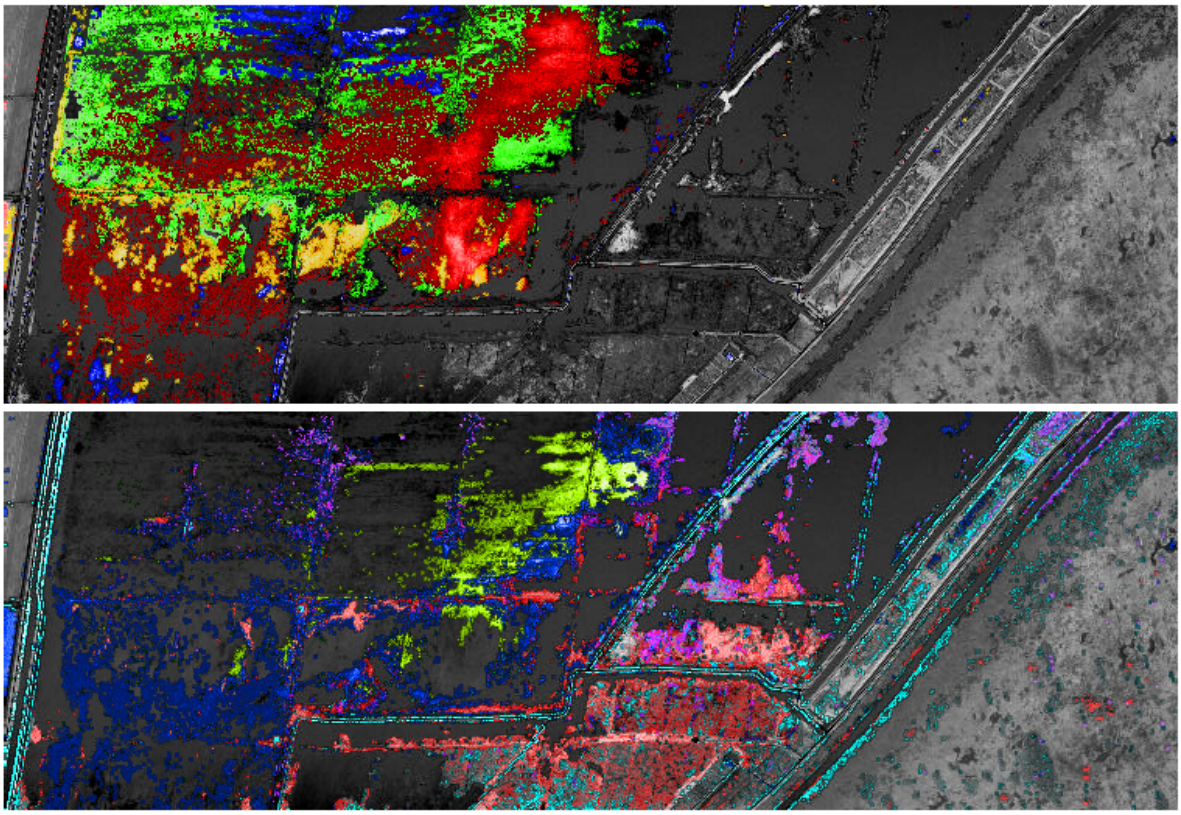


Figure 6-6: Top image: Possible SAV (4 green vegetation endmembers shown in color and non-photosynthetic vegetation in black and white). Bottom: Possible Non-SAV (seven green vegetation endmembers shown in color).

7.0 Expected Resolution Requirements for STA Remote Sensing Monitoring

The 4.5 m GSD collected by the Probe-1 sensor appears to be adequate for mapping SAV classes in HSI data. A larger GSD (and thus a wider swath and smaller volume of data) may be sufficient for routine operational collections, particularly where mapping of change from one collection date to another may be more important than one-time mapping of all species and conditions. The lower resolution may decrease the number of vegetation endmembers that can be identified from the scene; the exact limits can be tested prior to any future collections, to optimize operational requirements and balance mapping accuracy with data collection and analysis costs.

