Preliminary Report on the Distribution of Modern Fauna and Flora at selected sites in North-central and North-eastern Florida Bay

by

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Open-File Report 96-732

1996

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INTRODUCTION

The passage of the Everglades Forever Act in 1994 and the mandate that the Everglades ecosystem be restored to its "natural state" has focused scientific attention on the southern Florida ecosystem. An essential part of the restoration is to determine the history of the ecosystem prior to significant human alteration and to separate natural variability in the ecosystem from human-induced change. The U.S. Geological Survey (USGS), in cooperation with National Oceanic and Atmospheric Administration (NOAA), South Florida Water Management District (SFWMD), the National Park Service (NPS), and the Army Corps of Engineers (ACOE), among others, is conducting research to provide information on the distribution of fauna and flora throughout the Everglades ecosystem over the last 150-200 years. This report is produced by the Ecosystem History of South Florida component of the U.S. Geological Survey's Ecosystem Program, and is one of a series of USGS Open-File Reports on the distribution of biogenic components in sediments sampled from the south Florida region.

Florida Bay is an integral part of the Everglades ecosystem. It constitutes 850 square miles of water within Everglades National Park and has been the subject of much concern in recent decades. Sea-grass die-offs, algal blooms, declining numbers of fish, shellfish, and sponges have been issues of public concern (Lodge, 1994, p. 182-185). The primary question is to what degree do these changes represent natural variation within the ecosystem versus human-induced change. A series of sediment cores from Florida Bay is being examined (Wingard, et al, 1995; Ishman, et al, 1996) to determine the changes that have occurred over the last 150-200 years. The fauna and flora present in these cores are used to interpret the biological, physical, and chemical parameters of the environment at different intervals in the past. In order to interpret the significance of the down-core fauna and flora more accurately, it is important to understand the distribution, salinity, and substrate preferences and tolerances of the modern fauna and flora. Thus, we have established 19 monitoring sites in Florida Bay that are sampled twice per year in February and July, to determine seasonality. This report includes data from 13 sites sampled in 1995 located in the north-central and northeastern portions of Florida Bay (Figure 1; Table 1).

ACKNOWLEDGMENTS

We would like to thank our colleagues at South Florida Water Management District, National Oceanic and Atmospheric Administration, and Everglades National Park for their cooperation and assistance in this investigation. The Keys Marine Lab, Florida Institute of Oceanography, Long Key, FL provided the facilities, boats, and personnel to assist us in the collection of the samples. We have benefited from discussions with William Lyons, Florida Marine Research Institute, St. Petersburg, FL; Robert Halley, Charles Holmes, and Gene Shinn, U.S. Geological Survey, St. Petersburg, FL; and . Thomas M. Scott, Florida Geological Survey, Tallahassee, FL. Our reviewers, Harry

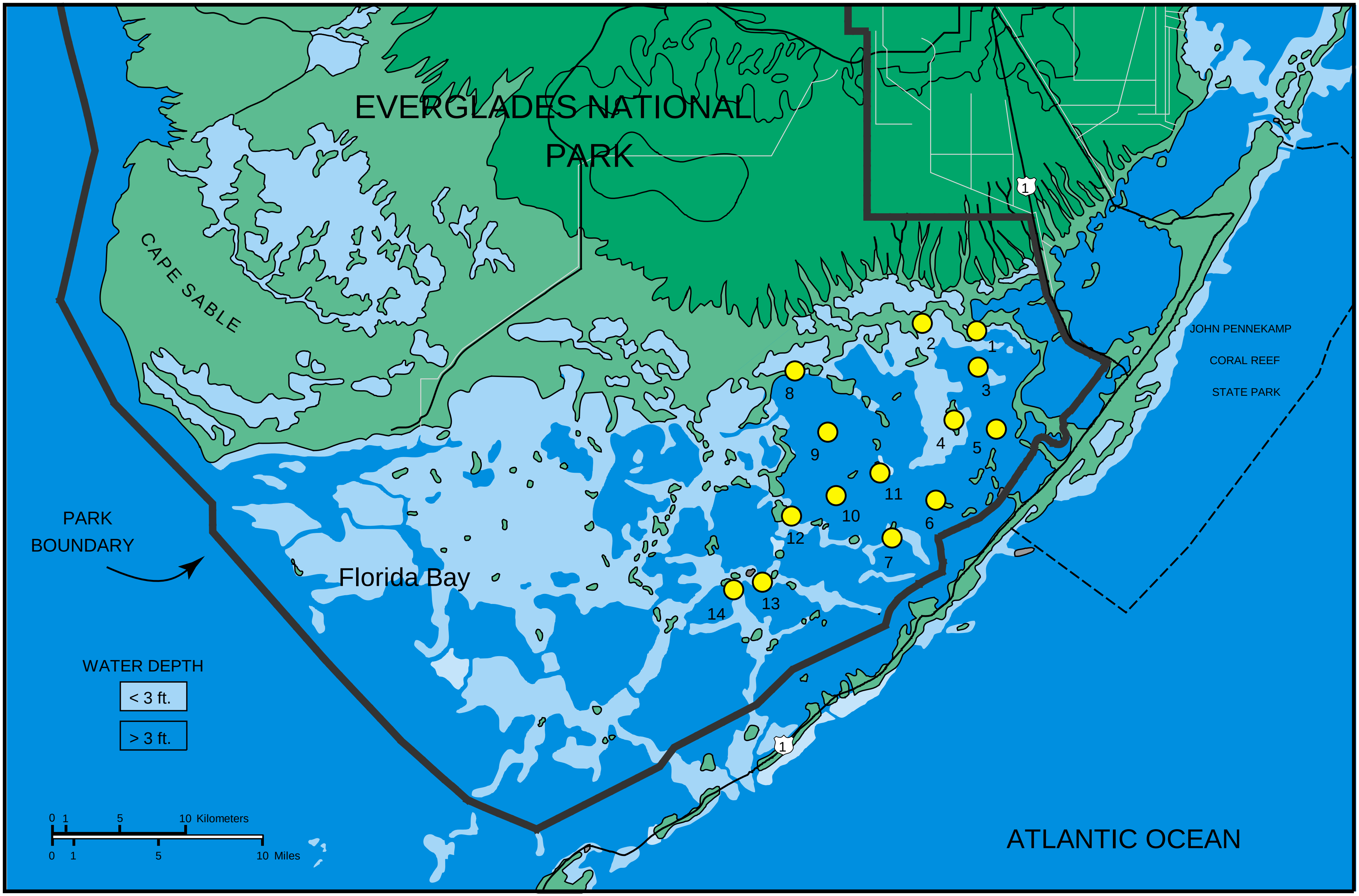

Figure 1. Location of 14 monitoring sites sampled in 1995 and discussed in this report (note: site 10 is not discussed herein).

Table 1: Localities and sample descriptions

Site #	Location	Month Sampled	Sample Description	Biota Analyzed for this report: Forams	Molluscs	Dinocysts	Pollen	GPS Data: LATITUDE	LONGITUDE	Error +/- FT	SALINITY (ppt): Top	Bot-tom	DEPTH (ft.)	BOTTOM CONDITIONS	GENERAL AREA
1	Shell creek -mouth	Feb	Bag - NE of channel			X		N 25 12.430	W 80 29.226	96	24	25	1	Mud with Thalassia, some eel grass	Mouth of creek flowing from Long Sound; surrounded by Mangroves.
1	Shell creek -mouth	Feb	Push core - SW of channel	X				N 25 12.430	W 80 29.226	96	24	25	2	Shelly lag with eel grass	Mouth of creek flowing from Long Sound; surrounded by Mangroves.
1	Shell creek -mouth	July	Push core - SW of channel	X				N 25 12.398	W 80 29.252	350	9	10	2.5	Shelly lag with eel grass	Mouth of creek flowing from Long Sound; surrounded by Mangroves.
2	Trout creek H2O station	Feb	2 Bags - 10 yrds off island			X		N 25 12.719	W 80 32.014	93	9	9	2.5	Mix of mud, shell lag, root material; scattered eel grass but not healthy	10 yards off mangrove island near mouth of Trout Creek at water monitoring station.
2	Trout creek H2O station	July	Push core - 10 yrds off island	X				N 25 12.782	W 80 32.006	151	0	0	2.7	Soft mud with some shell material. Scattered eel grass - not healthy.	10 yards off mangrove island near mouth of Trout Creek at water monitoring station.
3	Duck key H2O station	Feb	Bag - inlet in mangroves			X		N 25 10.797	W 80 29.375	108	25	25	1	Firm mud, very sparse eel grass.	Southern end of mangrove island in center of basin away from any mud banks or other islands.
3	Duck key H2O station	July	Push core - inlet in mangroves	X				N 25 10.789	W 80 29.368	97	12	11	1	Firm mud, very sparse eel grass.	Southern end of mangrove island in center of basin away from any mud banks or other islands.
4	Northern Nest key	Feb	Bag - side of bank			X		N 25 08.724	W 80 30.563	102	26	26	2	Soft, muddy, Thalassia covered (70-80%); sparse eel	Mud Bank at southrn end of northern mangrove island in center of basin.

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Site #	Location	Month Sampled	Sample Description	Biota Analyzed for this report: Forams	Molluscs	Dinocysts	Pollen	GPS Data: LATITUDE	LONGITUDE	Error +/- FT	SALINITY (ppt): Top	Bot-tom	DEPTH (ft.)	BOTTOM CONDITIONS	GENERAL AREA
5	Porjoe key - s. mudbank	Feb	Bag - edge of bank			X		N 25 08.157	W 80 28.352	90	27	28	1.5	Very soft mud with nearly 100% cover - eel grass or algae	To west of Little Buttonwood Sound on eastern edge of basin. Well developed mud bank on southern end of keys.
5	Porjoe key - s. mudbank	July	Push core - edge of bank	X				No GPS reading			17	18	2.5	Fairly firm mud with Thalassia covering	To west of Little Buttonwood Sound on eastern edge of basin. Well developed mud bank on southern end of keys.
6	Butternut key H2O station	Feb	2 push cores	X				N 25 05.207	W 80 31.157	93	31	31	3	Firm bottom with layers of peat and coarse sediment	Mangrove island; samples from ne side of western tip of island. Basin lies to the west - open water. A long mud bank is present to the east of the island.
6	Butternut key H2O station	Feb	Bag			X		N 25 05.207	W 80 31.157	93	31	31	2	Coarse sediment overlying peats and clay.	Mangrove island; samples from ne side of western tip of island. Basin lies to the west - open water. A long mud bank is present to the east of the island.
7	Bottle key SE mudbanks	Feb	Bag - grass			X		N 25 03.724	W 80 33.504	117	28	29	1.5	Thalassia bed on very soft mud; patchy.	String of mangrove islands. Very shallow flats with lots of juvenile mangroves.
7	Bottle key SE mudbanks	Feb	Push core - grass	X				N 25 03.724	W 80 33.504	117	28	29	1.5	Thalassia bed on very soft mud; patchy.	String of mangrove islands. Very shallow flats with lots of juvenile mangroves.

