
Pollen Census Data from Southern Florida: Sites Along a Nutrient Gradient in Water Conservation Area 2A

Debra A. Willard

U. S. Geological Survey, 926A National Center, Reston, VA 20192



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INTRODUCTION

Recent increases in nutrient concentrations at sites throughout the Water Conservation Areas of southern Florida and expansion of cattail populations into areas previously populated by sawgrass have led to considerable discussion on their affect on vegetational abundance and distribution. Critical questions concern the response of plant communities to the increased nutrient loads and whether vegetational changes observed over the last few decades are greater than those that have occurred naturally throughout the history of the region. To address these questions, pollen assemblages from peat cores have been examined as proxy evidence for vegetational abundance. Research on these sites is part of a larger study on the [terrestrial ecosystem history of southern Florida](#), which focuses on analysis of a series of cores collected throughout the historic Everglades to interpret floral changes over the last few thousand years, with particular emphasis on high-resolution studies of the last 150 years.

This report is part of [a series of reports](#) documenting pollen data from cores collected in the historic Everglades. Sites F1 and U3 represent end members of a transect of sites along a nutrient gradient south of the Hillsboro Canal in Water Conservation 2A ([Figure 1](#)). Site F1 (26° 16.892'N, 80° 18.407'W) is situated at a high-phosphorous site in which the vegetation consists of a nearly monospecific stand of cattails (*Typha*) in

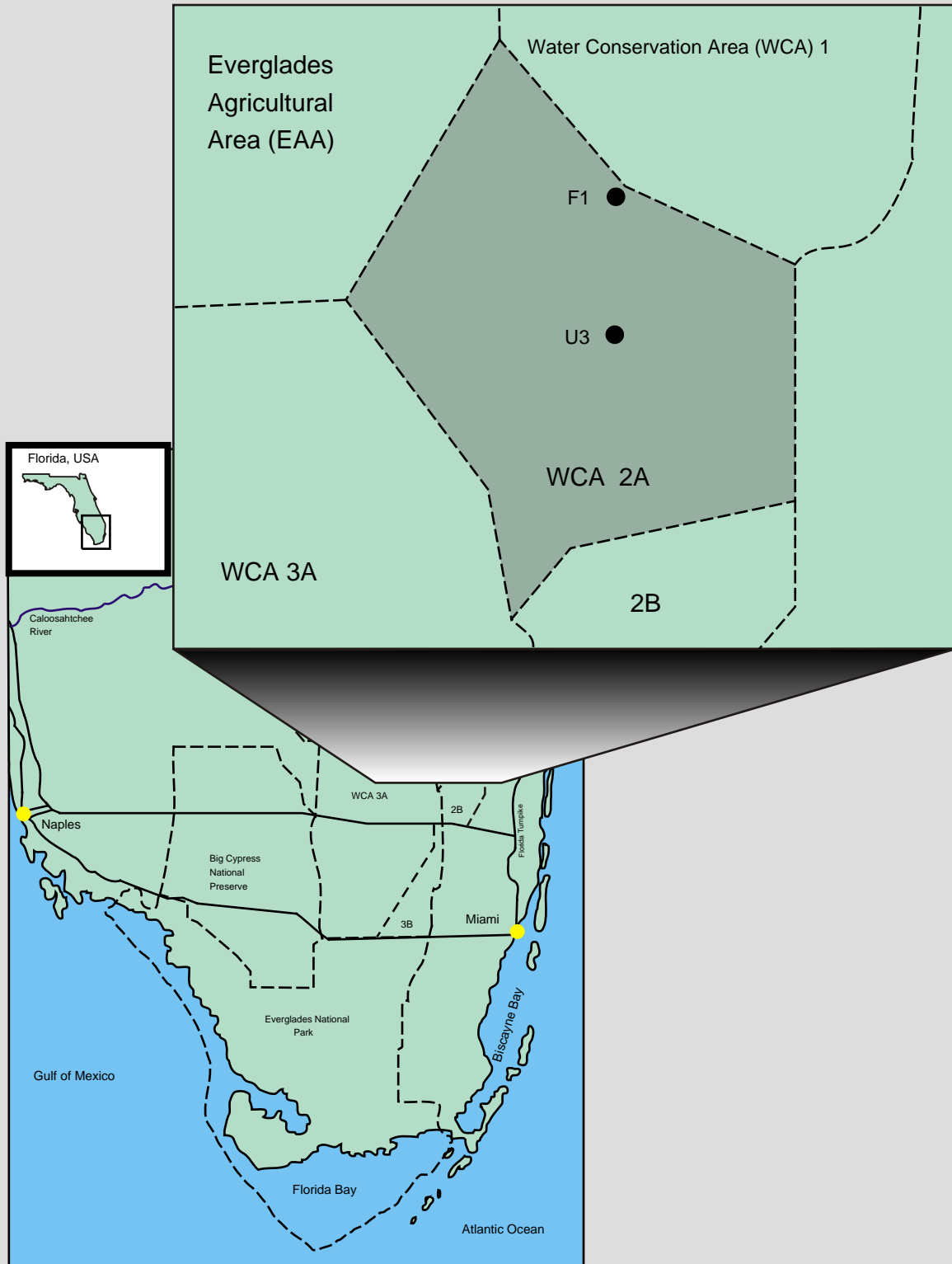


Figure1. Location of Sites F1 and U3, Water Conservation Area 2A, southern Florida.

approximately 1 meter of water. Site U3 (26° 17.25'N, 80° 24.68'W) is located in an area with pristine nutrient content in the surface water, and its vegetation is a mixture of cattails and sawgrass (*Cladium*) in about 0.5 meter of water. These sites are part of a transect in the South Florida Water Management District's "Threshold Study Sites", which are undergoing extensive chemical analyses to document changes in nutrient content temporally and spatially (Orem et al., 1997). Examination of pollen assemblages from these cores was initiated to determine the timing of cattail expansion in the region as well as other vegetational changes.

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METHODS OF INVESTIGATION

Cores were collected at sites F1 and U3 with a modified piston corer 10.16 cm (4 inches) in diameter, which is capable of taking a 1 meter core. We attempted to sample only the "peat" by physically moving the surface vegetation aside and beginning the coring at the "soil level" with minimal disturbance to the surface vegetation and peat. At Site F1,

however, the water depth and the thickness of the vegetation hindered this method, and some surface vegetation was sampled.

Upon completion of coring, each core was capped and transported to the laboratory. In the laboratory, cores were extruded at 1 or 2 centimeter increments, weighed and sacked. Because of the extremely permeable nature of the material, wet bulk density could not be accurately measured, and only dry bulk density was determined. In sampling for radiometric analyses, roots were removed physically prior to chemical dissolution. Bulk samples were sent to Beta Analytic for carbon-14 analysis. The resulting dates are indicated on the pollen diagrams (Figures 2 and 4) as years before present (BP); the error represents counting error (± 1 sigma standard deviation). Each sample also has been analyzed for the short-lived radioisotopes ^{210}Pb and ^{137}Cs (Holmes and Marot, in prep), and their current age model is used for interpretation of the timing of vegetational change.

Peat samples weighing approximately 0.5 g were used for pollen preparation. Samples were dried and weighed before being spiked with *Lycopodium* marker tablets for calculation of absolute pollen concentrations (Stockmarr, 1971). Samples were treated with dilute HCl to dissolve the marker tablet, neutralized with deionized water, and rinsed twice with glacial acetic acid to dry the material for acetolysis. Samples were acetolyzed in a hot water bath for 10 minutes, neutralized, and treated with 10% KOH in a hot water bath for 15 minutes. After neutralization, the samples were sieved with 149 μm and 10 μm nylon mesh to remove extraneous plant material and clay-sized particles. Some samples were run through a heavy-liquid separation with ZnCl_2 (S.G. = 2.1) to remove sand and other mineral matter. The pollen residue was mixed with warm glycerine jelly and mounted on microscope slides for examination.