8.0 Cost Comparison of STA Mapping Using HSI vs. Current Methods

In addition to comparing image data and resolution, the operational costs of current mapping methods and HSI should be examined. A preliminary analysis was performed as part of this study. The cost for CIR aerial photography was provided by the SFWMD based on the cost of past STA vegetation mapping contracts. HSI costs were calculated based on current data acquisition, analysis, and anticipated groundtruthing costs. Table 8-1 displays the cost components associated with HSI relative to the size of the area requiring mapping. These costs can vary depending on several factors including configuration of the area to be mapped, special

mapping requirements, and data acquisition costs. Figure 8-1 compares the cost of HSI mapping to the existing baseline technology CIR aerial photography. The cost of these contracts was $6.84/acre.

Table 8-1: HSI Cost Per Acre

	Acres		
Cost Components	**10,000**	**40,000**	**60,000**
Flight Lines	$1.56	$1.28	$1.13
Planning, Coordination, Management	$0.98	$0.67	$0.49
Groundtruthing	$0.85	$0.45	$0.40
Data Processing & Analysis	$0.73	$0.49	$0.45
Minimum Total Cost Per Acre	$4.12	$2.89	$2.47

Note: Assumes currently quoted HyMap flightline costs

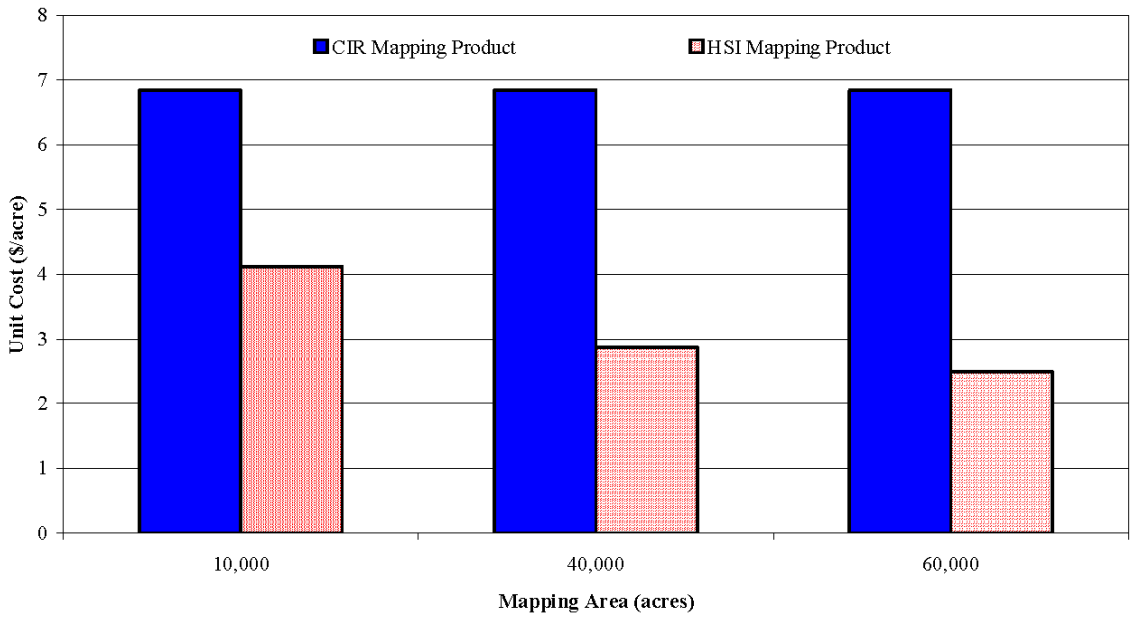


Figure 8-1: Cost comparison of HSI vs. CIR based STA mapping.

9.0 CONCLUSION

HSI offers several advantages over CIR, including timeliness and quantitative analysis results. While spatial resolution is lower than CIR, standard analysis techniques are designed to extract information at subpixel levels, thereby mitigating the impact of the lower resolution.

As seen in the field spectrometer data, there are discernible differences in spectral signatures related to species, water depth, and biomass (or spatial abundance), and the presence of even sparse SAV can be detected from spectral measurements. The robustness of these differences across a large area could not be determined from field spectrometer data alone, but are a strong predictor of the utility of spectral information for mapping SAV species in the STAs.