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Site #	Location	Month Sampled	Sample Description	Biota Analyzed for this report				GPS Data			SALINITY (ppt)		DEPTH (ft.)	BOTTOM CONDITIONS	GENERAL AREA
				Forams	Molluscs	Dinocysts	Pollen	LATITUDE	LONGITUDE	Error +/- FT	Top	Bot-tom			
7	Bottle key SE mudbanks	Feb	Bag - mud			X		N 25 03.724	W 80 33.504	117	28	29	1.5	Very soft mud with no vegetation on surface; patchy.	String of mangrove islands. Very shallow flats with lots of juvenile mangroves.
7	Bottle key SE mudbanks	July	Push core - high on bank, mud	X				N 25 03.911	W 80 33.020	83	23	23	1	Soft mud with sparse eel grass.	String of mangrove islands. Very shallow flats with lots of juvenile mangroves.
8	Little Madeira Bay mouth	Feb	Push core - bar to w of east island	X	X			N 25 10.497	W 80 37.926	102	17.5	21	1	Substrate relatively firm sparse Thalassia cover, dead algae.	Mouth of Bay which Taylor Creek feeds into. 2 small mangrove islands on either side of mouth.
8	Little Madeira Bay mouth	Feb	Bag - bar to w of east island			X	X	N 25 10.497	W 80 37.926	102	17.5	21	1	Substrate relatively firm sparse Thalassia cover, dead algae.	Mouth of Bay which Taylor Creek feeds into. 2 small mangrove islands on either side of mouth.
8	Little Madeira Bay mouth	July	Push Core - bar to west of east island	X	X			N 25 10.517	W 80 37.934	120	12	13	2.5	Muddy; Thalassia and eel grass present but in bad shape; some algae.	Mouth of Bay which Taylor Creek feeds into. 2 small mangrove islands on either side of mouth.
8	Little Madeira Bay mouth	July	Bag - bar to west of east island				X	N 25 10.517	W 80 37.934	120	12	13	2.5	Muddy; Thalassia and eel grass present but in bad shape; some algae.	Mouth of Bay which Taylor Creek feeds into. 2 small mangrove islands on either side of mouth.
9	Middle of basin s. of Little Madeira Bay	Feb	Push core		X			N 25 08.056	W 80 37.081	90	24	23	6	Hard rock substrate with only about 6" of sediment covering. Bottom vegetation very sparse with <1% Thalassia & Penicillus	Center of basin; fair distance from any islands.

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Site #	Location	Month Sampled	Sample Description	Biota Analyzed for this report: Forams	Molluscs	Dinocysts	Pollen	GPS Data: LATITUDE	LONGITUDE	Error +/- FT	SALINITY (ppt): Top	Bot-tom	DEPTH (ft.)	BOTTOM CONDITIONS	GENERAL AREA
9	Middle of basin s. of Little Madeira Bay	July	Bag			X	X	N 25 08.068	W 80 37.050	356	15	15	6	Hard rock substrate with only about 4" of sediment covering. Bottom vegetation very sparse with <1% Thalassia; no Penicillus seen.	Center of basin so fair distance from any land.
9	Middle of basin s. of Little Madeira Bay	July	Push Core	X	X			N 25 08.068	W 80 37.050	356	15	15	6	Hard rock substrate with only about 4" of sediment covering. Bottom vegetation very sparse with <1% Thalassia; no Penicillus seen.	Center of basin so fair distance from any land.
11	Bank to sw of Park Key	Feb	Push core - top of mud bank		X			N 25 06.227	W 80 34.045	129	22	22	0.1	Very soft mud. Sparse grass, < 5% Halodule.	Samples on mud bank 100 yrds to SW of southern Park Key bank. Key is sparsely developed mangrove island.
11	Park Key SW bank	Feb	Bag - top of bank			X	X	N 25 06.227	W 80 34.045	129	22	22	0.1	Very soft mud. Sparse grass, < 5% Halodule.	Samples on mud bank 100 yrds to SW of southern Park Key bank. Key is sparsely developed mangrove island.
11	Park Key SW bank	July	Push core - top of bank	X	X			N 25 06.365	W 80 33.860	102	15	15	0.5	Very soft mud. Sparse grass, < 5% Halodule.	Samples on mud bank 100 yrds to SW of key to south of Park Key. Key is sparsely developed mangrove island.

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Site #	Location	Month Sampled	Sample Description	Biota Analyzed for this report: Forams	Molluscs	Dinocysts	Pollen	GPS Data: LATITUDE	LONGITUDE	Error +/- FT	SALINITY (ppt): Top	Bot-tom	DEPTH (ft.)	BOTTOM CONDITIONS	GENERAL AREA
11	Park Key SW bank	July	Bag - top of bank				X	N 25 06.365	W 80 33.860	102	15	15	0.5	Very soft mud. Sparse grass, < 5% Halodule.	Samples on mud bank 100 yrds to SW of key to south of Park Key. Key is sparsely developed mangrove island.
12	Russell Key SE bank	Feb	Bag - top of bank			X		N 25 04.058	W 80 37.722	93	26	26	0.1	Soft mud; scattered Thalassia - ~10-20%, not healthy where exposed on top of bank.	Taken about 200 yrds off Mangrove Island on top of mud bank and erosional side of bank.
12	Russell Key SE bank	Feb	Bag - sides of mud bank			X	X	N 25 04.058	W 80 37.722	93	26	26	2	Mud at surface with shell lag below; Thalassia 20% coverage.	Taken about 200 yrds off Mangrove Island on top of mud bank and erosional side of bank.
12	Russell Key SE bank	Feb	Push core - N side of bank		X			N 25 04.058	W 80 37.722	93	26	26	1	Mud at surface with shell lag below; Thalassia 20% coverage.	Taken about 200 yrds off Mangrove Island on top of mud bank and erosional side of bank.
12	Russell Key SE bank	July	Push Core - side of bank	X	X			N 25 04.054	W 80 37.652	99	23	21	2.5	Thick mud at surface with shell lag below; ~ 25% Thalassia but not healthy.	Taken about 200 yrds off Mangrove Island on top of mud bank and erosional side of bank.
12	Russell Key SE bank	July	Bag - side of bank			X	X	N 25 04.054	W 80 37.652	99	23	21	2.5	Thick mud at surface with shell lag below; ~ 25% Thalassia but not healthy.	Taken about 200 yrds off Mangrove Island on top of mud bank and erosional side of bank.
13	Bob Allen Key mud bank	Feb	Bag - mud			X	X	N 25 01.352	W 80 39.624	87	30	30	2.5	Very soft mud; devoid of anything living on surface; very distinct, well-defined areas.	~ 1/4 mile s. of mangrove Island. Shallow mud flats & grassy areas extend out for quite some distance.

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Site #	Location	Month Sampled	Sample Description	Biota Analyzed for this report: Forams	Molluscs	Dinocysts	Pollen	GPS Data: LATITUDE	LONGITUDE	Error +/- FT	SALINITY (ppt): Top	Bot-tom	DEPTH (ft.)	BOTTOM CONDITIONS	GENERAL AREA
13	Bob Allen Key mud bank	Feb	Push core - mud	X	X			N 25 01.352	W 80 39.624	87	30	30	2.5	Very soft mud; devoid of anything living on surface; very distinct, well-defined areas.	~ 1/4 mile s. of mangrove Island. Shallow mud flats & grassy areas extend out for quite some distance.
13	Bob Allen Key mud bank	Feb	Push core - Grass	X	X			N 25 01.352	W 80 39.624	87	30	30	2.5	Thallassia grass bed with 80% coverage in mud overlying shell lag; very distinct area.	~ 1/4 mile s. of mangrove Island. Shallow mud flats & grassy areas extend out for quite some distance.
13	Bob Allen Key mud bank	Feb	Bag - Grass			X		N 25 01.352	W 80 39.624	87	30	30	2.5	Thallassia grass bed with 80% coverage in mud overlying shell lag; very distinct area.	~ 1/4 mile s. of mangrove Island. Shallow mud flats & grassy areas extend out for quite some distance.
13	Bob Allen Key mud bank	July	Bag - mud			X	X	N 25 01.352	W 80 39.624	Not recor ded	26	26	2	Very soft mud; devoid of anything living on surface; very distinct, well-defined areas.	~ 1/4 mile s. of Mangrove Island. Shallow mud flats & grassy areas extend out for quite some distance.
13	Bob Allen Key mud bank	July	Push core - mud	X	X			N 25 01.352	W 80 39.624	Not recor ded	26	26	2	Very soft mud; devoid of anything living on surface; very distinct, well-defined areas.	~ 1/4 mile s. of Mangrove Island. Shallow mud flats & grassy areas extend out for quite some distance.
13	Bob Allen Key mud bank	July	Bag - grass				X	N 25 01.352	W 80 39.624	Not recor ded	26	26	1.5	Thallassia grass bed with 50% coverage (not healthy) in mud; very distinct area.	~ 1/4 mile s. of Mangrove Island. Shallow mud flats & grassy areas extend out for quite some distance.
14	Bob Allen Key H20 station	Feb	Bag - ~ 40 yrds offshore from island			X		N 25 01.618	W 80 40.896	105	31	32	3	Fairly firm mud with scattered Thalassia; shell lag below mud.	South side of Mangrove island near water monitoring station at western most Bob Allen Key.

Dowsett and Bruce Wardlaw, U.S. Geological Survey, Reston, VA, provided helpful comments and suggestions to improve this manuscript.

Thomas M. Scott, Florida Geological Survey, Tallahassee, FL. assisted in the collection of all samples. Nancy Stamm, Lauren Hewitt, Alessandro Bagalia (volunteer), Carey Costello, Steve Wandrei, Nancy Carlin, Jill D'Ambrosio, and Ian Graham, U.S. Geological Survey, Reston, VA, prepared the samples for calcareous analysis. Tom Sheehan, Nancy Durika, and Patrick Buchanan, U.S. Geological Survey, Reston, VA, prepared the samples for palynological analysis. Rob Stamm and Patrick Buchanan, U.S. Geological Survey, Reston, VA prepared the illustrations for this report.

METHODS OF INVESTIGATION

Collection of the Samples

The 13 sites discussed in this report were sampled in February and July of 1995. Samples were collected by wading or snorkeling; this enabled us to make detailed observations of the substrate, living fauna and flora, and micro-habitats that existed at each site and to obtain representative samples from sub-environments. Table 1 indicates the environmental conditions present for the samples taken at each site. Latitude and longitude were recorded using the onboard GPS, and checked using a handheld GPS. Data on the surface and bottom water salinity, water depth, substrate, water clarity, living fauna, and a general area description were recorded for each site. Salinity measurements were taken using a refractometer (Table 1; Figure 2).