Depth (cm from top)	TREES AND SHRUBS	<i>Alnus</i>	Alder	Anacardiaceae	Cashew family	<i>Betula</i>	Birch	<i>Bumelia</i>	<i>Bumelia</i> /Buckthorn	<i>Bursera simaruba</i>	Gumbo Limbo	<i>Carya</i>	Hickory	<i>Casuarina</i>	Australian Pine	<i>Celtis</i>	Hackberry	<i>Cephalanthus</i>	Buttonbush	Euphorbiaceae	Spurge family	Fabaceae	Bean/Legume family	<i>Fraxinus</i>	Ash	<i>Ilex</i>	Holly
0-2		0.00		0.00		0.00		0.00		0.00		0.83		0.00		0.00		0.00		0.00		0.28		0.00		0.00	
2-4		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
4-6		0.00		0.00		0.00		0.00		0.00		0.00		0.67		0.00		0.33		0.00		0.00		0.00		0.00	
6-8		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.94		0.00		0.00		0.00		0.00	
8-10		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
10-12		0.00		0.00		0.00		0.00		0.00		0.28		1.10		0.00		0.83		0.00		0.28		0.00		0.00	
12-14		0.00		0.00		0.00		0.00		0.00		1.45		0.00		0.00		0.00		0.00		0.48		0.00		0.00	
14-16		0.00		0.00		0.55		0.00		0.00		0.27		1.92		0.00		0.27		0.00		0.27		0.00		0.00	
16-18		0.00		0.00		0.00		0.00		0.00		0.77		2.31		0.00		0.00		0.00		0.00		0.00		0.00	
18-20		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.24		0.24		0.48	
20-22		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
22-24		0.00		0.00		0.00		0.00		0.00		0.97		0.00		0.00		0.00		0.97		1.93		0.00		0.00	
24-26		0.00		0.00		0.00		0.55		0.55		0.55		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
26-28		0.00		0.00		0.00		0.00		0.00		0.79		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
28-30		0.00		0.00		0.00		0.00		0.00		0.84		0.00		0.00		0.00		0.00		1.68		0.00		0.00	
30-32		0.51		0.00		1.02		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
32-34		0.61		0.00		0.61		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.61		0.00		0.00	
34-36		0.00		0.00		0.99		0.00		0.00		0.00		0.00		0.00		0.49		0.00		0.00		0.00		0.00	
36-38		0.00		0.00		0.37		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.37		0.00		0.00	
38-40		0.00		0.00		0.98		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
40-42		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.70		0.00		0.00	
42-44		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
44-46		0.00		0.00		0.00		0.00		0.00		0.49		0.00		0.00		0.00		0.00		0.49		0.00		0.49	
46-48		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.52		0.00		0.00		0.00		0.00		0.00	
48-50		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
50-52		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
52-54		0.00		0.00		0.00		0.00		0.00		0.50		0.00		0.00		0.00		0.00		1.01		0.00		0.00	
54-56		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.63		0.00		0.00		0.00		0.00		0.00	
56-58		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
58-60		0.00		0.00		0.49		0.00		0.00		0.00		0.00		0.00		0.00		0.49		0.49		0.00		0.00	
60-62		0.00		0.00		0.00		0.00		0.00		0.44		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
62-64		0.00		0.59		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
64-66		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
66-68		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.85		0.00		0.00	
68-70		0.00		0.00		0.56		0.00		0.00		0.00		0.00		0.00		0.56		0.56		0.56		0.00		0.00	
70-72		0.74		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	

Table 1. Percent abundance and total pollen concentration in samples from site F1, Water Conservation Area 2A

Depth (cm from top)	Liquidambar	Sweet Gum	Magnolia	Magnolia	Melastomaceae	Myrica	Wax Myrtle/Bayberry	Pinus	Pine	Quercus	Oak	Salix	Willow	Taxodiaceae/Cupressaceae	Cypress/Cedar families	Ulmus	Elm	HERBACEOUS PLANTS	Apiaceae	Parsley family	Asteraceae	Aster/Daisy family	Chenopodiaceae	Pigweed family	Cyperaceae	Sawgrass family
0-2	0.00		0.00		0.00	0.00		0.00		0.83		0.00		0.00		0.00			0.00		1.38		79.61		1.10	
2-4	0.00		0.00		0.00	0.00		1.67		0.28		0.00		0.00		0.00			0.00		0.56		85.56		0.56	
4-6	0.00		0.00		0.00	0.00		1.33		1.33		0.00		0.00		0.00			0.00		0.67		87.67		0.33	
6-8	0.00		0.00		0.00	0.00		1.88		0.94		0.00		0.00		0.00			0.00		1.57		88.71		0.94	
8-10	0.00		0.00		0.00	0.33		1.63		0.00		0.00		0.00		0.00			0.00		1.31		91.50		1.31	
10-12	0.28		0.00		0.00	0.28		3.03		0.83		0.00		0.28		0.00			0.00		3.31		81.54		1.93	
12-14	0.00		0.00		0.00	0.48		6.28		0.48		0.00		0.00		0.00			0.00		3.38		77.78		3.86	
14-16	0.00		0.27		0.00	6.87		5.77		1.10		0.00		0.00		0.00			0.00		4.67		68.68		0.82	
16-18	0.00		0.00		0.00	1.54		6.15		0.00		0.00		0.00		0.00			0.00		0.77		83.08		0.77	
18-20	0.00		0.24		0.00	11.08		16.39		0.24		0.00		0.00		0.00			0.00		2.89		56.63		1.20	
20-22	0.59		0.59		0.00	5.29		28.24		2.94		0.00		0.59		0.00			0.00		1.18		32.35		5.29	
22-24	0.00		0.00		0.00	7.73		20.77		5.31		0.00		0.00		0.48			0.00		1.93		37.20		4.83	
24-26	0.00		0.00		0.00	3.28		16.94		3.28		0.00		0.00		0.00			0.00		0.55		27.32		12.57	
26-28	0.00		0.00		0.00	2.38		18.25		2.38		0.00		0.00		0.00			0.00		2.38		46.03		7.94	
28-30	0.00		0.00		0.00	0.84		21.85		0.84		0.00		0.00		0.00			0.00		1.68		38.66		10.92	
30-32	0.00		0.00		0.00	0.51		25.38		1.52		0.00		0.00		0.51			0.00		0.51		24.87		20.81	
32-34	0.00		0.00		0.00	1.22		22.56		1.83		0.00		0.00		0.00			0.00		1.22		47.56		3.66	
34-36	0.00		0.00		0.00	3.45		25.12		0.99		0.00		0.00		0.00			0.00		0.99		49.26		0.49	
36-38	0.00		0.00		0.00	2.94		24.63		3.31		0.00		0.00		0.00			0.00		1.84		33.82		3.68	
38-40	0.00		0.00		0.00	2.94		36.27		1.96		0.00		0.98		0.00			0.00		0.00		43.14		0.00	
40-42	0.00		0.00		0.70	4.93		17.61		2.82		0.00		0.00		0.00			0.00		0.70		25.35		1.41	
42-44	0.00		0.00		0.00	3.14		13.84		1.26		0.00		0.00		0.00			0.00		0.63		32.08		0.63	
44-46	0.00		0.00		0.00	0.00		28.57		1.97		0.00		0.00		0.00			0.00		0.49		30.05		2.96	
46-48	0.00		0.00		0.00	2.09		18.85		2.09		0.52		0.00		0.52			0.00		1.57		26.70		0.52	
48-50	0.00		0.00		0.00	0.00		4.07		0.34		0.00		0.00		0.00			0.00		0.00		3.73		0.00	
50-52	0.00		0.00		0.00	0.00		28.33		0.00		0.00		0.00		0.00			0.00		0.83		35.83		4.17	
52-54	0.00		0.00		0.00	2.51		25.13		5.53		0.50		0.00		0.00			0.00		2.51		37.69		2.51	
54-56	0.00		0.00		0.00	1.88		23.75		1.88		0.00		0.00		0.00			0.00		1.25		52.50		0.63	
56-58	0.00		0.00		0.00	2.43		31.07		2.91		0.00		0.00		0.00			0.00		2.43		36.41		0.49	
58-60	0.00		0.00		0.00	0.49		15.12		0.98		0.00		0.49		0.00			0.00		0.98		66.34		1.46	
60-62	0.00		0.44		0.00	1.75		17.03		3.93		0.00		0.00		0.00			0.00		0.44		62.88		0.00	
62-64	0.00		0.00		0.00	0.59		10.06		1.18		0.00		0.00		0.00			0.00		0.59		75.74		0.00	
64-66	0.00		0.00		0.00	3.24		11.35		2.70		0.00		0.00		0.00			0.54		0.54		66.49		0.54	
66-68	0.00		0.00		0.00	0.00		15.38		1.71		0.00		0.00		0.00			0.00		0.00		60.68		3.42	
68-70	0.00		0.00		0.00	1.68		15.08		2.79		0.00		0.00		0.00			0.00		2.79		57.54		2.79	
70-72	0.00		0.00		0.00	2.94		12.50		2.94		0.00		0.00		0.00			0.00		3.68		58.82		0.74	