The conclusions from the field spectrometer data were extended when, as part of an internally funded project, SAIC arranged for airborne HSI collection over STA 1-W. Analysis of these data helped to demonstrate that SAV (and non-SAV) can be detected, discriminated (i.e., different categories distinguished from one another), and possibly even identified directly from their spectral signatures across a large spatial area.

Finally, preliminary analysis of cost shows that use of HSI for SAV monitoring appears to offer significant savings in time and staff resources over other monitoring methods.

10.0 NEXT STEPS

The determination of species composition and photosynthetic biomass within a STA appears to be feasible based on the initial findings presented in this report.

This feasibility study did not include real-time ground-truthing, which would be initially required to classify the species that are currently only classified as distinct reflectance signatures. Such ground-truthing combined with close to concurrent acquisition of HSI spectra should address in a more quantifiable way biomass, water color, depth, and species.

Therefore, an HSI mapping project for one STA is recommended. This project would include the capture of aerial HSI data that would be closely followed by acquisition of groundtruthing data. The groundtruthing data would be used to extract and identify the specific spectral signatures of vegetative species and STA characteristics. Subsequently, this information would be used train and verify the performance of the mapping software and to map the STA and its biomass. With this information in hand, a cost-saving operating regimen for monitoring and change detection of the STA could likely be set up.

11.0 List of Acronyms

ACORN	Atmospheric CORrection Now Software
AVRIS	Airborne Visible/Infrared Imaging Spectrometer
CIR	Color Infrared
DN	Digital Numbers
ESSI	Earth Search Sciences, Inc.
GSD	Ground Sample Distance
HSI	Hyperspectral Imaging
JPL	Jet Propulsion Laboratory
NIR	Near Infrared
NPV	Non-Photosynthetic Vegetation
SAIC	Science Applications International Corporation
SAV	Submerged Aquatic Vegetation
SMA	Spectral Mixture Analysis
STA	Stormwater Treatment Area
SWIR	Short Wavelength Infrared
VIS	Visible Wavelength

12.0 References

Adams, J.B., M.O. Smith, and A.R. Gillespie, Imaging spectroscopy: Interpretation based on spectral mixture analysis, in *Remote Geochemical Analyses: Elemental and Mineralogical Composition*, edited by C.M. Pieters, and P. Englert, pp. 145-166, Cambridge University Press, 1993.

Appendix 10. Plants identified in the STAs from field surveys conducted in 1995 and 2003 to 2006.[1]