Where possible, at least one push core (a 1.5" diameter clear plastic tube) and one bag sample (1 gallon) were collected from each site. When a number of sub-environments existed at a site, each subenvironment was sampled. Push cores were obtained by pushing the plastic tubing into the substrate as deep as possible and maintaining a vacuum to extract the tube; the tubes were cut at the sediment-water interface and sealed to prevent disruption of the sediments. Bag samples were obtained by scooping the upper few inches of sediment into a 1 gallon plastic bag. The samples discussed here represent a sub-set of the total number of samples taken.

Benthic Foraminifera and Molluscs

The calcareous benthic fauna discussed in this report were extracted from the upper 10 cm of the push-cores. The samples were washed through a 63µm sieve and dried at <50°C. The >63µm size fraction was picked for benthic foraminifera and ostracodes[1] using a random number table between 1 and 45. When possible, a total of 300 benthic foraminifera or ostracode specimens were picked from the sample and mounted on gridded micropaleontologic slides. For samples containing fewer than 300 benthic

[1] Osctracodes have been processed and picked from these samples. Analysis and discussion of the ostracode distribution patterns will be included in a later report.

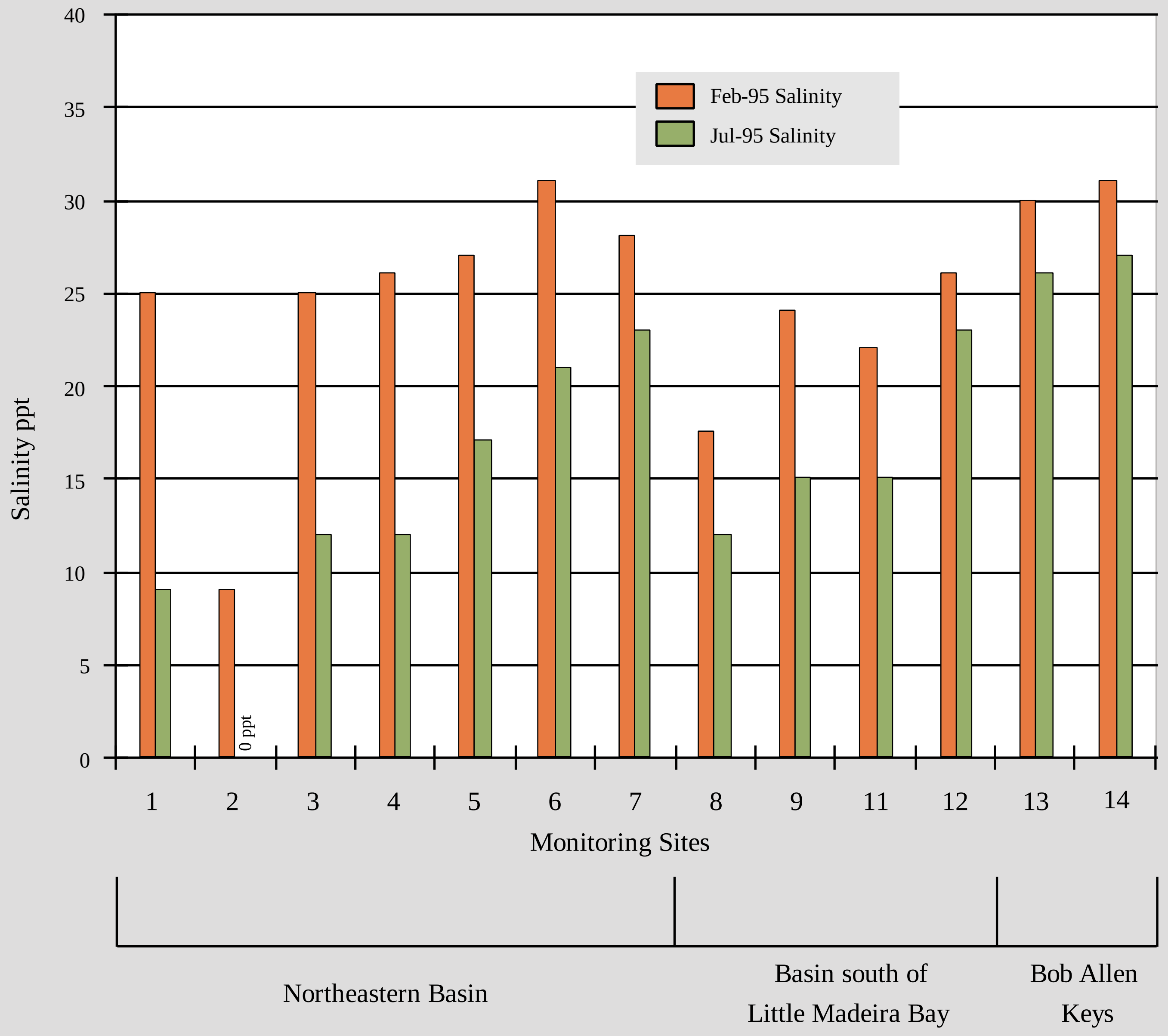

Figure 2. Histogram of February and July salinity measurements for each site sampled in 1995.

foraminifera or ostracode individuals, all of the specimens present were picked. Molluscs were picked from the >850µm size fraction; all molluscs, and fragments of molluscs recognizable to the generic level, present in the push cores were picked. Species abundances were standardized by calculating relative abundances (percent).

Pollen and Dinocysts

Material for palynological analysis was extracted from the bag samples. For each palynological sample, 40 g of material (dry weight) was treated in hydrochloric and hydrofluoric acid and processed for palynological studies. All samples were treated with warm KOH for 2-5 minutes, given ultrasonic pulse treatment for 5 seconds, acetolysed, and sieved between 8-150µm mesh. A tablet of *Lycopodium* marker grains was added for each sample, and dinocyst and pollen concentration were calculated according to the equation of Stockmarr (1971) using the value of 12,542 grains per tablet. One to four slides were counted for each sample. For dinocyst analyses, when the first slide showed fewer than 20 specimens, counting was not continued; four samples were examined (sites 1, 2, 3, and 6) but not counted although absolute cyst abundance was calculated. Dinocyst recovery in all samples was low; only three samples contained sufficient material to count 300 specimens. Most microscope slides are heavily dominated by phytoclasts. For pollen analyses, 300 pollen grains were counted per sample whenever possible. The two samples from the mouth of Little Madeira Bay (site 8) had much lower pollen concentrations than the other samples, and approximately 150 grains were counted for each of these samples.

ANALYSIS AND DISCUSSION OF THE BIOTIC COMPONENTS

Benthic Foraminifers

A total of sixteen surface sediment samples from 11 sites in Florida Bay were analyzed for benthic foraminifers. Preliminary results from this analysis show a total of 29 species present in the >63µm size fraction (Table 2). The benthic foraminifer assemblages are dominated by calcareous hyaline and miliolid forms. The dominant taxa include *Ammonia parkinsoniana typica*, *Elphidium galvestonense*, *E. delicatulum*, *Quinqueloculina bicostata*, *Q. bociana*, *Q. poeyana*, and *Q. seminulum*. Additional taxa present are *Miliolinella circularis*, *Rosalina floridensis*, *R. floridana* and *Archaias angulatus.*

Trends observed in the Florida Bay benthic foraminiferal distributions indicate a strong association between the relative abundance of *Ammonia parkinsoniana typica* and salinity. Results of linear regression analysis of the foraminiferal data and salinity show a strong inverse relationship (R^2=.88) between *Ammonia parkinsoniana typica* and salinity (Figure 3). Our results show that *Ammonia parkinsoniana typica* is most abundant (>20 percent) where average salinities are 18 parts-per-thousand (ppt) or less. Also associated with low salinity is *Elphidium galvestonense*. At salinities greater than 18 ppt the relative abundance of *Ammonia parkinsoniana typica* drops off significantly with *Quinqueloculina* spp. becoming the dominant taxa and *Miliolinella circularis*, *Elphidium delicatulum* and *Archaias angulatus* increasing in abundance. These trends are consistent with observations of benthic foraminiferal distributions in the Gulf Coast where *Ammonia parkinsoniana typica* and *Elphidium galvestonense* are associated with oligo- to euhaline conditions (Poag, 1978, 1981). Lidz and Rose (1989) attribute the distribution of *A. beccarii ornata* [=*A. parkinsoniana typica*] in Florida Bay to substrate and bay physiography. However, a clear trend in their data exists where the abundance of *A. beccarii ornata* decreases in regions where low salinities are less prevalent.

Our analysis has shown that the following species are good indicators of salinity. By using combinations of the abundance's of several of the species the down-core salinity patterns can be detected.

Species	Minimum salinity (ppt)	Maximum salinity (ppt)
Ammonia parkinsoniana typica	0	18
Ammotium sp.	0	3
Articulina mucronata	11	23
Elphidium galvestonense	0	25
Miliolina circularis	15	26
Quinqueloculina poeyana	20	26