Table 1. Percent abundance and total pollen concentration in samples from site F1, Water Conservation Area 2A

Depth (cm from top)	<i>Decodon</i>	Swamp Loosestrife	Ericaceae	Heath family	<i>Nuphar</i>	Spatterdock	<i>Nymphaea</i>	Water Lily	Poaceae	Grass family	Polygonaceae	Knotweed family	<i>Sagittaria</i>	Arrowhead	<i>Thalictrum</i>	Rue Anemone	<i>Typha</i>	Cattail	<i>Utricularia</i>	Bladderwort	Triporate grains	Tricolpate grains	Tricolpate grains	Total pollen counted	Pollen/gram dry sediment
0-2	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		14.60		0.00		0.00	0.00	0.00	365	653,976
2-4	0.00		0.00		0.00		0.28		0.00		0.00		0.00		0.28		10.28		0.00		0.00	0.00	0.00	360	134,780
4-6	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		7.00		0.00		0.00	0.00	0.00	301	137,278
6-8	0.00		0.00		0.00		0.00		0.00		0.31		0.00		0.00		3.13		0.00		0.00	0.00	0.00	316	45,555
8-10	0.00		0.00		0.00		0.00		0.00		0.65		0.00		0.00		1.96		0.00		0.00	0.00	0.00	302	126,256
10-12	0.00		0.00		0.28		0.00		0.83		0.55		0.00		0.00		1.10		0.00		0.00	0.00	0.00	355	136,997
12-14	0.00		0.48		0.00		0.00		0.00		0.97		0.48		0.00		0.48		0.00		0.00	0.00	0.00	202	112,599
14-16	0.00		0.00		1.92		0.00		0.27		0.27		0.82		0.27		0.00		0.27		0.00	0.00	0.00	354	125,067
16-18	0.00		0.00		0.00		0.00		0.00		1.54		0.00		0.00		2.31		0.00		0.00	0.00	0.00	131	57,649
18-20	0.00		0.00		0.00		3.13		0.72		0.24		1.20		0.00		0.96		0.00		1.20	0.00	0.00	89	27,561
20-22	0.59		0.59		0.00		11.18		0.59		1.18		7.06		0.00		0.00		0.59		0.00	0.00	0.00	60	26,404
22-24	0.48		0.48		0.00		5.80		0.00		0.48		7.73		0.00		0.00		0.48		0.48	0.00	0.00	56	18,982
24-26	0.00		0.55		0.00		13.11		1.09		0.55		18.03		0.00		0.00		0.00		0.00	0.55	0.00	55	57,484
26-28	0.00		0.00		0.00		3.17		0.79		2.38		6.35		0.00		0.79		2.38		1.59	0.00	0.00	129	38,986
28-30	0.00		0.00		0.00		10.08		0.00		0.84		10.08		0.00		0.00		0.00		0.00	0.00	0.00	120	39,606
30-32	0.00		0.00		0.00		8.63		2.03		1.02		9.64		0.00		0.51		1.02		1.02	0.00	0.00	202	41,876
32-34	0.00		0.00		0.00		6.10		1.22		1.22		7.93		0.00		0.00		0.61		1.22	0.00	0.61	168	67,970
34-36	0.00		0.49		0.00		3.94		0.99		0.00		7.39		0.00		0.00		0.49		3.94	0.00	0.00	212	52,652
36-38	0.74		0.00		0.00		9.93		0.74		1.47		13.97		0.00		0.00		0.00		0.37	0.00	0.00	96	50,168
38-40	0.00		1.96		0.00		5.88		0.00		0.00		4.90		0.00		0.00		0.98		0.00	0.00	0.00	104	42,076
40-42	0.00		2.11		0.00		14.08		0.70		1.41		26.76		0.00		0.00		0.00		0.00	0.00	0.00	53	19,843
42-44	0.00		1.26		0.00		37.74		0.00		1.26		5.66		0.00		1.26		0.63		0.00	0.00	0.00	41	38,091
44-46	0.00		0.49		0.00		27.58		0.00		0.00		4.93		0.00		0.00		0.49		0.00	0.00	0.49	203	159,911
46-48	0.00		1.57		0.00		37.70		0.00		0.00		4.71		0.00		0.00		0.52		0.52	0.00	0.00	86	19,791
48-50	0.00		0.00		0.00		91.53		0.00		0.00		0.34		0.00		0.00		0.00		0.00	0.00	0.00	301	290,396
50-52	0.00		0.83		0.00		26.67		0.00		1.67		0.00		0.00		0.83		0.00		0.00	0.00	0.00	119	30,459
52-54	0.00		0.00		0.00		11.06		0.50		0.00		7.54		0.00		0.00		0.50		0.00	0.00	0.00	70	25,084
54-56	0.00		1.25		0.00		6.88		0.00		0.63		6.88		0.00		0.00		0.63		0.00	0.00	0.00	51	29,075
56-58	0.00		0.49		0.00		16.02		1.46		0.00		2.91		0.00		0.00		0.97		0.00	0.00	0.00	74	46,405
58-60	0.49		0.00		0.00		5.37		0.49		0.98		1.95		0.00		0.00		0.98		1.46	0.00	0.00	212	183,373
60-62	0.00		0.00		0.00		6.11		0.00		0.44		3.93		0.00		0.87		0.44		0.87	0.00	0.00	236	92,497
62-64	0.00		0.00		0.00		2.96		0.59		0.59		5.33		0.00		0.59		0.59		0.00	0.00	0.00	170	96,915
64-66	0.00		0.00		0.00		10.27		0.00		0.00		2.70		0.00		0.00		1.08		0.00	0.00	0.00	190	82,172
66-68	0.00		0.00		0.00		7.69		1.71		0.85		7.69		0.00		0.00		0.00		0.00	0.00	0.00	121	104,661
68-70	0.00		0.00		0.00		7.82		0.00		0.00		2.79		0.00		1.12		0.00		0.00	0.00	0.56	184	76,924
70-72	0.00		0.00		0.00		8.09		2.21		0.00		2.21		0.00		1.47		0.00		0.00	0.00	0.00	135	38,049

Table 1. Percent abundance and total pollen concentration in samples from site F1, Water Conservation Area 2A