Order	Family	Taxa Name	Common Name	STA-1E	STA-1W	STA-2	STA-3/4	STA-5	STA-6	Status[2]	Gr. Habit[3]	Origin[4]
MACRO-ALGAE												
Charales	Characeae	*Chara* sp.	muskgrass	✓	✓	✓	✓	+	✓	obl	-	n
		Nitella tenuissima	stonewort				+			obl	-	n
FERNS & ALLIES												
Equisetales	Equisetaceae	*Equisetum* sp.	horsetail; scouring rush		+			+		facw	f	-
Hydropteridales	Azollaceae	*Azolla caroliniana*	Carolina mosquito fern	+	+	+	+	+		obl	ff	n
	Salviniaceae	*Salvinia minima*	water spangles; water fern		+	+	+	✓	+	obl	ff	e
Polypodiales	Dryopteridaceae	*Nephrolepis cordifolia*	tuberous sword fern			+				fac	f	e
	Osmundaceae	*Osmunda regalis*	royal fern		+					obl	f	n
	Pteridaceae	*Acrostichum danaeifolium*	giant leather fern		+	+				obl	f	n
		Pteris tripartita	giant brake		+					facw	f	e
	Thelypteridaceae	*Thelypteris dentata*	downy maiden fern		+					facw	f	e
MONOCOTS												
Alis**matal**es	Alismataceae	*Sagittaria lancifolia*	bulltongue arrowhead	+	+	✓	✓	+	✓	obl	f	n
		Sagittaria latifolia	broadleaf arrowhead		+	✓			+	obl	f	n
Arales	Araceae	*Colocasia esculenta*	wild taro		+					obl	f	e
		Peltandra virginica	green arrow arum					+		obl	f	n
		Pistia stratiotes	water lettuce	✓	✓	+	+	✓		obl	ff	n
	Lemnaceae	*Lemna minor*	common duckweed		+					obl	ff	n
		Lemna sp.	duckweed	✓	✓	+	+	✓	+	obl	ff	n
		Spirodela polyrhiza	giant duckweed		+			✓		obl	ff	n
		Wolffia columbiana	Columbian watermeal		+					obl	ff	n
		Wolffiella gladiata	Florida mudmidget		+					obl	ff	n
Commelinales	Commelinaceae	*Commelina* sp.	dayflower	+	+					facw	f	-
Cyperales	Cyperaceae	*Cladium jamaicense*	Jamaica swamp sawgrass		+	✓	+		✓	obl	gr	n
		Cyperus esculentus	yellow nutgrass	+	+					fac	gr	e
		Cyperus haspan	haspan flatsedge					+		obl	gr	n
		Cyperus odoratus	fragrant flatsedge		+					facw	gr	n
		Cyperus planifolius	flatleaf		+					fac	gr	n
		Cyperus sp.	sedge		✓		+	+		-	gr	-
		Eleocharis interstincta	knotted spikerush	+	+		✓		+	obl	gr	n
		Eleocharis sp.	spikerush		+	+				obl	gr	n
		Rhynchospora colorata	starrush whitetop		+					facw	gr	n
		Schoenoplectus californicus	California bulrush		+					obl	gr	n
		Schoenoplectus sp.	bulrush	+						obl	gr	n
		Schoenoplectus tabernaemontani	softstemmed bulrush		+					obl	gr	n
	Poaceae	*Andropogon virginicus*	chalky bluestem		+					fac	gr	n
		Echinochloa crusgalli	barnyardgrass		+					facw	gr	e
		Eustachys petraea	pinewoods fingergrass		+					fac	gr	n
		Melinis repens	rose natalgrass		+					upl	gr	e
		Oryza sativa	rice		✓					obl	gr	e
		Panicum hemitomon	maidencane	✓	+	+	+	+	✓	obl	gr	n
		Panicum repens	torpedograss	+	+	+	✓	+	✓	facw	gr	e
		Panicum sp.	-	+	+		+	+		-	gr	-
		Paspalidium geminatum	Egyptian paspalidium						+	obl	gr	n
		Saccharum officinarum	sugarcane				+			facu	gr	e
		Setaria magna	giant bristlegrass		+					obl	gr	n
		Sorghum sp.	-		+					-	gr	e
		Urochloa mutica	paragrass					+	✓	facw	gr	e
Hydrocharitales	Hydrocharitaceae	*Egeria densa*	Brazilian waterweed				+			obl	fs	e
		Hydrilla verticillata	hydrilla	✓	✓	✓	✓	✓		obl	fs	e
		Limnobium spongia	frog's-bit		+			+		obl	ff	n
		Vallisneria americana	American eelgrass				+			obl	fs	n
Liliales	Pontederiaceae	*Eichhornia crassipes*	common water hyacinth		✓			+		obl	ff	e
		Pontederia cordata	pickerelweed		+	✓	+	+	+	obl	f	n
Najadales	Najadaceae	*Najas guadalupensis*	southern naiad	✓	✓	✓	✓	+		obl	fs	n
		Najas marina	spiny naiad				✓			obl	fs	n
	Potamogetonaceae	*Potamogeton* sp.	pondweed		+	✓	+	+		obl	fs	-

Appendix 10. (Continued).