Table 2: Percent abundance of benthic foraminifera at monitoring sites

Site #	Month Collected	Agglutinated 1	*Ammodiscus ensis*	*Ammonia parkinsoniana typica*	*Ammotium* sp.	*Archais angulatus*	*Artuculina mucronata*	*Bigenerina irregularis*	*Bolivina transluscens*	*Buccella hannai*	*Elphidium galvestonense*	*Elphidium delicatulum*	Grass	*Miliammina fusca*	*Miliolinella circularis*	*Miliolinella labiosa*	*Nodobaculariella cassis*	*Peneroplis proteus*
Basin South of Little Madeira Bay																		
Site 8	Feb	0.00	0.20	19.02	0.00	0.41	0.00	0.00	0.41	0.00	19.43	4.29	0.00	0.20	0.82	0.00	0.00	0.00
Site 8	July	0.00	0.00	31.77	0.00	3.69	0.00	0.00	0.25	0.00	29.56	0.74	0.00	0.74	0.25	0.25	0.00	0.00
Site 9	July	0.00	0.00	21.60	0.00	1.85	0.00	0.31	0.00	0.00	37.35	1.23	0.00	6.17	3.09	0.00	0.00	0.00
Site 11	July	0.00	0.00	8.88	0.00	1.72	0.00	0.00	0.00	0.00	23.21	5.16	0.00	0.29	10.60	0.57	0.00	0.00
Site 12	July	0.00	0.00	4.79	0.00	0.32	0.00	0.00	0.00	0.00	16.61	13.74	0.64	0.00	7.99	0.00	0.00	0.00
Bob Allen Keys																		
Site13 (mud)	Feb	0.00	0.32	0.32	0.00	0.65	0.00	0.00	0.00	0.00	1.29	19.03	2.26	0.00	21.29	0.00	0.00	0.00
Site 13 (grass)	Feb	0.32	0.00	0.65	0.00	2.90	0.00	0.00	0.00	0.00	4.84	5.81	0.65	0.65	21.61	0.97	0.00	0.00
Site 13 (mud)	July	0.00	0.00	0.30	0.00	1.22	0.00	0.00	0.00	0.00	10.64	17.02	0.30	0.30	11.55	0.00	0.00	0.30
Northeastern Basin																		
Site 1	Feb	0.65	0.00	25.00	0.00	1.30	0.00	0.00	0.32	0.00	24.68	5.19	0.00	1.62	0.32	0.32	0.00	0.00
Site 1	July	0.33	0.00	36.93	0.00	2.29	0.00	0.33	0.33	0.00	32.68	2.94	0.00	2.61	0.65	0.00	0.00	0.00
Site 2	July	0.00	0.00	49.56	0.29	0.00	0.00	0.00	0.00	0.00	40.18	1.47	0.00	0.00	0.00	0.00	0.00	0.00
Site 3	July	0.00	0.00	20.50	0.00	0.21	0.83	0.00	0.00	0.62	9.11	23.40	0.00	1.24	4.97	0.21	0.00	0.00
Site 5	July	0.00	0.00	4.72	0.00	0.00	0.31	0.00	0.63	0.00	5.66	21.07	0.31	0.63	2.52	0.00	0.31	0.00
Site 6	Feb	1.00	0.33	9.00	0.00	10.00	0.00	0.00	0.00	0.33	34.00	1.67	0.33	7.67	1.33	0.00	0.00	0.00
Site 7	Feb	0.00	0.00	5.52	0.00	0.32	0.00	0.00	0.00	0.00	11.04	8.77	0.00	0.00	12.99	0.97	0.00	0.00
Site 7	July	1.24	0.00	2.17	0.00	24.46	0.00	0.00	0.00	0.00	8.67	4.33	1.55	1.86	9.60	1.24	0.00	0.00

Table 2: Percent abundance of benthic foraminifera at monitoring sites

Site #	Month Collected	*Quinqueloculina bicostata*	*Q. bociana*	*Q. poeyana*	*Q. seminulum*	*Rosalina floridana*	*Rosalina floridensis*	*Spiroloculina antillarum*	*Triloculina tricarinata*	*Triloculina subrotunda*	*Trochammina conica*	*Trochammina inflata*	*Trochammina* sp.	Number of speciemens counted / sample
Basin South of Little														
Site 8	Feb	0.00	7.36	3.68	9.61	0.82	31.90	0.20	0.00	1.43	0.00	0.00	0.20	489
Site 8	July	0.99	1.48	2.22	7.88	1.48	17.98	0.00	0.25	0.49	0.00	0.00	0.00	406
Site 9	July	8.02	3.70	11.73	2.16	0.00	0.31	0.00	0.00	2.47	0.00	0.00	0.00	324
Site 11	July	3.44	18.05	14.33	12.32	0.00	0.29	0.00	0.86	0.29	0.00	0.00	0.00	349
Site 12	July	10.54	12.14	21.41	7.35	0.96	0.00	0.00	1.92	1.60	0.00	0.00	0.00	313
Bob Allen Keys														
Site13 (mud)	Feb	12.90	16.13	12.58	10.32	1.94	0.00	0.00	0.97	0.00	0.00	0.00	0.00	309
Site 13 (grass)	Feb	22.26	6.13	24.52	6.77	0.65	0.00	0.00	0.00	0.97	0.00	0.00	0.00	310
Site 13 (mud)	July	12.77	8.81	21.88	11.85	2.13	0.00	0.00	0.61	0.30	0.00	0.00	0.00	329
Northeastern Basin														
Site 1	Feb	1.95	1.30	11.69	22.40	1.30	1.95	0.00	0.00	0.00	0.00	0.00	0.00	308
Site 1	July	0.33	0.98	6.21	11.44	0.98	0.00	0.00	0.98	0.00	0.00	0.00	0.00	306
Site 2	July	0.00	0.00	2.64	5.57	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	341
Site 3	July	7.87	6.42	7.04	12.22	0.62	2.07	0.83	1.45	0.41	0.00	0.00	0.00	483
Site 5	July	3.77	11.64	21.07	26.73	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	318
Site 6	Feb	1.33	0.33	9.67	3.33	0.00	0.00	0.00	17.33	0.67	0.67	1.00	0.00	300
Site 7	Feb	6.82	15.58	18.83	16.23	0.00	2.60	0.00	0.32	0.00	0.00	0.00	0.00	308
Site 7	July	14.86	7.12	15.79	2.79	0.00	0.93	0.00	1.86	1.55	0.00	0.00	0.00	323

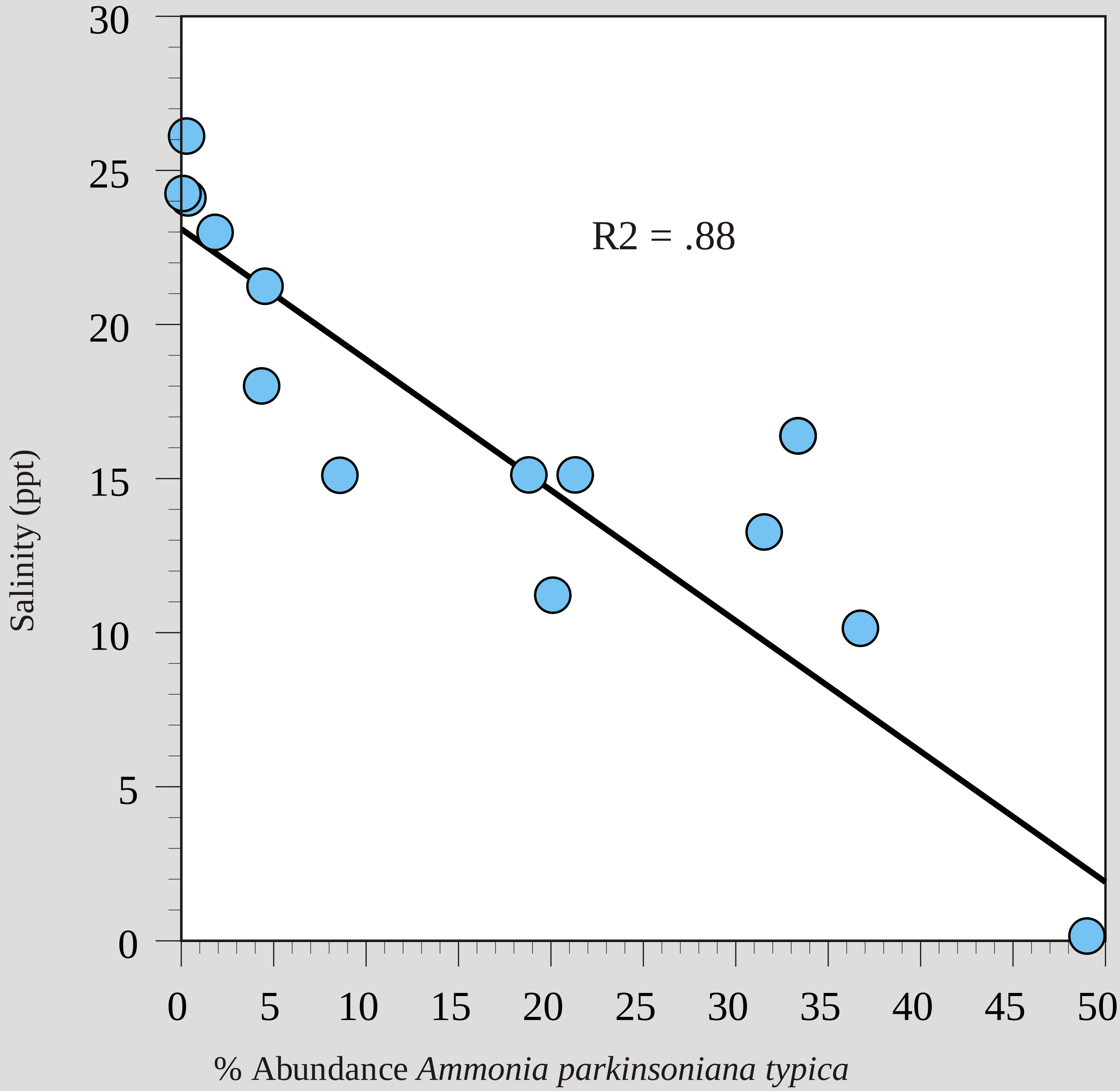

Figure 3: Regression plot of the benthic foraminifer *Ammonia parkinsoniana typica* verses salinity.

Molluscs

Eleven samples from five sites in central and eastern Florida Bay were analyzed for molluscan faunal content. Initial results of the analysis of the >850 μm size fraction are shown in Table 3; 60 fauna were identified to species level, 8 to generic level, and 7 to a broad family or environmental category (for simplicity some of the categories have been combined in Table 3). The assemblages were dominated by four ubiquitous taxa that comprised 54.7 percent of the total 15,923 specimens counted: *Transenella* spp., *Cerithium* spp., *Brachiodontes* sp., and *Bittium varium*. *Anomalocardia* sp., *Parastarte triquetra* and the group of terrestrial and freshwater gastropods were also present in significant numbers. Combined, these seven groups account for 72.6 percent of all the specimens examined.

Table 4 lists the average, minimum, and maximum salinities for molluscs collected at the monitoring sites in Florida Bay. An examination of this table, and of published salinity ranges (Perry and Schwengel, 1955; Parker, 1959; Warmke and Abbott, 1961; Andrews, 1971; Turney and Perkins, 1972; Emerson and Jacobson, 1976) indicates that *Cyrenoida floridana*, *Polymesoda* sp., Melampidae, *Mytilopsis leucophaeta* and the group of terrestrial and freshwater gastropods can be used as indicators of oligohaline to mesohaline conditions in interpreting down-core salinity conditions. The majority of the remaining molluscs are polyhaline to euhaline and can tolerate a wide range of salinities.

No obvious seasonal trends could be detected in the molluscan faunal data. A Q-mode cluster analysis using the chord distance measure on the occurrence data set (Figure 4) demonstrates that the February and July samples from each site tend to cluster together. This cluster pattern suggests that no significant changes occurred at these sites from the dry to the wet season for 1995. An examination of the values for individual species at each site reveals very few consistent patterns. Among the gastropods, only *Cerithiopsis greeni* shows a trend, declining in abundance from February to July, but this species is present in very low numbers at only three sites, so the results are inconclusive. Among the pelecypods, *Anomalocardia* sp., *Chione cancellata*, and *Lima* sp., show consistent seasonal changes at all five sites. These patterns may be related to seasonal spawning for the individual species but without additional data this would be difficult to determine (see Moore and Lopez, 1969, for a discussion of seasonal spawning in *Chione cancellata*). No clear seasonal pattern of increasing or decreasing overall abundance could be determined by examining the total number of specimens present at each site in February and July.