Depth (cm from top)	<i>Alnus</i>	Alder	<i>Betula</i>	Birch	<i>Bumelia</i>	<i>Bumelia/Buckthorn</i>	<i>Carya</i>	Hickory	<i>Casuarina</i>	Australian Pine	<i>Celtis</i>	Hackberry	<i>Cephalanthus</i>	Buttonbush	<i>Cornus</i>	Dogwood	<i>Cyrilla</i>	Ti-Ti	Euphorbiaceae	Spurge family	Fabaceae	Bean/Legume family	<i>Fraxinus</i>	Ash	<i>Ilex</i>	Holly
0-2	0.00		0.00		0.56		1.11		0.00		0.00		0.00		0.00		0.00		0.00		0.56		0.00		0.00	
2-4	0.24		0.49		0.00		0.00		0.49		0.00		0.49		0.00		0.00		0.24		0.00		0.00		0.00	
4-6	0.00		1.31		0.00		1.63		1.63		0.00		0.00		0.00		0.00		0.33		0.33		0.00		0.00	
6-8	0.29		0.29		0.00		2.05		0.00		0.00		0.59		0.00		0.00		0.29		0.29		0.29		0.59	
8-10	0.00		0.00		0.00		1.71		0.00		0.00		0.00		0.00		0.00		0.00		1.14		0.00		0.00	
10-12	0.94		0.94		0.47		1.88		0.00		0.94		1.88		0.00		0.00		0.47		0.94		0.00		0.47	
12-14	0.38		2.28		0.00		0.76		0.00		0.00		0.38		0.00		0.00		0.00		1.14		0.00		0.38	
14-16	0.00		2.11		0.00		0.42		0.00		0.42		0.42		0.00		0.00		0.00		0.00		0.00		0.00	
16-18	0.00		0.93		0.00		0.00		0.00		0.47		0.47		0.47		0.00		0.47		1.86		0.47		0.00	
18-20	0.00		0.59		0.00		0.00		0.00		0.59		0.59		0.00		0.00		0.59		0.59		0.59		0.00	
20-22	0.66		2.97		0.00		0.99		0.00		0.00		0.00		0.00		0.00		0.00		0.66		0.00		0.00	
22-24	0.00		0.00		0.00		0.47		0.00		0.47		0.00		0.00		0.47		0.00		0.47		0.47		0.00	
24-26	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
26-28	0.63		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.63		0.00		0.00	
28-30	BARREN																				BARREN					
30-32	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
32-34	0.49		0.00		0.00		0.00		0.00		0.00		0.49		0.00		0.00		0.00		0.97		0.00		0.00	
34-36	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
36-38	0.41		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.41		0.00		0.00	
38-40	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
40-42	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
42-44	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
44-46	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.60		0.00		0.00	
46-48	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.47		0.00		0.00	
48-50	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
50-52	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
52-54	0.63		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.63		0.00	
54-56	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
56-58	0.47		0.47		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
58-60	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
60-62	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
62-64	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
64-66	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
66-68	0.00		0.00		0.00		0.77		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	

Table 2. Percent abundance and total pollen concentration in samples from Site U3, Water Conservation Area 2A

Depth (cm from top)	Juglans	Walnut	Liquidambar	Sweet Gum	Magnolia	Magnolia	Myrica	Wax Myrtle/Bayberry	Ostrya/Caprinus	Hophornbeam	Pinus	Pine	Quercus	Oak	Salix	Willow	Taxodiaceae/Cupressaceae	Cypress/Cedar families	Ulmus	Elm	Apiaceae	Parsley family	Asteraceae	Aster/Daisy family	Chenopodiaceae	Pigweed family
0-2	0.00		0.00		0.00		2.22		0.00		18.33		6.11		0.00		0.00		0.00		0.00		18.33		33.33	
2-4	0.24		0.24		0.00		3.16		0.00		14.81		1.70		0.24		0.00		0.00		0.00		25.49		31.07	
4-6	0.00		0.00		0.00		6.21		0.00		14.71		2.29		1.31		0.33		0.00		0.00		14.71		29.74	
6-8	0.00		0.00		0.29		5.28		0.00		12.61		3.52		0.00		0.59		0.00		0.00		10.56		29.03	
8-10	0.00		0.00		0.00		5.71		0.00		23.43		1.14		0.00		0.00		0.00		0.00		1.14		22.86	
10-12	0.00		0.00		0.00		17.84		0.00		21.13		4.23		0.00		0.94		0.47		0.00		0.94		16.90	
12-14	0.00		0.38		0.00		17.49		0.00		20.53		3.04		0.00		0.00		0.00		0.00		1.90		19.39	
14-16	0.00		0.00		0.00		4.64		0.00		25.32		2.11		0.00		0.42		0.00		0.42		1.69		29.11	
16-18	0.00		0.00		0.00		12.09		0.00		21.86		4.19		0.00		0.00		0.00		0.47		2.33		23.72	
18-20	0.00		0.00		0.00		11.24		0.00		26.04		5.92		0.00		1.18		0.00		0.59		0.00		24.85	
20-22	0.00		0.33		0.00		8.91		0.00		29.04		2.64		0.00		0.66		0.00		0.99		1.32		29.04	
22-24	0.00		0.00		0.00		7.94		0.00		32.71		5.14		0.00		0.47		0.00		0.47		0.93		15.42	
24-26	0.00		0.91		0.00		10.91		0.00		23.64		2.73		0.00		0.00		0.00		0.91		2.73		23.64	
26-28	0.00		0.00		0.00		27.85		0.63		33.54		2.53		0.00		0.00		0.00		0.00		0.63		8.23	
28-30													BARREN													
30-32	0.00		0.00		0.00		17.00		0.00		38.00		4.00		0.00		0.00		0.00		0.00		0.00		13.00	
32-34	0.00		0.00		0.00		10.19		0.49		27.67		6.31		0.00		0.00		0.00		1.46		0.97		21.36	
34-36	0.00		0.00		0.00		4.12		0.59		42.94		2.35		0.00		0.00		0.00		0.59		1.76		9.41	
36-38	0.00		0.00		0.00		2.48		0.00		64.46		2.07		0.00		0.00		0.00		0.00		0.83		8.26	
38-40	0.00		0.00		0.00		0.90		0.00		69.37		0.90		0.00		0.00		0.00		0.00		0.00		4.50	
40-42	0.00		0.00		0.00		2.22		0.00		48.89		2.22		0.00		0.00		0.00		0.00		0.74		8.89	
42-44	0.00		0.00		0.00		1.79		0.00		42.86		0.00		0.00		0.00		0.60		0.00		0.60		9.52	
44-46	0.60		0.00		0.00		0.60		0.00		32.34		0.60		0.00		0.00		0.00		0.00		0.00		31.74	
46-48	0.00		0.00		0.00		0.94		0.00		24.53		1.89		0.00		0.00		0.00		0.00		0.00		48.11	
48-50	0.00		0.00		0.00		0.30		0.00		6.59		1.20		0.00		0.30		0.00		0.00		0.30		78.14	
50-52	0.00		0.00		0.00		1.09		0.00		24.46		2.17		0.00		0.00		0.00		0.00		0.54		50.00	
52-54	0.00		0.00		0.00		3.14		0.00		25.79		1.89		0.00		0.00		0.00		0.00		0.63		41.51	
54-56	0.00		0.00		0.00		1.92		0.00		39.42		3.85		0.00		0.00		0.00		0.00		2.88		27.88	
56-58	0.00		0.00		0.00		1.42		0.00		48.11		0.00		0.00		0.00		0.00		0.00		1.89		33.02	
58-60	0.00		0.00		0.00		1.67		0.00		32.50		0.83		0.00		0.00		0.00		0.00		0.00		47.50	
60-62	0.00		0.00		0.00		0.96		0.00		41.35		1.92		0.00		0.00		0.00		0.00		0.96		44.23	
62-64	0.00		0.00		0.00		0.00		0.00		22.73		1.52		0.00		0.00		0.00		0.00		0.00		53.03	
64-66	0.00		0.00		0.00		4.00		0.00		36.00		4.00		0.00		0.00		0.00		0.00		0.00		48.00	
66-68	0.00		0.00		0.00		0.77		0.00		33.85		1.54		0.00		0.00		0.00		0.77		0.00		37.69	

Table 2. Percent abundance and total pollen concentration in samples from Site U3, Water Conservation Area 2A