Order	Family	Taxa Name	Common Name	STA-1E	STA-1W	STA-2	STA-3/4	STA-5	STA-6	Status[2]	Gr. Habit[3]	Origin[4]
Typhales	Typhaceae	*Typha domingensis*	southern cattail	✓	✓	✓	✓	✓	✓	obl	f	n
		Typha latifolia	broadleaf cattail		+					obl	f	n
Zingiberales	Marantaceae	*Thalia geniculata*	fireflag					+		obl	f	n
DICOTS												
Apiales	Apiaceae	*Centella asiatica*	spadeleaf		+					facw	f	n
		Hydrocotyle sp.	marshpennywort	+	✓		+	+		-	f	-
		Hydrocotyle umbellata	manyflower marshpennywort		+					facw	f	n
		Ptilimnium capillaceum	mock bishopsweed		+					obl	f	n
Asterales	Asteraceae	*Ambrosia artemisiifolia*	common ragweed		+					facu	f	n
		Baccharis glomeruliflora	silverling		+					fac	s	n
		Bidens alba	beggarticks		+					fac	f	n
		Conoclinium coelestinum	blue mistflower		+					fac	f	n
		Conyza canadensis	Canadian horseweed		+					facu	f	n
		Eclipta prostrata	false daisy		+					facw	f	n
		Emilia fosbergii	Florida tassleflower		+					upl	f	e
		Eupatorium capillifolium	dogfennel		+			+		fac	f	n
		Heterotheca subaxillaris	camphorweed		+					facu	f	n
		Mikania scandens	climbing hempvine		✓		+	+	+	facw	v/f	n
		Pluchea odorata	sweetscent		+		+			facw	ss/f	n
		Tridax procumbens	coatbuttons		+					upl	f	e
Capparales	Brassicaceae	*Lepidium virginicum*	Virginia pepperweed		+					facu	f	n
Caryophyllales	Amaranthaceae	*Alternanthera philoxeroides*	alligatorweed	+	✓		+	✓	+	obl	f	e
		Amaranthus australis	southern amaranth	+	+			+		obl	ss/f	n
		Amaranthus spinosus	spiny amaranth		+					facu	f	e
Dipsacales	Caprifoliaceae	*Sambucus nigra*	elderberry		+			+		facw	t/s	n
Fabales	Fabaceae	*Desmodium incanum*	zarzabacoa comun		+					upl	ss/f	e
Gentianales	Apocynaceae	*Catharanthus roseus*	Madagascar periwinkle		+					upl	ss/f	e
		Sarcostemma clausum	white twinevine		+	+	+	+	✓	facw	v/f	n
Haloragales	Haloragaceae	*Myriophyllum aquaticum*	watermilfoil			+				obl	fs	e
Lamiales	Boraginaceae	*Heliotropium polyphyllum*	pineland heliotrope		+					fac	ss/f	n
	Verbenaceae	*Lantana camara*	lantana		+					facu	s/v	e
		Phyla nodiflora	turkey tangle fogfruit	+	+					fac	f	n
		Verbena brasiliensis	Brazilian vervain		+					fac	ss/f	e
Malvales	Malvaceae	*Sida rhombifolia*	Cuban jute		+					facu	ss/f	n
		Urena lobata	caesarweed		+					facu	ss	e
Myricales	Myricaceae	*Morella cerifera*	wax myrtle			+	+			fac	t/s	n
Myrtales	Lythraceae	*Ammannia latifolia*	pink redstem		+					obl	f/ss	n
	Myrtaceae	*Callistemon viminale*	weeping bottlebrush		+					-	t/s	e
		Melaleuca quinquenervia	melaleuca		+					fac	t/s	e
	Onagraceae	*Gaura angustifolia*	southern beeblossom		+					-	f	n
		Ludwigia octovalvis	Mexican primrosewillow		+					obl	ss/f	n
		Ludwigia palustris	marsh seedbox				+			obl	f	n
		Ludwigia peruviana	Peruvian primrosewillow	+	✓		✓	✓		obl	s/ss/f	e
		Ludwigia repens	red ludwigia	+	+	+	✓	+		obl	f	n
Nymphaeales	Ceratophyllaceae	*Ceratophyllum demersum*	coontail	✓	✓	✓	+	✓		obl	fs	n
	Nymphaeaceae	*Nuphar lutea*	spatterdock				+	+		obl	ff	n
		Nymphaea odorata	fragrant waterlily		+	✓	+	+	+	obl	ff	n
Papaverales	Papaveraceae	*Argemone mexicana*	Mexican pricklypoppy		+					upl	f	n
Polygonales	Polygonaceae	*Polygonum hydropiperoides*	swamp smartweed		+					obl	f	n
		Polygonum sp.	smartweed	+	✓	+	+	✓	✓	obl	f	-
		Rumex sp.	docks		+					facw	f	-
Rhamnales	Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper		+					fac	v	n
		Vitis cinerea	Florida grape				+			fac	v	n
Rubiales	Rubiaceae	*Cephalanthus occidentalis*	common buttonbush						✓	obl	t/s	n
		Diodia virginiana	Virginia buttonweed		+					facw	ss/f	n
		Spermacoce verticillata	shrubby false buttonweed		+					-	ss	e
Salicales	Salicaceae	*Salix caroliniana*	carolina willow	✓	+	+	+	✓	✓	obl	t	n