Figure 4 shows the molluscan assemblages from the 5 sites analyzed form 3 main clusters. The first, cluster A, includes samples from the mud banks surrounding the basin south of Little Madeira Bay (sites 11 and 12) and from the Bob Allen Keys mudbank (site 13). Cluster A is split into 2 smaller groups, one composed of the two samples from the mudbanks southwest of Park Key (site 11) and a sample from Russell banks (site 12); the other composed of the samples from Bob Allen Keys mudbank (site 13) and a sample from Russell banks (site 12). Russell Key lies between Bob Allen and Park Key, so the grouping of the Russell Key samples with samples from both basins, as indicated by the cluster, is to be expected. Cluster B is composed of samples from the middle of the basin south of Little Madeira Bay (site 9); the center of the basin represents a very different substrate and deeper water than seen at any of the other sites (see Table 1 for a description of the localities). The samples from the mouth of Little Madeira Bay (site 8) form the most discrete cluster of the sites analyzed; the presence of a significant quantity of mesohaline, and terrestrial and/or freshwater fauna in these samples, which are rare or lacking in the other samples, probably accounts for the cluster pattern seen.

Turney and Perkins (1972) did a detailed analysis of the molluscan fauna in Florida Bay during the 1950's. They divided the Bay into four subenvironments on the basis of salinity, variability of salinity, water circulation and wind, and they characterized the molluscan fauna for each of these subenvironments. Site 8 at the mouth of Little Madeira Bay is in Turney and Perkins' (1972) northern subenvironment; the remainder of the sites analyzed for molluscan faunal content (sites 9, 11, 12, and 13) are in Turney and Perkins (1972) interior subenvironment. The cluster pattern seen in Figure 4 is consistent with Turney and Perkins' division.

The northern subenvironment, according to Turney and Perkins (1972, table 6), averages 26 species/station; 29-32 species were reported from their sites (7399 and 7400) located near the mouth of Little Madeira Bay. This report lists 26 molluscan faunal groups for site 8. Turney and Perkins (1972) identify *Anomalocarida cuniemeris* as the characteristic species of the northern subenvironment, and list *Ostrea* sp., *Parastarte triquetra*, *Lyonsia floridana*, *Rissoina browniana*, *Melongena corona*, and *Retusa canaliculata* [=*Acteocina canaliculata*] as species more common to this subenvironment than elsewhere in Florida Bay. A comparison of this list with the data presented in Table 3 might lead to the conclusion that the environment has changed a great deal in forty years. However, an examination of Turney and Perkins complete faunal list (1972, table 3) shows the differences are not as great as their description implies. Of the ten most abundant faunal groups found at site 8 in this study, Turney and Perkins list seven as abundant or common as follows:

Species	Site 8, Feb. 95 (%)	Site 8, July 95 (%)	Turney & Perkins (1972) Site 7399[1]	Turney & Perkins (1972) Site 7400[1]
Acteocina canaliculata	3.8	3.7	C	C
Anomalocardia sp.	3.5	3.3	A	A
Bittium varium	16.3	7.5	A	A
Brachiodontes sp.	6.5	15.8	C	A
Cerithidea spp.[2]	3.5	6.0	C	C
Cerithium spp.[2]	10.6	16.2	C	F
Crepidula spp.[2]	1.6	2.2	C	F
Polymesoda sp.	*	2.4	--	--
Rissoidae[3]	1.5	*	F	F
Terrestrial/Fresh water Gastropods[3]	45.5	25.9	R	R
Transennella spp.[2]	0.9	2.1	C	C

* Not among 10 most abundant groups in sample
[1] A=abundant, C=common, F=few, R=rare; after Turney and Perkins, 1972
[2] Turney and Perkins only report 1 species of this genus from these sites
[3] Turney and Perkins report 2 species from these sites

For the northern subenvironment of Turney and Perkins (1972), the primary differences between their study and ours is the importance they accorded to *Anomalocardia* as the characteristic molluscan fauna for this subenvironment, and the near absence of terrestrial and freshwater gastropods from their data; the only exception is their inclusion of two species of *Truncatella*. The combined group of terrestrial and freshwater gastropods (including *Truncatella*) is the dominant component of the molluscan assemblages found at site 8 in this study. Also notable are the increased numbers of *Cerithium* found in our samples, and the occurrence of the mesohaline to oligohaline fauna, *Polymesoda* sp. and *Cyrenoida floridana*, which Turney and Perkins do not list for sites 7399 and 7400. *Polymesoda* [=*Pseudocyrena* Turney and Perkins] occurs at only three of Turney and Perkins nine northern subenvironment sites (categorized as rare or few), and they do not list *Cyrenoida* at all. There are many explanations for the differences noted between the two studies, but an examination of a core (T-24) from the mouth of Taylor Creek in Little Madeira Bay (Ishman, et al, 1996) indicates that *Polymesoda*, *Cyrenoida* (listed as ? *Semele* in that report), and the terrestrial gastropods have been present nearly continuously in Little Madeira Bay since at least the 1950's. In addition, the data from Core T24 shows that *Anomalocardia* has been a significant component of the molluscan assemblage over time.

The interior subenvironment averages 34 species/station according to Turney and Perkins (1972) for the 25 sites they examined within this subenvironment. The molluscan assemblages examined at the four sites that lie within the interior subenvironment for this study average 29 faunal groups/site. Turney and Perkins (1972) identify *Brachiodontes exustus*, *Pinctada radiata*, *Cerithium muscarum* and *Bittium varium* as the characteristic molluscan species for the interior subenvironment. In addition, they list *Lucina multilineata*, *Rissoina bryerea*, *Modulus modulus*, and *Olivella* sp. as species that are more common in this subenvironment than elsewhere in Florida Bay. A comparison of the ten most abundant faunal groups from three sites examined in this study (9, 11, 13), with data from three Turney and Perkins (1972) interior subenvironment sites (7173, 7402, 7403) in close proximity to our sites, illustrates the spatial and temporal variability of the subenvironments. Of the 19 faunal groups that are abundant at least one of our modern interior subenvironment samples, 14 are listed as common or abundant at least one site by Turney and Perkins (1972) as follows:

Species	Site 13, mud, Feb (%)	Site 13, mud, July (%)	Site 13, grass, Feb (%)	T & P (1972) Site 7173[1]	Site 11, Feb (%)	Site 11, July (%)	T & P (1972) Site 7403[1]	Site 9, Feb (%)	Site 9, July (%)	T & P (1972) Site 7402[1]
Acteocina canaliculata	7.3	*	--	R	7.9	4.8	C	*	*	F
Alabina spp.	14.5	*	*	--	*	*	--	*	*	--
Anomalocardia sp.	4.4	*	*	C	11.5	7.8	F	2.1	2.0	F
Bittium varium	2.9	10.6	2.2	A	10.1	14.2	A	8.4	2.1	C
Brachiodontes sp.	*	45.0	64.2	C	6.4	5.7	C	3.1	9.6	A
Bulla sp.	2.9	*	*	F	1.1	2.7	C	2.0	2.0	C
Cerithium spp.[3]	14.5	9.6	4.9	A	10.6	16.2	C	12.8	11.8	C
Chione cancellata	--	*	1.6	A	*	*	F	*	*	A
Crepidula spp.[2]	--	6.5	2.0	F	*	2.8	R	1.7	1.5	R
Laevicardium spp.[2]	14.5	2.3	*	A	2.2	2.7	C	3.9	3.7	A
Marginellids	*	*	1.8	F	*	*	F	1.7	1.5	C
Modulus modulus	--	2.8	*	A	*	*	F	*	*	R
Olivella sp.	4.4	*	*	F	*	*	--	*	*	F
Parastarte triquetra	*	*	1.6	R	31.0	11.8	F	--	--	--
Pinctada radiata	--	3.6	2.2	C	*	*	F	*	*	A
Pyramidellidae	4.4	--	--	--	*	--	--	*	*	--
Rissoidae[4]	--	2.3	2.2	A	*	*	F	4.1	4.4	F
Tellina spp.[3]	--	2.6	*	C	1.6	*	R	*	*	F
*Transennell*a spp.[2]	21.8	4.1	9.2	F	9.4	15.8	C	45.2	39.9	A

* Not among 10 most abundant groups in sample
[1] A=abundant, C=common, F=few, R=rare; after Turney and Perkins, 1972
[2] Turney and Perkins only report 1 species of this genus from these sites
[3] Turney and Perkins report 2 species from these sites
[4] Turney and Perkins report 3 species from these sites

Table 3: Percent abundance of molluscs (>850 microns) at monitoring sites

Site Number	Month Collected	Gastropods	*Acteocina canaliculata*	*Alabina* spp.	*Batillaria minima*	*Bittium varium*	*Bulla* sp.	*Caecum puchellum / floridanum*	*Cerithidea* spp.	*Cerithiopsis greeni*	*Cerithium* spp.	*Crepidula* spp.	Limpets	Marginellids	Melampidae	*Modulus modulus*	Muricidae	*Olivella* sp.	Pyramidellidae	Rissoidae	*Triphora perversa*	Vitrinellid	Terrestrial / freshwater gastropods	Rare Gastropods
Basin South of Little Madeira Bay																								
8	Feb		3.81	0.00	0.00	16.34	0.23	0.00	3.50	0.00	10.58	1.63	0.00	0.54	0.54	0.70	0.62	0.16	0.00	1.48	0.00	0.16	45.53	0.23
8	July		3.71	0.47	0.00	7.47	1.04	1.25	6.04	0.00	16.18	2.24	0.00	0.43	0.26	0.47	0.60	0.04	0.09	1.81	0.00	0.13	25.94	0.00
12	Feb		0.27	0.11	0.81	18.13	0.75	0.00	0.00	0.11	15.22	5.33	0.00	0.97	0.00	2.80	0.32	0.48	0.91	4.63	0.00	0.27	0.00	0.27
12	July		1.83	0.61	0.00	9.13	0.30	1.67	0.00	0.00	14.16	6.54	0.00	0.76	0.00	2.44	0.15	0.76	0.91	1.98	0.00	0.91	0.00	0.30
11	Feb		7.92	0.15	0.44	10.05	1.12	0.00	0.05	0.05	10.59	1.07	0.00	0.34	0.00	0.49	0.39	0.19	0.05	0.34	0.00	0.05	0.24	0.05
11	July		4.88	0.11	0.27	14.22	2.65	0.11	0.00	0.00	16.18	2.76	0.05	0.90	0.00	1.33	0.21	0.80	0.00	1.17	0.00	0.16	1.06	0.11
9	Feb		0.95	0.21	0.00	8.40	1.96	0.43	0.06	0.12	12.83	1.68	0.03	1.65	0.00	0.55	0.21	0.55	0.27	4.06	0.15	0.55	1.34	0.09
9	July		1.17	0.31	0.00	2.10	1.97	0.06	0.06	0.00	11.84	1.48	0.06	1.54	0.00	0.74	0.25	0.93	0.25	4.44	0.00	0.31	1.05	0.06
Bob Allen Keys																								
13 (grass)	Feb		0.00	1.17	0.00	2.15	0.20	0.59	0.00	0.00	4.89	1.96	0.59	1.76	0.00	0.98	0.00	0.59	0.00	2.15	0.20	0.20	0.00	0.00
13 (mud)	Feb		7.25	14.49	0.00	2.90	2.90	0.00	0.00	0.00	14.49	0.00	0.00	1.45	0.00	0.00	0.00	4.35	4.35	0.00	0.00	0.00	0.00	0.00
13 (mud)	July		0.26	0.78	0.00	10.59	1.03	0.00	0.00	0.00	9.56	6.46	0.00	1.29	0.00	2.84	0.00	0.26	0.00	2.33	0.00	0.26	0.00	0.00
Total # specimens present in all samples			463	53	29	1618	219	60	189	7	2094	403	6	158	13	169	52	76	42	414	6	45	1272	17
Total percent of sps in all samples collected			2.91	0.33	0.18	10.16	1.38	0.38	1.19	0.04	13.15	2.53	0.04	0.99	0.08	1.06	0.33	0.48	0.26	2.60	0.04	0.28	7.99	0.11