Depth (cm from top)	Cyperaceae	Sawgrass family	Decodon	Swamp Loosestrife	Ericaceae	Heath family	Hippocratea	Melastomaceae	Myriophyllum	Water Milfoil	Nymphaea	Water Lily	Poaceae	Grass family	Polygalaceae	Polygonaceae	Knotweed family	Sagittaria	Arrowhead	Typha	Cattail	Utricularia	Bladderwort
0-2	12.78		0.00		0.00		0.00		0.00		0.56		0.00		0.00		0.00	1.11		1.11		0.00	
2-4	13.83		0.00		0.00		0.00		0.00		1.21		1.46		0.00		0.24	0.49		0.24		0.24	
4-6	12.09		0.00		0.33		0.00		0.00		2.61		1.31		0.00		0.00	1.31		0.00		0.33	
6-8	16.72		0.00		0.29		0.00		0.00		3.23		0.88		0.00		0.00	2.35		0.00		0.59	
8-10	25.14		0.00		0.57		0.00		0.00		7.43		0.57		0.00		0.00	1.14		0.00		0.57	
10-12	7.04		0.00		0.00		0.00		0.47		3.29		0.94		0.00		0.00	3.29		0.00		0.00	
12-14	7.60		0.38		0.38		0.00		0.00		1.90		1.14		0.00		0.00	5.32		0.00		1.90	
14-16	8.44		0.00		0.00		0.00		0.00		15.61		0.42		0.42		0.00	2.95		0.00		0.84	
16-18	6.05		0.00		0.00		0.00		0.00		5.12		0.47		0.00		0.00	6.51		0.47		1.86	
18-20	9.47		0.00		1.18		0.00		0.00		2.37		1.18		0.00		0.00	4.14		0.00		0.59	
20-22	6.60		0.00		0.00		0.00		0.00		3.96		0.66		0.00		0.00	2.97		0.00		0.00	
22-24	9.35		0.00		1.40		0.00		0.00		3.74		0.00		0.00		0.00	11.21		0.47		0.00	
24-26	12.73		0.00		0.00		0.00		0.00		5.45		0.91		0.00		0.00	8.18		0.00		0.00	
26-28	5.06		0.00		0.63		0.00		0.00		7.59		1.90		0.00		0.63	6.96		0.00		0.63	
28-30								BARREN															
30-32	8.00		0.00		1.00		0.00	1.00	0.00	5.00	1.00	0.00	0.00	6.00	5.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	
32-34	10.68		0.49		0.00		0.00	0.00	0.00	13.59	0.00	0.00	0.00	2.91	1.94	0.00	1.94	0.00	0.00	0.00	0.00	0.00	
34-36	9.41		0.59		1.18		0.00	0.00	0.00	18.82	0.00	0.00	0.00	0.00	6.47	0.59	6.47	0.59	0.59	0.59	0.59	0.59	
36-38	1.24		0.00		0.41		0.00	0.00	0.00	17.77	0.41	0.00	0.00	0.00	0.83	0.00	0.83	0.00	0.00	0.00	0.00	0.00	
38-40	2.70		0.00		0.00		0.00	0.00	0.00	18.92	0.00	0.00	0.00	1.80	0.90	0.00	0.90	0.00	0.00	0.00	0.00	0.00	
40-42	2.22		0.00		0.74		0.00	0.00	0.00	31.85	0.00	0.00	0.00	0.00	2.22	0.00	2.22	0.00	0.00	0.00	0.00	0.00	
42-44	1.19		0.00		1.19		0.00	0.00	0.00	39.29	0.00	0.00	0.00	0.00	2.38	0.00	2.38	0.00	0.00	0.00	0.00	0.00	
44-46	1.80		0.00		0.00		0.00	0.00	0.00	26.95	0.60	0.00	0.00	0.00	4.19	0.00	4.19	0.00	0.00	0.00	0.00	0.00	
46-48	0.94		0.00		0.47		0.00	0.00	0.00	14.15	1.42	0.00	0.00	0.00	6.13	0.00	6.13	0.00	0.00	0.00	0.47	0.47	
48-50	2.99		0.00		0.00		0.00	0.00	0.00	3.59	0.90	0.00	0.00	4.19	1.50	0.00	1.50	0.00	0.00	0.00	0.00	0.00	
50-52	5.43		0.54		0.54		0.00	0.00	0.00	8.70	1.09	0.00	0.00	1.09	3.80	0.00	3.80	0.00	0.00	0.00	0.00	0.00	
52-54	1.26		0.00		1.26		0.00	0.63	0.00	13.84	1.26	0.00	0.00	0.63	5.66	0.63	5.66	0.63	0.63	0.63	0.63	0.63	
54-56	2.88		0.00		0.00		0.00	0.00	0.00	16.35	0.00	0.00	0.00	2.88	0.96	0.00	0.96	0.00	0.00	0.00	0.00	0.00	
56-58	1.42		0.00		0.47		0.00	0.00	0.00	8.96	0.94	0.00	0.00	0.47	1.42	0.47	1.42	0.47	0.47	0.47	0.47	0.47	
58-60	1.67		0.00		0.00		0.00	0.00	0.00	13.33	0.83	0.00	0.00	0.00	1.67	0.00	1.67	0.00	0.00	0.00	0.00	0.00	
60-62	0.96		0.96		0.00		0.00	0.00	0.00	3.85	0.96	0.00	0.00	0.00	3.85	0.00	3.85	0.00	0.00	0.00	0.00	0.00	
62-64	1.52		0.00		0.00		0.00	0.00	0.00	18.18	0.00	0.00	0.00	0.00	1.52	0.00	1.52	0.00	0.00	0.00	0.00	0.00	
64-66	0.00		0.00		0.00		0.00	0.00	0.00	4.00	0.00	0.00	0.00	0.00	4.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	
66-68	1.54		0.00		0.00		0.00	0.00	0.77	20.00	0.00	0.00	0.00	0.00	0.77	0.77	0.77	0.00	0.00	0.00	0.00	0.00	

Table 2. Percent abundance and total pollen concentration in samples from Site U3, Water Conservation Area 2A

Depth (cm from top)	Triporate grains	Total Pollen Counted	Pollen/gram dry sediment
0-2	3.89	188	88,977
2-4	2.67	447	71,447
4-6	7.19	318	60,752
6-8	9.09	358	122,645
8-10	4.00	193	51,605
10-12	9.86	213	62,359
12-14	13.31	274	47,922
14-16	3.38	247	74,202
16-18	8.37	222	57,072
18-20	7.69	174	38,598
20-22	5.94	308	39,709
22-24	7.94	220	54,209
24-26	7.27	111	32,884
26-28	1.27	160	71,241
28-30		12	4,915
30-32	0.00	101	18,201
32-34	0.00	208	21,878
34-36	0.59	78	16,005
36-38	0.00	242	47,330
38-40	0.00	111	80,444
40-42	0.00	136	21,824
42-44	0.00	168	19,393
44-46	0.00	84	17,902
46-48	0.47	127	15,771
48-50	0.00	334	86,924
50-52	0.54	95	8,460
52-54	0.00	165	32,524
54-56	0.96	104	70,648
56-58	0.00	213	35,503
58-60	0.00	44	14,628
60-62	0.00	106	18,002
62-64	0.00	26	6,271
64-66	0.00	10	3,035
66-68	0.77	135	29,619

Table 2. Percent abundance and total pollen concentration in samples from Site U3, Water Conservation Area 2A

Absolute pollen concentrations were calculated using the marker-grain method described by Benninghoff (1962). Marker tablets of *Lycopodium* spores were the source of the exotic grains, and the quantity of *Lycopodium* spores in the marker tablets was determined by the manufacturer with a Coulter Counter following the procedures of Stockmarr (1973). The concentration of spores in these tablets is 12,542 +/- 416. Absolute pollen concentration was calculated using the formula (Maher, 1981):

$$\text{pollen per gram dry sediment} = \frac{(\text{pollen grains counted} / \text{marker grains counted}) \times 12,542}{\text{weight of sediment}}$$

To calculate percent abundance, at least 100 grains were counted per sample, and samples with fewer than 100 grains/count have been omitted from the pollen diagrams (Figures 2-5). Ideally, 300 grains were counted, but in some samples the high proportion of phytodebris compared to pollen made acceptance of lower numbers necessary. Pollen assemblages were quantified from 36 samples at site F1 and 34 samples at site U3. Results of the counts are presented in Tables 1 and 2.