Appendix 10. (Continued).

Order	Family	Taxa Name	Common Name	STA-1E	STA-1W	STA-2	STA-3/4	STA-5	STA-6	Status[2]	Gr. Habit[3]	Origin[4]
Sapindales	Anacardiaceae	*Schinus terebinthifolius*	Brazilian pepper		+					fac	t/s	e
		Toxicodendron radicans	eastern poison ivy		+					fac	s/ss/f	n
	Zygophyllaceae	*Tribulus cistoides*	burrnut; Jamaican feverplant		+					-	v/ss/f	e
Scrophulariales	Lentibulariaceae	*Utricularia floridana*	Florida yellow bladderwort			+		+	+	obl	fs	n
		Utricularia sp.	bladderwort	+	+		✓	+	+	obl	fs	n
	Scrophulariaceae	*Bacopa caroliniana*	lemon bacopa		+		+			obl	f	n
		Bacopa monnieri	smooth waterhyssop		+		+			obl	f	n
Solanales	Convolvulaceae	*Ipomoea cordatotriloba*	tievine		+			+		facu	v/f	n
	Menyanthaceae	*Nymphoides aquatica*	big floatingheart	+	+		+	+		obl	ff	n
Urticales	Urticaceae	*Boehmeria cylindrica*	false nettle		+					obl	f	n
Violales	Cucurbitaceae	*Melothria pendula*	Guadeloupe cucumber		+					facw	v/f	n
		Momordica charantia	wild balsam apple		+					upl	v/f	e
			# taxa	26	104	27	41	41	22			
			# of taxa in all STAs	123								

1. Vegetation nomenclature and classification followed Tobe et al. (1998) and USDA (2009); + = taxa present, ✓ = common taxa detected in 5% or more of field surveys.
2. Status followed Wunderlin and Hansen (2008) and Tobe et al. (1998): obl = obligate wetland; facw = facultative wetland; fac = facultative; facu = facultative upland; upl = upland
3. Growth habit followed USDA (2009): f = forb/herb; ff = forb/herb-floating; fs = forb/herb-submersed; gr = graminoid; s = shrub; ss = subshrub; t = tree; v = vine.
4. Origin followed Wunderlin and Hansen (2008) and Tobe et al. (1998): e = exotic/non-native species; n = native species

Appendix 11. Chi-square analyses of differences in areal coverage of vegetation groups based on STA vegetation maps vs. areal coverages derived from vegetation field surveys.

Year=2003 STA=STA-2

		EAV	FAV	SAV-OW	cattail	Totals
MAP	Coverage	1005	13	2310	3366	6694
	Percent	7.51	0.10	17.25	25.14	50.00
SURVEY	Coverage	536	0	5534	625	6695
	Percent	4.00	0.00	41.33	4.67	50.00
TOTALS	Coverage	1541	13	7844	3991	13389
	Percent	11.51	0.10	58.59	29.81	100.00

Statistic	DF	Value	Prob.
Chi-square	3	3363.357	<0.0001

Year=2003 STA=STA-5

		EAV	FAV	SAV-OW	cattail	Totals
MAP	Coverage	242	150	1876	1861	4129
	Percent	2.93	1.82	22.72	22.54	50.00
SURVEY	Coverage	295	1290	2212	332	4129
	Percent	3.57	15.62	26.79	4.02	50.00
TOTALS	Coverage	537	1440	4088	2193	8258
	Percent	6.50	17.44	49.50	26.56	100.00