Table 3: Percent abundance of molluscs (>850 microns) at monitoring sites

Site Number	Month Collected	Unidentified gastropod fragments, unknowns, and juveniles	**Pelecypods**	*Anomalocardia* sp.	*Arcopsis adamsi*	*Brachiodontes* sp.	*Chione cancellata*	*Codakia* sp.	*Cumingia tellinoidea*	*Cyrenoida floridana*	*Laevicardium* spp.	*Lima* sp.	*Mytilopsis leucophaeta*	*Nucula proxima*	*Parastarte triquetra*	*Pinctada radiata*	*Pitar* sp.	*Polymesoda* sp.	*Tellina* spp.	*Transennella* spp.	Rare Pelecypods	Unidentified pelecypod fragments	Total number of specimens / sample
Basin South of Little Madeira Bay																							
8	Feb	0.08		3.50	0.08	6.54	0.08	0.00	0.23	0.31	0.54	0.00	0.62	0.00	0.08	0.00	0.00	0.54	0.31	0.93	0.08	0.00	1285
8	July	0.73		3.28	0.30	15.80	0.22	0.00	0.17	0.17	1.25	0.09	0.00	0.00	0.09	0.43	0.26	2.37	0.52	2.11	0.00	4.01	2317
12	Feb	0.86		0.81	0.11	23.45	0.91	0.16	1.67	0.00	3.77	0.22	0.00	0.11	2.53	2.96	0.00	0.00	0.97	3.93	0.05	6.13	1859
12	July	1.37		0.46	0.15	30.29	2.13	0.15	0.30	0.00	2.74	0.30	0.00	0.00	3.81	1.67	0.00	0.00	0.46	12.33	0.15	1.22	657
11	Feb	1.80		11.51	0.00	6.36	0.29	0.00	0.39	0.00	2.19	0.05	0.00	0.00	31.03	0.44	0.00	0.58	1.55	9.42	0.05	0.78	2059
11	July	1.59		7.75	0.11	5.73	0.53	0.27	0.48	0.00	2.71	0.16	0.00	0.00	11.83	1.86	0.00	0.11	1.49	15.81	0.11	2.55	1885
9	Feb	2.05		2.14	0.31	3.12	0.43	0.12	0.31	0.00	3.94	0.00	0.00	0.06	0.00	0.40	0.98	0.03	0.55	45.16	0.03	4.28	3273
9	July	7.16		1.97	0.12	9.56	0.49	0.12	0.62	0.00	3.70	0.06	0.00	0.12	0.00	1.36	1.11	0.00	1.17	39.85	0.12	3.82	1621
Bob Allen Keys																							
13 (grass)	Feb	1.37		0.39	0.00	64.19	1.57	0.00	0.00	0.00	0.59	0.39	0.00	0.00	1.57	2.15	0.00	0.00	0.78	9.20	0.00	0.39	511
13 (mud)	Feb	0.00		4.35	0.00	1.45	0.00	0.00	0.00	0.00	14.49	0.00	0.00	0.00	2.90	0.00	0.00	0.00	0.00	21.74	0.00	2.90	69
13 (mud)	July	1.03		1.81	0.26	44.96	1.29	0.00	0.78	0.00	2.33	0.78	0.00	0.00	0.26	3.62	0.00	0.00	2.58	4.13	0.00	0.52	387
Total # specimens present in all samples		304		636	26	2084	88	15	80	8	431	18	8	6	948	180	56	77	148	2909	9	487	15923
Total percent of sps in all samples collected		1.91		3.99	0.16	13.09	0.55	0.09	0.50	0.05	2.71	0.11	0.05	0.04	5.95	1.13	0.35	0.48	0.93	18.27	0.06	3.06	

Table 4: Salinity values for molluscan fauna

	Total Number			Salinity (ppt)		
	Specimens	Sites	Correlation Coefficient	Minimum	Maximum	Average
Gastropods:						
Acteocina canaliculata	463	10	-0.4603	12	30	21.05
Alabina spp.	53	10	-0.0487	12	30	22.30
Batillaria minima	29	3	0.9635	15	26	24.00
Bittium varium	1618	11	-0.3127	12	30	21.86
Bulla sp.	219	11	-0.4309	12	30	21.86
Caecum puchellum / floridanum	60	6	-0.3193	12	30	19.83
Cerithidea spp.	189	5	-0.7318	12	24	18.10
Cerithiopsis greeni	7	3	0.3273	22	26	24.00
Cerithium spp.	2094	11	-0.5711	12	30	21.86
Crepidula spp.	403	10	-0.0253	12	30	21.05
Limpets	6	4	0.8165	15	30	21.00
Marginellids	158	11	-0.1292	12	30	21.86
Melampidae	13	2	1.0000	12	17.5	14.75
Modulus modulus	169	10	0.1331	12	30	21.05
Muricidae	52	8	-0.3876	12	26	19.31
Olivella sp.	76	11	-0.2305	12	30	21.86
Pyramidellidae	42	7	0.3860	12	30	21.71
Rissoidae	414	10	-0.0104	12	30	21.05
Triphora perversa	6	2	---	24	30	27.00
Vitrinellid	45	10	0.0810	12	30	21.05
Terrestrial / freshwater Gastropods	1272	6	-0.4716	12	24	17.58
Pelecypods:						
Anomalocardia sp.	636	11	-0.4042	12	30	21.86
Arcopsis adamsi	26	8	-0.0961	12	26	19.81
Brachiodontes sp.	2084	11	-0.0146	12	30	21.86
Chione cancellata	88	10	0.3703	12	30	21.05
Codakia sp.	15	5	0.2511	15	26	22.10
Cumingia tellinoidea	80	9	0.3396	12	26	20.06
Cyrenoida floridana	8	2	---	12	17.5	14.75
Laevicardium spp.	431	11	-0.1469	12	30	21.86
Lima sp.	18	8	0.2954	12	30	21.13
Mytilopsis leucophaeta	8	1	---	8	17.5	17.50
Nucula proxima	6	3	---	15	26	21.67
Parastarte triquetra	948	9	-0.1521	12	30	22.39
Pinctada radiata	180	9	0.0027	12	30	21.44
Pitar sp.	56	3	0.9721	12	24	17.00
Polymesoda sp.	77	5	-0.6589	12	24	18.10
Tellina spp.	148	10	-0.2697	12	30	21.05
Transennella spp.	2909	11	-0.1042	12	30	20.83

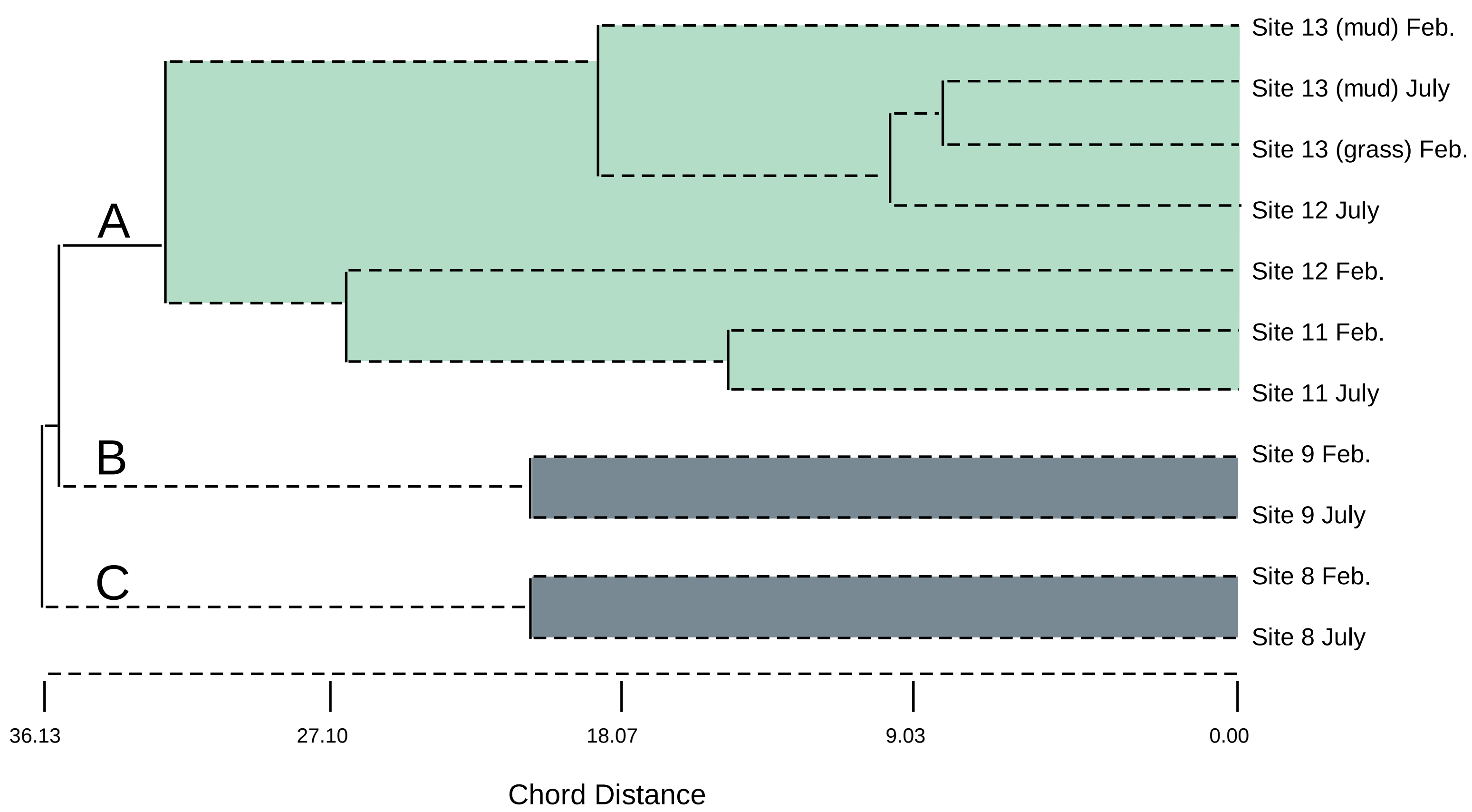

Figure 4. Q-mode cluster analysis of molluscan assemblages in 11 samples at 5 sites, using the chord distance measure.