RESULTS

Water Conservation Area 2A - Site F1

Four assemblage zones are identifiable in the core collected at Site F1. Pollen assemblages in Zone I, the lowermost zone (73-58 cm), are dominated by pollen of the Chenopodiaceae/Amaranthaceae (pigweed/amaranth families) (58-76%), with *Pinus* (pine) (10-17%), *Nymphaea* (waterlily) (3-10%), and *Sagittaria* (arrowhead) (2-8%) pollen

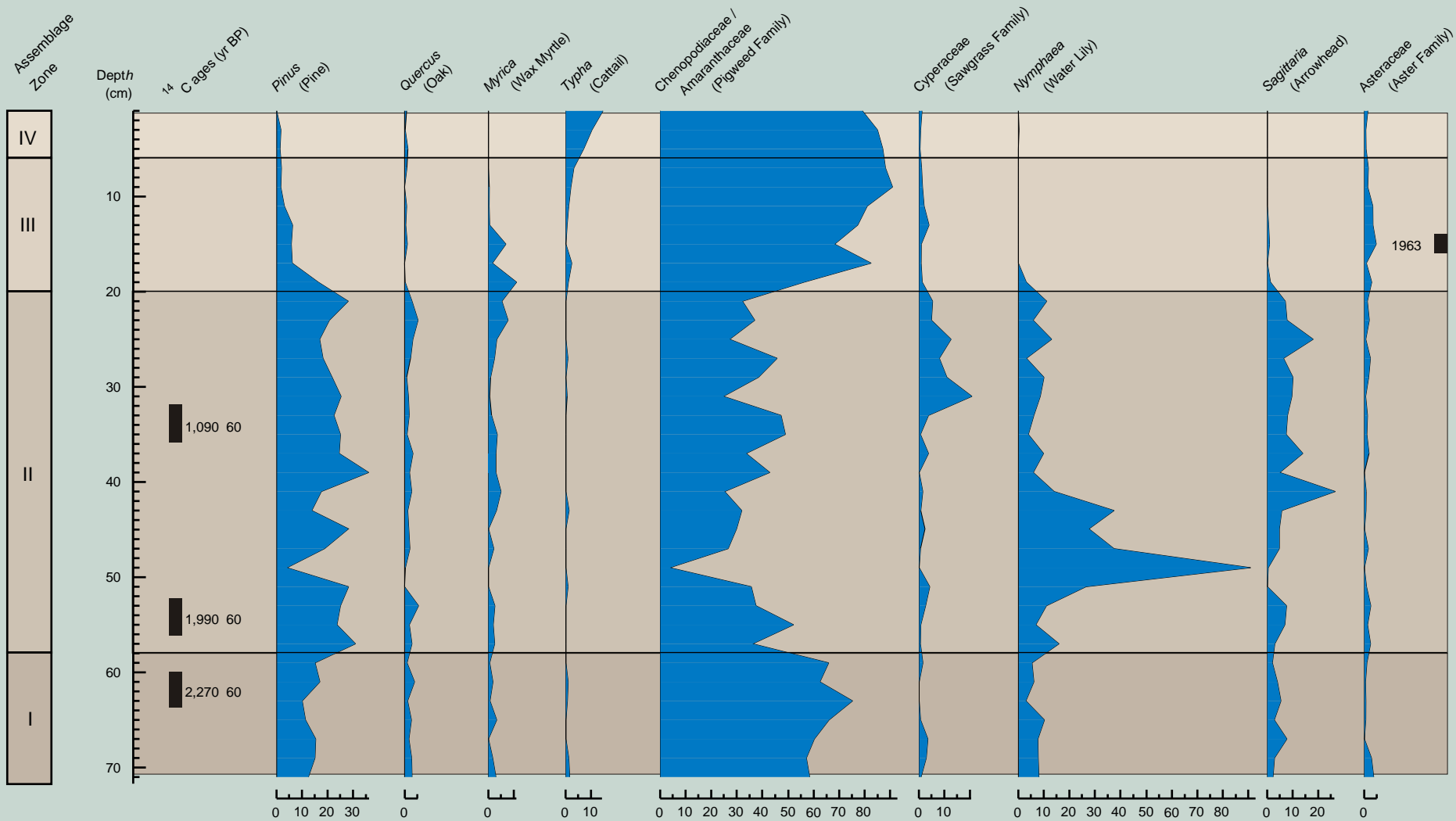


Figure 2. Percent abundance of pollen of selected taxa in core from Site F1, Water Conservation Area 2A, southern Florida.

common (Figure 2). *Cladium* (sawgrass) and *Typha* (cattail) pollen are present in low abundances in this interval, ranging from 0-3% and 0-1.5%, respectively. Total pollen concentration is high in this zone, typically ranging from 82,000 to 183,000 pollen grains/gram, and the bulk of the pollen is contributed by the Chenopodiaceae/Amaranthaceae (Figure 3).

In Zone II (58-20 cm), pollen of the Chenopodiaceae/Amaranthaceae is less abundant but still a prominent component of the assemblages, usually ranging from 20-53% abundance. Pollen of marsh vegetation is more abundant in this interval; *Nymphaea* pollen typically comprises 10-38% of the assemblage, *Sagittaria* makes up about 5-27% of the assemblages, and pollen of the sawgrass family, primarily *Cladium*, is common in the upper part of the zone (32-20 cm), ranging from 5-20% abundance. Pollen concentrations typically are lower in this zone, usually 19,000-68,000 grains/gram. The exceptions are found at the 48-50 cm interval, where *Nymphaea* pollen was unusually abundant and in the 44-46 cm interval.

Zone III (20-6 cm) is characterized by extremely high percentages of pollen of Chenopodiaceae/Amaranthaceae (56-91%) and a corresponding drop in percent abundance of every other taxon except the Asteraceae (aster family). Although the Asteraceae shows only a slight increase in percent abundance, its concentration increases up to tenfold over the lower zone, from about 500 grains/gram to as high as 6,000 grains/gram. The pollen of marsh plants virtually disappears (Figures 2-3). Total pollen concentration is higher in this zone (45,000-137,000 grains/gram) as the Chenopodiaceae/Amaranthaceae again increase in abundance.

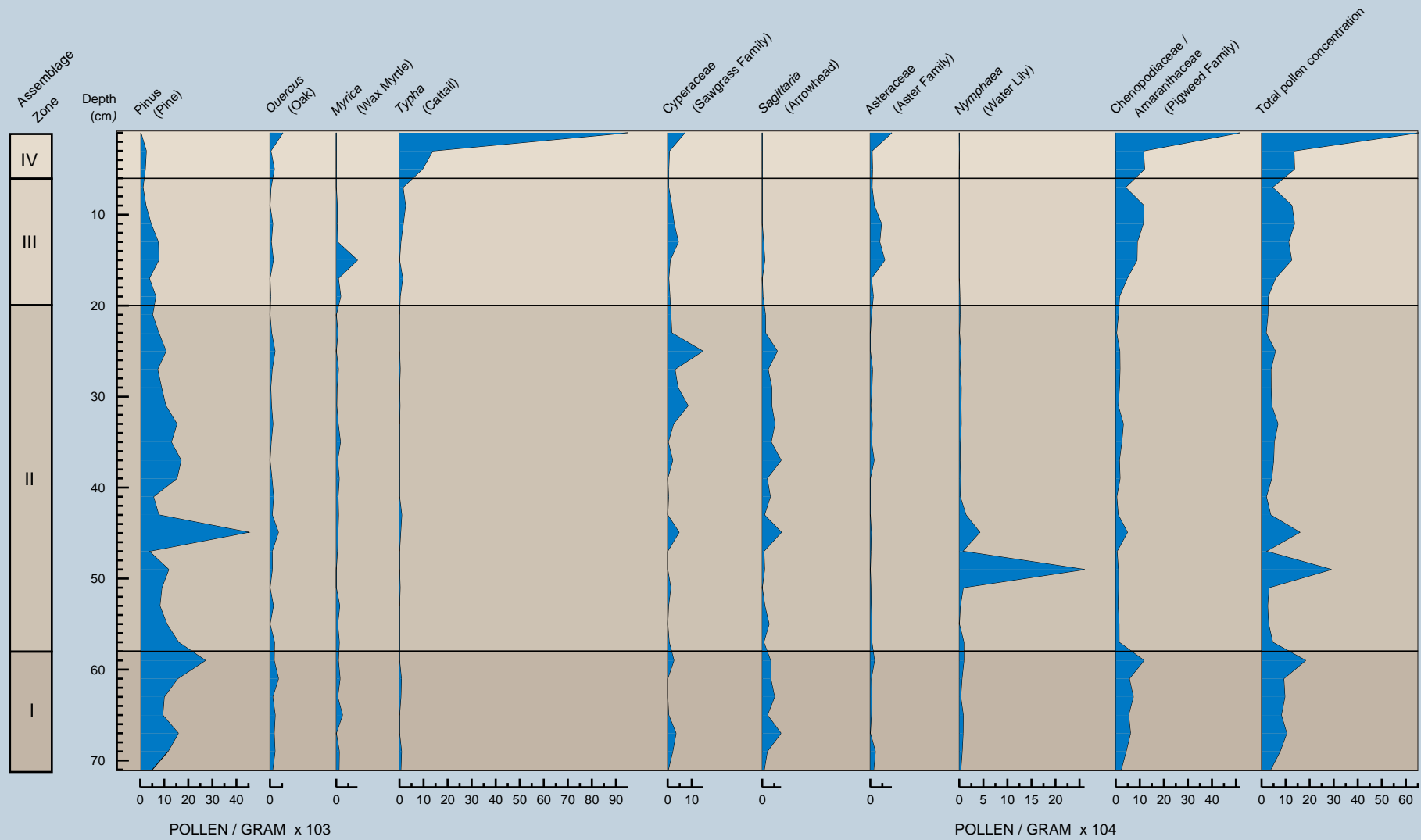


Figure 3. Pollen concentration (pollen grains / gram dry sediment) of selected taxa in core from Site F1, Water Conservation Area 2A, southern Florida. Note different scales.