Statistic	DF	Value	Prob.
Chi-square	3	2001.394	<0.0001

Year=2003 STA=STA-6

		EAV	FAV	SAV-OW	cattail	Totals
MAP	Coverage	401	8	220	238	867
	Percent	23.13	0.46	12.69	13.73	50.00
SURVEY	Coverage	364	28	447	28	867
	Percent	20.99	1.61	25.78	1.61	50.00
TOTALS	Coverage	765	36	667	266	1734
	Percent	44.12	2.08	38.47	15.34	100.00

Statistic	DF	Value	Prob.
Chi-square	3	255.945	<0.0001

Year=2005 STA=STA-1E

		EAV	FAV	SAV-OW	cattail	Totals
MAP	Coverage	1877	17	2724	98	4716
	Percent	19.90	0.18	28.88	1.04	50.01
SURVEY	Coverage	1027	420	3175	93	4715
	Percent	10.89	4.45	33.67	0.99	49.99
TOTALS	Coverage	2904	437	5899	191	9431
	Percent	30.79	4.63	62.55	2.03	100.00

Statistic	DF	Value	Prob.
Chi-square	3	655.052	<0.0001

Appendix 11. (Continued).

Year=2005 STA=STA-1W

		EAV	FAV	SAV-OW	cattail	Totals
MAP	Coverage	961	132	4980	900	6973
	Percent	6.89	0.95	35.71	6.45	50.00
SURVEY	Coverage	861	387	4993	732	6973
	Percent	6.17	2.77	35.80	5.25	50.00
TOTALS	Coverage	1822	519	9973	1632	13946
	Percent	13.06	3.72	71.51	11.70	100.00

Statistic	DF	Value	Prob.
Chi-square	3	148.089	<0.0001

Year=2005 STA=STA-2

		EAV	FAV	SAV-OW	cattail	Totals
MAP	Coverage	1537	11	2370	2755	6673
	Percent	11.52	0.08	17.76	20.64	50.00
SURVEY	Coverage	148	297	5338	890	6673
	Percent	1.11	2.23	40.00	6.67	50.00
TOTALS	Coverage	1685	308	7708	3645	13346
	Percent	12.38	2.30	57.39	26.88	100.00

Statistic	DF	Value	Prob.
Chi-square	3	3507.656	<0.0001

Year=2005 STA=STA-3/4

		EAV	FAV	SAV-OW	cattail	Totals
MAP	Coverage	3969	236	3534	7821	15560
	Percent	12.75	0.76	11.36	25.13	50.00
SURVEY	Coverage	3937	562	5062	5999	15560
	Percent	12.65	1.81	16.27	19.28	50.00
TOTALS	Coverage	7906	798	8596	13820	31120
	Percent	25.40	2.56	27.62	43.41	100.00

Statistic	DF	Value	Prob.
Chi-square	3	645.129	<0.0001

Year=2005 STA=STA-5

		EAV	FAV	SAV-OW	cattail	Totals
MAP	Coverage	371	20	1964	1780	4135
	Percent	4.49	0.24	23.75	21.52	50.00
SURVEY	Coverage	298	1876	1066	895	4135
	Percent	3.60	22.68	12.89	10.82	50.00
TOTALS	Coverage	669	1896	3030	2675	8270
	Percent	8.09	22.93	36.64	32.35	100.00