Dinocysts

Dinocyst assemblages were examined from 18 samples at 13 sites in north-central and northeast Florida Bay. The dinocyst assemblages in the samples consist of a small number of taxa (Table 5). All samples are dominated by the various species of the genus *Spiniferites* Mantell. Individual species were not differentiated in the present study due to poor preservation and taxonomic difficulties within the genus *Spiniferites*. Members of the *Operculodinium israelianum* (Rossignol) Wall plexus are listed as *Operculodinium* and are present in relative abundances of 7-23 percent. *Polysphaeridium zoharyi* (Rossignol) Bujak et al. is consistently present and comprises 5-34 percent of the assemblages. All samples included low numbers of *Nematosphaeropsis* (probably *N. rigida* Wrenn) and most included low numbers of *Lingulodinium machaerophorum* (Deflandre & Cookson) Wall. A few specimens each of *Tectatodinium pellitum* Wall and *Tuberculodinium vancampoae* (Rossignol) Wall are present in some of the samples. Only two samples included single specimens representing members of the family Congruentidiaceae.

Of the six samples from the basin south of Little Madeira Bay, three contained higher percentages of *Polysphaeridium zoharyi* (Figure 5) and lower percentages of *Operculodinium* than samples from other areas. *P. zoharyi* tolerates a wide range of salinities from hyper to hyposaline conditions, but in modern Mississippi Sound it is associated with low and fluctuating salinities. A sample from the basin south of Little Madeira Bay (site 9, July sample) contains 33.7 percent *Polysphaeridium zoharyi*, the highest abundance in any of the samples studied, and the lowest percentage of *Spiniferites* (46.3 percent). A sample from the mouth of Little Madeira Bay (site 8, February sample) contains 23 percent *Polysphaeridium zoharyi* and 58.6 percent *Spiniferites*. The calculated cysts per gram for samples from the basin south of Little Madeira Bay range from 45-125.

The northeast basin and the Bob Allen Keys show some similarities in dinocyst distribution patterns. Eight samples from seven sites were examined from the northeastern basin of Florida Bay (Figure 5), but four of these samples (sites 1, 2, 3, and 6; all February samples) did not contain enough specimens to count. Three of the four samples in the northeast basin contain the highest percentages of *Spiniferites* seen in all samples examined for this report; these high values may be indicative of the influence from the Atlantic water. Four samples from two sites were examined from the Bob Allen Keys. *Polysphaeridium zoharyi* is present in relatively low abundances (5.6-14.4 percent) in the northeast basin and at the Bob Allen Keys sites. *Operculodinium* shows the inverse pattern; it is present in relatively high abundances (10.0-23.4 percent) for both areas. Absolute abundance of cysts for the samples from Bob Allen Keys ranges from 13-73 per gram. The calculated cysts per gram for samples from the northeast basin ranges from 10-77.

Five sets of paired samples were examined to determine the influence of season, substrate or other variables on the observed distribution patterns. February/July pairs were examined from Bob Allen Keys mudbank (site 13) and Russell Bank (site 12) to see if there were any distinctive seasonal differences. In both pairs, the February sample yielded a greater number of cysts per gram, but the relative abundances of the taxa present in each pair were quite similar. Substrate comparisons were made between two pairs of samples from the Bob Allen Keys mudbank (site 13, February samples) and from Bottle Key (site 7, February samples). No significant differences in absolute abundance between the grass and mud substrates could be detected. At Bottle Key (site 7), the mud sample had less abundant *P. zoharyi* and more abundant *Spiniferites* than the grass sample. Bob Allen Keys mudbank (site 13) grass and mud samples show remarkably similar assemblages. Two mud samples taken at the same time from Russell Bank (site 12, February samples) show some differences. The sample from the erosional side of the bank, in 2.5 feet of water contains a slightly higher absolute abundance of cysts and a higher percentage of *Operculodinium* relative to *P. zoharyi* than the sample taken from the top of the bank in 1 inch of water.

Absolute abundance of dinocysts in all the samples examined ranges from 10 to 125 cysts/g. These values are one to two orders of magnitude below those reported by Wall and others (1977) for samples from the Middle Atlantic Bight and western South Africa and are consistent with high sedimentation rates. The values are far below concentrations that would be considered indicative of “bloom” conditions.

Table 5: Percent abundance of dinocysts at monitoring sites

NOT COUNTED	Site Number	Month Collected	*Polysphaeridium zoharyi*	*Spiniferites* spp.	*Operculodinium* spp.	*Nematosphaeropsis* spp.	*Lingulodinium machaerophorum*	*Tectatodinium pellitum*	Congruentidiaceae	*Tuberculodinium vancampoae*	Cysts / gram	Total # specimens counted
	Basin South of Little Madeira Bay											
	8	Feb	23.0	58.6	8.0	1.1	5.7	3.4	0.0	0.0	45	87
	9	July	33.7	46.3	7.7	1.3	8.7	2.0	0.0	0.3	97	300
	11	Feb	13.3	66.0	10.0	2.3	4.0	4.3	0.0	0.0	79	300
	12 (top of bank)	Feb	22.1	62.3	6.6	2.5	5.7	0.8	0.0	0.0	47	122
	12 (side of bank	Feb	14.3	65.3	11.3	4.0	4.7	0.3	0.0	0.0	125	300
	12 (side of bank	July	16.4	63.3	13.0	4.0	1.1	1.1	1.1	0.0	57	177
	Bob Allen Keys											
	13 (grass)	Feb	12.7	67.6	13.7	3.9	2.0	0.0	0.0	0.0	52	102
	13 (mud)	Feb	14.4	65.8	10.8	2.7	5.4	0.0	0.9	0.0	73	111
	13 (mud)	July	10.8	59.5	23.4	2.7	1.8	1.8	0.0	0.0	19	111
	14	Feb	13.6	64.5	17.3	2.7	1.8	0.0	0.0	0.0	13	110
	Northeastern Basin											
X	1	Feb									23	
X	2	Feb									29	
X	3	Feb									23	
	4	Feb	11.1	70.4	15.7	1.9	0.0	0.9	0.0	0.0	53	108
	5	Feb	15.0	70.0	10.0	2.5	0.0	1.3	0.0	1.3	31	80
X	6	Feb									10	
	7 (grass)	Feb	12.3	57.0	19.3	5.3	4.4	1.8	0.0	0.0	77	114
	7 (mud)	Feb	5.6	69.8	20.6	2.3	1.6	0.0	0.0	0.0	73	126

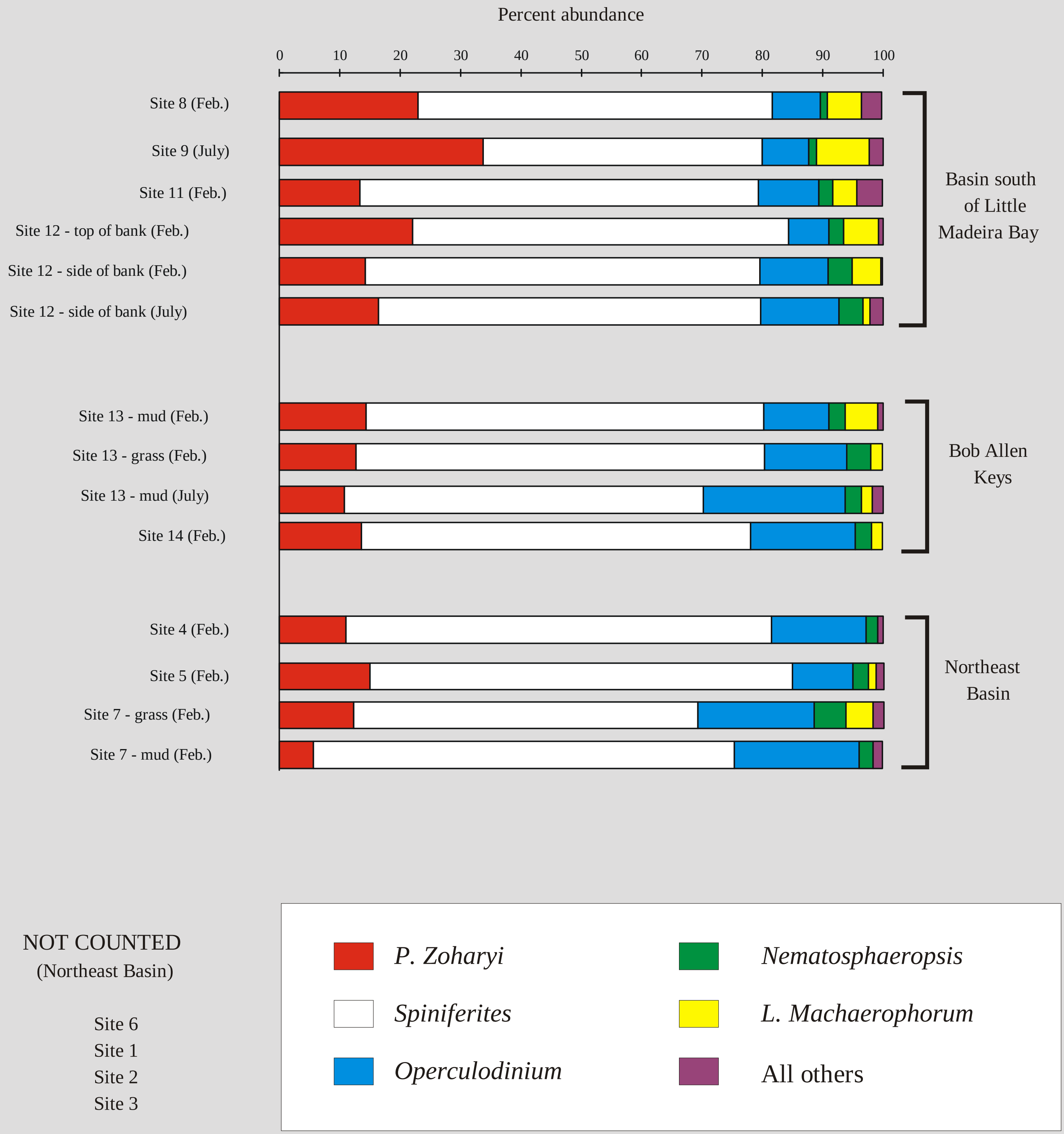

Figure 5. Dinocyst assemblages in 14 samples from 9 sites collected in Florida Bay, 1995.