Zone IV (6-0 cm) is characterized by the highest abundances of *Typha* pollen both in percent abundance and absolute concentration (Figures 2-3), with concentration of *Typha* pollen increasing nearly tenfold from Zone III. Pollen of the Chenopodiaceae/Amaranthaceae also is very abundant, and Asteraceae pollen maintains its high concentration from the zone below (750-9,000 grains/gram).

Water Conservation Area 2A - Site U3

Three assemblage zones are identifiable at Site U3. Zone I (68-44 cm) is characterized by the highest abundances of pollen of the Chenopodiaceae/Amaranthaceae (28-78%) (Figure 4). *Nymphaea* pollen is common (typically 5-27%), and *Sagittaria* and the Cyperaceae are represented by low percentages (1-6% and 1-5%, respectively). Total pollen concentration is relatively low in this zone (3,000-87,000 grains/gram) (Figure 5), especially when compared to the lowest zone at Site F1.

In Zone II (44-10 cm), the Chenopodiaceae/Amaranthaceae are less common (5-33%); Cyperaceae pollen increases in abundance, comprising up to 29% of the assemblages, and *Nymphaea* and *Sagittaria* are common, comprising 3-40% and 1-11% of the assemblages, respectively. *Myrica* pollen increases in abundance at 34 cm and comprises 5-28% of the assemblage between 34 cm and 10 cm depth. Pollen concentration is similar to that in Zone I, ranging from 16,000-80,000 grains/gram.

Zone III (10-0 cm) is distinguished by high percentages of Asteraceae pollen (11-25%). This represents a more than tenfold increase in Asteraceae pollen concentration from <1,000 grains/gram in Zone II to as high as 17,000 grains/gram in Zone III. Although percent abundance of Chenopodiaceae/Amaranthaceae pollen changes little,

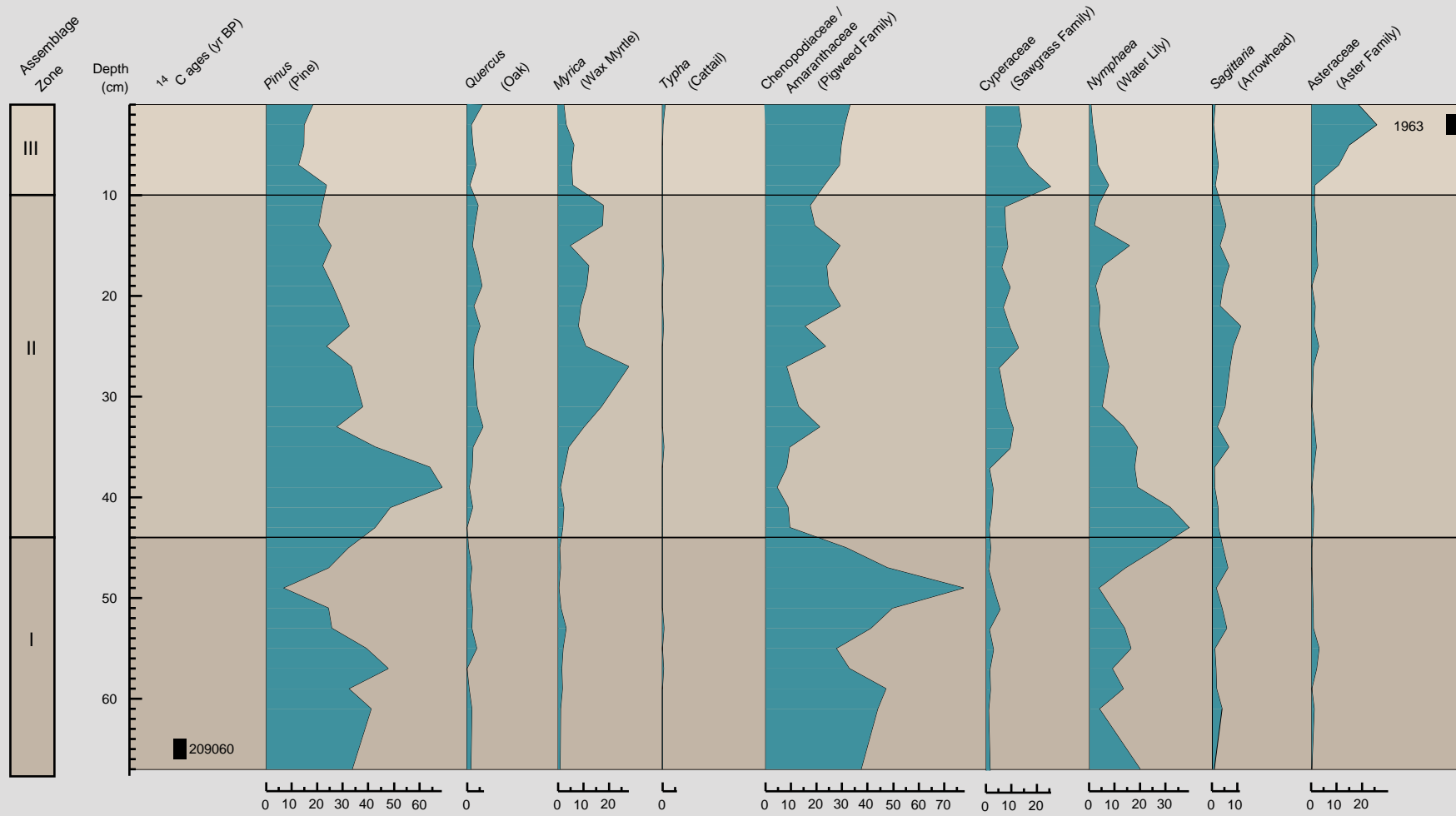


Figure 4. Percent abundance of pollen of selected taxa in core from Site U3, Water Conservation Area 2A, southern Florida.

their concentration is up to three times greater than in the lower zone. Similarly, *Typha* shows little change in percent abundance but increases from absence at 4-6 cm depth to 950 grains/gram in the top sample. Total pollen concentration also is higher in this zone (52,000-123,000 grains/gram) and is comparable to Zone III at Site F1.