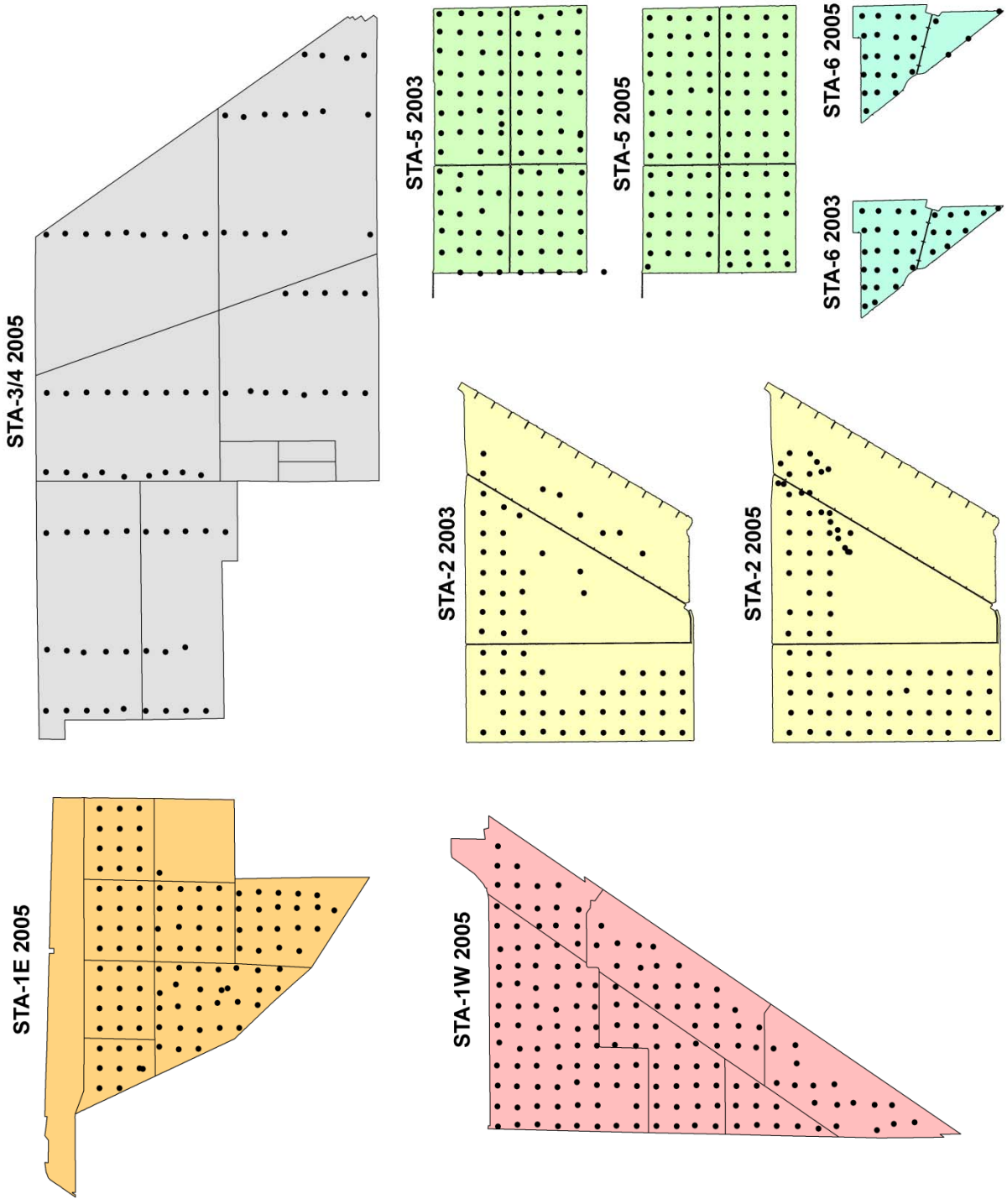
Statistic	DF	Value	Prob.
Chi-square	3	2383.744	<0.0001

Appendix 11. (Continued).

Year=2005 STA=STA-6

		EAV	FAV	SAV-OW	cattail	Totals
MAP	Coverage	401	3	160	297	861
	Percent	23.27	0.17	9.29	17.24	49.97
SURVEY	Coverage	225	0	225	412	862
	Percent	13.06	0.00	13.06	23.91	50.03
TOTALS	Coverage	626	3	385	709	1723
	Percent	36.33	0.17	22.34	41.15	100.00

Statistic	DF	Value	Prob.
Chi-square	3	82.109	<0.0001
Monte Carlo estimate for Chi-square	3	-	<0.0001



Appendix 12. Location of STA field sites (black dots) surveyed in the years when areal coverage s for vegetation groups based on this sampling method were compared to areal coverages derived from vegetation maps.