Pollen

Pollen assemblages were quantified from ten samples collected from five sites in central and eastern Florida Bay during February and July, 1995 (Table 6; Figure 6). Pollen composition and abundance show little variability among these samples. The assemblages are dominated by pine (*Pinus*) pollen, which exceeds 70 percent abundance in all but one sample. Oak (*Quercus*) pollen typically ranks second in abundance (3-10 percent), but pollen of the saltwort family (Chenopodiaceae) and aster family (Asteraceae) each exceed 5 percent abundance in some samples (Table 6). Other taxa consistently present in low abundances include Australian pine (*Casuarina*), red mangrove (*Rhizophora*), black mangrove (*Avicennia*), hickory (*Carya*), wax myrtle (*Myrica*), sweet gum (*Liquidambar*), and grass (Poaceae).

The high percentages of pine pollen seen in these samples are typical of marine sediments, with the percent abundance of bisaccate pollen such as pine typically increasing with distance from shore (Heusser, L.E. and Balsam, W.L., 1977; Mudie, P.J., 1982). The lowest values for percent abundance of pine are recorded for the samples from the mouth of Little Madeira Bay (site 8, see Table 6). The percent abundance of pine and oak pollen seen in these Florida Bay samples is comparable to other assemblages from the Gulf of Mexico and the eastern shelf of Florida (Litwin and Andrle, 1992; Edwards and Willard, in press). The Florida Bay samples differ, however, in comparison of the minor elements, particularly *Rhizophora* and *Casuarina*, which are not major components of the flora in other regions.

Table 6: Percent abundance of pollen at monitoring sites

Site number	Month Collected	*Pinus* (Pine)	*Carya* (Hickory)	Taxodiaceae (Cypress)	*Quercus* (Oak)	*Casuarina* (Australian Pine)	*Schinus* (Pepper Tree)	*Rhizophora* (Red Mangrove)	*Avicennia* (Black Mangrove)	*Conocarpus* (Buttonwood)	*Celtis* (Hackberry)	*Juglans* (Walnut)	*Myrica* (Wax Myrtle)	*Ulmus* (Elm)	*Betula* (Bircy)	*Alnus* (Alder)
Basin South of Little Madeira Bay																
8	Feb	57.04	1.41	0	9.86	2.11	0	0	2.11	1.41	0	0	2.82	0	0	0
8	July	72.73	3.25	0	4.55	0	0	0	1.3	0.65	0	0	0	0	0	0
9	July	87.5	0.3	0	4.88	1.52	0	0.3	0	0	0	0	0	0	0	0
11	Feb	74.63	0.6	0	8.66	2.09	0	0.3	0.3	0	0	0	2.39	0	0	0
11	July	88.95	0.29	0	4.07	1.16	0	0	0.29	0	0	0	0.58	0.29	0	0
12	Feb	84.54	0.63	0.32	5.68	0.63	0.32	0.63	0	0	0	0	1.89	0	0	0
12	July	83.73	1.36	0.34	3.73	0.68	0	0.34	0.34	0	0	0	0.34	0.34	0	0.34
Bob Allen Keys																
13 (mud)	Feb	75.63	0	0	10.04	1.43	0	0	0	0	0.36	0.36	2.87	0	0	0
13 (mud)	July	88.36	1.03	0	3.08	0.68	0	0	0	0	0	0	0.68	0	0.34	0.34
13 (grass)	July	92.59	1.23	0	2.78	0.93	0	0	0	0	0	0	0.31	0	0	0

Table 6: Percent abundance of pollen at monitoring sites

Site number	Month Collected	*Nyssa* (Gum Tree)	*Liquidambar* (Sweet Gum)	*Magnolia* (Magnolia)	*Ilex* (Holly)	*Rhus* (Sumac)	Euphorbiaceae (Spurge family)	*Decodon* (Swamp Loosestrife)	Chenopodiaceae Amaranthaceae (Saltwort/ Pigweed	Poaceae (Grass family)	Cyperaceae (Sawgrass family)	Asteraceae (Aster family)	*Typha* (Cattail)	Fabaceae (Legume/Bean family)	Pollen Concentration (pollen/gram)	Total counted
Basin South of Little Madeira Bay																
8	Feb	0.7	0.7	0.7	0.7	0	0	1.41	11.27	0	0	4.23	0	0	387	142
8	July	0	0	0	0	0	0	0.65	2.6	3.9	0	8.44	0	0	162	154
9	July	0	0.3	0	0	0	0	0	2.13	0	0.91	0.3	0.3	0.3	451	328
11	Feb	0	0.3	0	0.3	0	0	0	3.28	0.3	0	2.09	0.9	0.3	883	335
11	July	0	0.58	0	0	0.29	0	0	0.87	0	0.87	0	0	0.29	678	344
12	Feb	0	0.32	0	0	0	0	0	0.95	0.32	0.63	0.63	0	1.26	1069	317
12	July	0	1.02	0	0	0	0.34	0	2.03	0	0.68	2.03	0.34	1.02	462	295
Bob Allen Keys																
13 (mud)	Feb	0	0	0	0	0	0	0	1.79	0	0.72	0.36	0.36	1.44	648	279
13 (mud)	July	0	0.34	0	0	0	0	0	0.68	0.34	0.34	1.03	0.34	0.34	916	292
13 (grass)	July	0	0	0	0	0	0	0.31	0.62	0	0	0.31	0	0	781	324

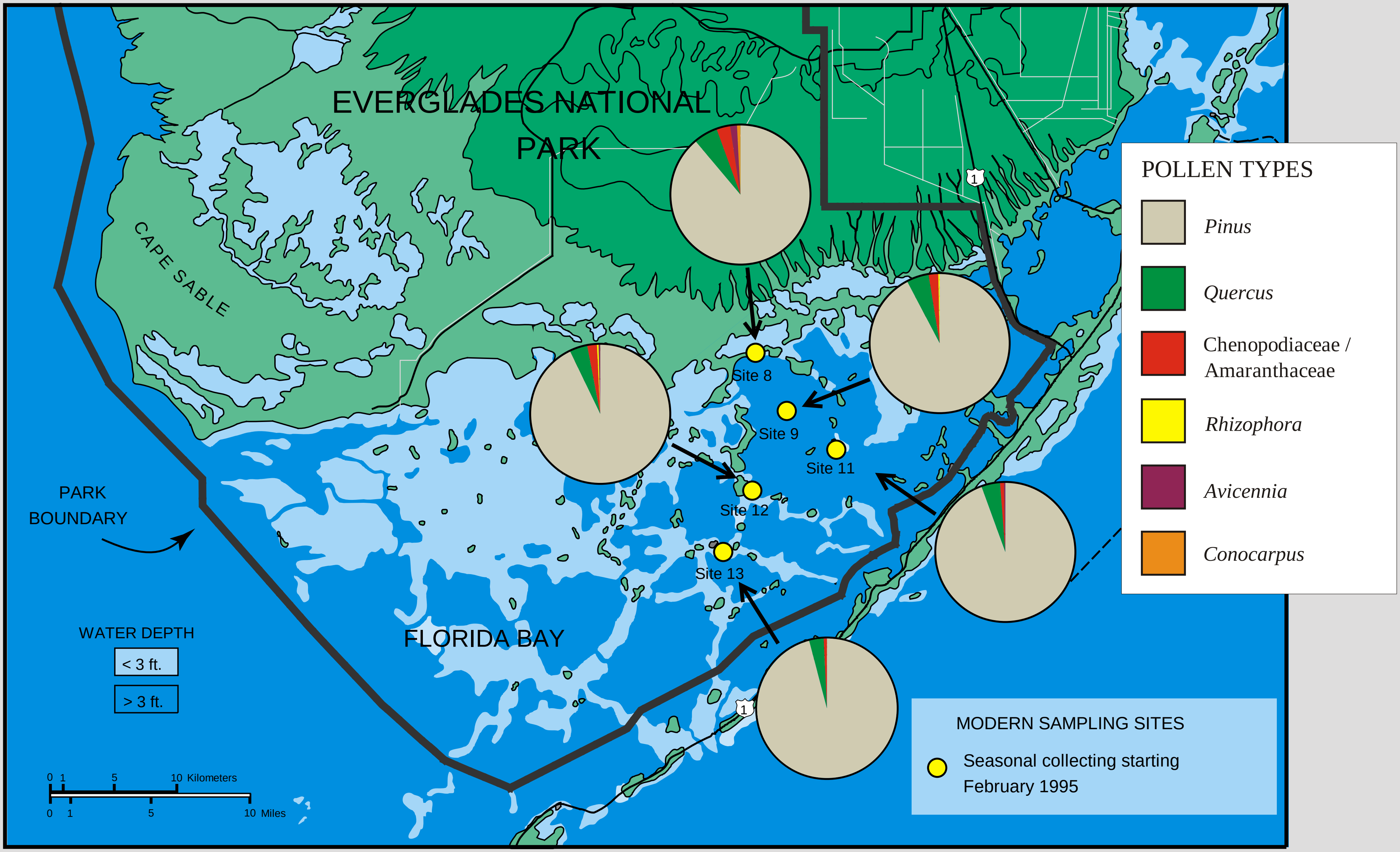

Figure 6. Distribution of selected pollen at 1995 sampling sites in Florida Bay.

SUMMARY

This analysis of selected sites in north-central and north-eastern Florida Bay is a first step in building a database for analysis of down-core data. These data indicate the changes in substrate and salinity conditions and the associated fauna and flora over a one-year period. Indicator species for low salinity conditions, seagrass beds, and other parameters of the environment have been identified for use in down-core analysis. Additional information will be gathered as we continue to study and monitor selected sites in Florida Bay. One concern in analysis of the down-core data is to understand the degree to which seasonality contributes to fluctuations in the fauna and flora. Although seasonality cannot be isolated as a single parameter, it would appear from this analysis that seasonality is not a factor in down-core variability. No seasonality could be detected for the 1995 sample sets, but this effect will continue to be monitored at these sites for a period of at least two more years. Only by continued monitoring of the living fauna and flora of Florida Bay can we begin to understand the geographic and temporal scale of the variations seen in the south Florida ecosystem over time.

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