DISCUSSION

Long-term patterns

The lower parts of the two cores demonstrate patterns of pollen abundance that appear to be correlative. Zone I in each core has higher abundances of pollen of the Chenopodiaceae/Amaranthaceae, both in terms of percent abundance and pollen concentration. The precise range of dates represented by this interval is unclear, but it includes 2,000 BP, based on radiocarbon dates from both cores. Although pollen of the Chenopodiaceae/Amaranthaceae strongly dominates the assemblages, this probably does not reflect the predominant vegetation or peat composition. Analysis of thin sections of the upper peats by from Sites F1 and U3 (dominated by Chenopodiaceae/Amaranthaceae pollen) by [Cohen \(1995\)](#) indicates that the F1 peats were either cattail or sawgrass peats, depending on depth, and the U3 peats were sawgrass peats; the dominant elements in the peat generally correspond to the subdominant elements in the pollen assemblages. Therefore, we consider the relatively high abundances of *Nymphaea* pollen (compared to *Cladium*) at both sites in this interval to be suggestive that peats in this interval were waterlily peats. No peats remain from these cores for sectioning, but petrographic analysis

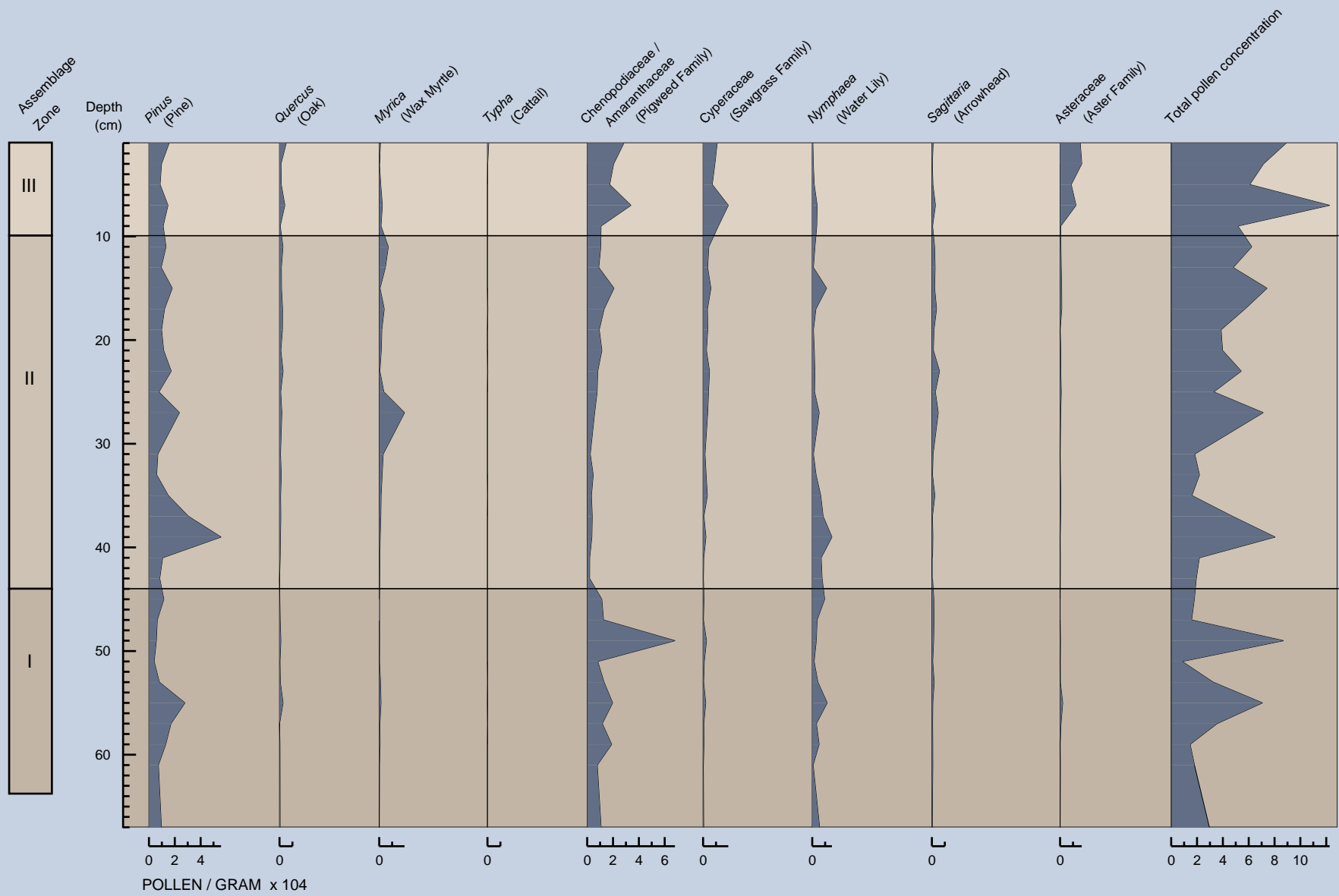


Figure 5. Pollen concentration (pollen grains / gram dry sediment) of selected taxa in core from site U3, Water Conservation Area 2A, southern Florida

of the peats would be useful to clarify the peat type and to interpret patterns of hydroperiod and fire regime over the older part of the peat.

Zone II at each site also appears to be correlative; pollen concentrations are about the same (typically 15,000-80,000 grains/gram), and both sites show similar patterns in the fluctuating abundances of marsh plants. *Nymphaea* pollen is most abundant at the bottom of the zone, and Cyperaceae pollen increases in abundance above that. *Sagittaria* is present in approximately constant amounts throughout the zone, and Chenopodiaceae/Amaranthaceae consistently comprise about 10-30% of the assemblages. The patterns shown by the bottom two intervals are consistent with a shift from long-hydroperiod, waterlily marshes into moderate-hydroperiod, flag or sawgrass marshes from around 2,000 BP to the 1800s. The minor increases in *Typha* abundance throughout both zones reflect its response to natural changes such as fire or lengthening and deepening of hydroperiod.

Short-term patterns

Although both sites show increased pollen concentrations (45,000-125,000 pollen grains/gram) in the last 150 years, the relative response of vegetation at the two sites differs. At both sites, pollen of the Asteraceae and Chenopodiaceae/Amaranthaceae more than double in abundance in the early 1900s. However, at Site U3, the greater change is in the abundance of Asteraceae pollen; at Site F1, the greater change is in the abundance of the Chenopodiaceae/Amaranthaceae. At the same level, marsh vegetation such as *Nymphaea*, *Sagittaria*, and *Cladium* declines greatly in abundance, remaining at low levels throughout the rest of the core. The current age model indicates that these changes may be correlated with construction of the Hillsboro Canal, which was completed by 1920

(Light and Dineen, 1994; C. Holmes, pers. comm.). Disturbance of the peat would have fostered increased abundances of opportunistic species, such as the Chenopodiaceae/Amaranthaceae and Asteraceae, and enabled them to outcompete the marsh vegetation that had dominated until that point.

Data from ^{137}Cs and “bomb” ^{14}C indicate that *Typha* abundance increased in both cores after 1963 (from 2-4 cm at Site U3 and from 12-14 cm at Site F1) (C. Holmes, pers. comm.). Given the current age model, the relatively small increase in *Typha* abundance between 16 and 18 cm may correspond to development of a 2,400 ha stand of cattails that developed before construction of WCA 2A from soil subsidence and associated lengthening and deepening of the hydroperiod in the 1950s (Davis, 1994). The continuing increase in abundance of *Typha* at Site F1 coincides with completion of construction of Water Conservation Area 2A; the levees around the area were completed in 1962, and the water-regulation scheme was set at a level later determined to be too high (Light and Dineen, 1994). The great increase in abundance in the top 6 cm at site F1 and the upper 2 cm at Site U3, however, appears to be correlated with *Typha* invasion of another 5,700 ha in the 1980s that has been tied to higher nutrient influx into the marsh at that time (Davis, 1994). The eutrophication and greater peat accumulation rate since the 1980s is reflected at Site F1 by the pollen concentrations, which increase up to five-fold (Figure 3), a pattern which is not as apparent at Site U3.

SUMMARY

Pollen data from two end-members of a transect of cores along a nutrient gradient in Water Conservation Area 2A show similar vegetational patterns from about 2,000 BP

until the early 1900s. Both cores demonstrate fluctuations among different types of marsh vegetation during this time, with generally deeper water and longer hydroperiods around 2,000 BP shifting to environments with more moderate hydroperiods populated by sawgrass or flag marshes that persisted until the late 1800s or early 1900s. In the early 1900s, both sites record increases in abundance of opportunistic taxa (pigweed and aster families), possibly in response to construction of the Hillsboro Canal. Similarly, both sites record increases in cattail abundance after 1963; however the magnitude of response differs greatly. At the nutrient-enriched Site F1, cattail abundance increased moderately after construction of WCA 2A in 1962; their abundance increased at the same time at “pristine” Site U3, but to levels that had been attained previously at the site. Sometime in the 1970s, pollen assemblages at both sites indicate tenfold increases in concentration of cattail pollen, to unprecedented levels at each site. However, concentrations at Site F1 are 100 times greater than at Site U3, indicating their nearly total colonization of Site F1 and more gradually increasing abundances at the more pristine Site U3.

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